NEW ZEALAND TREE-RING SITE REPORT 37

Tree-ring analysis of sub-fossil kauri (*Agathis australis*) timbers from Trappitt Farm, Babylon Coast Road, Dargaville, Northland

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This is a technical archive report describing crossdating and chronology development of tree-ring samples from Trappitt Farm, Korariwhero Flat, Babylon Coast Road, Dargaville. Please note that although the tree-ring dates presented here will not change, it is possible that interpretation of the results may change as new evidence comes to light.

Summary

Collection of sub-fossil kauri samples from the Northland region was undertaken for a FRST funded project '*Subfossil kauri collection and analyses*' (UOAX0901) to improve the quality of multi-centennial and multi-millennial tree ring data sets that can be used for palaeoclimate analyses. The intent was to add new data to the existing records and potentially, to extend the current temporal span of the calendar dated late-Holocene kauri chronology and/or develop new floating records for time periods not currently covered.

Fifteen samples were collected from kauri logs recovered from Korariwhero Flat, on the Trappitt Farm (TRPT), near Dargaville and analysed using dendrochronological techniques. There were three significant outcomes from the analysis.

1) Series from seven samples were dated to between 1700 BC and 100 BC. These provide a modest contribution to the late-Holocene kauri data set. For sections across this time period, sample depth in a composite master chronology would increase by one tree, and occasionally up to three trees.

2) Crossmatching was identified between one TRPT chronology, TRPT01, and two floating sequences from two other sub-fossil assemblages, CHIT (CHI006i) and HALH (HAL008). Careful review of the CHI006 sequence resulted in revision of the series and identification of an overlap with the calendar dated late-Holocene kauri chronology, dating the sequence at ~2369 to 1461 BC. This indicates that TRPT01 dates to ~2472 – 2157 BC and HAL008 to ~2486 to 1979 BC. However, further data are required to confirm the reliability of CHI006 across a ~250 year unreplicated section (between 1978 – 1724 BC) before calendar dates can be securely assigned to the sequences.

3) A decadal wood sample from the outer rings of TRP009a was radiocarbon dated to 4046±34 BP (WK32803; 2621- 2349 cal BC). The radiocarbon date indicates that this series may date to a period earlier than TRP01 and for which we currently have no other ring width data.

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Introduction

Long, high-resolution palaeoclimate records from New Zealand, as well as elsewhere in the Southern Hemisphere, are required to assist interpretation of changes in past climate. Since the 1980s, but particularly in the last twelve years, multi-centennial and multi-millennial length tree ring records have been developed from modern, archaeological[1] and, predominantly, sub-fossil (swamp) kauri, the latter dating the late-Holocene (e.g. Boswijk *et al* 2006) and from before the last Glacial Maximum (Palmer *et al* 2006). The climate signal within these records is being investigated to understand, for example, variability of the El Niño-Southern Oscillation during the last millennium (e.g. Fowler *et al* 2008) whilst the late-Holocene record is also being employed in calibration of the radiocarbon timescale for the Southern Hemisphere (Hogg *et al* 2011). Radiocarbon analyses are also used to generate high resolution climate data using carbon isotopes. The multi-centennial and multi-millennial kauri records from the Holocene and last Glacial period provide a unique opportunity to reconstruct annual climate change under a range of different boundary conditions; however, often sample depth in the chronologies is low (<10 samples) which may affect reliability of reconstructions derived from tree-ring data. Therefore, additional material is required to improve the quality of the tree ring records. In addition, the analysis of new material may result in an extension of the temporal span of current records, or the development of new records for time periods not currently covered.

In 2008, a two-year FRST funded project – *Sub-fossil Kauri Collection and Analyses* (SFK) – was established at the University of Auckland (UOAX0901) to improve regional and local paleoclimate data derived from sub-fossil kauri (*Agathis australis*) tree rings for periods in the last 130,000 years before present (BP). The project encompasses collection, analyses and archiving of sub-fossil kauri, high-resolution radiocarbon analyses of dendrochronologically matched (but not calendar-dated) wood contemporary with the Younger Dryas cooling event (13.0 – 10.5 ka cal BP), and awareness raising amongst local communities so that the scientific value of the sub-fossil kauri is recognised.

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[1] The term 'archaeological' is used to distinguish timbers derived from standing structures and in-ground sites from modern (living tree) or sub-fossil kauri.

This technical report describes the collection of sub-fossil kauri from one site, Trappitt Farm (TRPT), and details chronology development and the dendrochronological dating of material. Other significant outcomes are highlighted. The intent is to provide an archive document covering details not necessarily included in higher level academic publications, and which can also be used to convey information concerning the swamp kauri to relevant stakeholders, including the landowners, sawmillers and the Kauri Museum, Matakohe which acts as a repository for swamp kauri.

Trappitt Farm

Fifteen samples were collected from logs excavated from Trappitt farm, situated ~9km WNW of Dargaville and to the north of the North Kaipara Peninsula (Figure 1; NZMS260-PO7 817868; Lat 35° 55' Long 173° 47'; elevation 16 m above sea level). The site is accessed off Babylon Coast Road and is located towards the upper reaches of the Korariwhero Flat that drains eastwards into the Kaihu River. Other sub-fossil kauri assemblages, such as the Yakas (YAKK) group (Boswijk and Palmer, 2004) have been collected from different farms within the same drainage system. Comparison of the site locations suggests that TRPT and YAKK are quite close to each other.

The site is in a region that is characterised by low hills of Red Hill and Tangikiki Sand and Te Kopuru Sand, interspersed with east-west orientated valleys of Parore Peat and Kaipara peaty clay (see Sutherland *et al* 1980 and discussion by D'Costa *et al* 2009). Palaeoenvironmental research by D'Costa *et al* 2009 indicates that around 6000 years BP the Korariwhero Flat transitioned from a marine influenced system to freshwater swamp forest. Pollen analysis indicates kauri has been present in the wider Dargaville region for several thousand years, whilst dendrochronological analysis indicates presence of kauri at Korariwhero Flat from ~3600 years BP. No specific context or environmental information, such as the location and orientation of logs or depth and composition of the peat, is available for the TRPT assemblage, but the distribution of root plates across the nearby YAKK site indicates that kauri grew on the swamp surface (D'Costa *et al* 2009). Since human settlement the vegetation cover has undergone considerable change, particularly since European settlement in the 19th century with land clearance and the development of pastoral farming and plantation forestry.

Figure 1: Location of TRPT site. (A) The town of Dargaville is located in Northland, north of Auckland City. (B) Trappitt Farm is ~9km west-north-west of Dargaville. (C) shows the approximate location of the swamp (white circle) where trees were recovered (35° 55' S 173° 47' E). State Highway 12 and the junction with Babylon Coast Road are visible in the top right corner. Images: Google Earth, 2011.

Dendrochronology

Dendrochronology or tree-ring analysis is based on the measurement and comparison of patterns of tree growth. The principles and methodology of tree-ring analysis are described in Baillie (1982), albeit with reference to analysis of Northern Hemisphere oak timbers, and more recently by Speer (2010). In brief, each year during the growing season trees lay down a single growth ring, formed in the cambium directly under the bark. In many species, including kauri, these annual rings are clearly defined by a boundary formed at the end of the growing season, which separates one growth season from the next. The width of the annual ring is limited by climatic conditions as well as being influenced by local environmental factors, previous growth years and genetic make-up of the tree. Because growth conditions change from year to year, ringwidth also varies creating a pattern of wide and narrow rings which is unique in time but common to trees that have grown at the same time under similar conditions. Therefore it is possible to compare the growth patterns of different trees and identify those which are contemporary. Starting with living trees where the calendar date of the outermost ring is known and overlapping series from successively older trees, timbers and/or natural deposits of preserved wood, long absolutely dated tree-ring chronologies can be built. Tree-ring series of unknown age can be compared to these and accurate calendar dates obtained. Comparison of many different living kauri from several sites throughout the upper North Island indicate that these trees have a common signal in their rings (Fowler *et al,* 2004) and the suitability of this species for dendrochronology and dendroclimatology is well established.

Methods

Fifteen samples were obtained from logs recovered from Trappitt Farm (TRPT) by Nelson Parker, owner of 'Nelson's Kaihu Kauri', a sawmill specialising in swamp kauri. A set of three samples (here labelled TRP013, TRP014 and TRP015) were obtained initially from Nelson Parker. One radiocarbon date was obtained for TRP014 (WK25246; 2221 ± 33BP). This was the expected age range for wood from the site given the location and elevation, and earlier dating of other samples from the site; the YAKK set are all late-Holocene. At the time measured series for these three samples did not crossmatch to the late Holocene kauri master, most likely because of ring issues.

Further logs were excavated from the site and removed to Nelson Parker's sawmill, where they were viewed for dendrochronological sampling. Twelve samples (TRP001 – TRP012) were collected in summer 2009-10. The samples were transported to the Kauri Museum, Matakohe for storage and, whilst there, were further reduced in size. In most cases, two radial strips were cut from each biscuit but in some cases, the size of the sample must have precluded this as only one radial strip per section was present in the assemblage that was subsequently delivered to the Tree-Ring Laboratory at the School of Environment, The University of Auckland. Unfortunately no details were available regarding dimensions of the cross-sections or unusual or notable features, and photographs were not taken prior to the samples being reduced to radial strips. All off-cuts are stored at the Kauri Museum, Matakohe.

Once at the Tree-Ring Laboratory, the samples were further trimmed to a size[2] suitable to fit on a travelling stage beneath a binocular microscope and the cross-sectional surface was sanded to a fine polish so that the ring sequence could be clearly seen. Each sample was assessed for suitability for analysis prior to measurement of the growth rings, based on clarity of the ring pattern, presence or absence of significant suppression or wedging rings, and having sufficient rings for crossmatching. The latter was not a significant issue, as most samples clearly had sufficient rings for analysis. Total ring width was measured using a set-up comprised of a travelling stage fitted with a linear encoder linked to a computer, and a binocular microscope. Ring widths were recorded in Dendro Input, which is part of the Dendro for Windows (DfW) suite (Tyers, 2004). Four samples were broken (TRP001, TRP007, TRP010, TRP015) and were measured in two sections, denoted by a suffix 'aa' and 'ab'.

Radii from the same tree were measured, and the series crossmatched and then averaged to produce a tree-sequence. As measurement of each sample was completed, series (e.g TRP003a) and tree-sequences (e.g TRP005) were compared against each other to identify those that crossmatched. Series and tree-sequences were also compared individually to an unpublished composite kauri master chronology, AGAUc07c_raw, constructed from data derived from modern trees, archaeological wood, and sub-fossil (swamp) kauri, to obtain calendar dates. The computer programs CROS (Baillie and Pilcher, 1973) and Cross84 (Munro, 1984), included in the Dendro for Window (DfW) suite (Tyers, 2004) were used to assist crossmatching. These programs compare pairs of samples and calculate the correlation co-efficient (r) for every position of overlap. Students *t* is calculated to provide a measure of the probability of the r value

[2] In most cases, the width of the radial strip was reduced by about half. This produced a duplicate sample that can be used for other research purposes.

arising by chance, with a t-value of 3.5 or greater usually indicative of a match (Baillie, 1982). All *t* and r values reported here are from CROS.

All suggested matches (between series, tree sequences and against master chronologies) were checked using line plots of the series overlaid on a light-table. Visual inspection of line plots is an important part of the crossmatching process. Kauri can produce false rings (the annual ring is divided by an apparent boundary) and can also have locally absent rings, where the annual ring is not complete around the entire circumference of the tree. Overlaying line plots enables identification of sections that are in sequence and then which go out of sync. This guides inspection of the sample to locate the problem. False rings can be determined by close inspection of the apparent boundary across the width of the sample and comparison of the same ring on different samples. Observation of many kauri growth rings indicates that the false boundaries are diffuse and usually fade out further along the ring. Locally absent rings are identified when a ring is absent from one radius but present on other same-tree samples, and on other samples from different trees. Usually inspection of the sample can locate the ring merging into the boundary with the previous year's growth. This allows for a measured value to be inserted into the series. If a ring is wholly absent from a radius a 'zero' value is inserted. If the location of missing rings cannot be reliably resolved, the series is truncated to cover only the reliable section of tree growth.

All TRPT series and tree-sequences that crossmatched were averaged together to form a site chronology, which reduces noise and enhances the common signal on which crossdating is dependant. Where calendar dates were identified by comparison to the late-Holocene kauri master, the position of match was checked against all independent site chronologies to verify through replication of results that the dating was correct. In the event that no matches were identified to other series/sequences from TRPT or to the kauri master, the series/sequences were also compared to undated series/sequences from other site assemblages.

Occasionally, crossmatching may identify tree-ring series (not from the same biscuit) that are very similar, indicated by high *t* scores and r values between series, and supported by similar characteristics of the wood samples, such as colour of wood, form of the rings, and events such as suppression episodes. This may indicate that although the samples were cut from different logs, the logs were actually derived from a single parent tree ('same-tree'). As part of the excavation process, kauri trunks are cut into separate logs enabling them to be transported to the mill on a truck. The logs are then usually stacked in piles. Therefore, there is potential for a sub-fossil kauri assemblage to contain (unrecognised) duplicate samples. In cases where possible 'same-tree' material is identified, the ring width series are averaged together to produce a single tree-sequence for use in chronology development to avoid introducing bias into the site curve (English Heritage, 2004).

Preservation conditions will affect the completeness of a ring sequence from a sub-fossil kauri. If the tree trunk was completely buried in an anaerobic environment, the wood and bark will be well preserved and it may be possible to obtain a reliable indication of tree age and to determine the year of tree death. If a trunk is partially exposed for some time before burial (or after re-exposure), the wood will start to decay and the outside, and sometimes inner, rings will be lost. In this case, only a minimum estimate of the life span of a tree can be determined.

Results

Details of all samples collected from Trappitt Farm, including series length, average growth rate, calendar dates and other comments are presented in Table 1. Almost all samples were measured, with the exception of one radii for TRP014 which had very narrow (and difficult) rings.

Series length of the measured assemblage ranged from 167 rings (TRP013) to ~ 831 rings (TRP014; the series length of this sample may be longer as it has a suppression episode and the series was measured in two sections.) The average series length was 359 rings. Several samples had additional rings at the inner or outer end that could not be measured or were truncated from the series during the crossmatching process due to concerns about reliability of the ring width pattern.

Site Chronologies

Three site chronologies were produced as a result of intra-site comparison of samples. These are TRPT01, TRPT02 and TRPT03. Ring width listings for these chronologies are presented in Appendix 1.

1) TRPT01

TRPT01 is comprised of four series (TRP001aa, TRP004a, TRP006a and TRP007ab) (Figure 2; Table 2) and spans 361 years. There are some similarities between the actual samples and between the ring width series, including ring issues in the same decades, which raise the possibility that some of the samples might be from the same parent tree.

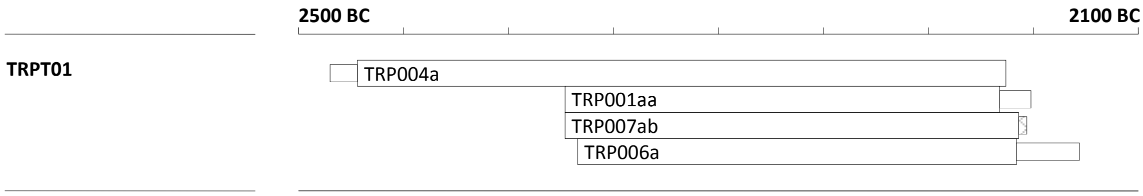

Figure 2: Crossmatched position of series included in TRPT01.

During the crossmatching process, TRPT01 was tested against other TRPT series/sequences and to the late-Holocene kauri master but no matches were identified. TRPT01 was also compared to undated series from other site assemblages, including CHIT (Chitty Farm) and HALH (Hal Harding Farm). Previously, a match had been identified between two floating series from these sites: HAL008 and CHI006i (see Boswijk and Palmer, 2012 for details). The latter sample had been radiocarbon dated to 3933 ± 39 BP (WK15530; 2468-2209 cal BC). The entirety of TRPT01 matched to HAL008 and a partial overlap with CHI006i was identified. This provided replication for 316 years of HAL008, including a section not spanned by CHI006, and 200 years of CHI006i. The location of the three sites is shown in Figure 3.

Figure 3: Location of TRPT, CHIT and HALH, near Dargaville.

The identification of a match between series from three separate sites prompted a careful review of the CHI006 series. When the CHIT site assemblage was analysed in 2004, a 489- year tree-sequence only for CHI006 was constructed (CHI006i) although the measured ring width series extended for >1000 years. This was due to problems reconciling the outer sections of series (see Boswijk, 2005a). A radiocarbon date obtained from the sample indicated that it should overlap with the start of the late-Holocene kauri chronology but this was not pursued at the time due to lack of additional material that could assist in confirming that the CHI006 ring pattern was correct or aid resolution of any ring issues. Subsequent to identification of links with TRPT01 internal matching between the CHI006 radii was carefully reviewed. The CHI006 radii were also checked across the periods of common overlap against HAL008 and TRPT01, and all wood samples were carefully inspected in the locations where locally absent rings were identified. A new tree-sequence for CHI006 was made and crosschecked with HAL008, TRPT01 (Table 3) and the late Holocene kauri chronology. A 264-year overlap between CHI006 and AGAUc07_raw was identified (t = 6.74, r = 0.39), indicating a possible calendar date span for CHI006 of 2367 BC to 1461 BC (Figure 4).

The linkage raises the prospect of a ~650 year extension to the late Holocene kauri chronology; however, sample depth in the master chronology in the period from 1700 to 1400 BC is low. The potential match needs further replication to be confident in fixing the end date of CHI006. Unfortunately, crossdating between CHI006 and TRP005, which dates to 1692 to 1348 BC (see below) is weak (t =3.84. r =0.25). Additionally, a ~250 year section of CHI006 is not replicated. More material is required that overlaps with HAL008 and CHI006, and with the late-Holocene kauri chronology to confirm that there are no missing rings in the unreplicated section before the calendar dating of these series and tree-sequences can be accepted.

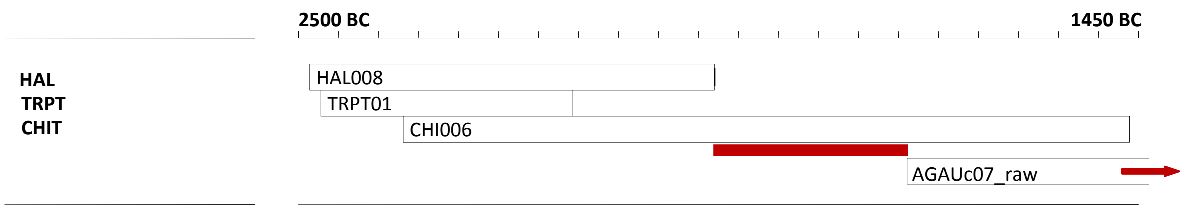

Figure 4: Crossmatched position of HAL008, TRPT01 and CHI006. The end section of AGAUc07_raw is also shown, with the arrow indicating that the record extends into the present (ends AD 2002). The calendar dates are indicative only as further replication is required (solid bar indicates unreplicated section) before the series can be anchored and the late-Holocene chronology extended.

2) TRPT02

TRPT02 is comprised of two series (TRP003a, TRP011a) and one tree-sequence (TRP010) (Figure 5; Table 4) and spans 360 years. The chronology was crossdated to the late-Holocene kauri master at 1192 to 833 BC (Table 5).

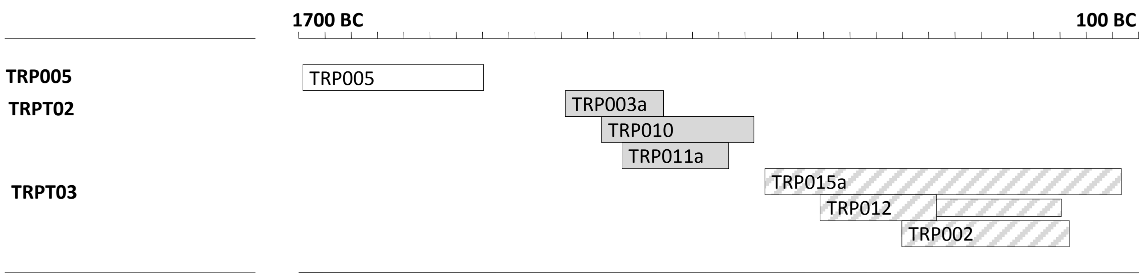

Figure 5: Crossdated position of calendar dated TRPT series/sequences. Solid shading indicates series and tree-sequences in TRPT02. Striped shading indicates series and tree sequences included in TRPT03.

3) TRPT03

This chronology is comprised of one series (TRP015a) and two tree sequences (TRP002, TRP012) and spans 680 years (Figure 5; Table 4). These samples had ring issues. Only the inner 223 years of TRP012a and TRP012b could be securely matched to each other due to the outer sections of both radii having multiple locally absent rings and lensing rings, and on TRP012b, two cases of possible false rings or faint ring boundaries. Therefore TRP012 is a truncated sequence. TRP015a had a suppression episode, coinciding with a break in the wood. The series was measured in two sections and careful checking was required across the break, to ensure the ring pattern between the end of TRP015aa and start of TRP015ab was correctly aligned.

TRPT03 was crossdated against AGAUc07_raw at 812 to 133 BC (Table 5). There is only a 21 year gap between the end of TRPT02 and start of TRPT03.

Other series

Only one other series from the assemblage was dated: TRP005, at 1692 to 1348 BC (Figure 5; Table 5; Appendix 1). This is a period of low sample depth in the late-Holocene record, decreasing rapidly from ten sequences at 1350 BC to one sequence by 1724 BC, but statistical and visual comparison to independent site chronologies and tree-sequences provides confidence in the match. Therefore TRP005 is a useful addition to increasing replication in this time period.

Unmatched series

Series from four samples remain unmatched. These are TRP008, TRP009, TRP013 and TRP014. This may be because of unresolved locally absent rings that prevent matching, or may be because the samples are from time periods for which we currently have no other data. The latter appears to be the case for TRP009. Radiocarbon dating of ten rings from the outer section of the sample (rings 373 – 382) returned a date of 4046±34 BP (WK32803; 2621-2349 cal BC[3]). The calibrated range overlaps with the older end of TRPT01 but no crossmatching was identified between these series. Therefore it is probable that this series is earlier than TRPT01.

Discussion and Conclusion

Analysis of the swamp kauri assemblage from TRPT has been successful in producing new data for the period between ~2500 BC and 100 BC. The pattern of samples clustering into separate groups which date across a wide time period is similar to outcomes from other swamp kauri assemblages from the region. For example, the CHIT assemblage produced two site chronologies dating to 477 BC – AD 842 and 1257 BC – 676 BC respectively, as well as a single calendar-dated series (CHI008), and floating sequences radiocarbon dated to before >1724 BC (see Boswijk 2005a for details).

The TRPT assemblage was also similar to other assemblages from the region in that most samples had 'difficult' rings. This encompasses suppression episodes where the rings become very narrow and which usually coincide with locally absent rings, lensing rings, overlapping rings (associated with lensing and locally absent rings) and false rings. Without secure context information for this assemblage, we can only speculate that the ring issues reflect growth on, or adjacent to, wet and/or unstable ground. It is possible that unrecognised ring issues may account for series from three trees not being crossdated. Alternatively, they could date to time periods for which we currently have no other data, as is the case for TRP009.

The purpose of sampling kauri from swamps in the Northland region is to improve the quality of multi-centennial and multi-millennial tree ring data sets that can be used for palaeoclimate

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[3] The calibrated BC date was calculated using OxCal 4.1 (Bronk Ramsey 2009) online against the SHCal04 southern hemisphere atmospheric curve (McCormac et al 2004).

analyses by adding new data to the existing records. Additionally, new material may result in the extension of the current temporal span of the calendar dated or floating records, or development of new records for time periods not currently covered. The collection and analyses of the TRPT material has contributed the following to achieving these aims:

1) Seven samples were dated to between 1700 BC and 100BC. These provide a modest contribution to the late Holocene kauri data set. For sections across this time period, sample depth (trees) in a master chronology would increase by one tree, and occasionally up to three trees.

2) Crossmatching was identified between TRPT01 and two floating sequences from the CHIT and HALH assemblages. Revision of the CHI006 sequence resulted in identification of an overlap with the late-Holocene chronology, potentially dating the sequence to ~2369 – 1461 BC. This indicates that TRPT01 dates to ~2472 – 2157 BC and HAL008 to ~2486 to 1979 BC. Further data are required to confirm the reliability of CHI006 especially across a ~250 year unreplicated section (between ~1978 BC and 1724 BC) before calendar dates can be securely assigned to the all of these series and sequences.

3) The radiocarbon date for TRP009 indicates that this series is probably earlier than TRPT01. Therefore, we have at least one floating series from TRPT for a time period not previously covered.

It is of note that TRPT is from the same swamp system as the YAKK assemblage. The analysis of the TRPT samples indicates presence of kauri on, or near Koraiwhero Flat, from at least the mid-2000s BC until the late 1200s AD (Figure 6). Although the tree ring record is not continuous, and series do not always capture the entirety of a trees' lifespan, the implication is of continual presence of kauri in the locality over ~4000 years (certainly from 1700 BC until the late AD 1200s) and an on-going process of tree preservation in the swamp system during this time.

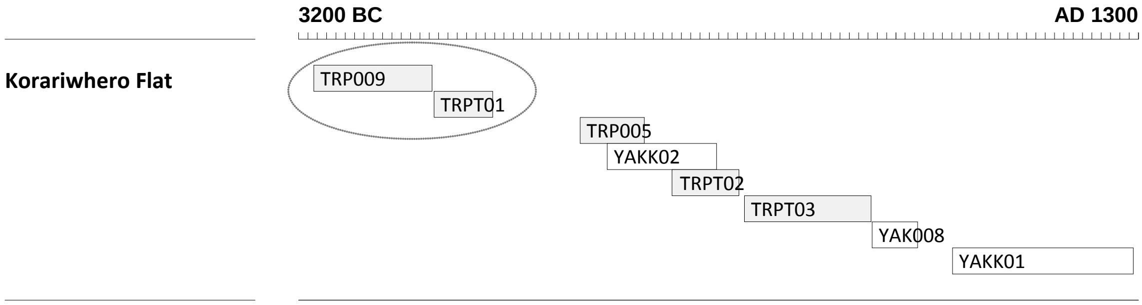

Figure 6: Position of floating (dotted oval) and calendar dated site chronologies and tree sequences from TRPT (shaded bars) and YAKK. Wide bars represent measured span of the site chronologies or sequences, narrow bars are unmeasured rings.

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References

Baillie, M.G.L. (1982) *Tree-ring dating and Archaeology*. The University of Chicago Press, Chicago.

Baillie, M.G.L. and Pilcher, J.R. (1973) A simple crossdating program for tree ring research. *Tree-ring Bulletin* 33: 7-14

Boswijk, G. (2005a) Tree-ring analysis of sub-fossil kauri (*Agathis australis*) from the Chitty's Farm, Colville Road, Dargaville, Northland. *School of Geography and Environmental Science Working Paper* 27. Auckland: University of Auckland. 24 pp

Boswijk, G. (2005b) Tree-ring analysis of sub-fossil kauri (*Agathis australis*) from the Harding's Farm, Hilliam Road, near Dargaville, Northland. *School of Geography and Environmental Science Working Paper* 26. Auckland: University of Auckland, 27 pp.

Boswijk, G. (2005c) Tree-ring analysis of sub-fossil kauri (*Agathis australis*) from near Maitahi Road, Dargaville, Northland. *School of Geography and Environmental Science Working Paper* 28. Auckland: University of Auckland, 18 pp.

Boswijk, G., Fowler, A., Lorrey, A., Palmer, J and Ogden, J. (2006) Extension of the New Zealand kauri (*Agathis australis*) chronology to 1724 BC. *The Holocene* 16 (2): 188 – 199

Boswijk, G., and Palmer, J.G., (2003) Tree-ring analysis of sub-fossil kauri (*Agathis australis*) from near Lake Whangape, Huntly West, Waikato. *Department of Geography Working Paper* 19. Auckland: University of Auckland. 31pp.

Boswijk, G. and Palmer, J. (2004) Tree-ring analysis of sub-fossil kauri (*Agathis australis*) from Yakas' Farm, Babylon Coast Road, near Dargaville, Northland. *School of Geography and Environmental Science Working Paper* 22. Auckland: University of Auckland. 17 pp.

Boswijk, G. and Palmer, J. (2012) Tree-ring analysis of sub-fossil kauri (*Agathis australis*) from Hal Hardings Farm, near Dargaville, Northland. *School of Environmental Science Working Paper 44*. Auckland: University of Auckland. 29 pp.

Bronk Ramsey, C. (2009) Bayesian analysis of radiocarbon dates. *Radiocarbon* 51 (1): 337-360.

D'Costa, D., Boswijk, G., Ogden, J. (2009) Holocene vegetation and environmental reconstructions from swamp deposits in the Dargaville region of the North Island, New Zealand: implications for the history of kauri (*Agathis australis*) *The Holocene* 19: 559- 574

English Heritage (2004) *Dendrochronology: Guidelines on producing and interpreting dendrochronological dates*. English Heritage Publications.

Fowler, A., Boswijk, G. & Bridge, M. (2001) Tree-ring analysis of sub-fossil kauri (*Agathis australis*) from Pukekapia Road, Waikato. *Department of Geography Working Paper 16*. Auckland: University of Auckland. 25 pp.

Fowler, A., Boswijk, G., and Ogden, J. (2004) Tree-ring studies on *Agathis australis* (kauri): a synthesis of development work on late Holocene chronologies. *Tree-ring Research* 60 (1*)*: 15-29

Fowler, A.M., Boswijk, G., Gergis, J., Lorrey, A. (2008) ENSO history recorded in *Agathis australis* (kauri) tree rings. Part A: kauri's potential as an ENSO proxy.' *International Journal of Climatology 28*: 1-20

Hogg, A., Palmer, J., Boswijk, G., & Turney, C. (2011). High-precision radiocarbon measurements of tree-ring dated wood from New Zealand: 195 BC - AD 995. *Radiocarbon* 53(3): 529-542.

McCormac, F. G., Hogg, A.G., Blackwell, P.G., Buck, C.E., Higham, T.F.G., Reimer, P.J. 2004: SHCal04 Southern Hemisphere Calibration, 0 – 11.0 cal KYR BP. *Radiocarbon* 46 (3): 1087 – 1092.

Munro, M.A.R. (1984) An improved algorithm for crossdating tree-ring series. *Tree-ring Bulletin* 44: 17-27

Palmer, J., Lorrey, A., Turney, C.S.M., Hogg, A., Baillie, M., Fifield, K., and Ogden, J. (2006) Extension of New Zealand kauri (*Agathis australis*) tree-ring chronologies into Oxygen Isotope Stage (OIS) 3. *Journal of Quaternary Science* 21 (7): 779 – 787

Speers, J.H (2012) *Fundamentals of Tree-Ring Research.* University of Arizona Press, Tucson.

Sutherland, C.F., Cox, J.E., Taylor, N.H. and Wright, A.C.S. (1980a) *Soil map of Mangakahia-Dargaville area (sheet P 06/07), North Island, New Zealand.* Soil Bureau, Department of Scientific and Industrial Research.

Tyers, I.G. (2004) Dendro for Windows Program Guide 3rd edition. *ARCUS Report 500b.* Sheffield.

Table 1: Details of all samples collected from TRPT

Sample = wood; Radii = measured series; Dimensions = length of sample only; Rings = measured, +n indicates unmeasured or excluded heartwood (h) or sapwood (s) rings; Bark = terminal ring at waney edge present (+B), or spring/summer if ½Bs; AGR = Average growth rate (mm) per annum; Date Span = calendar years (BC/AD), calendar dates in "" are indicative only, or relative if undated; Comments = additional details about the sample.

Sample	Radii	Dimensions	No. of Rings	Bark Edge	Average Growth Rate (mm p.a.)	Dated Span	Comments
TRP001a			***h244*+208**		**1.76**	**"2373 BC-2166 BC"**	**Outer section only**
	TRP001aa	381 x 0	208+*15h*		1.76	"2373 BC-2166 BC"	Outer section
	TRP001bb	442 x 0	244		1.69	1-244	Inner section; undated
TRP002	**TRP002**		**320**		**1.80**	**551 BC-232 BC**	
	TRP002a	560 x 0	291		1.66	527 BC-237 BC	
	TRP002b	666 x 0	320		1.90	551 BC-232 BC	
TRP003a	**TRP003a**	**630 x 0**	**188**	**+½Bs**	**2.69**	**1192 BC-1005 BC**	
TRP004a	**TRP004a**	**882 x 0**	***13h*+310**	**-**	**2.38**	**"2472 BC-2163 BC"**	
TRP005			**345**	**+½Bs**	**1.74**	**1692 BC-1348 BC**	
	TRP005a	575 x 0	345	+½Bs	1.64	1692 BC-1348 BC	
	TRP005b	565 x 0	220+*2h*		2.05	1626 BC-1407 BC	
TRP006a	**TRP006a**	**357 x 0**	**210*+30h***		**1.59**	**"2367 BC-2158 BC"**	
TRP007a			***h172*+217**	**+4s+B**	**1.17**	**"2373 BC-2157 BC"**	**Outer section only**
	TRP007aa	210 x 0	172		1.17	1-172	Inner section; undated
	TRP007ab	278 x 0	217	+4s+B	1.17	"2373 BC-2157 BC"	Outer section
TRP008a	**TRP008a**	**370 x 0**	**552**		**0.64**	**1-552**	
TRP009	**TRP009**		**634**		**1.33**	**1-634**	**Radiocarbon date from rings 373 – 382**
	TRP009a	730 x 0	423+*165h*		1.46	1-423	**of TRP009a: WK32802; 4046±34.**
	TRP009b	785 x 0	520+*10h*		1.48	115-634	
TRP010	**TRP010**		**291**		**2.29**	**1123 BC-833 BC**	
	TRP010aa	630 x 0	120		1.67	1123 BC-1004 BC	Inner section
	TRP010ab	630 x 0	138		2.63	972 BC-835 BC	Outer section
	TRP010b	735 x 0	283		2.49	1115 BC-833 BC	
TRP011a	**TRP011a**	**550 x 0**	**204**		**1.62**	**1084 BC-881 BC**	
TRP012			**223*+238h***		**1.12**	**707 BC-485 BC**	
	TRP012a	510 x 0	162+*238h*		1.19	646 BC-485 BC	
	TRP012b	515 x 0	223+*205h*		1.11	707 BC-485 BC	
TRP013a	**TRP013a**	**555 x 0**	**167**		**3.24**	**1-167**	**Original label: TP1**
TRP014a		**705 x 0**	**~831**				**Original label: TP2; split into two**

						sections because of suppression band.
	TRP014aa		619	0.55	1-619	Inner section
	TRP014ab		212	0.66	1-212	Outer section
TRP015a	**TRP015a**	**880 x 0**	**680**	**1.26**	**812 BC-133 BC**	**Original label: TP3**
	TRP015aa		198	1.08	812 BC-615 BC	Inner section
	TRP015ab		517	1.26	649 BC-133 BC	Outer section

Table 2: Crossmatching between TRPT01 series

t-value /r value; * = empty triangle; calendar dates are indicative only.

Filenames	*start dates*	*dates end*	**TRP001aa** *"2373 BC 2166 BC"*	**TRP004a** *"2472 BC 2163 BC"*	**TRP006a** *"2367 BC 2158 BC"*	**TRP007ab** *"2373 BC 2157 BC"*
TRP001aa	*"2373 BC*	*2166 BC"*	*	6.57/0.42	4.37/0.30	8.52/0.51
TRP004a	*"2472 BC*	*2163 BC"*	*	*	7.42/0.47	6.80/0.43
TRP006a	*"2367 BC*	*2158 BC"*	*	*	*	8.10/0.49
TRP007ab	*"2373 BC*	*2157 BC"*	*	*	*	*

n = 6 min t = 4.37 max t = 8.52 mean t = 6.96 s.d. = 1.34

Table 3: Crossmatching between CHI006, HAL008 and TRPT01

t-value /r value; * = empty triangle; calendar dates are indicative only.

Filenames	*start dates*	*dates end*	CHI006 *"2369 BC 1461 BC"*	HAL008 *"2486 BC 1980 BC"*	TRPT01 *"2472 BC 2157 BC"*
CHI006	*"2369 BC*	*1461 BC"*	*	5.72/0.28	6.42/0.41
HAL008	*"2486 BC*	*1980 BC"*	*	*	8.35/0.43
TRPT01	*"2472 BC*	*2157 BC"*	*	*	*

n = 3 min t = 5.72 max t = 8.35 mean t = 6.83 s.d. = 1.11

Table 4: Crossdating between series and tree-sequences included in TRPT02 and TRPT03.

t-value / r value; \ = no overlap; * = empty triangle

Filenames			TRPT02			TRPT03		
			TRP003a	**TRP010**	**TRP011a**	**TRP002**	**TRP012**	**TRP015a**
	start	*dates*	*1192 BC*	*1123 BC*	*1084 BC*	*551 BC*	*707 BC*	*812 BC*
	dates	*end*	*1005 BC*	*833 BC*	*881 BC*	*232 BC*	*485 BC*	*133 BC*
TRP003a	*1192 BC*	*1005 BC*	*	5.66 / 0.47	3.17 / 0.35	\	\	\
TRP010	*1123 BC*	*833 BC*	*	*	6.70 / 0.43	\	\	\
TRP011a	*1084 BC*	*881 BC*	*	*	*	\	\	\
TRP002	*551 BC*	*232 BC*	*	*	*	*	4.71 / 0.52	6.43 / 0.34
TRP012	*707 BC*	*485 BC*	*	*	*	*	*	6.96 / 0.43
TRP015a	*812 BC*	*133 BC*	*	*	*	*	*	*

n = 6 min t = 3.17 max t = 6.96 mean t = 5.60 s.d. = 1.32

Table 5: Crossdating of TRPT02, TRPT03 and TRP005 (independantly dated tree-sequence) to AGAUc07c_raw and independent site chronologies and tree sequences.

For this table, only *t*-values are shown. Individual series included in the TRPT site chronologies are also shown (in grey). Reference chronologies are arranged by start date. \ = overlap < 25 years; - = t-values less than 3.00

Filenames						TRPT02			TRPT03		
			TRPT02	**TRPT03**	**TRP005**	**TRP003a**	**TRP010**	**TRP011a**	**TRP002**	**TRP012**	**TRP015a**
	start	*dates*	*1192 BC*	*812 BC*	*1692 BC*	*1192 BC*	*1123 BC*	*1084 BC*	*551 BC*	*707 BC*	*812 BC*
	dates	*end*	*833 BC*	*133 BC*	*1348 BC*	*1005 BC*	*833 BC*	*881 BC*	*232 BC*	*485 BC*	*133 BC*
AGAUc07c_RAW *(TRL, unpubl)*	*1724 BC*	*AD 2002*	14.32	14.82	9.20	8.93	13.35	6.31	4.62	7.42	10.95
Northland											
CHI008 *(Boswijk 2005a)*	*1718 BC*	*1511 BC*	\	\	8.25	\	\	\	\	\	\
DARGVL01 *(TRL, unpublished)*	*1589 BC*	*AD 120*	8.91	16.02	-	6.67	7.82	3.51	7.34	9.01	10.31
YAKAS2 *(Boswijk and Palmer, 2004)*	*1547 BC*	*961 BC*	9.23	\	5.70	7.71	8.90	3.26	\	\	\
HARDING2 *(Boswijk 2005b)*	*1466 BC*	*437 BC*	13.56	14.44	3.53	8.99	11.33	5.34	7.13	9.17	9.10
MAI005 *(Boswijk 2005c)*	*1362 BC*	*944 BC*	7.59	\	\	5.39	7.60	5.15	\	\	\
POU001 *(Boswijk 2004)*	*1315 BC*	*741 BC*	5.64	6.48	\	-	7.87	-	\	\	6.38
CHITTY2 *(Boswijk 2005a)*	*1257 BC*	*676 BC*	11.21	7.70	\	7.28	10.48	5.46	\	-	7.05
CHITTY1 *(Boswijk 2005a)*	*477 BC*	*AD 842*	\	11.90	\	\	\	\	4.58	\	9.95
MAITAHI *(Boswijk 2005c)*	*576 BC*	*AD 370*	\	15.21	\	\	\	\	7.33	4.99	11.04
Waikato											
PUKE *(Fowler et al 2001)*	*1724 BC*	*922 BC*	7.87	\	5.39	5.31	7.39	-	\	\	\
WHANGAPE *(Boswijk and Palmer, 2003)*	*1180 BC*	*131 BC*	7.28	8.11	\	-	7.70	4.53	-	5.63	6.40

n = 70 min t = 2.36 max t = 16.02 mean t = 7.66 s.d. = 3.28

Appendix 1: Raw ring width listings for TRPT chronologies and TRP005

TRPT01

Four timber mean of 316 years length
Dated "2472 BC to 2157 BC" (indicative dates only)
Average ring width 176.55 Sensitivity 0.30

Years	Ring width data										No of series									
2472 BC									89	111									*1*	*1*
-	78	87	102	116	48	59	92	62	81	42	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	135	187	106	183	189	178	156	48	164	188	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
2450 BC	170	229	114	102	142	56	224	216	205	67	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	68	63	68	78	98	46	125	134	88	162	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	87	151	206	217	206	130	69	186	197	178	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	239	189	237	242	157	200	172	232	283	226	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	267	209	281	315	206	307	153	280	327	399	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
2400 BC	288	337	353	300	375	269	264	165	185	131	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	218	187	131	219	107	176	275	209	232	159	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	91	241	250	289	79	254	278	99	179	172	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*3*	*3*	*3*
-	107	118	109	77	148	138	152	113	142	119	*3*	*3*	*3*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
-	101	144	106	145	92	117	139	120	142	58	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
2350 BC	142	181	124	145	158	174	113	89	135	149	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
-	233	203	145	223	226	134	207	247	201	216	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
-	215	199	213	211	202	200	177	141	179	157	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
-	189	131	151	188	214	213	257	195	226	138	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
-	227	222	213	212	208	185	176	203	233	145	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
2300 BC	240	138	257	279	174	268	222	227	217	210	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
-	222	221	227	180	185	125	145	113	243	294	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
-	209	228	106	149	161	139	195	250	261	241	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
-	285	293	263	166	208	230	255	178	209	221	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
-	154	180	208	196	233	184	226	83	208	234	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
2250 BC	289	253	233	93	125	121	156	192	155	189	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
-	184	189	117	194	153	163	66	204	234	273	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
-	268	250	199	242	93	136	216	181	224	220	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
-	163	179	170	229	259	273	199	253	229	130	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
-	241	239	116	184	145	167	189	164	165	168	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
2200 BC	130	202	150	200	123	171	187	295	269	259	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
-	263	127	224	227	137	157	136	40	154	157	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
-	93	152	172	162	175	124	186	189	102	125	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
-	169	128	92	117	85	104	138	122	51	29	*4*	*4*	*4*	*4*	*4*	*3*	*3*	*3*	*2*	*2*
-	16	23	61	85							*2*	*2*	*2*	*1*						

TRPT02

Three timber mean of 360 years length
Dated 1192 BC to 833 BC
Average ring width 224.38   Sensitivity 0.30

Years	Ring width data										No. of series/sequences									
1192 BC									242	288									*1*	*1*
-	274	328	375	396	430	245	462	515	255	239	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	307	369	326	238	172	174	87	144	130	232	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	251	198	213	78	190	186	173	78	185	317	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	210	228	265	313	253	336	129	158	167	110	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
1150 BC	151	77	146	237	173	49	40	94	103	100	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	146	173	205	239	266	282	122	227	329	348	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	271	258	296	151	303	205	181	189	165	171	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*2*	*2*	*2*
-	129	156	189	79	98	121	120	154	161	149	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	72	130	171	180	179	237	154	268	334	253	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
1100 BC	297	202	229	258	174	216	185	209	205	215	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	221	169	141	220	209	223	220	214	127	205	*2*	*2*	*2*	*2*	*2*	*2*	*3*	*3*	*3*	*3*
-	178	120	149	244	208	245	318	264	103	208	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
-	213	266	200	254	278	291	284	197	276	332	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
-	261	349	492	471	373	423	325	455	294	465	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
1050 BC	392	324	298	258	304	199	305	298	400	316	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
-	364	286	323	217	294	253	251	222	184	286	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
-	211	236	146	257	242	114	264	239	116	177	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
-	81	136	211	154	239	155	252	143	211	185	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
-	157	118	184	190	255	260	160	213	227	188	*3*	*3*	*3*	*3*	*3*	*3*	*2*	*2*	*2*	*2*
1000 BC	162	168	105	96	146	193	116	157	136	63	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	173	112	148	99	127	91	130	67	160	119	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	132	180	117	229	195	206	115	196	239	203	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	262	206	245	162	232	202	250	104	262	176	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	222	237	150	123	144	60	123	126	89	175	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
950 BC	113	125	151	101	184	178	88	127	130	178	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	220	183	131	157	193	185	136	183	152	188	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	114	209	172	196	191	186	205	168	228	192	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	184	274	233	172	215	189	199	120	247	237	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	209	183	236	197	111	193	164	222	137	187	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
900 BC	136	268	258	250	222	252	177	295	267	237	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	269	221	206	209	244	217	223	199	225	203	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	324	331	442	230	367	423	403	294	356	109	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	335	299	352	161	363	171	346	273	405	289	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	488	444	490	431	329	438	271	439	453	297	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
850 BC	406	289	306	417	259	401	336	330	294	296	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	302	365	168	256	284	311	367	190			*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*		

TRPT03

Three timber mean of 680 years length
Dated 812 BC to 133 BC
Average ring width 136.88   Sensitivity 0.36

Years	Ring width										No. of series/sequences									
812 BC									49	79									*1*	*1*
-	43	87	84	114	116	98	120	77	130	110	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
800 BC	152	151	156	111	200	95	224	229	132	222	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	211	82	211	192	307	240	370	241	318	238	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	140	238	78	196	174	96	131	96	131	88	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	102	79	96	83	93	177	147	168	59	123	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	104	163	97	178	89	124	142	212	287	96	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
750 BC	163	159	264	301	299	214	246	249	191	182	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	156	174	103	78	73	95	99	67	51	61	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	75	60	110	77	88	58	73	108	138	101	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	133	87	151	144	142	38	170	177	174	167	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	158	170	73	112	98	80	84	93	85	114	*1*	*1*	*1*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
700 BC	89	151	102	137	85	116	39	91	83	58	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	113	73	111	121	106	41	125	102	53	124	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	87	118	68	115	83	125	56	91	104	81	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	73	71	62	76	151	44	149	137	165	136	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	151	138	69	57	77	77	39	105	68	96	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
650 BC	86	118	129	32	58	49	59	74	41	56	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	54	53	69	19	66	48	68	36	66	22	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	56	28	85	81	48	40	51	11	87	71	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	94	56	95	38	68	35	70	47	45	104	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	77	31	100	94	69	70	24	43	33	98	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
600 BC	59	108	44	100	134	42	96	54	137	141	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	50	112	97	113	50	76	38	77	87	116	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	119	150	58	138	84	169	130	171	199	119	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	142	154	112	186	143	159	84	111	125	159	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	133	214	182	156	186	89	72	98	103	165	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*3*
550 BC	166	160	191	102	119	187	81	88	123	144	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
-	222	211	249	139	257	228	194	225	153	127	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
-	151	182	124	157	184	184	114	203	195	122	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
-	145	119	117	111	149	71	138	148	125	184	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
-	85	117	114	158	113	156	102	175	247	136	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
500 BC	184	66	191	207	143	106	108	94	132	140	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
-	212	140	159	109	114	128	73	192	187	250	*3*	*3*	*3*	*3*	*3*	*3*	*2*	*2*	*2*	*2*
-	243	216	216	261	280	165	200	211	212	227	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	233	150	215	178	230	150	93	91	165	193	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	224	55	113	152	186	253	152	216	245	181	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
450 BC	215	223	158	170	211	144	138	256	175	316	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	368	335	216	160	194	203	265	240	153	173	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	162	100	176	98	206	243	246	207	216	229	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	211	254	214	168	213	204	201	208	118	229	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	213	58	109	140	201	192	164	84	136	128	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
400 BC	87	176	130	136	123	115	122	142	143	96	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	71	101	108	23	148	112	98	158	103	127	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	104	114	78	86	133	158	153	181	81	175	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	216	186	210	231	188	206	146	184	153	134	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	163	179	158	140	215	216	110	133	168	169	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
350 BC	156	144	156	82	22	123	129	175	37	110	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	93	167	140	89	155	139	163	192	110	211	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	149	218	210	209	118	131	112	150	155	166	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*

-	110	173	95	185	153	179	177	132	81	131	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	137	181	170	131	125	189	109	200	198	190	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
300 BC	147	129	190	179	177	59	153	186	129	99	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	117	164	210	85	151	100	159	89	125	117	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	93	165	139	76	100	72	143	121	64	148	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	124	102	196	210	190	96	209	194	206	177	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	72	94	21	125	100	140	96	121	83	82	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
250 BC	101	176	109	194	187	181	214	167	111	120	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
-	111	284	283	239	256	238	175	112	199	235	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*1*
-	154	207	180	201	63	196	212	177	245	137	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	254	237	214	174	234	230	176	249	79	108	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	53	170	114	72	183	171	88	165	136	170	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
200 BC	138	169	39	118	67	168	132	115	105	84	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	136	98	131	100	172	115	146	176	105	272	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	266	203	312	225	219	116	85	117	75	160	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	95	79	65	42	26	89	43	176	157	144	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	98	149	115	69	109	52	53	37	97	100	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
150 BC	84	125	74	82	47	81	56	129	161	223	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
-	76	73	82	93	151	126	105	149			*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*		

TRP005

Tree-sequence of 345 years length
Dated 1692 BC to 1348 BC
½ unmeasured ring with bark
Average ring width 173.85   Sensitivity 0.38

1692 BC									105	143
-	94	138	146	192	77	169	120	238	233	182
-	227	159	56	55	63	217	154	113	138	84
-	61	36	51	73	157	120	157	86	110	150
-	173	85	179	109	146	193	198	281	286	218
1650 BC	157	258	96	211	126	274	218	207	239	264
-	95	62	146	95	211	198	163	180	173	289
-	331	281	397	381	396	371	146	346	164	376
-	298	363	282	184	314	199	362	227	72	207
-	203	204	288	388	154	224	392	235	315	105
1600 BC	247	132	274	226	278	168	369	104	298	200
-	389	203	310	254	198	244	157	205	250	390
-	245	315	368	348	351	219	303	285	309	331
-	217	329	393	560	301	481	338	406	370	405
-	435	414	473	236	331	313	258	412	306	273
1550 BC	323	267	376	240	320	254	189	165	184	243
-	274	172	189	96	94	54	155	168	181	99
-	126	86	109	182	131	117	189	106	81	72
-	74	131	127	174	130	89	139	168	132	201
-	143	173	194	168	74	73	63	55	100	108
1500 BC	227	90	73	68	157	208	175	173	173	153
-	141	83	95	140	137	109	79	120	60	85
-	61	72	52	64	79	35	35	67	85	57
-	38	49	61	57	50	51	94	100	60	40
-	34	55	103	82	113	135	130	104	117	155
1450 BC	130	154	169	156	217	251	122	110	122	144
-	192	97	175	166	103	93	150	81	97	63
-	147	66	106	73	161	107	103	116	264	171
-	326	289	247	197	160	234	182	127	78	155
-	126	251	181	254	55	49	30	77	137	197
1400 BC	106	116	111	213	256	199	335	172	422	272
-	422	403	93	67	153	221	143	102	96	220
-	83	63	81	131	52	26	56	50	54	28
-	28	11	56	65	157	103	87	169	164	118
-	100	50	76	49	68	42	103	97	260	185
1350 BC	42	28	117							