

THE USE OF TREE-RING ANALYSIS TO DETERMINE THE CONSTRUCTION DATE OF HISTORIC BUILDINGS IN SOUTHERN MANITOBA

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Introduction

Despite the proven success shown using tree-ring analysis in both archaeological and palaeoclimatological studies in Europe and the United States, the technique has not been widely applied in Canada (Baillie 1982; Bradley and Jones 1992). This is ironic considering the abundance of trees in Canada and the extensive use of logs in early Canadian building construction. Log cabins of various styles were often the first structures erected when pioneers homesteaded, and several building styles continue to be used up to the present day. Historic wooden buildings, or remnants of them, dating from the 17th, 18th and 19th Centuries are not uncommon in Eastern Canada. York Factory, on Hudson Bay, is probably the oldest wooden structure in Western Canada, dating in part from the 1790s. Charette House, originally situated along the Red River in St. Norbert, was reputedly built around 1811 (Shipley 1969:2). Unfortunately, only a single metre-long oak timber remains of this house. Other oak structures were constructed along the Red and Assiniboine rivers during the last century. Some of these structures, such as the Brown House (Fig. 1), have been relocated to a second site. Others, such as the Barber House or the St. Boniface Museum, remain in their original location.

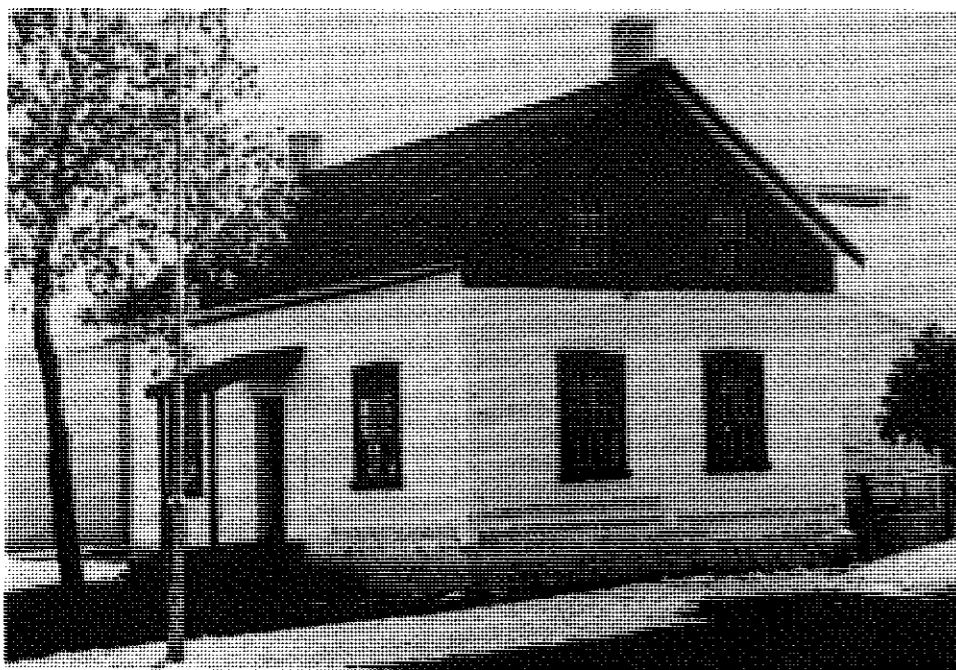


Figure 1. Brown House (St. James Museum) is typical of many mid-19th Century buildings in the Winnipeg area.

In Manitoba, historic structures are generally dated by studying construction style and/or archival records. Unfortunately, historic records are often incomplete or contradictory. For example, archival maps of The Forks from the 1890s, failed to accurately show the location of a flour mill and adjoining structures uncovered during recent archaeological excavation. Subsequent tree-ring analysis have been used to show that parts of the mill were constructed after the summer of 1893 (Kroker and Goundry 1994).

Tree-ring analysis not only determines the cutting date of timbers from archaeological structures to within a single year, but can also ascertain the particular season that the timbers were cut. In the early spring, prior to the major growing season, distinctively structured earlywood is added to the tree stem. This is followed by equally distinctive latewood in the summer and early fall. The early and latewood combine to form a complete tree ring. Therefore, it is possible to determine whether the tree was cut in spring, summer or late fall by examining the completeness of the outer ring. In ring-porous hardwoods such as oak, elm and ash, this is a relatively easy task but is more subjective in diffuse-porous trees such as spruce, pine, fir and tamarack.

The exact cutting date of a tree can only be determined if the log terminates at the bark. Analysis becomes difficult if logs were debarked and/or finished before they were used. However, the presence of a smooth outer log surface, a continuous circumferential ring, or the presence of the appropriate number of sapwood rings may indicate that the log is complete, even though the bark has been removed. Experience has shown that oak trees in southern Manitoba usually have between 7 and 13 sapwood rings.

Knowing the cutting date of a particular log does not guarantee that this date coincides with building construction. Logs from older structures are frequently recycled in newer structures, and it may be necessary to analyze several logs from the building before the correct construction date is determined. Similarly, it is difficult to ascertain the time lapse between the felling of the tree and building construction. Large oak timbers, such as those used in many of the early structures of southern Manitoba, are most easily hewn when they are green. Personal experience has shown that logs that have dried for a few years become unmanageably hard. In most cases the buildings are believed to have been constructed during the first or second summer after the trees were cut. However, extremely large buildings, such as the St. Boniface Museum, are known to have been built over a period of several years and tree-ring dating may give variable results. In some instances, the shape of the log clearly indicates it was shaped when the wood was green. The sides of squared logs were generally hewn flat and at right angles to each other. Subsequent drying may cause the log to split, the sides to cup or the timber to take on a rhombohedral cross-section.

Despite these shortcomings, tree-ring analysis provides a relatively fast and accurate method of determining the construction date of historic and prehistoric structures and associated artifacts if a suitable master tree-ring curve is available for cross-dating. A master tree-ring curve is constructed by combining the ring widths for a number of trees, all anchored in the same year and spanning approximately the same growth interval. In this study, ten trees of known cutting date, spanning the interval between 1710 and 1990, were combined to produce a master curve for cross-dating the historic logs (Fig. 2). Combining the results of measurement on a number of trees, preferably from different stands but in the same general geographic area, has the effect of reinforcing the signal (climate) that the trees have in common and diminishing that part of the signal unique to each tree. These unique signals may be due to local factors such as pathogens, fire, soil, slope, aspect or other factors (Fritts 1976; Schweingruber 1989).

The purpose of this paper is to introduce the technique of tree-ring analysis to archaeological dating, demonstrate the applications of dendrochronology using Winnipeg area examples and to compile data to extend the master tree-ring curve. Oak logs from five structures --

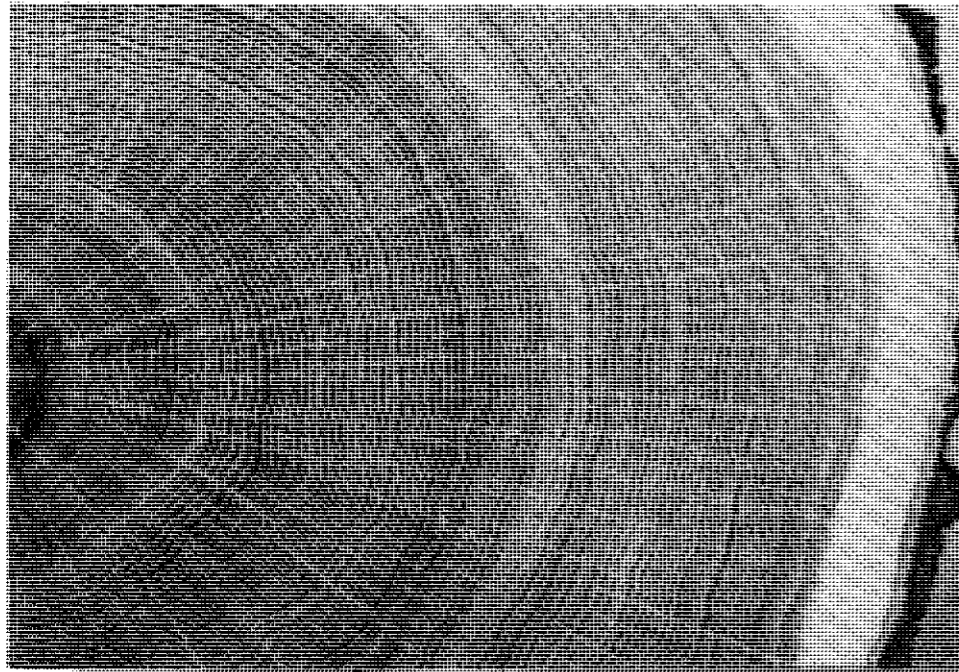


Figure 2. Cross-section of the Winchester #2 log used in the construction of the oak master curve. Note the 13 white-coloured sapwood around the rim of the tree.

St. Boniface Museum, Seven Oaks House, Upper Fort Garry, Brown House and St. Andrews Rectory -- will be discussed and cross-dated with selected modern oak trees. All structures were built between ca. 1840 and ca. 1860. The modern oak trees which form the dendrochronology data base started growth in the early 1700s and were felled at known dates between 1959 and 1990. All trees are from the Winnipeg area.

Buildings and Structures

The five structures were selected because either the construction date was unknown, or because the logs could be used to extend the master chronology or help cross-date other historic logs. Cross-dating is often necessary because not all trees have a pattern of tree-ring variation that can be readily identified across a wide geographical area. In some cases, the provenance of the historic logs is unknown. Logs from distant sites may have tree-ring patterns that are slightly different from local comparative samples as a result of local growing conditions which may make cross-dating more difficult. It is an axiom of dendrochronology that the trees used in cross-dating must all be from the same general geographical area and therefore all exhibit the same growth patterns in their annual rings.

St. Boniface Museum

St. Boniface Museum is housed in what is reputed to be the largest oak structure in North America and the oldest standing building in Winnipeg. Built as a convent for the Grey Nuns, the

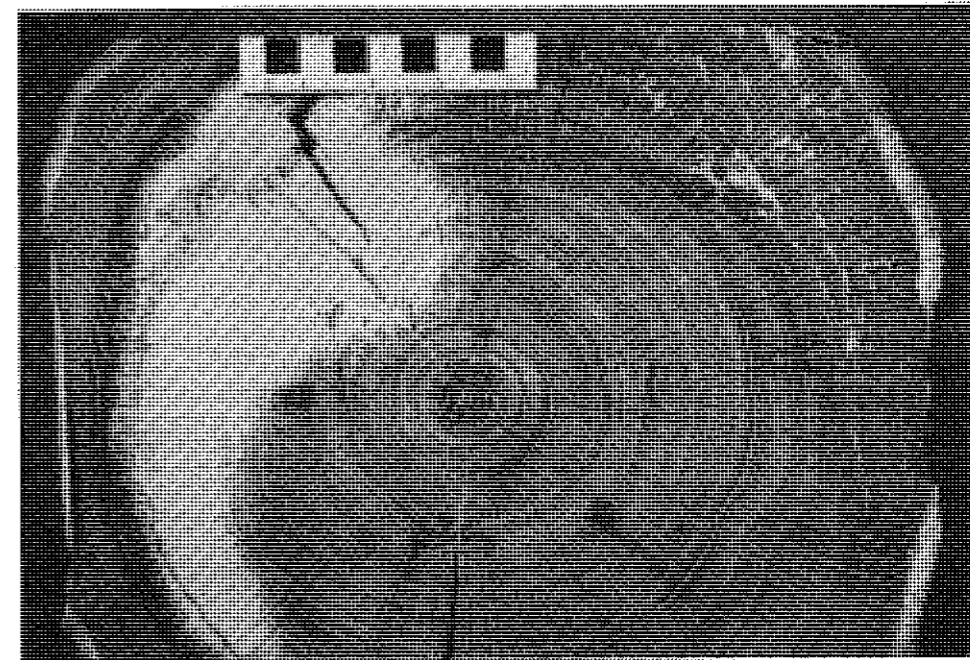


Figure 3. Polished section of the St. Boniface Museum #1 log showing the variation in the tree-ring width and the 11 sapwood rings along the outer edge. The white colour on the left side of the log is due to rot.

building has also served as a hospital, school, orphanage and seniors retirement home. Construction was begun in 1845 and completed in 1848 (King 1982:33). A cross-section from a single log (possibly the restored sill log) was obtained for tree-ring analysis in 1991 (Fig. 3).

Seven Oaks House

Also known as Inkster House, Seven Oaks House is believed to be the second oldest house in Winnipeg. This building dates from 1851, although a side addition may date to ca. 1826. This, however, remains to be determined. Two logs of unknown provenance were obtained and measured to determine the validity of an 1826 construction date. However, the rings in the smallest log (Seven Oaks #1) were too narrow to accurately measure. Consequently, only the results of the measurements on Seven Oaks #2 (Fig. 4) are discussed in this report.

Upper Fort Garry

Fort Garry, situated near the confluence of the Red and Assiniboine rivers in Winnipeg, was originally Fort Gibraltar, a North West Company post built in 1817 and acquired by the HBC after the 1821 amalgamation. The 1826 flood practically destroyed the fort and prompted the construction of Lower Fort Garry south of present-day Selkirk. By the mid 1830s, the Hudson's Bay Company decided to refurbish a post in the Red River Settlement, and construction on a second Upper Fort Garry began in 1835. As Winnipeg grew and the fur trade declined, the fort slowly fell into ruin. Today, only the main gate remains. Recent excavations revealed the presence

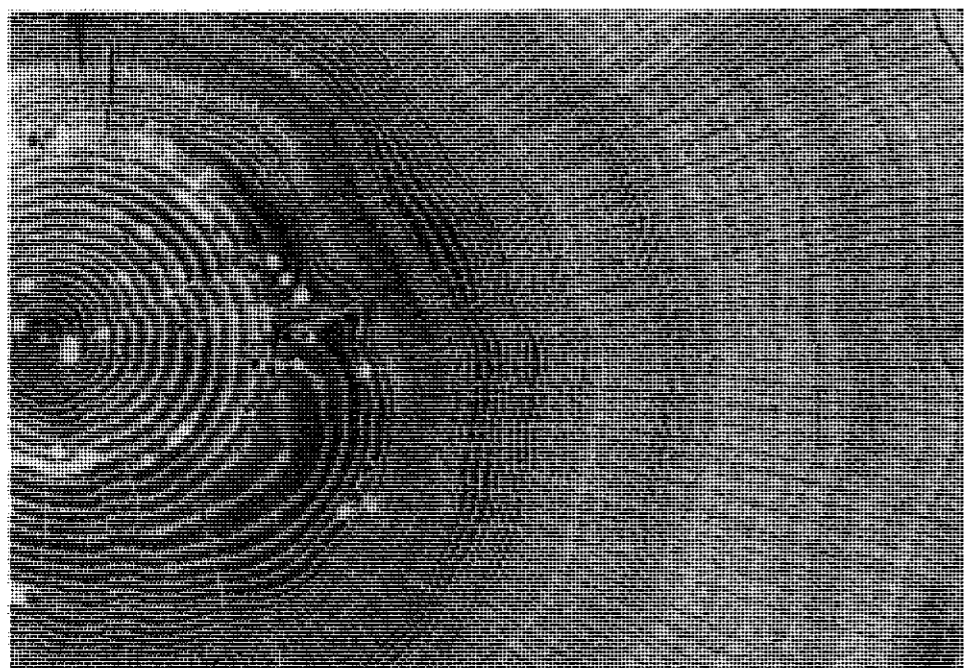


Figure 4. Polished section of the Seven Oaks House #2 log showing the variation in the tree-ring width from the centre to the edge of the log. Seven sapwood rings are evident in the upper right-hand corner of the photograph.

of two privy/refuse pits located inside the west wall of the fort (Monks 1983; 1984). On the basis of the artifacts recovered, it was speculated that Log Structure 1 dated to the time when the 6th Regiment of Foot (Royal Warwickshire Regiment) was stationed at the fort, while Log Structure 2 dated after the 6th Regiment had returned to England (Monks 1983:24). The 6th Regiment arrived at Upper Fort Garry in September 1846 and left in the early summer of 1848 (McLeod 1989:3).

In 1992, a landscaping project at Bonnycastle Park permitted the excavation of the northeast corner of Structure 1 (Fig. 5). Portions of seven oak logs were recovered; and while the top two crib logs were badly decomposed and could not be used, the lower five were in good condition. Tree-ring analysis can determine when the cribs were constructed -- that is, if they were built specifically for the 6th Regiment of Foot or whether they had existed prior to their arrival. The five logs that were analyzed showed all the same cutting dates, and only the results from Upper Fort Garry #5 will be presented.

Brown House

Constructed ca. 1856, this small Red River frame house originally stood along the Assiniboine River on River Lot 39, Parish of Headingly and was constructed by William Brown (Badertscher 1984:9). The house was subsequently moved to its present location at the St. James Museum and restored. Two badly deteriorated logs were removed from the building during restoration and were measured to determine a more precise construction date. Only the result of measurements on the Brown House #2 log are presented.

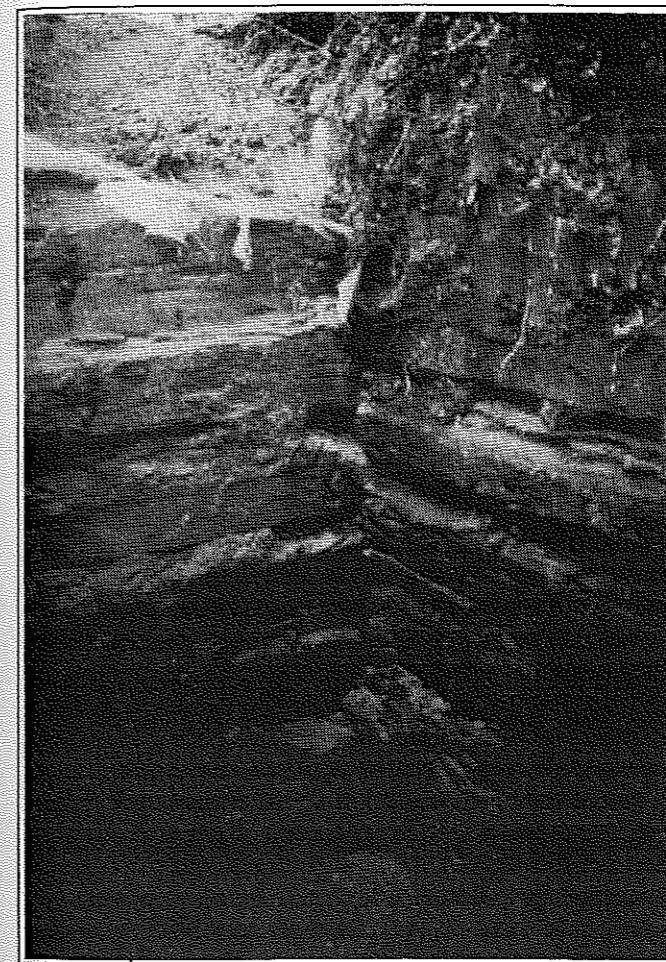


Figure 5. The inside of the Upper Fort Garry Structure 1 showing the timbers before they were sampled for tree-ring dating.

A cross-sectional slab approximately 5-8 centimetres in thickness was prepared for analysis from each oak log. Prior to measurement, the slab surface was sanded with paper varying from 60 to 600 grit. Measurements on each log were made along three radii from the pith to the bark and were spaced approximately 120 degrees apart. The three measurements ensure that no rings were missed and, when averaged, provide a more reliable estimate of ring width than that of a single measurement. All measurements were made using a 40-power comparator graduated in 0.02mm increments. The data for each log were plotted on a graph to produce a tree-ring curve. All curves were plotted at the same scale and were visually compared with each other and with an oak master curve, anchored in 1990. The master curve was constructed from the analysis of 10 modern oak trees from the Winnipeg area.

Tree-Ring Cross-Dating

The tree-ring curves for the five historic structures and the master curve for Winnipeg are shown in Figure 6. The historic logs all have more than 100 rings and, in the case of Seven Oaks House #2, over 200 rings. This is considerably more than the usual 50 to 100 rings recommended for reliable cross-dating (Schweingruber 1989). The master curve extends from the early 18th

St. Andrew's Rectory

Construction of the rectory at St. Andrew was begun sometime between 1851 and 1853 and was completed by December 1854 (Guinn 1978:24). This stone structure replaced an earlier log rectory which had been built during the early 1820s. The stone rectory's principal architect, and perhaps primary mason, was Reverend Archdeacon Cockran who was reappointed to the parish in October 1853. The rectory was constructed in what was commonly known as the "Hudson's Bay Style", which was a transplant of the Georgian architectural styles in Scotland during the 18th and 19th Centuries (Butterfield 1988:30).

Methods

Only oak logs (*Quercus macrocarpa*) were used in the present study, as this was frequently the wood of choice in 19th Century construction and has preserved well up to the present day. Similar work might be undertaken using spruce or pine, or any other wood, if a sufficient amount of material could be found.

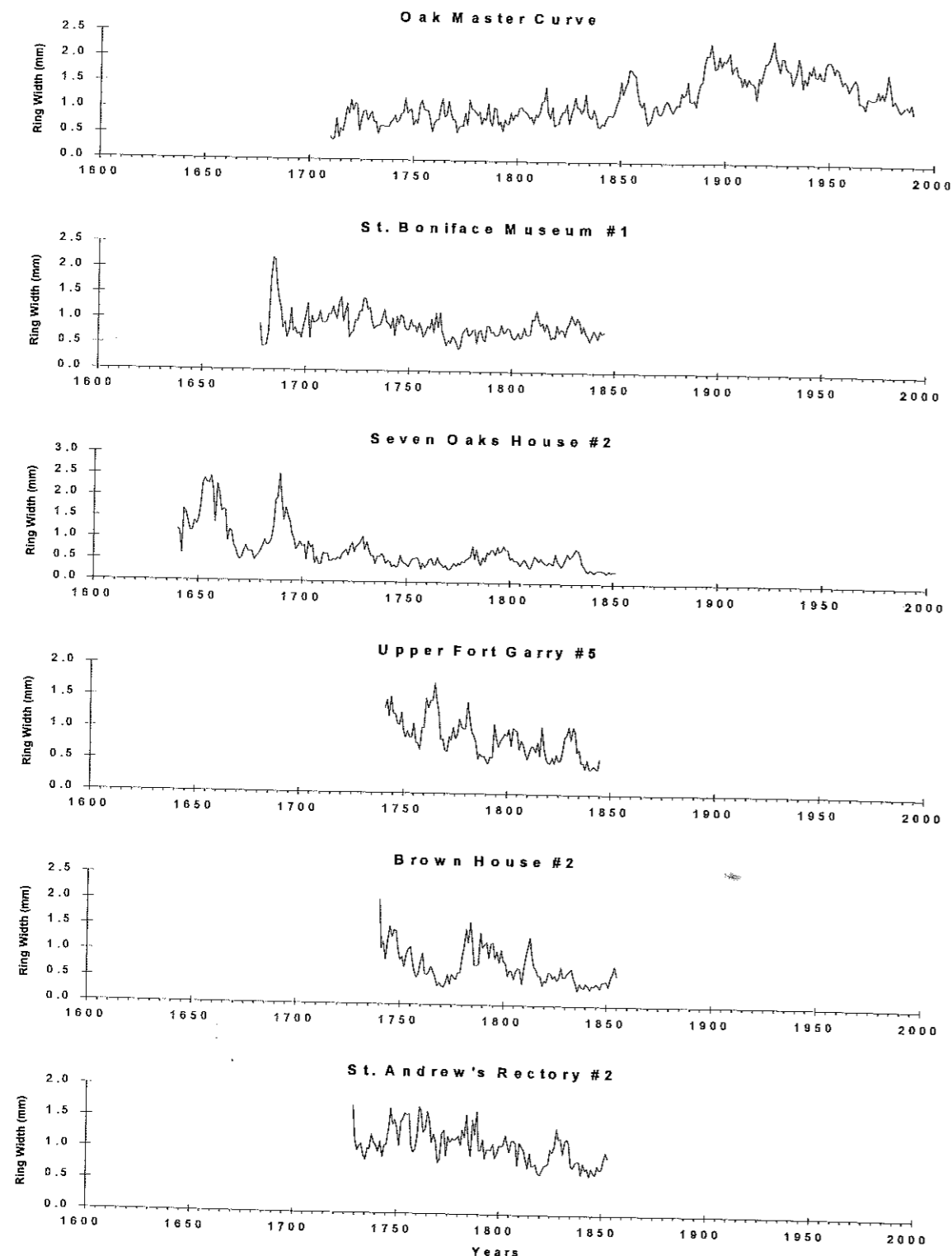


Figure 6. The master tree-ring curve and cross-dated curves for the five historic logs.

Century (1710) to 1990, which is sufficient to date logs cut in the late 18th and middle 19th Centuries.

To facilitate visual comparison of the curves, the 100-year segment from 1780 to 1880 was plotted at an expanded scale (Fig. 7). Kildonan Park #2, one of the 10 curves used to compile the master curve, has been included to illustrate the technique of cross-dating, as well as the potential pitfalls of using a single tree-ring curve displaying abundant local variation.

Several large-scale events recorded in the master curve aid in the cross-dating of the historic logs. The late 1830s and 1840s, or "the Franklin years", a period of extensive cold, are characterized by unusually narrow rings (see Alt *et al.* 1985). The 1850s are identified by conspicuously wide rings, wider than any rings in the previous 100 years. These two events recorded in the master curve are readily recognizable in oak trees throughout southern Manitoba. The narrow rings of the 1840s are also observed in cedar trees from the north end of Lake Winnipegosis, as well as in spruce trees from the area around Hudson Bay (Nielsen unpublished data and Scott *et al.* 1988). The cold years of the 1840s were preceded by slightly wider rings in the late 1820s and early 1830s, although this interval by itself cannot readily be differentiated from earlier intervals that gave rise to similar narrow tree-ring patterns.

The wide rings of the late 1820s and early 1830s and the decline into "the Franklin years" are also recorded in the Seven Oaks #2, Upper Fort Garry #5 and St. Andrew's #2 logs. Although present, it is not as well developed in the St. Boniface #1 or Brown House #2 logs. Neither is it particularly well displayed in the Kildonan Park #2 log, although it is common in other logs not shown.

Several marker years, indicated by unusually narrow rings (Stokes and Smiley 1968), aid in the correlation of the curves and are shown as vertical marks in Figure 7. A narrow ring in 1783 is seen in the St. Boniface, Seven Oaks, Brown House and St. Andrew's logs, but is not present in the Upper Fort Garry log. This is followed by a peak in 1784 in the Seven Oaks, Brown House and St. Andrew's curves. A marker year is present in 1786 in the Seven Oaks, Upper Fort Garry, Brown House and St. Andrew's curves. 1789 shows a peak and is followed by a narrow ring in 1793 in Seven Oaks, Brown House and St. Andrew's. Seven Oaks and Upper Fort Garry have wide rings in 1794. Upper Fort Garry and Brown House have narrow rings in 1802. A narrow ring in 1806 is the first correlation between Kildonan Park and the historic log from Upper Fort Garry. A narrow ring is seen in 1809 in the curves for St. Boniface, Brown House and St. Andrew's, while Seven Oaks and Upper Fort Garry have narrow rings in 1810. The year 1825 shows a narrow ring in Kildonan Park, Seven Oaks and Upper Fort Garry, and 1831 shows a narrow ring in St. Boniface, Upper Fort Garry, St. Andrew's and possibly Kildonan Park as well. Narrow rings are again found in 1834 in Kildonan Park, St. Boniface and Upper Fort Garry. The year 1836 is a narrow ring in Kildonan Park, St. Boniface, Upper Fort Garry, Brown House and St. Andrew's but is not obvious in Seven Oaks House. St. Boniface, Seven Oaks and Upper Fort Garry have narrow rings in 1838 and Upper Fort Garry and St. Andrew's again in 1840. A small peak is present in 1845 in St. Boniface, Upper Fort Garry, Brown House and St. Andrew's. Seven Oaks, Brown House and St. Andrew's all show a narrow ring in 1847 followed by a slightly wider ring in 1848 and a narrow ring again in 1849 in Seven Oaks and St. Andrew's. The end of "the Franklin years" is marked by an increase in the ring width in 1852 in the Kildonan Park, Brown House and St. Andrew's Rectory curves.

The five historic logs and the master curve have numerous correlated reference points but cross-dating with the Kildonan Park #2 log by itself is tenuous (Fig. 7). The tree-ring curves shown in Figures 6 and 7 illustrate the variation in ring widths that can be expected from trees growing in geographically dispersed stands or trees affected by a variety of local environmental factors.

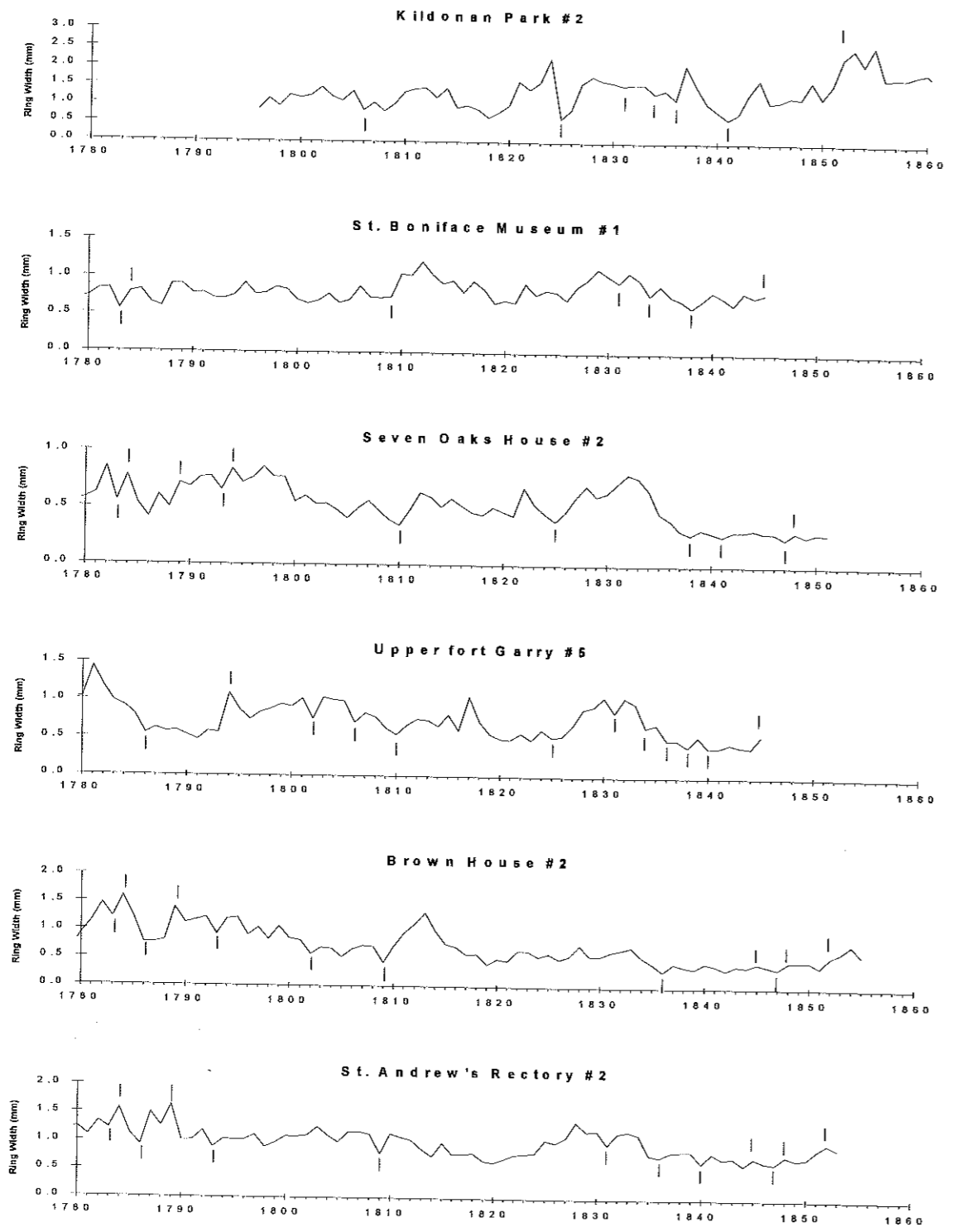


Figure 7. Terminal portions of the tree-ring curves for the five historic logs and one curve (Kildonan Park #2) from the master curve in Figure 6. The vertical lines are major points of agreement among the curves.

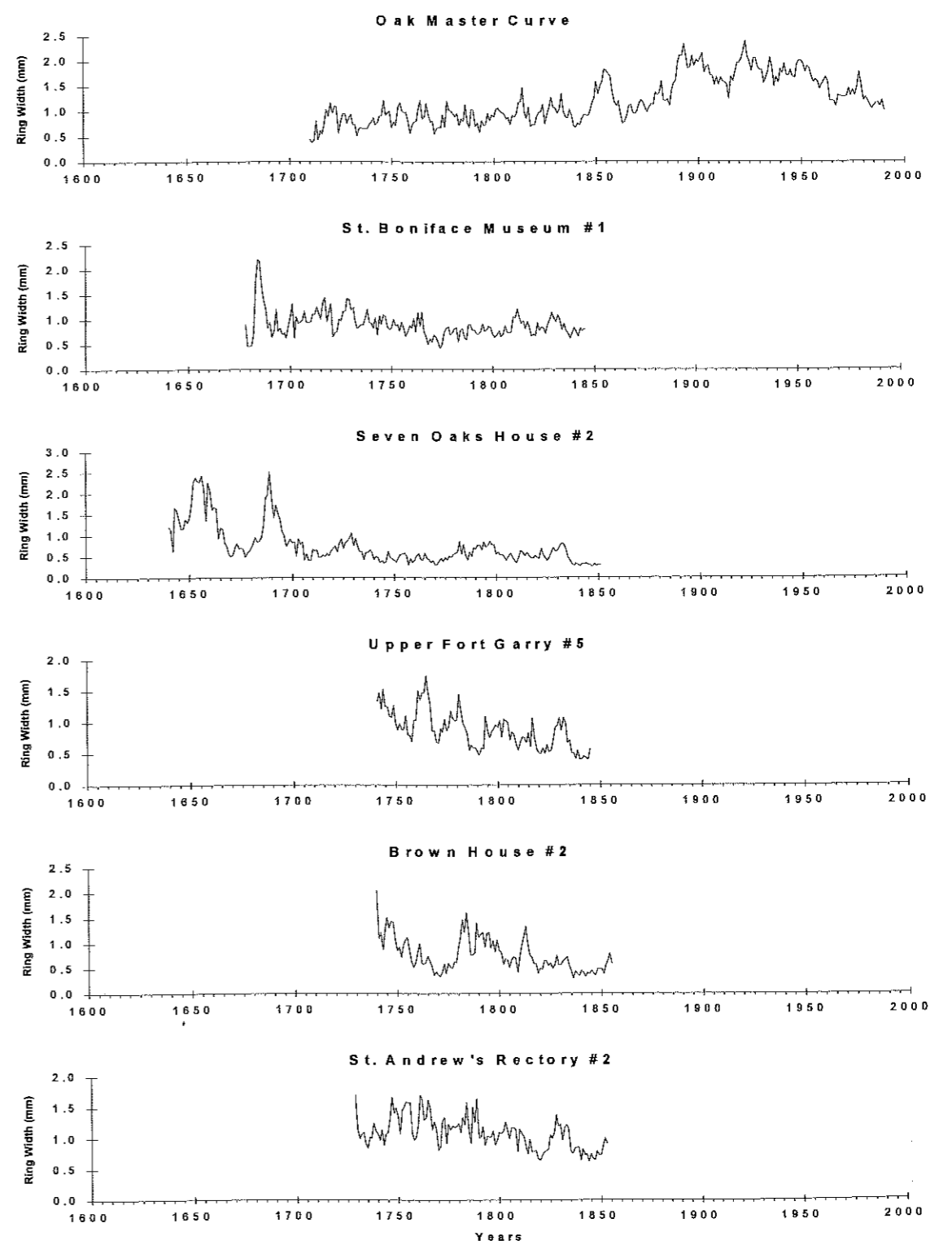


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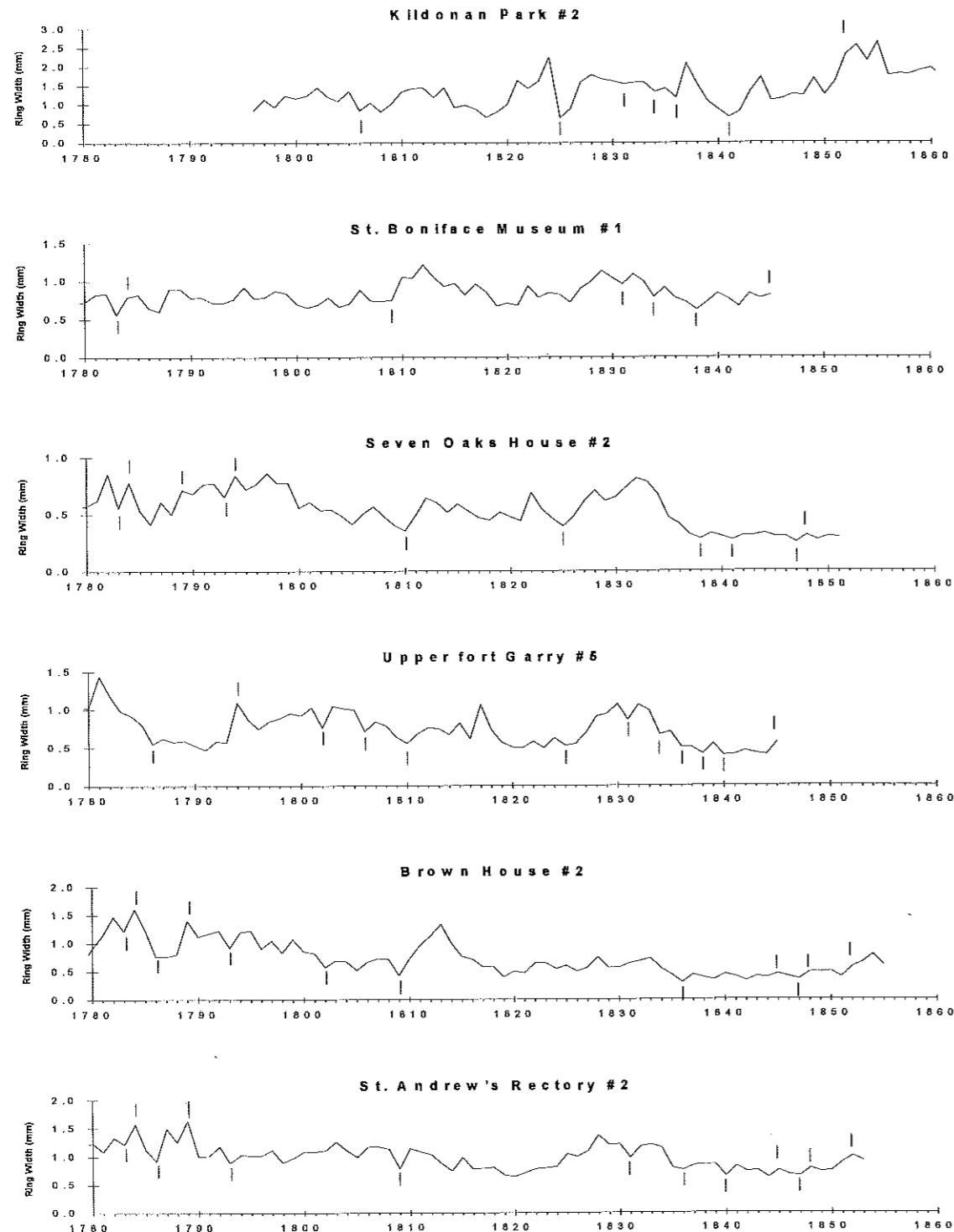


Figure 7. Cont'd.

Although the trees were probably harvested from a variety of locations along the Red and Assiniboine rivers between Emerson, Winnipeg and Portage la Prairie, they have a common climate signal. It is this climate signal that makes cross-dating possible. Cross-dating of the historic logs with the master curve is more reliable although it is difficult to discern in Figure 6.

Cutting Dates

Once the tree-ring curves for the historic logs have been cross-dated with a curve that is anchored at a known date, the cutting dates of the logs can be determined. This can only be done if the logs terminate at the bark. The cutting dates and the years spanned by each of the five Red River samples are listed in Table 1.

Table 1. Summary of the dendrochronological and historical data for the master curve and five historic logs.

Tree-ring Curve	Construction Date (Historical Records)	Span of Tree-Ring Curve	Cutting Date of Logs
Master Curve		1710-1990	
St. Boniface Museum #1	1845-1848	1678-1845	Late 1845 or early 1846
Seven Oaks House #2	1851	1640-1851	Summer 1851
Upper Fort Garry #5	1846	1742-1846	Summer 1846
Brown House #2	ca 1856	1740-1855	Late 1855 or early 1856
St. Andrews Rectory #2	1851-1854	1729-1853	Late 1853 or early 1854

The St. Boniface Museum log has a complete outer ring indicating that the tree was cut after the 1845 growing season and before the 1846 growing season. An 1845 cutting date confirms the historical information for the construction of this building.

The Seven Oaks House log, on the other hand, appears to have a very narrow outer ring or possibly a truncated outer ring which suggests it was cut either in the late summer of 1851 or during the following winter. This date confirms the construction date for this building and establishes this log as not being derived from an earlier 1826 structure.

The last ring in the Upper Fort Garry log is composed entirely of earlywood, indicating the tree was cut in late spring or early summer of 1846. The last ring for this curve has not been included in Figures 6 and 7; only the last complete ring for 1845 is shown. Obviously this structure was built for the arrival of the 6th Regiment of Foot in September of 1846.

The last ring in the Brown House log appears to be complete, indicating the tree was cut late in the growing season of 1855 or during the following winter. This confirms the suspected construction date of 1856.

The last ring of the St. Andrew's Rectory log also appears to be complete, indicating it was cut either late in 1853 or early in 1854, before the spring growing season started.

Conclusions and Recommendations

Construction of a master tree-ring curve, using 10 oak trees spanning the interval between 1710 and 1990, has permitted the dendrochronological dating of oak logs from five historic structures in the Winnipeg area.

Cross-dating of the curves indicates cutting dates of (1) late 1845 or early 1846 for the St. Boniface Museum #1 log; (2) the summer of 1846 for the log structure (privy/refuse pit) at Upper Fort Garry; (3) the summer of 1851 for the Seven Oaks House #2; (4) late 1853 or early 1854 for the St. Andrew's Rectory #2 log and (5) late 1855 or early 1856 for the Brown House #2 log. These cutting dates for the five logs confirm suspected or known construction dates for the St. Boniface Museum, Seven Oaks House, Brown House and St. Andrew's Rectory as determined from historical records. In addition, the cutting dates of the logs from the privy/refuse pit at Upper Fort Garry indicate the structure was built in preparation for the arrival of the 6th Regiment of Foot in September 1846.

This dendrochronological study of modern and historic logs clearly establishes this as a viable dating technique that has applications in Manitoba and the western plains wherever suitable material is available.

Care must be taken to construct regionally reliable master tree-ring curves, anchored at known dates, before cross-dating of archaeological or geological material can be successfully undertaken. The shortcomings of trying to match individual trees is clearly shown with the problematic cross-dating of the historic logs with the Kildonan Park #2 tree anchored in 1990.

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