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# Using dendrochronology to date the Val Comeau canoe, New Brunswick and developing an eastern white pine chronology in the Canadian Maritimes

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ABSTRACT

This paper examines the dendrochronological analysis that was needed to establish the construction date of the Val Comeau canoe. The canoe was unearthed in northeastern New Brunswick after a large storm hit the area. It is currently housed at the New Brunswick Provincial Museum in Saint John, and had been radiocarbon dated to 440 ± 50 years. After a scanning electron microscope analysis, the species of the canoe wood was determined to be eastern white pine (*Pinus strobus* L.). A chronology for the white pine species was constructed for New Brunswick using living trees and structures; however, the dates did not extend far enough back in time to overlap the range of radiocarbon dates on the canoe. Another eastern white pine chronology was established for Nova Scotia which included an Acadian sluice whose chronology extended back into the radio carbon date range on the canoe. The Val Comeau canoe was successfully pattern matched against the sluice chronology and dated to a minimum cut date of 1557. Regional white pine chronologies for New Brunswick and Nova Scotia were also developed in the process which will help with future dendrochronological investigations within these regions.


## Introduction

Canoes are an important part of the history for many regions in North America and especially for many First Nations groups. They have been used traditionally as a key mode of transportation much like an automobile or train is used today to move goods and people. In North America, dugout canoes have been used extensively along the eastern seaboard by both European settlers and First Nations groups. There is still discussion as to whether dugouts were in use before Europeans arrived, and if so to what extent. In the past it has been suggested that Europeans brought this idea with them to North America (Rogers, 1965).

In either case, First Nations dugout canoes have been discovered from Florida (Wheeler et al., 2003) to Nova Scotia (Carter et al., 1982) and near the Great Lakes in Ontario (Kidd, 1960; Johnston, 1962; Richard, 1962; Rogers, 1965; Mitchell et al., 1968). There have been three dugout canoes found in the Maritime Provinces of Canada. One found on Brier Island, Nova Scotia, in 1976 was constructed from a single log and a second found in the same province near Uniacke Lake was constructed of two logs joined at the center (Carter et al., 1982), as well as the Val Comeau canoe in this paper. Most of the dugout canoes that have been found were constructed of two or more logs, and these types of canoes were still in use in northern New Brunswick into the late 1930s (MacKean and Percival, 1979).

### *The Val Comeau canoe*

The Val Comeau canoe was discovered in northeastern New Brunswick after a large storm hit the area (Fig. 1). It was uncovered on a beach in Val Comeau during the summer of 2003. It measured 4.8-m long and the bottom had a depth of approximately 10 cm. The canoe was in an advanced state of deterioration; the sides were no longer present and the wood was no longer solid throughout most of the canoe. As a valuable artifact, it was transferred to, and is now kept at the New Brunswick Provincial Museum in Saint John, where it is undergoing preservation. The Museum had the artifact dated through a radiocarbon process (Beta lab – 200541), and the conventional calibrated age of the wood with 2 sigma was determined to be 440 ± 50 BP. The intercepts for this date were AD 1410–1520 (BP 540–430) and AD 1590–1620 (BP 360–330). This range of dates brings up the possibility that the canoe may or may not be pre-European, making it potentially the earliest dugout canoe of its kind discovered in the Maritimes.

### *Dendrochronology*

Dendrochronology is the study of the annual radial-growth rings of a tree (Stokes and Smiley, 1968). Using annual rings, wood

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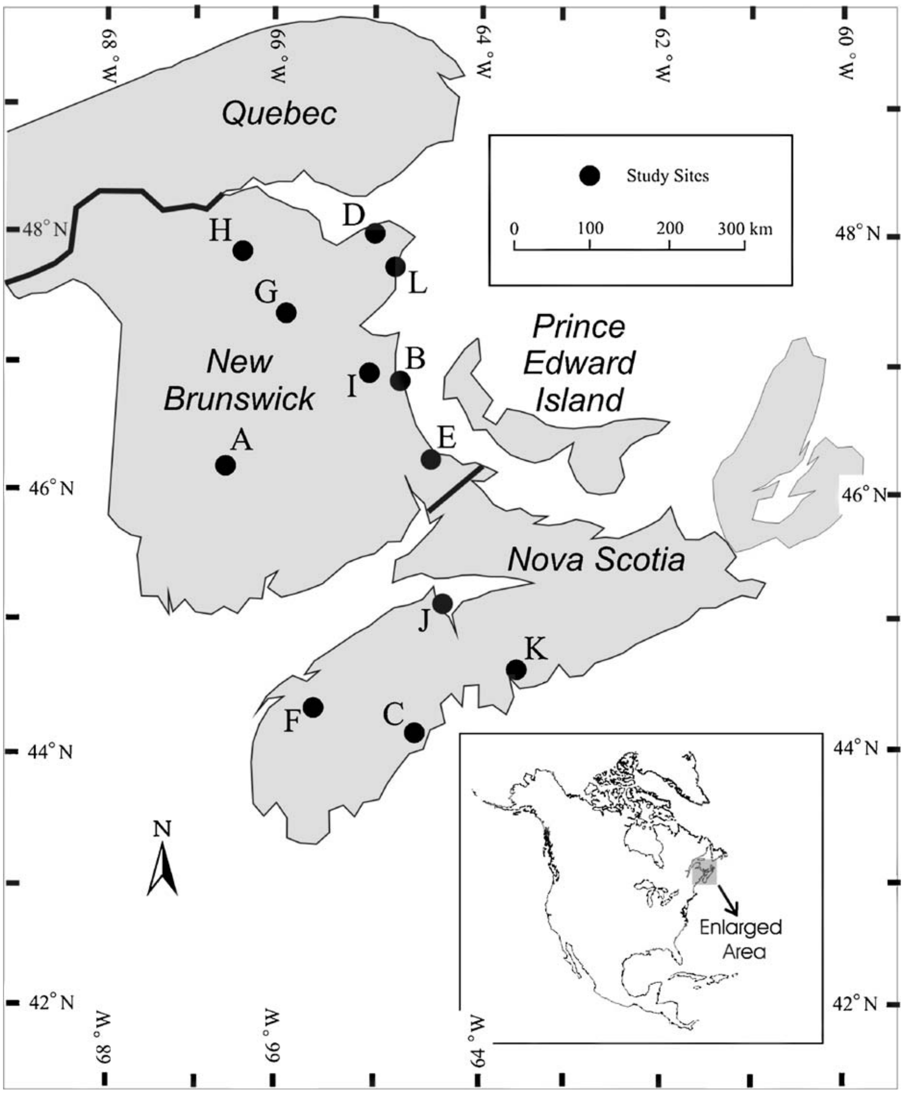


**Fig. 1.** Location of study sites in New Brunswick and Nova Scotia. The study sites are: (A) Fredericton, New Brunswick; (B) Jardine, New Brunswick; (C) Old Meeting House, Nova Scotia; (D) Babineau Farm, New Brunswick; (E) Haute-Aboujagane, New Brunswick; (F) Sporting Lake, Nova Scotia; (G) Sheephouse Falls, New Brunswick; (H) Bathurst, New Brunswick; (I) Powell Barn, New Brunswick; (J) Grand-Pré, Nova Scotia; (K) Government House, Nova Scotia; and (L) Val Comeau canoe, New Brunswick.

can be aged by simple counting methods, and the width of each band of annual-radial growth is also affected by factors such as local climate. These factors vary the size of the rings, creating a distinguishable pattern of growth for a given species at a given location (Fritts, 1976). In most temperate locations, climate is the most prevalent parameter affecting the growth of the tree, and its rings. Because of this, a master chronology of radial growth can be constructed for an area, since trees of the same species usually exhibit similar growth patterns, due to their comparable environmental conditions. An undated series can be crossdated (or pattern matched) against a master chronology to determine its temporal placement. If the pattern matches to a significant level, then the date of the undated wood can be determined. Crossdating of undated material that came from a structure or artifact is a component of dendroarchaeology (Kaennel and Schweingruber, 1995).

There are few dendroarchaeological studies in Canada (e.g., Nielsen et al., 1995; Smith et al., 1998; Brelsford, 2003) and even fewer in the Maritimes (e.g., Selig et al., 2007; Robichaud and Laroque, 2008). In New Brunswick, Prince Edward Island, and Nova Scotia, there has been an extensive history of logging and ship building, as well as numerous forest fires, which have removed much of the old growth forests from the province (Loo and Ives, 2003). The result of this deforestation is that master chronologies derived from living trees extend back in time, at most, a few hundred years. In order to extend the chronologies further back in time, historic structures and artifacts, which often contain timber older than the forests, are used (e.g., Robichaud and Laroque, 2008).

Dendrochronology has been used to date ships and boats throughout the world (Fletcher, 1977; Bonde and Christensen, 1993; Daly, 2007; Daly and Nymoen, 2008). This procedure is a bit more difficult to do however, as determining the origin of a boat can create a problem in trying to locate master chronologies for comparison. Dendrochronology has been used to date a dugout canoe, specifically the craft from Oxford Island (Baillie, 1982). There are problems associated with dating these dugouts, as they tend to be hollow for most of their length and therefore only have a few rings in the shell of the structure, unless the bow or aft provide a large section of material to analyze (Baillie, 1982). Added to this difficulty is that single-tree dugout structures only provide one ring sequence to crossdate against master chronologies.

The main objective of this study is to establish a more precise date of construction for the Val Comeau canoe than was

**Fig. 2.** The Val Comeau canoe being housed in a rubber-lined container at the New Brunswick Provincial Museum in Saint John. It is currently undergoing a preservation treatment with polyethylene glycol to arrest the deterioration process.

established by the radiocarbon process. By establishing a regional master chronology for eastern white pine (*Pinus strobus* L.) that would overlap the radiocarbon date range, we hoped to accomplish this task. After this objective is met, it would be possible to determine whether the canoe was constructed before European arrival in the area. To construct such a long master chronology, both structures and live trees need to be sampled to create a long-lived eastern white pine master chronology.

## Methods

### *Artifact sampling*

In February 2007, the New Brunswick Provincial Museum asked the Mount Allison Dendrochronology (MAD) Lab to travel to the museum and sample the Val Comeau canoe. We were allowed to collect three core samples from the canoe, prior to preservation treatments (Fig. 2). At the time, the canoe was submerged in a large rubber basin to arrest any decaying processes. The samples were carefully extracted from the canoe using a 5.1-mm Swedish increment borer and followed standard dendrochronology methods (Stokes and Smiley, 1968). Care was taken to collect the samples from areas of the canoe that were the most structurally sound and the thickest to provide the longest ring sequences. There was no bark present on the canoe, as it was either removed at construction or had eroded, but the general curved shape of the tree and the condition of the wood around the branch knots (where minute bark pieces were present) indicated that outer rings of the tree were probably near. This was especially true of the sample collected near the aft of the craft. There were no adze-style marks on the outside of the structure, indicating that little shaping occurred on this portion of the canoe. The inside of the canoe did display rough markings of stone axes used to carve out the center portion of the canoe, while erosion of rings is apparently minimal, most of the inner rings were not present to sample.

The samples were transported to the MAD Lab, and two of the three cores were glued into slotted mounting canes, and sanded flat to a high polish. The third core was too fragmented to be mounted. The annual ring widths of the two viable cores were measured to the nearest 0.001 mm using a 63× light microscope coupled to a Velmex stage measuring system (Velmex Inc., Bloomfield, New York). The measured ring widths from the two cores were visually crossdated against each other, and then averaged to create an undated chronology for the dugout canoe.

### *Species identification*

The third core sampled from the canoe was used to determine the species used to construct the canoe so that an appropriate master chronology could be referenced for dating the artifact. A scanning electron microscope (SEM), with magnifications ranging from 400 to 5000×, was used to positively identify the species. Three views were checked at high magnifications (radial, tangential, and transverse) to determine that the species was eastern white pine.

### *Master chronology development*

Because there was no New Brunswick eastern white pine master chronology old enough to overlap the possible time frame indicated by the radiocarbon date, a master chronology had to be created. This was done by sampling areas of possible old growth eastern white pine and structures built out of eastern white pine across the province (Fig. 1). Three sites with old live trees were located and sampled (Fredericton, Jardine, and Bathurst). Two sites with detrital logs and structures made of eastern white pine were also located (Sheephouse Falls and Powell barn) (Fig. 1). These samples were mounted, surfaced and analyzed using standard dendrochronological techniques (Stokes and Smiley, 1968), and the samples from New Brunswick were determined not to be old enough to overlap the range of the carbon date on the canoe.

Existing white pine chronologies available from the MAD Lab for the greater Maritime region where checked for overlap between the new and old samples. White pine chronologies from the Old Meeting House (O'Neill et al., 2006), Babineau Farm (Leighton et al., 2006), Haute-Aboujagane and Sporting Lake were used to develop a regional chronology, but the series still did not overlap the approximated carbon date time frame.

Samples of eastern white pine discovered within a historical Acadian sluice from the Grand-Pré region in Nova Scotia were obtained by the MAD Lab. The range of construction dates for the sluice were suspected to be closer to the approximate range from the radiocarbon date of the canoe, as based on historical records, the Acadian people were present in the region starting in 1604 (Dunn, 2004). The sluice was dated using a red spruce chronology, as the sides of the sluice were constructed from red spruce (Robichaud and Laroque, 2008). Assumptions at the time were that the whole structure was constructed at the same or a similar time as the sides. With this assumption made, the white pine sluice was assigned an estimated construction date of 1686 (Robichaud and Laroque, 2008). The white pine sluice samples underwent the same mounting and sanding procedures as above and a floating chronology was developed from these ring-width measurements (Robichaud and Laroque, 2008).

Cross-section samples were also obtained from the Nova Scotia government house, which was being renovated in early 2008. The large beams from the structure provided an extended ring series of eastern white pine growth which overlapped with the range of dates provided by the radiocarbon date estimates, and the other existing chronologies. These government house samples were processed, and the ring measurements between the floating chronologies and the master chronologies from all of the above series were both visually and statistically checked for signal homogeneity using COFECHA (Holmes, 1986). All floating samples and live chronologies were then single detrended using a conservative spline in ARSTAN (Cook and Holmes, 1986).

## Results

Measurements from the two canoe cores provided a 67-year sequence to crossdate against any derived master chronology. Although the samples are few in number (only two), the ring sequence was sufficient in length to establish a good match, especially if a pattern of overlap could be established between the canoe and another absolutely dated chronology.

The live samples of eastern white pine from Fredericton were 144 years old and spanned a time frame from 1863 to 2007; the pine at Jardine were 153 years old and spanned from 1854 to 2007 (Fig. 3). These chronologies had an overall mean series correlation of 0.652 and 0.517 respectively (Table 1). The third site with live trees was from Bathurst and exhibited growth extending 324 years, spanning from 1683 to 2007, with a mean series correlation of 0.518 (Fig. 3, Table 1). A regional white pine master chronology from Bathurst and Fredericton was constructed having a mean series correlation of 0.491 (Table 1). The regional chronology was used to crossdate all of the other structural samples from New Brunswick.

Statistical and visual methods were used to crossdate the structural samples and establish dates for each location. The outermost rings were present on about half of the samples (indicated by the presence of beetle galleries and bark), allowing us to identify the felling date of the timber used in the Powell barn (1858) (Fig. 3). The beams sampled in the Powell barn had dates spanning from 1683 to 1858 and a mean series correlation of 0.463 (Table 1). The Sheephouse Falls tree was felled in 1952 (Fig. 3). The samples collected from the large log extended from 1952 to 1701 and had a mean series correlation of 0.608 (Table 1).

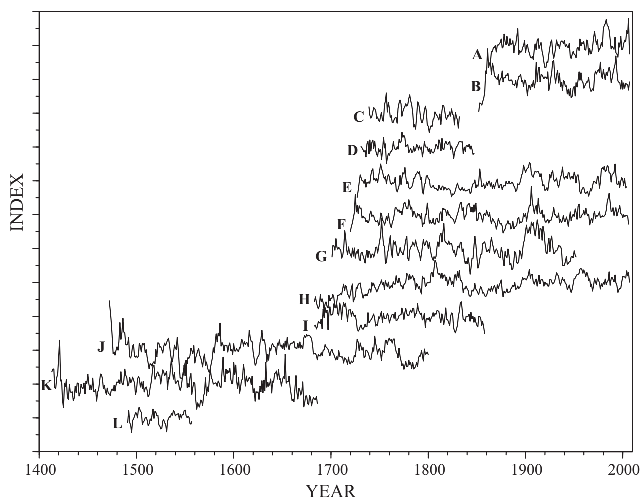


**Fig. 3.** Individual standardized chronologies from sites around New Brunswick and Nova Scotia used in this study. (A) Fredericton, New Brunswick; (B) Jardine, New Brunswick; (C) Old Meeting House, Nova Scotia; (D) Babineau Farm, New Brunswick; (E) Haute-Aboujagane, New Brunswick; (F) Sporting Lake, Nova Scotia; (G) Sheephouse Falls, New Brunswick; (H) Bathurst, New Brunswick; (I) Powell Barn, New Brunswick; (J) Government House, Nova Scotia; (K) Grand-Pré, Nova Scotia; and (L) Val Comeau canoe, New Brunswick.

**Table 1**
The time span and chronology information for each of the chronologies developed in this study. Age ranges, series correlation, and number of cores are listed.

| Site | Age range | Outside date | Series correlation | Number of cores |
|---|---|---|---|---|
| Fredericton | 1863–2007 | 2007 | 0.652 | 39 |
| Jardine | 1854–2007 | 2007 | 0.517 | 20 |
| Old Meeting House | 1738–1832 | 1832 | 0.473 | 7 |
| Babineau Farm | 1731–1847 | 1847 | 0.524 | 24 |
| Haute-Aboujagane | 1727–2004 | 2004 | 0.192 | 39 |
| Sporting Lake | 1720–2006 | 2006 | 0.481 | 31 |
| Sheephouse Falls | 1701–1952 | 1952 | 0.608 | 11[a] |
| Bathurst | 1683–2007 | 2007 | 0.518 | 50 |
| Powell Barn | 1683–1858 | 1858 | 0.463 | 8 |
| NS Government House | 1442–1805 | 1805 | 0.396 | 26 |
| Grand-Pré | 1413–1686 | 1686 | N/A | 1[a] |
| Val Comeau canoe | 1491–1557 | 1557 | 0.545 | 2[a] |

*Note*: all correlation values over 0.3821 are significant to the 99% confidence level using 50-year segments lagged 25 years.
[a] Indicates cores from only one tree.

The Babineau Farm and Haute-Aboujagane, pre-existing chronologies in the MAD Lab archive, were also crossdated with the New Brunswick regional chronology (Fig. 3). However, they only spanned from 1731 to 1847 and 1727 to 2004 respectively (Table 1). The chronologies created from the live and structural samples from across New Brunswick extended from 2007 to 1683 for a total of 324 years (Table 1).

Preexisting Nova Scotia chronologies from the MAD Lab archive were assessed to try to establish a longer pattern of eastern white pine growth. Chronologies from the Old Meeting House contained 93 years of growth extending from 1832 to 1738 (Fig. 3, Table 1). The Sporting Lake chronology contained 286 years of growth and extended from 1720 to 2006, with a mean series correlation of 0.481 (Fig. 3, Table 1).

The Acadian sluice from the Grand-Pré region, which was approximately dated using a red spruce chronology to 1686, with a ring series of 1413–1686 (Robichaud and Laroque, 2008; Fig. 3), was analyzed in further detail against the regional white pine chronologies. A match was attempted between the Acadian sluice and the Government House chronology to further lock the white pine sample of the sluice in time, however there was not a strong match likely due to spatial differences. Through crossdating with the other Nova Scotia samples, it was established that the Government House chronology spanned from 1442 to 1805 and had a mean series correlation of 0.396 (Table 1).

The Acadian sluice wood, turned out to be the missing link to crossdating the Val Comeau canoe. The growth patterns exhibited by the sluice had a very good visual match to the canoe's growth pattern (Fig. 4). This pattern matched the tree used to build the canoe with a date of 1557; the Pearson correlation between the canoe and sluice is 0.177 ($n = 67$, $p < 0.07$) (Table 1). It is important to note that both the canoe and the sluice had chronologies derived from one individual tree.

## Discussion

Results indicate that the tree used to construct the canoe was felled after the year 1557. This date may not be the last year of tree growth as the bark was not present, but the overall shape of the dugout gives the impression that most of the rings were intact. The overall correlation between the Acadian sluice and the canoe is lower than we would like, probably because it is between only

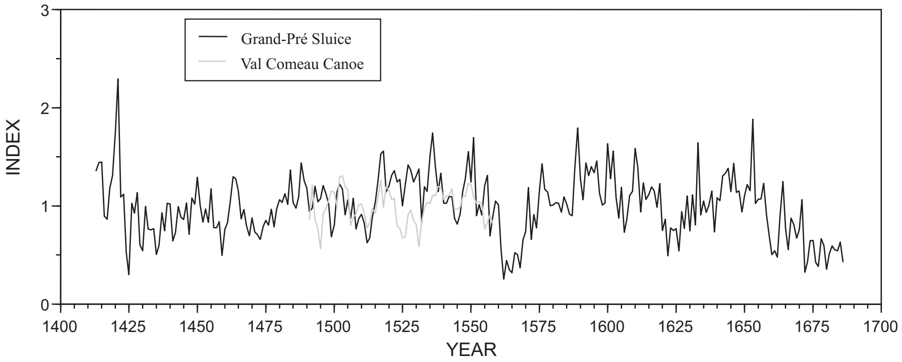


**Fig. 4.** Pattern match between the Acadian sluice from Grand-Pré and the Val Comeau canoe, illustrating a correlation of 0.177 ($n = 67$, $p < 0.07$).

two pieces of wood, one from the sluice and one from the canoe. Crossdating between two individual ring patterns will never be as strong as if it were between two master chronologies (Baillie, 1982), but given how difficult it was to overlap the carbon-dated time period, it is remarkable how well the match fits (Fig. 4). In general, even close white pine sites throughout New Brunswick did not have high correlations with the Fredericton and Bathurst sites having a Pearson correlation of 0.167 ($n = 145$). The 1557 date, therefore, generates the question of whether or not the canoe was constructed before or after the arrival of Europeans.

Historical documents suggest that the first Europeans to visit the Canadian Maritimes were John Cabot and his crew in 1497, but the first European settlement was not established until 1604 (Dunn, 2004). In 1604 Pierre de Guast set up a fur trade on Saint Croix Island, although it was there for only 1 year. The following year, 1605, Port Royal was constructed and was inhabited intermittently until 1613 (Dunn, 2004). Therefore, the date of construction for the canoe puts it in the time period after the first explorer arrived in Canada, but before the first settlement was established. It can still not be determined conclusively whether the Europeans had any influence on the construction of this dugout, but, because the canoe was found in such a distant location compared to where most of the European contact was, it is doubtful.

The origin of the canoe was also brought into question through this analysis, because the chronology from the canoe was dated using a chronology from the Grand-Pré region of Nova Scotia. It is possible that the canoe originated in Nova Scotia and was transported to its resting area in northeastern New Brunswick, as First Nations groups traversed the entire region. The similarity in growth patterns for New Brunswick (e.g., Fredericton live chronology and the Bathurst live chronology) suggests the possibility of a widely shared climatic signal over the entire area. There may also be shared similarities in the growth patterns across New Brunswick and Nova Scotia due to similar climates, but because the samples key to the pattern match are only from one tree each, more samples are needed to verify the patterns. More research needs to be undertaken to examine the shared climatic signals across the Maritime region, and this cannot be done without the discovery of more old growth forests or structures from across the two provinces.

## Conclusion

A master chronology for eastern white pine was created from samples throughout New Brunswick and Nova Scotia as well as past white pine chronologies which extend back in time to 1413. The Val Comeau canoe was finally dated using a chronology from a Grand-Pré sluice which crossdated visually, and statistically ($r = 0.177$, $n = 67$, $p < 0.07$) between the two chronologies, placing the canoe tree's felling after 1557.

Creating a regional Eastern white pine chronology for both New Brunswick and Nova Scotia was time consuming and not without its difficulties, but building these regional chronologies, and extending them back in time, will be highly useful to future projects. In this study, the construction of the chronologies has enabled us to date a dugout canoe, an initially impossible project, and will probably be useful in dating future archaeological finds in the Maritimes given the prominence of eastern white pine to the region. It is important to continue to establish regional chronologies for all the species of this area, as it increases the options to generate more detailed paleoclimatic, forest inventory, and archaeological information on the area. Such information can be used to assess past influences by humans on the forests and provide data concerning the historical changes that have occurred through time. This dendrochronological information continues to be important in the region, especially due to the lack of remaining old growth forest.

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