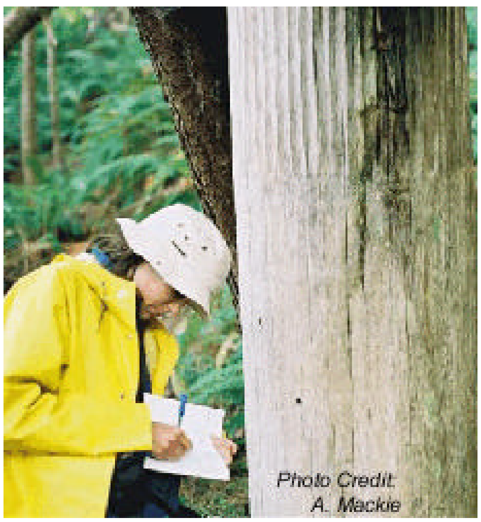
Dendroarchaeological Investigations at Kiix?in National Historic Site, Vancouver Island, BC

Investigative Report of Wood Elements



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UVTRL Report 2003-01

Acknowledgements

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1. Introduction

Kiix?in represents one of the few traditional Nuu-chah-nulth villages with standing house remains. According to wood conservator Mary-lou Florian (2001:2), the hand-hewn posts and beams at Kiix?in outline traditional-style bighouses built around the "1820-30's at the time when the Huu-ay-aht reclaimed their village from the Clallam tribe". The Huu-ay-aht occupied the village until the 1880s or early 1890s, when they moved to nearby Diana Island.

The beams and posts of the Kiix?in bighouses are hewn from mature Western redcedar (*Thuja plicata*) trees. Despite being abandoned over a century ago, eight bighouses remain in various states of preservation. While the beams of the bighouses have partially or completely collapsed, many remain solid beneath a thin perimeter of weathered wood. Many of the corner posts remain upright and a few still display fluted ornamentation.

In August, 2002, with the permission of the Huu-ay-aht people and with the support of Parks Canada, researchers from the University of Victoria Tree-Ring Laboratory (UVTRL), completed a dendroarchaeological investigation of the remaining posts and beams at Kiix?in. The intention of these investigations was to use standardized dendroarchaeological research techniques to establish when the Kiix?in bighouses were constructed

2. Research Methods

The science of dendrochronology is based on the fact that trees produce an annual radial growth increment (Cook and Kairiukstis 1990; Baillie 1995). Because the annual radial growth characteristics of adjacent trees of the same species are similar, a master chronology can be developed to describe these growth characteristics over the length of the stand's life span. Undated samples can be crossdated into this master chronology to identify when they were alive.

Chronology building and cross dating provide a simple and effective tool for the dendroarchaeological dating of historic structures (Pilcher 1983; Baillie 1995; Smith *et al*. 1999). In order to determine the date of construction of the various bighouses at Kiix?in, sampling was completed in a manner that caused minimal damage to the structure. This was accomplished by extracting tree core samples from the beam and posts with the use of a two-thread 5 mm increment corer. Whenever possible, the hole created by the corer was filled with a cork plug to discourage weathering.

Increment core samples were extracted from some 60 wood elements. The majority of these samples came from beams (n=39), only a limited number (n=21) came from standing or collapsed posts. For the most part the beams proved to be reasonably solid. Surface rotting and perimeter wood loss was, however, evident on beams located both suspended above and lying on the ground.

By contrast, many of the posts were partially or completely rotted. This limited their dendroarchaeological utility, as does the fact that many appeared to have been more carefully and thoroughly 'dressed' than the beams.

Two increment core samples were extracted, approximately 180° apart, from each beam and post. The samples were transported in plastic straws to the UVTRL where they were prepared, counted, and measured. Each core sample was prepared according to standard dendroarchaeological procedures (Stokes and Smiley 1996). After air-drying, each core was glued into a grooved board, labelled, and prepared for analysis by sanding with progressively finer grades of sand paper (100 to 800 grit). Cores were then hand-polished to enhance the definition and contrast of the annual tree-ring boundaries.

All the increment core samples were examined a minimum of three times using digital and manual measuring systems. Samples were first converted to high-resolution digital images (800 to 2000 DPI) with an Agfa Duoscan scanner. Annual rings were then counted and measured to the nearest ±0.01mm using a WinDENDRO (2002a) digital tree-ring image processing system (Guay *et al*. 1992). Counts of the annual rings were repeated on a Velmex-type measuring stage using a Wild M3B stereomicroscope until the total number of rings counted could be replicated a minimum of three times. Any significant anomalies in the annual rings, such as scars or distinctly wide or narrow rings, were recorded. Each set of measured ring-widths was visually crossdated to a series of narrow marker rings. The crossdated time-series were then quality checked using the International Tree-Ring Data Bank (ITRDB) software program COFECHA (Holmes, 1983, 1999). Any erroneous segments were then corrected (i.e., remeasured) or deleted from the data set until a statistically significant floating chronology was produced (Holmes 1983, 1999).

The floating chronologies were subsequently compared to a locally prepared Western redcedar master chronology to determine when the trees used to construct the Kiix?in bighouses were felled. Increment cores were extracted from thirty-eight living Western redcedar trees located along the shoreline (n=20) and within the adjacent forest (n=18). Figure 1 presents a graphic representation of the master Kiix?in Western redcedar chronology used in this analysis. Changes in the annual tree ring-width indices are plotted as a function of time.

The master chronology spans the interval between 1511 to 2002 AD (series correlation 0.431; mean sensitivity 0.168; autocorrelation 0.8). Growth trends in the early part of the Kiix?in Western redcedar chronology are quite variable and likely an artefact of the limited sample depth. Intervals of reduced growth rates occur from 1600 to 1650, 1690 to 1765, 1800 to 1820, and 1835 to the 1860's AD. Lesser episodes of reduced growth occur in the 20th century, from 1915 to 1930 and again in the 1970's. Notable intervals of above average growth occurred in the late 1600s, late 1700's, and early 1900's AD.

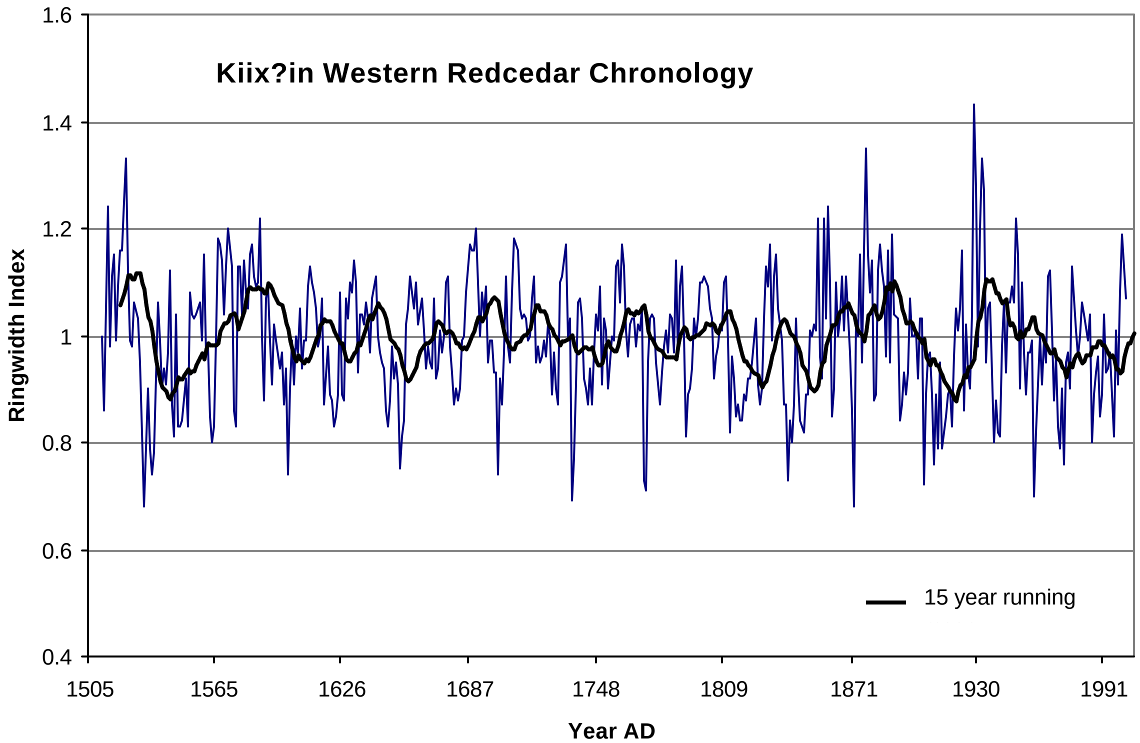


Figure 1. The Kiix?in Western redcedar master tree-ring chronology (1511 to 2002 AD). The 15-year running mean emphasizes extended periods of enhanced and reduced tree-ring growth.

The Kiix?in Western redcedar master chronology was examined to confirm that climatic variables were responsible for limiting radial growth. Figure 2 shows the growth response of the Kiix?in redcedar master chronology to temperature and precipitation data from the Port Alberni climate station (1900-1990 AD). The figure illustrates the amount of variation in ring-width explained by temperature and precipitation over a 15-month interval, from June of the previous year to August of the growth year. A 15-month growth period was used to capture the annual growth signal, as coniferous trees are often influenced by growth in the preceding year. This response function analysis reveals a strong positive response to mean June temperature of the growing season. Of the 54 percent variation in annual radial growth explained by the climate response function, almost equal proportions are attributed to climate in the growth and proceeding year. In the Kiix?in study, discovery of this climate-radial growth relationship validates the potential utility of the chronology for cross-dating purposes.

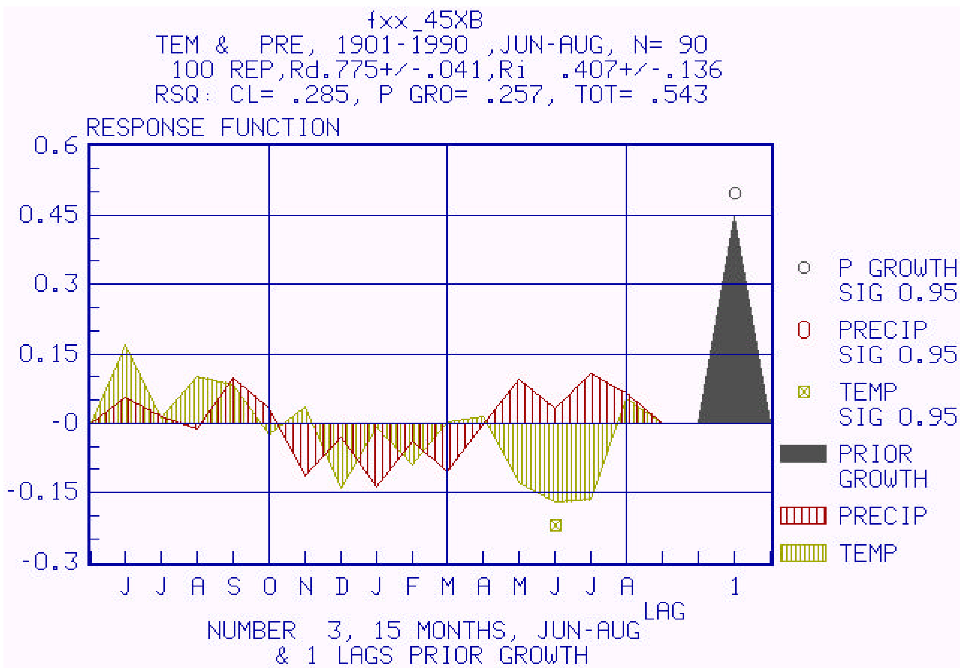
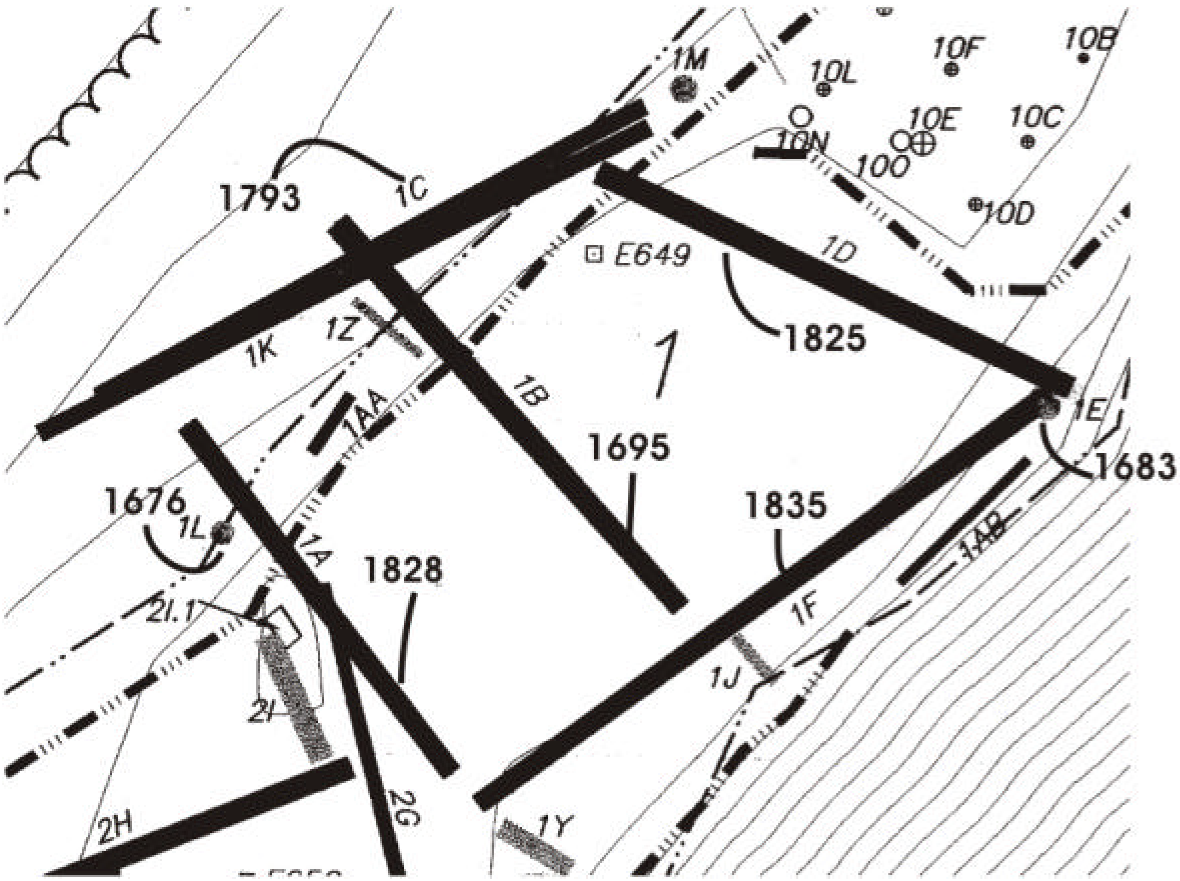


Figure 2. Response function analysis of the relationship between climate parameters and radial growth inherent in the Kiix?in Western redcedar master chronology. The analysis reveals a strong positive response to mean June temperature of the growing season. Of the 54 percent variation in annual radial growth explained by the climate response function, almost equal proportions are attributed to climate in the growth year and in the proceeding year.

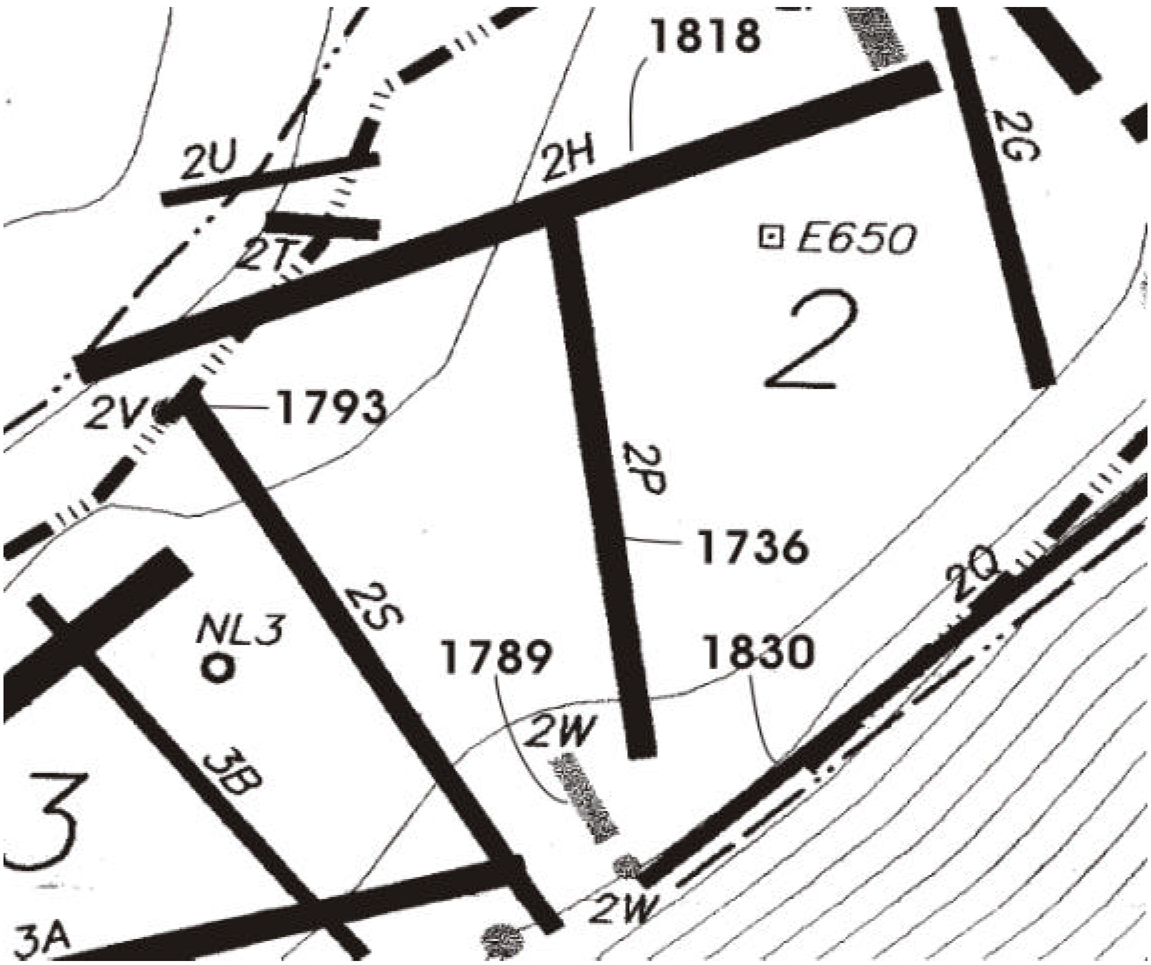
3. Results

The results of the dendroarchaeological survey of the Kiix?in bighouses are summarized in Appendix 1. Figures 3 to 11 present the dates assigned to the outermost ring of each wood element at the eight Kiix?in bighouses. Of the 60 posts and beams from which samples were recovered, successful perimeter cross-dates were established for 34. The majority of cross-dates were determined for beams (21 of 39) and only a small proportion of the posts were successfully cross-dated (9 of 21). While some beams had fewer than 50 years intact tree-rings (e.g. 4C), a number had greater than 250 years measureable annual rings (e.g. 2H). Similarly the posts proved to have a variable number of annual rings present, ranging from less than 100 (e.g. 8C) to more than 290 (e.g. 2O). These ring counts should be considered as a minimum, however, as most of the wood elements had weathered perimeters and /or rotten interiors. Furthermore, as noted previously, many of the posts sampled had been dressed.



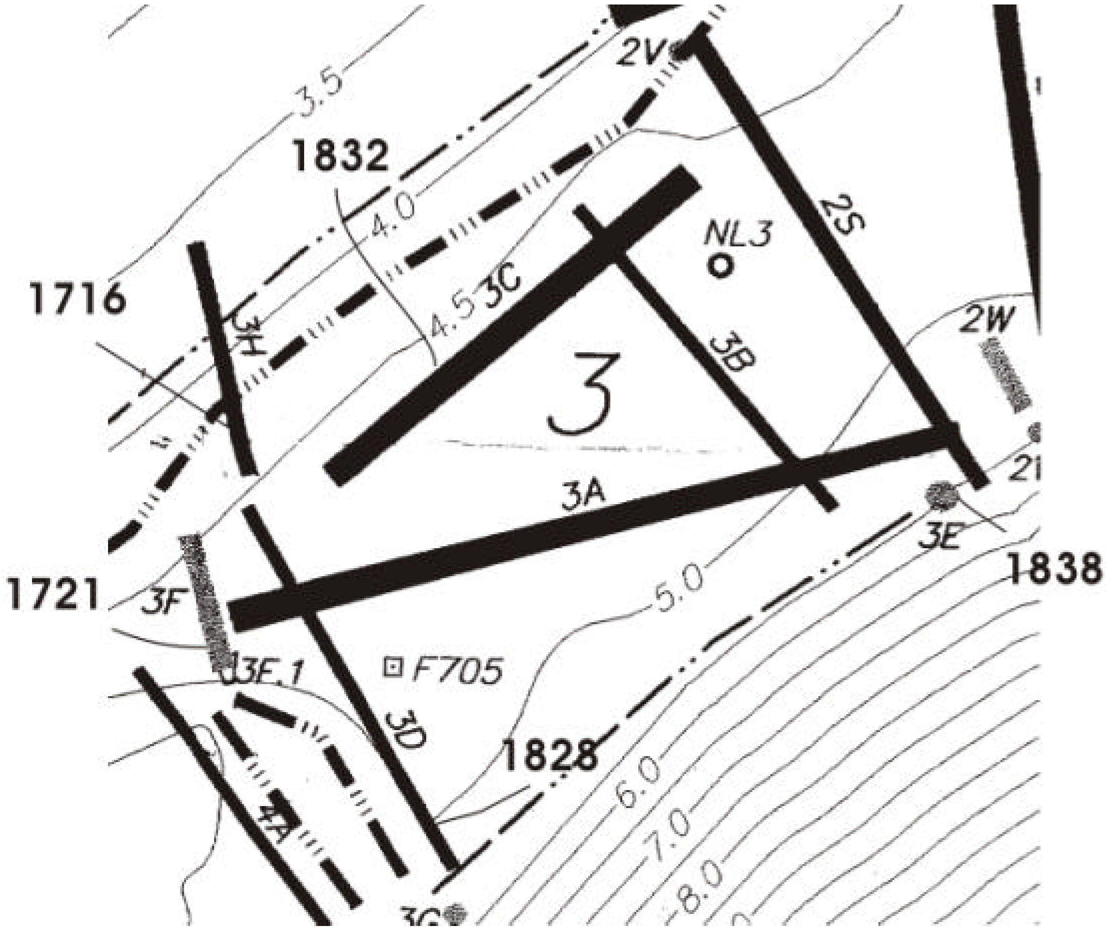
UVTRL #	2002 Structural Element		Maximum Number Rings	Outermost Tree-ring Age
	No.	**Description**		
HKS1A	1A	Beam	249	1828
HKS1B	1B	Beam	158	1695
HKS1C	1C	Beam	96	1793
HKS1D	1D	Beam	183	1825
HKS1E	1E	Post	177	1683
HKS1F	1F	Beam	87	**1835**
HKS1L	1L	Post	162	1676

Figure 3. Outermost tree-ring age at Kiix?in bighouse #1.



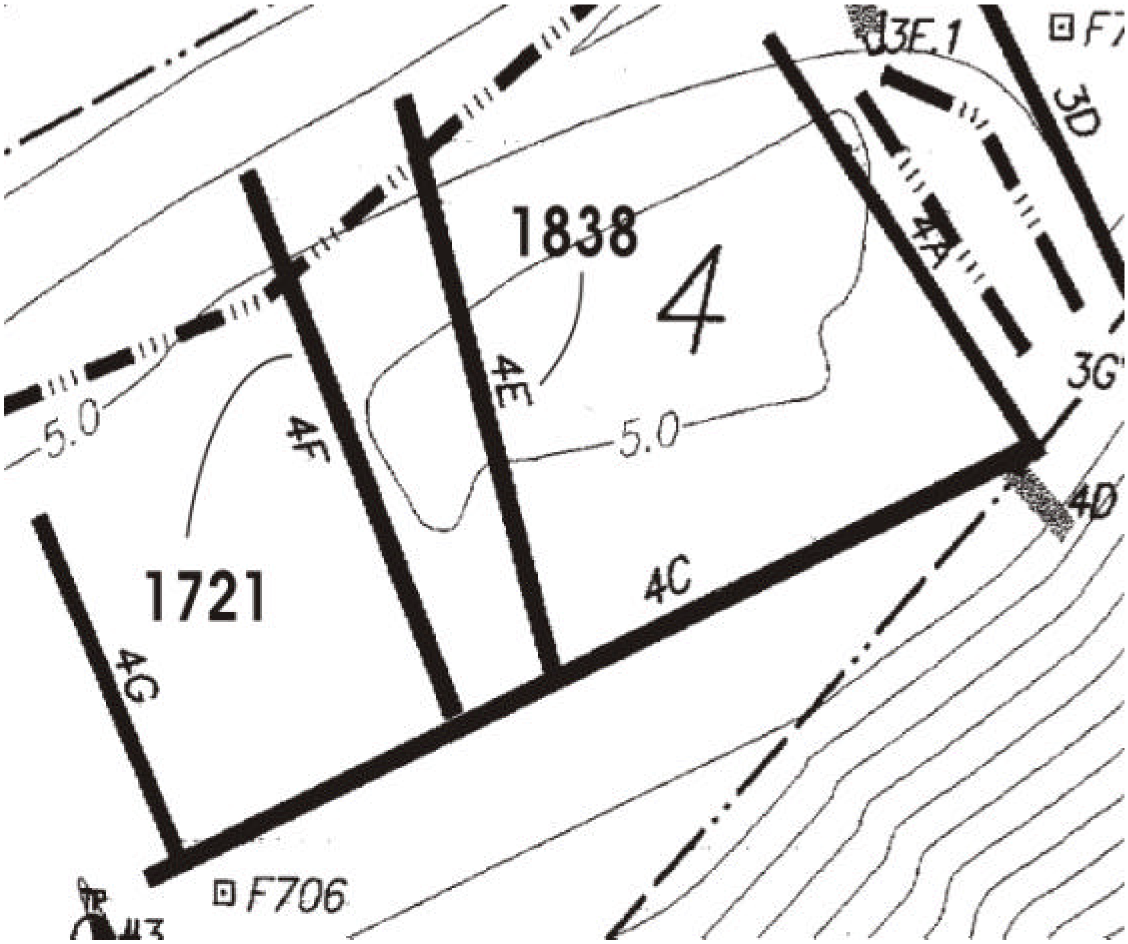
UVTRL #	**2002 Structural Element**		**Maximum Number Rings**	**Outermost Tree-ring Age**
	No.	**Description**		
HKS2H	2H	Beam	264	1818
HKS2P	2P	Beam	90	1736
HKS2Q	2Q	Beam	88	**1830**
HKS2V	2V	Post	138	1793
HKS2W	2W	Beam	109	1789

Figure 4. Outermost tree-ring age at Kiix?in bighouse #2.



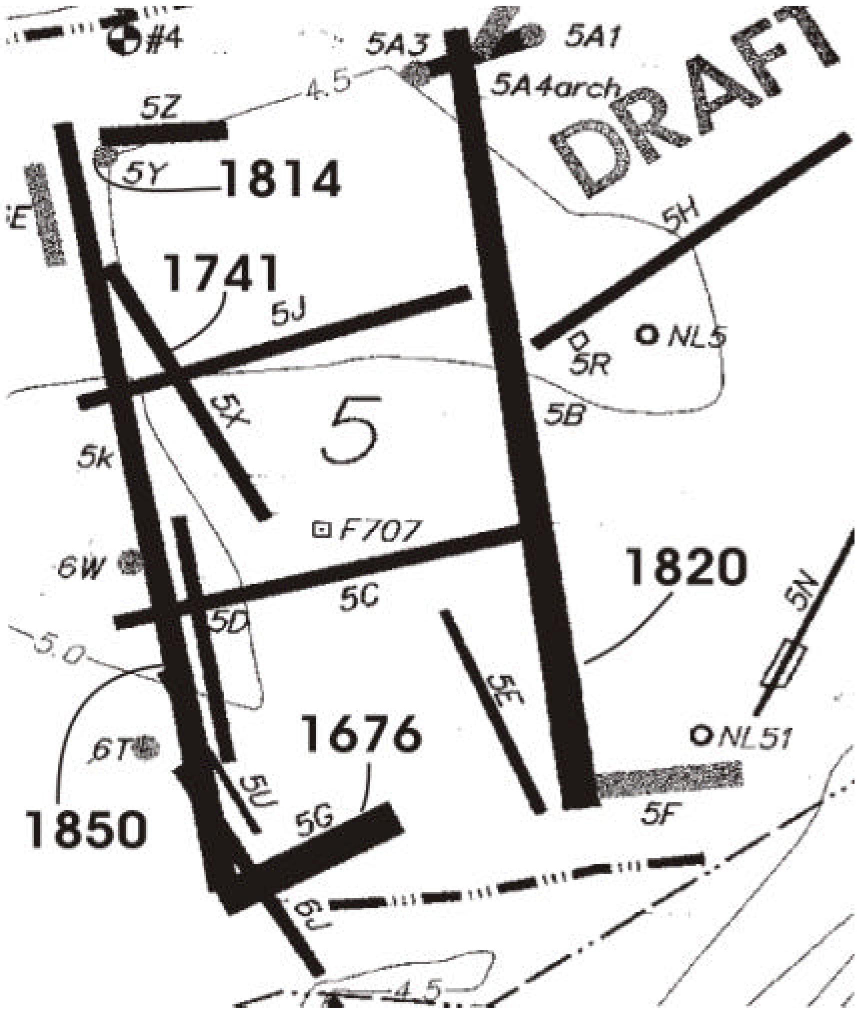
UVTRL #	2002 Structural Element		Maximum Number Rings	Outermost Tree-ring Age
	No.	Description		
HKS3C	3C	Beam	130	1832
HKS3D	3D	Beam	212	1828
HKS3E	3E	Post	99	**1838**
HKS3F	3F	Beam	97	1721
HKS3Y1	3H	Beam	139	1716

Figure 5. Outermost tree-ring age at Kiix?in bighouse #3.



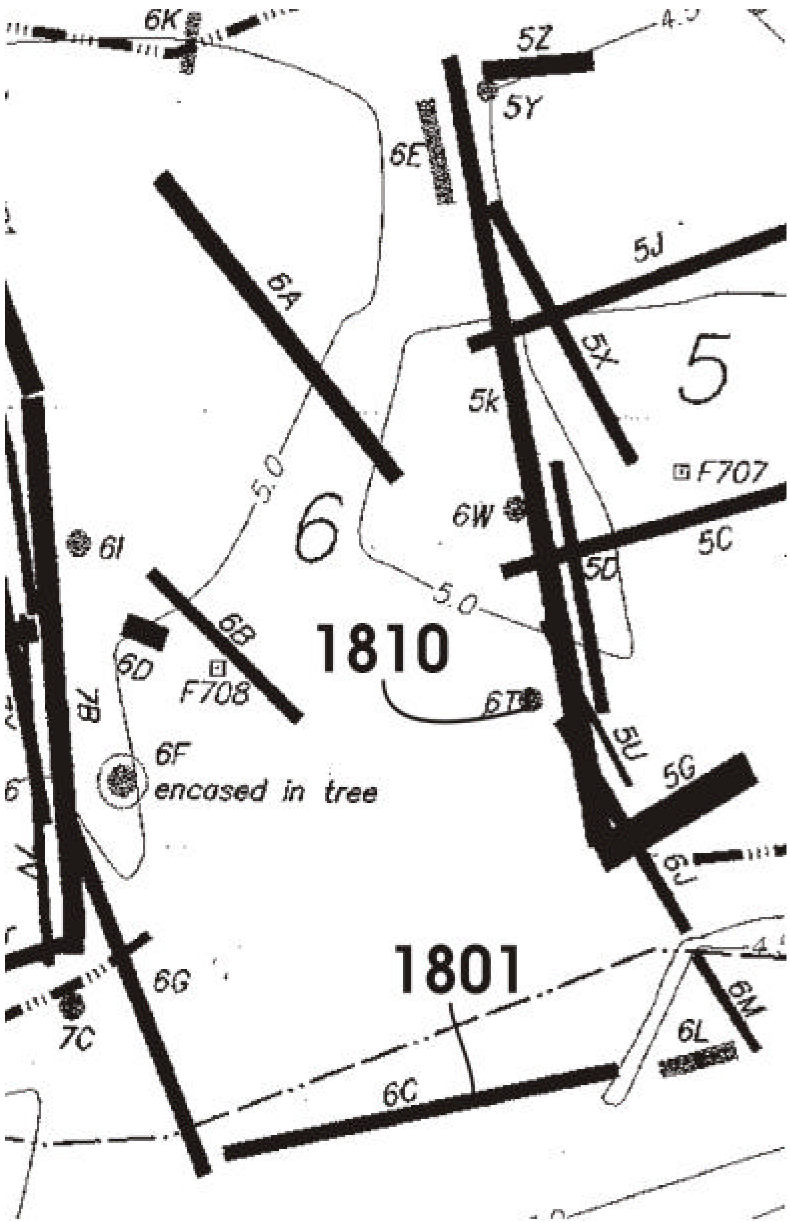
UVTRL #	2002 Structural Element		Maximum Number Rings	Outermost Tree-ring Age
	No.	Description		
HKS4E	4E	Beam	93	**1838**
HKS4F	4F	Beam	93	1721

Figure 6. Outermost tree-ring age at Kiix?in bighouse #4.



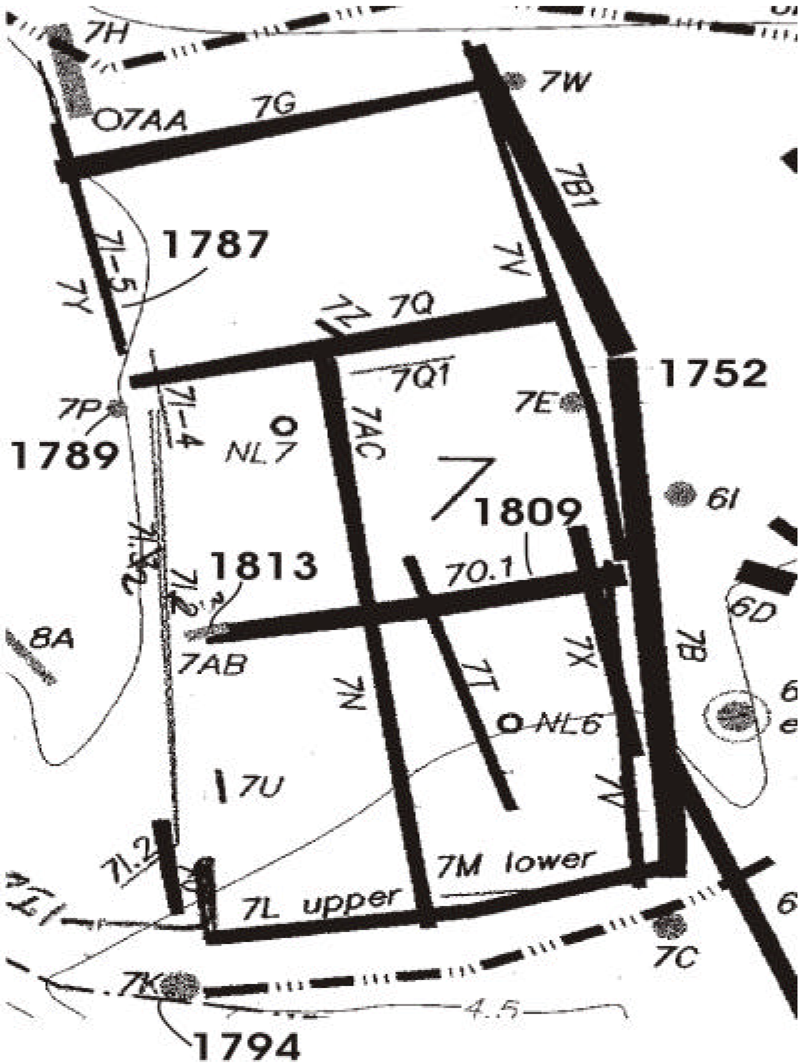
UVTRL #	2002 Structural Element		Maximum Number Rings	Outermost Tree-ring Age
	No.	Description		
HKS5B	5B	Beam	188	1820
HKS5G	5G	Beam	177	1676
HKS5K	5K	Beam	149	**1850**
HKS5X	5X	Beam	76	1741
HKS5Y	5Y	Post	142	1814

Figure 7. Outermost tree-ring age at Kiix?in bighouse #5.



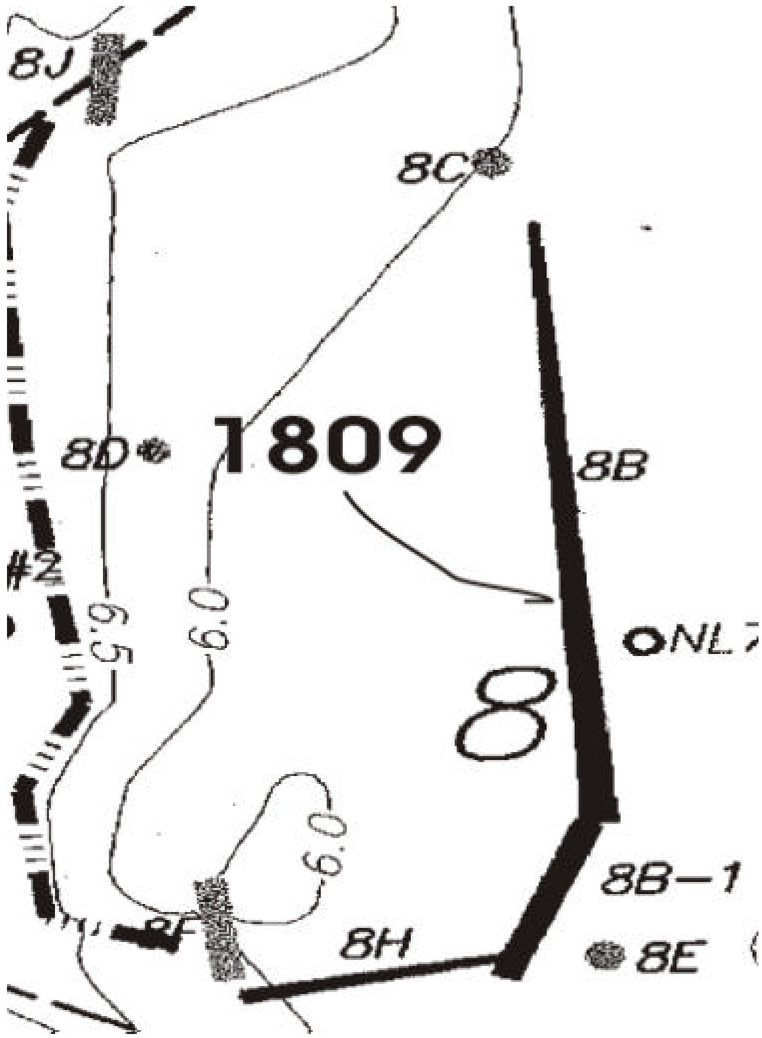
UVTRL #	2002 Structural Element		Maximum Number Rings	Outermost Tree-ring Age
	No.	Description		
HKS6C	6C	Beam	79	1801
HKS5T	6T	Post	216	**1810**

Figure 8. Outermost tree-ring age at Kiix?in bighouse #6.



UVTRL #	2002 Structural Element		Maximum Number Rings	Outermost Tree-ring Age
	No.	Description		
HKS7A	7AB	Post	123	**1813**
HKS7B	7B	Beam	157	1752
HKS7K	7K	Post	142	1794
HKS7M	7M	Beam	87	1805
HKS7O	7O	Beam	100	1809
HKS7P	7P	Post	80	1789
HKS7Y	7Y	Beam	61	1787

Figure 9. Outermost tree-ring age at Kiix?in bighouse



UVTRL #	2002 Structural Element		Maximum Number Rings	Outermost Tree-ring Age
	No.	Description		
HKS8B	8B	Beam	52	1809

Figure 10. Outermost tree-ring age at Kiix?in bighouse #8.

4. Discussion

A dendroarchaeological survey of eight Huu-ay-aht bighouses at Kiix?in on Vancouver Island shows that they were constructed of Western redcedar trees felled in the 19th century (Figure 11). While this observation substantiates earlier findings, the perimeter dates established for several of the bighouses suggest that at least some of the structures were built somewhat later than previously suggested. This is certainly true in the case of Houses #1, 3, 4, and 5, where the outermost cross-dated tree rings date to greater than 1835 AD. As the amount of perimeter wood loss due to weathering and preparation is difficult to ascertain, no precise felling or construction date can be presented.

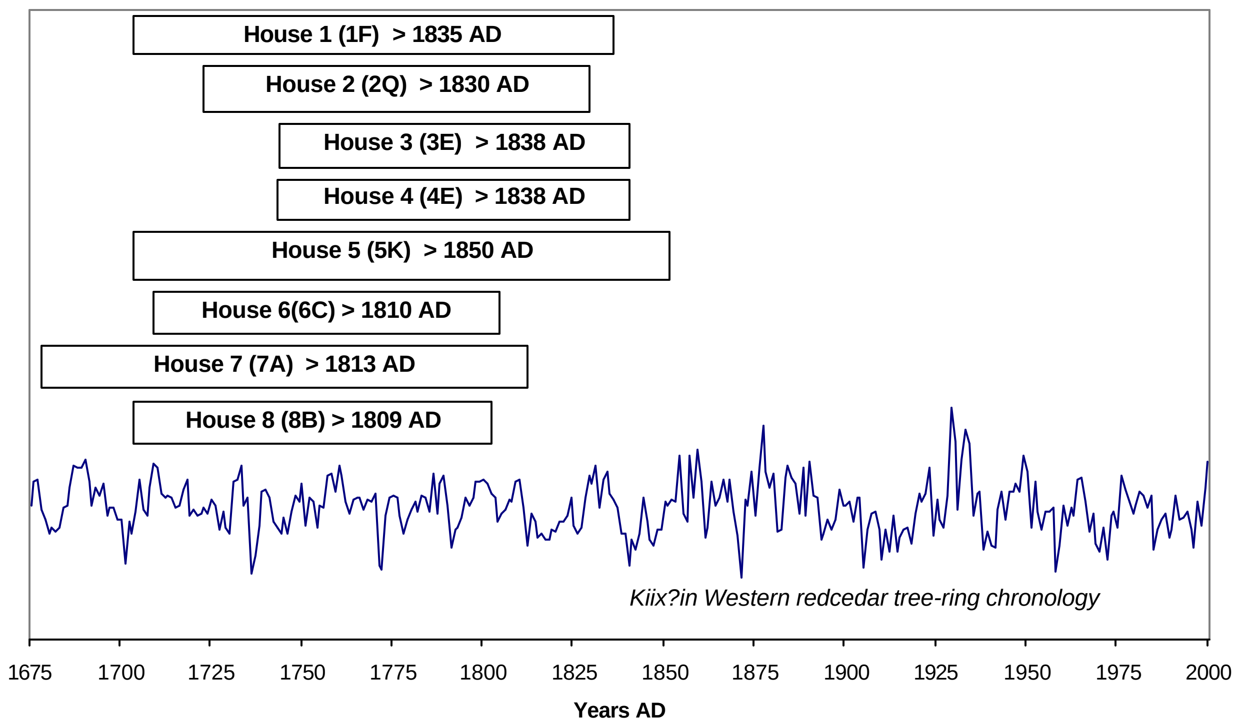


Figure 11. The duration and outermost tree-ring date of individual wood elements at each Kiix?in bighouse sampled in 2002. The dates assigned to bighouses 6 to 8 suggests they may predate the other structures by 20 to 25 years.

Additional findings of the survey include:

1. Recognition that Houses 6, 7 and 8 may predate the other structures by 20 to 25 years. While multiple cross-dates and Houses 6 and 7 seem to substantiate this conclusion, only a single cross-date supports this interpretation at House 8 (Appendix A).

2. Observation that, while incomplete ring sequences (pith to perimeter) due to rotting and weathering were commonplace, none of the wood elements sampled was older than 300 years. A large number appear to have been *ca*. 200 years old when felled. Incomplete tree-ring sequences (pith to perimeter) due to surface weathering and interior rotting are partially responsible for the large number of relatively 'young' ages described in Appendix 1.

3. Suggestion that the corner posts used in the construction of individual bighouses may come from individual trees. This was particularly notable in the case of House 2. More detailed studies would be required to confirm this.

4. Observation that most posts were constructed from older trees with tight tree-ring sequences. Presumably these more substantive elements provided structural strength to the bighouses.

5. Observation that, in some cases, dressing and decorating of individual corner posts (e.g. 1E, 1L; Appendix 1) resulted in the loss of greater than 100 years of tree-ring record.

   By contrast, a few individual posts (e.g. 2V, 3E, 5T; Appendix 1) have 'young' perimeter cross dates. This observation suggests that some of the posts used to construct the bighouses were not decorated/dressed prior to being incorporated into the structures.

6. Observation that the wood elements at Kiix?in are in variable states of preservation. While all of the posts and beams show some degree of surface weathering/rotting, the interior of most beams remains remarkably solid. It should be noted, however, that a number of beams have rotten centres and/or missing pith areas.

   By contrast, many of the Kiix?in posts are in various states of disintegration. While this is obvious in some cases, a number of the seemingly 'solid' posts have 'mushy' interiors. A few posts (e.g. 5Y, 6T; Appendix 1) were solid throughout.

7. Observation that the nurse trees found growing on the Kiix?in bighouses range upwards to +60 years in age. While only a limited number of these were sampled, it does emphasize the difficulties the Huu-ay-aht face as they develop a management plan.

8. It was not possible to confidently cross-date a significant proportion of the samples. Many could not be cross-dated because they contained too few tree rings in total and/or becuases they did not contain distinctive tree ring sequences. A few elements with a large number of rings also did not cross-date. The reasons for this vary, but seem partially related to overriding forest gap dynamics that reduced on their inherent climatic signal.

5. Summary

A dendroarchaeological survey of eight Huu-ay-aht bighouses at Kiix?in on the west coast of Vancouver Island was undertaken in the summer of 2002. Standardized dendroarchaeological techniques were employed to collect and analyze increment core samples collected from 60 post and beams. Floating ringwidth series were compared to a locally prepared Western redcedar master chronology (1511 to 2002 AD) to determine when the trees used to construct the Kiix?in bighouses were felled. The findings of the survey indicate that several of the bighouses were built after 1835 AD, somewhat later than previously suggested. As the amount of perimeter wood loss due to weathering and preparation is difficult to ascertain, no precise felling or construction date can be presented.

The results of this dendroarchaeological survey provide additional insights into Kiix?in history and offer direct evidence for the general state of preservation of individual posts and beams. Additionally, the successful dating of a traditional Nuu-chah-nulth village using a dendroarchaeological approach highlights the potential this technique may hold for developing similar insights at other sites along Canada's Pacific Coast.

6. References

Baillie, M.G.L. 1995. *A Slice Through Time: Dendrochronology and Precision Dating*. B.T. Batsford Ltd., London. 176 pp.

Cook, E.R.; and Kairiukstsis, L.A. 1990. *Methods of Dendrochronology: Applications in the Environmental Sciences*. Kluwer Academic Publishers, Dordrecht. 394 pp.

Holmes, R. L., 1983: Computer-assisted quality control in tree-ring dating and measurement. *Tree-Ring Bulletin* 43:69-75.

Holmes, R. L., 1999: Documentation for programs in the Dendrochronology Program Library and the Dendroecology Program Library. 14 pp.

Pilcher, J.R. 1983. Radiocarbon calibration and dendrochronology - an introduction. In: *Archaeology, Dendrochronology and the Radiocarbon Calibration Curve.* Edited by B.S. Ottawa. University of Edinburgh, Edinburgh, Occasional Paper No. 9: 5-14.

Smith, D.J.; Ferbey, T.; and Laroque, C.P. 1999. *Tree-Ring Dating of Log Cabin, Tangle Creek, Jasper National Park, 1998 (Parks Canada Archaeological Inventory Site #1700R).* Report prepared for Parks Canada. University of Victoria Tree-Ring Laboratory. Department of Geography, University of Victoria. UVTRL Report 99-01.

Stokes, M. A. and Smiley, T. L., 1996: *An Introduction to Tree-Ring Dating.* The University of Arizona Press, Tucson. 73 pp.

Appendix 1. Dendroarchaeological findings at Kiix?in bighouses.

House No. (UVTRL Sample No.)	2002 Structural Element		Notes	Number of Annual Rings Sampled	Crossdated Age of Element
	No.	Descrip.			
HOUSE 1					
HKS1A1 HKS1A2	1A	Beam	- perimeter wood loss, sampled east side	163 249	1627-1789 1580-1828
HKS1B1 HKS1B2	1B	Beam	- perimeter wood loss and rotten interior	101 158	 1538-1695
HKS1C1 HKS1C2	1C	Beam	- perimeter wood loss, sampled underneath	45 96	 1698-1793
HKS1D1 HKS1D2	1D	Beam	- rotten center, sampled east side	174 183	 1643-1825
HKS1E1 HKS1E2	1E	Post	- fluted corner post, spongy interior	171 177	1511-1683
HKS1F1 HKS1F2	1F	Beam	- lots perimeter wood loss, sampled south	86 87	1704-1789 1751-1835
HKS1L1 HKS1L1	1L	Post	- outer rings missing, rotten in center	162 76	1511-1672 1601-1676
HKS1M1 HKS1M2	1M	Post	- spongy, water-filled	190 160	
HKS1Y1 HKS1Y2	1Y	Post	- leaning post, some fluting on post top	91 120	

HOUSE 2					
HKS2G1 HKS2G2	2G	Beam	- solid beam	37 44	
HKS2H1 HKS2H2	2H	Beam	- solid core, no bark, spongy center	264 262	1538-1801 1557-1818
HKS2I1 HKS2I2	2I	Post	- spongy, very rotted	 42	
HKS2O1 HKS2O2	2O	Post	- no bark, solid, old-growth	274 290	
HKS2P1 HKS2P2	2P	Beam	- rotten perimeter and interior	64 90	1673-1736
HKS2Q1 HKS2Q2	2Q	Beam	- spongy outside, but solid core	88 82	1722-1809 1799-1830
HKS2S1 HKS2S2	2S	Beam	- solid core	58 67	
HKS2T1 HKS2T2	2T	Beam	- rotten and spongy		
HKS2V1 HKS2V2	2V	Post	- solid in places, mushy overall	127 138	1668-1794 1659-1793
HKS2W1 HKS2W2	2W	Post	- weathered	109 99	1681-1789 1682-1780

House 3					
HKS3A1 HKS3A2	3A	Beam	- solid, moss-covered	85 78	
HKS3B1 HKS3B2	3B	Beam	- rotten inside	29 39	
HKS3C1 HKS3C2	3C	Beam	- outer perimeter mushy, interior solid	110 130	1719-1828 1703-1832
HKS3D1 HKS3D2	3D	Beam	- no bark, fairly solid, quite wet	212 169	1602-1813 1657-1828
HKS3E1 HKS3E2	3E	Post	- fairly rotten and messy cores	61 99	 1783-1838
HKS3F1 HKS3F2	3F	Post	- very rotten perimeter	97 43	 1549-1721
HKS3Y1 HKS3Y2	3H	Beam	- solid, old growth	139 129	1573-1711 1592-1716
House 4					
HKS4A1 HKS4A1	4A	Beam	- solid log	57 47	
HKS4C2 HKS4C2	4C	Beam	- rotten	37 37	
HKS4E1 HKS4E2	4E	Beam	- sampled area suspended above ground	56 93	 1787-1838
HKS4F2 HKS4F2	4F	Beam	- solid interior, but perimeter is rotten	93 77	 1549-1721
HKS4G1 HKS4G2	4G	Beam	- moss-covered lying on ground	26 27	

House 5					
HKS5B2	5B	Beam	- sampled 3 m from entrance	188	1644-1820
HKS5C1 HKS5C2	5C	Beam	- overall poor shape	20 112	
HKS5D1 HKS5D2	5D	Beam	- solid but moss-covered	106 120	
HKS5E1 HKS5E2	5E	Beam	- on ground, surface is rotten	28 38	
HKS5F1 HKS5F2	5F	Post	- leaning post, sampled underneath	177 173	
HKS5G1 HKS5G2	5G	Beam	-	49 49	1628-1676
HKS5H1 HKS5H2	5H	Beam	- on ground, poor cores	51 21	
HKS5K1 HKS5K2	5K	Beam	- rotten interior, very wet	149 94	1702-1850 1738-1831
HKS5X1 HKS5X2	5X	Beam	- solid core	63 76	 1666-1741
HKS5Y1 HKS5Y2	5Y	Post	- solid core	123 142	1666-1788 1673-1814

House 6					
HKS6A1 HKS6A2	6A	Beam	- front beam, sampled on west side, solid	84 57	
HKS6B1 HKS6B2	6B	Beam	- solid core, rotten in pith area	185 199	
HKS6C1 HKS6C2	6C	Beam	- half buried, rotten surface, solid interior	78 79	1720-1797 1723-1801
HKS6J1 HKS6J2	6J	Beam	- spongy exterior	52 60	
HKS6T1 KHS6T2	6T	Post	- corner post, good core	216 207	1595-1810

House 7					
HKS7A1 HKS7A2 HKS7A3	7AB	Post	- solid core, perimeter wood missing	52 123 50	1691-1813
HKS7B1 HKS7B2	7B	Beam	- spongy perimeter, rotten interior	114 157	1639-1752
HKS7C1 HKS7C2	7C	Post	- solid, ½ moon shape, roots running to grd	106 148	
HKS7E2	7E	Post	- no bark, axe marks, underside sampled	129	
HKS7G1	7G	Beam	- rotten	76	
HKS7K1 HKS7K2	7K	Post	- ½ moon shape like 7C, solid	128 142	 1653-1794
HKS7M1 HKS7M2	7M	Beam	- no bark, solid core	87 84	1718-1804 1727-1805
HKS701 HKS7O2 HKS7O3 HKS7O4	7O	Beam	- resting on ground, surface rot, nurse logs on top.	96 100 93 88	1710-1805 1716-1809
HKS7P1 HKS7P2	7P	Post	- surface rot	65 80	1725-1789 1689-1765
HKS7Y1 HKS7Y2	7Y	Beam	- mushy core		1726-1787

House 8					
HKS8B1 HKS8B2	8B	Beam	- sampled on east side, solid cores	52 30	1758-1809
HKS8Y1	8C	Post	- standing, lots of perimeter loss	41	
HKS8D1 HKS8D2	8D	Post	- broken top, no bark, rotten	49 59	
HKS8E1	8E	Post	- lots perimeter loss of tissue	46	