Late Holocene aggradation in the lower Humber River valley, Toronto, Ontario

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Received January 6, 1988
Revision accepted June 21, 1989

Alluvial fills are common in the lower reaches of rivers along the western shore of Lake Ontario. The Humber River floodplain at Toronto is underlain by a 2.5 km long wedge of alluvium that thins upstream from Lake Ontario. Floodplain sediments were studied for their lithology, 14C age, and fossil pollen. On the levees, grey clay is overlain by oxidized silt and sand. Sediment cores from two flood ponds grade upward from gravel, sand, and silt, to silty marl, mineral peat, and clay, to heterogeneous silt and sand. Base-level (Lake Ontario) rise directly controlled aggradation between 6500 and 1800 years ago, after which time base level no longer directly controlled aggradation because levees had emerged alongside the channel and reduced the supply of sediment to the floodplain. For the past 150 years, upstream forest clearance and urbanization increased sediment input to the floodplain, broadened the levees, and filled the flood ponds.

Average flood-pond aggradation rates were estimated from seven 14C dates; these rates declined from 65 cm/100 years between 6500 and 3800 years ago, to 47 cm/100 years between 3800 and 3400 years ago, to 26 cm/100 years between 3400 and 1800 years ago. These rates reflect contemporaneous lake-level rise. Between 1800 and 150 years ago, the average aggradation rate declined below the estimated rate of lake-level rise to 14 cm/100 years. Since then, the average aggradation rate has increased tenfold to 140 cm/100 years, surpassing the historic rate of lake-level rise of 23 cm/100 years. Fossil pollen from the flood ponds reflects local flood plain and regional upland vegetation during the past 4000 years.

Les dépôts de remplissage alluvionnaire sont fréquents le long des segments rectilignes inférieurs des rivières qui bordent la rive occidentale du lac Ontario. La plaine de débordement de la rivière Humber à Toronto recouvre un prisme d'alluvions d’une longueur de 2,5 km, lequel s’amincit en amont à partir du lac Ontario. Les sédiments de la plaine de débordement ont été étudiés dans le but de caractériser leur lithologie, leurs âges au 14C et leurs pollens fossiles. Sur les levées, l’argile grise est recouverte de sable et de limon oxygénés. Les carottes de sédiments prélevées dans deux étangs d’inondation sont composées de bas en haut de gravier, sable et limon, ensuite de limon marneux, tourbe minérale et argile, puis de limon et sable hétérogènes. L’élévation du niveau de base (lac Ontario) contrôlait directement l’aggradation, il y a entre 6500 et 1800 ans. Depuis 1800 ans, le niveau de base ne contrôlait plus directement cette aggradation, parce que les levées qui avaient émergé le long de la bordure du chenal inhibaient en partie l’alimentation en sédiments de la plaine de débordement. Il y a moins de 150 ans, la déforestation et l’urbanisation en amont ont contribué à accroître la livraison des sédiments vers la plaine de débordement, ont élargi les levées et ont rempli les étangs d’inondation. Les taux moyens d’aggradation dans les étangs d’inondation furent estimés à partir de sept dates 14C; ils diminuèrent de 65 cm/100 ans entre 6300 et 3800 ans, à 47 cm/100 ans entre 3800 et 3400 ans puis à 26 cm/100 ans entre 3400 et 1800 ans. Ces taux attestaient une élévation du niveau du lac contemporaine. Entre 1800 ans et 150 ans, il y a le taux moyen d’aggradation est passé en-dessous du taux estimé d’élévation du niveau du lac de 14 cm/100 ans. Il y a moins de 150 ans, le taux moyen d’aggradation était 10 fois plus élevé, soit 140 cm/100 ans, dépassant alors la plus forte élévation du niveau du lac enregistrée de 23 cm/100 ans. Les pollens fossiles des étangs d’inondation sont les témoins d’une plaine de débordement locale et de l’existence d’une végétation régionale de plateau, durant les derniers 4000 ans. [Traduit par la revue]


Introduction

River-valley aggradation occurs when the amount of sediment transported into a reach exceeds the amount transported out of the reach (Smith 1973). Two main factors control aggradation in a graded river (Mackin 1948). Downstream control, or base-level rise, lowers the stream gradient, resulting in the accumulation of a wedge of sediment that is thickest at the control point and thins upstream. Upstream control due to increased sediment supply steepens stream gradient by depositing a wedge of sediment that thins downstream from the sediment source. Sediment forming this wedge is frequently coarser than underlying sediment.

Valley fills are common in the lower reaches of rivers, such as the Humber, Credit, and Rouge, along the western shore of Lake Ontario (Fig. 1). This fill is the result of Holocene water-level rise (base-level rise) caused by differential isostatic rebound of the St. Lawrence River outlet, near Kingston, relative to the west end of the basin. Nothing has been published
about the effect of lake-level rise on river-valley aggradation and floodplain formation, but there have been two studies on lagoon sedimentation in western Lake Ontario. Flint et al. (1988) studied sediments in three lagoons near St. Catharines, Ontario, at the west end of the Lake Ontario basin, where Holocene lake-level rise was greatest. They estimated that water-level rise at an average rate of 25 cm/100 years over the past 3300 years, causing transgression and lagoon formation. McCarthy and McAndrews (1988) studied transgression and lagoon formation at Grenadier Pond in Toronto. They determined that the rate of water-level rise was 30–40 cm/100 years from 4200 to 1900 years ago, when the embayment was isolated from Lake Ontario by a bar.

We present here a record of late Holocene aggradation and floodplain formation in the lower Humber River where it enters Lake Ontario at Toronto. Floodplain sediments were studied for their lithology, fossil pollen, and radiocarbon age. The data were used to estimate average aggradation rates, describe floodplain formation, and reconstruct vegetation history. Aggradation rates were then used to refine the western Lake Ontario water-level curve of Anderson and Lewis (1985).

Lake Ontario water-level history

High-level glacial Lake Iroquois filled the Lake Ontario basin between 12,500 and 11,800 years ago (Fig. 2). Laurentide ice blocked the St. Lawrence outlet, and drainage to the Atlantic Ocean was via the Mohawk River at Rome, New York. As glacial ice retreated northwards, the St. Lawrence valley outlet was uncovered. By 11,400 years ago, water level in the Lake Ontario basin had fallen to 100–120 m below the present lake level of 75 m asl (Anderson and Lewis 1985). For the past 10,500 years, differential uplift of the glacioisostatically depressed St. Lawrence outlet relative to the western end of the basin has caused water level to rise continuously but at a steadily decreasing rate. Superimposed on this trend is the "Niagising flood," a rapid water-level rise that may have peaked at as much as 1 m above the modern lake level about 4000 years ago (Anderson and Lewis 1985; Sutton et al. 1972). The historic rate of lake-level rise is 23 cm/100 years (Kite 1972), but past rates were greater because isostatic rebound decelerates over time (Andrews 1970).

Physiographic and geologic setting

The Humber River has a drainage area of 900 km². It is almost entirely underlain by Ordovician shale and limestone bedrock of the Georgian Bay Formation. The bedrock is overlain by Late Wisconsinan glacial drift and glacial lake deposits. In its lower 12 km the river has eroded through the surficial deposits and incised the underlying bedrock.

The study reach occupies the lower 2.5 km of the Humber River valley between Bloor Street (Toronto) and Lake Ontario (Fig. 3). Above Bloor Street the river flows on or close to bedrock and has a gradient of 4 m/km; below Bloor Street the grade to Lake Ontario is 0.5 m/km. In the study reach, which is incised 15 m below the level of the surrounding upland, the river flows in a single meandering channel, flanked by levees and shallow flood ponds.

The channel is laterally stable within the study reach. Comparison of an 1834 map with a 1978 airphoto shows that the plan form of the channel has not changed in over 144 years (Weninger 1986). The Humber River floods during spring snowmelt and occasionally during autumn rainfall. Aggradation occurs when sediments are deposited on the floodplain during overbank flows.

The floodplain supports a sparse, disturbed forest dominated by Manitoba maple (Acer negundo), cottonwood (Populus deltoides), willow (Salix), silver maple (Acer saccharinum), black ash (Fraxinus nigra), and Siberian elm (Ulmus pumila). Understory species include red osier dogwood (Cornus stolonifera), nettles (Urtica), goldenrod (Solidago), and grape (Vitis). Cattail (Typha latifolia) and the alien purple loosestrife (Lythrum salicaria) dominate the edges of the ponds; water lilies
(Nuphar, Nymphaea) grow in the ponds. Wild rice (Zizania) was present in the 19th century but is now absent.

**Stratigraphy**

**Test borehole records**

Weninger (1986) compiled engineering test borehole logs from cross-valley transects at the Gardiner Expressway and Bloor Street. They define a bedrock valley beneath a wedge of alluvium that thins upstream from a thickness of 27 m at the expressway to 6 m at Bloor Street. The elevation of the bottom of the bedrock valley at the Gardiner Expressway is 47 m asl.

**Floodplain sediments**

A 2.5 cm diameter hand-driven soil probe with a 30 cm long barrel was used to core the floodplain sediments. Fifty-five holes were made to a depth of 3 m; a further 16 holes stopped at less than 3 m because of buried obstructions. The cores were examined visually and by hand texturing. Two lithologic units were identified: (1) heterogeneous, oxidized silt and sand; and (2) grey clay. An oxidized silt and sand unit overlies grey clay in 60% of the holes that penetrated to 3 m. The average depth to clay is 130 cm. In general, the depth to clay is greater near the channel and upstream and decreases away from the channel and downstream. Holes drilled close to the channel generally contain coarser sediment and less organic matter than holes drilled farther away.

**Flood-pond cores**

A modified Livingstone piston sampler (Wright 1967) was used to core through winter ice of flood ponds 3 and 5. The sediment–water interface and at least 50 cm of underlying sediment were cored with a clear plastic tube (Rowley and Dahl 1956). Cores were retrieved in mostly contiguous 1 m long segments. Casing was used to ensure penetration of the same hole. A bumper jack was used to push the sampler down and to pull it up.

The cores were described visually, by hand texturing, and by testing with 10% HCl for CaCO$_3$. Thermal analysis was done at 10 cm intervals, and percentages of organic matter, CaCO$_3$, and mineral matter (residual ash) were calculated (Dean 1974).

Ponds 3 and 5 were cored to 1090 and 1230 cm, respectively (Fig. 4). Coring was stopped by coarse sand and gravel. Seven levels were radiocarbon dated (Table 1), and the dates were plotted against depth (Fig. 5). The bottoms of both cores have an estimated age of 4000 years.

Three lithologic units were identified in the flood ponds: (1) a lower silt and clay with sand layers; (2) a middle silty peat, silty marl, and silty clay; and (3) an upper sandy silt with sand layers and occasional pebbles. In pond 3, mineral matter predominates below 500 cm and above 200 cm, with peaks of organic matter and CaCO$_3$ between 500 and 200 cm corresponding to peat and marl layers. In pond 5, mineral matter predominates below 800 cm and above 200 cm, and organic matter and CaCO$_3$ peak between 800 and 200 cm.

**Pollen analysis and vegetation history**

Sediment samples of measured volume (usually 0.9 mL) were analyzed at 10–40 cm intervals for fossil pollen and spores. The samples were spiked with a known number of Lycopodium clavatum spores and then treated with HCl, KOH, HF, and acetolysis solution (Faegri and Iversen 1975). The pollen concentrate was stained with safranin and mounted in silicone oil. Clastic-rich samples were sieved to obtain the pollen-rich 15–150 μm fraction (Cwynar et al. 1979). Pollen
Fig. 4. Stratigraphy, thermal analysis, and pollen diagram from sediment cores of (a) pond 3 and (b) pond 5. Sum includes tree and shrub pollen. Gramineae and aquatics were individually added to the sum before their percentages were calculated. "Other weeds": Tubuliflorae, Liguliflorae, Chenopodiaceae, Rumex, Plantago, and Cruciferae. "Other emergent aquatics": Impatiens, Sagittaria, Sparganium type, and Typha latifolia. "Floating aquatics": Potamogeton, Myriophyllum, Nuphar, Ranunculaceae, Nymphae, and Brasenia and in pond 5, additionally, Lemma, Utricularia, and Polygonum.
Fig. 5. Comparison of western Lake Ontario water levels for the last 6500 years. The upper curve from Anderson and Lewis (1985) features a peak of \(-2\) m above present lake level at 4000 BP, representing the Nipissing flood. The lower curve is based on the altitudes of \(^{14}\)C-dated sediment levels from the Humber flood ponds (Table 1). The unnumbered dots are \(^{14}\)C transgression dates from Grenadier Pond (McCarthy and McAndrews 1988).

### Table 1. Radiocarbon dates from ponds 3 and 5

<table>
<thead>
<tr>
<th>No.</th>
<th>Location</th>
<th>Depth in core (cm)</th>
<th>Age (years BP)</th>
<th>Sample description</th>
<th>Laboratory No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pond 3</td>
<td>216</td>
<td>150±50</td>
<td>Wood</td>
<td>TO-248</td>
</tr>
<tr>
<td>2</td>
<td>Pond 3</td>
<td>490–500</td>
<td>1870±70</td>
<td>Peat</td>
<td>WAT-1588</td>
</tr>
<tr>
<td>3</td>
<td>Pond 3</td>
<td>884–894</td>
<td>3490±70</td>
<td>Silty peat</td>
<td>WAT-1589</td>
</tr>
<tr>
<td>4</td>
<td>Pond 3</td>
<td>1030–1040</td>
<td>3800±80</td>
<td>Silty peat</td>
<td>WAT-1331</td>
</tr>
<tr>
<td>5</td>
<td>Pond 5</td>
<td>393–396</td>
<td>1790±80</td>
<td>Wood</td>
<td>BETA-21320</td>
</tr>
<tr>
<td>6</td>
<td>Pond 5</td>
<td>798–800</td>
<td>3248±80</td>
<td>Wood</td>
<td>BETA-18298</td>
</tr>
<tr>
<td>7</td>
<td>Pond 5</td>
<td>1095–1097</td>
<td>3880±60</td>
<td>Wood</td>
<td>TO-835</td>
</tr>
</tbody>
</table>

**Notes:** The dates are plotted against depth in Fig. 5. The tops of the cores are 74.5 m asl. Laboratories: BETA, Beta Analytic Inc.; TO, Isotrace, University of Toronto; WAT, University of Waterloo.

and spores were identified by comparison with a modern pollen reference collection aided by the illustrated key of McAndrews et al. (1973). At least 100 tree- and shrub-pollen grains were identified and counted at each level. Herb pollen and spores were also counted, and the counts for individual taxa and groups of taxa outside the sum were added to the sum before their percentages were calculated, thus reducing high values of local herb-pollen producers. Pollen spectra were grouped into the pollen zones of McAndrews (1981). Woody-plant-pollen density was calculated from the number of Lycopodium spores counted relative to pollen grains counted.

Pollen grains are well preserved except below 700 cm in pond 5 (Fig. 4). Tree- and shrub-pollen density generally parallels the abundance of organic matter. Pollen densities are three to six times higher where organic matter is abundant than where mineral matter predominates. This is probably a function of the rate of aggradation (i.e., peat accumulates more slowly than mineral sediment) and differential deposition (i.e., flowing water selectively transports and deposits pollen). The lowest pollen densities were found above 200 cm in both cores and below 800 cm in pond 5.

Two regional pollen zones (McAndrews 1981) are present in the flood-pond cores. Zone 3 represents the mixed forest of southern Ontario before European settlement. Pinus (pine) is the dominant pollen type, but Quercus (oak), Betula (birch), Ulmus, and Acer are present in moderate amounts. Fagus (beech) increases upward to a broad peak between 500–700 cm and then declines again. The boundary with zone 2, the earlier Pinus zone, was not reached, confirming that the age of the bottoms of the cores is less than 7600 years.

Zone 4 in both cores is dominated by weedy herbs and Gramineae (grass), reflecting deforestation, agriculture, and urbanization. Ambrosia (ragweed) rises sharply at the zone 3–4 boundary and remains high throughout zone 4. In the pond 5 core, there was a seed of Ambrosia artemisiifolia and many seeds of witch grass (Panicum) and crab grass (Digitaria), both weedy annuals. Populus and Salix are more abundant in zone 4. The probable source trees, cottonwood and willow, are dominants on the floodplain today. The rise in their abundance suggests floodplain-forest expansion during the past century, probably due to the broadening of the leves at the expense of the flood ponds. Similarly, in pond 5, where Acer pollen is separated into species, the rise of A. negundo reflects the modern dominance of Manitoba maple in the floodplain forest.

Local floodplain vegetation is also represented. In zone 3 of pond 3, Gramineae pollen percentages parallel organic matter, indicating that the source is a local aquatic grass. The pollen morphology is similar to that of wild rice (McAndrews 1969), but no fossil seeds were found in the core to confirm its presence, although wild rice grew in the Humber marshes in the nineteenth century (Weninger 1986). Instead, there are
seeds of witch grass (*Panicum*) in the intervals 620—769 and 1020—1050 cm, indicating local subaerial weedy habitat in addition to or as an alternative to a wild-rice marsh.

The zone 3 flood-pond pollen assemblage is unlike contemporary assemblages from upland lakes (McAndrews 1981) because it has abundant herb pollen such as *Ambrosia*, Gramineae, and aquatic plants including Cyperaceae. This partly reflects seasonal flooding, which provided a fresh, fertile, and moist soil for the growth of annuals on the floodplain. Also, shallow nutrient-rich ponds and pond margins with seasonally fluctuating water levels supported episodic growth of perennial aquatic plants. In both cores, microfossils of *Ambrosia*, *Pteridium* (bracken fern), Cyperaceae, and emergent aquatics are most abundant below 650 cm, whereas floating-aquatic-plant pollen is most abundant above 650 cm, particularly in pond 5 core, suggesting that the ponds became deeper.

Plant macrofossil analysis from the pond 5 core indicates that the fossil seeds were mostly those of aquatic plants that today grow in clear ponds, e.g., naiad (*Najas flexilis*), pondweed (*Potamogeton*), milfoil (*Myriophyllum*), and water lilies; and in marshes, e.g., cattail, bulrush (*Scirpus validus* type), spike rush (*Eleocharis*), sedges (Carex), and sweet flag (*Acorus*); and of annual species of exposed mud flats, e.g., umbrella sedge (*Cyperus engelmannii*), beggar's-ticks (*Bidens cernua*), knotweed (*Polygonum lapathifolium*), and yellow cress (*Rorippa*). Like the pollen of aquatic plants, the seeds were most abundant where organic matter was relatively high, in the intervals 1130—980 cm and 750—200 cm. The relatively fewer fossils in levels 1230—1130 cm, 1000—750 cm, and 200—0 cm, which correlates with lower organic matter and higher mineral matter content, suggests relatively rapid sedimentation.

**Aggradation rates**

**Prehistoric aggradation rates**

Flood-pond aggradation rates were estimated from seven radiocarbon dates from the flood-pond cores. Aggradation rates decelerated over time in both cores. Compaction with depth was probably insignificant because of the predominance of clastics.

Our oldest radiocarbon date is 3880 BP (TO-835) at 64 m asl (Table 1). Lake Ontario water level is projected to have reached 47 m asl, the altitude of the bottom of the bedrock valley at the Gardiner Expressway, about 6500 years ago (Fig. 5). The differences between these two dates and altitudes yield an aggradation rate for the intervening 17 m of alluvium of 65 cm/100 years. This maximum estimate assumes that aggradation began when lake level reached the altitude of the bottom of the valley.

Aggradation rates in pond 3 decreased from a high of 47 cm/100 years between 3800 and 3490 years ago, to 24 cm/100 years between 3490 and 1870 years ago, to a low of 16 cm/100 years between 1870 and 150 years ago. Aggradation rates in pond 5 decreased from 47 cm per 100 years between 3880 and 3250 years ago, to 28 cm/100 years between 3250 and 1790 years ago, to 11 cm/100 years between 1790 and 150 years ago. These rates are comparable with those measured in other aggrading fluvial systems. For example, Smith (1973) measured an aggradation rate of 25 cm/100 years in the Alexandra—North Saskatchewan river system.

**Historic aggradation rates**

Historic aggradation rates were inferred from the radio-carbon-dated pollen-zone 3—4 boundary and the modern sediment surface. The rise in *Ambrosia* pollen in historic sediments from eastern North America is associated with European settlement (McAndrews 1988). The *Ambrosia* rise has been varved dated at A.D. 1840 at Crawford Lake (McAndrews and Boyko-Diakonow, in press), 50 km west of the Humber River. A similar date for the Humber River is supported by records of settlement in the Humber River watershed that indicate that the number of mills and the size of villages increased rapidly during the 1830's and that settlement was well underway by 1850 (Ontario Department of Planning and Development 1948). *Ambrosia* pollen rises above background levels of 2—3% between 185 and 205 cm in both flood-pond cores, yielding historical aggradation rates of 130 and 140 cm/100 years in ponds 3 and 5, respectively. These rapid rates are due to increased sediment influx from land clearance and urbanization in the watershed.

**Discussion**

The erosion of the bedrock valley that underlies the study reach began with the draining of glacial Lake Iroquois 11,800 years ago. As lake level dropped, the base level of the Humber River also fell and the river eroded through the unconsolidated Wisconsinan glacial deposits and into the underlying bedrock. Downcutting in the study reach continued until no later than 6500 years ago, when rising base level initiated aggradation.

The radiocarbon dates from the Humber Valley flood ponds define a late Holocene water-level curve for Lake Ontario (Fig. 5). Radiocarbon dates of transgression at nearby Grenadier Pond confirm the Humber curve. All dates are below the water-level curve of Anderson and Lewis (1985) and thus do not support the postulated Nipissing flood. The average rate of lake-level rise declined from a high of 65 cm/100 years between 6500 and 3800 years ago, to 47 cm/100 years between 3800 and 3400 years ago, to 26 cm/100 years between 3400 and 1800 years ago. Between 1800 years ago and the present, the rate of lake-level rise declined to 23 cm/100 years. The position of the youngest date at 150 BP (TO-248) reflects the deepening of the flood ponds that occurred between 1800 and 190 years ago.

Vertical aggradation has been the dominant mode of floodplain formation in the Humber River during the past 4000 years. Lateral channel migration was unlikely because rising base level would have reduced the amount of energy available for channel shifting. The presence of well-defined levees and vertically extensive and predominantly fine-grained flood-pond deposits and the lack of channel movement over the past 144 years further support the claim that vertical aggradation by overbank flooding and deposition of sediment has been the dominant mode of floodplain formation over the last 4000 years.

The fining-upward sequence and declining aggradation rates below 2 m core depth are linked to the decreasing rate of base-level rise due to the decreasing rate of isostatic rebound. Initially, gravel and sand were deposited on the floodplain by relatively frequent high-energy overbank floods or by the channel itself. Marshes were widespread. As the rate of base-level rise slowed, levees were built up alongside the channel, the amount of sediment delivered to the floodplain decreased, and ponds formed in the depressions behind the levees. As the levees grew, continued reduction in sediment input caused aggradation rates to decline. Flood-pond sedimentation rates between 1800 and 190 years ago were less than the historic
rate of lake-level rise, which is less than the contemporaneous rate of lake-level rise, and as a result the ponds deepened. Still-water conditions allowed authigenic peat and marl to accumulate along with fine-grained mineral sediment deposited out of suspension from occasional overbank flows.

The alternation between peat and marl suggests that floodplain water levels fluctuated. Lower water levels encouraged peat formation and the encroachment of marshes, whereas higher water levels stimulated marl production and the growth of pond plants. Fluctuations in water levels are probably related to fluctuations in precipitation and evaporation. Larsen (1985) identified temporary high water levels lasting 200—300 years in Lake Huron and Lake Michigan, which he attributed to climatic cycles.

Accelerated aggradation controlled by upstream sediment influx began around 150 years ago. A seven- to eightfold increase in aggradation rates and coarser sediment texture are both consistent with upstream control of aggradation associated with upstream disturbance of the watershed. Weedy plants colonized disturbed ground both on the floodplain and in the watershed and contributed large amounts of weed pollen to the sediments. The frequent sand layers above 200 cm reflect flood events in the Humber River after A.D. 1840. Historical accounts confirm that severe floods occurred in 1850, 1857, 1878 (Ontario Department of Planning and Development 1948), and 1954. The increased severity of flooding in the historic period relative to the prehistoric period is related to forest clearance and urbanization, which decreased interception, infiltration, and evapotranspiration and increased overland flow and flood peaks.

Increased sediment input broadened the levees and filled the flood ponds over the past 144 years. The historic rate of lake-level rise is 23 cm/100 years, but the average flood-pond aggradation rate (140 cm/100 years) exceeds this rate by a factor of six. Ponds that were 0.5 m deep in 1984 would have been about 2.0 m deep in 1840. If sedimentation continues at this rate, the ponds will be filled within 40 years. 210Pb dating of sediment from the upper 150 cm in pond 3 indicates that sedimentation rates have declined during the past 30 years, extending pond life expectancy by 10—15 years (Weninger 1986).

The near-surface oxidized silt and sand unit on the floodplain is stratigraphically equivalent to and contemporaneous with the upper flood-pond unit. The change in sediment colour, the upward coarsening of grain size, and the decreasing depth to clay in the downstream direction are consistent with upstream control of aggradation due to increased sediment supply. The gray clay at depth represents deposition before historic disturbance in the watershed.

Conclusions

Late Holocene aggradation in the lower Humber River was controlled by rising base level. Historic aggradation was controlled by upstream sediment input. Flood-pond aggradation rates between 6500 and 1800 years ago reflect contemporaneous rates of lake-level rise that do not include a Nipissing flood near modern water level. Between 1800 and 150 years ago, the growth of levees alongside the channel reduced sediment input to the flood ponds, and aggradation rates decreased below contemporaneous rates of lake-level rise. Aggradation rates have increased in the last 150 years, surpassing the historic rate of lake-level rise, in response to increased sediment input from upstream. Similar rates will likely be found in other streams affected by rising base level along the western Lake Ontario shoreline. Fossil pollen assemblages reflect both regional upland vegetation and local floodplain communities. The *Ambrosia* pollen rise is useful for dating historic pond sediments and estimating historic aggradation rates.

Acknowledgments

This research was conducted while JMW held a Natural Sciences and Engineering Research Council of Canada (NSERC) scholarship and was supported by NSERC grant A5699 to JHM. We thank A. V. Jopling for criticizing a draft of this manuscript and two anonymous referees for their helpful comments.


