Forest dynamics in relation to late-Holocene climatic variability, eastern Ontario, Canada

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Abstract

Pollen profiles from two lakes, Tawny Pond (44°48’59”N, 77°10’54”W, 276m) and Stoll Lake (44°58’16”N, 77°17’22”W,303m) in Addington Highlands, eastern Ontario, Canada were analyzed to understand the effects of late-Holocene climate change and European settlement on eastern Ontario’s forests. Both lakes were analyzed at high temporal resolution and record vegetation dynamics over the last 1000 years. Throughout the past 1000 years, *Pinus, Tsuga, Betula, Quercus, Acer* and *Fagus* were the dominant taxa in the pollen record. The pollen records show vegetation response in relation to the Medieval Warm Period and the Little Ice Age. From 970-1200 AD the forest was dominated by hemlock, beech and maple trees. From 1200-1870 AD the forest composition changed as pine and boreal trees became more abundant and/or had increased relative pollen production. Most recently, since 1870 AD, herbaceous plants (weeds) increased, whereas softwoods decreased and hardwoods increased, due to landscape changes associated with European settlement. These results show that high resolution studies of unvarved lakes, with an appropriate chronology, can detect multi-decadal climate variability. This thesis was also concerned with making management suggestions to the forestry community. Future climate change will likely create a forest composition more similar to that of the Medieval Warm Period than the time of European colonization, and thus should be the basis for forest planning.

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Chapter 1: Introduction

1.1 Introduction

During the Holocene, eastern Ontario transformed from a tundra landscape with sparse cold-adapted vegetation to a temperate landscape covered by the Eastern Great Lakes Lowland Forest. Holocene landscape transformation occurred in response to decadal-, century- and millennia- scale climate changes (Delcourt & Delcourt, 1987). Although the broad-scale climate variability and vegetation migration have been extensively studied, the impact of decadal- to century-sale climate variability on vegetation is less understood. This thesis examined the impact of late-Holocene decadal- and century-scale climate variability on the temperate forest of eastern Ontario.

During the last 150 years the landscape of eastern North America was greatly altered by the arrival of European settlers who extensively logged and converted undisturbed forests to farmland (Whitney, 1994; Russell & Davis, 2001). Prior to European settlement, Native American activity caused significant modification of the forests in some areas (Munoz & Gajewski, 2010; Doolittle, 1992); however, Native American land clearing practices did not occur at the same scale as European settlement and most of Ontario remained relatively undisturbed. Thus, the dominant factor causing changes in vegetation prior to European settlement was changing climate regimes; within the late Holocene these include the Medieval Warm Period (MWP) and the Little Ice Age (LIA) (Wanner *et al.*, 2008).

In this study, pollen records (Faegri and Iverson, 1989) from two small lakes (Tawny Pond and Stoll Lake) in Addington Highlands Township, eastern Ontario, Canada are used to examine vegetation dynamics during the last 1000 years. The principal objective of this thesis is to observe the forest history of Addington Highlands in relation to the climate variations of the MWP and LIA and European settlement. Previous palynological studies of eastern North America's vegetation history document large-scale biome changes and the northward expansion of plants in relation to post-glacial climate warming (Bernabo & Webb III, 1977; Prentice *et al*., 1991; Overpeck *et al*., 1992; Jackson *et al*., 2000b). These studies were primarily concerned with millennia-scale climate forcings and lack the temporal resolution to observe decadal- and century-scale climate and vegetation variability. My study analyzed pollen and charcoal at a high temporal resolution to assess changes in vegetation composition in relation to environmental variability. My study also analyzed forest disturbance after the arrival of European settlers.

Another objective of this study was to produce practical results for the forestry industry or private landowners attempting to reconstruct pre-settlement forest compositions after landscape disturbance. There is a current trend in forestry practices to achieve pre-settlement "historical" forest compositions as benchmarks for management initiatives aimed at restoring forest ecosystems to more "natural" conditions (Betts and Loo, 2002). This management strategy is based on two methods. The "witness tree method" uses early European survey records to establish the nature of the pre-settlement forest and set management targets (Jackson *et al*., 2000). Alternatively the "potential forests approach" examines features of the landscape (climate, topography, bedrock and soils) and uses them to model the pattern in forest distribution (Zelazny *et al.,* 1997). The results of these methods are used as the benchmark upon which to base reforestation and preserve species diversity of the forest. In this study, I explore the use of paleoecological records as another source of data about the nature of the pre-settlement forests.

Maintenance of species diversity is a facet of sustainable forest management as outlined in legislation by the Canadian Council of Forest Ministers (CCFM) (CCFM, 2000). The CCFM endeavors to preserve genetic diversity in order to maintain the health of a working forest and protect it against future climate change (Johnston *et al*., 2009). Since future climate change is assumed to be unpredictable, a reasonable objective in order to maintain forest health over the long term is to conserve genetic and species diversity (Spittlehouse & Steward, 2003; Johnston *et al*., 2006). Genetic and species diversity is achieved by the re-introduction of species lost through European settlement (Zelazny *et al*., 1997). This establishes stand-level diversity in replanted forests based on tolerant and moderately tolerant species from the pre-settlement ecosystem. Results obtained from paleoecological records can provide information about long-term climate and vegetation interactions and can offer management suggestions to the forestry community. This study attempts to make suggestions on forestry management and offers a paleoecological perspective on the notion of a "pre-European settlement forest" as a strategy for ecosystem management. This thesis provides a pollen-inferred vegetation history of Addington Highlands and displays the dynamic nature of the forest in relation to changes in late-Holocene climate variability.

1.2 Study Area

The study area is located in Addington Highlands Township, Lennox and Addington County, Eastern Ontario, Canada (Figure 1). The township was formed in 1998 by the amalgamation of the townships of Kaladar, Anglesea, Effingham, Denbigh, Abinger and Ashby. The municipality approximately follows Ontario Highway 41 north from the junction of Ontario Highway 7 to the southwestern corner of Renfrew County. Currently, Addington Highlands is sparsely populated, with a population density of 1.9 people per square kilometer and 2,532 year round residents (Statistics Canada, 2011). The residents inhabit small hamlets, villages and private dwellings spread throughout the township.

Granite and gneiss bedrock produce thin and acidic soils throughout Addington Highlands (Gillespie *et al*., 1963). The southward incursion of the Canadian Shield creates an environment of thin poor soils, exposed pre-Cambrian rock and numerous lakes and bogs not seen in other parts of

Ontario at the same latitude (Beschel *et al*., 1962). The thin soils in the region prevented the spread of large-scale agriculture and caused the area around Mazinaw Lake to be one of the last parts of southern Ontario to be settled (Campbell, 2000). Currently there are isolated areas within the former Kaladar and Denbigh townships that support small farms (McLeman, 2008), however, large scale land clearance for agriculture is not a dominant feature of the landscape.

Tawny Pond (~2 ha) is located at the southeastern edge of the hamlet of Cloyne, Ontario (44°48’59”N, 77°10’54”W, 276m). It is accessible via Little Pond Road and Jewel Road found on the east side of Ontario Highway 41. Tawny Pond is surrounded by cottages and permanent homes on its western shore and by secondary mixed forest on its remaining sides. It is spring fed, indicated by the lack of inflowing rivers and streams. On the southern shore, a small stream flows south. A beaver dam/lodge severely restricts the amount of water transported from Tawny Pond to Story Lake, located roughly 500m south.

Stoll Lake (~37 ha) is located further north, approximately 18km along Ontario Highway 41 (44°58’16”N, 77°17’22”W,303m). It is accessible via Forest Road on the west side of Ontario Highway 41, just north of Mazinaw Lake. The forest around Stoll Lake is currently being logged and was historically part of the Sawyer-Stoll Lumber Company stand (Campbell, 2000).

After the creation of the Addington Colonization Road (Ontario Highway 41) in 1854, settlement began in the area (Campbell, 2000). The principal reason for settling the Mazinaw Lake area (which includes Tawny Pond and Stoll Lake) was to gain access to the dense pine forest stands that dominated the region in the mid-1800s. During this time there was widespread logging to the east and south of Addington Highlands. Beginning in the 1830s logging proceeded up the Mississippi River, westward from the Ottawa River and the area around Flinton, southwest of Cloyne, may have been logged as early as the 1820s as lumbering progressed up the Moira and Skootamatta watersheds (Campbell, 2000). Settlement and lumbering access to the Mazinaw Lake area occurred in earnest after the creation of the Addington Colonization Road (Axford *et al*., 2008). When European settlement began, the environment was altered primarily through logging and small scale forest clearing for farms and homesteads.

Cloyne was established after the 1850s due to a lumbering boom and improvements to the Addington Colonization Road. Cloyne grew slowly after initial settlement, facilitated by the lumber companies in the area; they encouraged settlement as a source of local farm produce, winter labourers and general tradespeople (Campbell, 2000). By 1858 there was a small settlement of people in Cloyne, but no sawmill. In 1860 more settlers arrived and in 1861 a mill was built on the Marble River near Mazinaw Lake (Axford *et al*., 2008). Cloyne's first school house was built in 1868 and its first (Methodist) church was built in 1870 (Axford *et al*., 2008). As the community developed a general supply store and a post office were built.

Life in the early days of Cloyne was difficult. Campbell (2000) documented the hardships and lives of Cloyne's pioneer community in *The Mazinaw Experience: Bon Echo and Beyond,* the following is based on this book. The poor soils of the area did not support agriculture, and erosion and repeated fires caused by large-scale logging depleted the thin topsoil and further hindered early attempts at agriculture. Settlers were able to provide for themselves by growing a variety of grains, corn, buckwheat, turnips, hay and small vegetable gardens. From 1855 to 1870 a full-scale lumber industry developed in the Mazinaw Lake region and during this time an enormous amount of timber was taken from the area. Mostly red and white pine trees were floated down the Mississippi and Madawaska Rivers to the Ottawa River where they were milled. The pine trees were up to 38 metres high with a diameter of one metre or more, and grew in densities of 500 to 800 trees per hectare. Lumber chutes and dams were built on many rivers and steam-driven boats were used to haul log booms on the large lakes in the area. From 1870 to 1890, the Addington Highlands area experienced its greatest economic boom, largely based on lumbering and farming. By the late 1890s, however, the major lumbering operations had started to move further north. Large-scale lumbering was on the decline, causing the market for local agriculture to dwindle; by the end of the 1800s, the land in the Mazinaw Lake area had been stripped of most of its trees and fire had consumed much of the already thin soil. No record of one big fire engulfing the whole area exists; rather a series of smaller fires, spread over a number of years impacted the landscape.

Lumbering in the region of Stoll Lake occurred well into the mid-1900s. In 1938 the Sawyer-Stoll Lumber Company built a mill and village near Stoll Lake. At the height of its operations, the firm employed 200 workers and built a school and a post office within the village. In 1962, Sawyer-Stoll closed their mill on Stoll Lake. Several years later, a partial recovery in the Ontario market saw the start-up of operations, but in 1975 a fire destroyed the original mill.

Today, Cloyne is a settlement of approximately 100 people in the immediate surrounding area. The main sectors of employment in the area are construction, retail/service provision (particularly tourism) and small-scale natural resources extraction (agriculture, forestry, fishing and hunting) (McLeman, 2008). Controlled logging currently exists in the Mazinaw Lake area, but at a smaller scale than the logging boom of the 1800s.

Chapter 2: Literature Review

2.1 Pollen Studies of eastern North America

Addington Highlands is currently part of the Eastern Great Lakes Temperate Lowland Forest Region (Rowe, 1972). The forests of this region are mixed conifer-hardwoods, characterized by *Pinus strobus*, *Pinus resinosa, Tsuga canadensis* and *Betula alleghaniensis*. Other broadleaf trees are also common, including *Acer saccharum*, *Acer rubrum*, *Quercus rubra*, *Tilia americana* and *Ulmus americana*. This biome is transitional between the Boreal Forest of the north and the Broadleaf Deciduous Forest of the south. Addington Highlands lies near the northern edge of the Eastern Great Lakes Lowland Forest Region with cold tolerant softwoods representing a large portion of the present-day forest.

To document changes in the forest through time, fossil pollen from sediment cores are used. The use of fossil pollen in documenting vegetation history and as a paleoclimate proxy has an extensive literature (e.g., Webb III *et al*., 1987; Faegri & Iverson, 1989). Several studies of fossil pollen in eastern North America have synthesized the vegetation and climate history through the Holocene at several timescales (e.g., Bartlein *et al*., 1986; Bennett, 1987; Gajewski, 1987; Gajewski, 1988; Campbell & McAndrews, 1993; Fuller, 1997; Viau *et al*., 2006).

During the Wisconsinan Glaciation (110,000 to 10,000 yr. BP), the Laurentide Ice Sheet covered most of present-day Canada and extended south to the upper Midwest United States and New England (Eyles & Westgate, 1987). Evidence of the glaciation includes unsorted till and glacial landforms found throughout Canada and the northern United States. The vegetation of North America was relegated to the unglaciated portion of the southern United States during this time. At ~22,000 yr. BP, *Picea* and *Pinus* were important components of the vegetation near the ice margin (Webb III *et al.*, 1993). Further south, the vegetation consisted of a *Picea*-dominated forest in the continental interior, *Pinus* dominated forest along the Atlantic coast and interior highlands, temperate hardwood forest growing locally near the lower Mississippi Valley and open vegetation/warm-temperate *Pinus* forest on the Florida peninsula (Jackson *et al*., 2000b).

Before 12,000 yr. BP, near the end of the last glacial period, *Picea*, Cyperaceae, northern *Pinus*, *Quercus* and *Carya* pollen showed a general north-south distribution from the ice margin to Florida (Webb III *et al.*, 1993). Between 12,000 yr. BP and 9,000 yr. BP there was a rapid northward movement of tree species resulting from the northward retreat of the Laurentide Ice Sheet and major changes in climatic regimes (Prentice *et al*., 1991); this led to a northeast to southwest vegetational gradient between central Canada and Nebraska. The gradient represents a northeast to southwest sequence of peak values for *Picea, Pinus, Quercus* and forb pollen reflecting *Picea*-dominated forest to *Pinus* forest, *Quercus* forest and finally prairie (Webb III *et al*., 1993). This vegetational pattern is similar to the modern boreal, to broadleaf deciduous, to prairie vegetation gradient seen in eastern North America and represents the earliest development of modern vegetation biomes in the pollen record. After 9,000 yr. BP, pollen of southern pines increased in the southern United States and established the modern southern conifer forest. *Betula, Fagus, Quercus* and *Tsuga* continued to migrate northward, largely at the expense of northern *Pinus* (Webb III *et al.*, 1993). In general terms, the movement of tree species in the early-Holocene can be generalized as a northward movement of tree taxa as the Laurentide Ice Sheet melted from 11,000 yr. BP to 6000 yr. BP (Webb III *et al*., 1983).

In southern Quebec and Ontario, cold-adapted tundra plants covered the early-Holocene landscape, to eventually transition to a Boreal forest. Near the end of the early Holocene, pollen data show that Ontario was dominated by *Picea*, *Abies balsamea*, *Larix laricina* and *Populus,* with small amounts of *Quercus, Fraxinus, Ulmus, Ostrya* and *Carpinus* (Bennett, 1987). By the mid-Holocene *Pinus* species became dominant (Ritchie, 1987). Towards the late-Holocene, *Pinus strobus* decreased while *Tsuga* and *Fagus* increased in abundance on the landscape (Mott & Farley-Gill, 1981; Fuller, 1997).

2.2 Climate of the Holocene in eastern North America

The melting of the Laurentide Ice Sheet greatly changed the atmospheric circulation patterns governing North America's climate which caused a change in the distribution of the vegetation (Webb III *et al*., 1993). Early-Holocene climate changes were caused largely by variations in the seasonal and latitudinal distribution of solar radiation, but also by the effect of the Laurentide Ice Sheet on the atmospheric circulation (Mayewski *et al*., 2004). Viau *et al*. (2006) proposed a four-part division of the Holocene climate of North America: a rapid warming of the early-Holocene until circa 8000 yr. BP, a cooling between 8000 yr. BP and 6000 yr. BP, a warmer middle-Holocene from 6000 yr. BP to 3000 yr. BP and cooling in the late-Holocene after 3000 yr. BP. Within these four regimes, transitions occur on average every 1200 years. Several large-scale studies of Holocene climate variations agree that after the middle-Holocene climatic optimum, a decreasing summer temperature trend is clearly visible (Mayewski *et al*., 2004, Viau *et al*., 2006, Wanner *et al*., 2008).

In the last 2000 years (late-Holocene) millennial and century climate variations have been the dominant temporal scales of climatic change identified in the paleoclimate record. Before anthropogenic modification in the late 19th century, the major climatic trend for the late-Holocene, with minor deviations, was decreasing mean annual temperatures since the mid-Holocene climatic optimum (Wanner *et al*., 2008). This cooling was the consequence of orbital variations that produced declining summer insolation in the Northern Hemisphere (Kutzbach & Webb III, 1993; Bradley, 2003). The decadal- to multi-century climate events of the late-Holocene include the Medieval Warm Period (MWP) and the Little Ice Age (LIA). These events have been seen in high-resolution proxy records derived from tree-ring records (Crowley, 2000; Mann *et al*., 2008), pollen records (Gajewski, 1987, 1987b, 1988, 1993) and ice core records (Fisher *et al*., 1995; Fisher *et al*., 2012). Swain (1978) and Gajewski (1987) show large scale and coherent changes in the vegetation of eastern North America in relation to late-Holocene millennial- and century-scale climate variability.

The MWP was a period of relatively warm climate between 800 and 1200 AD (Bradley *et al*., 2003; Grove, 2004). Ice core studies reveal that during the MWP, glacier retreat in certain areas of the earth may have been affected by brief cold periods of glacial advance. This suggests that the MWP was global in extent, but not uniform climatically (Grove & Switsur, 1994). During the LIA (1450-1850 AD) worldwide alpine glacial extents were larger than present, reaching their maximum between the 17^{th} and 19^{th} centuries (Grove, 1988; Wanner *et al.*, 2008). The LIA was global in extent and was probably caused by reduced solar activity and strong tropical volcanic activity (Solomon *et al*., 2007). Gajewski (1988) reconstructed relatively moist conditions between 1000 and 1300 AD, relatively dry conditions between 1300 and 1500 AD and relatively moist conditions between 1500 and 1800 AD using pollen records from eastern North America.

2.3 Vegetation of the late Holocene

The climate of the late-Holocene had significant impacts on the forests of eastern North America. Pollen diagrams show a late-Holocene increase of *Picea* and other Boreal forest taxa and a decrease of *Tsuga* and *Fagus* in the conifer-hardwood forest of the American northeast and Midwest (Swain, 1978; Gajewski *et al*., 1987b; Gajewski, 1998). Rapid changes in vegetation composition were observed between 1200 to 900 years ago and 500 to 400 years ago, providing evidence of the influence of late Holocene climatic variability on inter-biome changes of species composition (Gajewski *et al*., 1987b). Fuller (1997) notes a decline of *Tsuga canadensis* and *Fagus grandifolia* beginning at 1000 years ago in southern Ontario. There was a corresponding increase in abundance *of Pinus banksiana-resinosa*, *Salix*, *Picea glauca*, *Abies balsamea* and *Alnus rugosa* pollen (Fuller, 1997). In upland sites of central New England a distinct change in forest composition occurred approximately 600 to 500 years ago, characterized by a gradual decline in the abundance of *Fagus*, *Tsuga* and *Acer saccharum*, corresponding in time to the beginning of the LIA (Fuller, 1998). Similar changes in late-Holocene vegetation dynamics occurred in Ontario. A late-Holocene pollen study by Campbell & McAndrews (1991) found that changes in vegetation dynamics across Ontario were related to LIA cooling. Cooler mean annual temperatures caused the contraction of the northern range of most temperate species and a southward expansion for many boreal taxa across Ontario (Campbell & McAndrews, 1991). *Fagus*, with its northern limit just south of Lake Nipissing (Fowells, 1965), declined in the northern part of its range. *Pinus strobus*, which is most abundant just to the north of the limit of *Fagus* (Delcourt *et al*., 1984), had its optimal growing range shifted southwards by 70-140 km; this corresponds to a decrease in mean annual temperature and a decrease in fire frequency. Boreal taxa expanded southwards and *Picea* and *Pinus banksiana* or *Pinus resinosa*, the forest dominants, began to replace *Pinus strobus*, with an intermediate peak of the early-successional *Betula* and *Populus* (Campbell & McAndrews, 1991). In the interval between the reduction of *Fagus* and the increase of *Pinus strobus* in southern Ontario, other species, including *Quercus, Betula, Populus, Ulmus* and *Ostrya virginiana* had a brief “bloom” (Campbell & McAndrews, 1991). These species were already common in the area, are slightly less shade-tolerant than *Fagus*, and took advantage of the increased frequency of canopy gaps.

More recently, since ~1820 AD, the forests of southern Ontario have experienced large-scale modification, as land clearance by European settlement and the spread of agriculture disrupted the forest (McAndrews, 1976).

Chapter 3: Methodology

3.1 Field Methods and Site Selection

Tawny Pond presented ideal conditions for sediment core extraction and palynological study. Tawny Pond is located close to Little Pond Road behind a small number of cottages and permanent homes and was accessible thanks to homeowner Jack Kelly. It is a small, spring-fed lake with no inlets and one outlet. Stoll Lake is located immediately beside Forest Road, a seasonal logging road.

Several lake sediment cores (5 cm diameter) were taken from Tawny Pond and Stoll Lake in the spring and fall of 2011. A miniature gravity Glew corer (Glew, 1991) was used to extract the uppermost sediment of the lakes, but these were not subsequently used. A modified Livingstone corer (Wright *et al*., 1984) was used to obtain longer sediment cores. The cores were extracted from the deepest sections of the lakes as determined by sonar measurements. Tawny Pond had a depth of ~3m and Stoll Lake had a depth of ~5m.

An 83cm Livingstone core (Tawny Livingstone 01) was obtained in April 2011, a 57cm Livingstone core (Tawny Livingstone 04) and a 145cm Livingstone core (Tawny Livingstone 06) were obtained in September and October 2011. Depths 0-83cm (0.5-1cm interval) of Tawny Livingstone 01 were used for pollen analysis and the interval from 81-83cm was used for ^{14}C dating. These analyses were begun before a longer core was collected in the fall of 2011. In order obtain an older pollen sequence, depths 80-145cm (1cm interval) of Tawny Livingstone 06 were used for pollen analysis and the interval from 143-145cm was used for ^{14}C dating. Depths 0-57cm of Tawny Livingstone 04 were used for ^{210}Pb dating.

At Stoll Lake a Glew corer was used to extract a 30cm core (Stoll Glew 01) and a modified Livingstone corer was used to collect an 82cm sequence (Stoll Livingstone 01) in October 2011.

Depths 0-82cm (1-2cm interval) of Stoll Livingstone 01 were used for pollen analysis. Depths 0-30cm of Stoll Livingstone 01 were used for ^{210}Pb dating and the intervals from 30-32cm and 81-82cm were used for ^{14}C dating.

After collection, all cores were left in their core tubes, transported back to the University of Ottawa and extruded in the LPC lab. A polymer gel (sodium polyacrylate) was added to the top of the Tawny Livingstone 06 core after collection. The gel preserved the structure of surficial sediment and allowed transport to the laboratory without disturbance (Tomkins *et al*., 2008). In the lab sediments were stored in refrigerators at 4°C.

Conductivity and pH were measured at Tawny Pond using a Eutech Instruments Multi-Parameter PCSTestr 35. Tawny Pond had a pH of 7.48 and a conductivity of 129µS in April 2011 and a pH of 7.93 and a conductivity of 290µS in October 2011. Measurements were not made at Stoll Lake.

3.2 Laboratory Methods

The unconsolidated uppermost sediments of the Livingstone and Glew cores were extracted using an extruder and stored in plastic bags (Glew, 2001). The uppermost 30cm of Tawny Livingstone 01 were extracted at 0.5 cm intervals and the uppermost 22cm of Stoll Livingstone 01 were extracted at 1cm intervals. The deeper, consolidated sediments of all Livingstone cores were then extruded from their PVC casting, wrapped in plastic and aluminum foil and stored.

3.3 Loss-on-ignition and Carbonate content

Loss on ignition (LOI) was used to quantify the amount of organic and carbonate content of the sediments (Heiri *et al*., 2001). Each sediment core was subsampled for LOI at 1cm intervals. One cubic centimeter subsamples were placed into clean, weighed crucibles. The sediment was weighed and dried in the oven for 12-24 hours at 105°C to obtain a dry weight. To oxidize the organic matter the samples were ignited in a muffle furnace for 4 hours at 550°C (Heiri *et al*., 2001). Finally the samples were ignited in a muffle furnace at 950°C for 2 hours; the high heat evolves carbon dioxide from carbonate leaving oxide (Heiri *et al*., 2001). Weight loss at each step in the LOI process was recorded as a percent of the original dry weight sample.

3.4 Chronology

Radiocarbon and Lead-210 dating was used to establish chronologies for the Tawny Pond and Stoll Lake sediment cores. Radiometric ^{210}Pb dating is used for the uppermost sediments ranging from 0-150 years old and ^{14}C dating is used for deeper sediments ranging from 500 to 40,000 years old (Smol, 2008).

Organic material was extracted from the sediment for ^{14}C dating. Sediment from the cores was initially washed through a 90µm sieve to remove fine material. Under a stereo microscope, dark, identifiable organic matter (fibers, charcoal, etc.) was picked from the sediment. Organic matter for Carbon-14 dating was extracted from the 81- 83cm interval of the Tawny Livingstone 01 core and from the 143cm-145cm interval of the Tawny Livingstone 06 core. Organic matter for Carbon-14 dating was extracted from the 30cm-32cm and 81cm-82cm intervals from Stoll Livingstone 01. Radiocarbon dating was performed by Beta Analytic. Carbon-14 dates were calibrated using CALIB 6.0 and the calibration dataset IntCal 09.14c (Stuiver and Reimer, 1993; Reimer et al., 2009).

Wet samples (15.6cm^3) of the bulk sediment from the uppermost sediment of the cores were sent to Flett Research for ^{210}Pb dating. Samples were sent from the first 57cm of the Tawny Livingstone 04 core. Dates, based on linear regression models, were returned for depths 0cm-47cm.

At Stoll Lake ^{210}Pb dates were sent out for the first 30cm of the Stoll Livingstone 01, and dates were returned for depths 0cm-30cm.

The age-depth curves for Tawny Pond and Stoll Lake were based on polynomial regression (Blaauw, 2010), fit in Excel. Based on the dates, the Tawny Pond pollen record extends back 1040 years (970 AD) and has a temporal resolution of 2 to 21 years per sample. The Stoll Lake pollen record extends back 570 years (1440 AD) and has a temporal resolution of 1.4 to 11 years per sample.

Multiple cores (Tawny Livingstone 01, 04, 06) were used to establish a chronology at Tawny Pond. One core (Stoll Livingstone 01) was used to establish a chronology at Stoll Lake. Tawny Livingstone 01 (83 cm) was recovered in spring 2011. Pollen analysis revealed that the *Ambrosia* rise occurred at 52cm and the core would therefore only provide a short record. Tawny Livingstone 06 (145cm) was collected in fall 2011 to extend the Tawny Pond record. The sequences from the different cores were correlated based on the LOI analysis.

3.5 Pollen Analysis

Sediment was subsampled for pollen analysis by scraping away the outer sediment of the core to remove contaminated sediment and extracting $1cm^3$ from the centre of the core using a calibrated spoon. The pollen profile of Tawny Pond is based on subsamples at 0.5-1.0cm intervals from Tawny Livingstone 01 (0-83cm) and Tawny Livingstone 06 (80-145cm). The pollen profile of Stoll Lake is based on pollen subsamples collected at 1.0-2.0cm intervals from Stoll Livingstone 01.

Using the methodology of Faegi & Iverson (1989) and protocols of the Laboratory of Paleoclimatology and Climatology (Gajewski, 2009), pollen were extracted from the sediments. Pollen extraction involves subjecting the sediment to various acids and bases to eliminate non-polliniferous material from the samples (Faegri & Iverson, 1989). The extraction process begins by subjecting the sediment to (in order): 10% HCl (to eliminate carbonates), 10% KOH (to eliminate organic matter), HF (to eliminate silica), acetolysis solution (1 part sulphuric acid and 9 parts acetic anhydride), ethanol and *tert*-Butanol to prepare the pollen for mounting in silicone oil. Two *Lycopodium* spore tablets (batch number 938934) were added to the sediment at the beginning of the preparation process to enable computation of pollen concentrations (Faegri & Iverson, 1989). The processed sediment was mounted on microscope slides using silicon oil.

Fossil pollen and spores were identified with a Nikon Eclipse 80i light microscope under a magnification of 400x, with 1000x for critical identification (Bennett & Willis, 2001). Identification of fossil pollen material was based on comparison with reference material and texts (Faegri & Iverson, 1989; McAndrews *et al*., 1973; Moore, Webb & Collinson, 1991). The slides were scanned for fossil pollen along traverses regularly spaced across the slide and all pollen and spores encountered were identified and counted. For this study, a minimum pollen sum of 500 grains per slide was counted.

3.6 Micro-Charcoal Analysis

Microscopic charcoal analysis was performed on all pollen slides. Analysis of charcoal involves searching for black, opaque, angular particles on the slides (Carcaillet *et al.,* 2001; Scott, 2010). Charcoal was counted until approximately half the amount of *Lycopodium* spikes seen when counting for pollen grains was reached. This study used the size-class method and the area of each particle was measured by use of a gridded eyepiece in the microscope (Waddington, 1969; Whitlock & Larson, 2001). Charcoal was separated into 5 classes in this study: **1:** 980μm^2-1960μm^2, **2:** 1960μm^2-3920μm^2, **3:** 3920μm^2-7840μm^2, **4:** 7840μm^2-15680μm^2 and **5:** 15680μm^2 and larger. The geometric mean of each size class was used to determine the total area of charcoal for each slide. Charcoal concentrations were computed by the use of *Lycopodium* spikes.

3.7 Presentation of Results

The pollen and charcoal data are plotted as stratigraphic diagrams using the C2 program (Juggins, 2010). All pollen and spores of vascular plants except aquatics were included in the main sum. *Lycopodium* spikes were added to permit the computation of pollen/charcoal concentrations and pollen/charcoal accumulation rates. Pollen concentrations are affected by the rate at which pollen arrives on a sediment surface and the rate at which that sediment accumulates (Bennett & Willis, 2001). Pollen accumulation rates represent the accumulation of pollen (grains) at the sediment surface (per cm^2) per year (Seppa & Hicks, 2006).

A principal components analysis (PCA) ordination was used to summarize the relationships among the pollen taxa of Tawny Pond and Stoll Lake. The R program (www.r-project.org) was used for PCA analysis. The scores of each pollen spectrum were plotted in a stratigraphic diagram using C2. The first four components of the Tawny Pond and Stoll Lake PCAs were used to define the zonation of the pollen records.

3.8 Paleoclimate Reconstruction

Mean summer (June, July, August) temperatures and total summer precipitation were reconstructed using the Modern Analogue Technique (MAT) (Sawada, 2006) and version 1.8 of the North American Modern Pollen Database (NAMPD) (Whitmore *et al*., 2005). The summer precipitation data in the NAMPD were averages and not sums, so values were multiplied by three. Modern pollen data from the Eastern Deciduous Forest between 50-100°W longitude and 20-50°N latitude were used as potential candidates for modern analogues. The average of the 3 closest analogues and a squared chord distance dissimilarity coefficient (Williams and Shuman, 2008) was used to compute the reconstructed climate variables. A pollen sum of 24 arboreal pollen taxa was used for the reconstruction, including *Pinus*, *Picea*, *Abies*, Cupressaceae, *Larix*, *Tsuga*, *Betula*, *Quercus*, *Fraxinus*, *Populus*, *Ulmus*, *Ostrya/Carpinus*, *Acer*, *Fagus, Carya, Juglans, Tilia, Platanus, Castanea, Celtis, Carylus, Alnus*, *Salix* and *Myrica* (Paquette, 2012).

Chapter 4: Results

Forest dynamics in relation to late-Holocene climatic variability, eastern Ontario, Canada

4.1 Introduction

The variable climate of the Holocene caused the vegetation of eastern Ontario to change continually. Previous studies of the paleoecology of eastern North America noted large-scale biome changes and the northward expansion of plants in relation to post glacial climate warming (Bernabo & Webb III, 1977; Prentice *et al*., 1991; Overpeck *et al*., 1992; Jackson *et al*., 2000b). These studies were primarily concerned with millennial-scale climate changes and lack the temporal resolution to observe multi-decadal and century-scale climate and vegetation variability. Recent paleoecological studies have focused on late-Holocene changes in vegetation composition (Gajewski, 1987; McAndrews & Boyko-Diakonow, 1989; Fuller, 1997; St. Jacques *et al*., 2008; Paquette, 2012). These studies use high temporal-resolution pollen records to observe the effect of multi-decadal and century-scale climate variability on vegetation. Other studies have concentrated on vegetation alteration due to European settlement (Fuller *et al*., 1998; Bjune *et al*., 2009) and Native American land clearance (Doolittle, 1992; Munoz & Gajewski, 2010).

This study uses fossil pollen records from two small lakes in eastern Ontario to examine vegetation dynamics during the last 1000 years. Tawny Pond and Stoll Lake are located in Addington Highlands Township, eastern Ontario, Canada (Figure 1). The principal objective of this study was to document the forest history of Addington Highlands in relation to multi-decadal to century-scale climate variability and land-use changes, including the Medieval Warm Period (MWP), the Little Ice Age (LIA) and European settlement.

Another objective of this study was to produce practical results for the forestry industry or private landowners attempting to manage forests after exploitation. There is a current trend in forestry practice to achieve pre-settlement "historical" forest compositions as benchmarks for management initiatives aimed at restoring forest ecosystems to more "natural" conditions (Betts and Loo, 2002). This management strategy is based two methods. The "witness tree method" uses old survey records from early European surveyors to establish the nature of the pre-settlement forest (Jackson *et al*., 2000). The "potential forests approach" examines enduring features of the landscape (climate, topography, bedrock, and soils) to model the pattern in forest distribution (Zelazny *et al.,* 1997). The results of these methods are used as the benchmark upon which to base reforestation and preserve the species diversity of the forest. This study will present an alternative benchmark, using paleoecological records to reveal the many scales of forest dynamics, and suggest more reasonable targets for management practices.

Maintenance of species diversity is a facet of sustainable forest management as outlined in legislation by the Canadian Council of Forest Ministers (CCFM) (CCFM, 2000). The CCFM legislation attempts to preserve genetic diversity to maintain the health of a working forest and protect it against future climate change (Johnston *et al*., 2009). Since future climate change is assumed to be unpredictable, a reasonable objective in the long-term maintenance of forest health is to conserve genetic and species diversity (Spittlehouse & Steward, 2003; Johnston *et al*., 2006). Genetic and species diversity is achieved by the re-introduction of species lost through European settlement (Zelazny *et al*., 1997). This establishes stand-level diversity in replanted forests based on tolerant and moderately tolerant species from the pre-settlement ecosystem.

Results obtained from paleoecological studies can provide information about long-term climate and vegetation interactions and can offer management suggestions to the forestry community. This study attempts to make suggestions for forestry management and provides a pollen-inferred vegetation history of Addington Highlands that displays the dynamic nature of the forests in relation to changes in late-Holocene climate and European settlement.

The study area is near the northern edge of the Eastern Great Lakes Lowland Forest Region, with cold-tolerant softwoods dominating the present day forest (Rowe, 1972). Tawny Pond (44°48’59”N, 77°10’54”W, 276m) is located at the southeastern edge of the hamlet of Cloyne, Ontario (Figure 1). It is surrounded by cottages and permanent homes on its western shore and secondary mixed forest on its remaining sides. Stoll Lake (44°58’16”N, 77°17’22”W, 303m) is located approximately 18km north along Ontario Highway 41. Stoll Lake is located in a forest stand that is currently being logged and was historically part of the Sawyer-Stoll Lumber Company stand (Campbell, 2000). Tawny Pond has a ~2ha surface area so the pollen source area is mainly local (Traverse, 1988); Stoll Lake, with its larger surface area (~37 ha), is accumulating more regional pollen (Jacobson & Bradshaw, 1981; Bunting *et al*., 2004). High temporal-resolution pollen analysis of these two sites will therefore provide both local and regional representations of the forest through time.

Currently Addington Highlands is sparsely populated, with a population density of 1.9 people per square kilometer and 2,532 year round residents (Statistics Canada, 2011). The residents inhabit small hamlets, villages and private dwellings spread throughout the township. Granite and gneiss bedrock is found throughout and produces thin and acidic soils (Gillespie *et al.*, 1963). The soils in the region prevented the establishment of large-scale agriculture and caused the area around Mazinaw Lake to be one of the last parts of southern Ontario to be settled. European settlement occurred after the creation of the Addington Colonization Road (Ontario Highway 41) in 1854 AD, and from 1855 to 1870 AD a full-scale lumber industry developed (Campbell, 2000; Axford et al., 2008). The landscape was primarily altered through large-scale land clearance for lumbering and small-scale land clearance for homesteads and small farms. Currently, agriculture is not a dominant feature on the landscape and much of Addington Highlands is covered with secondary mixed forest (McLeman, 2008).

4.2 Methods

Lake sediment cores (5cm diameter) were taken from Tawny Pond and Stoll Lake in the spring and fall of 2011 using a modified Livingstone piston corer (Wright *et al*., 1984). All cores were left in their PVC casting until extruded in the lab. The uppermost unconsolidated sediments of the cores were extruded at 0.5cm intervals and stored in plastic bags. The deeper consolidated sediments were extruded and wrapped in plastic film and aluminum foil and stored at 4°C.

At Tawny Pond an 83cm Livingstone core (Tawny Livingstone 01) was obtained in April 2011 and a 57cm Livingstone core (Tawny Livingstone 04) and a 145cm Livingstone core (Tawny Livingstone 06) were obtained in September and October 2011. At Stoll Lake an 82cm Livingstone core (Stoll Livingstone 01) was collected in October 2011. Multiple cores were extracted from Tawny Pond because of high sedimentation rates. Pollen analysis on Tawny Livingstone 01 revealed that the *Ambrosia* rise occurred at 52cm and the core was therefore too young to document late-Holocene forest dynamics; Tawny Livingstone core 06 was therefore collected in fall 2011 to extend the Tawny Pond record.

Wet samples (15.6cm^3) from the uppermost sediment were sent to Flett Research for ^{210}Pb dating and organic matter (charcoal, plant material) picked from the sediment was sent to Beta Analytic for ^{14}C dating. Multiple cores (Tawny Livingstone 01, 04, 06) were used to establish a chronology and pollen profile at Tawny Pond. One core (Stoll Livingstone 01) was used to establish a chronology and pollen profile at Stoll Lake. The sequences from the different cores were correlated based on the LOI analysis (below).

The chronology of Tawny Pond is based on ^{210}Pb dates from Tawny Livingstone 04 (0-57cm) and ^{14}C dates from Tawny Livingstone 01 (81-83cm) and Tawny Livingstone 06 (143-145cm). The pollen profile is based on records from Tawny Livingstone 01 (0-83cm) and Tawny Livingstone 06 (80-145cm). The chronology of Stoll Lake is based on ^{210}Pb dates from depth 0-30cm and ^{14}C dates from the 30-32cm and 81-82cm intervals of Stoll Livingstone 01. The pollen profile is also based on Stoll Livingstone 01.

Loss on ignition (LOI) was conducted at 1cm intervals on all cores (Heiri *et al*., 2001). The sediment was weighed and dried in the oven for 12-24 hours at 105°C to obtain a dry weight. To oxidize the organic matter the samples were ignited in a muffle furnace for 4 hours at 550°C. Finally the samples were ignited in a muffle furnace at 950°C for 2 hours to determine carbonate weight (Heiri *et al*., 2001).

Sediment was subsampled for pollen analysis at 0.5cm-1cm intervals at Tawny Pond and 1cm-2cm intervals at Stoll Lake. Samples of 1cm^3 were processed using standard methods of preparation (Faegri & Iverson, 1989), including treatment in HCl, KOH, HF and acetloysis, before being stored in Si oil. Two *Lycopodium* spore tablets (batch number 938934) were added to the sediment at the beginning of preparation to enable computation of pollen and charcoal concentrations (Faegri & Iverson, 1989). Pollen were identified and counted under a magnification of 400x and 1000x for critical identification. Fossil pollen were compared with reference material and standard texts to aid in identification (Faegri & Iverson, 1989; McAndrews *et al*., 1973; Moore, Webb & Collinson, 1991). At least 500 pollen grains were counted for each sample. The pollen data are expressed as percentages of the total pollen count, excluding pollen of aquatic plants (Bennett & Willis, 2001).

Microscopic charcoal was tallied for each sample using the size-class method (Waddington, 1969; Whitlock & Larsen, 2001) with a gridded eyepiece. The geometric mean of each size class was used to determine the total area of charcoal on each slide.

Mean summer (June, July, August) temperature and total summer (JJA) precipitation were reconstructed using the Modern Analogue Technique (MAT) (Sawada, 2006) and version 1.8 of the North American Modern Pollen Database (Whitmore *et al.*, 2005). Modern pollen data spanning the Eastern Deciduous Forest biome between 50-100°W longitude and 20-50°N latitude were extracted as potential candidates for modern analogues. The average of the three closest analogues and a squared chord distance dissimilarity coefficient (Williams & Shuman, 2008) was used to compute the reconstructed climate variables. A pollen sum of 24 arboreal pollen taxa was used for the reconstruction, including *Pinus*, *Picea*, *Abies*, Cupressaceae, *Larix*, *Tsuga*, *Betula*, *Quercus*, *Fraxinus* undifferentiated, *Populus*, *Ulmus*, *Ostrya/Carpinus*, *Acer*, *Fagus, Carya, Juglans, Tilia, Platanus, Castanea, Celtis, Carylus, Alnus*, *Salix* and *Myrica* (Paquette, 2012).

4.3 Results

4.3.1 Sediment

The loss on ignition (LOI) analysis of Tawny Livingstone 01, 04 and 06 showed similar results, thereby enabling the splicing of the final record from the three cores. Organic content (LOI at 550°C) ranged between 48% and 78% and the carbonate content (LOI at 950°C) ranged between 2% and 5% (Figure 2). Organic content was high (~70%) in the deep portions of the cores. There was a decrease in organic matter from 70% to 60% between 47cm and 38cm and a second between 17cm and 12cm, when organic matter again decreased from 60% to 52%. The carbonate content was low in these sediments.

Organic content of Stoll Livingstone 01 ranged between 35% and 50%, with two spikes of one sample each of higher values. Carbonate content ranged between 3% and 5% (Figure 3). Only insignificant variations were seen in this core.

4.3.2 Chronology

Samples between depths of 0-47 cm from Tawny Livingstone 04 were dated using ^{210}Pb dates and a linear regression model was used to assign ages to the sediment (Table 1). At Stoll Lake ^{210}Pb dates between depths of 0-30cm were dated and a linear regression model used to assign ages (Table 2). Radiocarbon dates were calibrated using CALIB 6.0 and the calibration dataset IntCal 09.14c (Stuiver and Reimer, 1993; Reimer et al., 2009) (Table 3).

A polynomial was used to derive age-depth curves for Tawny Pond (Figure 4) and Stoll Lake (Figure 5) from the ^{210}Pb determinations and the lower radiocarbon date. In both lakes, the more recent of the two ^{14}C dates was much too old compared to the ^{210}Pb ages; these dates were not used to fit the polynomial. If all the ^{14}C dates had been used to develop the chronology, the middle portion of the cores would have a very high sedimentation rate, but there is no evidence, in either the sediment, nor in the pollen influx data, to support this kind of chronology.

4.3.3 Pollen Record

Tawny Pond

The pollen percentage diagram (Figure 6) was divided into four zones based on major changes in the pollen assemblages, as illustrated by a principal components analysis of the percentages (discussed below). Zone T1 (970-1200 AD) was characterized by a relatively high percentages of *Tsuga* pollen and low percentages of *Pinus* and Boreal taxa, the latter including pollen of *Picea*, *Abies*, and *Larix*. *Acer*, *Fagus* and pollen of other trees and shrubs were relatively high during zone T1. Pollen of herbaceous taxa (non-arboreal pollen; NAP), spores and aquatics are very low in this zone and do not show noticeable changes in percentages.

Zone T2 (1200-1720 AD) was characterized by an increase in *Pinus* percentages. In this zone *Acer*, *Fagus* and Other AP pollen percentages were low or decreasing. *Tsuga* pollen percentages remained relatively stable until approximately 1500 AD, when they began to increase. *Tsuga* percentages continued to increase until 1600 AD, followed by a decrease for the remainder of zone T2. *Alnus* pollen was practically absent from the pollen record for the majority of zone T2, and began to increase slightly beginning around 1650 AD. NAP, spores and aquatic pollen again had relatively low percentages throughout zone T2.

In zone T3 (1720-1870 AD) pollen percentages for Boreal taxa were relatively high. *Pinus* pollen percentages increased during zone T3a (1720-1820 AD), reaching maximum values in zone T3b (1820-1870 AD). *Tsuga* pollen percentages decreased during T3a and stabilized in subzone T3b. *Betula* pollen increased in subzone T3a and decreased in subzone T3b. *Quercus* and other hardwood pollen percentages were relatively high in subzone T3a.

Zone T4 (1870 AD-present) is marked by a sizable increase in non-arboreal pollen percentages (NAP), especially *Ambrosia*, *Rumex*, Poaceae and Asteraceae. Spores, such as *Pteridium* and *Dryopteris,* and aquatic pollen also increased at the beginning of Zone T4. *Pinus* and *Tsuga* percentages declined substantially during the past 150 years. The zone was divided into two subzones, T4a from 1870-1945 AD and T4b from 1945 AD-present. In subzone T4a, pollen of hardwood taxa remained stable and relatively low, while *Alnus* and *Ambrosia* increased. In subzone T4b, pollen of hardwood taxa and *Rumex* increased, while *Tsuga*, *Alnus* and *Ambrosia* decreased.

Pollen accumulation rates (PAR) at Tawny Pond are relatively low in zones T1 and T2, except for a period of increased *Tsuga* influx in the central part of zone T2 (Figure 7). PAR increased in zone T3 and T4a and decreased in T4b for most taxa.

Stoll Lake

The core from Stoll Lake is shorter, extending slightly more than 550 years (Figure 8). The pollen percentage diagram was divided into two zones, with a principal components analysis (below) indicating a transition around 1880 AD. In zone S1 (1450-1880 AD) the pollen percentages of most taxa were relatively stable, with a few exceptions. Around 1600 AD Boreal taxa increased after being almost absent from the pollen record. In 1830 AD *Tsuga* pollen percentages decreased, and *Fagus* decreased slightly beginning around 1750 AD. *Pinus* pollen percentages were high in zone S1, comprising over 40% of the pollen rain. Other taxa with high percentages in zone S1 include *Tsuga*, *Betula*, *Quercus* and other AP.

A small increase in *Ambrosia, Rumex*, Poaceae, Asteraceae and Other NAP at 1880 AD marks the transition into zone S2 (1880 AD-present). *Tsuga* pollen percentages remained low in zone S2 and *Pinus* and Boreal taxa slightly decreased.

The sedimentation rates remained relatively constant at Stoll Lake (Figure 5), so pollen accumulation rates (PAR) generally parallel the pollen percentage curve (Figure 9). In zone S1, there were few changes in PAR of most taxa, except for the increase in Boreal taxa at 1600 AD and the slight decrease in *Tsuga* PAR around the 1830s AD. *Salix* PAR increased, beginning in the early 1700s AD. In zone S2 PAR of *Populus* and *Betula* increased, as did the PAR of the non-arboreal taxa.

4.3.4 Micro-Charcoal

Charcoal accumulation rates were relatively low in zones T1, T2 and T3a at Tawny Pond (Figure 10) and zone S1 at Stoll Lake (Figure 11). In both lakes, the amount of charcoal increased in the uppermost zones. At Tawny Pond, charcoal input was high in zone T4a, and deceased slightly in zone T4b. Several peaks are seen above the background level. At Stoll Lake, charcoal influx increased slightly in zone S2, concurrent with an increase in NAP PAR. A one-sample peak in charcoal is dated at 1955 AD, and this may be associated with a fire in 1975 AD that burned down the lumber mill on Stoll Lake.

4.3.5 Numerical Analysis

A principal components analysis (PCA) was used to summarize the relationships among the pollen taxa of Tawny Pond (Figure 12) and Stoll Lake (Figure 13). Major changes in the values of the scores were used to define the location of the pollen zones. In both sites, over 60% of the variance was explained by the first four components.

At Tawny Pond the scores of component 1 were large and negative in zones T1 and T2, although there was a long term increasing trend (Figure 12). They remained negative in zone T3 and became positive in zone T4. Component 1 is positively correlated with NAP and shrubs and negatively correlated with *Tsuga* and hardwoods. The scores of component 2 were large and negative in zone T1. They oscillated around zero and remained low in zones T2 and T3a. They then became positive in zones T3b and T4a and large and negative in zone T4b. Component 2 is positively correlated with cold-tolerant conifers and negatively correlated with hardwoods and NAP. The scores of component 3 were large and positive in zone T1 and oscillated around zero in zone T2; they were negative in zone T3, positive in zone T4a and negative in T4b. Component 3 is positively correlated with hardwoods, shrubs and spores and negatively correlated with *Pinus* and

Betula. Scores of component 4 were only relatively large (positive) in zone T3a. Component 4 is positively correlated with Boreal taxa and Other AP and negatively correlated with hardwoods and NAP.

At Stoll Lake the scores of component 1 were large and negative for the majority of zone S1 (Figure 13). At the end of zone S1 (1860 AD) the scores became close to zero, before increasing to large positive values in zone S2. Component 1 is positively correlated with *Betula*, *Populus* and non-arboreal pollen and negatively correlated with *Tsuga*, *Fagus* and Other AP. The scores of components 2, 3 and 4 show few trends, except for a period of negative values in component 2 in the first part of zone S2. Component 2 is positively correlated with *Acer*, Boreal taxa and *Ambrosia* and negatively correlated with *Pinus* and Spores. The scores of components 3 and 4 are low and oscillate around zero.

4.3.6 Paleoclimate Reconstruction

Tawny Pond

The Tawny Pond record had an average mean summer (June, July, August) temperature of 17.8°C and an average total summer precipitation of 259mm (Figure 14, Appendix E). Mean summer temperatures were relatively high in zone T1, ranging between 17.9-18.6°C. Summer temperature decreased beginning around 1650 AD and continuing through zones T3a and T3b. In zones T4a and T4b summer temperatures were variable, with no long term trend. Summer precipitation during zone T1 and T2 were relatively low, and increased through zone T3a and 3b. Summer precipitation increased and was variable in zone T4a and decreased slightly in zone T4b.

Stoll Lake

The Stoll Lake record had an average mean summer temperature of 17.8°C and an average total summer precipitation of 244mm (Figure 15, Appendix E). Mean summer temperatures decreased slightly over the past 550 years. Summer precipitation was relatively low in zone S1 and increased slightly in zone S2.

Comparison to Instrumental Record

The mean summer temperature reconstructions from Tawny Pond and Stoll Lake were compared to long term instrumental records from Ottawa, Toronto and the Atlantic Multidecadal Oscillation (AMO) (Figure 16).

The Stoll Lake reconstruction showed some correlation with the other records, but lacked the temporal resolution to permit a detailed comparison, so will not be further discussed. Tawny Pond, Ottawa and Toronto all show colder than average temperatures in the late 1800s AD. The first decades of the 20th century were mostly warm in all three records, until an abrupt transition to colder than average temperatures from 1928-1932 AD. The 1940s AD and 1950s AD were mostly warm, as was the period since the 1990s, although Tawny Pond reconstructed colder than average temperatures from 2005 AD to present. Tawny Pond, Stoll Lake, Ottawa and Toronto all showed a significant correspondence with positive and negative phases of the AMO in the 20th century.

4.4 Discussion

When interpreting forest composition from pollen diagrams, the relative pollen production and transport properties of the various species must be accounted for (Sugita, 2007). The forest was initially dominated by hemlock, beech and maple trees then transitioned to a forest with an increased abundance of pine and boreal tree (spruce, larch, fir) species. Most recently there has been an increase of herbaceous plants in the forest, a decrease conifers and an increase in hardwood trees.

Zonation of the Tawny Pond and Stoll Lake pollen diagrams, based exclusively on changes in pollen percentages, corresponds with well-known climate regimes of the past 1000 years (Gajewski, 1987; Viau *et al*., 2006; Wanner *et al*., 2008; Mann *et al*., 2008), and shows the effect of large-scale climate change on the Addington Highlands forest, as well as the influence of European settlement on the vegetation. At Tawny Pond, zone T1 (970-1200 AD) corresponds to the latter part of the Medieval Warm Period (MWP), and zone T2 (1200-1720 AD) represents the transition and beginning of the Little Ice Age (LIA). Zone T3a (1720-1820 AD) and zone T3b (1820-1870 AD) represent colder periods of the LIA and zone T4a (1870-1945 AD) and zone T4b (1945-present) represent the European settlement of the area. At Stoll Lake zone S1 (1454-1880 AD) represents the LIA and zone S2 (1880-present) represents European settlement.

Between 970 and 1200 AD, the forest around Tawny Pond was dominated by relatively high percentages of hemlock, beech and maple, which is interpreted as relatively warm and moist conditions and confirmed by the paleoclimate reconstruction (Figure 14). Between 1200 and 1720 AD, hemlock, beech and maple declined and pine and Boreal trees increased, interpreted as a cooling period. The abrupt decrease of hemlock at 1600 AD corresponds to the onset of the LIA (Gajewski, 1987; Fuller, 1997) at Tawny Pond. There is a corresponding increase in pine and Boreal trees at this time. After 1600 AD, the reconstruction showed a decrease in summer temperatures and increase in summer precipitation (Figure 14).

At the beginning of zone T3b (1820-1870 AD) birch and hardwood trees declined and pine and Boreal trees became more abundant. This is the coldest period of the LIA in Addington Highlands, and the paleoclimate reconstruction showed a slight decrease in summer temperatures and increase in precipitation. Pine and Boreal trees flourished in the slightly colder period of the LIA and out-competed birch and other hardwood trees. However, the immediate response would have been an increase in the relative pollen production of the conifers at the expense of hardwoods and hemlock, this may account for the fast response of the pollen record to a relatively abrupt climate change.

At Tawny Pond the *Ambrosia* rise occurred at 52cm depth; this is dated to approximately 1870 AD. At Stoll Lake the *Ambrosia* rise occurred at 28cm depth and corresponds to approximately 1880 AD. The timing of European settlement is well known at these sites because of local settlement histories (Campbell, 2000; Axford *et al*., 2008); settlement occurred later at Stoll Lake because it is located further north. After the hamlet of Cloyne was established near Tawny Pond, the Addington Colonization Road was improved and settlement continued north to Stoll Lake. The depth of the *Ambrosia* rise in Tawny Pond corresponds with a 10% decrease in organic content in the sediment cores. The decrease of organic content in the sediment may reflect more erosion into the basin (Fuller *et al*., 1998) as a result of forest clearance for settlement and logging in the area immediately around Tawny Pond.

Zones T4a and T4b (1870 AD-present) at Tawny Pond and zone S2 (1880 AD-present) at Stoll Lake show vegetation change as a consequence of the activities of Europeans in Addington Highlands. Ragweed, sorrels, grasses and other herbaceous plants increased as a consequence of forest clearance and the beginning of European-style agriculture. However, the major impact on the Addington Highlands forest was through logging, as little agriculture actually occurred in the area because of poor soil and exposed bedrock (Campbell, 2000; Axford *et al*., 2008). Opening of the forest encouraged the growth of herbaceous and shrub taxa, as demonstrated in the pollen profile.

As seen in the pollen profile of Tawny Pond, and especially in the scores of the principal components analysis, the vegetation succession around the lake since the 1870s AD can be divided into two subzones, from 1870-1945 AD (zone T4a) and from 1945 AD to present (zone T4b). In the first part of this period (zone T4a), pine, hemlock and Boreal tree species decreased and herbaceous plants, alder and birch trees increased in abundance. After 1945 AD (zone T4b), birch continued to increase and oak, maple, poplar, and sorrel vegetation started to increase. Hemlock and ragweed decreased, while pine and Boreal trees remained relatively stable in zone T4b. In the latter part of the 1800s AD Addington Highlands experienced an economic boom in the lumbering industry, towards the mid-1900s AD people and lumber companies left and different sectors of employment were attempted (Campbell, 2000). The changes in European settlement patterns therefore accounts for the two subzones in zone T4. The late-1800s AD decrease in pine and hemlock is the result of extensive logging and the mid-1900s, the decrease in ragweed and grasses are the result of people leaving the township. Around this time the Canadian government introduced new forestry laws to promote sustainable forestry and preserve forestry resources (MNR, 2012). This is likely the cause of relatively stable amount of pine from 1960 AD to present.

At Stoll Lake, vegetation changes during European settlement (zone S2) were less noticeable. The increase in ragweed and other herbaceous plants is smaller than observed at Tawny Pond. Hemlock deceased and birch increased in abundance, but this began in the early 1800s AD, before the major settlement of the area, perhaps in response to cold conditions at that time.

The surface area of the water bodies likely accounts for greater changes in Tawny Pond's vegetation record and more nuanced changes at Stoll Lake; Tawny Pond (~2ha) is significantly smaller than Stoll Lake (~37 ha). The relatively large surface area of Stoll Lake causes the pollen arriving into the sediment to be dominated by regional pollen (Jacobson & Bradshaw, 1981; Prentice, 1985; Sugita *et al*., 1999), and the influx of regional pollen masks vegetation changes that may have occurred in the immediate vicinity of the lake.

A comparison of the last 155 years of reconstructed mean summer temperatures from Tawny Pond and Stoll Lake shows concurrent changes with long term instrumental records from

Ottawa and Toronto (Figure 16). Synchronous periods of warm and cold relative to the mean summer temperatures are seen in the Tawny Pond and Stoll Lake reconstructions and the Ottawa and Toronto climate record. Toronto's temperature record shows cold temperatures relative to the mean from the mid-1800s AD to the early-1900s AD and warm temperatures relative to the mean in the latter part of the 1900s AD. The long-term warming may be caused in part by Toronto's increase in population in the 20th century, adding to the urban heat island effect (Oke, 1973). Nevertheless, the Tawny Pond, Ottawa and Toronto records are in agreement suggesting a high amount of accuracy in the high resolution MAT paleoclimate reconstructions.

The Atlantic Multidecadal Oscillation (AMO) was also compared to the Tawny Pond and Stoll Lake reconstructions and the Ottawa and Toronto temperature records. The AMO has an important role in modulating the summer climate of eastern North America and western Europe (Sutton and Hodson, 2005). Figure 16 shows concurrent changes between the warm and cool mean summer temperatures of Tawny Pond, Stoll Lake, Ottawa and Toronto and warm and cool phases of the AMO in the 20th century. This correlation further suggests an association between the AMO and eastern North American summer temperatures and demonstrates the ability to see decadal-scale climate variation in high resolution pollen records.

Addington Highlands was dominated by hemlock, beech and maple trees and had a relatively warm and dry climate during the latter part of the MWP. From 1200-1870 AD there was long term cooling and increased precipitation associated with the LIA and the forest became dominated by pine and boreal tree species. From 1870 AD to present the forest vegetation was altered by European settlement. Extensive logging around Tawny Pond and Stoll Lake cleared the forest and removed large amounts of pine, hemlock and Boreal tree species. Herbaceous plants (ragweed, sorrels, grasses) increased because of gaps created in the forest and European style agriculture.

Table 1

Pb-210 activity and estimated age of sediment from Tawny Pond, Addington Highlands, eastern Ontario. All ages are based on sediment collected from the Tawny Pond Livingstone 04 core. Age was estimated with a linear regression model. The maximum Cs-137 activity, which was deposited in 1966 (Ritchie and McHenry, 1990), 45 years before the core was collected, occurs at 26.5cm depth.

Depth (cm)	Pb-210 Activity (DPM/g)	Age (Years Ago)	Cs-137 Activity (DPM/g dry wt)
1	50.08	7.81	-
3.5	-	-	2.78
4	71.41	15.81	-
6	41.91	22.08	-
8	34.16	28.13	-
8.5	-	-	3.2
10	27.63	33.40	-
12	22.85	37.94	-
14	12.39	46.20	-
14.5	-	-	-0.69
18.5	-	-	5.05
19	11.64	58.82	-
19.5	-	-	1.83
21.5	-	-	8.73
23.5	-	-	5.3
24	9.40	70.09	-
25.5	-	-	4.97
26.5	-	-	9.96
27	7.43	79.46	-
27.5	-	-	1.69
28.5	-	-	1.88
29.5	-	-	-2.25
31	5.71	88.92	-
34	4.06	100.17	-
40	3.64	112.93	-
47	2.91	120.63	-

Table 2

Pb-210 Activity and estimated age of sediment from Stoll Lake, Addington Highlands, eastern Ontario. All ages are based on sediment collected from the Stoll Lake Livingstone 04 core. Age was estimated with a linear regression model. The maximum Cs-137 activity, which was deposited in 1966 (Ritchie and McHenry, 1990), 45 years before the core was collected occurs at 11.5cm depth.

Depth (cm)	Pb-210 Activity (DPM/g)	Age (Years Ago)	Cs-137 Activity (DPM/g dry wt)
0.5	51.34	0.70	-
1.5	64.77	2.55	-
2.5	62.08	5.77	-
4.5	54.29	11.12	-
5.5	-	-	5.05
6.5	43.55	18.72	1.69
7.5	-	-	4.79
8.5	-	-	4.12
9.5	30.47	34.10	-
10.5	-	-	5.9
11.5	-	-	8.3
12.5	-	-	5.15
13.5	-	-	1.4
14.5	23.08	48.02	-
15.5	-	-	3.08
16.5	13.81	56.20	3.66
17.5	10.48	63.68	-
18.5	-	-	1.42
19.5	7.22	75.57	-
22.5	7.15	89.34	-0.94
25.5	4.96	106.68	-
29.5	2.71	118.72	-

Table 3

Conventional radiocarbon ages and calibrated ages, (CALIB 6.0; Stuiver and Reimer, 1993; Reimer et al., 2009) for Tawny Pond and Stoll Lake, Addington Highlands, eastern Ontario. All samples were derived from identifiable organic material extracted from sediment cores.

Lake/Pond	Laboratory No.	Depth (cm)	$^{13}C/^{12}C$ Ratio	Conventional Radiocarbon Age	Calibrated Age Ranges (probability)	Sigma (σ)
Tawny Pond LI 01	BETA 318202	81-83	-27.1 o/oo	780 +/- 30 BP	743-786 (1.00)	1σ
					731-798 (1.00)	2σ
Tawny Pond LI 06	BETA 318203	143-145	-26.3 o/oo	1090 +/- 30 BP	1022-1066 (0.65)	1σ
					1091-1113 (0.35)	1σ
					998-1118 (1.00)	2σ
Stoll Lake Stoll LI 01	BETA 318200	30-32	-25.6 o/oo	230 +/- 30 BP	61-65 (0.058)	1σ
					213-230 (0.391)	1σ
					343-365 (0.552)	1σ
					61-76 (0.096)	2σ
					206-275 (0.419)	2σ
					328-376 (0.481)	2σ
					475-479 (0.004)	2σ
Stoll Lake Stoll LI 01	BETA 318201	81-82	-25.0 o/oo	400 +/- 30 BP	400-408 (0.109)	1σ
					519-567 (0.891)	1σ
					386-437 (0.195)	2σ
					489-574 (0.805)	2σ

Table 4

Eigenvalues (explained variance) and loadings of a principal components analysis performed on the pollen percentages of core from Tawny Pond.

	Component			
Taxon	**1**	**2**	**3**	**4**
Boreal	0.07	0.18	0.01	0.63
Pinus	0.11	0.46	-0.33	-0.08
Tsuga	-0.34	0.03	0.25	-0.13
Betula	0.18	-0.34	-0.39	0.14
Quercus	0.03	-0.40	-0.28	0.29
Acer	-0.22	-0.35	0.20	-0.07
Fagus	-0.27	-0.14	0.28	-0.17
Populus	0.09	-0.33	0.11	-0.16
Other AP	-0.15	-0.27	0.21	0.52
Alnus	0.31	0.12	0.31	0.16
Salix	0.31	-0.09	0.15	0.07
Ambrosia	0.34	-0.09	0.07	-0.11
Rumex	0.27	-0.19	-0.08	-0.19
Poaceae	0.33	0.01	0.16	-0.09
Asteraceae	0.30	-0.22	-0.07	-0.11
Pteridium	0.21	0.22	0.37	0.12
Dryopteris	0.24	-0.08	0.34	-0.02
Eigenvalues	**0.38**	**0.16**	**0.10**	**0.09**

Table 5

Eigenvalues (explained variance) and loadings of a principal components analysis performed on the pollen percentages of core from Stoll Lake.

	Component			
Taxon	**1**	**2**	**3**	**4**
Boreal	0.19	0.24	-0.22	-0.14
Pinus	0.17	-0.47	0.36	-0.07
Tsuga	-0.37	0.06	-0.06	-0.07
Betula	0.33	-0.10	-0.08	-0.15
Quercus	-0.10	0.27	0.30	0.53
Acer	0.02	0.60	0.04	0.07
Fagus	-0.28	-0.04	-0.13	0.02
Populus	0.22	0.12	-0.28	0.16
Other AP	-0.30	0.06	-0.01	0.04
Alnus	0.11	-0.12	-0.22	0.46
Salix	0.21	-0.02	0.25	-0.14
Ambrosia	0.33	0.24	0.04	0.12
Rumex	0.32	0.14	0.02	-0.03
Poaceae	0.33	-0.14	0.08	0.02
Asteraceae	0.24	0.15	-0.15	-0.06
Pteridium	0.02	-0.34	-0.26	0.58
Dryopteris	-0.01	-0.09	-0.64	-0.22
Eigenvalues	**0.35**	**0.10**	**0.09**	**0.07**

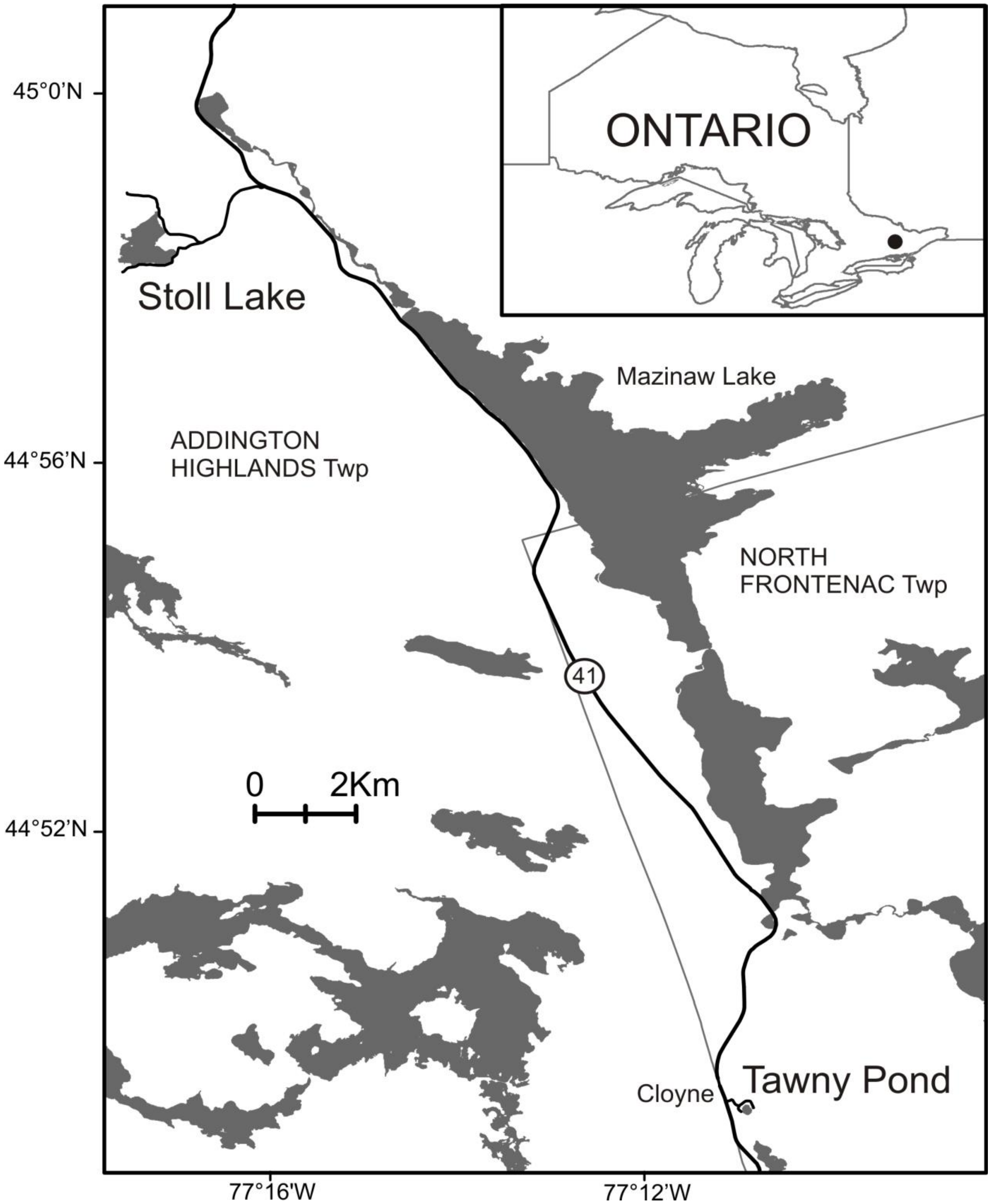

Figure 1: Location of Tawny Pond and Stoll Lake in Addington Highlands Township. Small lakes have been removed, and only major roads are shown.

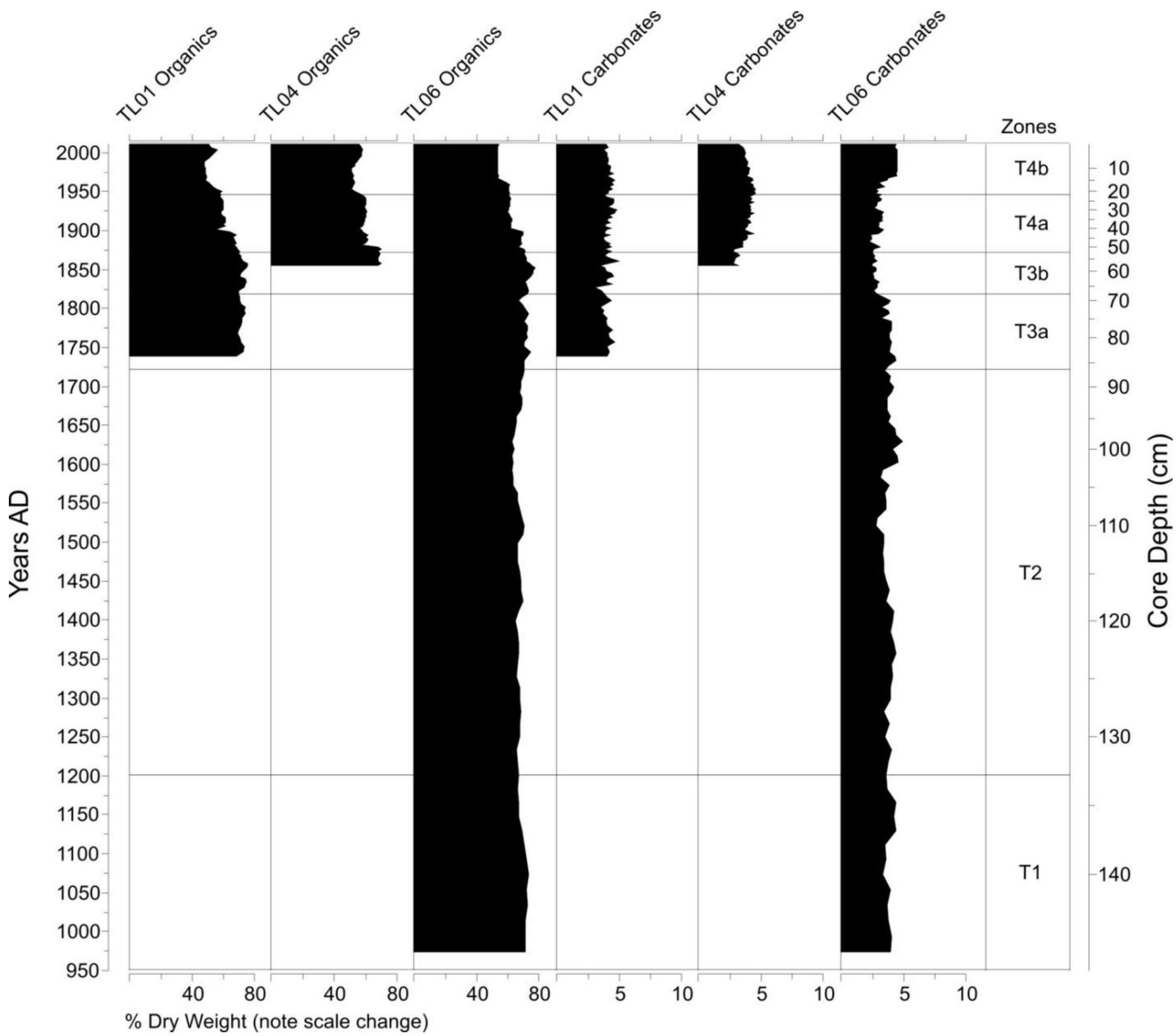

Figure 2: Loss on Ignition for Tawny Pond, Addington Highlands, eastern Ontario.

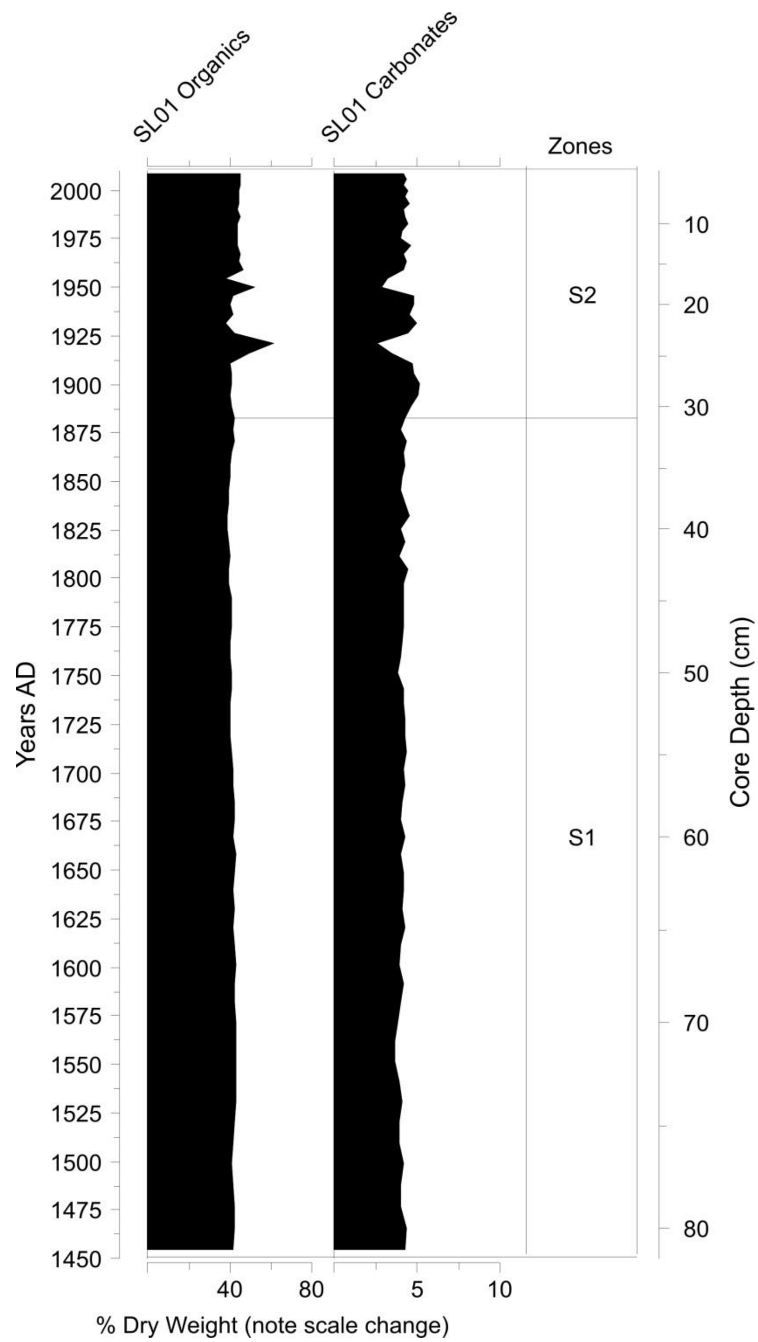

Figure 3: Loss on Ignition for Stoll Lake, Addington Highlands, eastern Ontario.

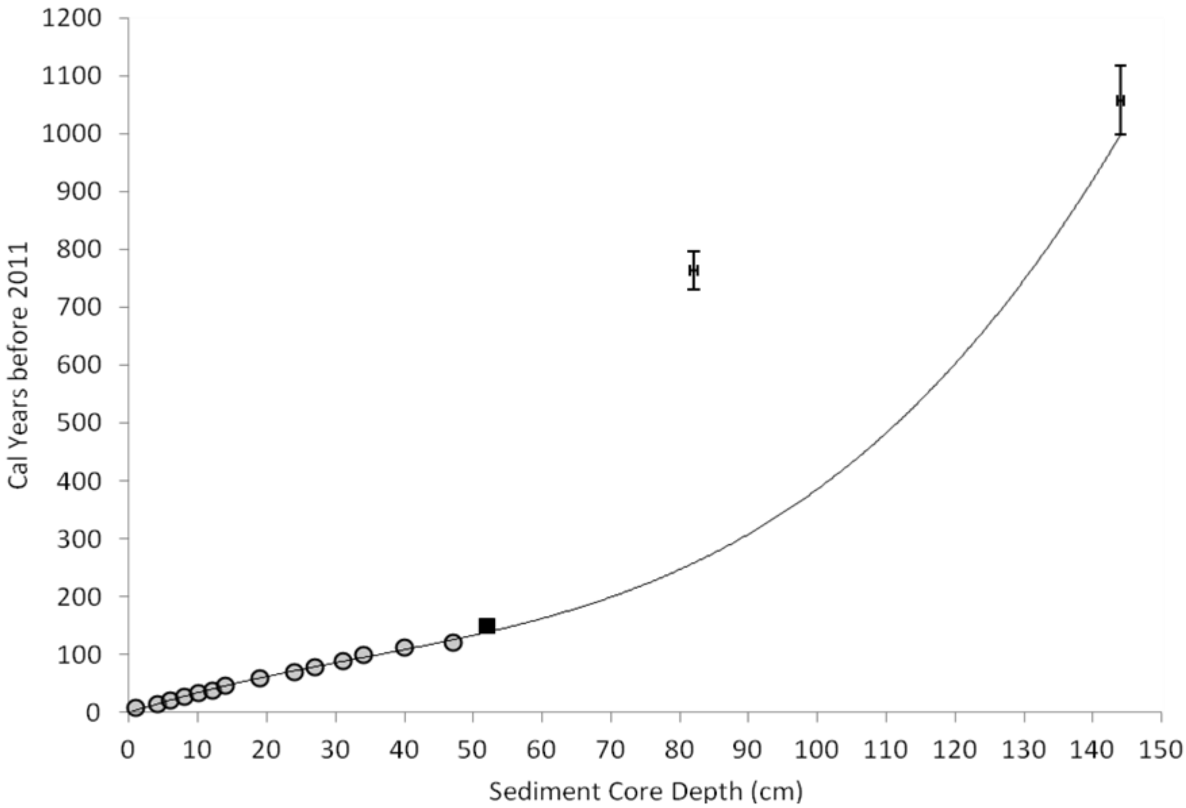

Figure 4: Chronology for sediment core from Tawny Pond. The grey circles indicate the ^{210}Pb age determinations. The points with error bars are the calibrated ^{14}C ages found at 82cm (age not used in developing the chronology; see text) and 144cm depth, including the total 2 sigma range. The age-depth curve is estimated based on the ^{210}Pb dates and the youngest point of the calibrated radiocarbon range ($y = 0.0005x^3 - 0.049x^2 + 3.909x$, $R^2 = 0.99$). The black square at depth 52cm indicates depth of the *Ambrosia* rise in the pollen data and the estimated historical age of this increase; note that this was not used in developing the regression curve, but is included for verification.

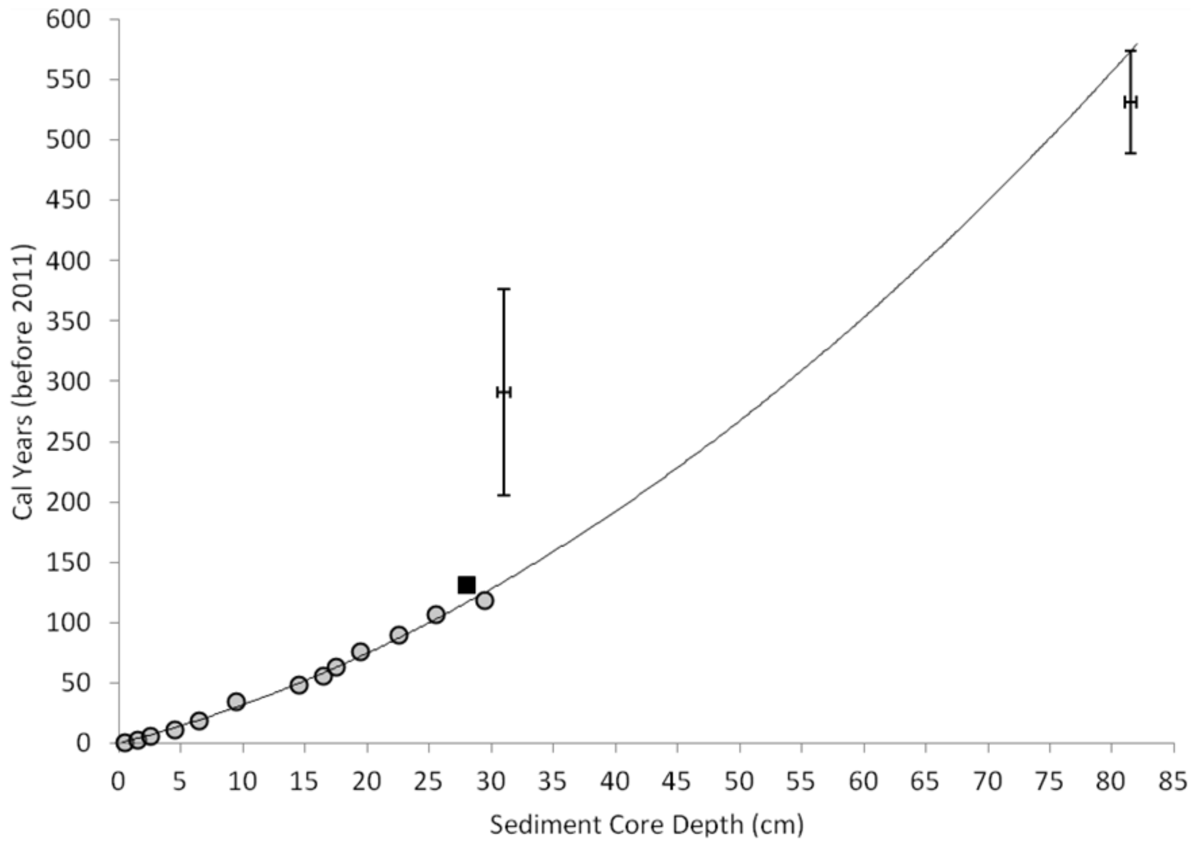

Figure 5: Chronology for sediment core from Stoll Lake. The grey circles indicate the ^{210}Pb age determinations. The points with error bars are the calibrated ^{14}C ages from 31cm (age not used in developing the chronology; see text) and 81.5cm depth, including the total 2 sigma range. The age-depth curve is estimated based on the ^{210}Pb dates and the oldest point of the calibrated radiocarbon range ($y = 0.0537x^2 + 2.6612x$, $R^2 = 0.9996$). The black square at depth 28cm indicates the *Ambrosia* rise in the pollen data and the estimated historical age of this increase; note that this was not used in developing the regression curve, but is included for verification.

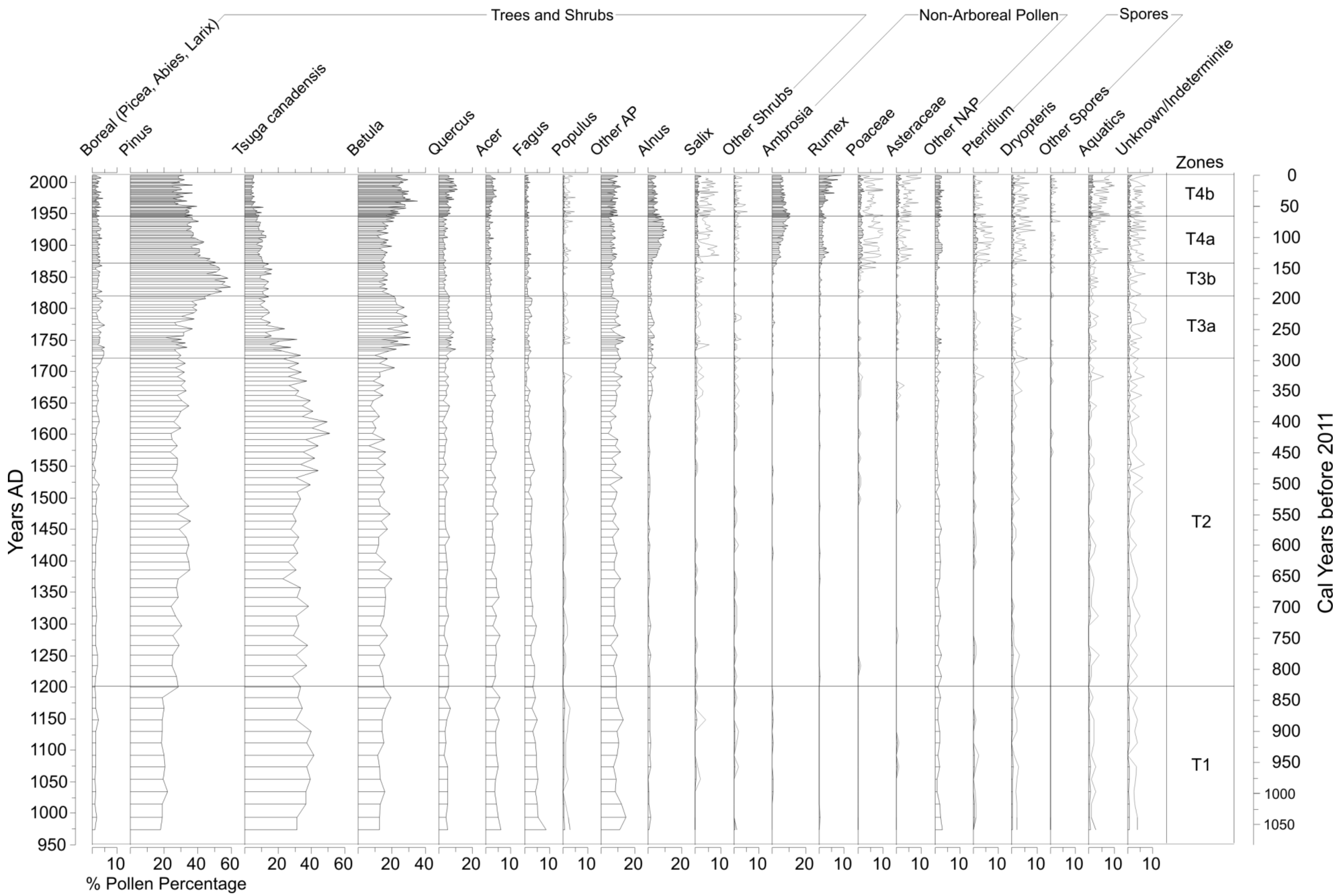

Figure 6: Pollen Percentage diagram for Tawny Pond, Addington Highlands, eastern Ontario. Major taxa are shown and a 5x exaggeration is shown on taxa representing a small portion of the pollen record.

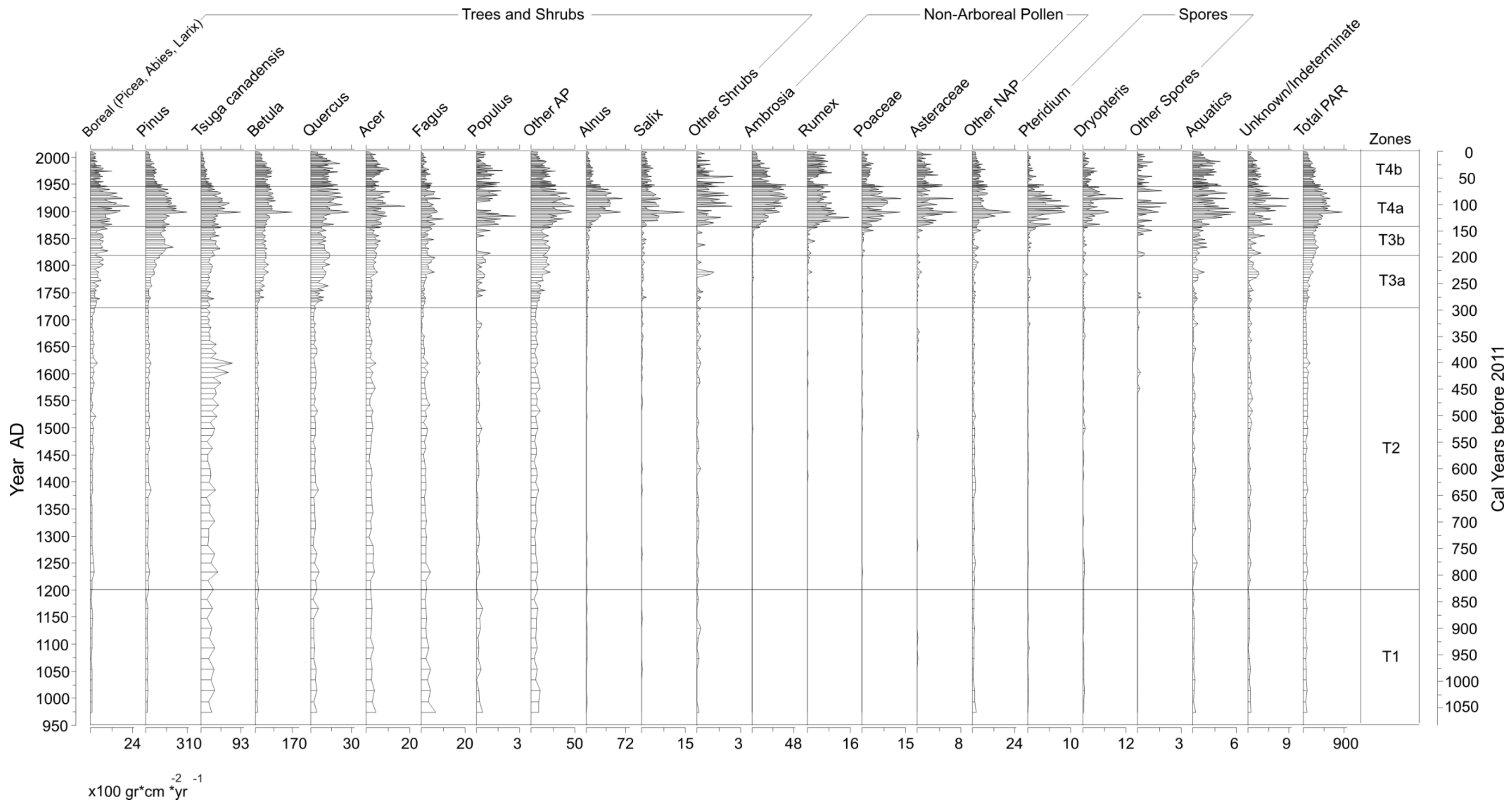

Figure 7: Pollen Accumulation Rates (PAR) for Tawny Pond, Addington Highlands, eastern Ontario.

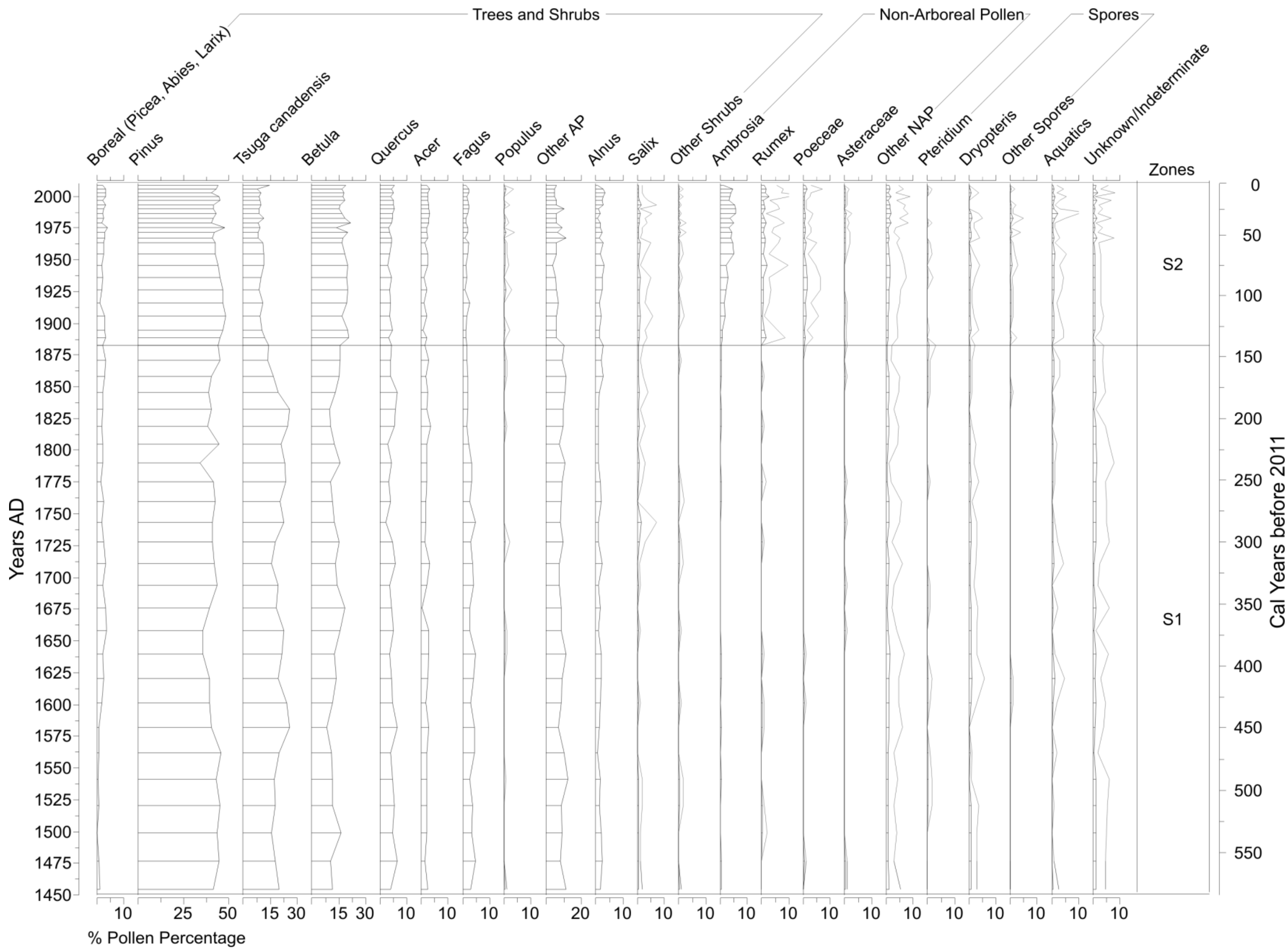

Figure 8: Pollen Percentage diagram for Stoll Lake, Addington Highlands, eastern Ontario. Major taxa are shown and a 5x exaggeration is shown on taxa representing a small portion of the pollen record.

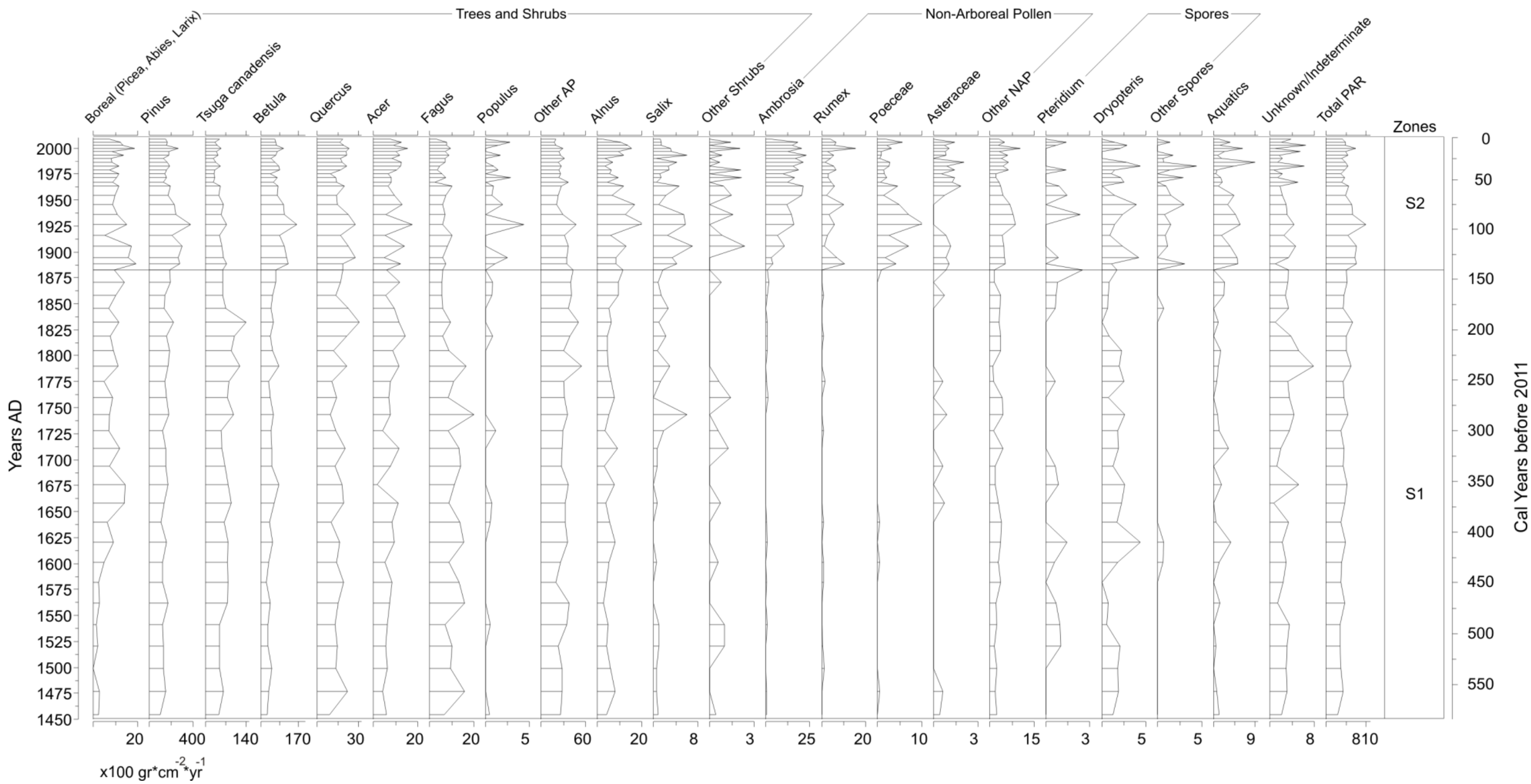

Figure 9: Pollen Accumulation Rates (PAR) for Stoll Lake, Addington Highlands, eastern Ontario. Total PAR is based on all pollen types.

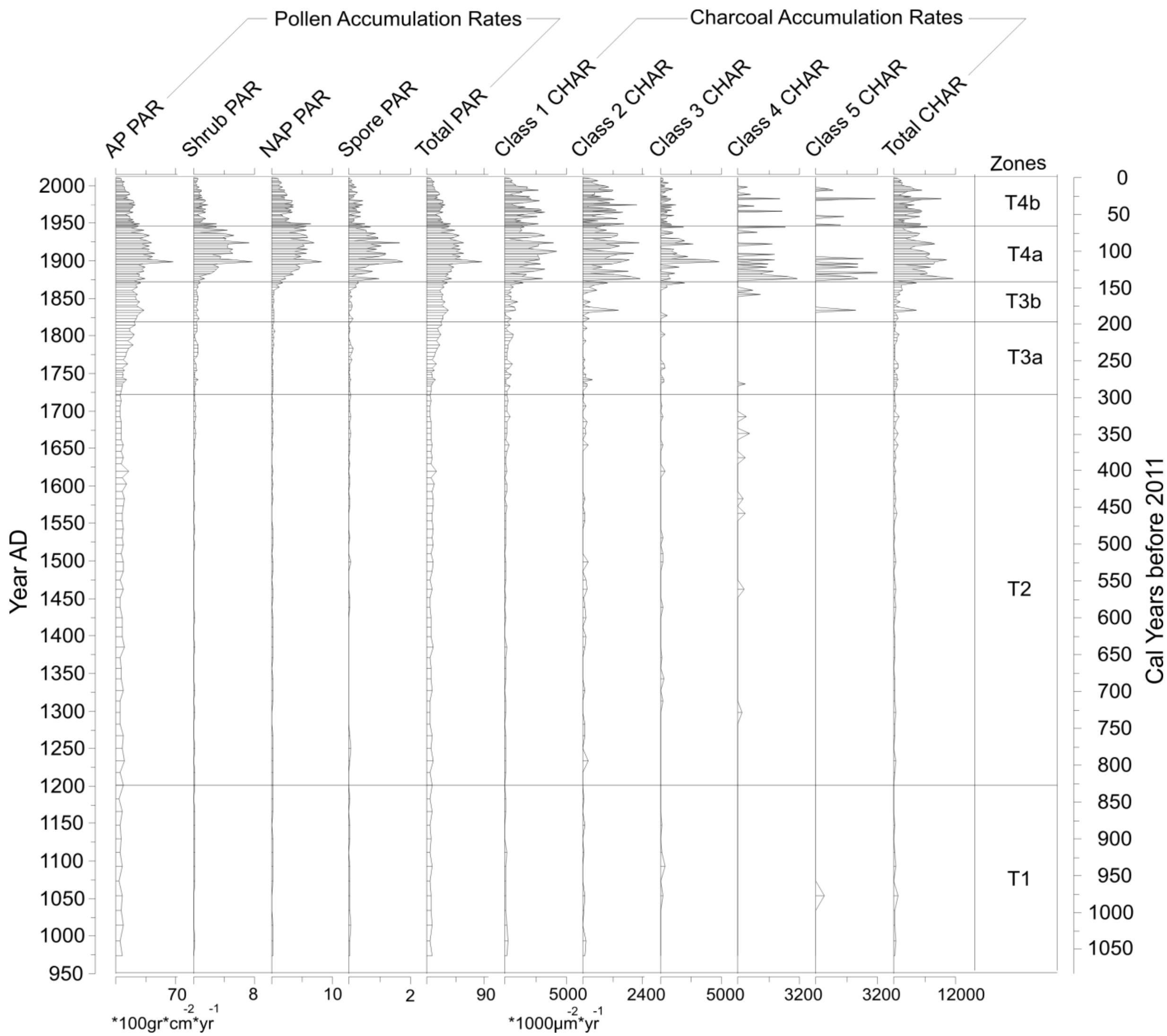

Figure 10: Pollen Accumulation Rates (PAR) and Charcoal Accumulation Rates (CHAR) for Tawny Pond, Addington Highlands, eastern Ontario.

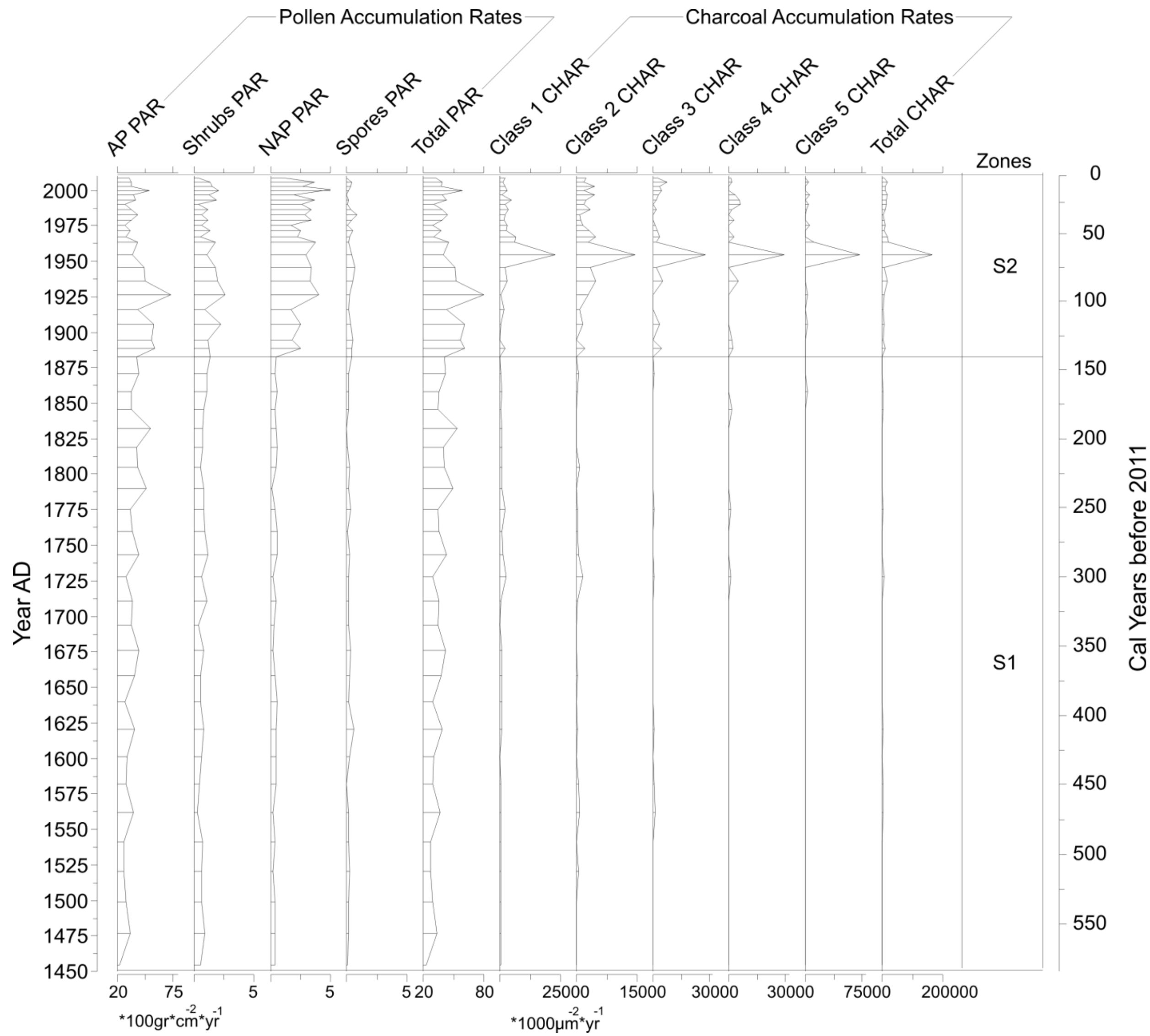

Figure 11: Pollen Accumulation Rates (PAR) and Charcoal Accumulation Rates (CHAR) for Stoll Lake, Addington Highlands, eastern Ontario.

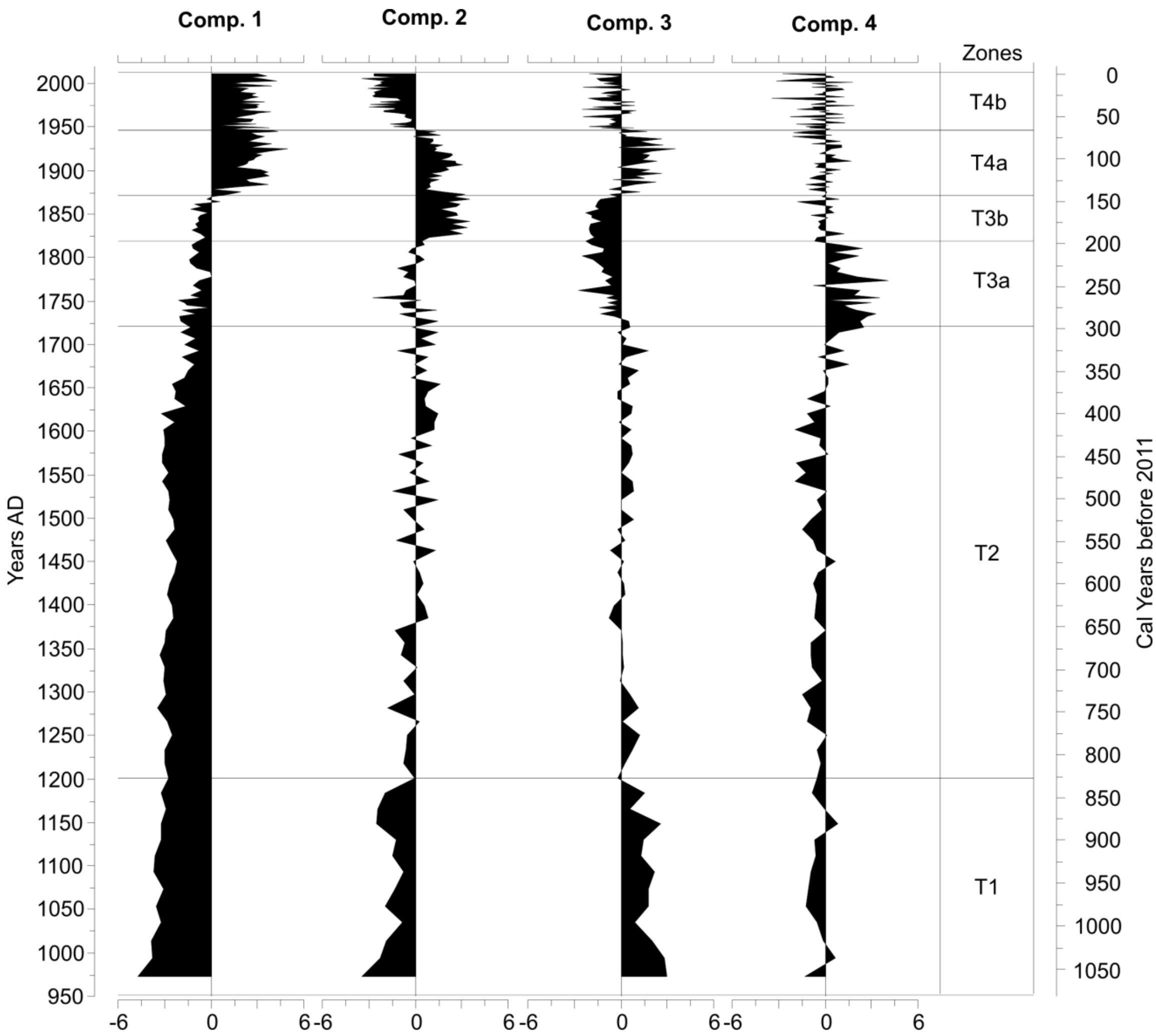

Figure 12: Principal component scores of pollen percentages for Tawny Pond, Addington Highlands, eastern Ontario.

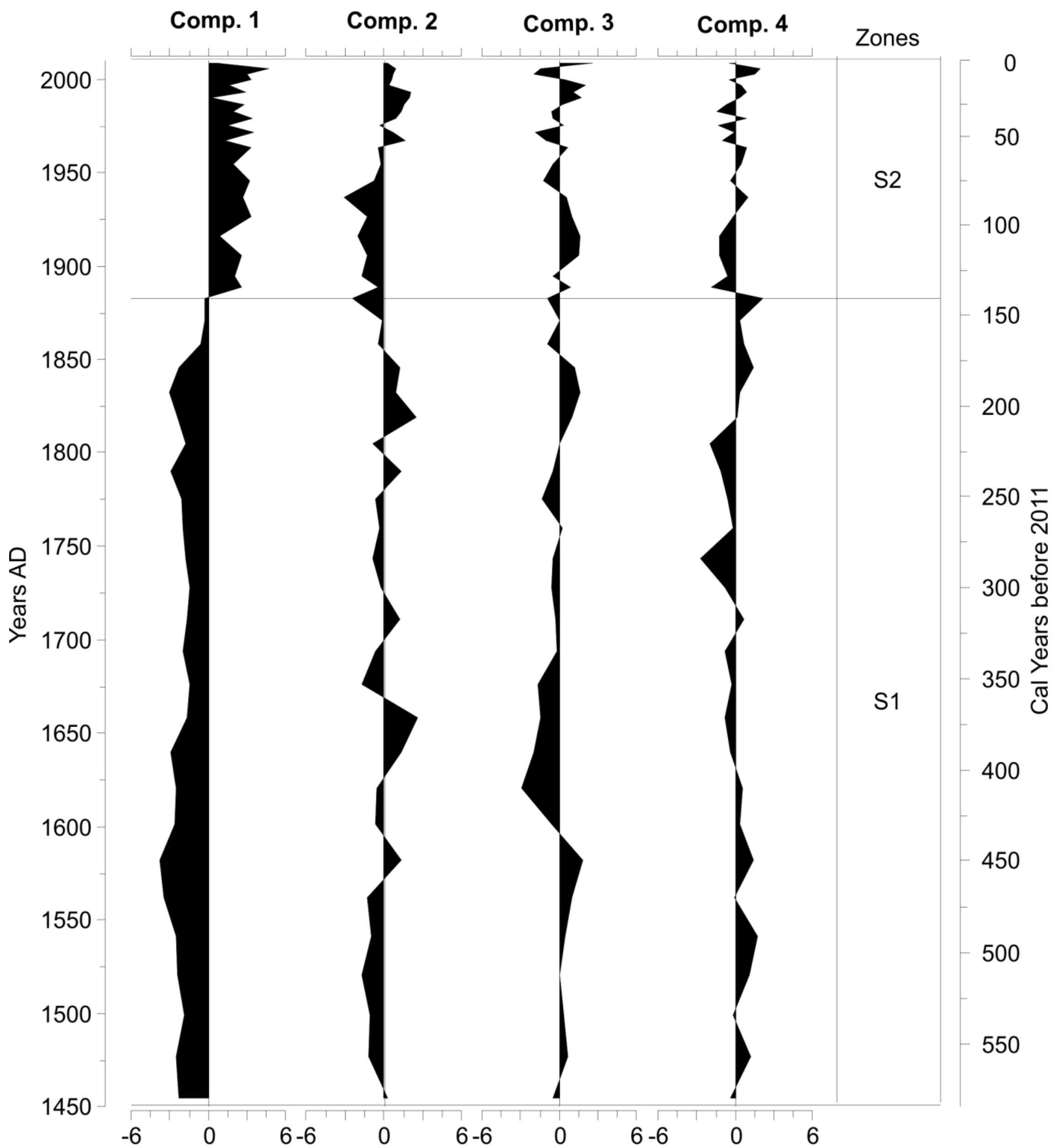

Figure 13: Principal component scores of pollen percentages for Stoll Lake, Addington Highlands, eastern Ontario.

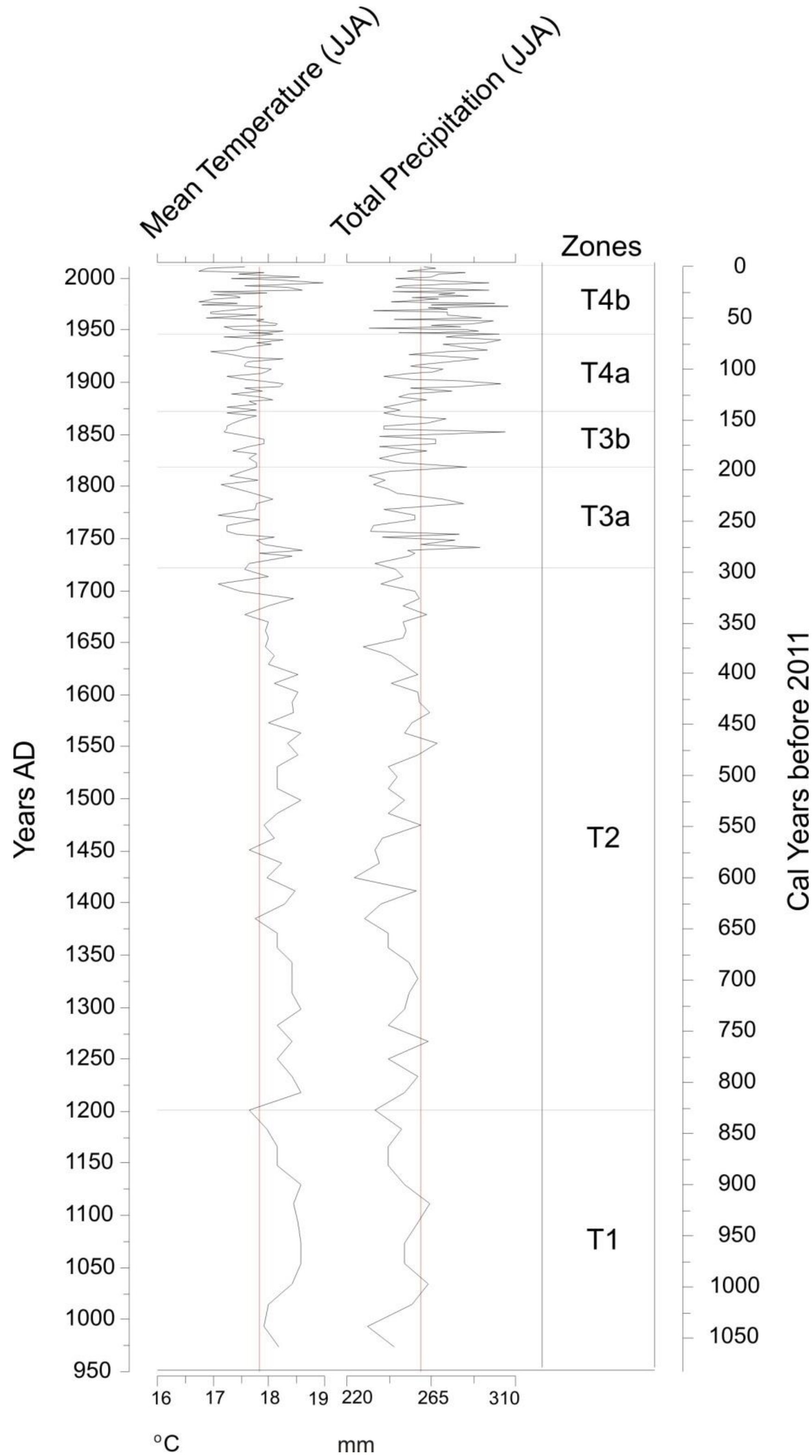

Figure 14: Mean summer (JJA) temperature (°C) and total summer precipitation (mm) of Tawny Pond, based on the Modern Analogue Technique (MAT). The red line represents the mean temperature (17.8°C) and the mean total precipitation (259mm) of the reconstruction.

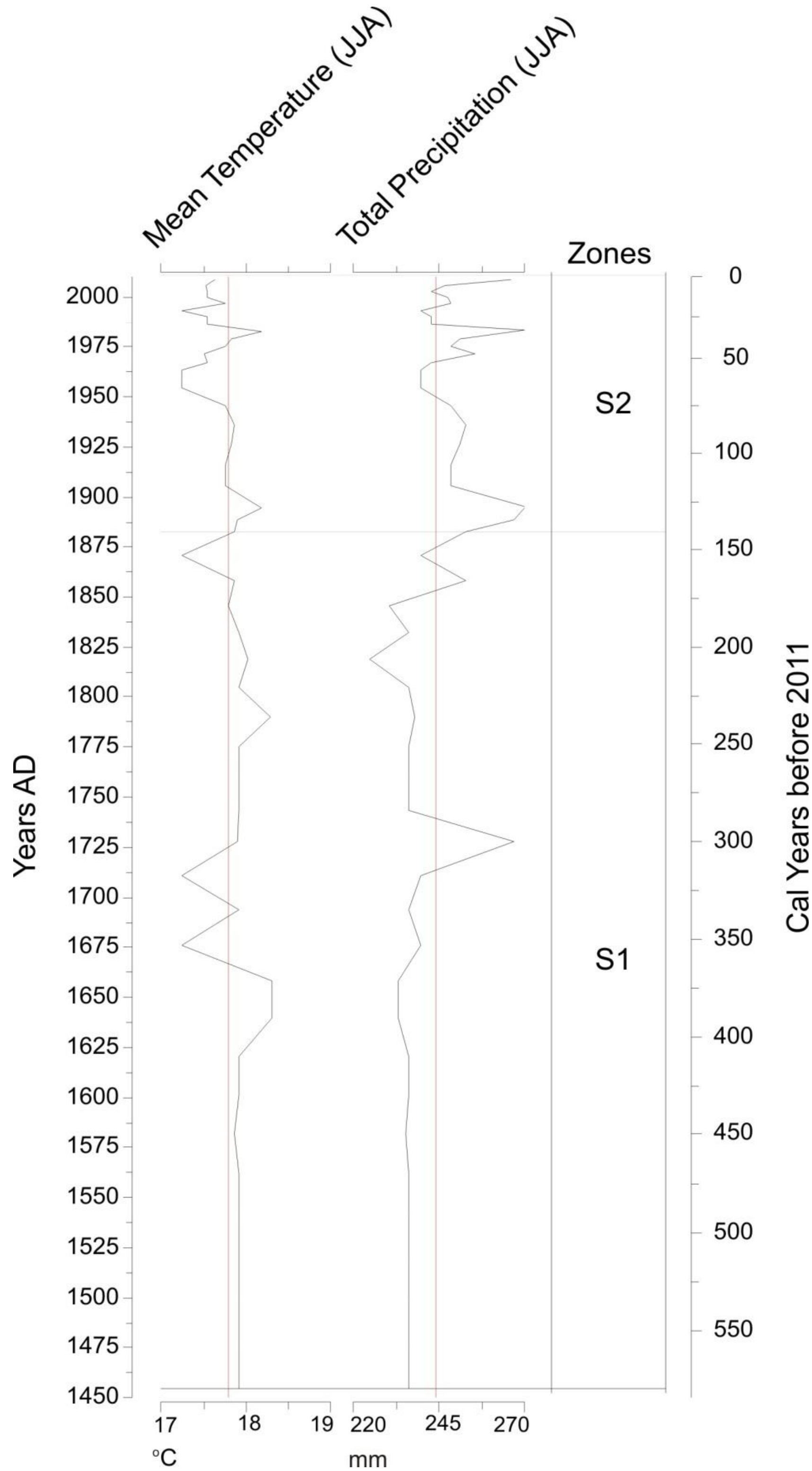

Figure 15: Mean summer (JJA) temperature (°C) and total summer precipitation (mm) of Stoll Lake, based on the Modern Analogue Technique (MAT). The red line represents the mean temperature (17.8°C) and the mean total precipitation (244mm) of the reconstruction.

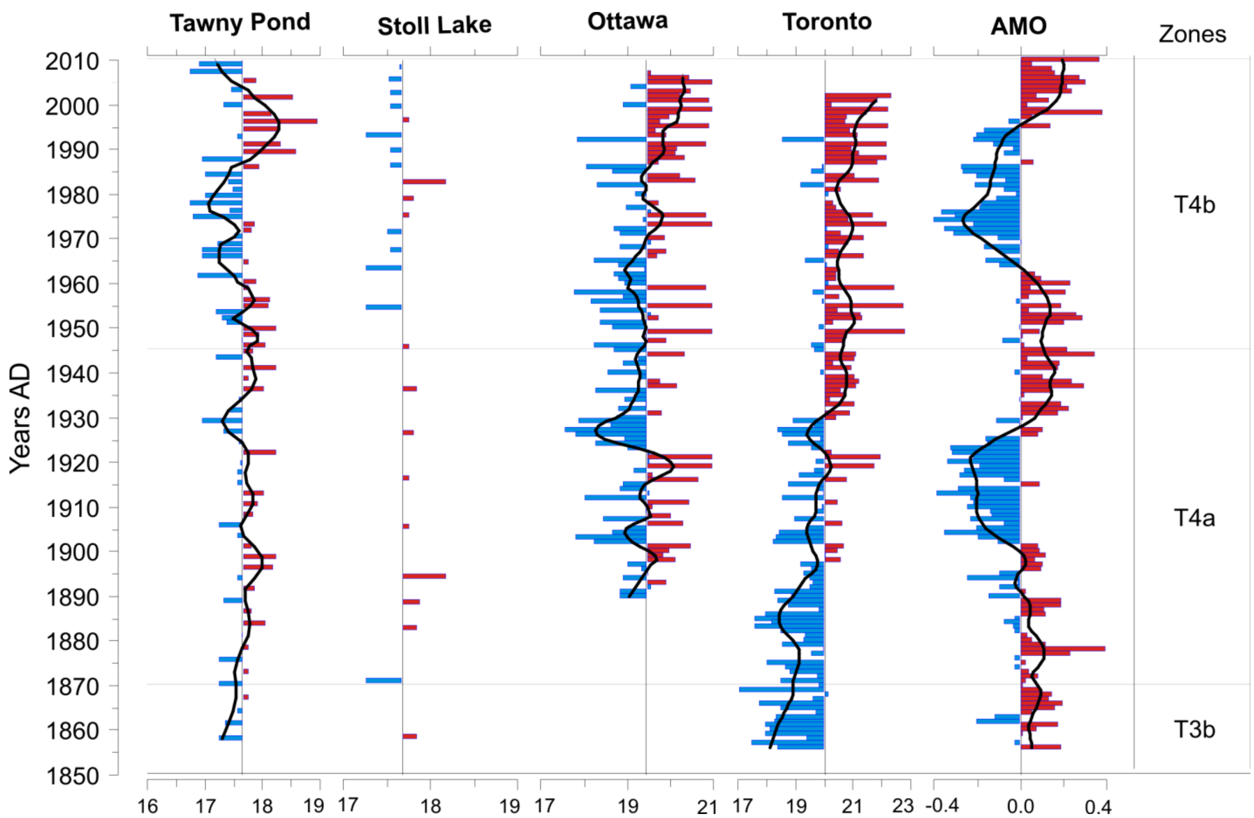

Figure 16: Comparison of Tawny Pond and Stoll Lake mean summer (JJA) temperature (°C) reconstructions with instrumental records from Ottawa, Ontario, Toronto, Ontario and Atlantic Multidecadal Oscillation (AMO) sea surface temperature anomalies (Enfield, Mestas-Nunez and Trimble, 2001; Environment Canada, 2012). The zones are based on PCA scores from Tawny Pond pollen percentages (see text).

Chapter 5: Conclusions and Future Work

Throughout the past 1000 years, *Pinus, Tsuga, Betula, Quercus, Acer* and *Fagus* were the dominant taxa in the pollen record. The changes in the relative abundance of pollen taxa through time indicate changes in the Addington Highlands forest composition. From 970-1200 AD the forest was dominated by hemlock, beech and maple trees. Between 1200-1870 AD the forest composition changed as pine and boreal tree species became more abundant and/or had increased relative pollen production. Most recently, since 1870 AD, herbaceous plants (weeds) increased, whereas softwoods decreased and hardwoods increased.

A principal components analysis (PCA), based on pollen percentages, was used to divide the pollen record into four zones at Tawny Pond and two zones at Stoll Lake. The zonation of both pollen records is based on the scores of the PCA and shows times of rapid change in the forest composition. Zone T1 at Tawny Pond had a high abundance of deciduous pollen (*Tsuga, Acer, Fagus*); zone T2 had a long term increase in *Pinus* and Boreal taxa pollen and a decrease in deciduous pollen. During zones T3a and T3b there was an increase in Boreal taxa and *Pinus* and a decrease in all deciduous taxa pollen percentages. Zones T4a and T4b showed an increase in non-arboreal taxa, a decrease in *Pinus, Tsuga* and Boreal taxa and an increase in deciduous taxa. At Stoll Lake zone S1 corresponds to high amounts of arboreal taxa, especially *Pinus*, and zone S2 corresponds to an increase in non-arboreal taxa.

The climate associated with the zonation of the pollen records was reconstructed using the modern analogue technique (Sawada, 2006). At Tawny Pond, zone T1 was reconstructed to be relatively warm and dry, zone T2 was reconstructed as a long term cooling and relatively dry, zones T3a and T3b were reconstructed to relatively cold and wet climates and zones T4a and T4b were reconstructed as relatively cool and wet climates. At Stoll Lake zone S1 was reconstructed as a long term cooling and dry, and zone S2 reconstructed as relatively cool and moist.

The timing of the zone boundaries at Tawny Pond and Stoll Lake correspond the MWP and LIA climate regimes of the late-Holocene (Gajewski, 1987; Campbell & McAndrews, 1991; Fuller *et al*., 1998; St. Jacques *et al*., 2008; Paquette, 2012). Tawny Pond recorded a two part LIA; initial onset from 1600-1820 AD with the coldest period from 1820-1870 AD, as indicated by the reconstruction. The final period of the LIA was marked by an increase in pine and a decrease in birch and other hardwoods. The reconstruction of Tawny Pond and Stoll Lake match well with long term instrumental climate records from Ottawa and Toronto, suggesting that decadal-scale climate variability can be seen in high resolution pollen-based paleoclimate reconstructions.

Micro-charcoal results from both Tawny Pond and Stoll Lake suggest that fire was not an important factor affecting forest composition or dynamics during the last 1000 years (Figures 10-11) (Clark *et al*., 1996; Carcailett & Richard, 2000). There was an increase in charcoal after European settlement associated with forest clearing, burning and agriculture (Muller *et al*., 2008) and Tawny Pond had a slight increase in charcoal above the background level at the beginning of the LIA (1650 AD). Overall micro-charcoal levels at both sites are relatively low. These results are indicative of the fire regime of a mixed conifer-deciduous forest (Hély *et al*., 2000). The relatively moist climate of eastern North America and the lower fuel load of the mixed-wood forest reduced fire dominance in this area.

The results of this study demonstrate the ability to conduct high resolution pollen analysis on unvarved sediments. Sediment cores were subsampled at 0.5-2cm intervals and had a temporal resolution of between 1.4 and 21 years. The resulting pollen records showed detailed vegetation dynamics in response to climate change of the past 1000 years. Tawny Pond, with its smaller surface area, was able to show local climate-induced vegetation dynamics and changes in European settlement and logging practices. Stoll Lake provided a more regional picture of the vegetation and European settlement history. Both lakes showed synchronous changes in vegetation at the onset of new climate regimes and changes in human settlement patterns. For example, at both sites *Tsuga* decreased and Boreal taxa increased at the onset of the LIA. During European settlement herbaceous plants increased in abundance and *Pinus*. The results show that a high-resolution analysis of unvarved sediment will show immediate change in vegetation in response to changes in climate or settlement. Difficulties are still encountered with the establishment of a chronology; unvarved sediments do not give the precise dating control of varved sediment (Lamoureux, 2001). However, with a sufficient number of ^{210}Pb and ^{14}C dates throughout the length of the core, chronological error can be substantially reduced. The recent development of R packages for polynomial and Bayesian age depth modelling has improved the establishment of unvarved chronologies and allows for better comparisons between chronologies of different studies (Blaauw, 2010; Blaauw & Christen, 2011).

The results of this study are of interest to forestry managers. Forestry management attempts to recreate “natural” pre-European settlement biodiversity to account for the reduction in tree species since European settlement (Zalazny *et al*., 1997). This reforestation technique creates a stable forest by building stand-level diversity of tolerant and moderately tolerant species which will maintain forest health and protect it against future climate change (Spittlehouse & Steward, 2003; Johnston *et al*., 2006; Johnston *et al*., 2009). However, global temperatures have been increasing since the mid-20th century and are expected to increase in the coming decades (Hansen *et al*., 2010; IPCC, 2012); thus climate conditions are different now, and will continue to be different from those at the time of European settlement. In the Holocene there have been periods (Holocene Climate Optimum, MWP) where the climate was warmer/comparable to present day (Viau *et al*., 2006;

Wanner *et al*., 2008). The Addington Highlands forest was dominated by hemlock, beech and maple 1000 years ago at the end of the MWP. Continued climate warming in Addington Highlands will promote the growth and dominance of hemlock, beech and maple trees and a decrease in pine and Boreal tree species, creating a forest composition more akin to the MWP than that at European settlement, which occurred during the LIA. This natural succession is counter to the current reforestation practices outlined above. This study shows that planning forests for future climate change should not be solely based on biodiversity estimates from the pre-settlement forest, a time of relatively cold temperatures in the Addington Highlands, as elsewhere. Management of future forest stands should look to paleoecological studies which record vegetation response to climate change through time. The present study has shown rapid changes in the forest composition are recorded in high-resolution pollen studies. High-resolution studies, such as this one, are a powerful tool for reconstructing past vegetation composition and documenting vegetation change in relation to climate change.

When communicating paleoecological studies to forestry managers it is important to emphasize the effect of relative pollen production and pollen transport properties on the pollen record. This was discovered while discussing the results of this thesis with a local forestry manager from Addington Highlands. He had difficulty explaining why certain species (notably *Abies* and *Populus*) were so rare in the pollen record, but abundant on the current landscape. Once pollen production and transport properties were explained, the pollen record better concurred with the forester's experience. An explanation of pollen production and transport properties should be accompanied with a pollen profile if there is further collaboration between paleoecologists and forestry managers.

There can be several future studies on the themes of this thesis. Further coring can be completed at Tawny Pond and Stoll Lake to extend back in time the vegetation history of Addington Highlands. Collecting longer cores at both sites would further document forest dynamics in relation to climate regimes of the middle- to late-Holocene. Cores can also be collected from other lakes in Addington Highlands. This would reinforce the results of this study and further document the vegetation history of the region. Further work can be completed on bridging the gap between forestry and paleoecological literature. The two fields of study are closely related to each other; increasing dialogue between researchers can yield meaningful results to both paleoecology and forestry.

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Appendix A: Loss-on-Ignition Data

Tawny Pond Livingstone 01

Depth (cm)	Cal Year (before 2011)	Year AD	Crucible weight (g)	105°C dry weight (g)	550°C ignition weight (g)	950°C ignition weight (g)	Organics weight (g)	Carbonate weight (g)	Organics as percent of dry weight (%)	Carbonates as percent of dry weight (%)
0	0.00	2011	9.5401	9.6288	9.5835	9.5800	0.0453	0.0035	51.071	3.9459
1	3.86	2007	8.3787	8.4510	8.4131	8.4101	0.0379	0.0030	52.421	4.1494
2	7.63	2003	9.9446	10.008	9.9721	9.9697	0.0363	0.0024	56.897	3.7618
3	11.30	2000	10.650	10.729	10.686	10.683	0.0431	0.0032	54.419	4.0404
4	14.88	1996	9.2051	9.2911	9.2459	9.2424	0.0452	0.0035	52.558	4.0698
5	18.38	1993	9.4330	9.5194	9.4755	9.4719	0.0439	0.0036	50.810	4.1667
6	21.79	1989	10.058	10.138	10.099	10.096	0.0384	0.0033	48.181	4.1405
7	25.13	1986	9.2421	9.3185	9.2819	9.2788	0.0366	0.0031	47.906	4.0576
8	28.39	1983	9.1363	9.2035	9.1713	9.1684	0.0322	0.0029	47.917	4.3155
9	31.57	1979	9.8965	9.9727	9.9355	9.9322	0.0372	0.0033	48.819	4.3307
10	34.68	1976	9.3547	9.4393	9.3977	9.3941	0.0416	0.0036	49.173	4.2553
11	37.72	1973	8.0185	8.0984	8.0595	8.0558	0.0389	0.0037	48.686	4.6308
12	40.70	1970	10.363	10.438	10.401	10.398	0.0369	0.0030	49.597	4.0323
13	43.62	1967	9.2935	9.3685	9.3314	9.3281	0.0371	0.0033	49.467	4.4000
14	46.47	1965	8.8539	8.9227	8.8890	8.8858	0.0337	0.0032	48.983	4.6512
15	49.28	1962	9.4873	9.5557	9.5209	9.5179	0.0348	0.0030	50.877	4.3860
16	52.02	1959	9.4601	9.5295	9.4929	9.4897	0.0366	0.0032	52.738	4.6110
17	54.72	1956	7.4462	7.5164	7.4788	7.4758	0.0376	0.0030	53.561	4.2735
18	57.37	1954	8.5112	8.5707	8.5375	8.5348	0.0332	0.0027	55.798	4.5378
19	59.98	1951	7.6145	7.6727	7.6381	7.6357	0.0346	0.0024	59.450	4.1237
20	62.54	1948	9.4333	9.4905	9.4572	9.4548	0.0333	0.0024	58.217	4.1958
21	65.07	1946	9.3593	9.4137	9.3816	9.3795	0.0321	0.0021	59.007	3.8603
22	67.56	1943	10.228	10.286	10.252	10.250	0.0339	0.0023	58.348	3.9587
23	70.02	1941	9.4750	9.5316	9.4979	9.4953	0.0337	0.0026	59.541	4.5936
24	72.45	1939	9.8645	9.9206	9.8870	9.8844	0.0336	0.0026	59.893	4.6346
25	74.85	1936	11.043	11.097	11.064	11.062	0.0328	0.0025	60.294	4.5956
26	77.23	1934	10.036	10.092	10.059	10.056	0.0335	0.0025	60.036	4.4803
27	79.59	1931	8.0631	8.1212	8.0864	8.0840	0.0348	0.0024	59.897	4.1308
28	81.93	1929	9.2171	9.2770	9.2408	9.2382	0.0362	0.0026	60.434	4.3406
29	84.26	1927	8.3718	8.4272	8.3940	8.3913	0.0332	0.0027	59.928	4.8736
30	86.58	1924	9.5778	9.6335	9.6008	9.5982	0.0327	0.0026	58.707	4.6679
31	88.89	1922	9.3659	9.4239	9.3898	9.3871	0.0341	0.0027	58.793	4.6552
32	91.19	1920	9.3918	9.4463	9.4138	9.4115	0.0325	0.0023	59.633	4.2202
33	93.50	1918	10.259	10.311	10.279	10.277	0.0315	0.0023	61.523	4.4922
34	95.80	1915	9.1227	9.1753	9.1428	9.1406	0.0325	0.0022	61.787	4.1825
35	98.11	1913	9.4630	9.5118	9.4816	9.4796	0.0302	0.0020	61.885	4.0984
36	100.4	1911	10.024	10.073	10.043	10.041	0.0299	0.0021	61.396	4.3121
37	102.7	1908	9.4342	9.4843	9.4540	9.4520	0.0303	0.0020	60.479	3.9920
38	105.1	1906	9.0769	9.1236	9.0949	9.0931	0.0287	0.0018	61.456	3.8544
39	107.4	1904	9.1030	9.1553	9.1252	9.1229	0.0301	0.0023	57.553	4.3977
40	109.8	1901	8.0210	8.0722	8.0437	8.0416	0.0285	0.0021	55.664	4.1016

Depth (cm)	Cal Year (before 2011)	Year AD	Crucible weight (g)	105°C dry weight (g)	550°C ignition weight (g)	950°C ignition weight (g)	Organics weight (g)	Carbonate weight (g)	Organics as percent of dry weight (%)	Carbonates as percent of dry weight (%)
41	112.2	1899	9.8201	9.8689	9.8374	9.8355	0.0315	0.0019	64.549	3.8934
42	114.6	1896	9.3078	9.3511	9.3220	9.3203	0.0291	0.0017	67.206	3.9261
43	117.1	1894	9.5421	9.5839	9.5552	9.5534	0.0287	0.0018	68.660	4.3062
44	119.5	1891	9.3455	9.3877	9.3595	9.3579	0.0282	0.0016	66.825	3.7915
45	122.0	1889	8.8813	8.9209	8.8943	8.8928	0.0266	0.0015	67.172	3.7879
46	124.6	1886	8.3889	8.4312	8.4026	8.4009	0.0286	0.0017	67.612	4.0189
47	127.2	1884	7.7998	7.8392	7.8121	7.8104	0.0271	0.0017	68.782	4.3147
48	129.8	1881	8.6744	8.7151	8.6877	8.6860	0.0274	0.0017	67.322	4.1769
49	132.5	1879	8.3116	8.3503	8.3236	8.3219	0.0267	0.0017	68.992	4.3928
50	135.2	1876	10.403	10.441	10.415	10.413	0.0267	0.0015	69.351	3.8961
51	138.0	1873	9.9008	9.9371	9.9114	9.9098	0.0257	0.0016	70.799	4.4077
52	140.8	1870	9.4683	9.5075	9.4800	9.4784	0.0275	0.0016	70.153	4.0816
53	143.7	1867	9.5363	9.5725	9.5466	9.5452	0.0259	0.0014	71.547	3.8674
54	146.6	1864	9.4133	9.4486	9.4233	9.4218	0.0253	0.0015	71.671	4.2493
55	149.7	1861	9.4672	9.5008	9.4763	9.4746	0.0245	0.0017	72.917	5.0595
56	152.7	1858	7.4182	7.4513	7.4263	7.4249	0.0250	0.0014	75.529	4.2296
57	155.9	1855	8.7022	8.7359	8.7104	8.7092	0.0255	0.0012	75.668	3.5608
58	159.1	1852	8.8292	8.8597	8.8369	8.8357	0.0228	0.0012	74.754	3.9344
59	162.4	1849	9.7791	9.8146	9.7887	9.7873	0.0259	0.0014	72.958	3.9437
60	165.8	1845	9.8353	9.8718	9.8458	9.8442	0.0260	0.0016	71.233	4.3836
61	169.2	1842	9.9581	9.9952	9.9689	9.9672	0.0263	0.0017	70.889	4.5822
62	172.8	1838	9.9931	10.025	10.001	10.000	0.0240	0.0013	74.534	4.0373
63	176.4	1835	10.415	10.443	10.422	10.421	0.0207	0.0011	74.729	3.9711
64	180.1	1831	7.9738	8.0028	7.9812	7.9799	0.0216	0.0013	74.482	4.4828
65	184.0	1827	10.408	10.443	10.417	10.416	0.0262	0.0011	73.596	3.0899
66	187.9	1823	9.7990	9.8349	9.8097	9.8084	0.0252	0.0013	70.195	3.6212
67	191.9	1819	9.4332	9.4689	9.4440	x	0.0249	x	69.748	x
68	196.0	1815	9.6293	9.6662	9.6401	9.6386	0.0261	0.0015	70.732	4.0650
69	200.2	1811	9.7246	9.7586	9.7346	9.7331	0.0240	0.0015	70.588	4.4118
70	204.5	1806	9.1190	9.1541	9.1290	9.1276	0.0251	0.0014	71.510	3.9886
71	209.0	1802	9.5807	9.6120	9.5887	9.5876	0.0233	0.0011	74.441	3.5144
72	213.5	1797	9.5679	9.6020	9.5768	9.5755	0.0252	0.0013	73.900	3.8123
73	218.2	1793	8.7523	8.7843	8.7605	8.7593	0.0238	0.0012	74.375	3.7500
74	223.0	1788	9.2478	9.2820	9.2574	9.2560	0.0246	0.0014	71.930	4.0936
75	227.9	1783	10.560	10.600	10.571	10.570	0.0289	0.0016	71.891	3.9801
76	233.0	1778	8.5731	8.6121	8.5841	8.5825	0.0280	0.0016	71.795	4.1026
77	238.2	1773	9.9155	9.9509	9.9262	9.9246	0.0247	0.0016	69.774	4.5198
78	243.5	1768	9.4837	9.5218	9.4955	9.4939	0.0263	0.0016	69.029	4.1995
79	248.9	1762	10.087	10.124	10.098	10.096	0.0264	0.0016	70.588	4.2781
80	254.5	1757	9.1046	9.1454	9.1163	9.1144	0.0291	0.0019	71.323	4.6569
81	260.2	1751	8.8378	8.8699	8.8462	8.8449	0.0237	0.0013	73.832	4.0498
82	266.1	1745	7.9057	7.9413	7.9154	7.9139	0.0259	0.0015	72.753	4.2135
83	272.1	1739	9.5732	9.6146	9.5861	9.5844	0.0285	0.0017	68.841	4.1063

Tawny Pond Livingstone 04

Depth (cm)	Cal Year (before 2011)	Year AD	Crucible weight (g)	105°C dry weight (g)	550°C ignition weight (g)	950°C ignition weight (g)	Organics weight (g)	Carbonate weight (g)	Organics as percent of dry weight (%)	Carbonates as percent of dry weight (%)
0	0.00	2011	9.5807	9.6503	9.6114	9.6091	0.0389	0.0023	55.891	3.3046
1	3.86	2007	9.5737	9.6367	9.6006	9.5983	0.0361	0.0023	57.302	3.6508
2	7.63	2003	9.4667	9.5226	9.4902	9.4881	0.0324	0.0021	57.961	3.7567
3	11.30	2000	9.3657	9.4281	9.3921	9.3897	0.0360	0.0024	57.692	3.8462
4	14.88	1996	10.415	10.483	10.444	10.442	0.0390	0.0025	57.607	3.6928
5	18.38	1993	9.4600	9.5263	9.4891	9.4866	0.0372	0.0025	56.109	3.7707
6	21.79	1989	10.036	10.101	10.066	10.063	0.0355	0.0026	54.448	3.9877
7	25.13	1986	9.4343	9.4891	9.4598	9.4576	0.0293	0.0022	53.467	4.0146
8	28.39	1983	9.4836	9.5475	9.5136	9.5111	0.0339	0.0025	53.052	3.9124
9	31.57	1979	9.1189	9.1787	9.1481	9.1456	0.0306	0.0025	51.171	4.1806
10	34.68	1976	8.0207	8.0869	8.0532	8.0505	0.0337	0.0027	50.906	4.0785
11	37.72	1973	10.408	10.472	10.438	10.436	0.0335	0.0026	52.019	4.0373
12	40.70	1970	7.9733	8.0303	8.0003	7.9981	0.0300	0.0022	52.632	3.8596
13	43.62	1967	8.8378	8.9024	8.8687	8.8659	0.0337	0.0028	52.167	4.3344
14	46.47	1965	8.3883	8.4558	8.4203	8.4173	0.0355	0.0030	52.593	4.4444
15	49.28	1962	7.9055	7.9657	7.9335	7.9310	0.0322	0.0025	53.488	4.1528
16	52.02	1959	11.043	11.108	11.073	11.071	0.0342	0.0029	52.615	4.4615
17	54.72	1956	8.6744	8.7305	8.7012	8.6987	0.0293	0.0025	52.228	4.4563
18	57.37	1954	9.9152	9.9691	9.9413	9.9388	0.0278	0.0025	51.577	4.6382
19	59.98	1951	9.5776	9.6307	9.6024	9.6000	0.0283	0.0024	53.296	4.5198
20	62.54	1948	9.6291	9.6858	9.6538	9.6512	0.0320	0.0026	56.437	4.5855
21	65.07	1946	8.7521	8.8050	8.7745	8.7721	0.0305	0.0024	57.656	4.5369
22	67.56	1943	9.2168	9.2629	9.2353	9.2334	0.0276	0.0019	59.870	4.1215
23	70.02	1941	10.087	10.138	10.107	10.105	0.0307	0.0022	60.433	4.3307
24	72.45	1939	9.5676	9.6133	9.5856	9.5837	0.0277	0.0019	60.613	4.1575
25	74.85	1936	9.3917	9.4356	9.4092	9.4072	0.0264	0.0020	60.137	4.5558
26	77.23	1934	7.6142	7.6587	7.6318	7.6300	0.0269	0.0018	60.449	4.0449
27	79.59	1931	9.4871	9.5346	9.5061	9.5041	0.0285	0.0020	60.000	4.2105
28	81.93	1929	10.650	10.700	10.670	10.668	0.0299	0.0021	59.800	4.2000
29	84.26	1927	9.3077	9.3567	9.3272	9.3251	0.0295	0.0021	60.204	4.2857
30	86.58	1924	8.3786	8.4217	8.3955	8.3937	0.0262	0.0018	60.789	4.1763
31	88.89	1922	7.4461	7.4925	7.4644	7.4623	0.0281	0.0021	60.560	4.5259
32	91.19	1920	8.5732	8.6240	8.5934	8.5913	0.0306	0.0021	60.236	4.1339
33	93.50	1918	9.9444	9.9930	9.9636	9.9616	0.0294	0.0020	60.494	4.1152
34	95.80	1915	9.5398	9.5932	9.5613	9.5592	0.0319	0.0021	59.738	3.9326
35	98.11	1913	10.560	10.611	10.581	10.578	0.0302	0.0021	59.332	4.1257
36	100.4	1911	10.363	10.413	10.383	10.381	0.0294	0.0021	59.274	4.2339
37	102.7	1908	9.2482	9.3056	9.2717	9.2694	0.0339	0.0023	59.059	4.0070
38	105.1	1906	9.3546	9.4069	9.3765	9.3744	0.0304	0.0021	58.126	4.0153
39	107.4	1904	9.1044	9.1590	9.1284	9.1263	0.0306	0.0021	56.044	3.8462
40	109.8	1901	9.2048	9.2558	9.2264	9.2245	0.0294	0.0019	57.647	3.7255
41	112.2	1899	9.4132	9.4595	9.4326	9.4307	0.0269	0.0019	58.099	4.1037
42	114.6	1896	9.4680	9.5127	9.4858	9.4838	0.0269	0.0020	60.179	4.4743

Depth (cm)	Cal Year (before 2011)	Year AD	Crucible weight (g)	105°C dry weight (g)	550°C ignition weight (g)	950°C ignition weight (g)	Organics weight (g)	Carbonate weight (g)	Organics as percent of dry weight (%)	Carbonates as percent of dry weight (%)
43	117.1	1894	8.8539	8.9001	8.8717	8.8699	0.0284	0.0018	61.472	3.8961
44	119.5	1891	9.2418	9.2874	9.2600	9.2582	0.0274	0.0018	60.088	3.9474
45	122.0	1889	9.1028	9.1463	9.1195	9.1178	0.0268	0.0017	61.609	3.9080
46	124.6	1886	9.5420	9.5784	9.5562	9.5549	0.0222	0.0013	60.989	3.5714
47	127.2	1884	8.5110	8.5546	8.5287	8.5271	0.0259	0.0016	59.404	3.6697
48	129.8	1881	9.4334	9.4813	9.4536	9.4519	0.0277	0.0017	57.829	3.5491
49	132.5	1879	9.4326	9.4687	9.4442	9.4429	0.0245	0.0013	67.867	3.6011
50	135.2	1876	8.0186	8.0528	8.0288	8.0278	0.0240	0.0010	70.175	2.9240
51	138.0	1873	10.259	10.298	10.271	10.270	0.0264	0.0011	68.394	2.8497
52	140.8	1870	9.1228	9.1570	9.1333	9.1322	0.0237	0.0011	69.298	3.2164
53	143.7	1867	10.22	10.2600	10.2378	10.2367	0.0222	0.0011	68.731	3.4056
54	146.6	1864	9.3592	9.3920	9.3697	9.3687	0.0223	0.0010	67.988	3.0488
55	149.7	1861	9.1361	9.1736	9.1481	9.1470	0.0255	0.0011	68.000	2.9333
56	152.7	1858	8.3116	8.3431	8.3211	8.3202	0.0220	0.0009	69.841	2.8571
57	155.9	1855	9.2933	9.3268	9.3040	9.3029	0.0228	0.0011	68.060	3.2836

Tawny Pond Livingstone 06

Depth (cm)	Cal Year (before 2011)	Year AD	Crucible weight (g)	105°C dry weight (g)	550°C ignition weight (g)	950°C ignition weight (g)	Organics weight (g)	Carbonate weight (g)	Organics as percent of dry weight (%)	Carbonates as percent of dry weight (%)
0	0.00	2011	9.2176	9.2787	9.2454	9.2427	0.0333	0.0027	54.501	4.4190
1	3.86	2007	7.6149	7.6843	7.6468	7.6438	0.0375	0.0030	54.035	4.3228
2	7.63	2003	8.0187	8.0897	8.0516	8.0484	0.0381	0.0032	53.662	4.5070
3	11.30	2000	9.4603	x	x	x	x	x	x	x
4	14.88	1996	9.4347	x	x	x	x	x	x	x
5	18.38	1993	9.9162	x	x	x	x	x	x	x
6	21.79	1989	9.4672	x	x	x	x	x	x	x
7	25.13	1986	8.3707	x	x	x	x	x	x	x
8	28.39	1983	9.2938	x	x	x	x	x	x	x
9	31.57	1979	10.228	x	x	x	x	x	x	x
10	34.68	1976	9.3086	9.3860	9.3445	9.3410	0.0415	0.0035	53.618	4.5220
11	37.72	1973	10.088	10.158	10.120	10.117	0.0380	0.0031	54.054	4.4097
12	40.70	1970	8.3892	8.4560	8.4198	8.4168	0.0362	0.0030	54.192	4.4910
13	43.62	1967	8.6750	8.7458	8.7075	8.7048	0.0383	0.0027	54.096	3.8136
14	46.47	1965	9.4842	9.5494	9.5126	9.5102	0.0368	0.0024	56.442	3.6810
15	49.28	1962	10.025	10.089	10.051	10.049	0.0384	0.0020	59.351	3.0912
16	52.02	1959	8.0215	8.0848	8.0460	8.0439	0.0388	0.0021	61.295	3.3175
17	54.72	1956	9.5813	9.6373	9.6032	9.6012	0.0341	0.0020	60.893	3.5714
18	57.37	1954	9.5409	9.6010	9.5642	9.5625	0.0368	0.0017	61.231	2.8286
19	59.98	1951	8.5742	8.6276	8.5951	8.5935	0.0325	0.0016	60.861	2.9963
20	62.54	1948	9.1368	9.1970	9.1599	9.1582	0.0371	0.0017	61.628	2.8239
21	65.07	1946	9.1050	9.1596	9.1262	9.1244	0.0334	0.0018	61.172	3.2967
22	67.56	1943	10.404	10.460	10.426	10.424	0.0345	0.0017	61.388	3.0249
23	70.02	1941	9.4342	9.4894	9.4551	9.4533	0.0343	0.0018	62.138	3.2609
24	72.45	1939	8.8546	8.9083	8.8752	8.8735	0.0331	0.0017	61.639	3.1657
25	74.85	1936	9.1034	9.1610	9.1256	9.1239	0.0354	0.0017	61.458	2.9514
26	77.23	1934	9.4881	9.5493	9.5116	9.5098	0.0377	0.0018	61.601	2.9412
27	79.59	1931	9.9456	9.9913	9.9633	9.9620	0.0280	0.0013	61.269	2.8446
28	81.93	1929	8.3798	8.4354	8.4014	8.3999	0.0340	0.0015	61.151	2.6978
29	84.26	1927	9.8216	9.8710	9.8408	9.8393	0.0302	0.0015	61.134	3.0364
30	86.58	1924	8.5119	8.5673	8.5338	8.5319	0.0335	0.0019	60.469	3.4296
31	88.89	1922	9.4760	9.5320	9.4979	9.4960	0.0341	0.0019	60.893	3.3929
32	91.19	1920	9.1238	9.1846	9.1471	9.1451	0.0375	0.0020	61.678	3.2895
33	93.50	1918	9.3556	9.4098	9.3759	9.3741	0.0339	0.0018	62.546	3.3210
34	95.80	1915	9.2492	9.3072	9.2706	9.2687	0.0366	0.0019	63.103	3.2759
35	98.11	1913	9.3468	9.4030	9.3675	9.3656	0.0355	0.0019	63.167	3.3808
36	100.42	1911	9.7798	9.8363	9.8009	9.7992	0.0354	0.0017	62.655	3.0088
37	102.74	1908	9.9939	10.045	10.013	10.011	0.0319	0.0016	62.549	3.1373
38	105.08	1906	10.651	10.707	10.672	10.670	0.0349	0.0017	62.210	3.0303
39	107.43	1904	9.4343	9.4843	9.4532	9.4516	0.0311	0.0016	62.200	3.2000
40	109.80	1901	9.5428	9.5947	9.5608	9.5590	0.0339	0.0018	65.318	3.4682
41	112.19	1899	9.4143	9.4596	9.4279	9.4264	0.0317	0.0015	69.978	3.3113

Depth (cm)	Cal Year (before 2011)	Year AD	Crucible weight (g)	105°C dry weight (g)	550°C ignition weight (g)	950°C ignition weight (g)	Organics weight (g)	Carbonate weight (g)	Organics as percent of dry weight (%)	Carbonates as percent of dry weight (%)
42	114.61	1896	9.2427	9.2897	9.2568	9.2554	0.0329	0.0014	70.000	2.9787
43	117.05	1894	10.561	10.607	10.575	10.574	0.0322	0.0011	69.848	2.3861
44	119.53	1891	9.4688	9.5126	9.4825	9.4814	0.0301	0.0011	68.722	2.5114
45	122.04	1889	9.2060	9.2506	9.2199	9.2188	0.0307	0.0011	68.834	2.4664
46	124.59	1886	7.4187	7.4626	7.4324	7.4314	0.0302	0.0010	68.793	2.2779
47	127.17	1884	9.0781	9.1197	9.0908	9.0897	0.0289	0.0011	69.471	2.6442
48	129.80	1881	9.6776	9.7235	9.6919	9.6906	0.0316	0.0013	68.845	2.8322
49	132.48	1879	8.2462	8.2903	8.2606	8.2592	0.0297	0.0014	67.347	3.1746
50	135.20	1876	10.091	10.133	10.103	10.102	0.0295	0.0011	70.743	2.6379
51	137.98	1873	8.9264	8.9648	8.9373	8.9363	0.0275	0.0010	71.615	2.6042
52	140.81	1870	10.267	10.306	10.278	10.277	0.0273	0.0010	70.909	2.5974
53	143.69	1867	8.2580	8.2982	8.2695	8.2684	0.0287	0.0011	71.393	2.7363
54	146.64	1864	9.1631	9.2009	9.1737	9.1727	0.0272	0.0010	71.958	2.6455
55	149.66	1861	8.6188	8.6534	8.6283	8.6273	0.0251	0.0010	72.543	2.8902
56	152.73	1858	9.0837	9.1222	9.0937	9.0927	0.0285	0.0010	74.026	2.5974
57	155.88	1855	9.4220	9.4580	9.4307	9.4298	0.0273	0.0009	75.833	2.5000
58	159.11	1852	11.011	11.046	11.019	11.018	0.0275	0.0010	77.684	2.8249
59	162.40	1849	9.1142	9.1497	9.1226	9.1216	0.0271	0.0010	76.338	2.8169
60	165.78	1845	8.9779	9.0164	8.9870	8.9860	0.0294	0.0010	76.364	2.5974
61	169.24	1842	8.5116	8.5499	8.5211	8.5201	0.0288	0.0010	75.196	2.6110
62	172.78	1838	9.1272	9.1643	9.1370	9.1360	0.0273	0.0010	73.585	2.6954
63	176.41	1835	7.7531	7.7918	7.7640	7.7628	0.0278	0.0012	71.835	3.1008
64	180.13	1831	9.3769	9.4107	9.3863	9.3853	0.0244	0.0010	72.189	2.9586
65	183.95	1827	10.312	10.352	10.323	10.321	0.0297	0.0012	73.153	2.9557
66	187.86	1823	9.8666	9.9040	9.8764	9.8754	0.0276	0.0010	73.797	2.6738
67	191.87	1819	9.3598	9.4040	9.3719	9.3706	0.0321	0.0013	72.624	2.9412
68	195.99	1815	9.6529	9.6932	9.6652	9.6638	0.0280	0.0014	69.479	3.4739
69	200.21	1811	10.364	10.412	10.379	10.378	0.0323	0.0019	67.573	3.9749
70	204.54	1806	8.0449	8.0844	8.0569	8.0554	0.0275	0.0015	69.620	3.7975
71	208.98	1802	10.020	10.063	10.033	10.032	0.0304	0.0014	70.698	3.2558
72	213.54	1797	8.5146	8.5543	8.5257	8.5242	0.0286	0.0015	72.040	3.7783
73	218.21	1793	9.7256	9.7644	9.7358	9.7343	0.0286	0.0015	73.711	3.8660
74	223.01	1788	10.125	10.168	10.137	10.135	0.0311	0.0014	72.326	3.2558
75	227.93	1783	9.7255	9.7676	9.7378	9.7361	0.0298	0.0017	70.784	4.0380
76	232.97	1778	9.9900	10.034	10.002	10.000	0.0319	0.0018	72.665	4.1002
77	238.15	1773	9.1196	9.1640	9.1317	9.1299	0.0323	0.0018	72.748	4.0541
78	243.45	1768	9.5781	9.6221	9.5903	9.5886	0.0318	0.0017	72.273	3.8636
79	248.90	1762	10.192	10.235	10.204	10.202	0.0317	0.0017	72.706	3.8991
80	254.48	1757	9.0402	9.0822	9.0524	9.0507	0.0298	0.0017	70.952	4.0476
81	260.20	1751	10.112	10.157	10.125	10.123	0.0323	0.0018	71.145	3.9648
82	266.07	1745	8.9730	9.0137	8.9833	8.9817	0.0304	0.0016	74.693	3.9312
83	272.09	1739	10.416	10.457	10.427	10.426	0.0299	0.0018	72.573	4.3689
84	278.26	1733	8.8389	8.8863	8.8527	8.8506	0.0336	0.0021	70.886	4.4304
85	284.58	1726	10.037	10.076	10.048	10.047	0.0277	0.0015	70.844	3.8363

Depth (cm)	Cal Year (before 2011)	Year AD	Crucible weight (g)	105°C dry weight (g)	550°C ignition weight (g)	950°C ignition weight (g)	Organics weight (g)	Carbonate weight (g)	Organics as percent of dry weight (%)	Carbonates as percent of dry weight (%)
86	291.06	1720	9.8185	9.8581	9.8302	9.8288	0.0279	0.0014	70.455	3.5354
87	297.70	1713	8.3121	8.3551	8.3250	8.3233	0.0301	0.0017	70.000	3.9535
88	304.50	1707	9.5786	9.6224	9.5923	9.5906	0.0301	0.0017	68.722	3.8813
89	311.46	1700	10.408	10.453	10.422	10.420	0.0306	0.0019	68.610	4.2601
90	318.60	1692	9.5685	9.6154	9.5836	9.5817	0.0318	0.0019	67.804	4.0512
91	325.91	1685	7.9059	7.9493	7.9191	7.9175	0.0302	0.0016	69.585	3.6866
92	333.39	1678	9.6300	9.6733	9.6432	9.6416	0.0301	0.0016	69.515	3.6952
93	341.05	1670	7.9741	8.0176	7.9876	7.9860	0.0300	0.0016	68.966	3.6782
94	348.89	1662	9.3660	9.4084	9.3805	9.3788	0.0279	0.0017	65.802	4.0094
95	356.92	1654	9.3925	9.4420	9.4093	9.4074	0.0327	0.0019	66.061	3.8384
96	365.13	1646	10.260	10.311	10.278	10.275	0.0331	0.0022	64.902	4.3137
97	373.53	1637	9.5740	9.6241	9.5919	9.5897	0.0322	0.0022	64.272	4.3912
98	382.12	1629	7.4467	7.4990	7.4660	7.4634	0.0330	0.0026	63.098	4.9713
99	390.91	1620	9.6417	9.6899	9.6590	9.6570	0.0309	0.0020	64.108	4.1494
100	399.90	1611	11.043	11.094	11.062	11.059	0.0325	0.0023	63.353	4.4834
101	409.09	1602	8.7527	8.8027	8.7710	8.7687	0.0317	0.0023	63.400	4.6000
102	418.49	1593	8.1871	8.2352	8.2049	8.2033	0.0303	0.0016	62.994	3.3264
103	428.09	1583	10.225	10.269	10.241	10.240	0.0279	0.0014	63.554	3.1891
104	437.90	1573	9.4701	9.5164	9.4870	9.4852	0.0294	0.0018	63.499	3.8877
105	447.93	1563	9.0792	9.1242	9.0942	9.0926	0.0300	0.0016	66.667	3.5556
106	458.17	1553	7.9081	7.9555	7.9239	7.9222	0.0316	0.0017	66.667	3.5865
107	468.64	1542	9.7608	9.8025	9.7743	9.7728	0.0282	0.0015	67.626	3.5971
108	479.33	1532	9.2916	9.3361	9.3053	9.3040	0.0308	0.0013	69.214	2.9213
109	490.24	1521	9.0105	9.0526	9.0227	9.0215	0.0299	0.0012	71.021	2.8504
110	501.38	1510	9.8036	9.8469	9.8167	9.8152	0.0302	0.0015	69.746	3.4642
111	512.75	1498	9.6766	9.7261	9.6930	9.6913	0.0331	0.0017	66.869	3.4343
112	524.36	1487	9.1332	9.1814	9.1493	9.1477	0.0321	0.0016	66.598	3.3195
113	536.21	1475	9.4709	9.5141	9.4852	9.4837	0.0289	0.0015	66.898	3.4722
114	548.29	1463	9.2830	9.3240	9.2961	9.2947	0.0279	0.0014	68.049	3.4146
115	560.63	1450	9.2330	9.2770	9.2467	9.2451	0.0303	0.0016	68.864	3.6364
116	573.20	1438	8.1111	8.1547	8.1247	8.1230	0.0300	0.0017	68.807	3.8991
117	586.03	1425	9.3114	9.3558	9.3247	9.3231	0.0311	0.0016	70.045	3.6036
118	599.11	1412	9.6296	9.6743	9.6443	9.6424	0.0300	0.0019	67.114	4.2506
119	612.45	1399	7.7649	7.8086	7.7802	7.7784	0.0284	0.0018	64.989	4.1190
120	626.04	1385	8.6238	8.6710	8.6396	8.6377	0.0314	0.0019	66.525	4.0254
121	639.90	1371	9.4052	9.4543	9.4213	9.4192	0.0330	0.0021	67.210	4.2770
122	654.02	1357	9.2590	9.2972	9.2716	9.2699	0.0256	0.0017	67.016	4.4503
123	668.41	1343	10.391	10.435	10.406	10.403	0.0296	0.0018	66.817	4.0632
124	683.07	1328	9.0562	9.1016	9.0716	9.0697	0.0300	0.0019	66.079	4.1850
125	698.00	1313	10.438	10.483	10.452	10.450	0.0306	0.0018	67.699	3.9823
126	713.21	1298	9.9061	9.9534	9.9214	9.9195	0.0320	0.0019	67.653	4.0169
127	728.70	1282	9.0034	9.0499	9.0180	9.0164	0.0319	0.0016	68.602	3.4409
128	744.47	1267	9.7408	9.7870	9.7556	9.7538	0.0314	0.0018	67.965	3.8961
129	760.53	1250	9.6357	9.6813	9.6503	9.6487	0.0310	0.0016	67.983	3.5088

Depth (cm)	Cal Year (before 2011)	Year AD	Crucible weight (g)	105°C dry weight (g)	550°C ignition weight (g)	950°C ignition weight (g)	Organics weight (g)	Carbonate weight (g)	Organics as percent of dry weight (%)	Carbonates as percent of dry weight (%)
130	776.88	1234	9.9609	10.005	9.9759	9.9741	0.0292	0.0018	66.063	4.0724
131	793.52	1217	9.2546	9.2988	9.2693	9.2676	0.0295	0.0017	66.742	3.8462
132	810.45	1201	9.3579	9.4018	9.3724	9.3708	0.0294	0.0016	66.970	3.6446
133	827.69	1183	8.4204	8.4663	8.4356	8.4339	0.0307	0.0017	66.885	3.7037
134	845.22	1166	8.4346	8.4773	8.4485	8.4466	0.0288	0.0019	67.447	4.4496
135	863.06	1148	9.2712	9.3233	9.2883	9.2861	0.0350	0.0022	67.179	4.2226
136	881.20	1130	9.1241	9.1715	9.1385	9.1364	0.0330	0.0021	69.620	4.4304
137	899.65	1111	9.3201	9.3680	9.3340	9.3323	0.0340	0.0017	70.981	3.5491
138	918.42	1093	8.3880	8.4323	8.4002	8.3986	0.0321	0.0016	72.461	3.6117
139	937.50	1074	7.8504	7.8956	7.8624	7.8609	0.0332	0.0015	73.451	3.3186
140	956.90	1054	9.3852	9.4308	9.3979	9.3961	0.0329	0.0018	72.149	3.9474
141	976.62	1034	9.2264	9.2644	9.2366	9.2352	0.0278	0.0014	73.158	3.6842
142	996.67	1014	8.6483	8.7009	8.6632	8.6612	0.0377	0.0020	71.673	3.8023
143	1017.0	994	8.5713	8.6278	8.5876	8.5853	0.0402	0.0023	71.150	4.0708
144	1037.8	973	9.6223	9.6807	9.6390	9.6367	0.0417	0.0023	71.404	3.9384

Stoll Lake Livingstone 01

Depth (cm)	Cal Year (before 2011)	Year AD	Crucible weight (g)	105°C dry weight (g)	550°C ignition weight (g)	950°C ignition weight (g)	Organics weight (g)	Carbonate weight (g)	Organics as percent of dry weight (%)	Carbonates as percent of dry weight (%)
0	0	2011	10.561	10.579	10.571	10.57	0.0084	0.0006	46.154	3.2967
1	2.71	2008	8.3798	8.4106	8.3966	8.3953	0.014	0.0013	45.455	4.2208
2	5.54	2005	10.651	10.71	10.683	10.681	0.0268	0.0026	45.347	4.3993
3	8.47	2003	9.4883	9.5554	9.5248	9.522	0.0306	0.0028	45.604	4.1729
4	11.5	1999	9.9453	10.012	9.9823	9.9793	0.0295	0.003	44.361	4.5113
5	14.65	1996	8.5742	8.6642	8.6243	8.6204	0.0399	0.0039	44.333	4.3333
6	17.9	1993	8.855	8.9255	8.8942	8.891	0.0313	0.0032	44.397	4.539
7	21.26	1990	9.2428	9.3186	9.2852	9.282	0.0334	0.0032	44.063	4.2216
8	24.73	1986	9.1053	9.1804	9.1465	9.1433	0.0339	0.0032	45.14	4.261
9	28.3	1983	9.4344	9.5149	9.4796	9.476	0.0353	0.0036	43.851	4.472
10	31.98	1979	9.2493	9.3343	9.2971	9.2936	0.0372	0.0035	43.764	4.1176
11	35.77	1975	9.5412	9.62	9.5852	9.582	0.0348	0.0032	44.162	4.0609
12	39.67	1971	9.3468	9.4354	9.3965	9.3924	0.0389	0.0041	43.905	4.6275
13	43.67	1967	8.512	8.5619	8.5394	8.5373	0.0225	0.0021	45.09	4.2084
14	47.78	1963	9.5431	9.6319	9.5925	9.5886	0.0394	0.0039	44.369	4.3919
15	52.00	1959	9.4347	9.5336	9.4876	9.4834	0.046	0.0042	46.512	4.2467
16	56.33	1955	9.124	9.198	9.1698	9.1674	0.0282	0.0024	38.108	3.2432
17	60.76	1950	9.3555	9.4819	9.416	9.4123	0.0659	0.0037	52.136	2.9272
18	65.3	1946	10.404	10.501	10.461	10.456	0.0401	0.0047	41.469	4.8604
19	69.95	1941	9.8216	9.9269	9.8842	9.8791	0.0427	0.0051	40.551	4.8433
20	74.7	1936	9.2064	9.312	9.2678	9.263	0.0442	0.0048	41.856	4.5455
21	79.57	1931	9.1036	9.1934	9.1589	9.1544	0.0345	0.0045	38.419	5.0111
22	84.54	1926	9.4764	9.5861	9.5394	9.5345	0.0467	0.0049	42.571	4.4667
23	89.61	1921	9.4143	9.5619	9.4709	9.467	0.091	0.0039	61.653	2.6423
24	94.8	1916	9.4676	9.5636	9.5161	9.5127	0.0475	0.0034	49.479	3.5417
25	100.1	1911	9.994	10.08	10.045	10.041	0.0346	0.0041	40.233	4.7674
26	105.5	1906	7.4189	7.5269	7.4823	7.4771	0.0446	0.0052	41.296	4.8148
27	111	1900	9.4698	9.5711	9.5293	9.5241	0.0418	0.0052	41.264	5.1333
28	116.6	1894	9.0781	9.1862	9.1428	9.1373	0.0434	0.0055	40.148	5.0879
29	122.3	1889	9.7798	9.9011	9.851	9.8454	0.0501	0.0056	41.303	4.6167
30	128.2	1883	9.2945	9.3974	9.354	9.3496	0.0434	0.0044	42.177	4.276
31	134.1	1877	9.1371	9.2419	9.1982	9.194	0.0437	0.0042	41.699	4.0076
32	140.2	1871	8.3724	8.4744	8.431	8.4265	0.0434	0.0045	42.549	4.4118
33	146.3	1865	9.4844	9.5896	9.5462	9.5418	0.0434	0.0044	41.255	4.1825
34	152.6	1858	10.228	10.328	10.287	10.283	0.0405	0.0043	40.622	4.3129
35	158.9	1852	9.4351	9.5433	9.4996	9.4951	0.0437	0.0045	40.388	4.159
36	165.4	1846	10.409	10.516	10.474	10.469	0.0424	0.0043	39.479	4.0037
37	172	1839	8.0216	8.1278	8.0858	8.0812	0.042	0.0046	39.548	4.3315
38	178.7	1832	8.3122	8.425	8.3811	8.376	0.0439	0.0051	38.918	4.5213
39	185.5	1826	10.416	10.53	10.486	10.481	0.0446	0.0046	39.157	4.0386
40	192.4	1819	9.5746	9.6884	9.6433	9.6384	0.0451	0.0049	39.631	4.3058
41	199.4	1812	11.044	11.149	11.106	11.102	0.0428	0.0042	40.646	3.9886
42	206.5	1805	9.4609	9.5758	9.5306	9.5255	0.0452	0.0051	39.339	4.4386
43	213.7	1797	8.6751	8.7863	8.7422	8.7375	0.0441	0.0047	39.658	4.2266

Depth (cm)	Cal Year (before 2011)	Year AD	Crucible weight (g)	105°C dry weight (g)	550°C ignition weight (g)	950°C ignition weight (g)	Organics weight (g)	Carbonate weight (g)	Organics as percent of dry weight (%)	Carbonates as percent of dry weight (%)
44	221.1	1790	9.5814	9.6767	9.6376	9.6336	0.0391	0.004	41.028	4.1973
45	228.5	1783	9.3664	9.4573	9.4202	9.4164	0.0371	0.0038	40.814	4.1804
46	236	1775	10.025	10.12	10.081	10.077	0.0387	0.004	41.039	4.2418
47	243.7	1767	8.019	8.13	8.0849	8.0803	0.0451	0.0046	40.631	4.1441
48	251.5	1760	10.364	10.468	10.426	10.422	0.0421	0.0042	40.326	4.023
49	259.3	1752	10.26	10.372	10.326	10.322	0.0463	0.0043	41.229	3.829
50	267.3	1744	9.3598	9.4699	9.425	9.4204	0.0449	0.0046	40.781	4.178
51	275.4	1736	10.037	10.139	10.098	10.093	0.041	0.0043	40.354	4.2323
52	283.6	1727	9.1196	9.2283	9.1848	9.1801	0.0435	0.0047	40.018	4.3238
53	291.9	1719	7.9062	8.0088	7.9674	7.963	0.0414	0.0044	40.351	4.2885
54	300.3	1711	7.4471	7.5532	7.5096	7.5049	0.0436	0.0047	41.093	4.4298
55	308.8	1702	9.2179	9.3216	9.278	9.2736	0.0436	0.0044	42.044	4.243
56	317.4	1694	7.6151	7.7133	7.6721	7.6679	0.0412	0.0042	41.955	4.277
57	326.2	1685	9.3927	9.4993	9.4541	9.4497	0.0452	0.0044	42.402	4.1276
58	335	1676	9.3087	9.4095	9.3664	9.3623	0.0431	0.0041	42.758	4.0675
59	343.9	1667	9.5688	9.667	9.6258	9.6216	0.0412	0.0042	41.955	4.277
60	353	1658	8.7536	8.8469	8.8068	8.803	0.0401	0.0038	42.98	4.0729
61	362.2	1649	9.9167	10.015	9.973	9.9689	0.0418	0.0041	42.61	4.1794
62	371.4	1640	9.6307	9.7324	9.6901	9.6858	0.0423	0.0043	41.593	4.2281
63	380.8	1630	8.8393	8.9427	8.8987	8.8944	0.044	0.0043	42.553	4.1586
64	390.3	1621	10.088	10.192	10.148	10.144	0.0434	0.0044	41.973	4.2553
65	399.9	1611	8.3896	8.4984	8.4522	8.4478	0.0462	0.0044	42.463	4.0441
66	409.6	1601	9.8672	9.9644	9.9227	9.9189	0.0417	0.0038	42.901	3.9095
67	419.4	1592	8.515	8.6145	8.5719	8.5677	0.0426	0.0042	42.814	4.2211
68	429.3	1582	10.113	10.224	10.177	10.172	0.0473	0.0045	42.613	4.0541
69	439.3	1572	9.6429	9.752	9.7052	9.701	0.0468	0.0042	42.896	3.8497
70	449.4	1562	9.579	9.6723	9.6317	9.6283	0.0406	0.0034	43.516	3.6442
71	459.7	1551	7.9745	8.0809	8.0353	8.0314	0.0456	0.0039	42.857	3.6654
72	470	1541	9.5787	9.6928	9.6439	9.6394	0.0489	0.0045	42.857	3.9439
73	480.4	1531	8.9736	9.0659	9.0263	9.0225	0.0396	0.0038	42.904	4.117
74	491	1520	9.0406	9.1409	9.0984	9.0944	0.0425	0.004	42.373	3.988
75	501.7	1509	9.9904	10.095	10.051	10.047	0.0438	0.0041	42.035	3.9347
76	512.4	1499	10.192	10.302	10.257	10.252	0.0455	0.0046	41.289	4.1742
77	523.3	1488	9.8192	9.9253	9.8808	9.8765	0.0445	0.0043	41.942	4.0528
78	534.3	1477	9.7262	9.8343	9.788	9.7836	0.0463	0.0044	42.831	4.0703
79	545.4	1466	9.7261	9.839	9.7912	9.7862	0.0478	0.005	42.338	4.4287
80	556.6	1454	10.125	10.2381	10.1908	10.186	0.0473	0.0048	41.933	4.2553
81	567.9	1443	9.6529	9.7613	9.7162	9.7119	0.0451	0.0043	41.605	3.9668

Appendix B: Pollen Data

Tawny Pond

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Pinus dipl	Pinus hapl	Pinus undiff 1/2's	Pinus whole (undiff)	Picea 1/2's	Picea whole	Abies 1/2's	Abies whole	Cupressaceae	Larix	Tsuga canadensis	Betula
0	0.00	2011	0	52	68.5	28	0.5	1	0	1	13	2	24	124
0.5	1.94	2009	15	40	61.5	31	4.5	4	2	0	11	0	27	114
1	3.86	2007	12	47	50	24	3	9	3.5	1	3	0	24	120
1.5	5.75	2005	7	64	65	34	2	3	0	4	9	0	24	149
2	7.63	2003	3	91	77	26	2	3	0	0	4	3	29	181
2.5	9.47	2002	10	45	75	30	5	6	2	3	11	1	23	141
3	11.30	2000	3	80	62.5	28	0	5	0	1	10	4	36	159
3.5	13.10	1998	14	31	54.5	24	3.5	5	1.5	1	9	1	26	128
4	14.88	1996	0	127	67.5	18	0	1	0	0	8	1	24	141
4.5	16.64	1994	5	32	57.5	29	1	4	1	3	7	0	19	98
5	18.38	1993	8	32	55	23	3.5	4	0.5	3	9	1	26	113
5.5	20.10	1991	9	46	60.5	35	1.5	3	0	2	6	0	23	131
6	21.79	1989	1	102	78	18	2	3	0	0	14	2	25	169
6.5	23.47	1988	13	50	65.5	22	3	6	0.5	1	8	0	24	124
7	25.13	1986	0	67	78	7	4	2	0.5	0	11	3	25	175
7.5	26.77	1984	8	32	58	27	3.5	7	2	3	7	2	19	141
8	28.39	1983	1	80	84.5	13	0	1	0	1	7	1	26	125
8.5	29.99	1981	3	50	62	40	2.5	4	1.5	1	4	1	21	154
9	31.57	1979	10	25	76.5	15	3	5	1.5	2	6	2	14	124
9.5	33.13	1978	12	41	92.5	22	5	5	3	0	5	1	30	140
10	34.68	1976	0	119	78.5	7	2	3	0	0	19	4	28	192
10.5	36.21	1975	9	25	66.5	26	3.5	9	2.5	3	7	3	25	133
11	37.72	1973	0	74	86.5	10	1	4	0	1	11	1	26	192
11.5	39.22	1972	20	62	84	19	3.5	3	0.5	3	10	1	24	169
12	40.70	1970	1	89	87	22	1	3	0	0	10	1	23	207
12.5	42.17	1969	20	32	73	16	5	4	0.5	0	9	4	33	116
13	43.62	1967	9	31	72	18	2	5	3	1	8	1	27	126
13.5	45.05	1966	8	43	80.5	19	3.5	4	3	2	7	2	27	130
14	46.47	1965	9	39	74	21	3.5	6	3	0	11	2	25	147
15	49.28	1962	4	67	82.5	36	0.5	3	0	0	7	1	17	133
15.5	50.66	1960	5	16	106	53	3.5	3	4	8	7	0	59	97
16	52.02	1959	1	65	63	25	0	0	0	0	3	3	20	120
17	54.72	1956	2	33	96	32	2.5	4	1	0	6	1	30	110
17.5	56.05	1955	8	27	90.5	52	1.5	5	2	7	7	0	38	97
18	57.37	1954	3	85	112	28	1	5	0.5	0	13	1	42	158
18.5	58.68	1952	7	24	99.5	48	1	2	4	3	5	0	52	100

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Pinus dipl	Pinus hapl	Pinus undiff 1/2's	Pinus whole (undiff)	Picea 1/2's	Picea whole	Abies 1/2's	Abies whole	Cupressaceae	Larix	Tsuga canadensis	Betula
19	59.98	1951	3	62	115	23	2	4	2	0	7	3	39	155
19.5	61.26	1950	9	33	93.5	27	0.5	3	0	2	8	2	33	86
20	62.54	1948	1	113	79	23	1	3	0.5	1	6	3	45	134
20.5	63.81	1947	7	21	116	46	1	5	3.5	2	3	0	44	90
21	65.07	1946	3	27	92.5	29	5	5	1.5	0	4	2	40	81
21.5	66.32	1945	7	35	84	47	1	6	0	0	3	2	39	100
22	67.56	1943	0	127	137	37	4	4	0	1	13	3	59	174
23	70.02	1941	5	34	118	43	5.5	4	1	1	4	2	39	89
24	72.45	1939	4	85	121	60	2	5	0.5	4	14	2	41	140
25	74.85	1936	8	34	99.5	39	3.5	5	0	0	7	1	49	71
26	77.23	1934	6	41	95.5	37	4.5	8	1.5	2	6	0	49	86
27	79.59	1931	7	36	117	40	2.5	7	2	0	7	2	52	104
28	81.93	1929	2	26	113	42	5	3	2	3	10	1	40	78
29	84.26	1927	6	37	98.5	36	4.5	8	2.5	2	5	0	42	84
30	86.58	1924	11	43	78.5	42	4.5	5	1	4	8	2	45	74
31	88.89	1922	4	27	110	46	3.5	4	1.5	1	6	0	61	57
32	91.19	1920	3	25	124	47	2.5	6	1.5	0	9	0	53	94
33	93.50	1918	9	28	130	56	4.5	7	2	3	3	2	60	80
34	95.80	1915	6	25	115	45	3.5	7	1.5	2	3	1	65	58
35	98.11	1913	5	48	124	50	3.5	7	1.5	3	10	3	82	80
36	100.42	1911	9	53	85.5	42	5	10	0.5	1	0	2	39	65
37	102.74	1908	11	40	113	33	2.5	2	0.5	0	5	0	52	88
38	105.08	1906	9	34	136	55	1.5	6	3	0	4	2	57	78
39	107.43	1904	7	33	150	60	4	2	2	2	5	0	49	97
40	109.80	1901	15	53	111	45	5	5	2	3	6	2	39	75
41	112.19	1899	2	35	123	50	2.5	5	1	1	3	1	63	115
42	114.61	1896	2	24	112	53	5	5	2	1	8	2	53	67
43	117.05	1894	3	27	135	46	2	9	1	0	4	1	48	68
44	119.53	1891	6	66	115	72	2	6	0.5	2	8	2	57	91.5
45	122.04	1889	0	38	113	41	4	5	0	1	1	1	35	82
46	124.59	1886	7	36	102	34	4.5	5	1	1	8	2	43	72
47	127.17	1884	11	68	127	39	2.5	6	0.5	0	5	0	48	95
48	129.80	1881	7	40	112	49	4.5	8	1.5	2	6	1	52	80
49	132.48	1879	14	32	105	89	2	2	1.5	3	5	1	50	76
50	135.20	1876	9	61	105	56	4.5	8	0.5	3	6	0	53	67
51	137.98	1873	9	57	135	52	6.5	4	2	2	2	0	52	78
52	140.81	1870	19	68	120	38	5.5	3	1.5	2	2	1	75	76
53	143.69	1867	9	68	128	80	7.5	9	1.5	3	8	1	66	89
54	146.64	1864	11	88	122	78	1	3	0	1	2	3	61	91
55	149.66	1861	12	45	113	99	0	4	1	2	5	1	84	68

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Pinus dipl	Pinus hapl	Pinus undiff 1/2's	Pinus whole (undiff)	Picea 1/2's	Picea whole	Abies 1/2's	Abies whole	Cupressaceae	Larix	Tsuga canadensis	Betula
56	152.73	1858	10	66	125	59	5	7	0.5	1	4	2	60	81
57	155.88	1855	3	27	145	46	6.5	3	2.5	0	3	1	78	86
58	159.11	1852	6	73	121	75	4	6	1.5	2	4	2	48	89
59	162.40	1849	10	98	152	83	4	4	0	0	3	4	53	85
60	165.78	1845	14	78	120	41	1.5	4	0.5	3	4	4	62	87
61	169.24	1842	3	55	147	86	3	6	1.5	1	3	1	73	62
62	172.78	1838	13	73	113	61	1	5	3	0	3	1	61	78
63	176.41	1835	6	75	133	85	2.5	5	0.5	0	4	2	57	63
64	180.13	1831	10	65	115	65	1	4	0.5	4	6	0	74	89
65	183.95	1827	9	53	122	90	5.5	11	1.5	1	0	1	53	73
66	187.86	1823	13	79	112	57	4.5	2	0	1	3	1	61	101
67	191.87	1819	8	48	124	59	2	2	1	0	4	2	79	117
68	195.99	1815	6	52	130	40	3.5	3	1.5	2	3	5	43	112
69	200.21	1811	1	35	108	44	6	11	2	0	2	3	63	115
70	204.54	1806	9	67	110	42	3	6	1	0	6	4	51	133
71	208.98	1802	7	27	108	53	8	6	2	1	3	1	60	144
72	213.54	1797	8	33	92	66	5	3	0	2	4	5	68	120
73	218.21	1793	5	42	97	56	2	2	0	1	5	2	80	119
74	223.01	1788	9	45	81	29	2.5	7	0.5	0	6	2	60	154
75	227.93	1783	15	67	83	42	2.5	4	0	2	8	4	51	138
76	232.97	1778	12	33	60	29	0.5	7	1.5	2	5	6	77	134
77	238.15	1773	6	19	86	31	8	4	3.5	6	5	5	67	154
78	243.45	1768	5	21	109	54	3	1	2.5	2	5	0	122	90
79	248.90	1762	1	16	102	38	7.5	3	2.5	1	4	3	61	148
80	254.48	1757	12	23	87.5	31	1.5	2	1	3	7	4	77	104
80.5	257.32	1754	9	29	63.5	12	5	4	0.5	3	7	4	64	167
81	260.20	1751	5	14	93	41	1.5	4	2	5	1	1	157	69
81.5	263.12	1748	4	17	74	23	2.5	6	1	1	3	4	100	115
82	266.07	1745	12	19	98.5	52	3.5	3	3.5	2	8	3	102	105
82.5	269.06	1742	13	39	58	33	1	3	1	2	4	4	80	163
83	272.09	1739	5	23	106	52	5	5	7	9	4	1	152	74
83.5	275.16	1736	7	14	87	30	4.5	3	1.5	6	3	4	90	121
84	278.26	1733	11	17	86	31	4.5	9	5	3	3	3	119	100
85	284.58	1726	6	14	90	43	6	5	5	6	9	1	172	50
86	291.06	1720	10	25	77.5	48	3	3	4.5	4	9	7	135	101
87	297.70	1713	2	9	102	49	3	5	3	3	3	2	160	62
88	304.50	1707	7	14	79	41	2.5	1	1	1	6	2	136	114
89	311.46	1700	4	13	89	54	3	5	1	2	5	1	169	63
90	318.60	1692	11	25	93	33	1.5	4	0.5	1	12	3	152	78
91	325.91	1685	6	16	98	46	2	0	2.5	2	6	1	190	47

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Pinus dipl	Pinus hapl	Pinus undiff 1/2's	Pinus whole (undiff)	Picea 1/2's	Picea whole	Abies 1/2's	Abies whole	Cupressaceae	Larix	Tsuga canadensis	Betula
92	333.39	1678	7	23	72	45	2.5	6	0	1	6	3	132	76
93	341.05	1670	7	32	77	48	3	4	1	2	9	1	161	46
94	348.89	1662	8	23	75.5	41	2	5	0.5	1	3	1	159	77
95	356.92	1654	9	16	82	46	3.5	5	3.5	0	5	1	198	45
96	365.13	1646	12	20	76	62	2	4	1.5	1	5	1	169	35
97	373.53	1637	6	16	86.5	52	2.5	4	0.5	2	5	0	217	54
98	382.12	1629	12	17	73	49	2.5	5	0	1	4	4	183	66
99	390.91	1620	3	5	92.5	36	2.5	5	4	2	5	1	262	44
100	399.90	1611	9	19	84	43	1.5	2	2	2	4	1	207	55
101	409.09	1602	2	11	81	34	2.5	5	0.5	1	3	0	271	44
102	418.49	1593	7	17	58	36	1.5	3	0	0	4	0	175	74
103	428.09	1583	4	11	88.5	46	3.5	2	2	3	6	0	236	35
104	437.90	1573	8	17	71.5	26	3	0	1	1	8	3	183	84
105	447.93	1563	5	12	81.5	41	1.5	4	0	0	3	0	209	57
106	458.17	1553	10	26	72	36	1	0	0	1	6	0	174	86
107	468.64	1542	2	12	82	40	1.5	2	1	2	4	0	221	53
108	479.33	1532	7	17	73	28	2	0	0	1	7	0	157	77
109	490.24	1521	2	16	91.5	30	1	8	1.5	3	2	1	194	65
110	501.38	1510	7	15	74.5	45	2.5	0	0.5	2	4	2	157	80
111	512.75	1498	3	17	90.5	42	1	2	2	3	5	1	167	61
112	524.36	1487	6	12	82.5	79	1	2	0	2	7	2	164	67
113	536.21	1475	6	7	53	77	1	3	1	2	8	0	145	96
114	548.29	1463	5	19	86	72	2	2	2.5	1	5	3	155	69
115	560.63	1450	15	25	43.5	86	0.5	4	1.5	6	6	1	162	104
116	573.20	1438	6	29	59.5	83	1.5	5	0.5	1	6	2	174	64
117	586.03	1425	11	25	42	110	1.5	4	0.5	1	1	1	157	65
118	599.11	1412	7	22	69	74	1	1	1	2	4	3	165	56
119	612.45	1399	14	30	65.5	73	1.5	6	0	0	3	0	138	85
120	626.04	1385	4	16	74.5	86	2	1	0.5	0	2	2	158	62
121	639.90	1371	12	23	55.5	59	0.5	2	0	1	5	2	121	104
122	654.02	1357	9	23	67.5	49	1.5	3	1	0	6	1	180	84
123	668.41	1343	11	14	57.5	70	1	4	0.5	2	4	0	166	87
124	683.07	1328	3	12	71	48	1	3	0	3	5	0	211	87
125	698.00	1313	14	19	45.5	58	0	2	1.5	4	3	2	155	78
126	713.21	1298	12	23	69.5	67	4.5	1	0.5	0	4	1	182	73
127	728.70	1282	9	17	55.5	67	0	4	0.5	2	5	1	172	103
128	744.47	1267	4	15	73.5	57	1.5	4	0.5	1	3	0	195	66
129	760.53	1250	13	16	48	47	0.5	7	1.5	1	4	1	151	77
130	776.88	1234	6	14	64.5	43	0	6	0	4	6	1	190	66
131	793.52	1217	12	23	62.5	40	0	5	0	0	3	2	145	74

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Pinus dipl	Pinus hapl	Pinus undiff 1/2's	Pinus whole (undiff)	Picea 1/2's	Picea whole	Abies 1/2's	Abies whole	Cupressaceae	Larix	Tsuga canadensis	Betula
132	810.45	1201	8	18	69.5	63	1	3	0.5	1	6	0	188	85
133	827.69	1183	6	12	22.5	60	2	2	0.5	2	3	1	168	104
134	845.22	1166	3	12	50	36	1	4	0.5	1	9	0	176	83
135	863.06	1148	9	17	35	35	2.5	3	1.5	4	7	1	155	72
136	881.20	1130	7	10	46.5	34	2.5	5	0.5	0	6	0	203	73
137	899.65	1111	6	13	31.5	44	2	2	0.5	1	4	1	191	79
138	918.42	1093	5	8	44	44	2	1	0.5	3	4	0	208	59
139	937.50	1074	10	18	39.5	43	2	1	0.5	2	6	2	199	69
140	956.90	1054	2	10	45.5	37	1.5	3	0.5	0	10	0	194	65
141	976.62	1034	7	13	38	65	2.5	2	1	2	3	1	205	88
142	996.67	1014	2	18	38	35	1.5	3	1	0	12	0	181	66
143	1017.04	994	6	18	29.5	41	0	4	0	3	8	2	158	63
144	1037.75	973	6	11	38	38	2	3	0.5	0	5	0	162	65

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Quercus	Fraxinus penn	Fraxinus nigra	Populus	Ulmus	Ostrya/Carpinus	Acer rubrum	Acer saccharum	Acer saccharinum	Acer negundo	Acer	Fagus
0	0.00	2011	23	2	0	2	6	5	3	4	0	0	0	7
0.5	1.94	2009	33	4	4	4	5	25	3	1	3	2	2	0
1	3.86	2007	25	0	7	0	3	19	0	5	6	1	1	6
1.5	5.75	2005	51	4	5	3	5	9	4	3	11	0	4	3
2	7.63	2003	23	4	0	3	7	2	3	8	0	0	0	8
2.5	9.47	2002	50	4	10	3	5	17	5	2	3	3	4	5
3	11.30	2000	38	6	0	3	9	6	6	9	0	0	0	13
3.5	13.10	1998	47	1	9	0	3	18	3	3	4	3	2	2
4	14.88	1996	58	5	9	1	5	1	4	8	0	0	0	7
4.5	16.64	1994	50	5	6	1	4	22	5	3	6	0	2	4
5	18.38	1993	27	8	7	0	3	21	1	4	9	0	2	7
5.5	20.10	1991	44	6	12	1	3	12	5	4	5	0	1	7
6	21.79	1989	71	6	8	2	9	6	6	12	0	0	0	3
6.5	23.47	1988	30	6	3	2	7	17	6	5	5	3	3	5
7	25.13	1986	56	8	6	3	9	5	5	11	0	0	0	3
7.5	26.77	1984	30	3	14	3	8	11	1	3	7	0	4	1
8	28.39	1983	18	2	4	1	2	2	2	13	0	0	0	4
8.5	29.99	1981	24	2	9	0	5	12	8	3	3	0	2	1
9	31.57	1979	29	2	6	2	7	14	5	4	7	0	1	4
9.5	33.13	1978	19	1	4	0	6	18	4	8	6	0	4	7
10	34.68	1976	54	4	4	7	10	6	7	12	0	0	0	4
10.5	36.21	1975	20	4	6	1	7	19	3	2	6	0	3	4
11	37.72	1973	55	4	10	2	7	1	6	10	0	0	0	1
11.5	39.22	1972	32	4	6	0	3	12	1	10	5	0	0	7
12	40.70	1970	28	4	2	1	9	4	5	6	0	0	0	8
12.5	42.17	1969	31	3	4	3	9	17	4	4	5	1	1	10
13	43.62	1967	23	2	8	2	4	15	4	3	2	0	3	4
13.5	45.05	1966	23	1	8	3	7	15	4	3	1	3	1	5
14	46.47	1965	27	3	7	1	4	13	1	4	3	0	0	4
15	49.28	1962	27	0	0	2	7	3	5	5	0	0	0	5
15.5	50.66	1960	40	0	7	3	13	15	0	1	3	0	2	5
16	52.02	1959	26	1	3	0	10	2	2	4	0	0	0	5
17	54.72	1956	29	3	4	0	12	14	3	0	3	0	2	4
17.5	56.05	1955	32	1	4	1	18	16	4	4	3	0	2	3
18	57.37	1954	30	1	0	6	13	2	6	8	0	0	0	2
18.5	58.68	1952	26	0	9	1	10	20	2	2	4	0	1	10
19	59.98	1951	44	1	3	4	11	4	7	2	0	0	0	4
19.5	61.26	1950	26	2	10	1	10	5	3	1	2	0	0	6
20	62.54	1948	32	2	1	1	15	3	1	5	0	0	0	6
20.5	63.81	1947	27	2	9	1	12	22	0	3	6	0	2	8

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Quercus	Fraxinus penn	Fraxinus nigra	Populus	Ulmus	Ostrya/Carpinus	Acer rubrum	Acer saccharum	Acer saccharinum	Acer negundo	Acer	Fagus
21	65.07	1946	22	3	6	2	7	12	0	2	2	0	0	3
21.5	66.32	1945	9	1	4	1	10	5	1	2	0	0	1	6
22	67.56	1943	19	0	2	1	8	7	2	13	0	0	0	14
23	70.02	1941	25	2	7	0	8	13	2	1	2	0	0	2
24	72.45	1939	13	0	0	5	13	2	1	4	0	0	0	9
25	74.85	1936	17	0	3	1	10	14	2	9	1	0	2	8
26	77.23	1934	23	3	5	1	5	19	0	5	1	0	2	6
27	79.59	1931	16	1	5	2	4	7	3	2	3	0	1	8
28	81.93	1929	15	0	5	2	4	22	0	1	6	0	1	3
29	84.26	1927	25	2	4	0	6	17	2	5	1	0	1	1
30	86.58	1924	15	1	8	1	9	10	0	2	1	0	1	8
31	88.89	1922	21	0	3	1	7	21	0	3	1	0	0	2
32	91.19	1920	16	2	2	1	3	12	0	1	7	0	0	3
33	93.50	1918	19	0	5	0	12	15	5	1	2	0	3	4
34	95.80	1915	16	0	4	0	9	18	2	3	1	0	3	4
35	98.11	1913	32	0	7	0	13	19	1	1	3	1	1	8
36	100.42	1911	11	1	6	0	10	22	1	5	5	1	3	3
37	102.74	1908	14	1	7	0	7	7	1	0	0	0	0	6
38	105.08	1906	14	0	2	0	4	17	3	1	3	0	0	6
39	107.43	1904	18	0	6	0	8	18	1	6	0	0	1	8
40	109.80	1901	21	2	7	1	7	17	0	1	2	0	0	7
41	112.19	1899	19	1	7	0	12	6	3	1	1	0	1	5
42	114.61	1896	18	3	4	2	7	22	0	6	1	0	4	5
43	117.05	1894	21	0	3	1	5	14	0	0	3	0	0	6
44	119.53	1891	13	2	7	4	13	10	1	3	7	0	3	7
45	122.04	1889	12	3	1	0	4	15	2	2	2	0	2	3
46	124.59	1886	14	1	6	2	6	19	0	3	4	0	1	12
47	127.17	1884	18	1	13	1	11	6	2	6	0	0	0	7
48	129.80	1881	14	1	6	2	9	20	0	2	4	0	3	3
49	132.48	1879	14	1	8	2	11	15	1	3	5	0	3	9
50	135.20	1876	22	1	3	2	7	11	0	4	5	0	0	8
51	137.98	1873	16	0	8	0	4	12	1	4	0	0	0	7
52	140.81	1870	13	1	5	0	11	13	0	5	5	0	1	7
53	143.69	1867	18	0	9	0	6	11	1	2	0	0	0	11
54	146.64	1864	23	0	9	2	6	6	0	1	7	0	0	7
55	149.66	1861	13	0	3	0	6	15	0	1	4	0	3	4
56	152.73	1858	18	0	6	0	6	18	0	4	2	0	1	7
57	155.88	1855	15	0	2	1	7	21	0	2	4	0	5	5
58	159.11	1852	24	0	4	0	15	5	2	4	0	0	2	1
59	162.40	1849	20	0	5	0	9	8	0	4	5	2	0	14

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Quercus	Fraxinus penn	Fraxinus nigra	Populus	Ulmus	Ostrya/Carpinus	Acer rubrum	Acer saccharum	Acer saccharinum	Acer negundo	Acer	Fagus
60	165.78	1845	20	2	3	0	12	12	2	4	5	0	1	5
61	169.24	1842	11	3	2	0	6	15	1	3	1	0	3	7
62	172.78	1838	18	2	4	0	12	5	0	5	4	0	1	3
63	176.41	1835	15	1	1	0	5	20	2	2	2	0	1	3
64	180.13	1831	17	1	4	0	9	13	1	3	4	0	0	6
65	183.95	1827	21	4	10	0	8	12	0	4	3	0	0	5
66	187.86	1823	28	0	10	2	4	16	4	0	5	0	1	6
67	191.87	1819	35	3	5	1	10	8	2	2	5	0	2	7
68	195.99	1815	30	0	9	1	7	19	2	7	1	0	0	14
69	200.21	1811	32	1	5	2	13	27	0	4	3	1	1	14
70	204.54	1806	28	2	15	2	16	11	2	2	6	5	0	15
71	208.98	1802	34	1	4	0	11	24	1	4	3	0	0	6
72	213.54	1797	22	0	4	1	11	24	0	0	6	0	3	9
73	218.21	1793	31	2	5	0	12	16	2	0	6	0	5	11
74	223.01	1788	28	1	10	1	13	20	0	5	5	2	1	15
75	227.93	1783	35	2	8	2	14	3	1	5	3	3	1	6
76	232.97	1778	37	2	5	2	10	21	0	3	4	0	0	10
77	238.15	1773	29	2	7	0	14	28	0	8	2	1	1	7
78	243.45	1768	30	0	6	2	5	11	1	3	5	1	4	7
79	248.90	1762	44	0	3	0	11	16	1	3	3	0	3	4
80	254.48	1757	32	0	5	1	15	27	0	6	3	0	5	8
80.5	257.32	1754	46	2	16	3	16	30	0	7	4	0	0	6
81	260.20	1751	18	2	4	1	6	24	0	5	9	1	4	3
81.5	263.12	1748	36	4	5	0	20	24	3	0	4	0	3	8
82	266.07	1745	29	1	7	3	13	27	1	1	13	0	2	8
82.5	269.06	1742	39	5	7	0	17	8	4	6	0	0	1	7
83	272.09	1739	22	0	8	0	10	21	1	2	5	1	6	11
83.5	275.16	1736	54	0	6	0	11	33	1	3	5	1	1	8
84	278.26	1733	39	1	12	0	15	18	0	6	8	0	4	13
85	284.58	1726	21	0	6	0	9	25	0	1	5	0	2	8
86	291.06	1720	33	0	4	0	4	41	0	3	9	0	4	8
87	297.70	1713	18	0	5	0	8	23	1	2	6	0	1	6
88	304.50	1707	21	1	3	0	4	25	0	4	2	0	5	9
89	311.46	1700	16	0	3	0	3	22	0	4	8	0	3	1
90	318.60	1692	35	1	4	4	13	31	1	3	6	1	9	4
91	325.91	1685	20	1	4	2	5	26	0	1	6	0	2	4
92	333.39	1678	28	0	10	0	7	27	0	3	9	0	1	1
93	341.05	1670	20	1	4	1	7	12	0	2	10	0	1	10
94	348.89	1662	25	2	6	0	8	26	1	3	10	1	6	8
95	356.92	1654	13	0	8	0	8	16	0	4	3	0	6	5

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Quercus	Fraxinus penn	Fraxinus nigra	Populus	Ulmus	Ostrya/Carpinus	Acer rubrum	Acer saccharum	Acer saccharinum	Acer negundo	Acer	Fagus
96	365.13	1646	31	1	4	0	7	22	0	0	5	0	4	10
97	373.53	1637	28	1	2	1	3	15	0	1	9	0	5	9
98	382.12	1629	20	0	9	1	7	18	1	2	5	0	5	7
99	390.91	1620	10	0	2	1	3	17	0	3	10	0	3	11
100	399.90	1611	25	1	1	0	5	18	0	2	1	0	6	9
101	409.09	1602	17	0	3	1	5	9	0	3	4	1	5	14
102	418.49	1593	22	0	5	0	8	25	2	2	6	0	3	11
103	428.09	1583	21	1	4	0	7	18	0	4	9	0	3	8
104	437.90	1573	20	0	3	1	14	22	1	4	13	0	5	10
105	447.93	1563	13	0	2	1	5	19	1	3	6	1	6	13
106	458.17	1553	23	2	9	1	17	7	0	2	6	0	3	17
107	468.64	1542	11	1	1	1	10	13	1	4	3	0	2	20
108	479.33	1532	30	2	7	1	8	34	0	5	9	0	5	11
109	490.24	1521	14	0	1	0	5	16	0	6	4	0	3	13
110	501.38	1510	25	1	6	1	6	27	0	5	13	0	3	8
111	512.75	1498	18	2	4	2	4	17	0	5	6	1	4	14
112	524.36	1487	20	1	0	1	5	19	0	1	11	1	2	14
113	536.21	1475	19	0	4	2	5	24	0	7	13	1	4	13
114	548.29	1463	19	0	1	0	1	24	0	2	3	0	7	12
115	560.63	1450	26	1	5	1	17	29	1	5	10	0	1	12
116	573.20	1438	34	0	1	1	9	19	0	3	9	0	2	14
117	586.03	1425	21	0	3	1	10	25	0	6	11	0	2	15
118	599.11	1412	22	0	5	1	6	24	0	4	10	1	4	11
119	612.45	1399	24	1	4	0	6	23	0	6	5	0	4	16
120	626.04	1385	26	0	8	0	10	16	1	2	6	0	2	10
121	639.90	1371	23	0	7	1	6	39	1	5	9	1	7	14
122	654.02	1357	25	1	3	1	8	21	0	8	10	0	5	14
123	668.41	1343	23	0	5	1	14	18	0	14	6	0	9	14
124	683.07	1328	23	2	3	0	10	17	1	6	7	0	0	17
125	698.00	1313	28	1	4	1	9	22	1	5	12	0	3	14
126	713.21	1298	21	1	5	2	7	19	0	5	7	0	3	25
127	728.70	1282	19	1	4	2	14	34	2	13	16	0	3	23
128	744.47	1267	26	0	3	0	7	11	2	3	7	1	7	13
129	760.53	1250	18	0	5	1	11	20	1	6	12	0	2	13
130	776.88	1234	29	1	3	1	7	17	1	3	13	0	2	20
131	793.52	1217	29	0	4	0	9	24	0	4	14	0	1	19
132	810.45	1201	31	1	4	0	12	19	0	3	6	1	3	17
133	827.69	1183	19	0	7	1	14	17	0	10	12	0	9	22
134	845.22	1166	36	2	5	3	13	22	0	5	11	0	3	15
135	863.06	1148	24	1	6	2	17	29	1	11	13	0	2	26

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Quercus	Fraxinus penn	Fraxinus nigra	Populus	Ulmus	Ostrya/Carpinus	Acer rubrum	Acer saccharum	Acer saccharinum	Acer negundo	Acer	Fagus
136	881.20	1130	19	1	7	2	14	17	1	2	13	0	4	17
137	899.65	1111	21	0	9	1	14	15	1	4	12	1	3	23
138	918.42	1093	17	0	7	1	12	15	0	5	9	0	8	23
139	937.50	1074	28	1	1	1	11	19	0	5	15	0	6	25
140	956.90	1054	26	0	4	2	6	18	0	4	11	0	4	27
141	976.62	1034	31	1	6	0	13	17	0	4	11	1	5	25
142	996.67	1014	25	1	8	1	15	15	1	4	10	1	6	24
143	1017.04	994	20	2	8	2	19	30	0	7	14	0	4	26
144	1037.75	973	28	1	7	3	19	19	0	10	17	0	4	44

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Carya	Juglans	Tilia	Platanus	Castanea	Nyssa	Carpinus	Celtis	Liquidambar styraciflua	Morus	Corylus	Alnus crispa
0	0.00	2011	4	1	1	0	0	0	0	0	0	0	0	4
0.5	1.94	2009	0	0	4	0	0	0	0	0	0	0	0	17
1	3.86	2007	2	0	0	0	0	0	0	0	0	0	1	9
1.5	5.75	2005	3	0	2	0	0	0	0	0	0	0	0	7
2	7.63	2003	5	3	1	0	0	0	0	0	0	0	0	6
2.5	9.47	2002	2	0	2	2	1	0	0	0	0	0	0	13
3	11.30	2000	6	0	1	0	0	0	3	1	0	0	0	3
3.5	13.10	1998	2	0	1	1	0	0	0	0	0	0	0	10
4	14.88	1996	4	2	2	0	0	1	0	0	0	0	0	5
4.5	16.64	1994	0	2	1	2	2	0	0	0	0	0	1	11
5	18.38	1993	4	2	0	0	0	0	0	1	0	0	0	8
5.5	20.10	1991	5	1	1	0	0	0	0	0	0	0	0	7
6	21.79	1989	3	1	0	0	0	0	0	0	0	0	0	12
6.5	23.47	1988	0	1	1	0	0	0	0	0	0	0	1	12
7	25.13	1986	4	2	2	0	0	0	0	0	0	0	0	13
7.5	26.77	1984	3	0	0	0	1	0	0	0	0	0	0	9
8	28.39	1983	0	0	0	0	0	0	0	0	0	0	0	5
8.5	29.99	1981	7	1	1	0	0	0	0	0	0	0	0	14
9	31.57	1979	2	0	2	1	0	0	0	0	0	0	0	9
9.5	33.13	1978	2	0	0	0	1	0	0	0	0	0	1	10
10	34.68	1976	2	1	2	0	0	0	0	0	0	0	0	11
10.5	36.21	1975	3	0	2	0	1	0	0	0	0	0	0	11
11	37.72	1973	4	0	0	0	0	0	0	0	0	0	0	9
11.5	39.22	1972	0	2	2	0	1	1	0	0	0	0	0	6
12	40.70	1970	1	0	0	0	0	0	0	0	0	0	0	4
12.5	42.17	1969	1	1	2	0	2	0	0	0	0	0	0	13
13	43.62	1967	3	1	0	0	0	0	0	0	0	0	1	15
13.5	45.05	1966	4	1	1	0	0	0	0	0	0	0	0	12
14	46.47	1965	4	0	1	0	2	0	0	0	0	0	3	11
15	49.28	1962	0	0	0	0	0	0	0	0	0	0	2	6
15.5	50.66	1960	0	1	1	0	0	0	0	0	0	0	0	7
16	52.02	1959	1	0	0	1	0	0	1	0	0	0	0	8
17	54.72	1956	1	0	1	0	0	0	0	0	0	0	0	27
17.5	56.05	1955	1	1	1	0	0	0	0	0	0	0	0	8
18	57.37	1954	5	0	2	0	0	0	0	0	0	0	7	17
18.5	58.68	1952	0	1	2	0	2	0	0	0	0	0	1	6
19	59.98	1951	2	1	1	0	0	0	0	0	0	0	2	8
19.5	61.26	1950	0	1	1	0	0	0	0	0	0	0	0	20
20	62.54	1948	3	1	2	0	0	0	0	0	0	0	0	10
20.5	63.81	1947	2	0	1	0	1	0	0	0	0	0	0	9

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Carya	Juglans	Tilia	Platanus	Castanea	Nyssa	Carpinus	Celtis	Liquidambar styraciflua	Morus	Corylus	Alnus crispa
21	65.07	1946	1	1	0	0	1	0	0	0	0	0	1	17
21.5	66.32	1945	2	0	0	0	0	0	0	0	0	0	1	20
22	67.56	1943	3	1	1	0	0	0	0	0	0	0	0	20
23	70.02	1941	0	0	1	0	0	0	0	0	0	0	0	39
24	72.45	1939	3	0	1	0	0	0	1	0	0	0	0	7
25	74.85	1936	1	0	0	0	0	0	0	0	0	0	0	21
26	77.23	1934	1	1	3	0	0	0	0	0	0	0	1	26
27	79.59	1931	1	2	1	0	1	0	0	0	0	0	0	18
28	81.93	1929	0	0	0	0	0	0	0	0	0	0	0	42
29	84.26	1927	1	0	0	0	0	0	0	0	0	0	0	20
30	86.58	1924	1	0	2	0	0	0	0	0	1	0	0	34
31	88.89	1922	4	0	1	0	2	0	0	0	0	0	0	31
32	91.19	1920	1	1	1	0	0	0	0	0	0	0	0	36
33	93.50	1918	0	1	0	0	0	0	0	0	0	0	0	32
34	95.80	1915	1	0	0	0	1	0	0	0	0	0	0	26
35	98.11	1913	2	1	0	0	2	0	0	0	0	0	0	28
36	100.42	1911	0	1	1	0	0	0	0	0	0	0	0	14
37	102.74	1908	1	0	2	0	0	0	0	0	0	0	0	19
38	105.08	1906	0	0	1	0	0	0	0	0	0	0	0	29
39	107.43	1904	1	0	1	0	0	0	0	0	0	0	0	26
40	109.80	1901	0	0	2	0	2	0	0	0	0	0	1	25
41	112.19	1899	0	0	2	0	0	0	0	0	0	0	0	22
42	114.61	1896	0	0	0	0	0	0	0	0	0	0	0	22
43	117.05	1894	1	0	1	0	2	0	0	0	0	0	0	23
44	119.53	1891	0	1	2	0	0	0	0	0	0	0	1	20
45	122.04	1889	0	1	2	0	0	0	0	0	0	0	0	20
46	124.59	1886	3	0	1	0	0	0	0	0	0	0	0	12
47	127.17	1884	0	2	0	0	0	0	0	0	0	0	0	14
48	129.80	1881	1	2	0	0	0	0	0	0	0	0	0	15
49	132.48	1879	1	0	0	0	1	0	0	0	0	0	0	4
50	135.20	1876	0	1	2	0	1	0	0	0	0	0	0	7
51	137.98	1873	1	1	0	0	0	0	0	0	0	0	0	6
52	140.81	1870	2	0	2	0	1	0	0	0	0	0	0	10
53	143.69	1867	0	0	0	0	0	0	0	0	0	0	0	7
54	146.64	1864	0	0	0	0	0	0	0	0	0	0	0	6
55	149.66	1861	2	0	3	0	0	0	0	0	0	0	1	2
56	152.73	1858	2	0	1	0	0	0	0	0	0	0	0	3
57	155.88	1855	2	1	2	0	0	0	0	0	0	0	0	6
58	159.11	1852	2	0	0	0	0	1	0	0	0	0	0	6
59	162.40	1849	2	0	2	0	0	1	0	0	0	0	0	2

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Carya	Juglans	Tilia	Platanus	Castanea	Nyssa	Carpinus	Celtis	Liquidambar styraciflua	Morus	Corylus	Alnus crispa
60	165.78	1845	2	0	1	0	0	0	0	0	0	0	0	5
61	169.24	1842	0	0	2	0	0	0	0	0	0	0	0	7
62	172.78	1838	3	1	1	0	0	0	0	0	0	0	0	4
63	176.41	1835	0	0	1	0	0	0	0	0	0	0	0	5
64	180.13	1831	0	1	1	0	0	0	0	1	0	0	0	4
65	183.95	1827	2	1	0	0	0	0	0	0	0	0	0	7
66	187.86	1823	1	2	0	0	0	0	0	0	0	0	0	6
67	191.87	1819	2	0	1	0	0	0	0	0	0	0	0	2
68	195.99	1815	1	3	1	0	0	0	0	0	0	0	0	3
69	200.21	1811	1	0	4	0	0	0	0	0	0	0	0	8
70	204.54	1806	1	0	2	0	0	0	0	0	0	0	1	4
71	208.98	1802	2	2	3	0	0	0	0	0	0	0	0	1
72	213.54	1797	1	1	0	0	0	0	0	0	0	0	0	4
73	218.21	1793	4	0	1	0	0	0	0	0	0	0	0	6
74	223.01	1788	3	2	0	0	0	0	0	0	0	0	1	5
75	227.93	1783	5	0	0	0	0	1	0	1	0	0	3	7
76	232.97	1778	1	0	1	0	1	0	0	0	0	0	0	8
77	238.15	1773	2	2	0	0	0	0	0	0	0	0	0	10
78	243.45	1768	3	0	1	0	0	0	0	0	0	0	0	2
79	248.90	1762	2	1	1	0	0	0	0	0	0	0	0	6
80	254.48	1757	0	1	2	0	0	0	0	0	0	0	1	7
80.5	257.32	1754	2	1	2	0	0	1	0	0	0	0	0	8
81	260.20	1751	3	0	2	0	0	0	0	0	0	0	3	1
81.5	263.12	1748	1	1	3	0	2	0	0	0	0	0	0	5
82	266.07	1745	4	2	2	0	0	0	0	0	0	0	0	3
82.5	269.06	1742	1	1	1	0	0	0	0	0	0	0	0	12
83	272.09	1739	1	2	0	0	0	0	0	0	0	0	0	1
83.5	275.16	1736	3	0	1	0	0	0	0	0	0	0	0	8
84	278.26	1733	2	1	0	0	0	0	0	0	0	0	0	5
85	284.58	1726	3	0	2	0	0	0	0	0	0	0	0	6
86	291.06	1720	5	0	2	0	0	0	0	0	0	0	3	8
87	297.70	1713	2	0	2	0	0	0	0	0	0	0	0	5
88	304.50	1707	3	0	5	0	0	0	0	0	0	0	0	8
89	311.46	1700	0	0	3	0	0	0	0	0	0	0	0	4
90	318.60	1692	9	1	1	0	1	0	0	0	0	0	2	9
91	325.91	1685	2	0	2	0	0	0	0	0	0	0	0	3
92	333.39	1678	0	1	3	0	0	0	0	0	0	2	0	6
93	341.05	1670	2	0	5	0	0	0	0	1	0	0	2	6
94	348.89	1662	0	0	3	0	0	1	0	0	0	0	1	9
95	356.92	1654	1	2	4	0	0	0	0	0	0	0	0	2

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Carya	Juglans	Tilia	Platanus	Castanea	Nyssa	Carpinus	Celtis	Liquidambar styraciflua	Morus	Corylus	Alnus crispa
96	365.13	1646	1	0	1	0	0	0	0	0	0	0	1	2
97	373.53	1637	0	0	2	0	0	0	0	0	0	0	0	0
98	382.12	1629	4	1	4	0	0	0	0	0	0	0	1	3
99	390.91	1620	0	1	0	0	0	0	0	0	0	0	0	2
100	399.90	1611	2	1	1	0	0	0	0	0	0	0	1	1
101	409.09	1602	0	0	1	0	0	0	0	0	0	0	0	1
102	418.49	1593	1	1	2	0	0	1	0	1	0	0	1	1
103	428.09	1583	3	2	3	0	0	0	0	0	0	0	1	1
104	437.90	1573	5	2	6	0	0	0	0	0	0	0	0	2
105	447.93	1563	1	1	1	0	0	0	0	0	0	0	0	1
106	458.17	1553	2	0	3	0	0	0	0	0	0	0	0	1
107	468.64	1542	2	0	0	0	0	0	0	0	0	0	0	1
108	479.33	1532	1	2	2	0	0	0	0	0	0	0	0	1
109	490.24	1521	1	0	1	0	0	0	0	0	0	0	0	3
110	501.38	1510	1	1	2	0	0	0	0	0	0	0	1	2
111	512.75	1498	4	1	3	0	0	0	0	1	0	0	0	2
112	524.36	1487	1	1	0	0	0	0	0	0	0	0	0	2
113	536.21	1475	1	1	2	0	0	1	0	0	0	0	1	1
114	548.29	1463	1	0	4	0	0	0	0	0	0	0	1	1
115	560.63	1450	1	0	2	0	0	0	0	0	0	0	0	2
116	573.20	1438	0	2	0	0	0	0	0	0	0	0	0	1
117	586.03	1425	1	2	2	0	0	0	0	0	0	0	1	2
118	599.11	1412	6	3	0	0	0	0	0	0	0	0	0	4
119	612.45	1399	2	0	2	0	0	0	0	0	0	0	0	2
120	626.04	1385	1	0	2	0	1	0	0	0	0	0	0	1
121	639.90	1371	2	0	3	0	0	0	0	0	0	0	1	3
122	654.02	1357	3	0	1	0	0	0	0	0	0	0	0	0
123	668.41	1343	1	0	1	0	0	0	0	0	0	0	0	0
124	683.07	1328	3	0	3	0	0	0	0	0	0	0	1	1
125	698.00	1313	1	1	1	0	0	0	0	1	0	0	0	0
126	713.21	1298	4	0	2	0	0	0	0	0	0	0	1	3
127	728.70	1282	0	0	2	0	0	0	0	0	0	0	0	2
128	744.47	1267	3	0	4	0	0	0	0	0	0	0	0	1
129	760.53	1250	3	1	2	0	0	0	0	0	0	0	0	5
130	776.88	1234	2	0	2	0	0	0	0	0	0	0	0	0
131	793.52	1217	5	0	1	0	0	0	0	0	0	0	1	4
132	810.45	1201	3	0	3	0	1	0	0	0	0	0	0	2
133	827.69	1183	1	0	4	0	0	0	0	0	0	0	0	2
134	845.22	1166	0	0	2	0	0	0	0	0	0	0	0	2
135	863.06	1148	1	2	2	0	0	0	0	0	0	0	0	3

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Carya	Juglans	Tilia	Platanus	Castanea	Nyssa	Carpinus	Celtis	Liquidambar styraciflua	Morus	Corylus	Alnus crispa
136	881.20	1130	2	1	0	0	0	0	0	0	0	0	2	2
137	899.65	1111	4	1	6	0	0	0	0	1	0	0	0	3
138	918.42	1093	4	0	4	0	0	1	0	0	0	0	0	3
139	937.50	1074	1	1	1	0	0	0	0	0	0	0	1	8
140	956.90	1054	3	0	3	0	0	1	0	0	0	0	0	1
141	976.62	1034	0	1	5	0	0	0	0	0	0	0	0	2
142	996.67	1014	0	3	6	0	0	1	0	0	0	0	0	3
143	1017.04	994	2	0	5	0	0	0	0	0	0	0	0	7
144	1037.75	973	3	2	1	0	0	0	0	0	0	0	1	1

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Alnus rugosa	cf. Alnus	Salix	Myrica	Ericacae	Unknown	Indeterminate	Chenopodiaceae	Artemisia	Ambrosia	Rumex	Plantago
0	0.00	2011	2	0	2	0	0	3	5	0	1	25	43	2
0.5	1.94	2009	8	0	12	1	0	0	6	3	0	28	23	1
1	3.86	2007	11	0	4	2	0	1	2	2	0	30	15	0
1.5	5.75	2005	8	0	6	0	0	0	3	2	1	26	10	0
2	7.63	2003	1	0	5	0	0	0	1	1	3	38	47	2
2.5	9.47	2002	3	0	8	1	0	1	3	2	1	37	7	1
3	11.30	2000	12	0	3	2	0	0	5	1	2	32	27	6
3.5	13.10	1998	10	0	8	0	0	2	3	1	0	25	26	0
4	14.88	1996	7	0	5	0	0	0	7	0	1	27	14	0
4.5	16.64	1994	12	0	6	2	0	1	6	2	0	33	22	0
5	18.38	1993	14	0	7	1	0	2	1	0	0	28	25	1
5.5	20.10	1991	9	0	3	0	0	1	2	3	1	24	17	1
6	21.79	1989	3	0	7	0	0	0	3	0	0	46	13	0
6.5	23.47	1988	10	0	6	2	0	1	5	4	1	31	21	2
7	25.13	1986	7	0	1	2	0	0	3	3	0	28	5	2
7.5	26.77	1984	16	0	9	0	0	1	5	3	0	28	16	1
8	28.39	1983	4	0	2	1	0	3	0	0	1	35	30	3
8.5	29.99	1981	16	0	7	0	0	0	3	5	0	27	9	0
9	31.57	1979	12	0	7	1	0	1	4	0	0	37	8	2
9.5	33.13	1978	7	0	5	0	0	0	4	2	0	26	13	3
10	34.68	1976	14	0	3	1	0	0	4	0	0	52	15	2
10.5	36.21	1975	14	0	5	2	0	1	3	3	0	32	13	1
11	37.72	1973	5	0	5	0	0	0	2	4	0	42	13	1
11.5	39.22	1972	16	0	4	2	0	1	3	1	1	41	22	0
12	40.70	1970	3	0	2	0	0	1	3	0	0	32	17	2
12.5	42.17	1969	18	0	5	1	0	2	5	2	0	41	10	0
13	43.62	1967	10	0	5	1	0	1	3	2	1	42	10	0
13.5	45.05	1966	14	0	5	1	0	3	3	2	0	43	9	0
14	46.47	1965	9	0	7	2	0	1	5	2	1	43	8	0
15	49.28	1962	7	0	0	1	0	1	6	1	1	28	7	0
15.5	50.66	1960	13	0	2	0	0	0	3	2	0	33	4	0
16	52.02	1959	4	0	6	0	0	1	4	0	0	28	2	1
17	54.72	1956	2	0	8	0	0	0	1	3	0	46	1	0
17.5	56.05	1955	12	0	3	1	0	1	0	0	0	32	5	0
18	57.37	1954	12	0	8	0	0	1	5	1	0	57	6	3
18.5	58.68	1952	10	0	2	0	0	0	3	2	0	37	4	0
19	59.98	1951	10	0	1	1	0	1	6	0	1	67	8	0
19.5	61.26	1950	13	0	6	1	0	0	1	2	0	52	10	1
20	62.54	1948	5	0	5	0	1	0	1	0	1	60	5	3
20.5	63.81	1947	10	0	2	1	0	1	1	0	0	52	4	0

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Alnus rugosa	cf. Alnus	Salix	Myrica	Ericacae	**Unknown**	**Indeterminate**	Chenopodiaceae	Artemisia	Ambrosia	Rumex	Plantago
21	65.07	1946	12	0	5	1	0	1	5	1	2	39	8	1
21.5	66.32	1945	20	0	5	0	0	0	1	3	0	52	8	0
22	67.56	1943	16	0	5	2	0	1	3	0	0	83	23	4
23	70.02	1941	11	0	3	1	0	2	1	3	1	45	6	1
24	72.45	1939	11	0	5	0	0	2	8	1	1	54	10	3
25	74.85	1936	24	0	4	1	0	1	1	2	1	31	11	0
26	77.23	1934	23	0	4	1	0	1	4	1	1	36	6	1
27	79.59	1931	28	0	7	0	0	2	0	2	2	54	8	0
28	81.93	1929	8	0	6	3	0	2	5	1	0	28	5	0
29	84.26	1927	18	0	4	0	0	1	0	0	0	43	8	1
30	86.58	1924	25	0	6	1	0	2	6	0	0	36	4	1
31	88.89	1922	17	0	7	2	0	0	1	0	0	39	8	1
32	91.19	1920	10	0	0	1	0	0	4	3	0	33	5	1
33	93.50	1918	25	0	7	2	0	2	3	1	0	36	5	0
34	95.80	1915	18	0	5	2	0	1	0	0	1	34	9	0
35	98.11	1913	31	0	7	0	0	2	2	1	0	21	9	0
36	100.42	1911	22	0	5	2	0	1	6	0	0	30	6	0
37	102.74	1908	10	0	1	0	0	0	2	1	0	32	6	0
38	105.08	1906	6	0	2	0	0	1	4	2	0	27	9	1
39	107.43	1904	15	0	3	0	0	1	4	0	0	16	7	0
40	109.80	1901	19	0	6	0	0	1	5	1	0	28	10	0
41	112.19	1899	16	5	10	0	0	1	0	0	1	22	5	0
42	114.61	1896	10	0	7	1	0	1	1	1	1	21	14	0
43	117.05	1894	11	0	5	1	0	0	1	0	0	19	14	0
44	119.53	1891	18	0	9	0	0	2	3	2	1	28	9	0
45	122.04	1889	8	0	7	2	0	1	2	1	1	23	19	0
46	124.59	1886	13	0	6	1	0	1	5	1	0	17	9	0
47	127.17	1884	12	6	11	0	0	2	4	0	0	24	10	0
48	129.80	1881	9	0	1	1	0	1	3	1	0	26	13	0
49	132.48	1879	5	0	2	2	0	1	4	0	1	17	5	0
50	135.20	1876	8	0	2	1	0	2	5	0	0	13	6	0
51	137.98	1873	4	0	3	0	0	1	0	0	0	10	4	0
52	140.81	1870	4	0	0	0	0	0	0	0	0	14	6	0
53	143.69	1867	3	0	0	0	0	1	2	1	1	8	3	0
54	146.64	1864	7	0	0	0	0	1	1	0	1	3	2	0
55	149.66	1861	2	0	2	0	0	0	3	0	0	3	0	0
56	152.73	1858	5	0	1	0	0	1	2	0	0	4	2	0
57	155.88	1855	3	0	0	0	0	1	6	0	1	4	0	0
58	159.11	1852	5	0	0	0	0	1	3	0	1	1	0	0
59	162.40	1849	9	0	4	0	0	0	1	0	0	1	2	0

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Alnus rugosa	cf. Alnus	Salix	Myrica	Ericacae	**Unknown**	**Indeterminate**	Chenopodiaceae	Artemisia	Ambrosia	Rumex	Plantago
60	165.78	1845	1	0	1	0	0	1	0	0	0	0	5	0
61	169.24	1842	0	0	3	0	0	0	4	1	0	2	1	0
62	172.78	1838	0	0	0	1	0	1	0	0	0	1	0	0
63	176.41	1835	2	0	1	0	0	0	1	0	0	0	1	1
64	180.13	1831	1	0	1	0	0	0	1	0	1	1	0	0
65	183.95	1827	0	0	0	0	0	0	3	0	0	1	1	0
66	187.86	1823	6	0	2	0	0	0	6	0	0	2	3	1
67	191.87	1819	3	0	1	0	0	0	2	0	1	2	0	0
68	195.99	1815	7	0	0	0	0	0	1	0	0	0	2	0
69	200.21	1811	2	0	1	0	0	0	0	0	0	0	1	0
70	204.54	1806	6	0	3	0	0	1	3	1	0	2	2	1
71	208.98	1802	2	0	1	0	0	1	2	1	0	1	0	0
72	213.54	1797	0	0	0	0	0	0	2	2	0	2	0	0
73	218.21	1793	3	0	2	0	0	0	5	1	0	1	0	0
74	223.01	1788	5	0	1	2	0	0	6	0	0	2	4	0
75	227.93	1783	6	0	2	0	0	3	5	0	0	0	0	0
76	232.97	1778	11	0	2	0	0	2	5	0	0	7	0	0
77	238.15	1773	6	0	2	0	0	0	2	0	1	2	0	0
78	243.45	1768	2	0	0	0	0	0	1	0	0	0	2	0
79	248.90	1762	4	0	0	0	0	0	2	0	1	1	0	0
80	254.48	1757	12	0	1	0	0	1	4	0	0	2	0	0
80.5	257.32	1754	12	0	2	1	0	0	6	1	2	0	1	0
81	260.20	1751	1	0	0	0	0	0	3	0	0	1	0	0
81.5	263.12	1748	2	0	2	0	0	0	1	0	0	2	0	0
82	266.07	1745	3	0	0	0	0	1	3	0	0	0	1	0
82.5	269.06	1742	6	0	6	1	0	0	1	1	0	2	2	1
83	272.09	1739	3	0	3	1	0	0	3	0	2	0	0	0
83.5	275.16	1736	8	0	1	1	0	2	3	0	0	0	1	0
84	278.26	1733	3	0	0	0	0	1	3	0	0	1	0	0
85	284.58	1726	7	0	0	0	0	0	1	0	0	0	1	0
86	291.06	1720	5	0	1	0	0	1	4	0	0	0	0	0
87	297.70	1713	2	0	1	0	0	0	2	0	0	0	0	0
88	304.50	1707	17	0	3	1	0	0	4	1	0	0	0	0
89	311.46	1700	5	0	1	0	0	0	3	1	0	2	0	0
90	318.60	1692	9	0	4	0	0	2	6	0	0	1	0	0
91	325.91	1685	5	0	1	0	0	0	1	1	0	0	0	0
92	333.39	1678	5	0	1	1	0	0	4	0	0	1	0	0
93	341.05	1670	8	0	3	0	0	0	1	0	0	0	0	0
94	348.89	1662	3	0	3	0	0	1	5	0	1	2	1	0
95	356.92	1654	4	0	0	0	0	0	1	0	0	2	0	0

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Alnus rugosa	cf. Alnus	Salix	Myrica	Ericacae	Unknown	Indeterminate	Chenopodiaceae	Artemisia	Ambrosia	Rumex	Plantago
96	365.13	1646	0	0	1	1	0	0	3	0	0	0	0	0
97	373.53	1637	2	0	2	0	0	0	2	0	0	0	1	0
98	382.12	1629	6	0	2	0	0	1	4	0	0	1	0	0
99	390.91	1620	0	0	0	1	0	0	1	0	0	0	0	0
100	399.90	1611	1	0	1	0	0	0	2	0	0	1	0	0
101	409.09	1602	1	0	0	0	0	0	2	0	0	0	0	0
102	418.49	1593	1	0	1	0	0	1	2	1	0	0	0	0
103	428.09	1583	1	0	0	0	0	0	4	0	0	0	1	0
104	437.90	1573	3	0	0	0	0	0	2	0	0	0	0	0
105	447.93	1563	1	0	0	0	0	1	3	0	1	0	0	0
106	458.17	1553	1	0	1	0	0	0	7	0	1	0	0	0
107	468.64	1542	2	0	1	0	0	0	1	0	0	2	0	0
108	479.33	1532	3	0	0	0	0	1	5	0	0	1	0	0
109	490.24	1521	3	0	0	0	0	0	2	0	0	0	0	0
110	501.38	1510	2	0	0	0	0	1	5	1	0	1	0	0
111	512.75	1498	0	0	0	0	0	0	3	0	0	3	0	0
112	524.36	1487	1	0	0	0	0	0	2	2	0	0	1	0
113	536.21	1475	1	0	0	0	0	0	1	0	0	0	0	0
114	548.29	1463	0	0	0	0	0	0	3	0	0	0	0	0
115	560.63	1450	5	0	0	0	0	0	1	0	0	0	0	0
116	573.20	1438	0	0	0	0	0	0	1	0	0	0	0	0
117	586.03	1425	3	0	1	1	0	1	3	0	0	0	0	0
118	599.11	1412	0	0	0	0	0	0	1	0	0	2	1	0
119	612.45	1399	2	0	0	0	0	2	0	1	1	1	0	0
120	626.04	1385	2	0	1	0	0	0	3	1	0	0	0	0
121	639.90	1371	2	0	0	0	0	1	3	0	0	1	1	0
122	654.02	1357	3	0	1	1	0	1	3	0	0	1	0	0
123	668.41	1343	0	0	0	0	0	0	2	1	0	0	0	0
124	683.07	1328	3	0	0	0	0	0	3	0	1	1	0	0
125	698.00	1313	2	0	0	1	0	0	5	0	0	0	0	0
126	713.21	1298	5	0	0	0	0	1	2	0	0	0	0	0
127	728.70	1282	1	0	0	0	0	0	4	0	0	0	0	0
128	744.47	1267	0	0	1	0	0	0	1	0	1	1	0	0
129	760.53	1250	2	0	0	1	0	0	4	1	0	0	0	0
130	776.88	1234	3	0	0	0	0	0	1	0	0	1	0	0
131	793.52	1217	1	0	1	0	0	1	3	0	0	1	1	0
132	810.45	1201	4	0	0	0	0	0	0	0	0	1	0	0
133	827.69	1183	4	0	1	1	0	0	4	0	1	2	0	0
134	845.22	1166	4	0	0	0	0	1	1	0	1	1	0	0
135	863.06	1148	2	0	4	0	0	0	4	0	0	3	0	0

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Alnus rugosa	cf. Alnus	Salix	Myrica	Ericacae	**Unknown**	**Indeterminate**	Chenopodiaceae	Artemisia	Ambrosia	Rumex	Plantago
136	881.20	1130	4	0	0	0	0	0	3	1	0	0	0	0
137	899.65	1111	4	0	0	1	0	0	4	0	0	2	0	0
138	918.42	1093	3	0	0	0	0	0	0	0	0	0	0	0
139	937.50	1074	1	0	1	1	0	0	4	0	0	1	0	0
140	956.90	1054	0	0	2	0	0	0	3	0	0	2	0	0
141	976.62	1034	1	0	0	0	0	0	3	0	0	2	0	0
142	996.67	1014	0	0	0	0	0	0	3	0	0	0	0	0
143	1017.04	994	2	0	0	0	0	0	4	0	0	1	1	0
144	1037.75	973	2	0	0	0	0	1	3	0	0	0	0	0

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Poaceae	Cyperaceae	Asteraceae (Tub)	Asteraceae (Lig)	Ranunculaceae	Rosaceae	Polygonaceae	Ilex	Vitaceae	Cornaceae	Leguminosae	Ericaceae
0	0.00	2011	0	0	8	0	1	0	0	0	0	0	0	0
0.5	1.94	2009	5	0	3	1	1	0	0	0	1	5	0	1
1	3.86	2007	2	0	4	2	1	4	1	1	0	0	0	0
1.5	5.75	2005	10	0	13	0	6	0	1	0	0	0	0	0
2	7.63	2003	13	0	7	1	2	0	0	0	0	0	0	0
2.5	9.47	2002	3	0	3	0	1	4	2	1	0	0	0	0
3	11.30	2000	3	0	3	0	0	0	0	0	0	2	0	0
3.5	13.10	1998	6	0	3	3	3	0	0	0	1	3	0	0
4	14.88	1996	8	0	1	0	3	0	2	0	0	2	0	0
4.5	16.64	1994	4	0	3	0	0	4	0	1	2	1	0	0
5	18.38	1993	3	0	1	1	1	2	0	2	0	1	0	0
5.5	20.10	1991	5	0	4	0	2	0	1	0	0	1	0	0
6	21.79	1989	13	0	4	0	1	0	0	0	0	4	0	0
6.5	23.47	1988	3	0	6	2	0	6	0	1	4	1	0	0
7	25.13	1986	14	0	6	0	0	0	0	0	0	6	0	0
7.5	26.77	1984	4	0	4	1	1	2	1	0	0	1	0	0
8	28.39	1983	4	0	6	0	1	0	0	0	0	1	0	0
8.5	29.99	1981	4	0	3	0	2	0	1	1	0	1	0	0
9	31.57	1979	6	0	2	2	1	0	0	0	0	0	0	0
9.5	33.13	1978	6	0	5	0	2	3	1	2	0	1	0	0
10	34.68	1976	9	0	6	0	0	0	0	0	0	0	0	0
10.5	36.21	1975	5	0	2	1	1	1	0	0	0	2	0	0
11	37.72	1973	7	0	7	1	1	0	2	0	0	5	0	0
11.5	39.22	1972	7	0	6	0	0	1	1	1	0	0	0	0
12	40.70	1970	4	0	5	0	0	0	0	0	0	0	0	0
12.5	42.17	1969	6	0	4	0	0	0	0	0	1	5	1	0
13	43.62	1967	7	0	8	1	0	5	0	0	1	1	0	0
13.5	45.05	1966	6	0	3	1	1	0	0	1	0	4	0	0
14	46.47	1965	5	0	3	0	0	0	0	2	1	2	0	1
15	49.28	1962	5	0	5	0	3	0	0	0	0	1	0	0
15.5	50.66	1960	3	0	2	0	2	1	0	0	1	1	1	0
16	52.02	1959	4	0	2	0	1	0	0	0	0	0	0	0
17	54.72	1956	4	0	4	0	0	3	0	2	3	1	1	0
17.5	56.05	1955	2	0	3	0	1	1	0	3	0	1	0	0
18	57.37	1954	3	0	8	0	1	0	0	0	0	0	0	0
18.5	58.68	1952	3	0	2	0	0	1	0	0	0	1	0	0
19	59.98	1951	5	0	6	0	4	0	0	0	0	2	0	0
19.5	61.26	1950	6	0	6	0	0	1	0	0	1	3	0	0
20	62.54	1948	4	0	3	0	3	0	0	0	0	0	0	0
20.5	63.81	1947	3	0	4	0	0	0	0	0	0	1	0	0

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Poaceae	Cyperaceae	Asteraceae (Tub)	Asteraceae (Lig)	Ranunculaceae	Rosaceae	Polygonaceae	Ilex	Vitaceae	Cornaceae	Leguminosae	Ericaceae
21	65.07	1946	10	0	6	0	2	4	1	0	0	0	0	0
21.5	66.32	1945	7	0	4	0	3	0	0	1	1	2	0	0
22	67.56	1943	10	0	3	0	3	0	0	0	0	2	0	0
23	70.02	1941	7	0	2	0	0	1	2	0	0	1	0	0
24	72.45	1939	7	0	7	0	2	0	0	0	0	0	0	0
25	74.85	1936	9	0	0	0	2	0	0	0	0	0	0	0
26	77.23	1934	7	0	1	0	0	0	0	0	3	1	0	0
27	79.59	1931	7	0	3	0	0	1	0	1	1	4	0	0
28	81.93	1929	4	0	1	0	1	0	1	0	0	1	0	0
29	84.26	1927	8	0	1	0	0	2	0	0	0	0	0	0
30	86.58	1924	12	0	5	1	1	0	0	1	1	1	0	0
31	88.89	1922	8	0	2	1	0	2	0	0	0	1	1	0
32	91.19	1920	9	0	2	0	0	2	0	0	0	0	0	1
33	93.50	1918	13	0	1	0	1	2	0	1	1	0	0	1
34	95.80	1915	9	0	1	1	0	0	0	2	0	0	0	2
35	98.11	1913	11	0	5	0	1	0	0	2	0	2	0	0
36	100.42	1911	6	0	0	0	1	3	0	0	0	0	0	0
37	102.74	1908	2	0	1	0	2	0	0	0	3	0	0	0
38	105.08	1906	3	0	3	0	1	1	0	0	0	0	0	0
39	107.43	1904	9	0	3	0	2	4	0	0	0	5	1	0
40	109.80	1901	2	0	3	0	1	2	0	1	2	4	1	0
41	112.19	1899	9	0	5	0	1	1	1	0	5	3	0	0
42	114.61	1896	9	0	2	0	1	1	0	0	5	5	0	0
43	117.05	1894	8	0	5	2	0	0	1	0	5	5	0	0
44	119.53	1891	11	0	2	0	2	0	0	0	9	2	0	0
45	122.04	1889	2	0	0	1	0	4	0	0	2	1	1	0
46	124.59	1886	8	0	1	1	0	0	0	0	0	2	0	0
47	127.17	1884	11	0	4	3	4	0	0	0	4	0	0	0
48	129.80	1881	8	0	2	0	0	1	0	0	0	0	0	0
49	132.48	1879	0	0	4	1	0	0	0	0	0	1	0	0
50	135.20	1876	4	0	2	1	0	0	0	0	1	1	0	0
51	137.98	1873	7	0	1	0	1	2	0	0	0	1	0	0
52	140.81	1870	4	0	0	0	1	0	0	0	1	2	0	0
53	143.69	1867	1	0	0	0	0	1	0	0	0	0	0	0
54	146.64	1864	8	0	1	1	5	0	0	0	4	0	0	0
55	149.66	1861	0	0	0	0	0	1	0	0	0	0	0	0
56	152.73	1858	2	0	0	0	0	0	0	0	0	1	0	0
57	155.88	1855	0	0	0	0	1	0	0	0	0	0	0	0
58	159.11	1852	1	0	1	0	0	0	0	0	0	0	0	0
59	162.40	1849	1	0	0	0	2	0	0	0	0	1	0	0

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Poaceae	Cyperaceae	Asteraceae (Tub)	Asteraceae (Lig)	Ranunculaceae	Rosaceae	Polygonaceae	Ilex	Vitaceae	Cornaceae	Leguminosae	Ericaceae
60	165.78	1845	1	0	0	0	0	0	0	0	0	0	0	0
61	169.24	1842	0	0	0	0	0	0	0	0	0	0	0	0
62	172.78	1838	0	0	0	0	0	0	0	0	0	1	0	0
63	176.41	1835	0	0	0	0	3	1	0	0	0	0	0	0
64	180.13	1831	0	0	0	0	0	1	0	0	0	1	0	0
65	183.95	1827	2	0	0	0	0	1	0	0	0	0	0	0
66	187.86	1823	0	0	0	0	0	1	0	0	0	0	0	0
67	191.87	1819	1	0	1	0	3	0	0	0	0	0	0	0
68	195.99	1815	0	0	0	0	0	1	0	0	0	0	0	0
69	200.21	1811	0	0	0	0	1	1	0	0	0	0	1	0
70	204.54	1806	0	0	2	0	7	0	0	0	0	2	0	0
71	208.98	1802	0	0	0	0	1	2	0	1	0	0	0	0
72	213.54	1797	0	0	0	0	1	2	0	0	0	1	0	0
73	218.21	1793	0	0	1	0	0	1	0	0	1	1	0	0
74	223.01	1788	0	0	2	0	0	1	0	0	0	0	0	0
75	227.93	1783	0	0	1	0	3	1	0	0	0	0	0	0
76	232.97	1778	1	0	1	0	0	0	0	0	0	0	0	0
77	238.15	1773	0	0	0	0	0	0	0	0	0	0	0	0
78	243.45	1768	0	0	0	0	1	0	0	0	0	2	0	0
79	248.90	1762	0	0	1	0	0	1	0	0	0	0	0	0
80	254.48	1757	0	0	0	0	0	1	0	0	0	0	1	0
80.5	257.32	1754	1	0	0	0	0	0	0	0	0	0	0	0
81	260.20	1751	1	0	1	0	0	2	0	0	0	0	0	0
81.5	263.12	1748	0	0	0	0	1	2	0	0	0	0	1	0
82	266.07	1745	0	0	1	0	0	0	0	0	0	0	0	0
82.5	269.06	1742	0	0	0	0	2	0	0	0	0	0	0	0
83	272.09	1739	0	0	0	0	0	0	0	0	0	1	0	0
83.5	275.16	1736	0	0	1	0	1	1	0	0	1	1	0	0
84	278.26	1733	0	0	0	0	0	0	0	0	1	0	1	0
85	284.58	1726	1	0	0	0	0	0	0	0	0	0	0	0
86	291.06	1720	0	0	0	0	0	0	0	0	0	1	0	0
87	297.70	1713	1	0	0	0	0	0	0	0	0	0	0	0
88	304.50	1707	0	0	0	0	0	0	0	0	0	0	0	0
89	311.46	1700	0	0	0	0	0	0	0	0	0	1	0	0
90	318.60	1692	2	0	0	0	0	0	0	0	0	0	0	0
91	325.91	1685	1	0	0	0	0	0	0	0	0	0	0	0
92	333.39	1678	1	0	3	0	0	0	0	0	0	0	0	0
93	341.05	1670	1	0	0	0	0	0	0	0	0	0	0	0
94	348.89	1662	1	0	2	0	0	0	0	0	0	0	0	0
95	356.92	1654	0	0	0	0	0	0	0	0	0	0	0	0

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Poaceae	Cyperaceae	Asteraceae (Tub)	Asteraceae (Lig)	Ranunculaceae	Rosaceae	Polygonaceae	Ilex	Vitaceae	Cornaceae	Leguminosae	Ericaceae
96	365.13	1646	0	0	1	0	0	0	0	0	0	1	1	0
97	373.53	1637	0	0	0	0	0	0	0	0	0	0	0	0
98	382.12	1629	0	0	0	1	0	0	0	0	0	3	1	1
99	390.91	1620	0	0	0	0	0	0	0	0	0	0	0	0
100	399.90	1611	0	0	0	0	0	1	0	0	0	0	0	0
101	409.09	1602	1	0	0	0	0	0	0	0	0	2	0	0
102	418.49	1593	0	0	0	0	0	0	0	0	1	0	1	0
103	428.09	1583	0	0	0	0	0	0	0	0	0	0	0	0
104	437.90	1573	0	0	0	0	1	0	0	0	0	0	0	0
105	447.93	1563	1	0	0	0	0	0	0	0	0	0	0	0
106	458.17	1553	0	0	0	0	0	0	0	0	0	0	0	0
107	468.64	1542	0	0	0	0	0	0	0	0	0	0	0	0
108	479.33	1532	1	0	0	0	0	2	0	0	1	0	0	1
109	490.24	1521	1	0	0	0	0	1	0	0	0	0	0	0
110	501.38	1510	0	0	0	0	0	0	0	0	0	1	0	0
111	512.75	1498	1	0	0	0	0	0	0	0	0	2	0	0
112	524.36	1487	0	0	2	0	0	0	0	0	0	0	0	0
113	536.21	1475	0	0	0	0	0	0	0	0	0	2	0	0
114	548.29	1463	0	0	0	0	0	0	0	0	0	0	0	0
115	560.63	1450	0	0	0	0	0	0	0	0	0	0	0	1
116	573.20	1438	0	0	0	0	0	0	1	0	0	1	0	0
117	586.03	1425	0	0	0	0	0	0	0	0	0	0	0	0
118	599.11	1412	0	0	0	0	0	0	0	0	0	0	0	0
119	612.45	1399	0	0	0	0	0	0	0	0	0	1	0	0
120	626.04	1385	0	0	0	0	1	0	0	0	0	1	1	0
121	639.90	1371	0	0	0	0	0	0	0	0	0	0	0	0
122	654.02	1357	0	0	0	0	0	0	0	0	0	1	0	0
123	668.41	1343	0	0	0	0	0	1	0	0	0	0	0	0
124	683.07	1328	0	0	0	0	0	0	0	0	0	0	0	1
125	698.00	1313	0	0	0	0	1	0	0	0	0	0	0	1
126	713.21	1298	0	0	0	0	0	1	0	0	0	0	0	0
127	728.70	1282	0	0	1	0	0	0	0	0	0	0	1	0
128	744.47	1267	0	0	0	0	0	0	0	0	0	0	0	0
129	760.53	1250	0	0	0	0	0	0	0	0	0	0	0	2
130	776.88	1234	1	0	0	0	0	0	0	1	0	0	0	0
131	793.52	1217	0	0	0	0	0	0	0	0	0	0	0	0
132	810.45	1201	0	0	0	0	0	2	1	0	0	0	0	1
133	827.69	1183	0	0	0	0	0	0	0	0	0	0	0	0
134	845.22	1166	0	0	0	0	0	0	0	0	0	0	0	0
135	863.06	1148	0	0	0	0	0	1	0	0	0	0	0	0

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Poaceae	Cyperaceae	Asteraceae (Tub)	Asteraceae (Lig)	Ranunculaceae	Rosaceae	Polygonaceae	Ilex	Vitaceae	Cornaceae	Leguminosae	Ericaceae
136	881.20	1130	0	0	0	0	0	1	0	0	0	0	0	1
137	899.65	1111	0	0	1	0	0	0	0	0	0	2	0	0
138	918.42	1093	0	0	0	0	0	0	0	0	0	1	0	0
139	937.50	1074	0	0	1	0	0	0	0	0	0	0	0	0
140	956.90	1054	0	0	0	0	0	0	0	0	0	0	0	0
141	976.62	1034	0	0	0	0	0	0	0	0	0	0	1	0
142	996.67	1014	0	0	0	0	0	0	0	1	0	0	0	0
143	1017.04	994	0	0	0	0	0	0	0	0	0	1	0	0
144	1037.75	973	0	0	0	0	0	1	0	0	0	2	0	0

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Sambucus	Urtica	Potentilla	Iva	Suaeda	Lycopus virginicus	Menyanthes	Petalostemum purpureum	Apiaceae	Sarcobatus	Aquifoliaceae	Epilobium latifolium
0	0.00	2011	0	0	1	0	0	0	0	0	0	0	0	0
0.5	1.94	2009	0	0	0	0	0	0	1	0	0	0	0	0
1	3.86	2007	0	0	0	0	0	0	0	0	1	0	0	0
1.5	5.75	2005	0	0	0	0	0	0	0	0	0	0	0	0
2	7.63	2003	0	0	0	0	0	0	0	0	0	0	0	0
2.5	9.47	2002	0	0	0	0	0	0	0	0	0	0	0	0
3	11.30	2000	0	0	0	0	0	0	0	0	0	0	0	0
3.5	13.10	1998	0	0	0	0	0	0	1	0	0	0	0	0
4	14.88	1996	0	0	0	0	0	0	0	0	0	0	0	0
4.5	16.64	1994	0	0	0	0	0	0	0	0	0	0	0	0
5	18.38	1993	0	0	0	0	0	0	0	0	0	0	0	0
5.5	20.10	1991	2	0	0	0	0	0	0	0	0	0	0	0
6	21.79	1989	0	0	0	0	0	0	0	0	0	0	0	0
6.5	23.47	1988	0	0	0	0	0	0	0	0	0	0	0	0
7	25.13	1986	0	0	0	0	0	0	0	0	0	0	0	0
7.5	26.77	1984	0	0	0	0	0	0	0	0	0	0	0	0
8	28.39	1983	0	0	0	0	0	0	0	0	0	0	0	0
8.5	29.99	1981	1	0	0	0	0	0	1	0	0	0	0	0
9	31.57	1979	2	0	0	0	0	0	0	0	0	0	0	0
9.5	33.13	1978	0	0	0	0	0	0	0	0	0	0	0	0
10	34.68	1976	0	0	0	0	0	0	0	0	0	0	0	0
10.5	36.21	1975	0	0	0	0	0	0	0	0	0	0	0	0
11	37.72	1973	0	0	0	0	0	0	0	0	0	0	0	0
11.5	39.22	1972	0	0	0	0	0	0	1	0	0	0	0	0
12	40.70	1970	0	0	0	0	0	0	0	0	0	0	0	0
12.5	42.17	1969	0	0	0	0	0	0	0	0	0	0	0	0
13	43.62	1967	0	0	0	0	0	0	0	0	0	0	0	0
13.5	45.05	1966	2	0	0	0	0	0	0	0	0	0	0	0
14	46.47	1965	1	0	0	0	0	0	0	0	0	0	0	0
15	49.28	1962	0	0	0	0	0	0	1	0	0	0	0	0
15.5	50.66	1960	0	5	0	0	0	0	0	0	0	0	0	0
16	52.02	1959	0	0	0	0	0	0	0	0	0	0	0	0
17	54.72	1956	0	0	0	0	0	0	0	0	0	0	0	0
17.5	56.05	1955	1	7	0	0	0	0	0	0	0	0	0	0
18	57.37	1954	0	0	2	0	0	0	0	0	0	0	0	0
18.5	58.68	1952	0	3	0	0	0	0	0	0	0	0	0	0
19	59.98	1951	0	0	0	0	0	0	0	0	0	0	0	0
19.5	61.26	1950	1	0	0	0	0	0	0	0	1	1	0	0
20	62.54	1948	0	0	0	0	2	0	0	0	0	0	0	0
20.5	63.81	1947	0	2	0	0	0	0	0	0	0	0	0	0

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Sambucus	Urtica	Potentilla	Iva	Suaeda	Lycopus virginicus	Menyanthes	Petalostemum purpureum	Apiaceae	Sarcobatus	Aquifoliaceae	Epilobium latifolium
21	65.07	1946	0	0	0	0	0	0	0	0	0	0	0	0
21.5	66.32	1945	0	0	0	0	0	0	0	1	0	0	0	0
22	67.56	1943	0	0	0	0	0	0	0	0	0	0	0	0
23	70.02	1941	0	0	0	0	0	0	0	0	0	0	0	0
24	72.45	1939	0	0	0	0	0	0	0	0	0	0	0	0
25	74.85	1936	0	0	0	0	0	0	0	0	0	0	0	0
26	77.23	1934	0	0	0	0	0	0	0	0	0	0	0	0
27	79.59	1931	0	0	0	0	0	0	0	0	0	0	0	0
28	81.93	1929	0	0	0	0	0	0	0	0	0	0	0	0
29	84.26	1927	0	0	0	0	0	0	0	0	0	0	0	0
30	86.58	1924	0	0	0	0	0	0	0	0	0	0	0	0
31	88.89	1922	0	0	0	0	0	0	0	0	0	0	0	0
32	91.19	1920	0	0	0	0	0	0	0	0	0	0	0	0
33	93.50	1918	0	0	0	0	0	0	0	0	0	0	0	0
34	95.80	1915	0	0	0	0	0	0	0	0	0	0	0	0
35	98.11	1913	0	0	0	0	0	0	0	0	0	0	0	0
36	100.42	1911	0	0	0	0	0	0	0	0	0	0	0	0
37	102.74	1908	0	0	0	0	0	0	0	0	0	0	1	0
38	105.08	1906	0	0	0	0	0	0	0	0	0	0	0	0
39	107.43	1904	0	0	0	0	0	0	0	0	0	0	0	0
40	109.80	1901	0	0	0	0	0	0	0	0	0	0	0	0
41	112.19	1899	3	0	0	0	0	0	0	0	0	0	0	0
42	114.61	1896	0	0	0	0	0	0	0	0	0	0	0	0
43	117.05	1894	0	0	0	0	0	0	1	0	0	0	0	1
44	119.53	1891	2	0	0	0	0	0	0	0	0	0	0	1
45	122.04	1889	1	0	0	0	0	0	0	0	0	0	0	0
46	124.59	1886	0	0	0	0	0	0	0	0	0	0	0	0
47	127.17	1884	0	0	0	0	0	0	0	0	0	0	0	0
48	129.80	1881	0	0	0	0	0	0	0	0	0	0	0	2
49	132.48	1879	0	4	0	0	0	0	0	0	0	0	0	0
50	135.20	1876	0	0	0	0	0	0	0	0	0	0	0	0
51	137.98	1873	0	0	0	0	0	0	0	0	0	0	0	0
52	140.81	1870	0	0	0	0	0	0	0	0	0	0	0	0
53	143.69	1867	0	0	0	0	0	0	0	0	0	0	0	0
54	146.64	1864	0	0	0	0	0	0	0	0	0	0	0	0
55	149.66	1861	0	3	0	0	0	0	0	0	0	0	0	0
56	152.73	1858	0	0	0	0	0	0	0	0	0	0	0	0
57	155.88	1855	0	0	0	0	0	0	0	0	0	0	0	0
58	159.11	1852	0	0	0	0	0	0	0	0	0	0	0	0
59	162.40	1849	0	0	0	0	0	0	0	0	0	0	0	0

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Sambucus	Urtica	Potentilla	Iva	Suaeda	Lycopus virginicus	Menyanthes	Petalostemum purpureum	Apiaceae	Sarcobatus	Aquifoliaceae	Epilobium latifolium
60	165.78	1845	0	0	0	0	0	0	0	0	0	0	0	0
61	169.24	1842	0	0	0	0	0	0	0	0	0	0	0	0
62	172.78	1838	0	0	0	0	0	0	0	0	0	0	0	0
63	176.41	1835	0	0	0	0	0	0	0	0	0	0	0	0
64	180.13	1831	0	0	0	0	0	2	0	0	0	0	0	0
65	183.95	1827	0	0	0	0	0	0	0	0	0	0	0	0
66	187.86	1823	0	0	0	0	0	0	0	0	0	0	0	0
67	191.87	1819	1	0	0	0	0	1	0	0	0	0	0	0
68	195.99	1815	0	0	0	0	0	0	0	0	0	0	0	0
69	200.21	1811	0	0	0	0	0	0	0	0	0	0	0	0
70	204.54	1806	0	0	0	0	0	0	0	0	0	0	0	0
71	208.98	1802	0	0	0	0	0	0	0	0	0	0	0	0
72	213.54	1797	0	0	0	0	0	0	0	0	0	0	0	0
73	218.21	1793	0	0	0	0	0	0	0	0	0	0	0	0
74	223.01	1788	0	0	0	0	0	0	0	0	0	0	0	0
75	227.93	1783	0	0	0	0	0	0	0	0	0	0	0	0
76	232.97	1778	0	1	0	0	0	0	0	0	0	0	0	0
77	238.15	1773	0	0	0	0	0	0	0	0	0	0	0	0
78	243.45	1768	0	7	0	0	0	0	0	0	0	0	0	0
79	248.90	1762	0	0	0	0	0	0	0	0	0	0	0	0
80	254.48	1757	0	0	0	0	0	0	0	0	0	0	0	0
80.5	257.32	1754	0	0	0	0	0	0	0	0	0	0	0	0
81	260.20	1751	0	10	0	0	0	0	0	0	0	0	0	0
81.5	263.12	1748	0	0	0	0	0	0	0	0	0	0	0	0
82	266.07	1745	0	13	0	0	0	0	0	0	0	0	0	0
82.5	269.06	1742	0	0	0	0	0	0	0	0	0	0	0	0
83	272.09	1739	0	3	0	0	0	0	0	0	0	0	0	0
83.5	275.16	1736	0	0	0	0	0	0	0	0	0	0	0	0
84	278.26	1733	0	8	0	0	0	0	0	0	0	0	0	0
85	284.58	1726	0	5	0	0	0	0	0	0	0	0	0	0
86	291.06	1720	0	3	0	0	0	0	0	0	0	0	0	0
87	297.70	1713	0	7	0	0	0	0	0	0	0	0	0	0
88	304.50	1707	0	0	0	0	0	0	0	0	0	0	0	0
89	311.46	1700	0	8	0	0	0	0	0	0	0	0	0	1
90	318.60	1692	0	4	0	0	0	0	0	0	0	0	0	0
91	325.91	1685	0	6	0	0	0	0	0	0	0	0	0	0
92	333.39	1678	0	2	0	0	0	0	0	0	0	0	0	0
93	341.05	1670	0	6	0	0	0	0	0	0	0	0	0	0
94	348.89	1662	0	0	0	0	0	0	0	0	0	0	0	0
95	356.92	1654	0	7	0	0	0	0	0	0	0	0	0	0

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Sambucus	Urtica	Potentilla	Iva	Suaeda	Lycopus virginicus	Menyanthes	Petalostemum purpureum	Apiaceae	Sarcobatus	Aquifoliaceae	Epilobium latifolium
96	365.13	1646	0	2	0	0	0	0	0	0	0	0	0	0
97	373.53	1637	0	3	0	0	0	0	0	0	0	0	0	0
98	382.12	1629	0	0	0	0	0	0	0	0	0	0	0	0
99	390.91	1620	0	4	0	0	0	0	0	0	0	0	0	0
100	399.90	1611	1	0	0	0	0	0	0	0	0	0	0	0
101	409.09	1602	0	3	0	0	0	0	0	0	0	0	0	0
102	418.49	1593	0	0	0	0	0	0	0	0	0	0	0	0
103	428.09	1583	0	6	0	0	0	0	0	0	0	0	0	0
104	437.90	1573	0	0	0	0	0	0	0	0	0	0	0	0
105	447.93	1563	0	3	0	0	0	0	0	0	0	0	0	0
106	458.17	1553	0	4	0	0	0	0	0	0	0	0	0	0
107	468.64	1542	0	3	0	0	0	0	0	0	0	0	0	0
108	479.33	1532	0	0	0	0	0	0	0	0	0	0	0	0
109	490.24	1521	0	8	0	0	0	0	0	0	0	0	0	0
110	501.38	1510	0	0	0	0	0	0	0	0	0	0	0	0
111	512.75	1498	0	6	0	0	0	0	0	0	0	0	0	0
112	524.36	1487	0	6	0	0	0	0	0	0	0	0	0	0
113	536.21	1475	0	6	0	0	0	0	0	0	0	0	0	0
114	548.29	1463	0	7	0	0	0	0	0	0	0	0	0	0
115	560.63	1450	0	13	0	0	0	0	0	0	0	0	0	0
116	573.20	1438	0	5	0	0	0	0	0	0	0	0	0	0
117	586.03	1425	0	10	0	0	0	0	0	0	0	0	0	0
118	599.11	1412	0	9	0	0	0	0	0	0	0	0	0	0
119	612.45	1399	0	8	0	0	0	0	0	0	0	0	0	0
120	626.04	1385	0	5	0	0	0	0	0	0	0	0	0	0
121	639.90	1371	0	10	0	0	0	0	0	0	0	0	0	0
122	654.02	1357	0	2	0	0	0	0	0	0	0	0	0	0
123	668.41	1343	0	6	0	0	0	0	0	0	0	0	0	0
124	683.07	1328	0	5	0	0	0	0	0	0	0	0	0	0
125	698.00	1313	0	8	0	0	0	0	0	0	0	0	0	0
126	713.21	1298	0	5	0	0	0	0	0	0	0	0	0	0
127	728.70	1282	0	6	0	0	0	0	0	0	0	0	0	0
128	744.47	1267	0	5	0	0	0	0	0	0	0	0	0	0
129	760.53	1250	0	9	0	0	0	0	0	0	0	0	0	0
130	776.88	1234	0	4	0	0	0	0	0	0	0	0	0	0
131	793.52	1217	0	12	0	0	0	0	0	0	0	0	0	0
132	810.45	1201	0	1	0	0	0	0	0	0	0	0	0	0
133	827.69	1183	0	10	0	0	0	0	0	0	0	0	0	0
134	845.22	1166	0	5	0	0	0	0	0	0	0	0	0	0
135	863.06	1148	0	5	0	0	0	0	0	0	0	0	0	0

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Sambucus	Urtica	Potentilla	Iva	Suaeda	Lycopus virginicus	Menyanthes	Petalostemum purpureum	Apiaceae	Sarcobatus	Aquifoliaceae	Epilobium latifolium
136	881.20	1130	0	7	0	0	0	0	0	0	0	0	0	0
137	899.65	1111	0	7	0	0	0	0	0	0	0	0	0	0
138	918.42	1093	0	5	0	0	0	0	0	0	0	0	0	0
139	937.50	1074	0	9	0	0	0	0	0	0	0	0	0	0
140	956.90	1054	0	3	0	0	0	0	0	0	0	0	0	0
141	976.62	1034	0	3	0	0	0	0	0	0	0	0	0	0
142	996.67	1014	0	6	0	0	0	0	0	0	0	0	0	0
143	1017.04	994	0	9	0	0	0	0	0	0	0	0	0	0
144	1037.75	973	1	11	0	0	0	0	0	0	0	0	0	0

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Caryophyllaceae	Fabaceae	Saxifragaceae	Capifoliacea	Rhamnaceae	Umbelliferae	Rubiaceae	Amaranthaceae	Vaccinium uliginosum	Laminaceae	Nuphar	Typha latifolia
0	0.00	2011	0	0	0	0	0	0	0	0	0	0	0	2
0.5	1.94	2009	0	0	0	0	0	0	0	0	0	0	0	2
1	3.86	2007	1	0	0	0	0	0	0	0	0	0	0	2
1.5	5.75	2005	0	0	0	0	0	0	0	0	0	0	0	2
2	7.63	2003	0	0	0	0	0	0	0	0	0	0	1	1
2.5	9.47	2002	0	0	0	0	0	0	0	0	0	0	0	0
3	11.30	2000	0	0	0	0	0	0	0	0	0	0	0	0
3.5	13.10	1998	1	0	1	0	0	0	0	0	0	0	0	0
4	14.88	1996	0	0	0	0	0	0	0	0	0	0	0	0
4.5	16.64	1994	0	0	0	0	0	0	0	0	0	0	0	1
5	18.38	1993	0	0	0	0	0	0	0	0	0	0	0	2
5.5	20.10	1991	0	0	0	0	0	0	0	0	0	0	0	0
6	21.79	1989	0	0	0	0	0	0	0	0	0	0	0	2
6.5	23.47	1988	0	0	0	0	0	0	0	0	0	0	0	0
7	25.13	1986	0	0	0	0	0	0	0	0	0	0	0	1
7.5	26.77	1984	0	0	1	1	1	0	0	0	0	0	0	1
8	28.39	1983	0	0	0	0	0	0	0	0	0	0	0	1
8.5	29.99	1981	0	0	0	0	0	0	0	0	0	0	0	1
9	31.57	1979	0	0	0	0	0	0	0	0	0	0	0	1
9.5	33.13	1978	1	0	0	0	0	0	0	0	0	0	0	0
10	34.68	1976	0	0	0	0	0	0	0	0	0	0	0	2
10.5	36.21	1975	0	0	0	0	0	0	0	0	0	0	0	0
11	37.72	1973	0	0	0	0	0	0	0	0	0	0	0	3
11.5	39.22	1972	1	0	0	0	0	0	0	0	0	0	0	1
12	40.70	1970	0	0	0	0	0	0	0	0	0	0	0	0
12.5	42.17	1969	0	1	0	0	0	0	0	0	0	0	0	1
13	43.62	1967	0	0	0	0	0	0	0	0	0	0	0	2
13.5	45.05	1966	1	0	0	0	0	0	0	0	0	0	0	0
14	46.47	1965	0	0	0	0	0	0	0	0	0	0	0	0
15	49.28	1962	0	0	0	0	0	0	0	0	0	0	0	1
15.5	50.66	1960	0	0	0	0	0	0	0	0	0	0	0	0
16	52.02	1959	0	0	0	0	0	0	0	0	0	0	0	0
17	54.72	1956	0	0	0	0	0	0	0	0	0	0	1	1
17.5	56.05	1955	0	0	0	0	0	0	0	0	0	0	0	1
18	57.37	1954	0	0	0	0	0	0	0	0	0	0	0	1
18.5	58.68	1952	0	0	0	0	0	0	0	0	0	0	0	0
19	59.98	1951	0	0	0	0	0	0	0	0	0	0	0	0
19.5	61.26	1950	0	0	0	0	0	0	0	0	0	0	0	1
20	62.54	1948	0	0	0	0	0	0	0	0	0	0	0	2
20.5	63.81	1947	0	0	0	0	0	0	0	0	0	1	1	0

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Caryophyllaceae	Fabaceae	Saxifragaceae	Capifoliacea	Rhamnaceae	Umbelliferae	Rubiaceae	Amaranthaceae	Vaccinium uliginosum	Laminaceae	Nuphar	Typha latifolia
21	65.07	1946	0	0	0	0	0	1	0	0	0	0	0	1
21.5	66.32	1945	0	0	0	0	0	0	0	0	0	0	0	0
22	67.56	1943	0	0	0	0	0	0	0	0	0	0	0	1
23	70.02	1941	0	0	0	0	0	0	0	0	0	0	0	1
24	72.45	1939	0	0	0	0	0	0	0	0	0	0	1	0
25	74.85	1936	0	0	0	0	0	0	0	0	0	0	0	0
26	77.23	1934	0	0	0	0	0	2	0	0	0	0	0	0
27	79.59	1931	0	0	0	0	0	0	0	0	0	0	0	0
28	81.93	1929	0	0	0	0	0	0	0	0	0	0	0	0
29	84.26	1927	0	0	0	0	0	0	0	0	0	0	0	0
30	86.58	1924	0	0	0	0	0	0	0	0	0	0	0	3
31	88.89	1922	0	0	0	0	0	0	0	0	0	0	0	0
32	91.19	1920	0	0	0	0	0	0	0	0	0	0	0	3
33	93.50	1918	0	0	0	0	0	0	0	0	0	0	0	0
34	95.80	1915	0	0	0	0	0	0	0	0	0	0	0	1
35	98.11	1913	0	0	0	0	0	0	0	0	0	0	0	0
36	100.42	1911	1	0	0	0	0	0	0	0	0	0	0	0
37	102.74	1908	0	0	0	0	0	0	0	0	0	0	0	2
38	105.08	1906	0	0	0	0	0	0	2	0	0	0	0	4
39	107.43	1904	0	0	0	0	0	0	0	0	0	0	0	0
40	109.80	1901	0	0	0	1	0	1	0	1	0	0	0	1
41	112.19	1899	0	0	0	0	0	0	0	0	0	0	0	0
42	114.61	1896	0	0	0	0	0	0	0	0	0	0	0	2
43	117.05	1894	0	0	0	0	0	0	0	0	0	0	1	0
44	119.53	1891	0	0	0	0	0	0	0	0	0	0	0	1
45	122.04	1889	0	0	0	0	0	0	0	0	0	0	1	1
46	124.59	1886	0	0	0	0	0	0	0	0	0	0	1	0
47	127.17	1884	0	0	0	0	1	0	0	0	0	0	0	0
48	129.80	1881	1	0	0	0	0	0	0	0	0	0	0	0
49	132.48	1879	0	0	0	0	0	0	1	0	0	0	0	0
50	135.20	1876	0	0	0	0	0	0	2	0	0	0	0	0
51	137.98	1873	0	0	0	0	0	0	0	0	0	0	0	0
52	140.81	1870	0	0	0	0	0	0	0	0	0	0	0	0
53	143.69	1867	0	0	0	1	0	0	0	0	0	0	0	0
54	146.64	1864	0	0	0	0	0	0	0	0	0	0	1	0
55	149.66	1861	0	0	0	0	0	0	0	0	0	0	0	0
56	152.73	1858	0	0	0	0	0	0	0	0	0	0	0	0
57	155.88	1855	0	0	0	0	0	0	0	0	0	0	0	0
58	159.11	1852	0	0	0	0	0	0	0	0	0	0	0	0
59	162.40	1849	0	0	0	0	0	0	0	0	0	0	0	0

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Caryophyllaceae	Fabaceae	Saxifragaceae	Capifoliacea	Rhamnaceae	Umbelliferae	Rubiaceae	Amaranthaceae	Vaccinium uliginosum	Laminaceae	Nuphar	Typha latifolia
60	165.78	1845	0	0	0	0	0	0	0	0	0	0	0	0
61	169.24	1842	0	0	0	0	0	0	0	0	0	0	0	0
62	172.78	1838	0	0	0	0	0	0	0	0	0	0	0	0
63	176.41	1835	0	0	0	0	0	0	0	0	0	0	1	0
64	180.13	1831	0	0	0	0	0	0	0	0	0	0	0	0
65	183.95	1827	1	0	0	0	0	0	0	0	0	0	0	0
66	187.86	1823	0	0	0	0	0	0	0	0	0	0	0	0
67	191.87	1819	0	0	0	0	0	0	0	0	0	0	0	0
68	195.99	1815	0	0	0	0	0	0	0	0	0	0	0	1
69	200.21	1811	1	0	0	0	0	0	0	0	0	0	0	0
70	204.54	1806	0	0	0	0	0	0	0	0	0	0	0	1
71	208.98	1802	0	0	0	0	0	0	0	0	0	0	0	0
72	213.54	1797	0	0	0	0	0	0	0	0	0	0	0	0
73	218.21	1793	0	0	0	1	0	0	0	0	0	0	0	0
74	223.01	1788	0	0	0	0	0	0	0	0	0	0	0	0
75	227.93	1783	0	0	0	0	0	0	0	0	0	0	0	1
76	232.97	1778	0	0	0	0	0	0	0	0	0	0	0	0
77	238.15	1773	0	0	0	0	0	0	0	0	0	0	0	0
78	243.45	1768	0	0	0	0	0	0	0	0	0	0	0	0
79	248.90	1762	0	0	0	0	0	0	0	0	0	0	0	0
80	254.48	1757	0	0	0	0	0	0	0	0	0	0	0	0
80.5	257.32	1754	0	0	0	0	0	0	0	0	0	0	0	0
81	260.20	1751	0	0	0	0	0	0	0	0	0	0	1	0
81.5	263.12	1748	0	0	0	0	0	0	0	0	0	0	0	0
82	266.07	1745	1	0	0	0	0	0	0	0	0	0	0	0
82.5	269.06	1742	0	0	0	0	0	0	0	0	0	0	0	0
83	272.09	1739	0	0	0	0	0	0	0	0	0	0	0	0
83.5	275.16	1736	0	0	0	0	0	0	0	0	0	0	0	1
84	278.26	1733	0	0	0	0	0	0	0	0	0	0	0	0
85	284.58	1726	0	0	0	0	0	0	0	0	0	0	0	0
86	291.06	1720	0	0	0	0	0	0	0	0	0	0	0	0
87	297.70	1713	0	0	0	0	0	0	0	0	0	0	0	0
88	304.50	1707	0	0	0	0	0	0	0	0	0	0	0	0
89	311.46	1700	0	0	0	0	0	0	0	0	0	0	1	0
90	318.60	1692	0	0	0	0	0	0	0	0	0	0	1	0
91	325.91	1685	0	0	0	0	0	0	0	0	0	0	0	0
92	333.39	1678	0	0	0	0	0	0	0	0	0	0	1	0
93	341.05	1670	0	0	0	0	0	0	0	0	0	0	0	0
94	348.89	1662	0	0	0	0	0	0	0	0	0	0	0	0
95	356.92	1654	0	0	0	0	0	0	0	0	0	0	0	0

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Caryophyllaceae	Fabaceae	Saxifragaceae	Capifoliacea	Rhamnaceae	Umbelliferae	Rubiaceae	Amaranthaceae	Vaccinium uliginosum	Laminaceae	Nuphar	Typha latifolia
96	365.13	1646	1	0	0	0	0	0	0	0	0	0	1	0
97	373.53	1637	0	0	0	0	0	0	0	0	0	0	0	1
98	382.12	1629	0	0	0	0	0	0	0	0	0	0	0	0
99	390.91	1620	0	0	0	0	0	0	0	0	0	0	0	0
100	399.90	1611	0	0	0	0	0	0	0	0	0	0	0	0
101	409.09	1602	0	0	0	0	0	0	0	0	0	0	0	0
102	418.49	1593	0	0	0	0	0	0	0	0	0	0	0	0
103	428.09	1583	0	0	0	0	0	0	0	0	0	0	0	0
104	437.90	1573	0	0	0	0	0	0	0	0	0	0	0	0
105	447.93	1563	0	0	0	0	0	0	0	0	0	0	0	0
106	458.17	1553	0	0	0	0	0	0	0	0	0	0	0	0
107	468.64	1542	0	0	0	0	0	0	0	0	0	0	0	0
108	479.33	1532	1	0	0	0	0	0	0	0	0	0	0	0
109	490.24	1521	0	0	0	0	0	0	0	0	0	0	0	1
110	501.38	1510	0	0	0	0	0	0	0	0	0	0	0	0
111	512.75	1498	0	0	0	0	0	0	0	0	0	0	1	0
112	524.36	1487	0	0	0	0	0	0	1	0	0	0	0	0
113	536.21	1475	0	0	0	0	0	0	0	0	0	0	0	0
114	548.29	1463	0	0	0	0	0	0	0	0	0	0	0	0
115	560.63	1450	0	0	0	0	0	0	0	0	0	0	0	0
116	573.20	1438	0	0	0	0	0	0	0	0	0	0	0	0
117	586.03	1425	0	0	0	0	0	0	0	0	0	0	0	0
118	599.11	1412	0	0	0	0	0	0	0	0	0	0	0	0
119	612.45	1399	0	0	0	0	0	0	0	0	1	0	0	0
120	626.04	1385	0	0	0	0	0	0	0	0	0	0	0	0
121	639.90	1371	0	0	0	0	0	0	0	0	0	0	2	0
122	654.02	1357	0	0	0	0	0	0	0	0	0	0	0	0
123	668.41	1343	0	0	0	0	0	0	0	0	0	0	1	0
124	683.07	1328	0	0	0	0	0	0	0	0	0	0	0	0
125	698.00	1313	0	0	0	0	0	0	0	0	0	0	0	0
126	713.21	1298	0	0	0	0	0	0	0	0	0	0	0	0
127	728.70	1282	0	0	0	0	0	0	1	0	0	0	0	0
128	744.47	1267	0	0	0	0	0	0	0	0	0	0	0	0
129	760.53	1250	0	0	0	0	0	0	0	0	0	0	2	2
130	776.88	1234	0	0	0	0	0	0	0	0	0	0	0	0
131	793.52	1217	0	0	0	0	0	0	0	0	0	0	0	0
132	810.45	1201	0	0	0	0	0	0	0	0	0	0	0	0
133	827.69	1183	0	0	0	0	0	0	0	0	0	0	0	1
134	845.22	1166	0	0	0	0	0	0	0	0	0	0	0	0
135	863.06	1148	0	0	0	0	0	0	0	0	0	0	0	1

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Caryophyllaceae	Fabaceae	Saxifragaceae	Capifoliacea	Rhamnaceae	Umbelliferae	Rubiaceae	Amaranthaceae	Vaccinium uliginosum	Laminaceae	Nuphar	Typha latifolia
136	881.20	1130	0	0	0	0	0	0	0	0	0	0	0	1
137	899.65	1111	0	0	0	0	0	0	1	0	0	0	0	1
138	918.42	1093	0	0	0	0	0	0	0	0	0	0	0	0
139	937.50	1074	0	0	0	0	0	0	0	0	0	0	2	1
140	956.90	1054	0	0	0	0	0	0	0	0	0	0	1	0
141	976.62	1034	0	0	0	0	0	0	0	0	0	0	1	0
142	996.67	1014	0	0	0	0	0	1	0	0	0	0	1	0
143	1017.04	994	0	0	1	0	0	0	0	0	0	0	0	0
144	1037.75	973	0	0	0	0	0	0	0	0	0	0	0	0

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Typha angustifolia	Potamogeton	Nymphaea	Lemna	Sagittoria latifolia	Elodea	Sparganium	Suaeda	Hippuris	Myriophllum	Ephedra	Pteridium
0	0.00	2011	0	6	0	0	0	0	0	0	0	0	0	0
0.5	1.94	2009	0	3	3	0	0	0	0	0	0	0	0	1
1	3.86	2007	0	4	0	0	0	0	0	0	0	0	0	0
1.5	5.75	2005	0	5	0	0	0	0	0	0	0	0	0	1
2	7.63	2003	0	7	0	0	1	0	0	0	0	0	0	1
2.5	9.47	2002	0	0	0	0	0	0	0	0	0	0	0	4
3	11.30	2000	0	11	0	0	0	0	0	0	0	0	0	2
3.5	13.10	1998	0	5	1	0	0	0	0	0	0	0	1	3
4	14.88	1996	0	11	0	0	0	0	0	0	0	0	0	0
4.5	16.64	1994	2	5	0	0	0	0	0	0	0	0	0	1
5	18.38	1993	0	8	2	0	0	0	0	0	0	0	0	1
5.5	20.10	1991	0	5	0	0	0	0	0	0	0	0	0	0
6	21.79	1989	0	7	0	1	0	0	0	0	0	0	0	2
6.5	23.47	1988	0	2	0	0	0	0	0	0	0	1	0	1
7	25.13	1986	0	4	0	1	0	0	0	0	0	0	0	3
7.5	26.77	1984	0	4	2	0	0	0	1	0	0	0	0	0
8	28.39	1983	0	3	0	0	0	0	0	0	0	0	0	0
8.5	29.99	1981	0	0	0	0	0	0	1	0	0	0	0	0
9	31.57	1979	0	1	0	0	0	0	0	0	0	0	0	2
9.5	33.13	1978	0	4	2	0	0	0	0	0	0	0	0	0
10	34.68	1976	0	8	0	0	0	0	0	0	0	0	0	5
10.5	36.21	1975	0	2	0	0	0	0	2	0	0	0	0	1
11	37.72	1973	0	6	0	0	0	0	0	0	0	0	0	0
11.5	39.22	1972	0	4	1	0	0	0	0	0	0	0	0	1
12	40.70	1970	0	5	0	0	0	0	0	0	0	0	0	0
12.5	42.17	1969	0	3	0	0	0	0	0	0	0	0	1	1
13	43.62	1967	0	3	2	0	0	0	0	0	0	0	0	1
13.5	45.05	1966	0	2	0	0	0	0	0	0	0	0	0	3
14	46.47	1965	0	2	1	0	0	0	0	0	0	0	0	4
15	49.28	1962	0	4	0	0	0	0	0	0	0	0	0	0
15.5	50.66	1960	0	0	0	0	0	0	0	0	0	0	0	1
16	52.02	1959	0	4	0	0	0	0	0	0	0	0	0	2
17	54.72	1956	0	1	0	0	0	0	0	0	0	0	0	1
17.5	56.05	1955	0	0	0	0	0	0	0	0	0	0	0	0
18	57.37	1954	0	7	0	0	0	0	0	0	0	0	0	0
18.5	58.68	1952	0	0	0	0	0	0	0	0	0	0	0	0
19	59.98	1951	0	9	0	0	1	0	0	0	0	0	0	0
19.5	61.26	1950	0	1	0	0	0	0	1	1	0	0	0	5
20	62.54	1948	0	4	0	4	0	0	0	0	0	0	0	0
20.5	63.81	1947	0	1	1	0	0	0	0	0	0	0	0	3

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Typha angustifolia	Potamogeton	Nymphaea	Lemna	Sagittoria latifolia	Elodea	Sparganium	Suaeda	Hippuris	Myriophllum	Ephedra	Pteridium
21	65.07	1946	0	0	2	0	0	0	0	0	0	0	0	3
21.5	66.32	1945	0	0	0	0	0	0	0	0	0	0	0	4
22	67.56	1943	0	6	0	1	0	0	0	0	0	0	0	2
23	70.02	1941	0	0	0	0	0	0	0	0	0	0	0	2
24	72.45	1939	0	8	0	0	0	0	0	0	0	0	0	0
25	74.85	1936	0	3	1	0	0	0	0	0	0	0	0	5
26	77.23	1934	0	2	3	0	0	0	0	0	0	0	0	3
27	79.59	1931	0	1	0	0	0	0	0	0	0	0	0	4
28	81.93	1929	0	3	0	0	0	0	0	0	0	0	0	8
29	84.26	1927	0	0	0	0	0	0	0	0	0	0	0	1
30	86.58	1924	1	0	0	0	0	0	0	0	0	0	0	5
31	88.89	1922	0	0	1	0	0	0	0	0	0	0	0	3
32	91.19	1920	0	0	0	0	0	0	0	0	0	0	0	8
33	93.50	1918	0	1	0	0	0	0	0	0	0	0	0	5
34	95.80	1915	0	1	1	0	0	0	0	0	0	0	0	4
35	98.11	1913	0	1	1	0	0	0	0	0	0	0	0	6
36	100.42	1911	0	3	0	0	0	0	0	0	0	0	0	8
37	102.74	1908	0	0	0	0	0	0	0	0	0	0	0	8
38	105.08	1906	0	1	0	0	0	0	0	0	0	0	0	8
39	107.43	1904	0	3	0	0	0	0	0	0	0	0	0	2
40	109.80	1901	0	0	1	0	0	0	0	0	0	0	0	8
41	112.19	1899	0	4	0	0	0	0	0	0	0	0	0	6
42	114.61	1896	0	0	0	0	0	0	0	0	0	0	0	7
43	117.05	1894	0	4	2	1	0	0	0	0	0	0	0	6
44	119.53	1891	0	3	0	0	0	0	0	0	0	0	0	3
45	122.04	1889	0	2	1	0	0	0	0	0	0	0	0	1
46	124.59	1886	0	0	1	0	0	0	0	0	0	0	0	6
47	127.17	1884	0	0	0	0	0	0	0	0	0	0	0	3
48	129.80	1881	0	1	1	0	0	0	0	0	0	0	0	1
49	132.48	1879	0	0	2	0	0	0	0	0	0	0	0	1
50	135.20	1876	1	1	1	0	0	0	0	0	0	0	0	7
51	137.98	1873	0	1	1	0	0	0	0	0	0	0	0	5
52	140.81	1870	0	1	1	0	0	0	0	0	0	0	0	3
53	143.69	1867	0	0	0	0	0	0	0	0	0	0	0	4
54	146.64	1864	0	0	1	0	0	0	0	0	1	0	0	2
55	149.66	1861	0	1	1	0	0	0	0	0	0	0	0	1
56	152.73	1858	0	0	2	0	0	0	0	0	0	0	0	1
57	155.88	1855	0	1	1	0	0	0	0	0	0	0	0	0
58	159.11	1852	0	0	0	0	0	0	0	0	0	0	0	1
59	162.40	1849	0	1	1	0	1	0	0	0	0	1	0	0

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Typha angustifolia	Potamogeton	Nymphaea	Lemna	Sagittoria latifolia	Elodea	Sparganium	Suaeda	Hippuris	Myriophllum	Ephedra	Pteridium
60	165.78	1845	0	0	0	0	0	0	0	0	0	0	0	0
61	169.24	1842	0	3	0	1	0	0	0	0	0	0	0	2
62	172.78	1838	0	0	0	0	0	0	0	0	0	0	0	0
63	176.41	1835	0	1	1	0	0	0	0	0	0	0	0	1
64	180.13	1831	0	1	0	0	0	0	0	0	0	0	0	0
65	183.95	1827	0	0	1	0	0	0	0	0	0	0	0	1
66	187.86	1823	0	2	0	0	0	0	0	0	0	0	0	0
67	191.87	1819	0	0	0	0	0	1	0	0	0	0	0	0
68	195.99	1815	0	0	0	0	0	0	0	0	0	0	0	0
69	200.21	1811	0	1	1	0	0	0	0	0	0	0	0	0
70	204.54	1806	0	0	0	0	0	0	0	0	0	0	0	0
71	208.98	1802	0	0	0	0	0	0	0	0	0	0	0	0
72	213.54	1797	0	0	0	0	0	0	0	0	0	0	0	0
73	218.21	1793	0	1	0	0	0	0	0	0	0	0	0	1
74	223.01	1788	0	4	0	0	0	0	0	0	0	0	0	1
75	227.93	1783	0	1	0	0	0	0	0	0	0	0	0	1
76	232.97	1778	0	2	1	0	0	0	0	0	0	0	0	3
77	238.15	1773	0	2	1	0	0	0	0	0	0	0	0	2
78	243.45	1768	0	0	0	0	0	0	0	0	0	0	0	1
79	248.90	1762	0	0	0	0	0	0	0	0	0	0	0	0
80	254.48	1757	0	0	1	0	0	0	0	0	0	0	0	1
80.5	257.32	1754	0	1	0	0	0	0	0	0	0	0	0	1
81	260.20	1751	0	0	0	0	0	0	0	0	0	0	0	0
81.5	263.12	1748	0	3	0	0	0	0	0	0	0	0	0	1
82	266.07	1745	0	1	0	0	0	0	0	0	0	0	0	1
82.5	269.06	1742	0	2	0	0	0	0	0	0	0	0	0	2
83	272.09	1739	0	2	1	0	0	0	0	0	0	0	0	0
83.5	275.16	1736	0	2	0	0	0	0	0	0	0	0	0	2
84	278.26	1733	0	0	2	0	0	0	0	0	0	0	0	0
85	284.58	1726	0	0	0	0	0	0	0	0	0	0	0	0
86	291.06	1720	0	1	0	0	0	0	0	0	0	0	0	0
87	297.70	1713	0	0	0	0	0	0	0	0	0	0	0	0
88	304.50	1707	0	2	0	0	0	0	0	0	0	0	0	2
89	311.46	1700	0	0	0	0	0	0	0	0	0	0	0	0
90	318.60	1692	0	3	3	0	0	0	0	0	0	0	0	5
91	325.91	1685	0	0	1	0	0	0	0	0	0	0	0	1
92	333.39	1678	0	0	0	0	0	0	0	0	0	0	0	1
93	341.05	1670	0	0	0	1	0	0	0	0	0	0	0	0
94	348.89	1662	0	1	0	0	0	0	0	0	0	0	0	1
95	356.92	1654	0	0	0	0	0	0	0	0	0	0	0	1

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Typha angustifolia	Potamogeton	Nymphaea	Lemna	Sagittoria latifolia	Elodea	Sparganium	Suaeda	Hippuris	Myriophllum	Ephedra	Pteridium
96	365.13	1646	0	1	1	0	0	0	0	0	0	0	0	0
97	373.53	1637	0	0	0	0	0	0	0	0	0	0	0	0
98	382.12	1629	0	1	0	0	0	0	0	0	0	0	0	2
99	390.91	1620	0	0	0	0	0	0	0	0	0	0	0	0
100	399.90	1611	0	0	0	0	0	0	0	0	0	0	0	1
101	409.09	1602	0	0	0	0	0	0	0	0	0	0	0	1
102	418.49	1593	0	0	0	0	0	0	1	0	0	0	0	0
103	428.09	1583	0	0	1	0	0	0	0	0	0	0	0	1
104	437.90	1573	0	0	0	0	0	0	0	0	0	0	0	0
105	447.93	1563	0	0	2	0	0	0	0	0	0	0	0	0
106	458.17	1553	0	2	0	0	0	0	0	0	0	0	0	0
107	468.64	1542	0	0	0	0	0	0	0	0	0	0	0	0
108	479.33	1532	0	0	1	0	0	0	0	0	0	0	0	1
109	490.24	1521	0	1	0	0	0	0	0	0	0	0	0	0
110	501.38	1510	0	1	0	0	0	0	0	0	0	0	0	0
111	512.75	1498	0	0	0	0	0	0	0	0	0	0	0	0
112	524.36	1487	0	0	0	0	0	0	0	0	0	0	0	1
113	536.21	1475	0	0	0	0	0	0	0	0	0	0	0	0
114	548.29	1463	0	0	2	0	0	0	0	0	0	0	0	0
115	560.63	1450	0	0	0	0	0	0	0	0	0	0	0	1
116	573.20	1438	0	1	0	0	0	0	0	0	0	0	0	1
117	586.03	1425	0	3	0	0	0	0	0	0	0	0	0	1
118	599.11	1412	0	2	0	0	0	0	0	0	0	0	0	0
119	612.45	1399	0	0	0	0	0	0	0	0	0	0	0	1
120	626.04	1385	0	1	0	0	0	0	0	0	0	0	0	0
121	639.90	1371	0	0	0	0	0	0	0	0	0	0	0	0
122	654.02	1357	0	2	0	0	0	0	0	0	0	0	0	0
123	668.41	1343	0	0	0	0	0	0	0	0	0	0	0	0
124	683.07	1328	0	1	0	0	0	0	0	0	0	0	0	0
125	698.00	1313	1	3	0	0	0	0	0	0	0	0	0	0
126	713.21	1298	0	0	0	0	0	0	0	0	0	0	0	0
127	728.70	1282	0	0	0	0	0	0	0	0	0	0	0	0
128	744.47	1267	0	0	0	0	0	0	0	0	0	0	0	1
129	760.53	1250	0	0	0	0	0	0	0	0	0	0	0	1
130	776.88	1234	0	1	0	0	0	0	0	0	0	0	0	0
131	793.52	1217	0	1	0	0	0	0	0	0	0	0	0	0
132	810.45	1201	0	0	0	0	0	0	0	0	0	0	0	0
133	827.69	1183	0	0	1	0	0	0	0	0	0	0	0	0
134	845.22	1166	0	0	0	0	0	0	0	0	0	0	0	0
135	863.06	1148	0	1	0	0	0	0	0	0	0	0	0	1

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Typha angustifolia	Potamogeton	Nymphaea	Lemna	Sagittoria latifolia	Elodea	Sparganium	Suaeda	Hippuris	Myriophllum	Ephedra	Pteridium
136	881.20	1130	0	0	1	0	0	0	0	0	0	0	0	0
137	899.65	1111	0	0	1	0	0	0	0	0	0	0	0	0
138	918.42	1093	0	1	0	0	0	0	0	0	0	0	0	2
139	937.50	1074	0	0	0	0	0	0	0	0	0	0	0	1
140	956.90	1054	0	0	0	0	0	0	0	0	0	0	0	0
141	976.62	1034	0	2	0	0	0	0	0	0	0	0	0	1
142	996.67	1014	0	0	0	0	0	0	0	0	0	0	0	1
143	1017.04	994	0	0	1	0	0	0	0	0	0	0	0	1
144	1037.75	973	0	3	0	0	0	0	0	0	0	0	0	0

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Dryopteris	Sphagnum	L. lucidulum	Osmunda	Cystopteris	Thelypteris	Polypodiaceae	cf. Lycopodium	**L. clavatum (Exotic)**	**Total**
0	0.00	2011	3	0	1	0	0	0	0	0	364	481
0.5	1.94	2009	2	0	0	0	0	0	0	0	376	528
1	3.86	2007	5	0	0	0	0	0	0	0	316	476.5
1.5	5.75	2005	1	0	1	0	1	0	0	0	273	572
2	7.63	2003	4	0	0	0	0	0	0	0	384	628
2.5	9.47	2002	2	0	1	0	2	0	0	0	326	570
3	11.30	2000	1	0	0	0	0	0	0	0	374	604.5
3.5	13.10	1998	7	0	0	0	0	0	0	0	241	521.5
4	14.88	1996	0	0	1	0	1	0	0	0	306	589.5
4.5	16.64	1994	3	0	0	0	0	0	0	0	204	494.5
5	18.38	1993	4	0	0	0	0	0	0	0	197	489
5.5	20.10	1991	5	0	3	0	0	0	0	0	174	520
6	21.79	1989	4	0	0	0	1	0	0	0	207	664
6.5	23.47	1988	4	0	0	0	0	0	0	0	205	538
7	25.13	1986	3	0	1	0	0	0	0	0	275	589.5
7.5	26.77	1984	2	0	1	1	0	0	0	0	192	515.5
8	28.39	1983	1	0	0	1	0	0	0	0	270	490.5
8.5	29.99	1981	0	0	1	0	0	0	0	0	170	520
9	31.57	1979	6	0	0	0	0	0	0	0	122	474
9.5	33.13	1978	3	0	0	0	0	0	0	0	141	537.5
10	34.68	1976	5	0	0	0	1	0	0	0	268	703.5
10.5	36.21	1975	7	0	0	0	0	0	0	0	121	502.5
11	37.72	1973	6	0	0	0	0	0	0	0	195	625.5
11.5	39.22	1972	7	0	0	0	0	0	0	0	170	614
12	40.70	1970	3	0	0	0	0	0	0	0	198	593
12.5	42.17	1969	5	0	0	0	0	0	0	0	177	536.5
13	43.62	1967	5	0	0	0	0	0	0	0	175	504
13.5	45.05	1966	4	0	1	0	0	0	0	0	204	530
14	46.47	1965	2	0	2	0	0	0	0	0	153	532.5
15	49.28	1962	1	0	0	0	0	0	0	0	263	486
15.5	50.66	1960	5	0	0	0	0	0	0	0	242	538
16	52.02	1959	5	0	1	0	0	0	0	0	169	429
17	54.72	1956	2	0	0	0	0	0	0	0	188	505.5
17.5	56.05	1955	4	0	0	0	0	0	0	0	171	512
18	57.37	1954	3	0	2	0	1	0	0	0	301	668.5
18.5	58.68	1952	2	0	0	0	0	0	0	0	168	512.5
19	59.98	1951	1	0	1	0	0	0	0	0	240	632.5
19.5	61.26	1950	2	0	0	0	0	0	0	0	109	502
20	62.54	1948	4	0	0	0	0	0	0	0	216	598.5
20.5	63.81	1947	2	0	0	0	0	0	0	0	158	533.5

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Dryopteris	Sphagnum	L. lucidulum	Osmunda	Cystopteris	Thelypteris	Polypodiaceae	cf. Lycopodium	L. clavatum (Exotic)	Total
21	65.07	1946	2	0	0	0	0	0	0	1	112	478
21.5	66.32	1945	7	0	0	0	0	0	0	0	131	506
22	67.56	1943	5	0	0	0	0	0	0	0	308	819.5
23	70.02	1941	4	0	1	0	0	0	0	0	106	542.5
24	72.45	1939	11	0	3	0	2	0	0	0	257	673.5
25	74.85	1936	6	0	0	0	0	0	0	0	113	508
26	77.23	1934	3	0	0	0	0	0	0	0	94	541.5
27	79.59	1931	9	0	0	0	0	0	0	0	126	585.5
28	81.93	1929	5	0	0	0	0	0	0	0	127	508
29	84.26	1927	1	0	0	0	0	0	0	0	97	498.5
30	86.58	1924	10	0	0	0	0	0	0	0	83	534
31	88.89	1922	6	0	0	0	0	0	0	0	116	517.5
32	91.19	1920	2	0	0	1	0	0	0	0	97	535.5
33	93.50	1918	4	0	0	0	0	0	0	0	139	594.5
34	95.80	1915	3	0	2	0	0	0	0	0	92	517
35	98.11	1913	2	0	0	0	0	0	0	0	128	640
36	100.42	1911	2	0	0	0	0	0	0	0	77	492
37	102.74	1908	5	0	1	0	0	0	1	0	115	489.5
38	105.08	1906	2	0	0	0	0	0	0	0	93	542
39	107.43	1904	1	0	1	0	0	0	0	0	119	582
40	109.80	1901	6	0	0	0	0	0	0	1	89	560.5
41	112.19	1899	5	0	0	0	1	0	0	0	61	586.5
42	114.61	1896	6	0	0	0	0	0	0	0	115	523
43	117.05	1894	3	0	0	1	0	0	0	0	133	520.5
44	119.53	1891	5	0	0	0	0	0	0	0	126	634.5
45	122.04	1889	1	0	0	0	0	0	0	0	105	472.5
46	124.59	1886	3	0	0	0	0	0	0	0	99	475
47	127.17	1884	5	0	0	0	1	0	1	0	162	589
48	129.80	1881	2	0	1	0	0	0	0	0	124	519.5
49	132.48	1879	1	0	0	0	0	0	0	0	138	510
50	135.20	1876	6	0	0	0	0	0	0	0	102	510.5
51	137.98	1873	0	0	0	1	0	0	0	0	159	501
52	140.81	1870	2	0	0	0	0	0	0	0	123	525.5
53	143.69	1867	0	0	1	0	0	0	0	0	170	561.5
54	146.64	1864	1	0	0	0	2	0	0	0	148	570
55	149.66	1861	0	0	0	0	0	0	0	0	180	507.5
56	152.73	1858	0	0	1	0	0	0	0	0	161	510.5
57	155.88	1855	0	0	0	0	0	0	0	0	126	492
58	159.11	1852	1	0	0	0	0	0	0	0	141	512.5
59	162.40	1849	0	0	0	0	0	0	0	0	157	595

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Dryopteris	Sphagnum	L. lucidulum	Osmunda	Cystopteris	Thelypteris	Polypodiaceae	cf. Lycopodium	L. clavatum (Exotic)	Total
60	165.78	1845	1	0	0	0	0	0	0	0	112	502.5
61	169.24	1842	0	0	0	0	0	0	0	0	130	519.5
62	172.78	1838	2	0	0	0	0	0	0	0	107	481
63	176.41	1835	0	0	0	0	0	0	0	0	86	504.5
64	180.13	1831	0	0	0	0	0	0	0	0	97	508
65	183.95	1827	0	0	0	0	0	0	0	0	109	508
66	187.86	1823	2	0	1	0	0	0	0	0	114	545.5
67	191.87	1819	1	0	1	0	0	0	0	0	132	549.5
68	195.99	1815	0	0	0	0	0	0	0	0	116	511
69	200.21	1811	1	0	0	0	0	0	0	0	152	517
70	204.54	1806	1	0	0	0	0	0	0	0	158	576
71	208.98	1802	0	0	0	0	0	0	0	0	116	528
72	213.54	1797	0	0	0	0	0	0	0	0	122	502
73	218.21	1793	0	0	0	0	0	0	0	0	161	531
74	223.01	1788	1	0	0	0	0	0	0	0	113	537
75	227.93	1783	4	0	0	0	0	0	0	0	143	544.5
76	232.97	1778	1	0	0	0	0	0	0	0	162	509
77	238.15	1773	0	0	0	0	0	0	0	0	181	525.5
78	243.45	1768	4	0	0	0	0	0	0	0	226	515
79	248.90	1762	1	0	0	0	0	0	0	0	135	495.5
80	254.48	1757	1	0	0	0	0	0	0	0	242	491
80.5	257.32	1754	0	0	0	0	0	0	0	0	180	540
81	260.20	1751	1	0	0	0	0	0	0	0	252	500.5
81.5	263.12	1748	0	0	1	0	0	0	0	0	197	485.5
82	266.07	1745	2	0	0	0	0	0	0	0	259	554.5
82.5	269.06	1742	0	0	0	0	0	1	0	0	147	537
83	272.09	1739	1	0	0	0	0	0	0	0	179	554
83.5	275.16	1736	0	0	0	0	0	0	0	0	213	532
84	278.26	1733	2	0	0	0	0	0	0	0	242	537.5
85	284.58	1726	2	0	0	0	0	0	0	0	261	512
86	291.06	1720	7	0	0	0	0	0	0	0	347	574
87	297.70	1713	1	0	1	0	0	0	0	0	244	496.5
88	304.50	1707	2	0	0	0	0	0	0	0	299	526.5
89	311.46	1700	3	0	0	0	0	0	0	0	274	502
90	318.60	1692	3	0	0	0	0	0	0	0	298	592
91	325.91	1685	1	0	1	0	0	0	0	0	232	513.5
92	333.39	1678	2	0	0	0	0	0	0	0	222	493.5
93	341.05	1670	4	0	0	0	0	0	0	0	204	499
94	348.89	1662	1	0	0	0	0	0	0	0	215	528
95	356.92	1654	1	0	0	0	0	0	0	0	145	502

Top Depth on Slide (cm)	**Cal Year (before 2011)**	**Years (AD)**	Dryopteris	Sphagnum	L. lucidulum	Osmunda	Cystopteris	Thelypteris	Polypodiaceae	cf. Lycopodium	**L. clavatum (Exotic)**	**Total**
96	365.13	1646	2	0	0	0	0	0	0	0	189	493.5
97	373.53	1637	1	0	0	0	0	0	0	0	153	533.5
98	382.12	1629	2	0	0	0	0	0	0	0	198	529.5
99	390.91	1620	0	0	0	0	0	0	0	0	87	531
100	399.90	1611	1	0	0	0	0	0	0	0	166	512.5
101	409.09	1602	0	0	0	0	0	0	0	1	99	530
102	418.49	1593	0	0	0	0	0	0	0	0	138	476.5
103	428.09	1583	1	0	0	0	0	0	0	0	115	537
104	437.90	1573	1	0	0	1	0	0	0	0	122	521.5
105	447.93	1563	0	0	0	0	0	0	0	0	127	500
106	458.17	1553	1	0	0	0	0	0	0	0	136	522
107	468.64	1542	0	0	0	0	0	0	0	0	108	499.5
108	479.33	1532	2	0	0	0	0	0	0	0	123	507
109	490.24	1521	0	0	0	0	0	0	0	0	99	499
110	501.38	1510	1	0	0	0	0	0	0	0	142	504.5
111	512.75	1498	3	0	0	0	0	0	0	0	99	501.5
112	524.36	1487	0	0	0	0	0	0	0	0	111	519.5
113	536.21	1475	1	0	0	0	0	0	0	0	175	509
114	548.29	1463	0	0	0	0	0	0	0	0	105	509.5
115	560.63	1450	2	0	0	0	0	0	0	0	177	590.5
116	573.20	1438	2	0	0	0	0	0	0	0	176	538.5
117	586.03	1425	0	0	0	0	0	0	0	0	123	544
118	599.11	1412	1	0	0	0	0	0	0	0	113	522
119	612.45	1399	0	0	0	0	0	0	0	0	117	529
120	626.04	1385	0	0	0	0	0	0	0	0	75	510
121	639.90	1371	0	0	0	0	0	0	0	0	150	527
122	654.02	1357	0	0	0	0	0	0	0	0	130	540
123	668.41	1343	0	0	0	0	0	0	0	0	131	534
124	683.07	1328	1	0	0	0	0	0	0	0	95	554
125	698.00	1313	0	0	0	0	0	0	0	0	124	508
126	713.21	1298	1	0	0	0	0	0	0	0	137	557.5
127	728.70	1282	1	0	0	0	0	0	0	0	156	586
128	744.47	1267	1	0	0	0	0	0	0	0	81	519.5
129	760.53	1250	3	0	0	0	0	0	0	0	88	494
130	776.88	1234	2	0	0	0	0	0	0	0	62	515.5
131	793.52	1217	1	0	0	0	0	0	0	0	111	503.5
132	810.45	1201	1	0	0	0	0	0	0	0	82	560
133	827.69	1183	3	0	0	0	0	0	0	0	151	529
134	845.22	1166	1	0	0	0	0	0	0	0	81	508.5
135	863.06	1148	2	0	0	0	0	0	0	0	123	506

Top Depth on Slide (cm)	Cal Year (before 2011)	Years (AD)	Dryopteris	Sphagnum	L. lucidulum	Osmunda	Cystopteris	Thelypteris	Polypodiaceae	cf. Lycopodium	L. clavatum (Exotic)	Total
136	881.20	1130	2	0	0	0	0	0	0	0	93	512.5
137	899.65	1111	0	0	0	0	0	0	0	0	112	518
138	918.42	1093	1	0	0	0	0	0	0	0	74	500.5
139	937.50	1074	3	0	0	0	0	0	0	0	131	541
140	956.90	1054	2	0	0	0	0	0	0	0	72	491.5
141	976.62	1034	2	0	0	0	0	0	0	0	95	565.5
142	996.67	1014	2	0	0	0	0	0	0	0	60	496.5
143	1017.04	994	2	0	0	0	0	0	0	0	91	501.5
144	1037.75	973	2	0	0	0	0	0	0	0	68	516.5

Stoll Lake

Depth (cm)	**Cal Years (before 2011)**	**Year (AD)**	Pinus dipl	Pinus hapl	Pinus undiff 1/2's	Pinus undiff (whole)	Picea 1/2's	Picea whole	Abies 1/2's	Abies whole	Cupressaceae	Larix
1	2.71	2008	11	98	49	77	1	5	0.5	4	3	1
2	5.54	2005	19	103	66.5	51	1.5	7	1	6	4	2
3	8.47	2003	9	97	56.5	59	2.5	9	2	4	3	1
4	11.50	1999	20	105	58.5	71	0	11	1	3	3	3
5	14.65	1996	6	93	72	57	1	4	1.5	3	5	1
6	17.90	1993	20	75	52.5	60	0.5	11	1.5	3	3	0
7	21.26	1990	6	82	77.5	60	4	7	0	3	5	0
8	24.73	1986	33	82	52	74	2.5	6	0.5	3	3	0
9	28.30	1983	14	77	65.5	54	0.5	7	0.5	3	4	2
10	31.98	1979	22	94	63.5	44	1	5	0.5	2	4	2
11	35.77	1975	11	95	70.5	85	2.5	9	0.5	8	4	1
12	39.67	1971	24	89	47.5	59	1	9	0.5	2	4	2
13	43.67	1967	10	87	69	39	1	5	0	6	5	2
14	47.78	1963	8	84	57	61	1.5	7	0	3	3	1
16	56.33	1955	11	99	59	61	1	9	0.5	3	0	0
18	65.30	1946	15	111	67	39	1	7	0	1	3	0
20	74.70	1936	11	130	90.5	77	1	10	0	3	4	0
22	84.54	1926	11	93	81.5	75	0.5	5	0	4	6	1
24	94.80	1916	9	88	82	61	1	1	0	2	5	2
26	105.49	1906	14	110	53	77	2.5	7	1	0	3	4
28	116.61	1894	27	138	78.5	77	1.5	12	0.5	3	5	2
29	122.34	1889	24	95	74	74	1	8	1.5	2	1	6
30	128.17	1883	10	62	115.5	35	4.5	4	1	1	6	1
32	140.15	1871	8	76	78	83	2	7	1.5	5	4	2
34	152.56	1858	6	42	79.5	75	3	2	3	5	10	1
36	165.40	1846	5	43	75.5	82	2.5	3	2	1	8	2
38	178.67	1832	4	46	74	86	3	5	1	2	4	0
40	192.37	1819	5	56	80	64	2.5	5	1.5	1	5	0
42	206.50	1805	3	64	71	114	1.5	6	0	4	4	1
44	221.06	1790	6	38	71	63	3.5	5	1	0	3	2
46	236.04	1775	4	45	99.5	79	1.5	4	0.5	1	7	1
48	251.46	1760	8	56	86.5	69	4	6	0.5	1	7	1
50	267.31	1744	4	62	77	62	1.5	5	1	1	4	0
52	283.59	1727	6	78	63	61	2	6	0	1	6	3
54	300.29	1711	6	71	94	68	2	9	1.5	2	2	4
56	317.43	1694	7	52	78.5	100	3	6	0.5	0	5	2
58	335.00	1676	7	52	73.5	62	3.5	9	0	3	3	1
60	352.99	1658	2	40	83.5	58	1.5	8	1.5	3	4	5

Depth (cm)	**Cal Years (before 2011)**	**Year (AD)**	Pinus dipl	Pinus hapl	Pinus undiff 1/2's	Pinus undiff (whole)	Picea 1/2's	Picea whole	Abies 1/2's	Abies whole	Cupressaceae	Larix
62	371.42	1640	4	53	55	75	1	7	1	0	6	2
64	390.27	1621	5	68	73.5	64	1	3	0.5	8	6	0
66	409.56	1601	5	87	82	35	2.5	3	1	1	7	1
68	429.27	1582	8	66	78	49	3.5	0	1	1	3	2
70	449.41	1562	11	101	75	60	2	4	2	1	5	1
72	469.99	1541	9	80	78.5	79	3	8	0.5	1	5	1
74	490.99	1520	11	91	80.5	67	4	9	0	2	6	2
76	512.42	1499	6	87	76	55	1	5	0	0	4	0
78	534.28	1477	11	98	92.5	48	1	5	0.5	2	2	2
80	556.58	1454	10	72	78	72	3.5	7	1.5	2	4	2

Depth (cm)	**Cal Years (before 2011)**	**Year (AD)**	Tsuga canadensis	Betula	Quercus	Fraxinus penn	Fraxinus nigra	Populus	Ulmus	Ostrya/Carpinus	Acer rubrum	Acer saccharum
1	2.71	2008	77	100	29	4	4	0	3	15	3	4
2	5.54	2005	44	95	23	4	6	4	3	7	5	2
3	8.47	2003	55	98	27	1	4	2	4	14	1	3
4	11.50	1999	52	98	22	3	7	0	5	7	7	0
5	14.65	1996	48	92	26	2	5	0	2	14	0	4
6	17.90	1993	51	78	25	3	7	2	6	9	1	4
7	21.26	1990	49	82	29	2	7	0	6	35	1	4
8	24.73	1986	51	93	26	2	7	0	3	14	6	3
9	28.30	1983	58	93	24	4	7	1	6	7	3	4
10	31.98	1979	46	119	24	4	5	2	9	11	4	1
11	35.77	1975	52	75	17	2	11	0	4	24	2	4
12	39.67	1971	43	104	19	2	9	4	7	10	1	4
13	43.67	1967	41	88	22	2	9	0	7	32	0	4
14	47.78	1963	55	82	21	1	5	1	11	8	2	2
16	56.33	1955	62	99	19	0	6	1	13	11	4	1
18	65.30	1946	62	104	15	2	6	2	6	3	0	7
20	74.70	1936	67	133	29	3	9	0	8	10	3	3
22	84.54	1926	50	111	19	0	4	3	11	8	3	0
24	94.80	1916	56	100	20	4	7	0	9	9	2	1
26	105.49	1906	49	89	19	3	6	0	4	13	4	4
28	116.61	1894	73	138	33	5	11	3	10	9	1	0
29	122.34	1889	70	120	18	3	10	1	10	9	1	7
30	128.17	1883	72	78	22	0	9	0	10	23	1	3
32	140.15	1871	74	86	21	1	6	1	9	24	3	6
34	152.56	1858	83	75	19	0	7	1	9	25	2	4
36	165.40	1846	103	68	34	1	6	0	10	23	1	11
38	178.67	1832	134	53	29	0	8	0	8	27	1	3
40	192.37	1819	130	56	28	2	6	1	8	28	1	10
42	206.50	1805	119	72	16	1	3	0	11	16	0	6
44	221.06	1790	121	81	22	1	5	0	12	26	0	3
46	236.04	1775	128	58	17	1	2	0	8	25	0	3
48	251.46	1760	106	60	20	1	6	0	10	17	0	4
50	267.31	1744	112	64	11	0	4	0	11	21	0	2
52	283.59	1727	90	77	23	1	11	2	8	19	1	3
54	300.29	1711	90	76	32	0	7	0	10	22	1	9
56	317.43	1694	105	76	20	0	7	0	5	22	1	2
58	335.00	1676	90	92	21	0	7	0	10	23	0	2
60	352.99	1658	118	82	26	0	6	1	12	20	1	7
62	371.42	1640	112	66	18	1	4	1	8	32	1	7
64	390.27	1621	105	72	22	4	5	0	16	14	1	7

Depth (cm)	**Cal Years (before 2011)**	**Year (AD)**	Tsuga canadensis	Betula	Quercus	Fraxinus penn	Fraxinus nigra	Populus	Ulmus	Ostrya/Carpinus	Acer rubrum	Acer saccharum
66	409.56	1601	128	61	24	0	8	0	14	13	1	6
68	429.27	1582	128	43	32	2	3	0	7	18	1	9
70	449.41	1562	108	59	22	3	9	0	11	26	1	3
72	469.99	1541	98	67	26	0	8	1	12	40	0	3
74	490.99	1520	97	64	29	1	9	0	6	18	0	6
76	512.42	1499	81	82	23	2	7	0	11	18	1	5
78	534.28	1477	100	59	36	0	7	0	16	20	0	2
80	556.58	1454	111	66	22	0	11	1	11	34	1	2

Depth (cm)	**Cal Years (before 2011)**	**Year (AD)**	Acer saccharinum	Acer Negundo	Acer	Fagus	Carya	Juglans	Tilia	Platanus	Castanea	Nyssa
1	2.71	2008	2	0	3	5	0	0	1	0	0	1
2	5.54	2005	9	0	2	11	2	0	0	0	0	0
3	8.47	2003	3	2	4	11	2	0	0	0	0	0
4	11.50	1999	4	0	4	9	1	0	2	0	0	1
5	14.65	1996	5	0	4	9	3	0	0	0	0	0
6	17.90	1993	4	0	5	10	0	0	2	0	0	0
7	21.26	1990	9	0	1	12	1	0	0	0	0	0
8	24.73	1986	0	0	9	10	0	0	4	0	0	1
9	28.30	1983	5	0	2	5	1	0	2	0	0	0
10	31.98	1979	10	0	0	5	0	1	0	0	0	0
11	35.77	1975	5	0	1	10	2	1	0	0	0	1
12	39.67	1971	6	0	0	10	1	1	0	0	0	0
13	43.67	1967	5	0	4	4	1	1	1	0	0	0
14	47.78	1963	3	0	0	11	1	0	1	0	0	0
16	56.33	1955	7	0	1	10	0	0	1	0	0	0
18	65.30	1946	5	0	1	6	1	0	0	0	0	0
20	74.70	1936	0	0	1	9	1	1	1	0	0	0
22	84.54	1926	8	0	1	4	2	0	2	0	0	0
24	94.80	1916	3	0	0	12	1	1	0	0	1	0
26	105.49	1906	0	0	4	7	1	0	1	0	0	0
28	116.61	1894	4	0	1	7	0	0	1	0	0	1
29	122.34	1889	3	0	1	7	0	0	1	0	0	0
30	128.17	1883	1	0	2	7	1	1	0	0	2	0
32	140.15	1871	4	0	2	7	4	2	0	0	0	1
34	152.56	1858	2	0	0	8	4	0	0	0	1	1
36	165.40	1846	2	0	0	9	3	2	2	0	1	0
38	178.67	1832	6	0	1	9	1	1	0	0	0	0
40	192.37	1819	4	0	4	8	1	0	1	0	0	0
42	206.50	1805	3	0	3	12	4	0	1	1	1	0
44	221.06	1790	7	0	2	17	3	3	2	0	1	0
46	236.04	1775	7	0	2	17	3	0	1	0	1	1
48	251.46	1760	4	0	2	12	3	0	1	0	0	0
50	267.31	1744	5	0	2	23	0	1	0	0	0	0
52	283.59	1727	1	0	2	14	3	0	1	0	1	0
54	300.29	1711	5	0	3	21	1	1	0	0	1	0
56	317.43	1694	4	0	5	22	1	0	1	0	0	1
58	335.00	1676	0	0	0	13	0	0	0	0	0	0
60	352.99	1658	2	1	4	12	1	0	0	0	1	0
62	371.42	1640	3	0	4	24	5	1	1	0	0	0
64	390.27	1621	3	0	2	21	1	1	0	0	2	0

Depth (cm)	**Cal Years (before 2011)**	**Year (AD)**	Acer saccharinum	Acer Negundo	Acer	Fagus	Carya	Juglans	Tilia	Platanus	Castanea	Nyssa
66	409.56	1601	1	0	1	15	0	1	2	0	0	0
68	429.27	1582	3	0	1	22	0	0	1	0	0	0
70	449.41	1562	5	0	2	23	2	0	0	0	0	0
72	469.99	1541	8	0	2	14	2	1	2	0	0	0
74	490.99	1520	5	0	0	20	3	0	2	1	0	0
76	512.42	1499	4	0	1	16	4	0	1	0	0	0
78	534.28	1477	3	0	2	26	0	0	1	0	0	0
80	556.58	1454	7	0	4	16	2	0	0	1	0	0

Depth (cm)	**Cal Years (before 2011)**	**Year (AD)**	Celtis	Liquidambar styraciflua	Morus rubra	Corylus	Alnus crispa	Alnus rugosa	Salix	Myrica	**Unknown**	**Indeterminate**
1	2.71	2008	0	0	0	0	2	2	2	0	1	5
2	5.54	2005	0	0	0	1	4	11	2	1	0	3
3	8.47	2003	0	0	0	0	8	11	2	0	1	8
4	11.50	1999	0	0	0	1	4	11	3	1	1	0
5	14.65	1996	0	0	0	0	8	4	4	0	1	6
6	17.90	1993	0	0	0	1	5	9	7	0	0	2
7	21.26	1990	0	0	0	0	3	3	1	0	0	4
8	24.73	1986	0	0	0	0	1	9	6	1	0	2
9	28.30	1983	0	0	0	0	0	4	3	0	5	2
10	31.98	1979	0	0	0	3	4	5	4	0	0	1
11	35.77	1975	0	0	0	0	5	5	2	0	0	4
12	39.67	1971	0	0	0	2	2	11	2	1	0	2
13	43.67	1967	0	0	0	0	6	1	1	0	1	7
14	47.78	1963	0	0	0	1	3	10	5	0	1	1
16	56.33	1955	0	0	0	1	4	5	3	1	2	1
18	65.30	1946	0	0	0	0	5	12	1	0	0	3
20	74.70	1936	0	0	0	1	5	11	7	1	2	2
22	84.54	1926	0	0	0	0	5	9	4	0	0	3
24	94.80	1916	0	0	0	1	1	6	3	0	1	2
26	105.49	1906	0	0	0	2	4	7	6	0	2	2
28	116.61	1894	0	0	0	0	6	4	4	0	1	3
29	122.34	1889	0	0	0	0	0	8	4	0	0	1
30	128.17	1883	0	0	0	0	8	6	2	0	1	3
32	140.15	1871	0	0	0	0	9	3	1	1	0	4
34	152.56	1858	0	0	0	0	9	4	2	0	1	3
36	165.40	1846	0	0	0	0	5	3	4	0	1	4
38	178.67	1832	0	0	0	0	5	1	1	0	0	1
40	192.37	1819	0	0	0	0	4	2	3	0	0	5
42	206.50	1805	0	0	0	0	4	2	1	0	1	6
44	221.06	1790	0	0	0	0	3	2	3	0	1	7
46	236.04	1775	0	0	0	0	5	5	2	1	0	5
48	251.46	1760	0	0	0	0	8	3	0	2	1	4
50	267.31	1744	0	0	0	0	3	3	7	0	1	4
52	283.59	1727	0	0	0	0	4	2	3	1	1	5
54	300.29	1711	0	0	0	0	7	7	1	2	1	2
56	317.43	1694	0	0	0	0	0	5	1	0	0	2
58	335.00	1676	0	0	0	0	5	4	0	0	1	5
60	352.99	1658	0	0	0	0	5	0	1	1	0	1
62	371.42	1640	0	0	0	0	3	7	0	0	1	5
64	390.27	1621	0	0	0	0	8	3	0	0	0	3

Depth (cm)	**Cal Years (before 2011)**	**Year (AD)**	Celtis	Liquidambar styraciflua	Morus rubra	Corylus	Alnus crispa	Alnus rugosa	Salix	Myrica	**Unknown**	**Indeterminate**
66	409.56	1601	0	0	0	0	2	7	1	1	0	5
68	429.27	1582	0	0	0	0	2	5	0	0	0	4
70	449.41	1562	0	0	0	0	1	3	0	0	0	2
72	469.99	1541	0	0	0	0	9	1	2	2	1	6
74	490.99	1520	0	0	0	0	6	2	2	2	1	5
76	512.42	1499	0	0	1	0	6	4	1	0	1	4
78	534.28	1477	0	0	0	0	7	6	1	0	0	5
80	556.58	1454	0	0	0	0	6	4	2	1	1	4

Depth (cm)	**Cal Years (before 2011)**	**Year (AD)**	Chenopodiaceae	Artemisia	Ambrosia	Rumex	Plantago	Poaceae	Cyperaceae	Asteraceae (Tub)	Asteraceae (Lig)	Ranunculaceae
1	2.71	2008	1	1	5	6	1	3	0	0	0	0
2	5.54	2005	3	1	26	9	0	8	0	2	0	1
3	8.47	2003	0	1	21	8	1	3	0	1	0	0
4	11.50	1999	3	2	20	15	0	3	0	1	0	4
5	14.65	1996	1	1	16	3	0	1	0	1	0	0
6	17.90	1993	0	0	27	6	2	1	0	1	0	2
7	21.26	1990	4	0	30	7	0	1	0	0	0	0
8	24.73	1986	2	2	31	2	0	4	0	3	0	3
9	28.30	1983	1	0	18	6	1	3	0	1	0	1
10	31.98	1979	3	0	27	9	0	2	0	2	0	2
11	35.77	1975	2	0	18	5	1	3	0	1	0	0
12	39.67	1971	1	0	23	4	0	3	0	2	0	2
13	43.67	1967	0	0	20	7	0	1	0	1	1	0
14	47.78	1963	0	0	23	6	0	5	0	2	0	4
16	56.33	1955	3	0	28	3	0	2	0	1	0	1
18	65.30	1946	1	1	12	10	0	5	0	0	0	3
20	74.70	1936	1	1	19	4	0	9	0	0	0	5
22	84.54	1926	1	0	11	4	0	7	0	0	0	5
24	94.80	1916	0	1	8	3	0	3	0	1	0	4
26	105.49	1906	3	0	9	1	0	6	0	1	0	1
28	116.61	1894	0	2	4	8	0	2	0	1	0	2
29	122.34	1889	0	1	4	10	0	4	0	1	0	2
30	128.17	1883	0	1	1	0	0	1	0	1	0	0
32	140.15	1871	0	0	2	0	0	0	0	0	0	0
34	152.56	1858	0	0	1	1	0	0	0	1	0	0
36	165.40	1846	2	1	0	0	0	0	0	0	0	0
38	178.67	1832	0	0	1	0	0	0	0	0	0	0
40	192.37	1819	1	0	1	1	0	0	0	0	0	0
42	206.50	1805	0	0	1	0	0	0	0	0	0	0
44	221.06	1790	0	0	0	0	0	0	0	0	0	0
46	236.04	1775	0	0	1	2	0	0	0	1	0	0
48	251.46	1760	1	0	2	0	0	0	0	0	0	0
50	267.31	1744	0	0	0	0	0	0	0	1	0	1
52	283.59	1727	1	0	0	1	0	0	0	0	0	0
54	300.29	1711	0	1	0	0	0	0	0	0	0	0
56	317.43	1694	1	0	0	0	0	0	0	1	0	0
58	335.00	1676	0	0	0	0	0	0	0	0	0	0
60	352.99	1658	0	1	0	0	0	0	0	1	0	0
62	371.42	1640	1	1	1	1	0	1	0	0	0	0
64	390.27	1621	0	0	1	0	0	0	0	0	0	0

Depth (cm)	**Cal Years (before 2011)**	**Year (AD)**	Chenopodiaceae	Artemisia	Ambrosia	Rumex	Plantago	Poaceae	Cyperaceae	Asteraceae (Tub)	Asteraceae (Lig)	Ranunculaceae
66	409.56	1601	1	1	0	1	0	1	0	0	0	0
68	429.27	1582	0	0	1	1	0	0	0	0	0	0
70	449.41	1562	0	0	0	0	0	0	0	0	0	0
72	469.99	1541	0	0	2	0	0	0	0	0	0	1
74	490.99	1520	0	0	0	1	0	0	0	0	0	0
76	512.42	1499	1	1	0	2	0	0	0	0	0	0
78	534.28	1477	0	1	1	0	0	1	0	1	0	0
80	556.58	1454	1	0	1	0	0	0	0	1	0	0

Depth (cm)	Cal Years (before 2011)	Year (AD)	Rosaceae	Polygonaceae	Ilex	Vitaceae	Cornaceae	Leguminosae	Ericaceae	Lycopus virginicus	Saxifraga	Rubus
1	2.71	2008	1	0	1	0	0	0	0	0	0	0
2	5.54	2005	1	0	0	0	1	0	0	0	0	0
3	8.47	2003	0	0	2	0	0	0	0	0	0	0
4	11.50	1999	0	0	0	0	0	0	0	0	0	1
5	14.65	1996	2	0	0	0	0	0	0	0	0	0
6	17.90	1993	0	0	0	1	0	0	0	2	0	0
7	21.26	1990	0	0	2	1	0	0	0	0	0	0
8	24.73	1986	0	0	0	0	0	0	1	0	1	0
9	28.30	1983	2	0	0	0	0	0	0	0	0	0
10	31.98	1979	0	0	2	1	0	0	0	0	0	0
11	35.77	1975	1	0	0	0	0	0	0	0	0	0
12	39.67	1971	0	0	0	0	0	0	0	0	0	0
13	43.67	1967	2	0	0	1	1	0	0	0	0	0
14	47.78	1963	0	0	0	0	0	0	0	0	0	0
16	56.33	1955	0	0	2	0	0	0	0	0	0	0
18	65.30	1946	0	0	0	0	0	0	0	0	0	2
20	74.70	1936	0	0	0	0	1	0	0	0	0	1
22	84.54	1926	0	0	0	0	0	0	0	0	0	0
24	94.80	1916	0	0	0	0	0	0	0	0	0	0
26	105.49	1906	0	0	0	0	0	0	0	0	0	0
28	116.61	1894	0	0	0	0	0	0	0	0	0	1
29	122.34	1889	0	0	1	1	0	0	0	0	0	0
30	128.17	1883	0	0	0	0	1	0	0	0	0	0
32	140.15	1871	1	0	0	0	0	0	1	0	0	0
34	152.56	1858	2	0	1	1	1	0	0	0	0	0
36	165.40	1846	1	0	0	1	0	0	0	0	0	0
38	178.67	1832	0	0	2	1	0	0	0	0	0	0
40	192.37	1819	1	0	1	2	0	0	0	0	0	0
42	206.50	1805	2	0	2	1	0	0	0	0	0	0
44	221.06	1790	0	0	1	0	0	0	0	0	0	0
46	236.04	1775	0	0	1	0	1	0	0	0	0	0
48	251.46	1760	3	0	0	1	1	0	0	0	0	0
50	267.31	1744	0	0	1	0	1	0	2	0	0	0
52	283.59	1727	0	0	0	0	1	0	0	0	0	0
54	300.29	1711	3	0	3	0	0	0	0	0	0	0
56	317.43	1694	0	0	2	0	0	0	0	0	0	0
58	335.00	1676	1	0	0	0	0	0	0	0	0	0
60	352.99	1658	2	1	0	0	0	0	0	0	0	0
62	371.42	1640	1	0	1	2	1	0	0	0	0	0
64	390.27	1621	0	0	2	0	2	0	1	0	0	0

Depth (cm)	**Cal Years (before 2011)**	**Year (AD)**	Rosaceae	Polygonaceae	Ilex	Vitaceae	Cornaceae	Leguminosae	Ericaceae	Lycopus virginicus	Saxifraga	Rubus
66	409.56	1601	1	0	0	0	2	0	0	0	0	0
68	429.27	1582	1	0	2	1	1	0	1	0	0	0
70	449.41	1562	0	0	1	0	1	0	0	0	1	0
72	469.99	1541	1	0	1	0	1	0	0	0	0	0
74	490.99	1520	1	0	1	0	1	0	0	0	0	0
76	512.42	1499	1	0	0	0	0	0	0	0	0	0
78	534.28	1477	0	0	1	0	1	0	0	0	0	0
80	556.58	1454	1	0	1	2	0	0	1	0	0	0

Depth (cm)	**Cal Years (before 2011)**	**Year (AD)**	Nymphaea	Lemna	Sparganium	Cystopteris	Lycopus virginicus	Pteridium	Dryopteris	Sphagnum	L. lucidulum	Cystopteris
1	2.71	2008	0	0	0	0	0	0	0	0	0	0
2	5.54	2005	0	1	1	0	0	2	2	0	0	2
3	8.47	2003	0	0	0	0	0	1	4	0	0	0
4	11.50	1999	0	0	0	0	0	0	2	0	0	0
5	14.65	1996	0	0	0	0	0	0	0	0	0	0
6	17.90	1993	0	0	0	0	0	0	0	0	1	1
7	21.26	1990	0	0	0	0	0	0	0	0	1	0
8	24.73	1986	0	0	1	1	0	0	4	0	0	0
9	28.30	1983	0	0	0	0	0	0	5	0	0	1
10	31.98	1979	0	1	0	0	0	2	2	0	0	1
11	35.77	1975	0	0	0	0	0	0	2	0	0	0
12	39.67	1971	1	0	0	0	0	0	3	0	2	0
13	43.67	1967	0	0	0	0	0	0	4	0	0	0
14	47.78	1963	0	0	0	0	0	1	0	0	0	1
16	56.33	1955	0	1	0	0	0	2	2	0	1	1
18	65.30	1946	1	0	0	0	0	0	4	0	3	0
20	74.70	1936	0	0	0	0	0	3	3	0	1	0
22	84.54	1926	0	0	0	0	0	0	1	0	0	1
24	94.80	1916	0	0	0	0	0	0	1	0	0	0
26	105.49	1906	0	1	0	0	0	0	2	0	0	1
28	116.61	1894	0	2	0	0	0	1	5	0	0	0
29	122.34	1889	0	1	0	0	0	0	1	0	0	3
30	128.17	1883	0	0	0	0	0	3	2	0	0	0
32	140.15	1871	0	0	0	0	0	1	1	0	0	0
34	152.56	1858	2	0	0	0	0	1	1	0	0	0
36	165.40	1846	0	0	0	0	0	1	1	0	1	0
38	178.67	1832	0	0	0	0	0	0	0	0	0	0
40	192.37	1819	0	0	0	0	0	0	1	0	0	0
42	206.50	1805	1	0	0	0	0	0	3	0	0	0
44	221.06	1790	0	0	0	0	0	0	2	0	0	0
46	236.04	1775	0	0	0	0	0	1	4	0	0	0
48	251.46	1760	0	0	0	0	0	0	1	0	0	0
50	267.31	1744	0	0	0	0	0	0	3	0	0	0
52	283.59	1727	1	0	0	0	0	0	3	0	0	0
54	300.29	1711	1	0	0	0	1	0	3	0	0	0
56	317.43	1694	0	0	0	0	0	1	2	0	0	0
58	335.00	1676	1	0	0	0	0	1	3	0	0	0
60	352.99	1658	0	0	0	0	0	0	3	0	0	0
62	371.42	1640	1	0	0	0	0	0	3	0	0	0
64	390.27	1621	3	0	0	0	0	2	6	0	0	0

Depth (cm)	Cal Years (before 2011)	Year (AD)	Nymphaea	Lemna	Sparganium	Cystopteris	Lycopus virginicus	Pteridium	Dryopteris	Sphagnum	L. lucidulum	Cystopteris
66	409.56	1601	0	0	0	0	0	1	3	0	0	0
68	429.27	1582	0	0	0	0	0	0	0	0	0	0
70	449.41	1562	1	0	0	0	0	1	1	0	0	0
72	469.99	1541	0	0	0	0	0	2	1	0	0	0
74	490.99	1520	0	0	0	0	0	2	4	0	0	0
76	512.42	1499	0	0	0	0	0	0	3	0	0	0
78	534.28	1477	0	0	0	0	0	0	3	0	0	0
80	556.58	1454	2	0	0	0	0	0	3	0	0	0

Depth (cm)	**Cal Years (before 2011)**	**Year (AD)**	cf. Lycopodium	Dryopteris thelypteris	Osmunda	Botrychium	**L. clavatum (Exotic)**	**Total**
1	2.71	2008	0	0	0	0	125	533.5
2	5.54	2005	0	0	0	0	108	563
3	8.47	2003	0	0	0	0	102	548
4	11.50	1999	0	0	0	0	68	575.5
5	14.65	1996	0	0	0	0	86	508.5
6	17.90	1993	0	0	0	0	76	502.5
7	21.26	1990	0	0	0	0	111	542.5
8	24.73	1986	1	0	0	0	89	571
9	28.30	1983	3	1	0	0	68	511.5
10	31.98	1979	0	0	0	1	83	552
11	35.77	1975	0	0	0	0	103	547.5
12	39.67	1971	1	0	1	0	76	523
13	43.67	1967	0	0	0	0	85	503
14	47.78	1963	0	0	0	0	56	493.5
16	56.33	1955	0	0	0	0	68	547.5
18	65.30	1946	0	0	0	0	48	529
20	74.70	1936	0	0	0	0	58	688.5
22	84.54	1926	0	0	0	0	30	558
24	94.80	1916	0	1	0	0	49	515
26	105.49	1906	0	0	0	0	34	525.5
28	116.61	1894	0	0	0	0	46	692.5
29	122.34	1889	0	0	0	0	36	593.5
30	128.17	1883	0	0	0	0	44	502
32	140.15	1871	0	0	0	0	45	544.5
34	152.56	1858	0	0	0	0	48	499.5
36	165.40	1846	0	0	0	0	50	525
38	178.67	1832	0	0	0	0	31	519
40	192.37	1819	0	0	0	0	41	530
42	206.50	1805	0	0	0	0	41	562.5
44	221.06	1790	0	0	0	0	30	518.5
46	236.04	1775	0	0	0	0	45	546.5
48	251.46	1760	0	0	0	0	39	512
50	267.31	1744	0	0	0	0	31	501.5
52	283.59	1727	0	0	0	0	44	507
54	300.29	1711	0	0	0	0	40	573.5
56	317.43	1694	0	0	0	0	39	541
58	335.00	1676	0	0	0	0	28	495
60	352.99	1658	0	0	0	0	32	516.5
62	371.42	1640	0	0	0	0	41	522
64	390.27	1621	0	0	1	0	31	539

Depth (cm)	**Cal Years (before 2011)**	**Year (AD)**	cf. Lycopodium	Dryopteris thelypteris	Osmunda	Botrychium	**L. clavatum (Exotic)**	**Total**
66	409.56	1601	0	0	1	0	38	529.5
68	429.27	1582	0	0	0	0	36	500.5
70	449.41	1562	0	0	0	0	31	549
72	469.99	1541	0	0	0	0	42	580
74	490.99	1520	0	0	0	0	40	562.5
76	512.42	1499	0	0	0	0	34	516
78	534.28	1477	0	0	0	0	32	563
80	556.58	1454	0	0	0	0	46	573

Appendix C: Charcoal Data

Tawny Pond

Depth (cm)	**Cal Year (before 2011)**	**Years (AD)**	Class 1 (1/16 to 1/8)	Class 2 (1/8 to1/4)	Class 3 (1/4 to 1/2)	Class 4 (1/2 to 1)	Class 5 (1 or larger)	***L. clavatum* (Exotic)**	**Total Count**
0	0.00	2011	16	5	5	0	0	176	26
0.5	1.94	2009	11	4	1	0	0	189	16
1	3.86	2007	12	6	1	0	0	152	19
1.5	5.75	2005	8	3	0	0	0	136	11
2	7.63	2003	15	5	4	0	0	191	24
2.5	9.47	2002	18	7	0	0	0	165	25
3	11.30	2000	20	10	2	0	0	178	32
3.5	13.10	1998	28	8	0	1	0	126	37
4	14.88	1996	28	5	4	0	1	134	38
4.5	16.64	1994	35	8	2	0	1	108	46
5	18.38	1993	14	7	1	0	0	99	22
5.5	20.10	1991	17	3	1	0	0	103	21
6	21.79	1989	5	3	0	1	0	105	9
6.5	23.47	1988	8	2	0	0	0	103	10
7	25.13	1986	32	6	2	0	0	140	40
7.5	26.77	1984	20	1	0	0	0	104	21
8	28.39	1983	30	8	3	4	4	133	49
8.5	29.99	1981	20	6	2	0	1	88	29
9	31.57	1979	18	2	1	0	0	60	21
9.5	33.13	1978	11	4	0	0	0	70	15
10	34.68	1976	8	3	0	0	0	134	11
10.5	36.21	1975	4	7	2	0	0	62	13
11	37.72	1973	9	1	0	1	0	90	11
11.5	39.22	1972	15	1	2	0	0	87	18
12	40.70	1970	10	4	1	0	0	97	15
12.5	42.17	1969	24	5	0	0	0	86	29
13	43.62	1967	26	6	2	0	0	90	34
13.5	45.05	1966	25	2	1	3	0	107	31
14	46.47	1965	24	6	1	0	0	78	31
15	49.28	1962	21	5	0	0	0	138	26
15.5	50.66	1960	11	2	3	0	0	120	16
16	52.02	1959	20	2	1	0	1	83	24
17	54.72	1956	9	6	1	0	0	95	16
17.5	56.05	1955	6	0	0	0	0	88	6
18	57.37	1954	17	4	1	0	0	149	22
18.5	58.68	1952	7	0	1	0	0	88	8
19	59.98	1951	18	2	0	0	0	120	20

Depth (cm)	**Cal Year (before 2011)**	**Years (AD)**	Class 1 (1/16 to 1/8)	Class 2 (1/8 to1/4)	Class 3 (1/4 to 1/2)	Class 4 (1/2 to 1)	Class 5 (1 or larger)	**L. clavatum (Exotic)**	**Total Count**
19.5	61.26	1950	13	4	1	0	0	55	18
20	62.54	1948	16	5	2	0	1	103	24
20.5	63.81	1947	9	3	0	0	0	76	12
21	65.07	1946	7	2	0	0	0	61	9
21.5	66.32	1945	10	2	3	2	0	77	17
22	67.56	1943	16	3	0	0	0	150	19
23	70.02	1941	6	2	0	0	0	50	8
24	72.45	1939	9	2	2	1	0	99	14
25	74.85	1936	11	3	1	0	0	52	15
26	77.23	1934	14	3	0	0	0	53	17
27	79.59	1931	10	3	0	0	0	65	13
28	81.93	1929	2	1	2	0	0	65	5
29	84.26	1927	6	2	2	0	0	51	10
30	86.58	1924	14	4	1	0	0	45	19
31	88.89	1922	12	2	3	1	0	57	18
32	91.19	1920	11	3	0	0	0	52	14
33	93.50	1918	10	3	0	0	0	67	13
34	95.80	1915	9	0	1	0	0	48	10
35	98.11	1913	19	2	1	0	0	58	22
36	100.42	1911	10	3	1	0	0	37	14
37	102.74	1908	11	3	1	1	0	54	16
38	105.08	1906	10	2	2	0	0	46	14
39	107.43	1904	13	2	1	0	1	58	17
40	109.80	1901	12	4	4	1	0	53	21
41	112.19	1899	4	2	3	0	0	31	9
42	114.61	1896	15	3	0	1	1	63	20
43	117.05	1894	11	1	0	0	0	70	12
44	119.53	1891	6	2	2	1	1	62	12
45	122.04	1889	16	1	0	0	0	58	17
46	124.59	1886	10	4	0	1	0	50	15
47	127.17	1884	3	1	2	1	2	77	9
48	129.80	1881	11	4	1	1	0	70	17
49	132.48	1879	9	6	1	2	1	69	19
50	135.20	1876	16	6	1	2	1	56	26
51	137.98	1873	5	0	0	0	0	78	5
52	140.81	1870	9	3	3	0	0	63	15
53	143.69	1867	4	2	1	0	0	87	7
54	146.64	1864	5	1	1	0	0	72	7
55	149.66	1861	4	3	0	1	0	102	8
56	152.73	1858	5	1	0	0	0	88	6

Depth (cm)	**Cal Year (before 2011)**	**Years (AD)**	Class 1 (1/16 to 1/8)	Class 2 (1/8 to1/4)	Class 3 (1/4 to 1/2)	Class 4 (1/2 to 1)	Class 5 (1 or larger)	**L. clavatum (Exotic)**	**Total Count**
57	155.88	1855	1	0	0	1	0	65	2
58	159.11	1852	4	0	0	0	0	74	4
59	162.40	1849	4	0	0	0	0	81	4
60	165.78	1845	7	1	0	0	0	58	8
61	169.24	1842	2	0	0	0	0	65	2
62	172.78	1838	5	1	0	0	0	55	6
63	176.41	1835	5	4	0	0	1	45	10
64	180.13	1831	0	1	0	0	0	62	1
65	183.95	1827	1	0	1	0	0	60	2
66	187.86	1823	4	1	0	0	0	54	5
67	191.87	1819	2	0	0	0	0	68	2
68	195.99	1815	4	0	0	0	0	67	4
69	200.21	1811	1	1	0	0	0	76	2
70	204.54	1806	3	0	0	0	0	78	3
71	208.98	1802	7	0	1	0	0	68	8
72	213.54	1797	5	0	0	0	0	55	5
73	218.21	1793	6	1	0	0	0	88	7
74	223.01	1788	3	0	0	0	0	67	3
75	227.93	1783	3	0	0	0	0	73	3
76	232.97	1778	2	0	0	0	0	89	2
77	238.15	1773	3	0	0	0	0	89	3
78	243.45	1768	3	1	0	0	0	118	4
79	248.90	1762	8	0	1	0	0	76	9
80	254.48	1757	8	1	2	0	0	126	11
80.5	257.32	1754	2	0	0	0	0	90	2
81	260.20	1751	3	0	0	0	0	111	3
81.5	263.12	1748	9	1	0	0	0	85	10
82	266.07	1745	9	1	1	0	0	130	11
82.5	269.06	1742	2	3	1	0	0	76	6
83	272.09	1739	2	0	1	0	0	86	3
83.5	275.16	1736	2	2	0	1	0	104	5
84	278.26	1733	11	2	0	0	0	122	13
85	284.58	1726	3	0	0	0	0	94	3
86	291.06	1720	6	1	0	0	0	182	7
87	297.70	1713	6	0	0	0	0	111	6
88	304.50	1707	5	2	1	0	0	136	8
89	311.46	1700	5	0	0	0	0	119	5
90	318.60	1692	15	0	2	2	0	151	19
91	325.91	1685	5	3	0	0	0	125	8
92	333.39	1678	6	1	0	0	0	116	7

Depth (cm)	Cal Year (before 2011)	Years (AD)	Class 1 (1/16 to 1/8)	Class 2 (1/8 to1/4)	Class 3 (1/4 to 1/2)	Class 4 (1/2 to 1)	Class 5 (1 or larger)	L. clavatum (Exotic)	Total Count
93	341.05	1670	4	2	0	2	0	102	8
94	348.89	1662	3	0	0	0	0	105	3
95	356.92	1654	7	2	1	0	0	71	10
96	365.13	1646	5	0	0	0	0	99	5
97	373.53	1637	2	0	0	1	0	74	3
98	382.12	1629	3	0	0	0	0	102	3
99	390.91	1620	2	0	1	0	0	43	3
100	399.90	1611	1	0	0	0	0	83	1
101	409.09	1602	3	0	0	0	0	50	3
102	418.49	1593	3	0	0	0	0	71	3
103	428.09	1583	1	1	0	1	0	91	3
104	437.90	1573	5	0	0	0	0	106	5
105	447.93	1563	2	1	0	1	0	59	4
106	458.17	1553	3	1	0	0	0	72	4
107	468.64	1542	1	0	0	0	0	56	1
108	479.33	1532	1	0	1	0	0	62	2
109	490.24	1521	1	0	0	0	0	48	1
110	501.38	1510	1	0	1	0	0	73	2
111	512.75	1498	1	2	1	0	0	48	4
112	524.36	1487	1	0	0	0	0	56	1
113	536.21	1475	4	2	0	0	0	91	6
114	548.29	1463	0	2	0	1	0	62	3
115	560.63	1450	4	1	0	0	0	92	5
116	573.20	1438	1	2	2	0	0	88	5
117	586.03	1425	3	2	0	0	0	64	5
118	599.11	1412	1	0	0	0	0	69	1
119	612.45	1399	1	2	0	0	0	64	3
120	626.04	1385	3	1	0	0	0	42	4
121	639.90	1371	2	0	1	0	0	85	3
122	654.02	1357	3	0	0	0	0	70	3
123	668.41	1343	2	0	2	0	0	67	4
124	683.07	1328	1	1	0	0	0	48	2
125	698.00	1313	2	0	2	0	0	74	4
126	713.21	1298	4	0	0	1	0	62	5
127	728.70	1282	1	2	0	0	0	87	3
128	744.47	1267	3	1	0	0	0	49	4
129	760.53	1250	2	0	0	0	0	50	2
130	776.88	1234	2	2	0	0	0	31	4
131	793.52	1217	4	0	0	0	0	63	4
132	810.45	1201	1	0	0	0	0	41	1

Depth (cm)	Cal Year (before 2011)	Years (AD)	Class 1 (1/16 to 1/8)	Class 2 (1/8 to1/4)	Class 3 (1/4 to 1/2)	Class 4 (1/2 to 1)	Class 5 (1 or larger)	L. clavatum (Exotic)	Total Count
133	827.69	1183	3	1	0	0	0	85	4
134	845.22	1166	2	0	0	0	0	42	2
135	863.06	1148	0	2	1	0	0	70	3
136	881.20	1130	1	0	0	0	0	46	1
137	899.65	1111	5	1	1	0	0	57	7
138	918.42	1093	3	0	2	0	0	39	5
139	937.50	1074	2	0	0	0	0	63	2
140	956.90	1054	3	1	1	0	1	37	6
141	976.62	1034	4	1	0	0	0	51	5
142	996.67	1014	3	0	0	0	0	32	3
143	1017.04	994	7	2	0	0	0	45	9
144	1037.75	973	5	1	0	0	0	39	6

Stoll Lake

Depth (cm)	Cal Years (before 2011)	Year (AD)	Class 1 (1/16 to 1/8)	Class 2 (1/8 to1/4)	Class 3 (1/4 to 1/2)	Class 4 (1/2 to 1)	Class 5 (1 or larger)	L. clavatum (Exotic)	Total Count
1	2.71	2008	13	8	4	1	0	70	26
2	5.54	2005	7	5	10	1	2	56	25
3	8.47	2003	11	11	4	0	0	50	26
4	11.50	1999	11	3	4	0	0	33	18
5	14.65	1996	5	10	3	2	2	43	22
6	17.90	1993	21	5	2	3	0	40	31
7	21.26	1990	13	6	0	5	2	55	26
8	24.73	1986	19	9	2	1	1	46	32
9	28.30	1983	10	2	0	0	0	38	12
10	31.98	1979	9	3	0	2	0	43	14
11	35.77	1975	21	5	2	0	3	53	31
12	39.67	1971	14	8	3	0	0	38	25
13	43.67	1967	38	14	5	2	0	44	59
14	47.78	1963	24	6	2	0	4	29	36
16	56.33	1955	69	22	21	11	19	21	142
18	65.30	1946	11	8	2	0	0	32	21
20	74.70	1936	14	11	6	3	0	30	34
22	84.54	1926	2	5	0	0	1	20	8
24	94.80	1916	8	2	0	0	0	26	10
26	105.49	1906	2	3	3	0	1	20	9
28	116.61	1894	1	0	0	1	0	25	2
29	122.34	1889	8	4	4	1	0	19	17
30	128.17	1883	1	0	0	0	0	24	1
32	140.15	1871	2	1	1	0	0	25	4
34	152.56	1858	4	1	0	0	1	25	6
36	165.40	1846	2	0	0	1	0	25	3
38	178.67	1832	3	0	0	0	0	16	3
40	192.37	1819	5	0	0	0	0	23	5
42	206.50	1805	4	2	0	0	0	20	6
44	221.06	1790	4	0	0	0	0	16	4
46	236.04	1775	13	1	1	1	0	23	16
48	251.46	1760	4	1	0	0	0	23	5
50	267.31	1744	5	1	0	0	0	15	6
52	283.59	1727	15	5	1	1	0	22	22
54	300.29	1711	3	1	0	0	0	23	4
56	317.43	1694	1	0	0	0	0	20	1
58	335.00	1676	3	0	0	0	0	14	3
60	352.99	1658	5	1	0	0	0	17	6
62	371.42	1640	5	0	0	0	0	22	5

Depth (cm)	Cal Years (before 2011)	Year (AD)	Class 1 (1/16 to 1/8)	Class 2 (1/8 to1/4)	Class 3 (1/4 to 1/2)	Class 4 (1/2 to 1)	Class 5 (1 or larger)	L. clavatum (Exotic)	Total Count
64	390.27	1621	5	1	1	0	0	16	7
66	409.56	1601	1	0	0	0	0	19	1
68	429.27	1582	4	2	1	0	0	20	7
70	449.41	1562	3	2	2	0	0	17	7
72	469.99	1541	3	0	0	0	0	23	3
74	490.99	1520	3	2	0	0	0	19	5
76	512.42	1499	2	0	0	0	0	18	2
78	534.28	1477	2	0	0	0	0	16	2
80	556.58	1454	5	0	0	0	0	24	5

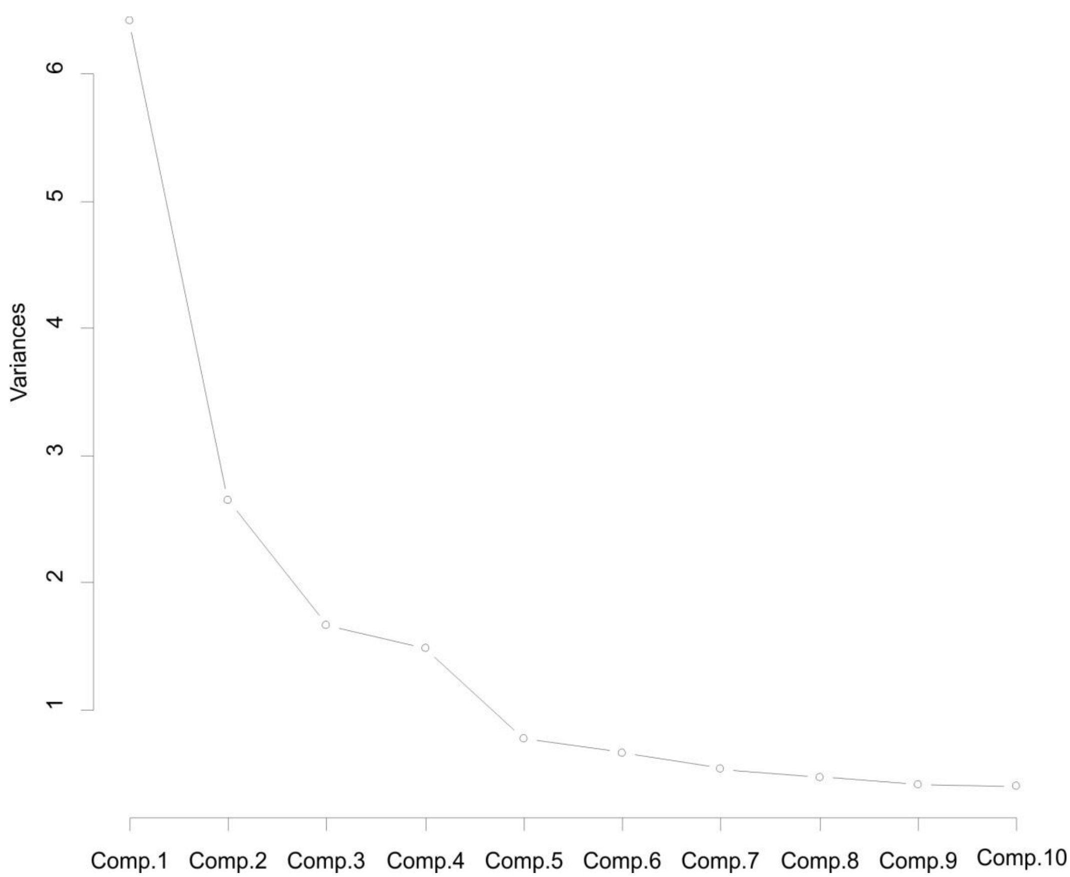
Appendix D: Principal components analysis (PCA) Code and Graphs

Tawny Pond

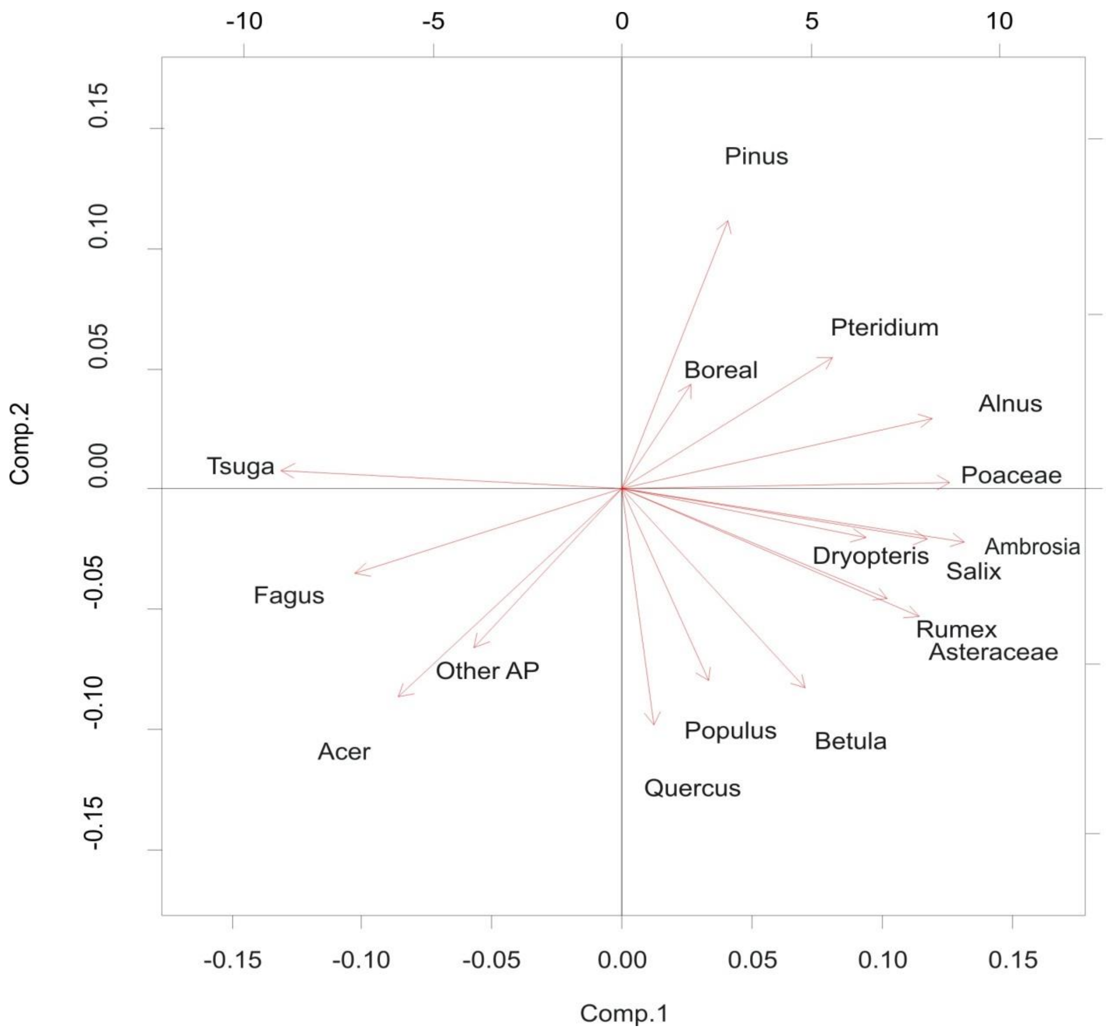
```
> setwd("c:\\data")
> list.files()
[1] "Tawny Pond_PCA thesis_xls.xls" "tawny.csv"
> tawny.df<-read.csv("c:\\data\\tawny.csv", header=T)
> names(tawny.df)

>tawny.pca<-princomp(tawny.df[3:19], cor=T)
> summary(tawny.pca, loadings=T, cutoff=0)
>tawny.pca$scores[,1:4]

>biplot(tawny.pca)
```



Scree Plot from Tawny Pond PCA.



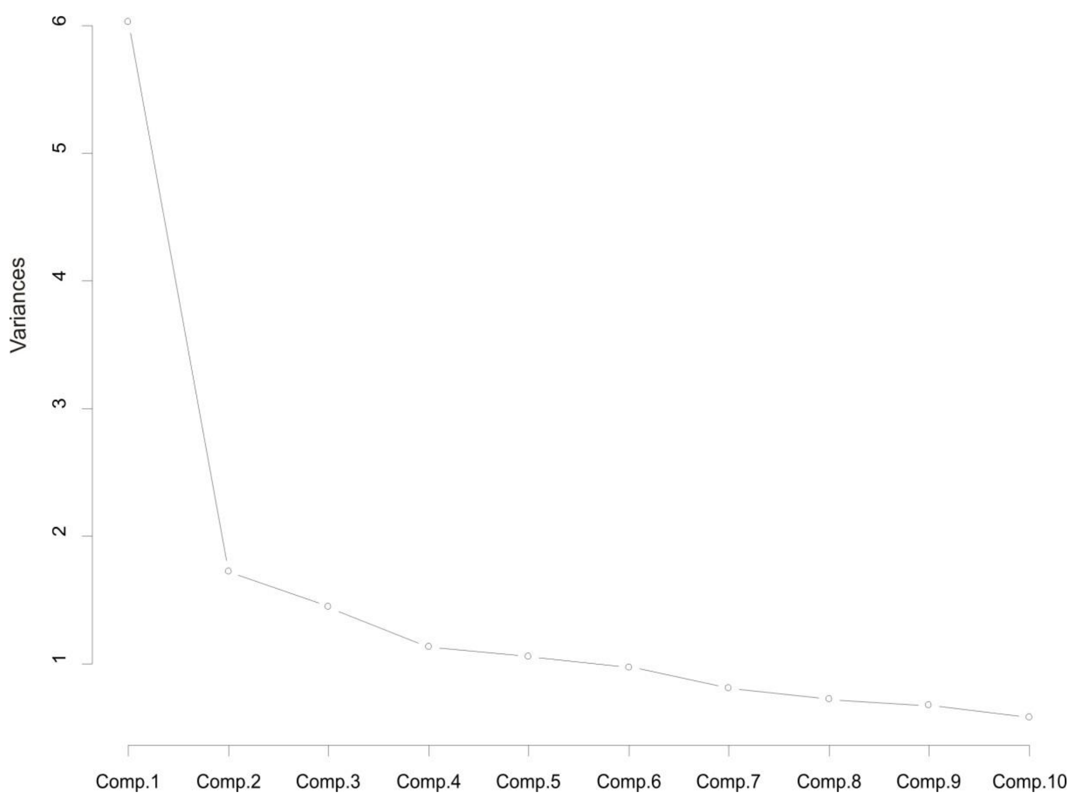
Loadings of components one and two from Tawny Pond PCA.

Stoll Lake

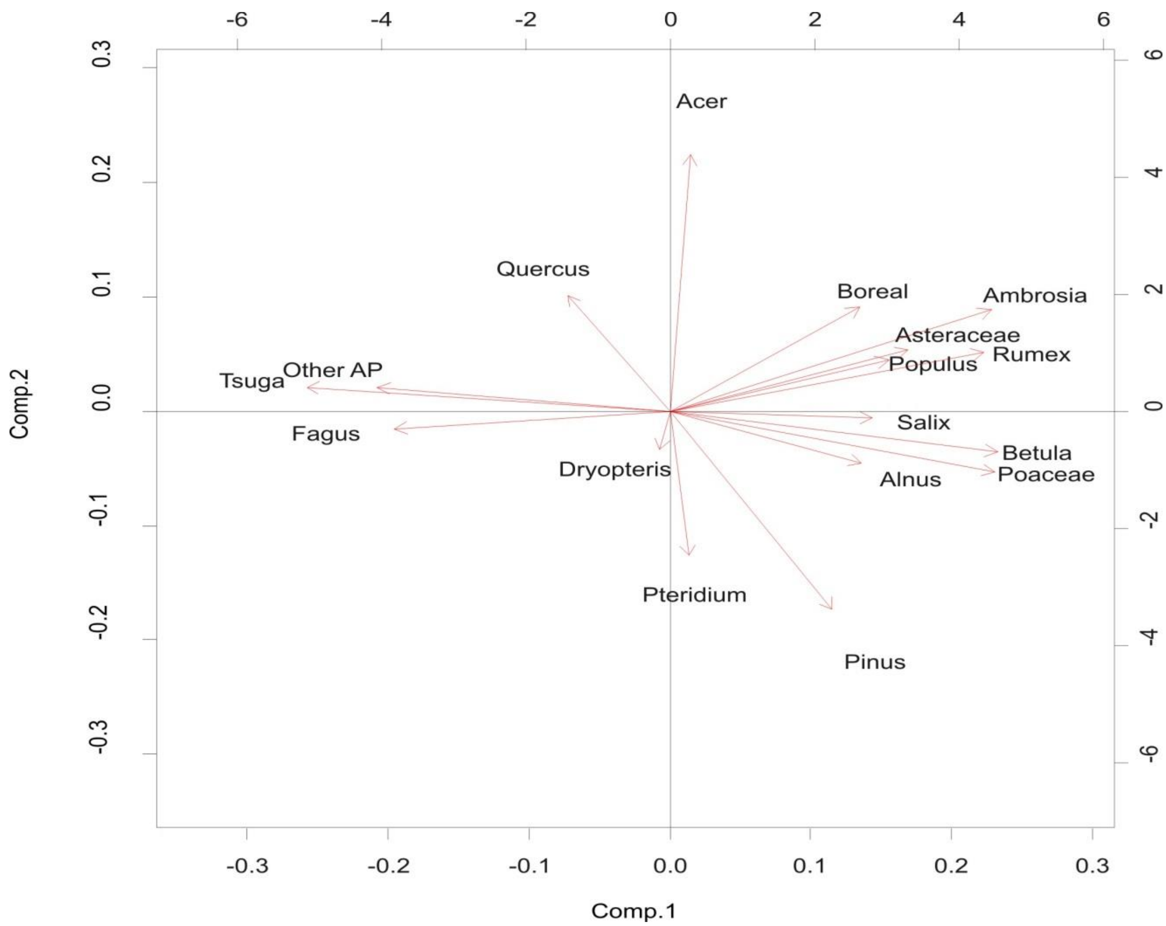
```
> setwd("c:\\data")
> list.files()
> Stoll.df<-read.csv("c:\\data\\Stoll.csv", header=T)
> names(Stoll.df)

>Stoll.pca<-princomp(Stoll.df[3:19], cor=T)
>Stoll.pca$scores[,1:4]

>biplot(Stoll.pca)
```



Scree Plot from Stoll Lake PCA.



Loadings plot of components one and two from Stoll Lake PCA.

Appendix E: Paleoclimate Reconstruction

Modern Analogue Technique reconstruction of Tawny Pond.

Depth (cm)	Years (AD)	Cal Year (before 2011)	Mean Temperature June, July, August (°C)	Minimum dissimilarity coefficient	Total Precipitation June, July, August (mm)
0	2011	0	17.57	5.00	261.00
0.5	2009	2	16.91	5.93	267.00
1	2007	4	16.74	4.57	252.33
1.5	2005	6	17.90	3.81	283.33
2	2003	8	17.46	5.87	269.33
2.5	2002	9	18.54	4.07	264.67
3	2000	11	17.32	3.96	246.00
3.5	1998	13	18.19	5.22	260.00
4	1996	15	18.97	4.49	296.00
4.5	1994	17	18.32	4.94	270.67
5	1993	18	17.58	6.73	249.67
5.5	1991	20	18.34	4.21	246.00
6	1989	22	18.59	3.84	295.67
6.5	1988	23	16.96	4.43	244.67
7	1986	25	17.98	4.75	277.33
7.5	1984	27	17.00	5.63	269.00
8	1983	28	17.41	3.14	285.00
8.5	1981	30	17.49	5.34	254.67
9	1979	32	17.00	4.87	269.00
9.5	1978	33	16.74	4.58	244.00
10	1976	35	17.42	5.01	298.67
10.5	1975	36	16.79	3.95	264.67
11	1973	38	17.89	3.95	306.00
11.5	1972	39	17.82	4.78	263.67
12	1970	41	17.52	3.82	274.00
12.5	1969	42	17.23	4.25	234.00
13	1967	44	16.97	4.42	273.33
13.5	1966	45	16.97	3.49	273.33
14	1965	46	17.77	5.29	274.00
15	1962	49	16.88	4.14	292.00
15.5	1960	51	17.91	4.17	245.00
16	1959	52	17.77	4.65	298.00
17	1956	55	18.14	3.61	287.33
17.5	1955	56	18.11	2.93	264.67
18	1954	57	17.19	4.15	280.67
18.5	1952	59	17.30	4.55	231.67
19	1951	60	17.38	3.51	283.67
19.5	1950	61	18.26	3.64	290.33
20	1948	63	17.96	4.31	269.33
20.5	1947	64	17.64	3.72	247.33

Depth (cm)	Years (AD)	Cal Year (before 2011)	Mean Temperature June, July, August (°C)	Minimum dissimilarity coefficient	Total Precipitation June, July, August (mm)
21	1946	65	18.07	3.44	301.33
21.5	1945	66	17.87	3.91	279.67
22	1943	68	17.20	4.41	272.67
23	1941	70	18.27	4.13	302.00
24	1939	72	17.77	5.13	294.33
25	1936	75	18.03	5.32	271.33
26	1934	77	17.59	4.35	282.00
27	1931	80	17.42	3.46	295.33
28	1929	82	16.97	5.60	273.33
29	1927	84	17.33	3.93	253.00
30	1924	87	17.59	4.30	282.00
31	1922	89	18.26	5.78	290.33
32	1920	91	17.62	4.59	274.67
33	1918	93	17.56	5.18	258.67
34	1915	96	17.57	6.08	254.00
35	1913	98	18.03	5.03	271.33
36	1911	100	17.93	5.30	266.00
37	1908	103	17.87	4.36	253.00
38	1906	105	17.26	4.20	239.67
39	1904	107	17.57	3.97	254.00
40	1901	110	17.84	5.42	280.33
41	1899	112	18.27	5.34	302.00
42	1896	115	18.21	5.77	281.33
43	1894	117	17.57	4.93	254.00
44	1891	120	17.89	4.68	276.00
45	1889	122	17.33	5.38	253.00
46	1886	125	17.83	5.57	248.00
47	1884	127	18.08	4.27	263.00
48	1881	130	17.63	4.74	256.33
49	1879	132	17.77	4.14	248.67
50	1876	135	17.26	3.12	239.67
51	1873	138	17.77	2.90	248.67
52	1870	141	17.26	3.98	239.67
53	1867	144	17.77	2.23	248.67
54	1864	147	17.57	3.97	272.67
55	1861	150	17.36	5.19	262.67
56	1858	153	17.26	3.74	239.67
57	1855	156	17.26	4.80	239.67
58	1852	159	17.19	3.97	304.33
59	1849	162	17.63	3.86	237.67
60	1845	166	17.90	3.63	267.00
61	1842	169	17.90	3.52	267.00
62	1838	173	17.63	3.91	237.67
63	1835	176	17.36	5.14	262.67

Depth (cm)	Years (AD)	Cal Year (before 2011)	Mean Temperature June, July, August (°C)	Minimum dissimilarity coefficient	Total Precipitation June, July, August (mm)
64	1831	180	17.77	4.06	248.67
65	1827	184	17.63	4.71	237.67
66	1823	188	17.77	3.05	248.67
67	1819	192	17.78	3.02	284.33
68	1815	196	17.54	4.12	243.00
69	1811	200	17.30	3.24	231.67
70	1806	205	17.81	4.24	240.67
71	1802	209	17.13	4.78	234.00
72	1797	214	17.42	5.89	242.33
73	1793	218	17.73	3.65	247.00
74	1788	223	18.08	4.55	271.33
75	1783	228	17.79	4.39	282.67
76	1778	233	17.74	5.11	239.67
77	1773	238	17.09	5.40	256.00
78	1768	243	17.84	5.22	256.33
79	1762	249	17.24	3.58	234.33
80	1757	254	17.26	5.44	232.33
80.5	1754	257	17.42	4.65	279.67
81	1751	260	18.09	7.65	239.00
81.5	1748	263	17.78	5.75	277.67
82	1745	266	17.90	5.00	259.67
82.5	1742	269	18.24	4.34	290.67
83	1739	272	18.59	7.01	252.00
83.5	1736	275	17.84	6.24	256.33
84	1733	278	18.41	5.05	253.00
85	1726	285	17.66	6.99	235.00
86	1720	291	17.58	7.12	245.67
87	1713	298	17.99	5.99	250.00
88	1707	304	17.09	6.28	238.33
89	1700	311	17.48	6.69	256.67
90	1692	319	18.44	8.05	258.33
91	1685	326	17.99	8.54	250.00
92	1678	333	17.58	6.11	262.33
93	1670	341	17.99	6.17	250.00
94	1662	349	17.93	6.23	251.67
95	1654	357	17.99	7.58	250.00
96	1646	365	17.94	5.68	228.67
97	1637	374	18.09	8.55	243.67
98	1629	382	17.99	5.90	250.00
99	1620	391	18.53	13.50	258.00
100	1611	400	18.09	6.88	243.67
101	1602	409	18.53	10.27	258.00
102	1593	418	18.42	6.76	259.00
103	1583	428	18.43	8.38	264.33

Depth (cm)	Years (AD)	Cal Year (before 2011)	Mean Temperature June, July, August (°C)	Minimum dissimilarity coefficient	Total Precipitation June, July, August (mm)
104	1573	438	17.99	6.68	255.00
105	1563	448	18.58	8.26	251.00
106	1553	458	18.33	4.92	268.33
107	1542	469	18.53	8.27	258.00
108	1532	479	18.14	6.37	242.33
109	1521	490	18.14	7.03	247.00
110	1510	501	18.14	5.91	242.33
111	1498	513	18.58	5.60	251.00
112	1487	524	18.14	6.60	242.33
113	1475	536	17.90	4.63	259.67
114	1463	548	18.09	7.65	239.00
115	1450	561	17.66	5.28	235.00
116	1438	573	18.23	6.32	237.00
117	1425	586	17.97	4.16	223.67
118	1412	599	18.48	5.85	257.33
119	1399	612	18.29	4.44	238.00
120	1385	626	17.74	4.01	229.67
121	1371	640	18.14	4.83	242.33
122	1357	654	18.14	5.68	242.33
123	1343	668	18.41	6.26	253.00
124	1328	683	18.41	5.32	257.67
125	1313	698	18.41	5.23	253.00
126	1298	713	18.58	3.57	251.00
127	1282	729	18.14	6.39	242.33
128	1267	744	18.42	5.32	263.67
129	1250	761	18.14	4.93	242.33
130	1234	777	18.41	4.87	257.67
131	1217	794	18.58	3.60	251.00
132	1201	810	17.66	3.84	235.00
133	1183	828	17.98	6.92	249.00
134	1166	845	18.14	7.15	242.33
135	1148	863	18.14	6.99	242.33
136	1130	881	18.58	7.91	251.00
137	1111	900	18.43	5.86	264.33
138	1093	918	18.53	6.26	258.00
139	1074	937	18.58	6.15	251.00
140	1054	957	18.58	8.15	251.00
141	1034	977	18.42	4.84	263.67
142	1014	997	17.99	7.33	255.00
143	994	1017	17.92	6.12	231.00
144	973	1038	18.19	5.70	245.00

Modern Analogue Technique Reconstruction of Stoll Lake.

Depth (cm)	**Years (AD)**	**Cal Year (before 2011)**	**Mean Temperature June, July, August (°C)**	**Minimum dissimilarity coefficient**	**Total Precipitation June, July, August (mm)**
1	2008	3	17.64	3.54	266.00
2	2005	6	17.52	3.70	246.67
3	2003	8	17.54	3.12	243.00
4	1999	12	17.54	2.56	247.67
5	1996	15	17.77	3.13	248.67
6	1993	18	17.26	2.59	239.67
7	1990	21	17.54	4.75	243.00
8	1986	25	17.54	2.82	243.00
9	1983	28	18.19	2.87	270.33
10	1979	32	17.83	3.25	251.00
11	1975	36	17.77	4.23	248.67
12	1971	40	17.51	3.34	255.67
13	1967	44	17.54	5.28	243.00
14	1963	48	17.26	2.34	239.67
16	1955	56	17.26	3.01	239.67
18	1946	65	17.77	4.01	248.67
20	1936	75	17.87	2.29	253.00
22	1926	85	17.83	3.91	251.00
24	1916	95	17.77	3.91	248.67
26	1906	105	17.77	3.42	248.67
28	1894	117	18.19	3.64	270.33
29	1889	122	17.90	3.78	267.00
30	1883	128	17.87	4.19	253.00
32	1871	140	17.26	4.36	239.67
34	1858	153	17.87	5.89	253.00
36	1846	165	17.80	4.55	230.67
38	1832	179	17.92	5.71	236.33
40	1819	192	18.02	6.04	224.67
42	1805	206	17.92	5.66	236.33
44	1790	221	18.29	4.24	238.00
46	1775	236	17.92	5.89	236.33
48	1760	251	17.92	5.08	236.33
50	1744	267	17.92	5.68	236.33
52	1727	284	17.90	5.64	267.00
54	1711	300	17.26	4.58	239.67
56	1694	317	17.92	5.06	236.33
58	1676	335	17.26	5.29	239.67
60	1658	353	18.31	5.81	233.00
62	1640	371	18.31	4.51	233.00
64	1621	390	17.92	5.06	236.33
66	1601	410	17.92	4.33	236.33
68	1582	429	17.87	3.50	235.33

Depth (cm)	Years (AD)	Cal Year (before 2011)	Mean Temperature June, July, August (°C)	Minimum dissimilarity coefficient	Total Precipitation June, July, August (mm)
70	1562	449	17.92	5.14	236.33
72	1541	470	17.92	5.85	236.33
74	1520	491	17.92	4.58	236.33
76	1499	512	17.92	3.75	236.33
78	1477	534	17.92	3.97	236.33
80	1454	557	17.92	6.25	236.33