Appendix VI:
TREE RING DATING OF EAGLE LAKE ARCHAEOLOGICAL SAMPLES

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(Edited by R.G. Matson)

The archaeological tree-ring samples analyzed in this study were collected as part of The Eagle Lake Project conducted by the University of British Columbia. The excavation sites are in the Eagle Lake (also known as Choelquoit Lake) area and the project was directed by R.G. Matson. Two reports (Magne and Matson 1984; Matson et al. 1980) and Chapter 1 of the main text describes the archaeology of the area and included in Matson et al. (1980) is a useful description of the natural and cultural environment by Deanna Ludowicz.

Of the 40 archaeological tree-ring samples, all are lodgepole pine (*Pinus contorta* Dougl.) except for one hardwood sample. Although the samples generally appeared to be of poor quality for dendrochronological analysis, dates were obtained from 12 of them. This demonstrates that lodgepole pine can be used for tree-ring dating and that trees growing in the Eagle Lake area produce ring series that are sensitive enough for dendrochronological studies.

Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) and lodgepole pine samples were taken to provide a "living-tree" chronology for crossdating with the archaeological tree-ring material. These samples are 5 mm increment cores from living trees and cross -sectional disks from recently cut trees and windfalls. One Douglas fir windfall provided a chronology extending back to 1380 AD. The lodgepole pine chronology derived from trees at Goosenob Lake proved to he most useful for crossdating with the archaeological samples.

Methods

Although the main method used in dating was the comparison of measured ring widths, ring density was visually observed and used to find or verify crossdating.
The annual ring widths of both the living trees and the archaeological samples were measured with an eyepiece micrometer used in a low-power binocular microscope.

The methods used to remove growth trends and summarize the ring series are described by Parker et al. (1981). The tree-ring indices used in this report are of "C" type, i.e., a digital filter is used to remove all fluctuations greater than 10 years in length and accentuate the year to year variations. To verify the dating, tree-ring chronologies from other areas were compared with the Eagle Lake data. If these chronologies were not already of the "C" type, they were converted to that form by running them through the digital filter standardizing procedure.

In almost all tree-ring dating that has been done in Canada, a computer crossdating technique has been used (Parker 1967, 1970; Parker et al. 1983, 1984). This method uses correlation and computer techniques to find the best crossdating fit (or establish if there is crossdating) between a dated tree-ring series and an undated tree-ring series. If crossdating is considered to be present between two ring series, that crossdating can be objectively

measured and verified by this computer dating program, known as the Shifting Unit Dating Program (SUDP). SUDP was used to find cross-datlng between the archaeological tree-ring composite chronologies and the living-tree chronologies in this study.

Analysis of the Archaeological Tree-Ring Samples

The archaeological tree-ring samples submitted for analysis in 1983 consist of charcoal and rotten wood excavated from EkSa 36 (Figure VI-1, Figure VI-2b) and EkSa 32, and a cross-sectional disk from a fairly well-preserved beam from Lingfield Creek Lodge (Figure VI-2a, c, d). Tree-ring dates ranging from cutting dates of 1851 to 1877, were obtained for 11 of the 35 samples from EkSa 36. The wood sample from Lingfield Creek Lodge dated at 1890 with a very variable outside surface. The four charcoal samples from EkSa 32 are very fragmentary and none contained enough annual rings to provide a tree-ring date. Data for the dated samples are presented (Table VI-1) to assist in the evaluation of why dates were obtained from some samples but not others.

The twelve archaeological tree-ring samples dated are generally not very well preserved and contain short ring series. However, the reliability of these dates is illustrated (Figures VI-3,-14) by computer crossdating and by comparison of broken-line plots of ring-width indices.

The procedure used to obtain the dates in this case is as follows:

1. All samples were examined under a low-power binocular microscope and those that showed any possible chance of being dated were selected for further study.

2. As each sample was examined, it was prepared by sanding (in the case of wood) or with a scalpel or razor blade (in the case of charcoal).

3. Using both ring density and ring width, crossdating was observed under the microscope, for eight samples from EkSa 36, i.e., the tree-ring patterns of width and density for any one matched all of the other seven, but calendar year dates were not known at that time.

4. Arbitrary dates were assigned and ring widths were measured.

5. Arbitrary dates were assigned also to the annual rings of the Lingfield Creek Lodge samples and its ring series was measured.

6. The ring series were standardized and ringwidth indices of the “C” type (Parker et al. 1981) were produced for all of these samples.

7. A composite chronology was built from ring series of five of the eight EkSa 36 samples.

8. Using the Shifting Unit Dating Program (SUDP), this five tree composite was crosated with the Lingfield Creek Lodge sample.

a

b

Figure VI-1. a. Preparing a tree-ring sample for removal from an excavation unit at EkSa 36.

b. An excavated roasting pit (Feature D) at EkSa 36.

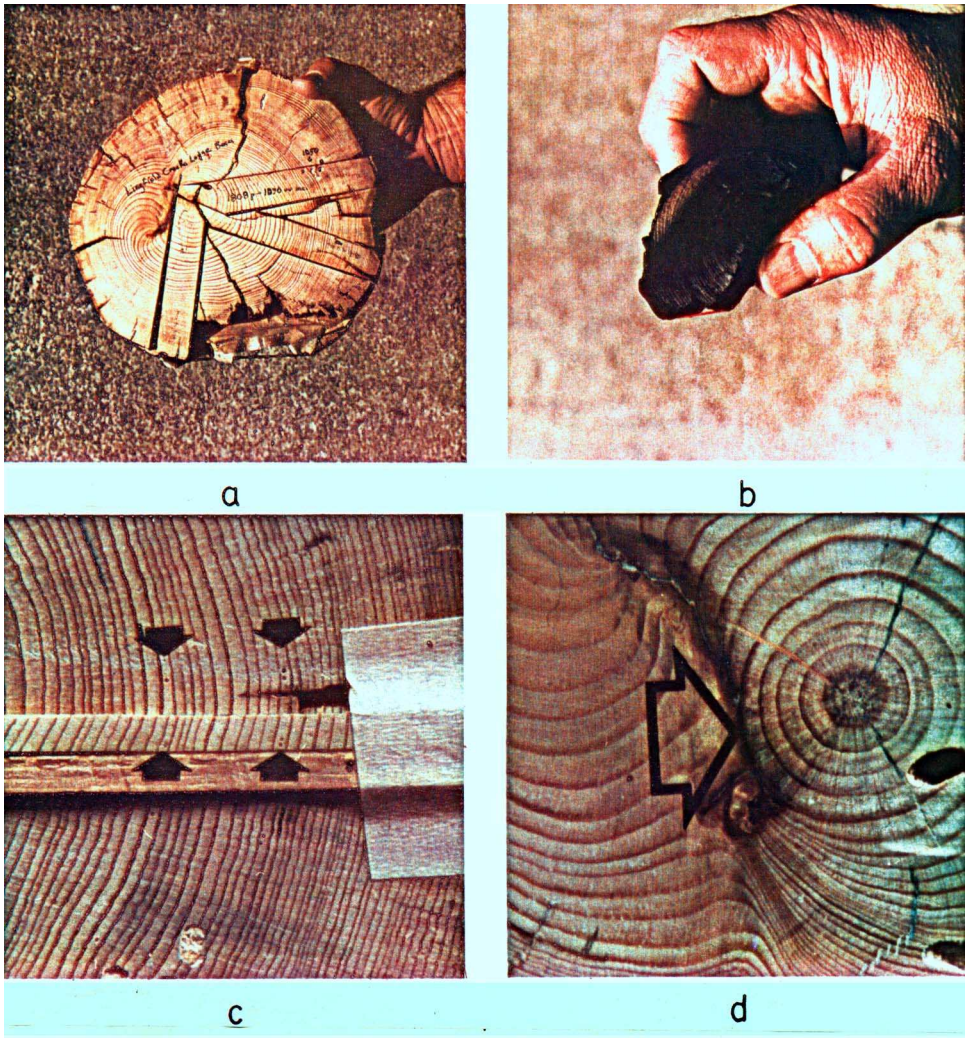

Figure VI-2. a. A cross-sectional disk of a construction beam from Lingfield Creek lodge. Ring-width measurements were made of three radial blocks sawn from this disk.

b. A example of good-quality archaeological sample excavted from EkSa 36. This sample (Dendro 30) consists of both charcoal and wood.

c. A 5 mm core from a living lodgepole pine tree growing near the roasting pit shown in Figure VI-1b, is resting on th disk from Lingfield Creek lodge. The arrows mark the annual rings formed in 1840 and 1850 and the crossdating between these two samples for that decade is apparent for both width and density.

d. The arrow points to a fire scar on the Lingfield Creek lodge disk. The annual ring damaged by fire was formed in 1811.

Sample Number	Tree-Ring Date	Provenience and Comments
Dendro 11	1822+p – 1873B	Unit 21, Layer B2; Mostly dirt; shell of charcoal and rotten wood; pith present; small rings; probably limb: 16 cm long, 5 cm wide.
Dendro 29	1817+p – 1860v inc.	Feature H, Unit 27, Layer B1; Rotten wood and large rings on inside of sample, charcoal andsmall rings on outside; small rings difficult to count; pith present; 39 cm long, 7 cm wide.
Dendro 30	1832p – 1877B	Feature H, Unit 27, Layer B1; Fairly well preserved; pith present; 29 cm long, 8 cm wide.
Dendro 31	1848+p – 1877r	Feature H, Unit 27, Layer B1; Pith present; 43 cm long, 8 cm wide.
Dendro 33	1822+p – 1877rB	Feature H, Unit 29, Layer B1; Much dirt; very fragmentary; 19 cm long, 7 cm wide.
Dendro 35	1832+p – 1877r	Feature H, Unit 29, Layer B1; Very fragile: good chronology; pith present; 19 cm long, 7 cm wide.
Dendro 54	1823 inc. – 1851B inc.	Unit 32, Layer B3; Consistsof wood, rotten wood andcharcoal; bark present; 7 cm long, 5 cm wide.
Dendro 72	1823+p – 1851vv	Unit 40, Layer B3; Charcoal and rotten wood; pith present; 18.5 cm long, 8 cm wide
Dendro 77	1830 inc. – 1877+vv	Unit 45, Layer B3; Mostly dirt with thin shell of charcoal and rotten wood. Small but complacent rings; measured to 1865, ring count to 1877; 27 cm long, 11 cm wide.
Dendro 93	1848 inc. – 1877rB	Unit 57, Layer B3; Mostly dirt; flat grain; not completely charred; 29 cm long, 12 cm wide.
Dendro 96	1813 inc. – 1858+vv	Unit 59, Layer BF; Charcoal and wood; about 25 rings in charcoal and an unknown number in rotten wood; 7.5 cm long, 4 cm wide.

Table VI-1. Dated tree-ring samples from EkSa36, the Bear Lake site.

9. Using SUDP again, the Lingfield Creek Lodge ring series was crossdated with a living-tree lodgepole pine chronology derived from trees located near Goosenob Lake which is near the EkSa 36 site.

10. The dating of the five samples from EkSa 36 and the Lingfield Creek Lodge sample was verified by a number of computer cross dating runs, using different combinations of archaeological tree-ring chronologies and comparing them with various living-tree chronologies derived from trees in the Eagle Lake area and other sites in the British Columbia Interior. Both broken line plot comparison and computer crossdating were used at this point.

11. The ring widths were measured on all other potentially useful samples and their ring series were compared with the various dated chronologies.

12. Some additional dates were obtained for a total of eleven from EkSa 36 plus the Lingfield Creek Lodge sample (Figures VI-3, -14).

Further verification of the dating of the twelve archaeological tree-ring samples was accomplished by crossdating the EkSa 36 11 tree summary, the Lingfield Creek Lodge sample and the 12 tree archaeological summary with a number of living-tree master chronologies from the British Columbia Interior. The broken-line plot comparison of this is shown in Figure VI-15.

Summary and Conclusions

Forty archaeological tree-ring samples from three sites in the Eagle Lake area were examined. Twelve tree-ring dates were obtained and this represents virtually all of the samples that are of dateable quality. Living-tree chronologies were built for lodgepole pine and Douglas fir.

Observations and conclusions are:

1. Lodgepole pine can be used for tree-ring dating.

2. Trees growing in the Eagle Lake area are of adequate quality for dendrochronological purposes.

3. The archaeological tree-ring samples excavated are almost exclusively lodgepole pine .

4. Charcoal is much better preserved than wood at these open sites.

5. Samples treated with paraffin and gasoline were much better preserved than the untreated ones.

6. Both ring width and ring density are useful for cross-dating purposes.

7. Some Douglas fir trees live to be at least 600 years old in the area.

Figures VI-3,-14. Presented in these figures are: (1) the results of the Shifting Unit Dating Program (SUOP); (2) the cross correlation value (r) of the 1st, 2nd, and 3rd best fit in bargraph form; (3) a photograph of the archaeological tree-ring samples; and (4) a brokenline plot comparison of the individual sample compared with the composite chronology. In each of the twelve cases, an individual dated tree ring sample is compared with a summary of the twelve dated archaeological samples. The unit length used on SUDP was made equal to the length of measured ring width series of the individual sample; therefore, only one line of output is obtained. Each sample dated at the expected place with a high correlation.

The symbols used with the inside dates are:

year	no pith ring present.
p	pith ring present.
+p	pith ring present, but due to the difficult nature of the ring series near the center of the specimen, an exact date cannot be assigned to it. The date is obtained by counting back from the earliest dated ring.
+	the innermost ring is not the pith ring andan absolute date cannot be assigned to it. A ring count is involved.

The symbols used with the outside date are:

B	bark present
c	the outermost ring is continuous around the full circumference of the specimen. This symbol is used only if a full section is present.
r	less than a full section is present, but the outermost ring is continuous around available circumference.
v	a subjective judgement that, although there is no direct evidence of the true outside on the specimen, the date is within a very few years of being a cutting date.
vv	there is no way of estimating how far the last ring is from the true outside.
+	the nature of the dating is such that one or more rings may be missing near the end of the ring series. The presence or absence of rings cannot be determined because the specimen does not contain enough additional rings to provide an adequate check.
++	a ring count was necessary due to the fact that beyond a certain point the specimen could not be dated.

The symbols **B**, **c** and **r** indicate cutting dates in order of decreasing confidence, unless a **+** or **++** is also present.

The abbreviations used for the tree species are:

DF	Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco)
Lpp	Lodgepole pine (*Pinus contorta* Dougl.)

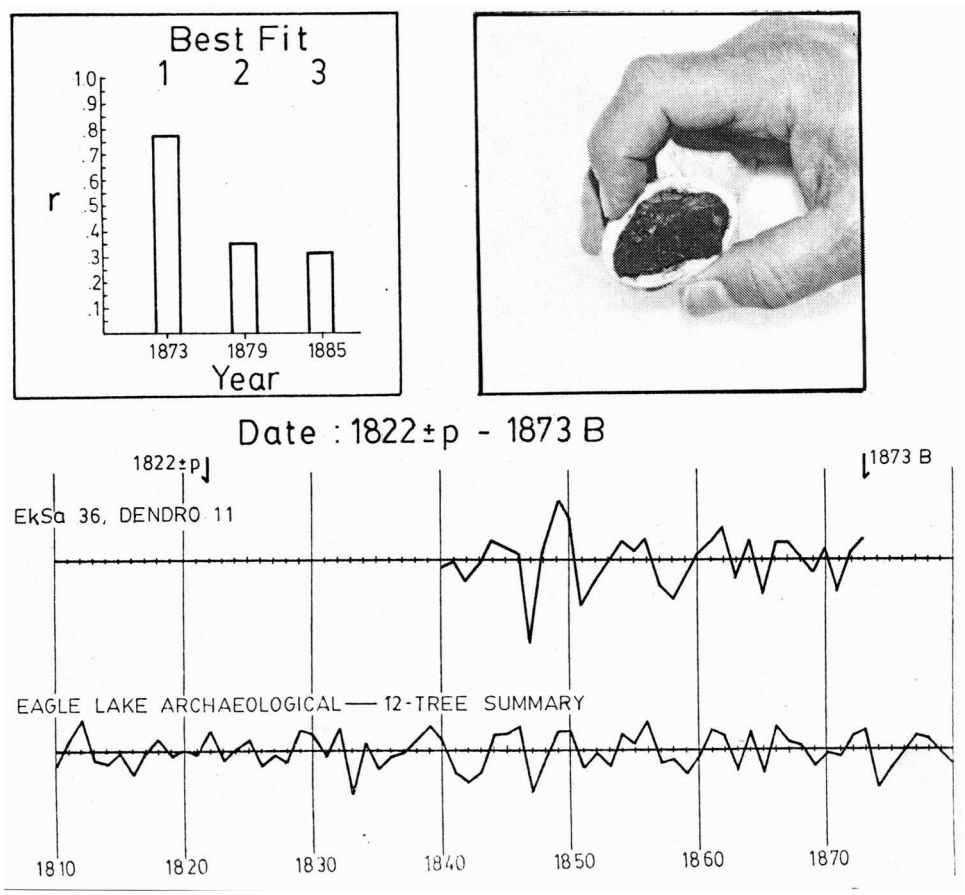

Figure VI-3. Dendro 11.

Master Series: Eagle Lake Archaeological–12-Tree Summary
Number of Ring Years = 79
Dated Interval = 1809 - 1887

Undated Series: Eagle Lake Archaeological – Dendro 11 EkSa 36 – Filter
Number of values = 34
Interval (Arbitrary) = 1840 -1872

Unit length = 34 Increment = 1

Undated Series unit	Last Ring on Undated series unit	Last Ring-Year of Best-Fit on Master			Correlation of Undated Series unit with Best-fit Master unit		
		First	Second	Third	First	Second	Third
1	1873	1873	1879	1885	0.775	0.350	0.305

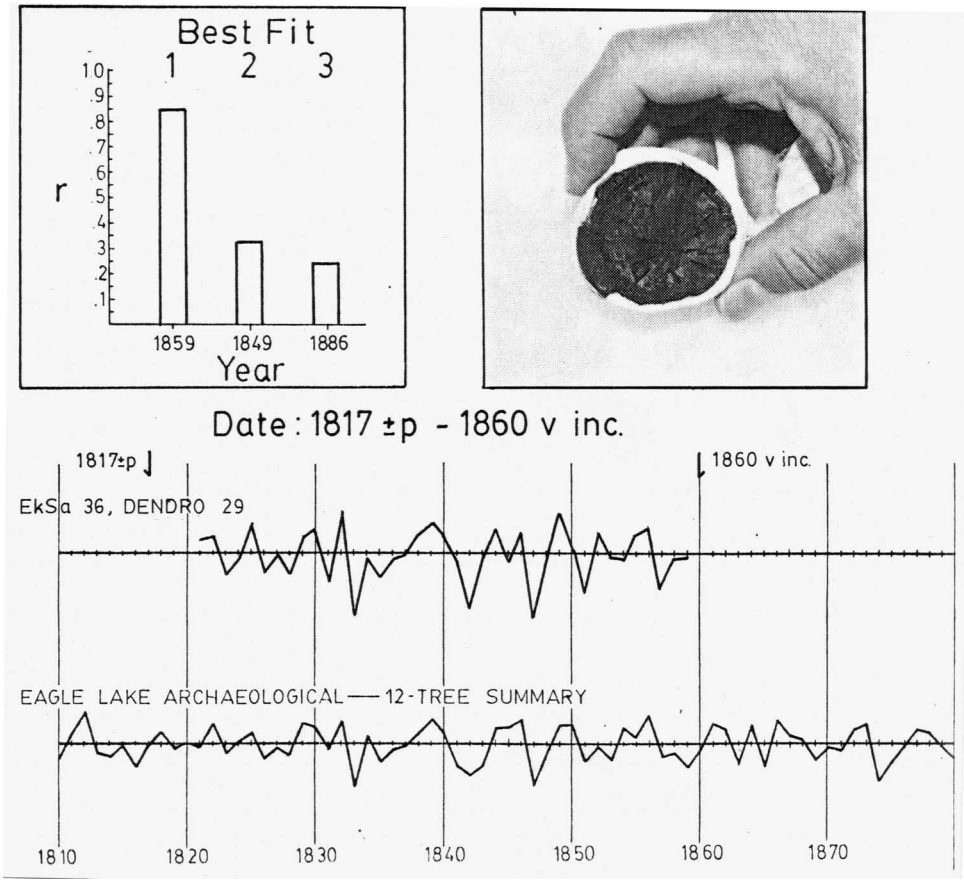

Figure VI-4. Dendro 29.

Master Series: Eagle Lake Archaeological–12-Tree Summary
Number of Ring Years = 79
Dated Interval = 1809 - 1887

Undated Series: Eagle Lake Archaeological – Dendro 29 EkSa 36 – Filter
Number of values = 39
Interval (Arbitrary) = 1821 -1859

Unit length = 39 Increment = 1

Undated Series unit	Last Ring on Undated series unit	Last Ring-Year of Best-Fit on Master			Correlation of Undated Series unit with Best-fit Master unit		
		First	Second	Third	First	Second	Third
1	1859	1859	1849	1886	0.841	0.324	0.240

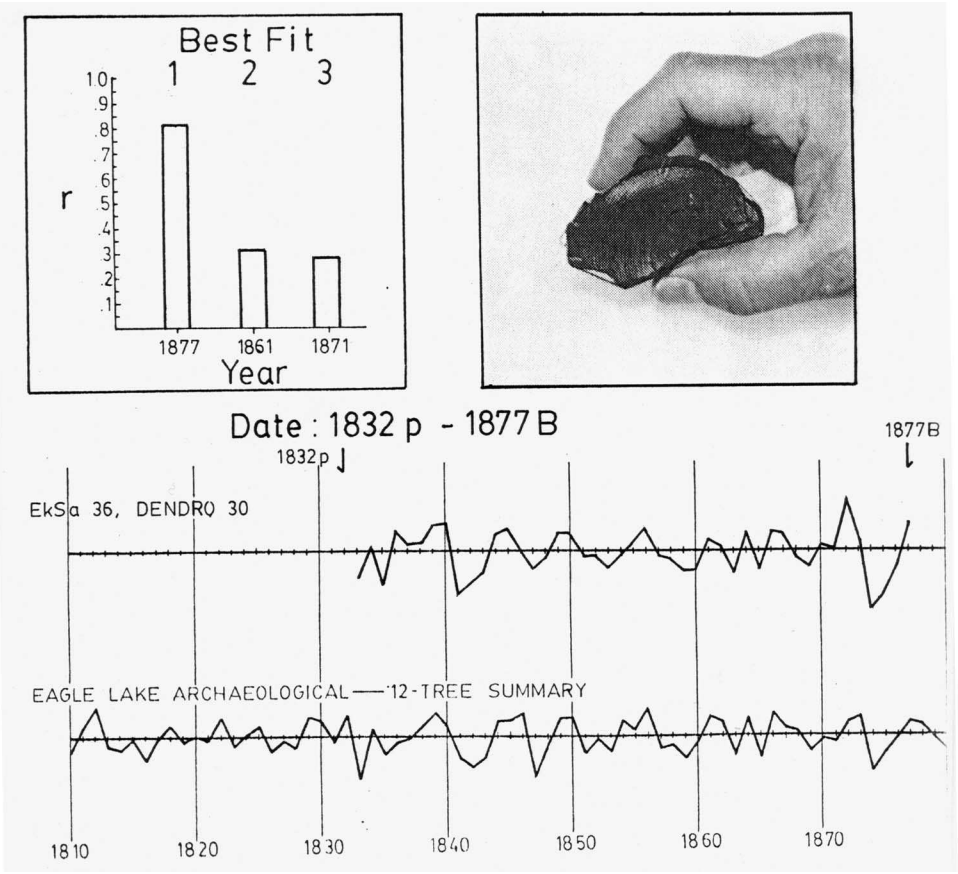

Figure VI-5. Dendro 30.

Master Series: Eagle Lake Archaeological–12-Tree Summary
Number of Ring Years = 79
Dated Interval = 1809 - 1887

Undated Series: Eagle Lake Archaeological – Dendro 30 EkSa 36 – Filter
Number of values = 45
Interval (Arbitrary) = 1833 -1877

Unit length = 45 Increment = 1

Undated Series unit	Last Ring on Undated series unit	Last Ring-Year of Best-Fit on Master			Correlation of Undated Series unit with Best-fit Master unit		
		First	Second	Third	First	Second	Third
1	1877	1877	1861	1871	0.810	0.310	0.282

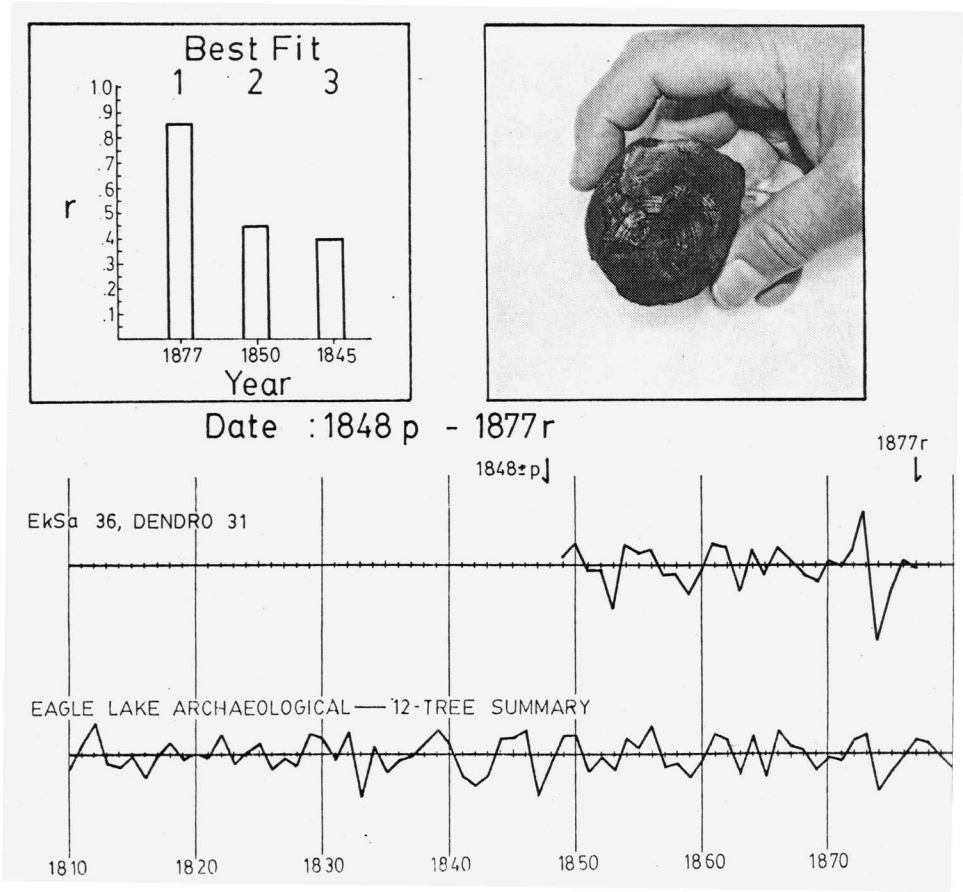

Figure VI-6. Dendro 31.

Master Series: Eagle Lake Archaeological–12-Tree Summary
Number of Ring Years = 79
Dated Interval = 1809 - 1887

Undated Series: Eagle Lake Archaeological – Dendro 31 EkSa 36 – Filter
Number of values = 29
Interval (Arbitrary) = 1849 -1877

Unit length = 29 Increment = 1

Undated Series unit	Last Ring on Undated series unit	Last Ring-Year of Best-Fit on Master			Correlation of Undated Series unit with Best-fit Master unit		
		First	Second	Third	First	Second	Third
1	1877	1877	1850	1845	0.852	0.460	0.396

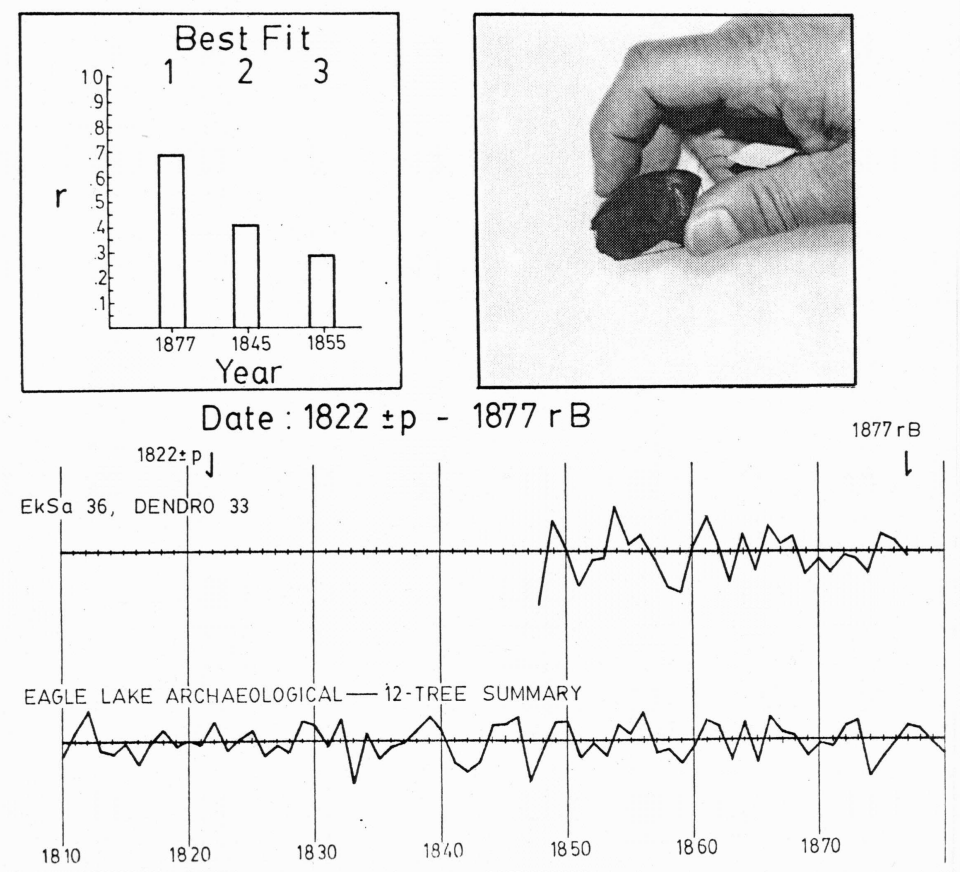

Figure VI-7. Dendro 33.

Master Series: Eagle Lake Archaeological–12-Tree Summary
Number of Ring Years = 79
Dated Interval = 1809 - 1887

Undated Series: Eagle Lake Archaeological – Dendro 33 EkSa 36 – Filtered Summary
Number of values = 30
Interval (Arbitrary) = 1848 -1877

Unit length = 30 Increment = 1

Undated Series unit	Last Ring on Undated series unit	Last Ring-Year of Best-Fit on Master			Correlation of Undated Series unit with Best-fit Master unit		
		First	Second	Third	First	Second	Third
1	1877	1877	1845	1855	0.695	0.405	0.294

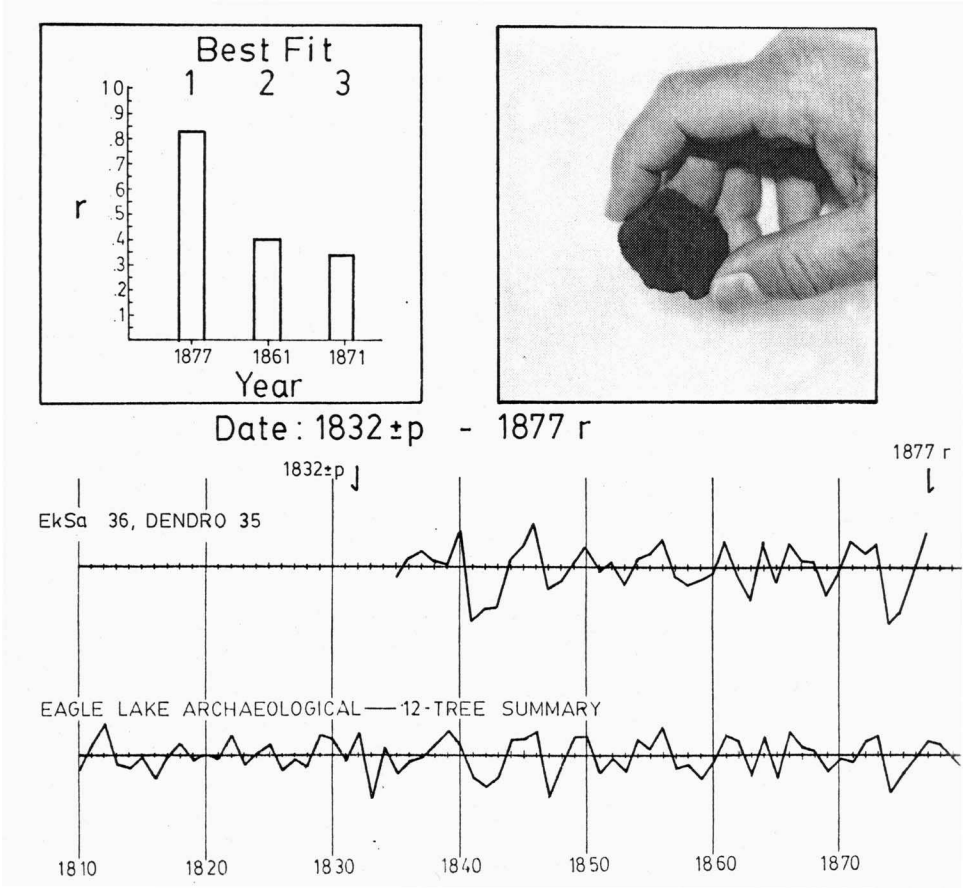

Figure VI-8. Dendro 35.

Master Series: Eagle Lake Archaeological–12-Tree Summary
Number of Ring Years = 79
Dated Interval = 1809 - 1887

Undated Series: Eagle Lake Archaeological – Dendro 35 EkSa 36 – Filtered Summary
Number of values = 43
Interval (Arbitrary) = 1835 -1877

Unit length = 43 Increment = 1

Undated Series unit	Last Ring on Undated series unit	Last Ring-Year of Best-Fit on Master			Correlation of Undated Series unit with Best-fit Master unit		
		First	Second	Third	First	Second	Third
1	1877	1877	1861	1871	0.832	0.406	0.346

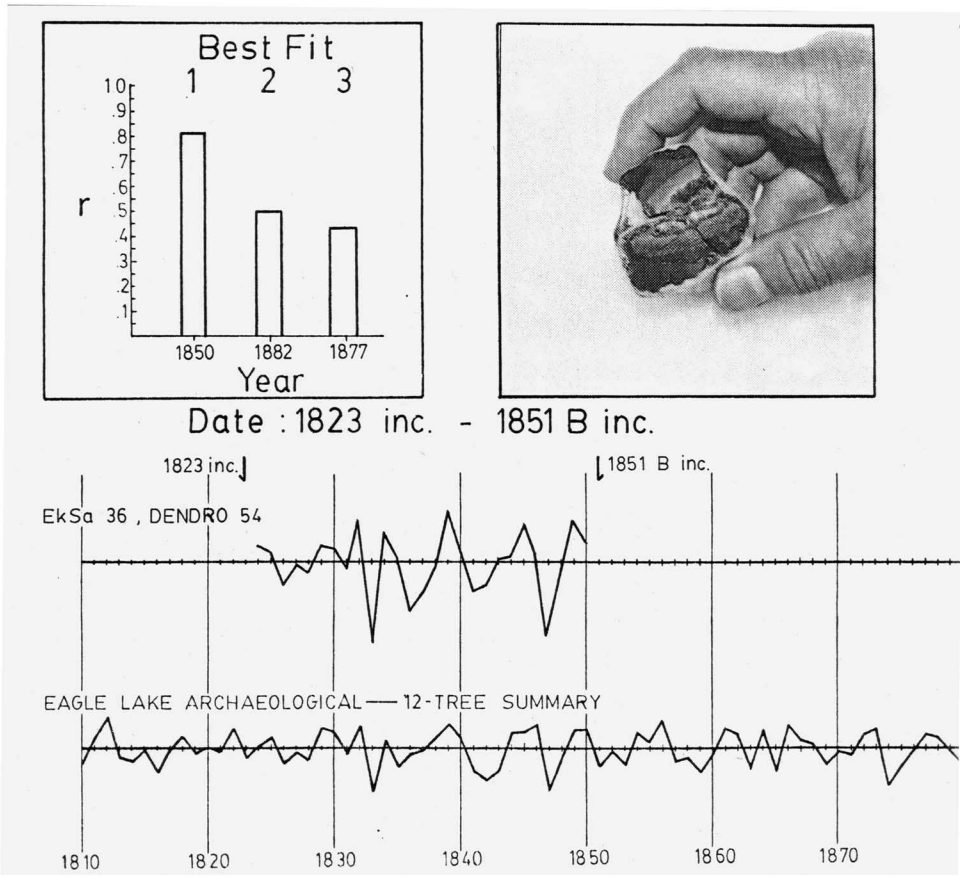

Figure VI-9. Dendro 54.

Master Series: Eagle Lake Archaeological–12-Tree Summary
Number of Ring Years = 79
Dated Interval = 1809 - 1887

Undated Series: Eagle Lake Archaeological – Dendro 54 EkSa 36 – Filtered Summary
Number of values = 27
Interval (Arbitrary) = 1824 -1850

Unit length = 27 Increment = 1

Undated Series unit	Last Ring on Undated series unit	Last Ring-Year of Best-Fit on Master			Correlation of Undated Series unit with Best-fit Master unit		
		First	Second	Third	First	Second	Third
1	1850	1850	1882	1877	0.821	0.499	0.441

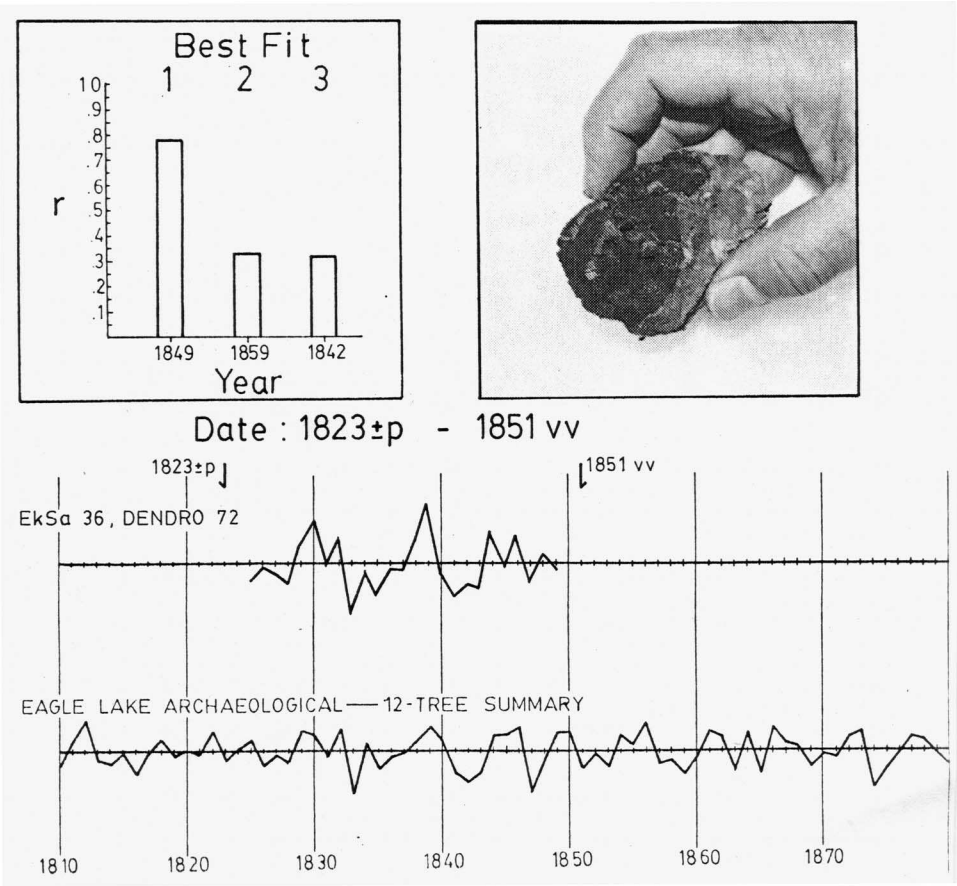

Figure VI-10. Dendro 72.

Master Series: Eagle Lake Archaeological–12-Tree Summary
Number of Ring Years = 79
Dated Interval = 1809 - 1887

Undated Series: Eagle Lake Archaeological – Dendro 72 EkSa 36 – Filtered Summary
Number of values = 25
Interval (Arbitrary) = 1825 -1849

Unit length = 25 Increment = 1

Undated Series unit	Last Ring on Undated series unit	Last Ring-Year of Best-Fit on Master			Correlation of Undated Series unit with Best-fit Master unit		
		First	Second	Third	First	Second	Third
1	1849	1849	1859	1842	0.779	0.333	0.322

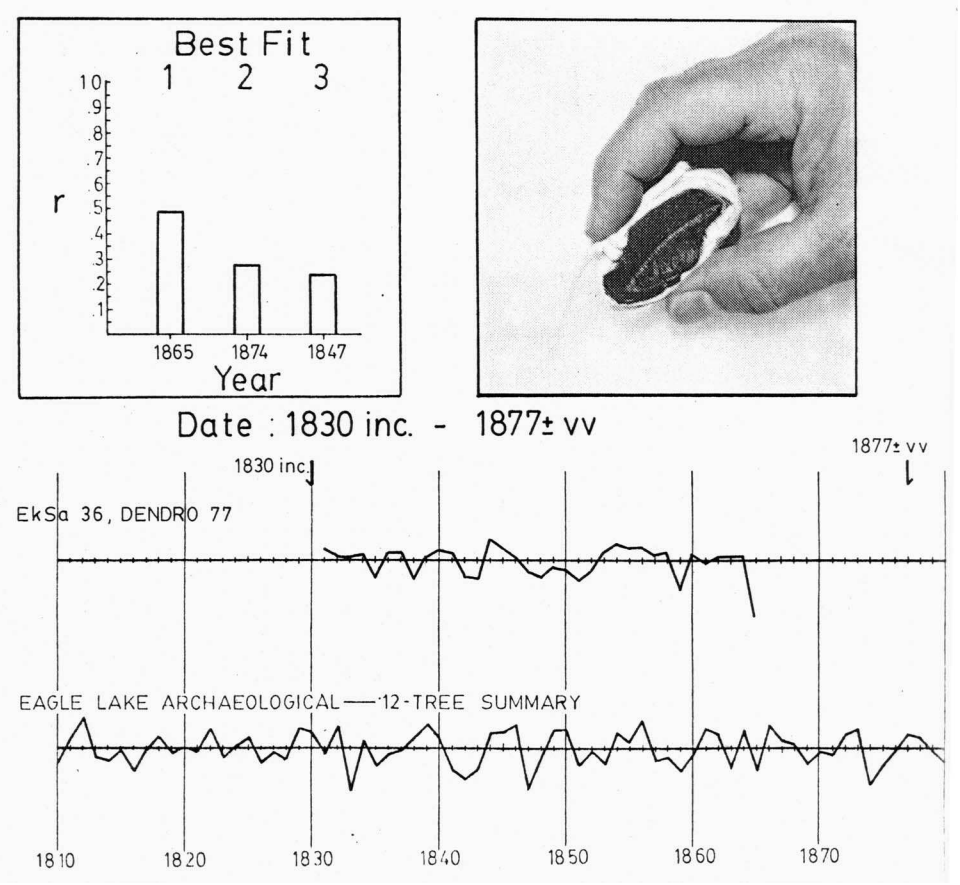

Figure VI-11. Dendro 77.

Master Series: Eagle Lake Archaeological–12-Tree Summary
Number of Ring Years = 79
Dated Interval = 1809 - 1887

Undated Series: Eagle Lake Archaeological – Dendro 77 EkSa 36 – Filtered Summary
Number of values = 35
Interval (Arbitrary) = 1831 -1865

Unit length = 35 Increment = 1

Undated Series unit	Last Ring on Undated series unit	Last Ring-Year of Best-Fit on Master			Correlation of Undated Series unit with Best-fit Master unit		
		First	Second	Third	First	Second	Third
1	1865	1865	1874	1847	0.479	0.272	0.240

The ring series of Dendro 77 is of poorer quality (more complacent) than the others but the match is good enough to accept.

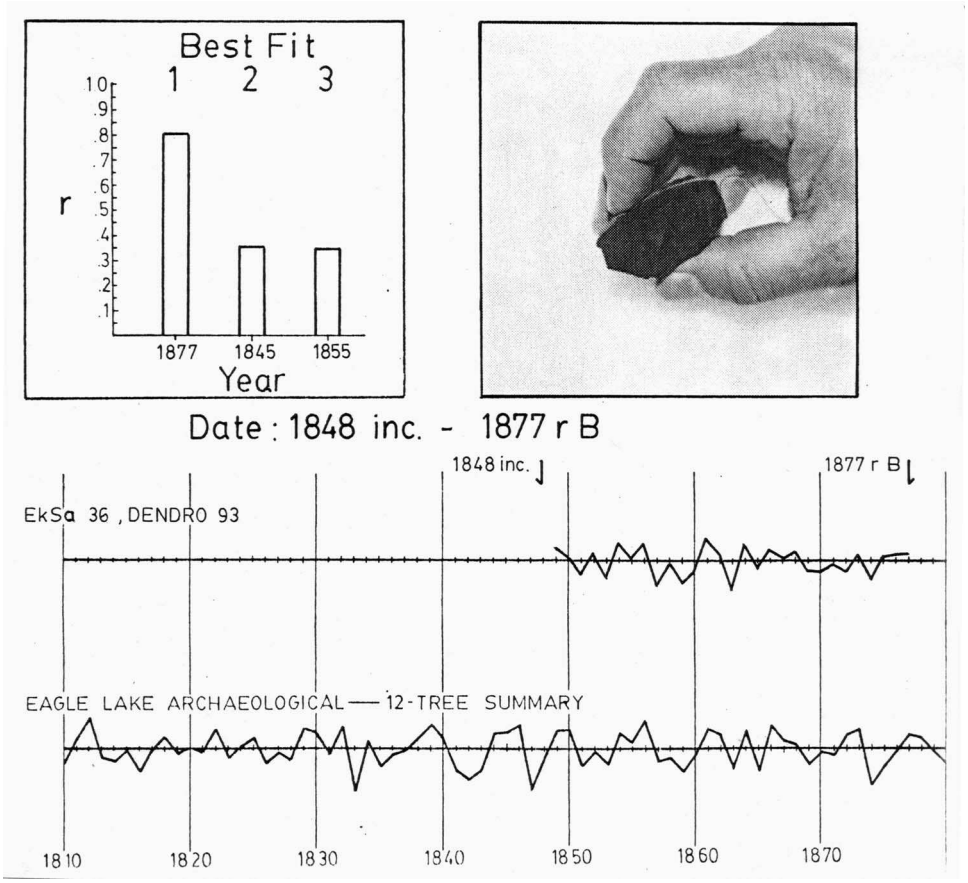

Figure VI-12. Dendro 93.

Master Series: Eagle Lake Archaeological–12-Tree Summary
Number of Ring Years = 79
Dated Interval = 1809 - 1887

Undated Series: Eagle Lake Archaeological – Dendro 93 EkSa 36 – Filtered Summary
Number of values = 29
Interval (Arbitrary) = 1849 -1877

Unit length = 29 Increment = 1

Undated Series unit	Last Ring on Undated series unit	Last Ring-Year of Best-Fit on Master			Correlation of Undated Series unit with Best-fit Master unit		
		First	Second	Third	First	Second	Third
1	1877	1877	1845	1855	0.809	0.355	0.350

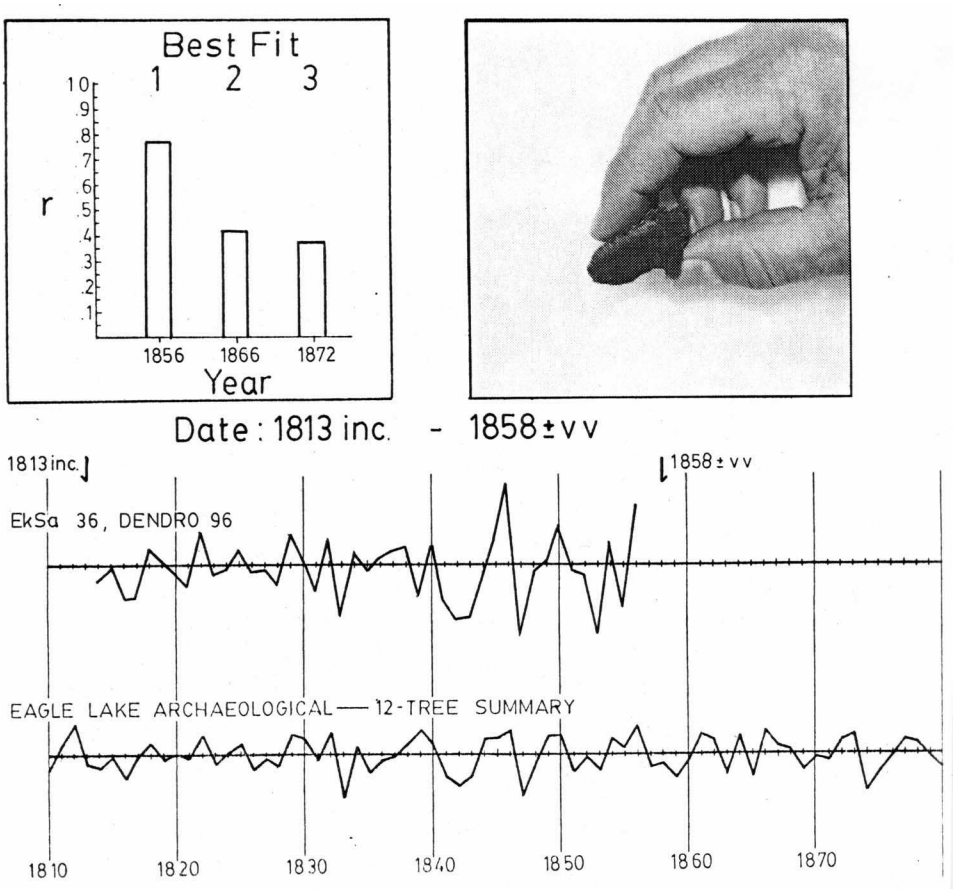

Figure VI-13. Dendro 96.

Master Series: Eagle Lake Archaeological–12-Tree Summary
Number of Ring Years = 79
Dated Interval = 1809 - 1887

Undated Series: Eagle Lake Archaeological – Dendro 96 EkSa 36 – Filtered Summary
Number of values = 43
Interval (Arbitrary) = 1814 -1856

Unit length = 43 Increment = 1

Undated Series unit	Last Ring on Undated series unit	Last Ring-Year of Best-Fit on Master			Correlation of Undated Series unit with Best-fit Master unit		
		First	Second	Third	First	Second	Third
1	1856	1856	1866	1872	0.776	0.422	0.376

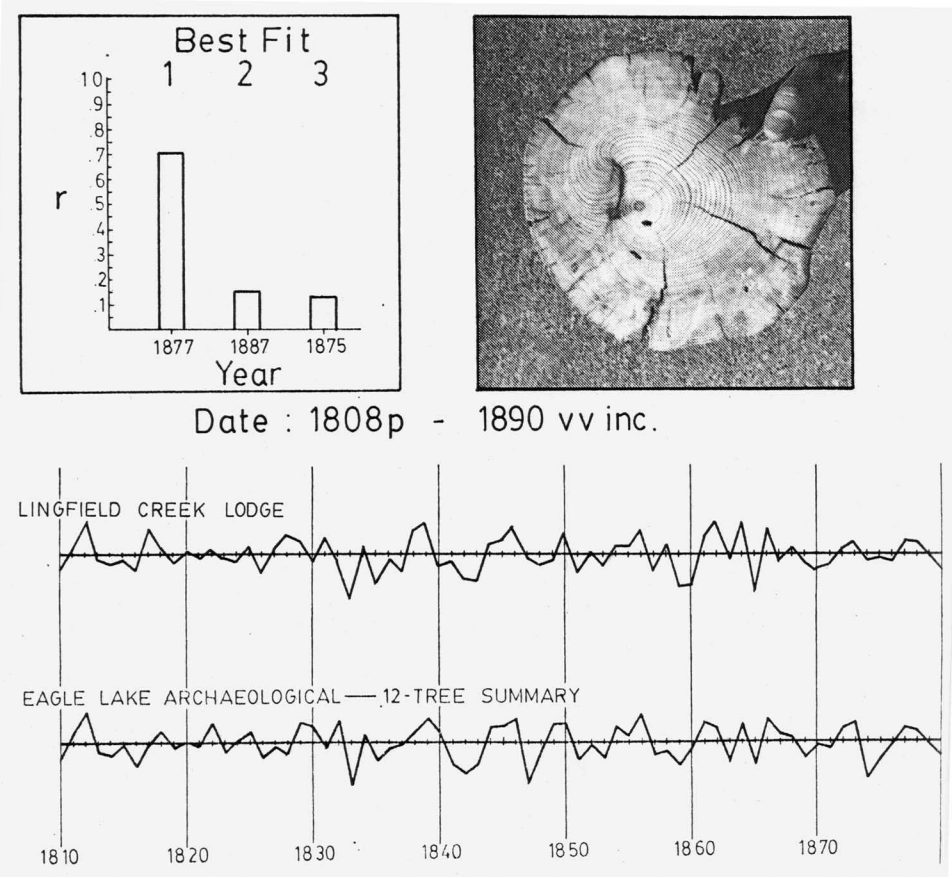

Figure VI-14. Dendro 96.

Master Series: Eagle Lake Archaeological–12-Tree Summary
Number of Ring Years = 79
Dated Interval = 1809 - 1887

Undated Series: Lingfield Creek Lodge – Shortened Interval – Filtered Summary
Number of values = 64
Interval (Arbitrary) = 1814 -1877

Unit length = 64 Increment = 1

Undated Series unit	Last Ring on Undated series unit	Last Ring-Year of Best-Fit on Master			Correlation of Undated Series unit with Best-fit Master unit		
		First	Second	Third	First	Second	Third
1	1877	1877	1887	1875	0.701	0.151	0.142

The ring series of the Lingfield Creek Lodge sample was compared with the composite chronology for the years 1814-1877, although the sample was actually measured to 1887. This was done so that the correlation comparison would be more comparable to those of the other samples. A ring count was made on this disk from 1887 to 1890 for a date of 1890 vv inc.

9. Using SUDP again, the Lingfield Creek Lodge ring series was crossdated with a living-tree lodgepole pine chronology derived from trees located near Goosenob Lake which is near the EkSa 36 site.

10. The dating of the five samples from EkSa 36 and the Lingfield Creek Lodge sample was verified by a number of computer cross dating runs, using different combinations of archaeological tree-ring chronologies and comparing them with various living-tree chronologies derived from trees in the Eagle Lake area and other sites in the British Columbia Interior. Both broken line plot comparison and computer crossdating were used at this point.

11. The ring widths were measured on all other potentially useful samples and their ring series were compared with the various dated chronologies.

12. Some additional dates were obtained for a total of eleven from EkSa 36 plus the Lingfield Creek Lodge sample (Figures VI-3, -14).

Further verification of the dating of the twelve archaeological tree-ring samples was accomplished by crossdating the EkSa 36 11 tree summary, the Lingfield Creek Lodge sample and the 12 tree archaeological summary with a number of living-tree master chronologies from the British Columbia Interior. The broken-line plot comparison of this is shown in Figure VI-15.

Summary and Conclusions

Forty archaeological tree-ring samples from three sites in the Eagle Lake area were examined. Twelve tree-ring dates were obtained and this represents virtually all of the samples that are of dateable quality. Living-tree chronologies were built for lodgepole pine and Douglas fir.

Observations and conclusions are:

1. Lodgepole pine can be used for tree-ring dating.

2. Trees growing in the Eagle Lake area are of adequate quality for dendrochronological purposes.

3. The archaeological tree-ring samples excavated are almost exclusively lodgepole pine .

4. Charcoal is much better preserved than wood at these open sites.

5. Samples treated with paraffin and gasoline were much better preserved than the untreated ones.

6. Both ring width and ring density are useful for cross-dating purposes.

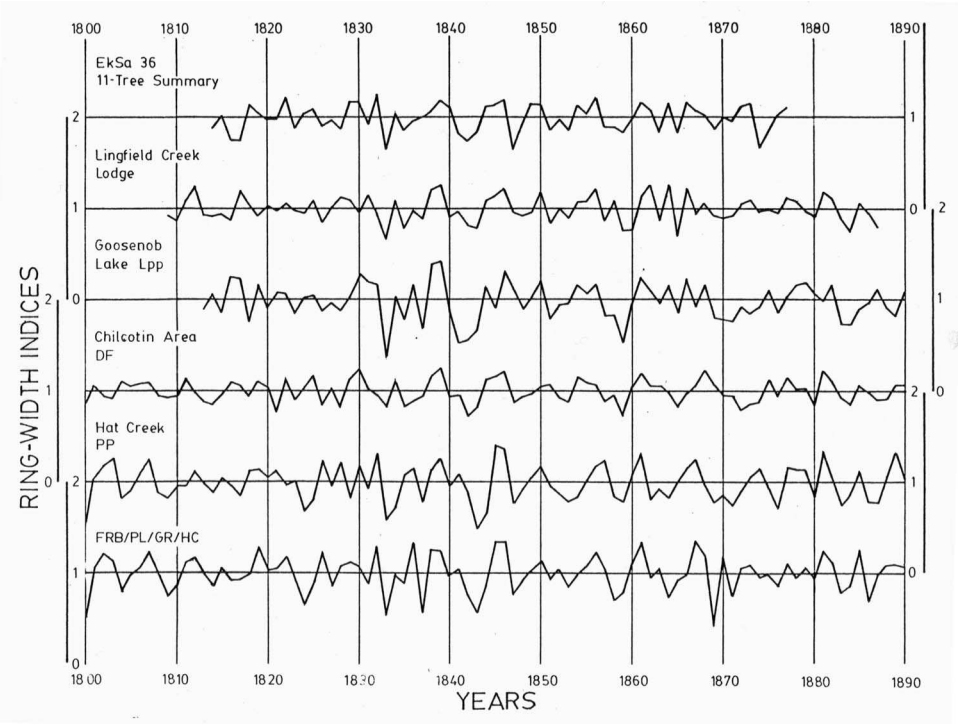

Figure VI-15. Broken-line plots of two archaeological tree-ring chronologies (EkSa 36 and Lingfield Creek lodge) with four living tree chronologies. (Details of living tree chronologies are reported elsewhere.)

7. Some Douglas fir trees live to be at least 600 years old in the area.

8. Douglas fir trees generally live to be much older than lodgepole pine trees.

9. Dates were obtained from about one third of the samples examined.

10. Almost all of the undated samples were not of dateable quality because they contained too few rings.

11. Although many of the samples collected are of poor dendrochronological quality, the quality of the samples cannot be assessed easily in the field without damaging them. For this reason, almost all samples excavated should be submitted for dendrochronological analysis and saved or discarded by the dendrochronologist in the laboratory.

12. Tree-ring dates range from cutting dates of 1851 to 1877 for samples from EkSa 36.

13. The most common cutting date for EkSa 36 samples is 1877.

14. The Lingfield Creek Lodge beam dated at 1890 vv incomplete.

15. None of the four samples from EkSa 32 was of dateable quality.

16. Dating techniques used were visual comparison, broken-line plot comparison of ring-width indices, and computer cross-dating.

17. The Lingfield Creek lodge sample matched well with samples from living lodgepole pine trees.

18. The annual ring formed in 1811 on the Lingfield Creek lodge beam was damaged by a fire.

19. The summary chronologies of the Eagle Lake archaeological samples cross-date well with the living-tree chronologies in that area and crossdating with other more distant areas can be realized if computer crossdating is used.

20. Cross correlation comparisons were made for many combinations of archaeological and living-tree chronologies. This provides a basis for evaluating crossdating between species, areas, and other variables.

21. Six new living-tree chronologies were built for the Eagle Lake area. This furnishes a foundation for future tree-ring dating in the area and adjacent regions.

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