TREE-RING ANALYSIS OF HERITAGE BUILDINGS IN ANNAPOLIS ROYAL, NOVA SCOTIA

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Abstract

This research project was carried out to determine the date of construction of six structures located in Annapolis Royal, Nova Scotia, by means of dendroarchaeological analysis. Cut dates were secured for timbers from all sites except one (The Guests). Construction of the buildings usually occurs in the same year as the cut date of the wood, or 1-2 years after. Results of the cut dates from wood from each building are as follows: The Ruggles-Munro House basement and first floor 1816-1819, second floor 1827, attic1832-33; the Guests House, no earlier than 1807 and no later than 1815; the Robertson House,1784; the De Gannes-Cosby House, 1708; the Riordan-Francis House 1843; and the Adams-Ritchie House/North wall, 1745-47.

Introduction

Nestled at the western end of the Annapolis Valley in Nova Scotia, Annapolis Royal is among the earliest European settlements in North America. The area was colonized by the French as early as 1605 which they named Port-Royal. Thorough historical research has generated well documented accounts of the rich past of the locality (Dunn, 2004) and recent attempts have been made to age several of its heritage buildings by dendroarchaeological methods with significant success (Robichaud *et al.*, 2005 and 2006).

Dendroarchaeology is the application of tree ring analysis to the dating of old wooden buildings and has two great advantages over other methods of inquiry: 1) it causes little damage to the structure, and 2) it yields a date with a precision of one year. The technique is well known world-wide but has been employed only recently in the Atlantic provinces of Canada, and almost exclusively by the Mount Allison Dendrochronology Laboratory.

Since many important structures remain inadequately dated in the area, the Annapolis Heritage Society wished to pursue dendroarchaeological investigation on six prominent historical buildings in the summer of 2007. The Society chose five new structures (the Ruggles-Munro House, the Guests House, the Robertson House, the De Gannes-Cosby House, and the Riordan-Francis House), as well as an additional test on a previously documented structure (the Adams-Ritchie House north wall).

Fieldwork and Laboratory Methods

Sampling of all buildings was carried out on May 3 and 4, 2007. Re-sampling on two structures was conducted later in July to gather better quality samples. We took core samples using manual increment borers on beams that displayed the last growing ring of a tree indicated by the presence of bark. Collected samples were placed in plastic straws, labeled, and their position in the structure was also mapped. The samples were then transported back to the lab for analysis.

In the lab, the cores were glued onto grooved wooden mounting canes to facilitate sanding of the samples. Mounted cores were then progressively sanded with increasingly finer grained sandpaper to expose the annual ring-growth patterns. The annual rings were measured using a 24 inch movable Velmex stage connected to a digital encoder which gave the measurements an accuracy of 1/1000 mm. Raw data was captured by J2X software and put into standard tree-ring decadal format. Ring-width data was crossdated with regional reference chronologies developed from earlier work in the region using the software COFECHA (Holmes *et al.*, 1986). We also visually tested pattern matching of line graphs of all series with the graphic software DeltaGraph®.

During the mounting process, any excess portions of the core samples were used for wood identification using a scanning electron microscope (SEM) available at the Mount Allison Digital Microscopy Facility. The SEM procedure enabled precise wood identification through the recognition of species-specific cell features and structures. The identification of the wood is important because different species have different growing reactions to climatic variables. When the species of a historic piece of wood is known, it then allows us to crossdate the samples with the proper reference chronology with more accurate and reliable results.

Results and Discussion

It is important to note that the dates presented here correspond to the felling of trees (cut dates) and not a construction date. The end of the construction of a building can possibly be the same year as the cut date but it also could be a year or two later depending on specific construction procedures. The samples that didn't have the last growth ring (i.e., wood was deteriorated, beam was completely squared, etc.) do not represent a cutting date. However, they are valuable because they help corroborate the whole dendrochronological assessment of the timeframe of the structure and are therefore included in the presentation of the results.

1. Ruggles-Munro House

The Ruggles-Munro House is located at 833 St George Street in Annapolis Royal. It is thought to have been built around 1818, but could have been even older. At the time of sampling, it was being renovated and therefore provided easy access to numerous beams from different parts of the house. A total of 53 cores and one cookie were taken from the basement beams (8), the main section on the first floor (12), the ell from the first floor (7), the main section of the second floor (12), the ell on the second floor (4), and the attic (11). Wood identification revealed that 36 samples were spruce, while the others were pine, hemlock or fir. Only the spruces were analyzed for crossdating as there are good reference chronologies available for the species.

The best results were obtained by comparing the Ruggles-Munro House data with a local chronology from the Barry Moody House, Port Royal (Robichaud *et al*., 2006). It is the younger part of the Barry Moody house that was predominately used for the derived dates in this study. Figures 1 to 6 illustrate some ring-width curves from different parts of the house and the Barry Moody local chronology. Table 1 summarizes the crossdating results.

Table 1: Tree-ring analysis and crossdating results from the Ruggles-Munro House.

Sample ID	*species*	*Sample location*	*Last growth ring*	*Date of last ring*	*Cut date*
BASEMENT					
07DS001	Spruce	ceiling	no	1817*	1818
07DS002	Spruce	ceiling	no	1817*	1818
07DS003	Fir?	ceiling	no	not dated	?
07DS004	Hemlock	ceiling	?	unusable	?
07DS005	Spruce	ceiling	yes	1817	1817
07DS006	Spruce	ceiling	yes	1817	1817
07DS007	?	ceiling	?	unusable	?
07DS008	Spruce	ceiling	maybe	1816	1816?
FIRST FLOOR – MAIN HOUSE					
07DS020a	Spruce	ceiling	yes	1817	1817
07DS020b	Spruce	ceiling	yes	1817	1817
07DS021	Spruce	ceiling	no	1813	?
07DS022	Spruce	wall	yes	1816	1816
07DS023	Fir?	wall	yes	not dated	?
07DS024	Spruce	wall	yes	1817	1817
07DS025	Fir?	wall	yes	not dated	?
07DS026	Spruce	ceiling	yes	1819	1819
07DS027	Fir?	wall	no	not dated	?
07DS028	Pine	wall	yes	not dated	?
07DS029	Spruce	ceiling	yes	1817	1817
07DS031	Spruce	wall	yes	1816	1816
FIRST FLOOR – ELL					
07DS030	Hemlock or fir	inner wall	yes	not dated	?
07DS035	Pine	wall	yes	not dated	?
07DS036	Spruce	ceiling	yes	1817	1817
07DS037	Spruce	ceiling	yes	1817	1817
07DS038	Spruce	ceiling	?	unusable	?
07DS039	Pine	ceiling	yes	not dated	?
07DS080a	Spruce	unknown	yes	1819	1819
07DS080b	Spruce	unknown	no	1813	(1819)
SECOND FLOOR – MAIN HOUSE					
07DS040	Spruce	wall	yes	1825?	?
07DS041	Spruce	wall	yes	unusable	?
07DS042	Spruce	wall	yes	1827	1827
07DS043	Spruce	wall	yes	1827	1827
07DS044	Spruce	wall	no	1821	?
07DS045	Spruce	wall	yes	1827	1827
07DS046	Spruce	wall	yes	1827	1827

07DS047	Spruce	wall	yes	1817	1817
07DS048	Fir?	wall	?	not dated	?
07DS049	Spruce	wall	?	unusable	?
07DS050	Pine	wall	yes	not dated	?
07DS051	Spruce	ceiling	yes	1827	1827
SECOND FLOOR – ELL					
07DS052	Spruce	wall	no	1813**	>1823
07DS053	Pine	wall	no	not dated	?
07DS054	Fir?	wall	yes	not dated	?
07DS055	Pine	wall	yes	not dated	?
ATTIC					
07DS060	Spruce	floor	yes	1832	1832
07DS061	Spruce	roof	yes	1832	1832
07DS062	Spruce	roof	yes	1833	1833
07DS063	?	roof	?	unusable	?
07DS064	?	wall	?	unusable	?
07DS065	Spruce	roof	no	1831	?
07DS066	Spruce	roof	?	unusable	?
07DS067	Pine	roof	no	not dated	?
07DS068	Pine	roof	?	not dated	?
07DS069	Spruce	roof	?	unusable	?
07DS070	Spruce	floor	yes	1833	1833

* one ring not measured at the end of the core (damaged)
** more than ten rings not measure at the end of the core (damaged)

Out of the 27 samples from the basement and the first floor (including the ell), 18 were spruce, 17 were crossdated and 16 had the crucial last growth ring giving the desired cutting date. It is apparent from our analysis that this whole section was built at the same time as the wood was cut between 1816 and 1819 (Figures 1, 2 and 3; Table 1).

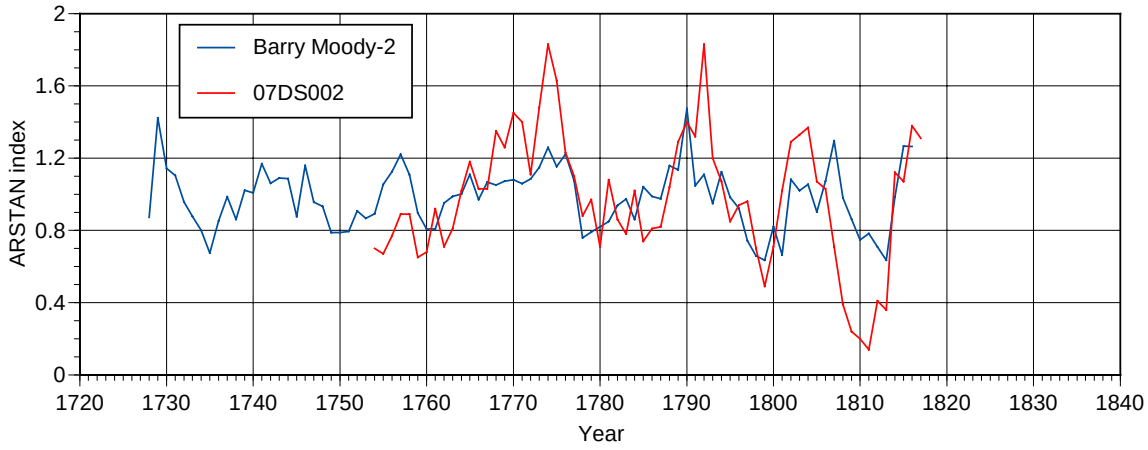

Figure 1: A sample from the basement of the Ruggles-Munro House (07DS002) compared to the Barry Moody local chronology. The end date of the sample is 1817.

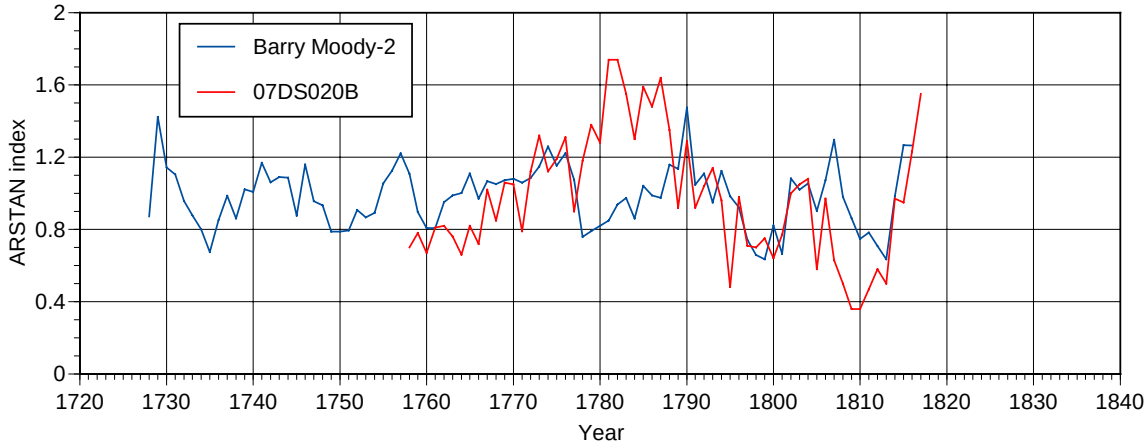

Figure 2: A sample from the first floor of the main part of the Ruggles-Munro House (07DS020B) compared to the Barry Moody local chronology. The end date of the sample is 1817.

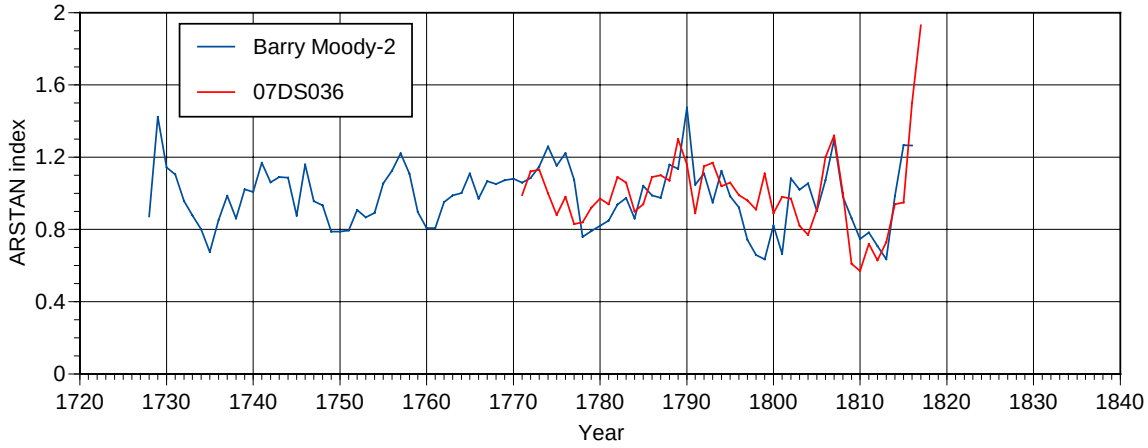

Figure 3: A sample from the first floor of the ell of the Ruggles-Munro House (07DS036) compared to the Barry Moody local chronology. The end date of the sample was determined to be 1817.

The second floor provided 11 useable spruce samples. Nine were crossdated from which we obtained seven cut dates. Results suggest that the second floor was built at a later time, in 1827 (Figure 4 and Table 1). Although we only have one workable sample from the ell and that it didn't have the last growth ring, its lowest possible age is consistent with that of the main section (Figure 5 and Table 3). Interestingly, one sample was older than the others (07DS047 was dated confidently at 1817) and is most probably recycled wood from the earlier construction phase.

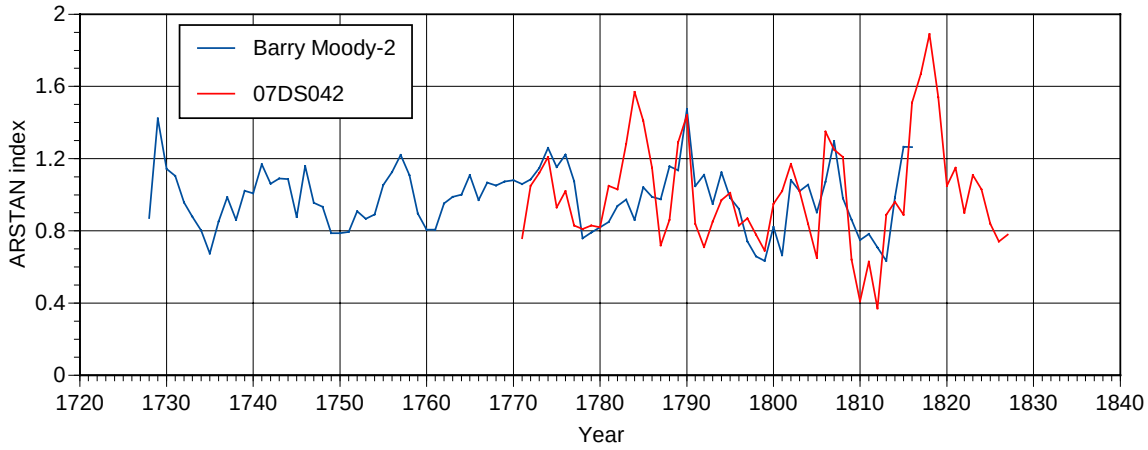

Figure 4: A sample from the second floor of the main part of the Ruggles-Munro House (07DS042) compared to the Barry Moody local chronology. The end date of the sample was determined to be 1827.

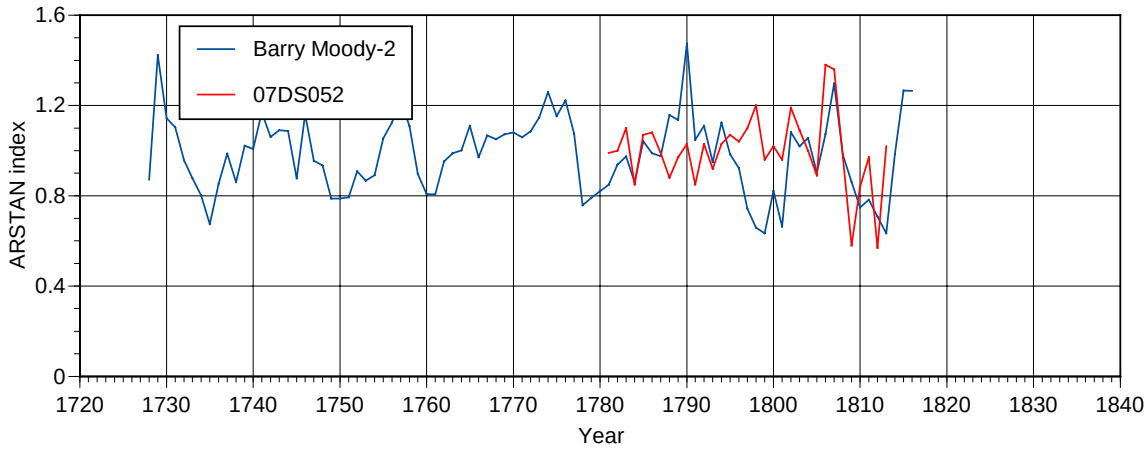

Figure 5: A sample from the second floor of the ell of the Ruggles-Munro House (07DS052) compared to the Barry Moody local chronology. The age of the sample is 1813 but it had at least 10 missing rings at the end of the core. The true cut date is most probably similar to the main part of the house on the second floor.

Eleven cores were taken in the attic of the Ruggles-Munro House. However, only five samples were workable as four were from species other than spruce and two more were unusable because of the poor condition of the wood (Table 1). Cut dates from four sound samples were determined and gave dates of 1832-33 (Figure 6 and Table 1) which suggests that the house in its current form was completed at about that time.

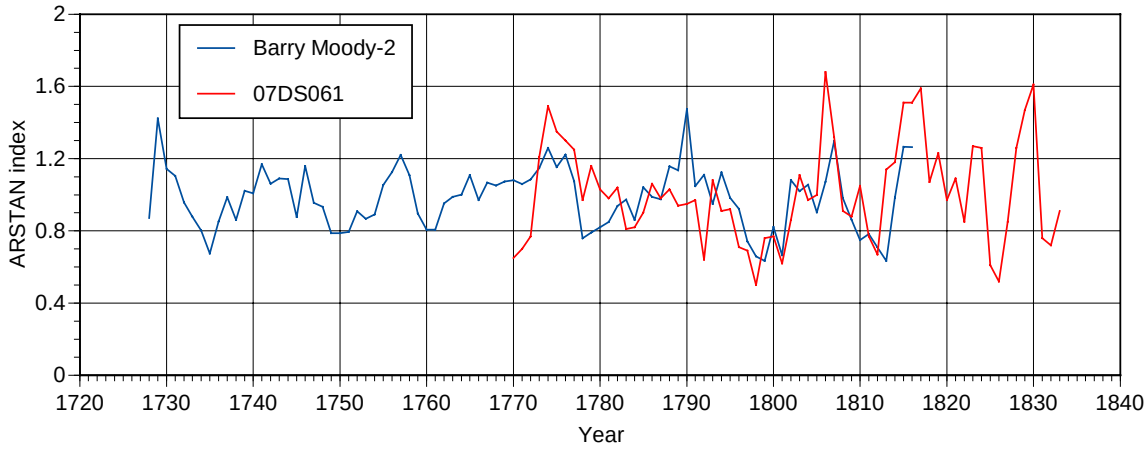

Figure 6: A sample from the attic of the Ruggles-Munro House (07DS061) compared to the Barry Moody local chronology. The end date determined for the sample is 1832.

2. Guests House

This house is located at 101 Victoria Street and is thought to be at least as old as 1815 or earlier. Only the basement was accessible for sampling and the wood was in very poor condition, so much so that only four samples were taken (three spruces and one fir). Of the four samples that could be extracted, only two were of a high enough quality to be in a workable state for further crossdating procedures. During the analysis, we were unsuccessful with the use of the COFECHA software in finding possible dates with the master chronologies, specifically because the samples had so few rings present (< 35). Therefore, we relied entirely on visual crossdating and information derived from the Historical Society. After much trial and error with several local and regional reference chronologies, the data retrieved from the Ruggles-Munro House structure (see above) proved to be the most helpful in determining a satisfactory pattern match (Figures 7 and 8).

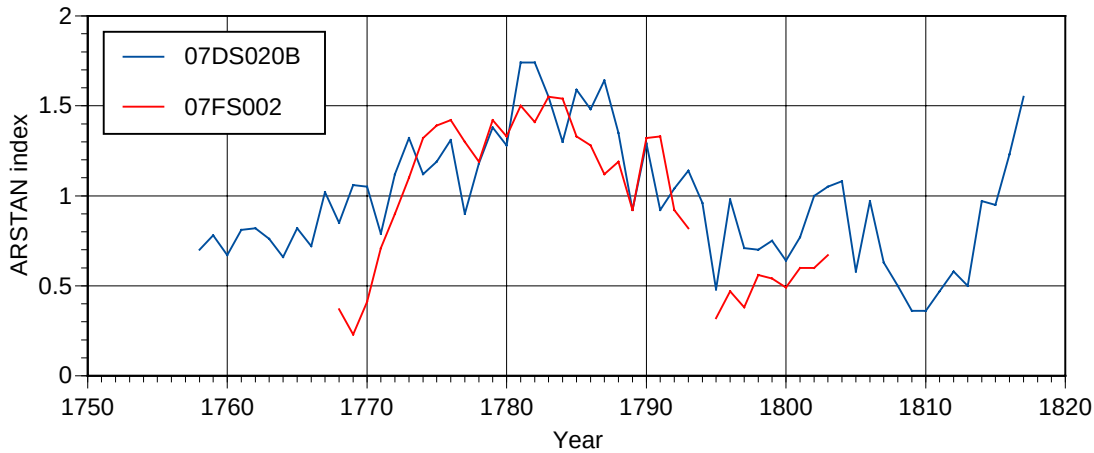

Figure 7: A sample from the Guests House (07FS002) compared to a curve from the Ruggles-Munro House (07DS020B). The terminal date of this sample is 1803.

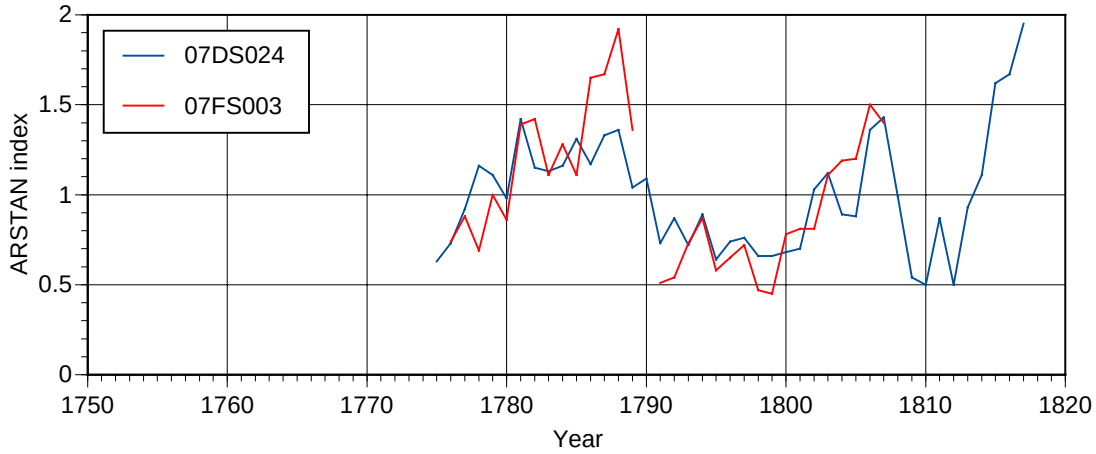

Figure 8: A sample from the Guests House (07FS003) compared to a curve from the Ruggles-Munro House (07DS024). The terminal date of this sample is 1807.

A terminal date was established for the two useable "Guests" samples. Although this was achieved, the samples didn't have the last growth ring present (Table 2). Based on the samples and notes taken while they were being extracted, we strongly believe that sample 07FS003 has fewer than 5-10 rings missing. As a result, we suggest that the construction of the Guests house was probably no earlier than 1807 and no later than 1815.

Table 2: Tree-ring dating results from the Guests House.

Sample ID	*species*	*Sample location*	*Last growth ring*	*Date of last ring*	*Cut date*
07FS001	Spruce	ceiling	no	unusable	?
07FS002	Spruce	ceiling	no	1803	?
07FS003	Spruce	ceiling	very close	1807	?
07FS004	Fir	ceiling	no	not dated	?

3. Robertson House

This house is located at 156 St George Street, next to the Bonnett House that was previously dated by the MAD Lab (Robichaud *et al*., 2006). The age of the building was uncertain, even though it was thought to have been built when the Loyalists arrived after 1783. Again, we had limited access to suitable beams for sampling. We were allowed to core four ceiling beams from the kitchen area and the adjoining hallway. All were spruce and all were in good condition. Successful crossdating was made with the use of the Middleton chronology (Robichaud *et al*., 2006) (Figure 9).

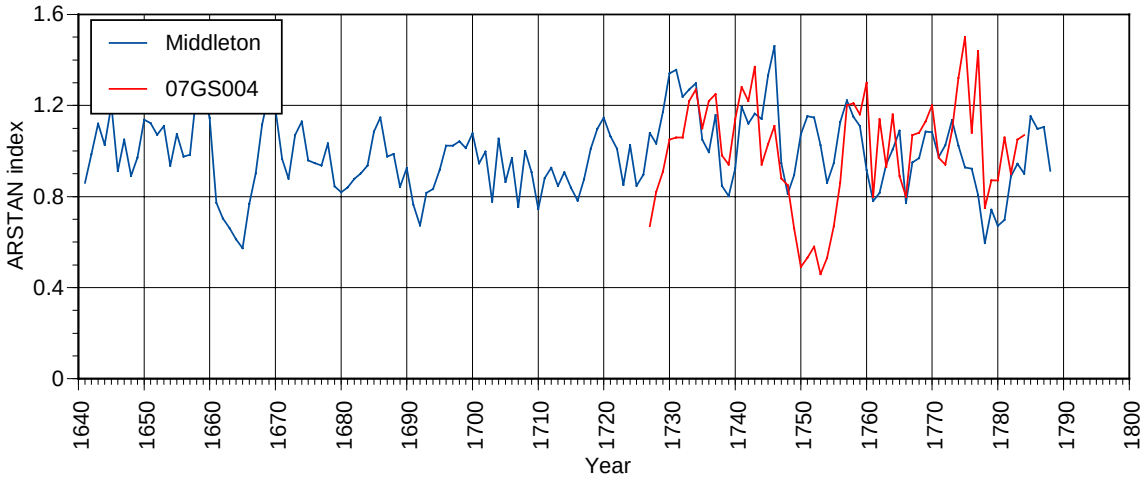

Figure 9: A sample from the Robertson House (07GS004) compared to the Middleton reference chronology. The cut date of the sample was determined to be 1784.

An age of 1784 was obtained on three of the four cores (Table 3) which corroborated the Loyalist arrival hypothesis.

Table 3: Tree-ring dating results for the Robertson House.

Sample ID	*Species*	*Location*	*Last growth ring*	*Date of last ring*	*Cut date*
07GS001	Spruce	kitchen ceiling	yes	1784	1784
07GS002	Spruce	kitchen ceiling	no	1782	?
07GS003	Spruce	hallway ceiling	yes	1784	1784
07GS004	Spruce	hallway ceiling	yes	1784	1784

4. De Gannes-Cosby House

This house is located at 477 St George Street and is said to be the oldest documented wooden structure in Nova Scotia and is a provincially and municipally designated heritage building. It was most probably built by Major Louis de Gannes de Falaise, a French military officer posted in Port-Royal in 1696. His house was burned in 1707 during the siege of the town and rebuilt afterwards. De Gannes returned to France in 1712 and the house was later occupied by Alexander Cosby, major in the 40th Regiment. The age of the building has been thoroughly assessed but still deserved confirmation with the use of the dendroarchaeological techniques. Access to suitable samples was possible in the attic (9 samples), and the living room (6 samples). Sampling was attempted on the basement beams but the wood was not sound enough to extract a core. All collected samples were fir except for one spruce. Dating this house was very challenging because all of the fir samples contained small

numbers of rings and there was only one spruce sample. This spruce sample was easily crossdated with the Soullard chronology (Robichaud *et al*., 2005) (Figure 10, Table 4).

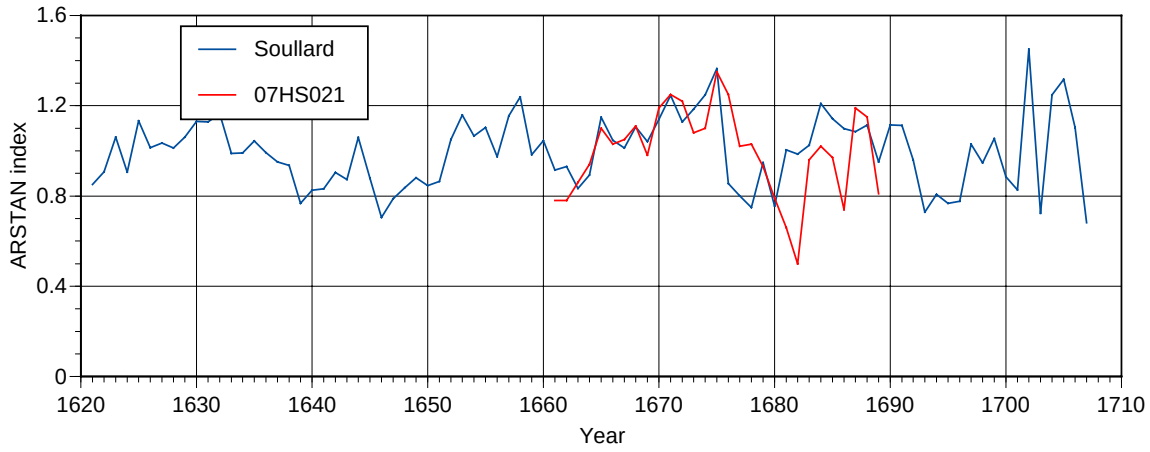

Figure 10: The only spruce sample from the de Gannes-Cosby House (07HS021) compared to the Soullard reference chronology. The end date of that sample is 1689 but lacks the last growth ring.

Table 4: Dating results of the de Gannes-Cosby House.

Sample ID	*species*	*Sample location*	*Last growth ring*	*Date of last ring*	*Cut date*
ATTIC					
07HS001	Fir		yes	not dated	?
07HS002	Fir		close	1691	?
07HS003	Fir		yes	1708	1708
07HS004	Fir		no	1690	?
07HS005	Fir		yes	1707	1707
07HS006	Fir		yes	1707	1707
07HS007	Fir		no	1684	?
07HS008	Fir		yes	1689	1689
07HS009	Fir		no	1703	?
LIVING ROOM					
07HS020	Fir	Ceiling	close	1693	?
07HS021	Spruce	Ceiling	close	1689	?
07HS022	Fir	Ceiling	?	unusable	?
07HS023	Fir	Ceiling	no	1697	?
07HS024	Fir	Ceiling	no	not dated	?
07HS025	Fir	Ceiling	no	1700	?

Because the spruce sample didn't have that critical last growth ring (Table 4), more work was needed to clarify the building date of the house. The first step was to crossdate samples of the de Gannes-Cosby House between each other to find out if they were of the same age. We used COFECHA, a statistical matching program and visual crossdating to do so and all were placed relatively to each other including the spruce sample. Overall, the correlation was significant in the group of fir samples ($n = 13$; $r = 0.575$ $p < 0.01$) and the spruce also correlated significantly with this group ($r = 0.427$, $p < 0.01$) (Table 5). Two groups emerge from this exercise: a first one roughly 10-15 yrs older than the second (Table 4; Figure 11).

Table 5: COFECHA output of correlations between the samples of the De Gannes-Cosby series (in virtual years).

Series	**Interval (virtual years)**	**No. of years**	**Correlation**
07HS003	68-108	40	0.671
07HS005	70-107	38	0.604
07HS006	66-107	42	0.566
07HS025	71-100	30	0.618
07HS023	70-97	28	0.498
07HS009	54-103	51	0.673
07HS007	55-84	30	0.480
07HS002	47-91	45	0.525
07HS004	59-90	32	0.691
07HS020	63-93	31	0.525
07HS008	64-89	26	0.547
07HS021	61-89	29	0.427
Mean		**35.2**	**0.575**

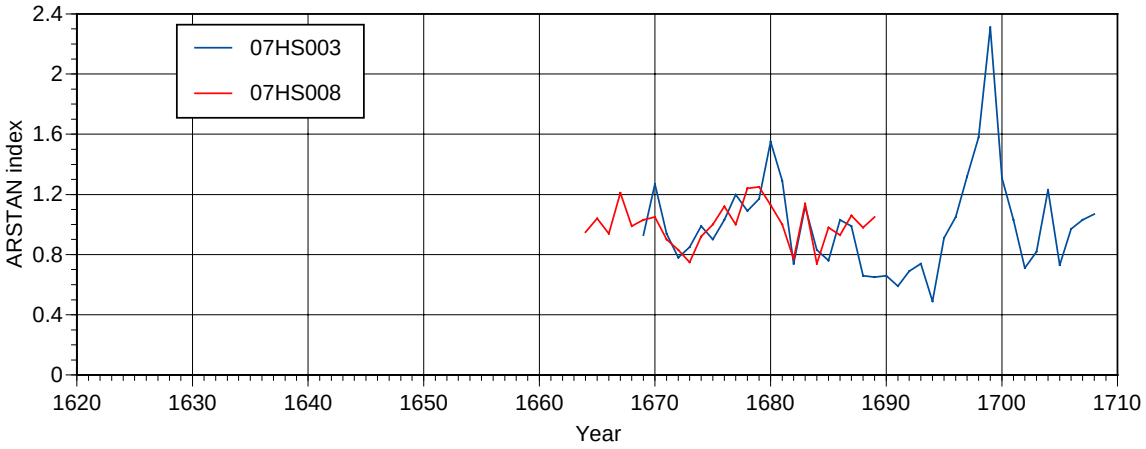

Figure 11: A fir sample from the older group of samples in the de Gannes-Cosby House (07HS008) compared to a fir sample from the younger group (05BS003).

We then used the two longest fir samples from the Soullard House which were dated at 1710 and compared them to the de Gannes-Cosby fir series. Figure 12 shows a significant pattern matching and suggests an age of 1708 for the new samples from the de Gannes-Cosby House.

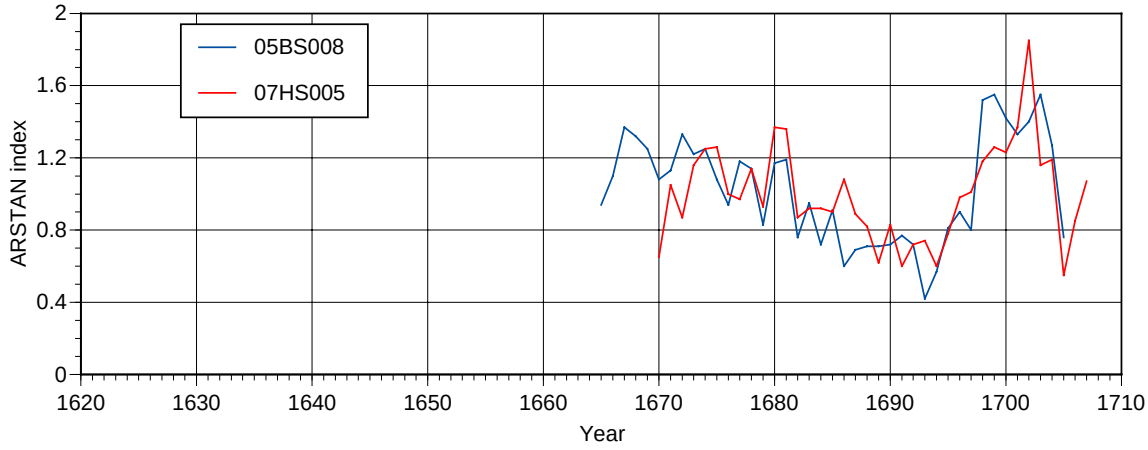

Figure 12: A fir sample from the de Gannes-Cosby House (07HS005) compared to a Soullard fir sample (05BS008). Using this pattern match, the cut date of the de Gannes-Cosby sample is 1708.

Collectively Table 4 displays the final results of our analysis and suggests that the house was built in 1708. It also hints that some of the beams in the current structure were probably recycled material, possibly taken from the remnants of the earlier house built in the late 1690s.

5. Riordan-Francis House

The date of the house was thought to be circa 1800, or possibly older although it has a mid-Victorian style. Located at 18 St James Street, structural beams were not accessible but several beams were salvaged from the house during repairs and were made available for dendrochronological testing. It is not known from which part of the house they came and since the building has a complex history (it was moved at one point in time), caution has to be made about the actual provenance of the wood.

Cookies (wedge pieces) were cut off the beams and brought back to the lab for processing. Two paths were measured on most cookies to enhance the tree-ring database. Wood identification showed several species but we were able to

crossdate all samples collected due to the large area available in a cut disk compared to a smaller increment core.

The best fit for crossdates came from a southeast New Brunswick reference chronology (Figure 13). The cut date for the spruce samples is 1843 (Table 6) and suggests that the wood is from later additions/renovations to the house or that the house itself is indeed from the mid-Victorian period not an early 1800 time period.

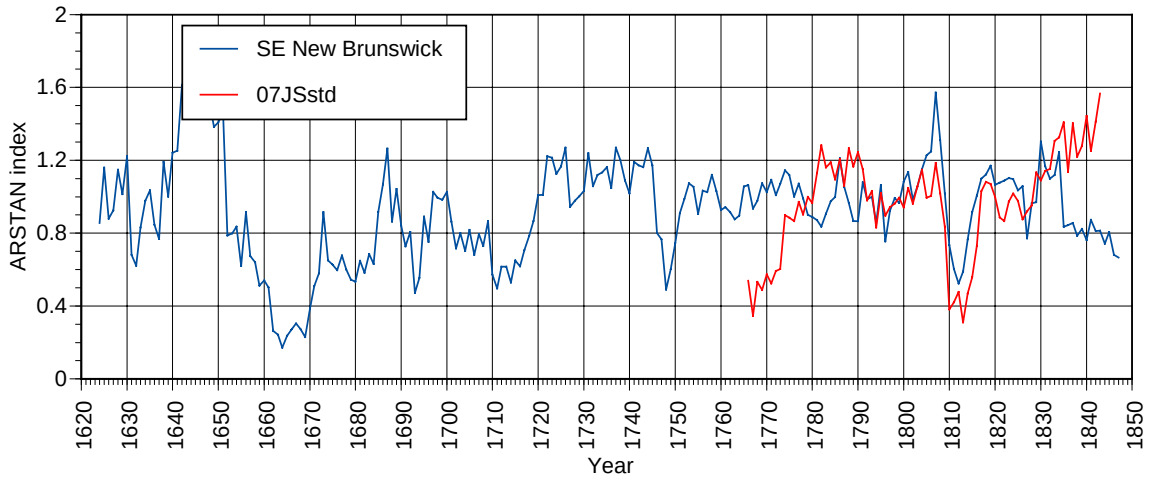

Figure 13: The combined spruce chronology from the Riordan-Francis House (07HJSstd) compared to the southeast New Brunswick reference chronology. The cut date of the spruce house beams is 1843.

Table 6: Tree-ring dating results from the Riordan-Francis House samples.

Sample ID	*species*	*Sample location*	*Last growth ring*	*Date of last ring*	*Cut date*
07JS001a	Pine	Unknown	close	1842	?
07JS001b	Pine	Unknown	close	1842	?
07JS002a	Pine	Unknown	no	1837	?
07JS002b	Pine	Unknown	no	1838	?
07JS003a	Spruce	Unknown	yes	1843	1843
07JS003b	Spruce	Unknown	yes	1843	1843
07JS004	Spruce	Unknown	yes	1843	1843
07JS005a	Fir	Unknown	close	1839	?
07JS005b	Fir	Unknown	close	1839	?
07JS006a	Spruce	Unknown	yes	1843	1843
07JS006b	Spruce	Unknown	no	1831	?

6. Adams-Ritchie "old wall"

One sample was taken from the north wall of the Adams-Ritchie house where wattle and daub is still currently visible. The Annapolis Historical Society wished

it to be tested because it was thought that the wall might be a remnant of a previous building older than the house dated at 1747 (Robichaud *et al*., 2006). The MAD Lab attempted a tree-ring analysis on the only sample that could be retrieved from that wall. The wood was in poor condition as far as coring is concerned: one or two outer rings were lost during the sampling and a known six to seven rings were not measurable. However, a series of over sixty consecutive rings made it possible for a crossdating attempt. Figure 14 illustrates a comparison between the "old wall" series and the Adams-Ritchie chronology made earlier from the ceiling beams. It is clear from this procedure that the samples are of the same age.

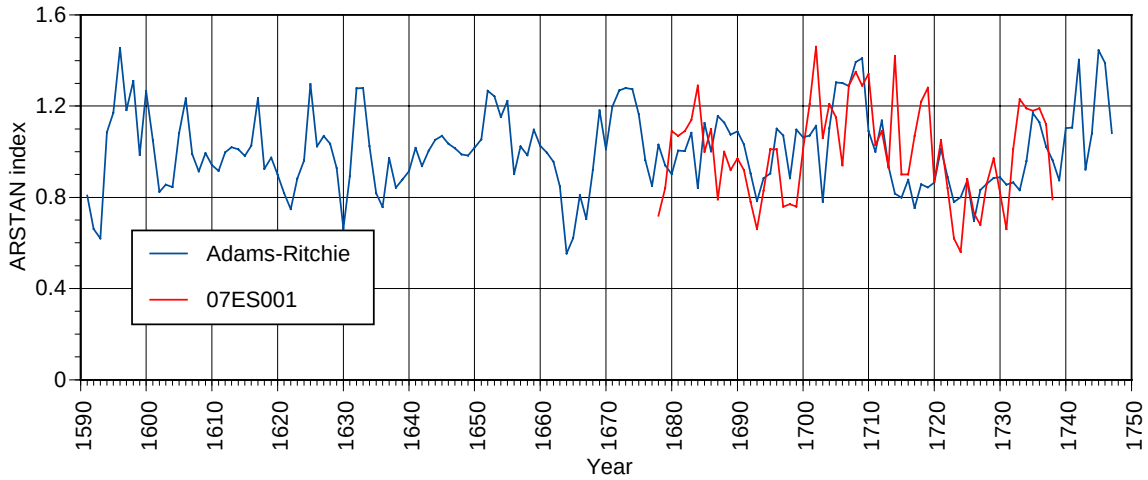

Figure 14: Ring-widths from a sample taken on the north wall of the Adams-Ritchie House (07ES001) compared the Adams-Ritchie chronology. The end date is 1738, but 6-7 unmeasured rings must be added, plus one or two more for rings lost during sampling, which would culminate in a date of approximately 1745-1747. This would be a similar date as was established by Robichaud *et al*. (2006).

Conclusion

The results of the tree-ring analysis conducted on the six houses that were studied in this project are summarized in Table 7.

A total of 89 samples were processed and the majority were dated. The Ruggles-Munro House series illustrated that the building was built in three phases. The first phase occurred in 1816-19 when the basement and the first floor including the back ell were established. The second phase saw the construction of a second floor in 1827, and during the third phase in 1832-33 the attic was finally added (Table 7).

The Guests House was more problematic as no samples with the last growth ring were retrieved because of the poor condition of the wood. However, one sample

illustrated an age of 1807 which can indicate a minimal construction date. The number of missing rings on that sample is estimated at less than 10 years and we therefore suggest a relatively wider range of construction ages between 1807 and 1815 (Table 7).

Table 7: Estimated construction dates from the dendroarchaeological study of the six buildings sampled in Annapolis Royal in the summer of 2007.

Building	**Estimated date before analysis**	**Range of cut dates**	**Estimated date of construction**
07DS – Ruggles-Munro House -Basement and 1st floor -2nd floor -Attic	-circa 1818; older?	 1817-1819 1827 1832-33	 1819-20 1827-28 1833-34
07FS – Guests House	-at least 1815; older?	-no cut dates -one sample without last growth ring dated at 1807	-no older than 1807, no younger than 1815
07GS – Robertson House	- after 1783; older?	1784	1784-85
07HS – De Gannes-Cosby House	-1708	1707-08	1708-09
07JS –Riordan-Francis House	-circa 1800; older?	1843	1843-44
07ES – Adams-Ritchie “old wall”	-older than 1747?	1745-47	1747

We also dated the Robertson House, although we only had four samples to work with. They were in excellent condition and gave a consistent age of 1784. The house was thus built during the early immigration of Loyalist refugees (Table 7).

The old age of the well known De Gannes-Cosby House is supported by our analysis. Two clusters of dates emerged: one in the early 1690s and another at 1707-08. We suggest that recycled wood from an older building possibly burnt during the 1707 attacks (Dunn, 2004) was used to build the 1708 house (Table 7).

From the Riordan-Francis House, we had only salvaged timbers to work with and they came in at an age of 1843. The house has a complex history and is thought to have been built at least around 1800 and could even be older. It also displays strong mid-Victorian features inherited from later renovations. Since we do not know from what part of the house the beams were taken, we suggest two possible interpretation of the 1843 date: 1) the beams are from mid-1800s renovations; 2) the house is younger than suggested (Table 7).

Finally, investigation on the north wall of the Adams-Ritchie house displaying a wattle and daub vestige is of the same age as the ceiling beams dated at 1747 (Table 7).

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