Springbank Reservoir

Shoreline Vegetation Succession Study, 2007 to 2014

A study to examine the natural re-vegetation of shorelines previously under long duration seasonal water

2015

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Cover Photo
Plot 2 on the north shore of the Thames River, May 2015. *Photo by Cathy Quinlan*

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Executive Summary

This vegetation study looked at the plant species that colonized previously inundated areas of the Springbank Reservoir in London, Ontario between 2007 and 2014. The lower shoreline was continuously exposed beginning in the fall of 2006 when the dam was shut down for a rebuild. The work was to be completed by 2008 but the new gates malfunctioned during tests in 2008 and have remained open since permitting natural river levels to occur upstream throughout the entire year.

In 2007, two plots were inventoried on September 4th on the south shore to get a general sense of the amount of plant colonization of exposed shoreline that had occurred in the year since the dam last operated. In 2010, with the dam still out of commission, it was decided to repeat the vegetation inventory in June, but expand and formalize the number of plots to five. In 2014, with the dam still not operating, the inventory was repeated, this time once in June and again in August.

The five plots were established along the reservoir from the dam area to 6.5 km upstream near the Forks of the Thames River, from the old high water mark of the reservoir to the current water level. The plots ranged in size from 168 m^2 to 3691 m^2. Each species of plant found was recorded as well as incidental sightings of fauna.

Several descriptive indices (i.e., means, averages, see Appendix C) were calculated to assess the quality and condition of the plant communities on each plot and overall across all five plots. Overall in 2014,

- 241 species of plants were recorded, a relatively large diversity considering the small size of the plots as compared to forest ecosystems of similar size.
- 51% of the plant species were native and 49% were non-native. The proportion of native to non-native species is typical for this type of young, disturbed habitat in London.
- The number of native plant species almost doubled from 2010 to 2014, from 62 to 122 species. The number of non-native species increased also, but by a factor of 1.5 (78 to 119 species).
- the Mean Conservatism Coefficient (MCC) was 3.4 which is in the low to moderate range indicating there were more generalist species than conservative species. This result is expected in a highly disturbed, young environment.
- The Floristic Quality Index (FQI) was 37.4, which is in the moderate range of native species diversity and richness. The FQI score increased slightly from 26.9 in 2010, affected by the lower species numbers in 2010.
- 50% of the plant species were perennial, 26% annual or biannual, and 24% woody vines, shrubs and trees. This proportion within the physiognomic classes is expected and a shift to more woody species will likely happen over time.
- The Average Coefficient of Wetness (CW) scores ranged from -0.9 to -2.2, meaning the plots have a moderate predominance of native wetland species. This result is expected as the sites are on sloped banks as well as low beaches that are exposed to periodic inundations, so they include a range of wetness conditions.

In 2014, the dominant woody species included Manitoba Maple, willow, dogwood and Black Alder. The herbaceous layer was dominated by a wide range of wildflowers that prefer open, sunny ground. The most abundant native species found included Canada Anemone, Swamp Milkweed, Virgin's-bower, Spotted Joe-Pye-weed, White Snakeroot, touch-me-nots, Field Mind, Stinging Nettle and White Vervain. The most abundant non-native plants included Tansy, Yarrow, Purple Loosestrife, Tansy, Wild Chervil and Mugwort. Overall, the plots had a slight dominance of native wetland species.

There were no species with a Coefficient of Conservatism (CC) score of 9 or 10, but there were four species with a score of 8: Common Hackberry, Sycamore, Hispid Buttercup and Fragrant Sumac (the latter likely a garden escape). Species with high CC scores (8 to 10 out of 10) are considered more specialized in habitat or condition and conserve themselves to very specific environment, usually unaltered communities. No species at risk plants were found.

While not part of this study, the authors conferred with Scott Gillingwater, Species at Risk (SAR) Biologist with the UTRCA about the impact of lower water levels on the native river turtles such as the Spiny Softshell. According to Gillingwater, turtles have benefitted from additional habitat that would otherwise be under water during the summer egg-laying period. There have been increased areas of shallow water to provide more foraging areas by SAR reptiles, since shallow water is generally clearer than the deeper water. According to Gillingwater there have been observations of Spiny Softshell, Northern Map, Midland Painted and Snapping Turtle along this stretch before and after 2006 when the Springbank Dam was last used.

The following recommendations are divided into two categories:

1) if the City of London decides to permanently decommission the dam and reservoir, or
2) if the City of London decides to resume operation of the dam and reservoir.

1. Recommendations if Springbank Dam and Reservoir is permanently decommissioned;

1a. Allow the vegetation to continue to naturalize with little active management, except in erosion prone areas.

Rationale

- The river acts as a natural transport system for seeds shed in the watershed upstream. Therefore, eradication of aggressive non-native species (e.g., species with a weediness score of -3) will be nearly impossible as non-native species will continue to populate the area from seed sources upstream.
- The river corridor is susceptible to natural fluctuations and flooding events. Plant species suited to these natural disturbance processes will naturally colonize the shorelines and banks (as they already have), many being spread from adjacent vegetated riparian areas. Thus, no planting is necessary.
- At certain erosion prone areas where vegetation does not appear to be establishing, the use of live staking of dogwood and willow cuttings (whips) may be advisable to assist with long-term stability. The cuttings will take root and assist to stabilize the banks.
- The riparian vegetation keeps erosion to a minimum. Any disturbance to the banks, especially steep banks, will impact erosion processes.
- Though the number of tree species is relatively low at present, there are a lot of individual saplings on many of the plots. These saplings will become larger trees in the future, providing shade to the water and increased input of organic matter (leaf litter fall) that impact fungus, bacteria and macro invertebrate communities in the soil and the river.
- The vegetation will increase the buffer zone from the existing trails to the water's edge. The existing trails and human activities along the river can be detrimental to sensitive wildlife, so the subsequent increase in buffer width may provide

additional protection from disturbances and trap more sediment and pollutants from surface runoff.

1b. Monitor the five vegetation sample plots periodically.

Rationale

- Vegetation monitoring should take place during the summer season (June to September) to track the progression of vegetation change and succession, a unique natural history experiment in dam removal and ecosystem recovery.
- Tree diameter measurements should be added to the study methodology to track basal area changes.

1c. Monitor other related factors such as erosion, water quality, aquatic habitat and wildlife to provide a more complete physical and biological evaluation of the longer term changes to the area.

Rationale

- River flow dynamics may shift over time and new areas of erosion may need to be addressed.
- Documenting the changes to water quality (both the chemical composition and benthic organisms as indicators of water quality) is very beneficial to understanding the impacts of dam removal on the Thames and river systems in general. Seasonally operated dams are not common, so studying the changes from this dam are even more useful.

The biophysical environment has changed enough since the dam last operated to suggest that wildlife, including some Species at Risk that use the Thames River System, maybe using the resource differently so some monitoring will be helpful in evaluating that change.

2. Recommendations if Springbank Dam operation is resumed;

2a. Before proceeding with flooding the river channel and adjacent shorelines, remove the existing vegetation within the reservoir zone.

Rationale and Details

- The newly vegetated shorelines add up to about 10 ha of land, a substantial amount of vegetation that, if to remain, could negatively impact both the water quality and recreational use of the reservoir.
- A qualified chainsaw operator should oversee the cutting down of the young trees and shrubs. Leave the existing root structure to prevent disturbing the soil.
    - If they are not removed, most of the established trees and shrubs will die from having their roots under water all summer. The trees will decompose and potentially be pulled out by their roots during high water levels, causing shoreline erosion and other concerns.
    - Drowned trees and shrubs can create unseen hazards for canoeists and rowers.
    - Stumps should be cut as low as possible to minimize risks to recreational boats.
- A brush hog or weed whacker should be used to cut down the herbaceous plants.

- All cut vegetation (woody and herbaceous) should be removed so that it does not decompose in the water, robbing it of oxygen.

2b. In the fall of the first few years after the dam is back in operation, survey the shoreline areas to see if there are any bank erosion issues.

Rationale

- Loss of vegetation may increase near bank velocities and rehabilitation may be required.

2c. Continue with normal monitoring of water quality and erosion before and after operation of the dam is resumed.

Rationale

- Water quality monitoring near sewage plant outfalls provides long-term data on the quality of the river water and should continue to provide even longer-term coverage.
- Recognizing the former reservoir environment has changed over the last several years, it will be useful to record changes when the dam/reservoir operations return. Seasonal dams are uncommon so any information that can be gathered adds to the overall understanding of their impacts on the environment.

2d. Monitor the impacts of the dam and reservoir operation on river and nearshore wildlife, especially aquatic turtles, birds, fish, and freshwater mussels.

Rationale

- The river environment has changed enough since the dam last operated to suggest that wildlife are now using the resource differently, so monitoring the impact of dam and reservoir operation is needed.
- The timing of the reservoir filling will be later (June) than in the past (May) due to fisheries concerns and this change may impact the survival of the nests of other wildlife species such as aquatic turtles and shorebirds.
- The loss of beaches and gravel bars for nesting and basking turtles and the loss of clearer, shallow water areas for turtle foraging should be monitored as well.
- Action plans to move nests may need to be developed.

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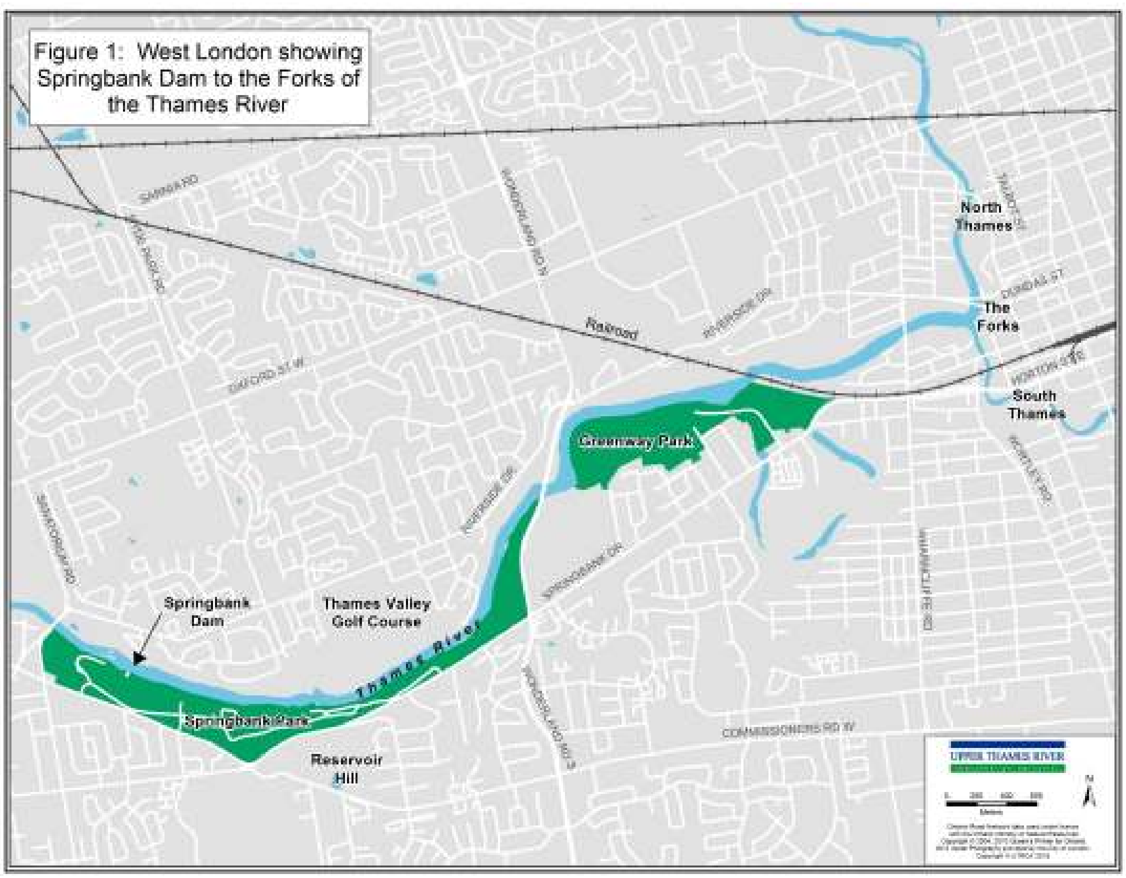
1.0 Background

Since 1878 there has been a dam on the main branch of the Thames River in west London, originally west of London. A brief history of Springbank Dam and Springbank Park is included in Appendix G. The current dam was built in 1929 by the City of London in the west end of Springbank Park for recreational purposes (Figure 1). There was extensive rehabilitation work carried out by the Upper Thames River Conservation Authority (UTRCA) in 1968-1969. In 1971, the UTRCA signed a management agreement with the City of London to look after maintenance of the dam.

When operating, Springbank Dam creates a large reservoir that extends approximately 7 km from the dam to the Forks along the main channel of the Thames River. The reservoir has an area of 55 ha and an upstream drainage area of 3,116 sq. km (311,600 ha). The water level is approximately 4 m above normal summer level depth at the dam and lessens to approximately 0.5 m above normal summer levels at the Forks of the Thames. The reservoir has been used by canoeists and rowers for many years.

Figure 1. West London showing Springbank Dam to the Forks of the Thames River



The dam was damaged during the July 9th, 2000 flood of the Thames River. Studies of the Springbank Dam in 2000 and 2002 recommended that the structure be rehabilitated to repair the damage caused by the flood and meet provincial dam safety guidelines. The City held public open houses and, overall, there was strong endorsement for rebuilding the dam and reservoir instead of decommissioning it and returning the river to its natural flow regime. The dam was shut down in 2006 for a $6.8-million rebuild that was to be completed by 2008. However, the new gates malfunctioned during tests in 2008. Since then the dam's gates have remained open.

Springbank Dam is owned primarily by the City of London and operated by the Upper Thames River Conservation Authority (UTRCA). The UTRCA has title to lands at the north and south abutments and holds the license of occupation of the river with MNRF. The dam is classified as a small to medium sized structure, being 67 m across and nearly 10 m high. Historically, it held back water for only six months of the year, from approximately May 24th (depending on fish migration, river flows, and construction activities) until early November. Following the intended rehabilitation of the dam in 2008, the dam is to operate for less than five months of the year, that is, after approximately June 15th until the first week in November.

Therefore, since 2006 the Thames River has flowed freely through this section of London at normal levels. Shoreline areas that were previously flooded/inundated each spring to fall were exposed as mudflats or gravel bars. Within a few short years, plants began to colonize these shorelines

Sprinbank Dam during the July flood of 2000. UTRCA Photo.

The rebuilt Springbank Dam, fall 2014. UTRCA photo.

1.1 Purpose of the Vegetation Study

Several studies have been conducted on fish species and fish movement resulting from the operation of Springbank Dam (Biotactic Incorporated 2008, 2009; Baldwin 2010), but there had not been any studies on the impact of the dam on the terrestrial (land) features. In the first few years after the dam became inoperable, there were public concerns about the appearance of the shoreline (i.e., bare soil exposed) and, later, the weedy plants that grew up (LFP 2009). There was also concern for the management implications of the newly established vegetation if and when the dam and reservoir were to be reinstated.

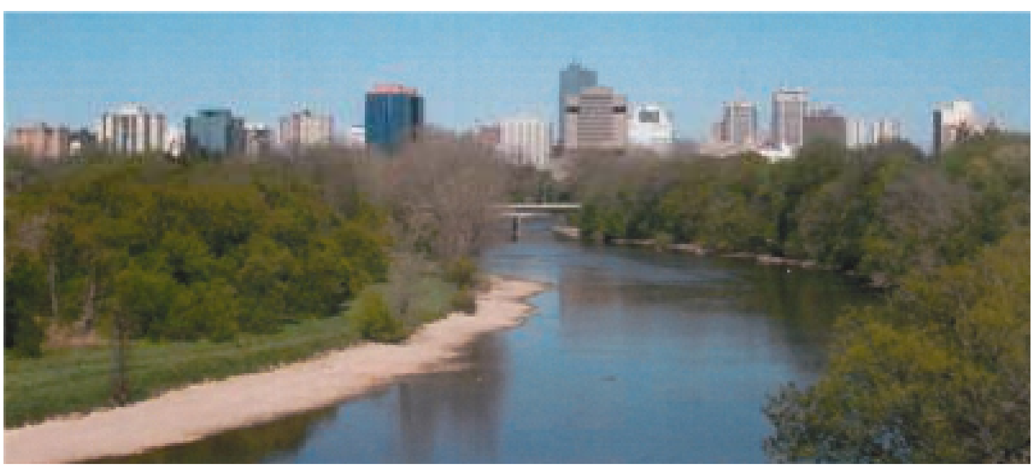
Because the reservoir is so long (7 km), there is a considerable area of shoreline that is now re-vegetating. By comparing 2007, 2013 and 2014 ortho imagery, it is estimated that the newly exposed shoreline totals 10 to 15 ha (UTRCA data). There is more exposed shoreline closer to the dam than at the Forks as the reservoir was deepest there.

The UTRCA felt there was a need for a quantitative study of the changes in the shoreline vegetation since 2006. The original purposes of this study were to:

1. to establish permanent plots in the riparian (near shoreline) area of the former Springbank Reservoir (areas between current water levels and former reservoir water level) to be used for comparison in future years,
2. to document any changes in terrestrial flora and fauna that can be attributable to the long term lower river levels upstream of Springbank Dam, and

Later, as the years went by without a change in the dam status, the study also served to develop recommendations for vegetation management given the opportunities and constraints presented by both the rehabilitation or decommissioning of the Springbank Dam.

Photos of the shoreline taken near the dam in 2006 and 2008 are included in Appendix H.



The Thames River looking upstream from near the CNR railway crossing west of Cavendish Park, showing recently exposed shoreline, circa 2007. London Community Foundation photo.

2.0 Methodology

2.1 Field Inventory and Plot Description

In July of 2007 when the dam was under rehabilitation and not used the UTRCA's Vegetation Specialist undertook a preliminary botanical inventory of two plots of the reservoir shoreline to get a general sense of the amount of plant colonization of exposed shoreline that had occurred. Following a failed repair in June 2008, the vegetation inventory was repeated in 2010 with an expansion to five plots. In 2014, the dam was still not functioning and so the inventory was repeated on the five plots.

Although numerous researchers and land managers have collected data on riparian vegetation, few protocols exist for systematic monitoring of riparian areas that are objective, precise, accurate, and repeatable to determine the level of anthropogenic influence on ecosystems across space and through time (Coles-Ritchie *et al*. 2004). For the purpose of documenting any changes in flora, it was decided that a full botanical inventory and a general description of all the vegetation found within five representative plots was sufficient.

Five locations were selected for the study plots, representing different sections, shores and slope profiles of the reservoir. Figure 3 shows the location of the five plots. Photographs of the five plots are shown in Figures 4 to 8.

Table 1 summarizes the dates of the field surveys for each plot over the three years. Generally, one to two plots were inventoried in a single day. A one-season inventory was conducted in the first two years, owing to time constraints. In 2014, a two-season inventory (early summer and late summer) was completed on all five plots.

Table 1. Date of field surveys

Year	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
2007	--	--	Sep. 4	Sep. 4	--
2010	Jun. 17	Jun. 17	Jun. 18	Jun. 18	Jun. 24
2014	Jun. 16, Aug. 18	Jun. 27, Aug. 21	Jun. 16, Aug. 18	Jun. 19, Aug. 19	Jun. 25, Aug. 19

The plots extended from the former reservoir water level (near normal water level) to the current, lower water level (i.e., no reservoir). Plot size was measured and geo-referenced using GPS. Table 2 summarizes the characteristics of each plot.

Maps showing the locations of the individual plots on aerial photographs are included in Appendix A1-A5. Cross sectional diagrams showing the plot slope and reference to the water level of the Springbank Dam Reservoir are found in Appendix B1-B5. Note that the assumed elevations (Y axis) are not correlated between the five cross-sections.

Incidental sightings of fauna (birds, mammals, reptiles, amphibians, and insects) were recorded while undertaking the botanical inventories. While not part of this study, the authors conferred with Scott Gillingwater, Species at Risk Biologist with the UTRC about the impact of lower water leverls on the native river turtles such as the Spiny Softshell, as he has carried out long-term studies of these reptiles in the area.

Figure 2. Location of the five plots in the Springbank Reservoir Study Area

Table 2. Plot descriptions

Plot	Location Description	Area (m^2)	Shore	Distance from Dam	Slope Profile	Site conditions
1	By the dam	999	south	0.1 km	steep	dry
2	West of Thames Valley Golf Course, end of Hyde Park Rd	3,691	north	1 km	gentle to flat	dry, stoney beach
3	Across the river from the golf course, by a bench	168	south	2 km	steep	dry
4	East of Wonderland Rd, Greenway	984	south	4 km	moderately steep slope and flat beach	dry slope and moist, scoured beach, experiences flooding
5	Cavendish Dyke, west of Wharncliffe Rd	620	north	6.5 km	flat	wet beach, experiences flooding
	Total	**6,462**				

Figure 3. Plot 1 by the Springbank Dam (plot is farther down slope)

Figure 4. Plot 2 west of Thames Valley Golf Course

Figure 5. Plot 3 across from the Thames Valley Golf Course

Figure 6. Plot 4 west of Greenway Sewage Treatment Plant

Figure 7. Plot 5 at the foot of Cavenish Dyke

3.0 Results and Discussion

The first part of this chapter (Section 3.1) presents the findings of the 2014 inventory and the second part (Section 3.2) shows a comparison of the 2014 inventory with the 2007 and 2010 inventories. The results of the 2007 and 2010 vegetation inventories are summarized in an earlier report titled Terrestrial Shoreline Report for the Springbank Reservoir (UTRCA 2011, Document 87569).

3.1 2014 Vegetation Inventory Findings

The full annotated checklist of vascular plants found in 2014 is provided in Appendix D.

3.1.1 Dominant Woody Species Composition

Table 3 summarizes the dominant woody species present in the vegetation layers of the five plots. Despite the young age of the communities (i.e., less than 10 years old), all had canopies 2 to 10 m in height. The dominant canopy trees included three native species (willow, Silver Maple, and Cottonwood) and five non-native species (Manitoba Maple, willow, Black Alder, Black Locust and Siberian Elm). Plots 1 and 2 had a fairly dense canopy (25-60%), while Plots 3, 4 and 5 had a sparser canopy (1-10%).

The subcanopy, slightly shorter, was also in the 2 to 10 m height range and contained similar species to the canopy but also had Common Buckthorn (non-native), Hackberry, and Sycamore. Plot 2 had the densest subcanopy (>60%), while Plots 3 and 4 were sparser (10-25%).

The understory, usually 1 to 2 m in height, varied across the five plots, but was dominated by shrubs and young trees. Some of the native species present included Silky Dogwood, Ninebark, willow, Riverbank Grape and Green Ash with non-natives such as Multi-flora Rose, Tartarian Honeysuckle and Manitoba Maple.

Table 3. Dominant species in the vegetation layers

Plot	Layer	Height (m)	Cover	Species in order of dominance
1	Canopy	2-10	25-60%	Manitoba Maple > Willow >> Silver Maple = Black Alder
	Sub Canopy	2-10	25-60%	Manitoba Maple = Common Buckthorn
	Understory	1-2	10-25%	Silky Dogwood >> Ninebark
2	Canopy	2-10	25-60%	Black Locust = Cottonwood > Black Alder
	Sub Canopy	2-10	>60%	Willow = Manitoba Maple = Cottonwood > Black Locust
	Understory	1-2	>60%	Willow > Dogwood = Multi-flora Rose > Riverbank Grape
3	Canopy	2-10	0-10%	Cottonwood
	Sub Canopy	2-10	10-25%	Black Alder > Hackberry
	Understory	2-10	10-25%	Common Buckthorn > Tartarian Honeysuckle = Rose
4	Canopy	2-10	0-10%	Black Locust = Manitoba Maple = Siberian Elm
	Sub Canopy	2-10	10-25%	Manitoba Maple > Willow > Common Buckthorn > Black Locust
	Understory	1-2	25-60%	Willow = Manitoba Maple >> Common Buckthorn = Green Ash
5	Canopy	2-10	0-10%	Black Locust > Manitoba Maple
	Sub Canopy	1-2	25-60%	Willow >> Sycamore
	Understory	1-2	25-60%	Willow

3.1.2. Herbaceous Plant Composition in the Ground Layer, 2014

In general, the plots were dominated by a wide range of wildflowers, both native and non-native, that prefer open, sunny ground in both wet and dry habitats (see Appendix D and photos in Appendix I).

The most abundant native species found included Canada Anemone, Swamp Milkweed, Virgin's-bower, Spotted Joe-Pye-weed, White Snakeroot, touch-me-nots, Field Mint, smartweed, Stinging Nettle, and White Vervain. The most abundant non-native plants included Tansy, Yarrow, Purple Loosestrife, Tansy, Wild Chervil, and Mugwort. Several species from the mustard family (non-native) were found also.

3.1.3 Plants with High Coefficient of Conservatism (CC) Scores

Plants with a CC score of 8, 9 or 10 are considered more specialized in habitat or condition and conserve themselves to very specific environments, usually unaltered communities (see Appendix C). Plants with low CC scores are considered generalist species that are found in a wide variety of habitats, including disturbed sites.

In 2014, there were no plants with scores of 9 or 10. There were four plant species that had a CC score of 8: Common Hackberry, Sycamore, Hispid Buttercup and Fragrant Sumac (see Table 4). None of these species is rare in our area, but they are faithful to their habitat type.

Some ecologists consider CC scores of 7 to be fairly conservative as well. There were four species with a CC score of 7 in the study area in 2014: Black Maple, Cut-leaved Coneflower, Golden Ragwort and Golden Alexanders. In 2007, two additional species were found, Carpenter's-square and Pale Touch-me-not, but they were not found in subsequent years.

Table 4. Species with high CC scores

Common Name	Scientific Name	CC Score	2014 Plots	2010 Plots	2007 Plots 3 and/or 4
Common Hackberry	*Celtis occidentalis*	**8**	1, 3, 4, 5		Yes
Sycamore	*Platanus occidentalis*	**8**	1, 2, 3, 4, 5	1, 3, 4, 5	Yes
Hispid Buttercup	*Ranunculus hispidus*	**8**	1, 2	2	
Fragrant Sumac*	*Rhus aromatic**	**8**	1		
Black Maple	*Acer saccharum*	7	1, 3, 4		
Cut-leaved Coneflower	*Rudbeckia laciniata*	7	1, 3, 4, 5	4	
Golden Ragwort	*Senecio aureus*	7	4		
Golden Alexanders	*Zizia aurea*	7	1		Yes
Carpenter's-square	*Scrophularia marilandica*	7			Yes
Pale Touch-me-not	*Impatiens pallida*	7			Yes

**Fragrant Sumac was very likely a planted specimen.*

3.1.4 Species At Risk

There was no plant species with At-Risk designations found in the study area over the three years surveyed.

3.1.5 Vegetation Quality Indices

The plant checklist in Appendix D also shows the plant properties such as Coefficient of Conservatism (CC), Weediness Score (WEED), and Coefficient of Wetness (CW). No species at risk or species with a provincial rank (SRANK) lower than S4 (common) were found.

Table 5 provides a summary of the number of species and various vegetation quality indices (means or averages) that are calculated from the plant properties (i.e., CC, WEED, and CW) for each of the plots and the study area as a whole. Descriptions of the various scores and calculations are included in Appendix C.

Table 5. Summary of the number of plant species and various quality Indices for 2014

Plot	# Species	# Native Species	# Non-native Species	% Non-native Species	MCC	FQI	MWS (Weed)	WI (Wet)
1	147	75	72	49%	3.4	29.4	-1.6	-1.2
2	149	77	72	48%	3.1	27.2	-1.6	-1.2
3	134	74	60	45%	3.4	29.2	-1.7	-0.8
4	144	67	77	53%	3.3	27.0	-1.7	-1.1
5	99	57	42	42%	3.4	25.7	-1.7	-1.6
Overall	**241**	**122**	**119**	**49%**	**3.4**	**37.6**	**-1.6**	**-0.9**
Analysis	**Relatively high**	**Relatively low**	**Relatively high**	**Relatively high**	**Moderate**	**Moderate**	**Moderate**	**Wetland**

*See Appendix C for a description and assessment of MCC, FQI, etc.

There were 241 unique species found across the five plots. This is a fairly large number of species given the small plot sizes. Each plot had between 134 and 147 species, except Plot 5 that had only 99 species. While the plots had similar species, they were not identical. Some 50 species (21% of 241) were found in all of the plots, 133 species (55%) were found in two to four plots and another 58 species (24%) were found in one plot only. The slope, aspect and local seed source would determine the specific plant species makeup of each plot.

Of the 241 species found, 122 were native species, while 119 (49%) were non-native (adventive) species. Each plot had a similar percentage of non-native species that ranged from 42 to 53%. The high percentage of non-native species is not surprising given the highly disturbed nature of riparian habitats and that fact that the areas are early successional, having been exposed for plant colonization since 2007 only. By comparison, woodlands in the Thames area have 25 to 33% non-natives (see Appendix C).

The MCC (Mean Coefficient of Conservatism) score for the entire study area was 3.4 and varied only slightly between the plots (3.1 to 3.4). Sites with low MCC scores (e.g., <4) contain more generalist species that are likely to be found in disturbed or early successional habitats. By way of comparison, woodlands in the Thames area have MCC scores of 3.0 to 5.3. Thus, the Springbank plots have a fair or moderate score, reflective of the disturbed nature of the site.

The FQI (Floristic Quality Index) is a similar scoring formula to MCC but uses the square root of the number of species multiplied by the MCC to better compare large and small sites. The five plots had FQI scores of 25 to 30, while the overall score was higher at 37.6. Habitats with FQI scores of <20 are considered minimally significant ecologically, while sites with FQI scores >35 are floristically significant, at least for woodlands (Michigan DNR 2001).

The MWS (Mean Weediness Score) for the entire study area is -1.6 and the score for each individual plot was very similar, -1.6 to -1.7. The possible range is -1 to -3, so a score of -1.6 means the impacts on the natural area from non-native adventive species is moderate.

The WI or Wetness Index is the average of all wetness scores for native species. For the entire study area the WI was -0.9 and the individual plot scores were fairly similar, ranging from -0.8 to -1.6. Sites with scores <0 have a predominant of native wetland species. The WI scores are not surprising considering the location of the plots so close to the water's edge, but not in standing water. The WI is calculated on native species only since the non-native plant species tend to tolerate a wide range of conditions and are not habitat specific, in general. Interestingly, the WI for the non-native species is 2.2, indicating a predominance of upland species.

Stand of young trees and wildflowers in Plot 2, May 2015. Facing downstream, the footpath is located at the normal reservoir level and the vegetation to the left is the new growth. See Appendix I for more photos. Cathy Quinlan

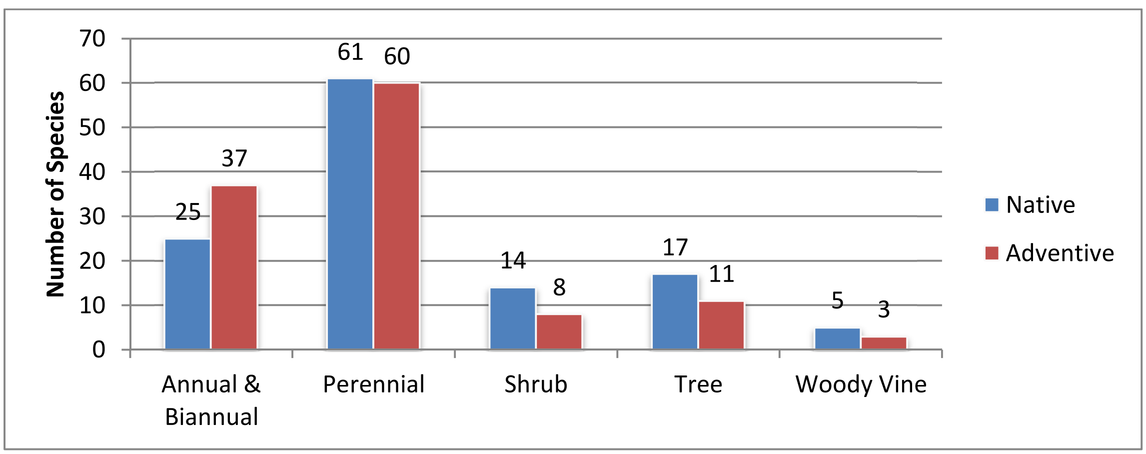
3.1.6 Physiognomy

Table 6 shows the number of species in each physiognomic group, that is, annual and biennial, perennial, shrub, tree and woody vine. Figure 9 shows the data in chart form. The annual and biennial species were grouped for simplicity and the fact that several species can have both life histories. The annual, biennial and perennial groups include both forbs and grasses as very few grass species were found.

Table 6. Physiognomy of native (N) and adventive (A) species in 2014

Plot	# Annual & Biennial Species		# Perennial Species		# Shrub Species		# Tree Species		# Woody Vine Species	
	N	**A**	**N**	**A**	**N**	**A**	**N**	**A**	**N**	**A**
1	18	25	35	35	10	3	10	8	2	1
2	22	24	36	36	5	6	9	5	4	1
3	14	14	32	34	10	6	14	5	4	1
4	13	21	35	40	5	7	10	8	4	1
5	15	13	28	19	4	2	8	8	2	0
Overall	**25**	**37**	**61**	**60**	**14**	**8**	**17**	**11**	**5**	**3**

Figure 8. The distribution of native and non-native taxa by physiognomic class for all five plots sampled in 2014



As expected, the plots were dominated by perennial plant species with 61 native and 60 non-native species found overall. There were larger numbers of annual and biennial species and smaller numbers of woody species. Woody species take longer to germinate and tend to be competed out by the faster growing herbaceous plants in recently disturbed areas. Also, there are far more species of herbaceous plants than woody plants in Ontario. No ferns were recorded. The various physiognomic groups all contained a fairly equal mix of native and non-native species, with a slight dominance in the native category except for annual/biennial group. Note: This data is a comparison of the number of different species, not their quantity or biomass in the plots.

3.2 Comparison of 2014 results with 2010 and 2007 findings

The checklist of vascular plants found in 2014 is provided in Appendix D and the checklist for 2010 and 2007 is presented in Appendix E. It is somewhat challenging to compare the data from the three sampled years (2007, 2010, 2014) since the methodology changed slightly each year owing to the way in which the study unfolded. In 2007 only two plots were inventoried once in September (they later became known as plots 3 and 4). In 2010, three more plots were established for a total of five plots and inventoried once in June. In 2014, the same five plots were inventoried in June and again in August, a larger inventory effort.

Therefore, the data is presented in two ways:

a) the overall study area (all five plots) for 2010 and 2014, and
b) Plots 3 and 4 only for 2007, 2010 and 2014.

This section looks at the results from the following perspectives over time:

- Number of plant species and % non-native species
- MCC scores
- FQI scores
- Mean Wetness scores
- Physiognomy
- Other

Common Milkweed, Asclepias syriaca, was found in all five plots in 2014. Photo: Cathy Quinlan

3.3.1 Number of Species

Figures 10a and 10b show the number of native and non-native plant species found in the overall study area and in plots 3 and 4 only. As Figure 10a shows, the total number of native species almost doubled from 2010 to 2014 (62 to 122 species) while the number of non-native species increased slightly less, by a factor of 1.5 (78 to 119 species). Figure 10b shows that for plots 3 and 4, the number of species declined by 20% from 2007 to 2010 but increased by 1.4 to 1.5 times in 2014 compared to 2007 levels. The decline in 2010 may be related to more significant flood events in 2008 and 2009 and/or the earlier date of the survey. Compared to a forest ecosystem, these plots have a large diversity of species.

Figure 9a. Number of species in the overall study area, 2010 and 2014

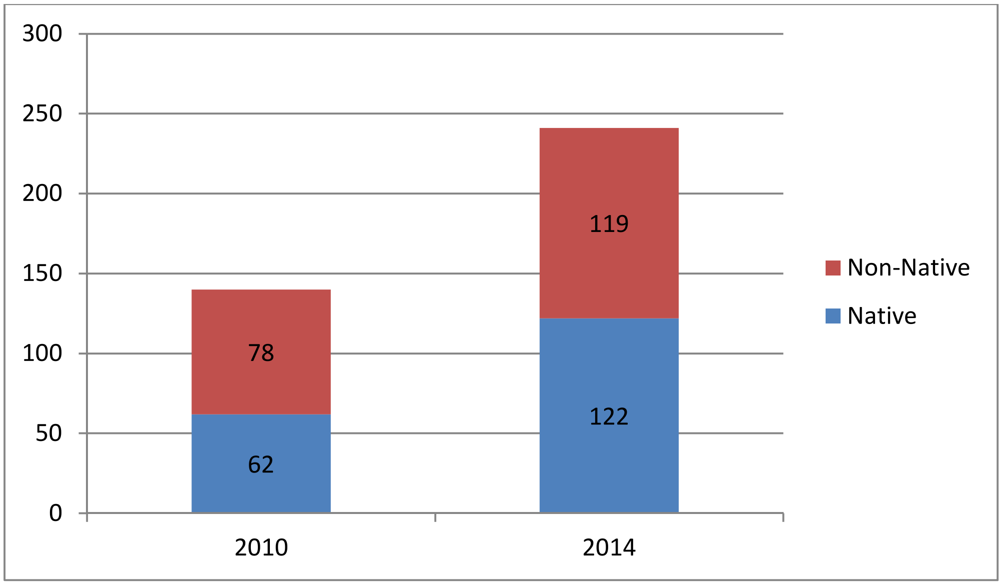
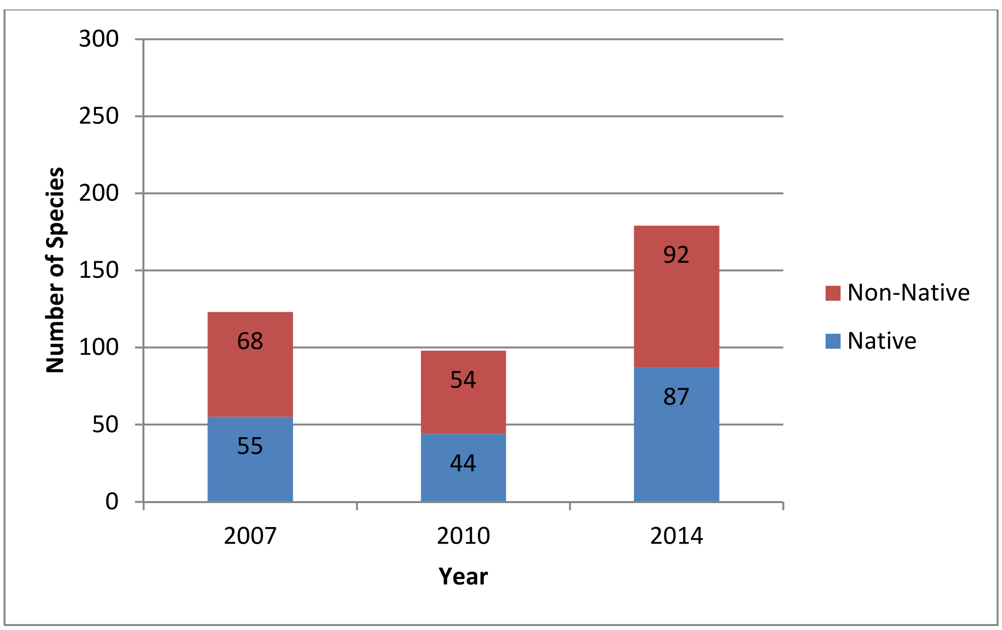


Figure 10b. Number of species in plots 3 and 4 only, 2007 to 2014



3.3.2 Mean Conservatism Coefficient (MCC)

The overall MCC score has not changed significantly over time, ranging from 3.2 to 3.4 (see Figures 11a and 11b). The five individual plots had scores of 2.9 to 3.5 in 2010 and 3.1 to 3.4 in 2014. This score is low to moderate, meaning there are not many conservative species (habitat specialists) but instead more generalist species (i.e., species that are able to adapt to disturbance). If the plots are allowed to succeed over time, one would expect the MCC to increase somewhat but probably never be very high due to the constant flooding disturbance.

Figure 10a. MCC scores for all plots combined, 2010 and 2014

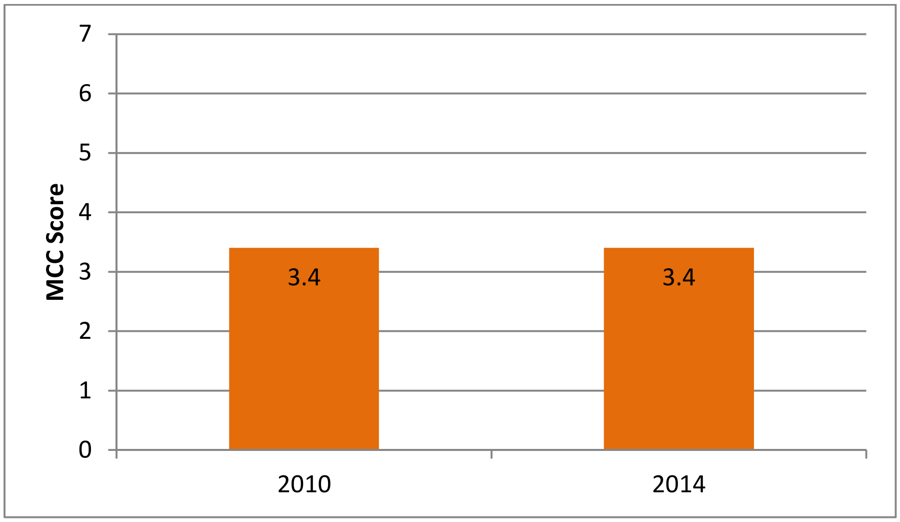
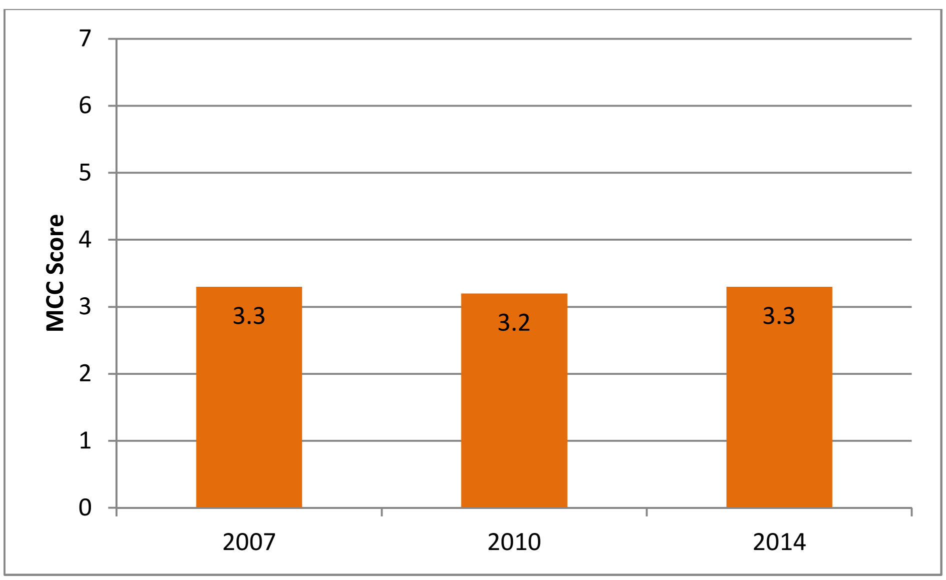


Figure 11b. MCC scores for plots 3 and 4, 2007 to 2014



3.3.3 Floristic Quality Index (FQI)

Unlike the MCC results above, the overall Floristic Quality Index (FQI) scores have changed somewhat over time. Figure 12a shows the FQI scores has gradually increased (improved) over time, but remain in the moderate range of native species diversity and richness. The larger number of species in 2014 is the key factor in explaining this change. In 2010 the individual plots had FQI scores of 15.2 to 21.3, while in 2014 they were higher at 25.7 to 29.4.

Figure 12b shows that FQI scores dropped from 2007 to 2010, mirroring the drop in the number of species from 2007 to 2010 that may be related to the significant flood events of 2008 and 2009.

Figure 12a. FQI scores for all plots combined, 2010 and 2014

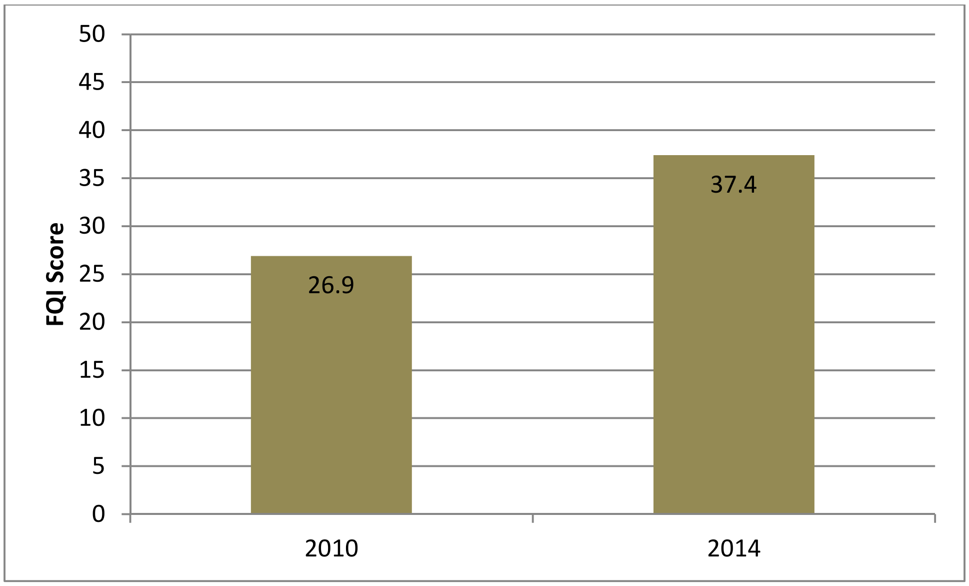
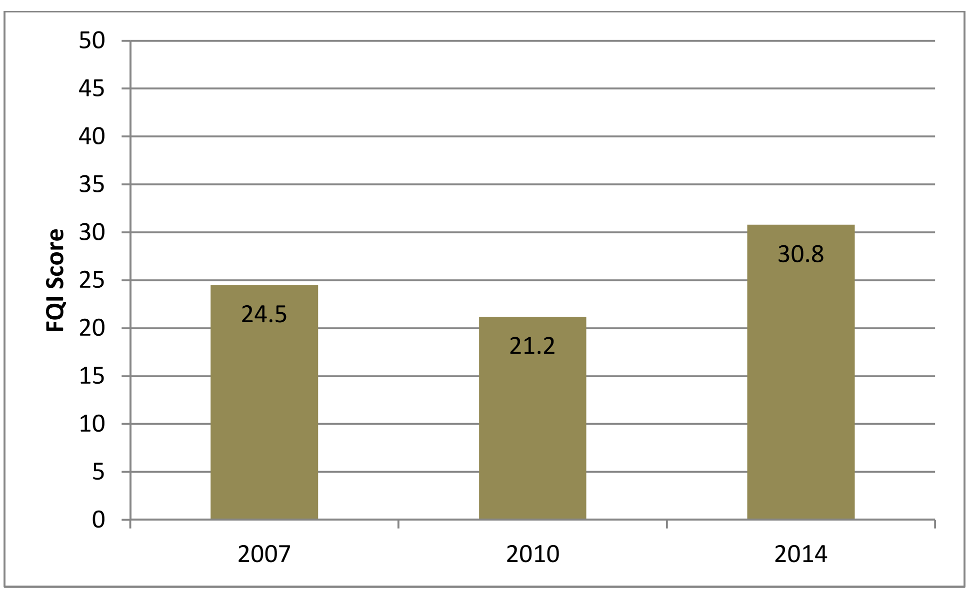


Figure 12b. FQI scores for plots 3 and 4, 2007 to 2014



3.3.4 Physiognomy

The proportion and number of plants in the various physiognomic classes has changed somewhat over time (see Figures 13a, 13b, 13c and 13d). Physiognomy refers to the form of a plant, whether woody, annual, biannual, etc.) The percentage of woody species has increased slightly from 2010 to 2014 but the actual number of species almost doubled. The proportion of annual/biennials has remained steady over this time, but the actual number of annual/biennial species almost doubled as well. The proportion of perennials declined slightly, but the number of perennials increased by a factor of 1.6.

Figure 13a. The proportion of plant species by physiognomic class for all five plots, 2010 and 2014

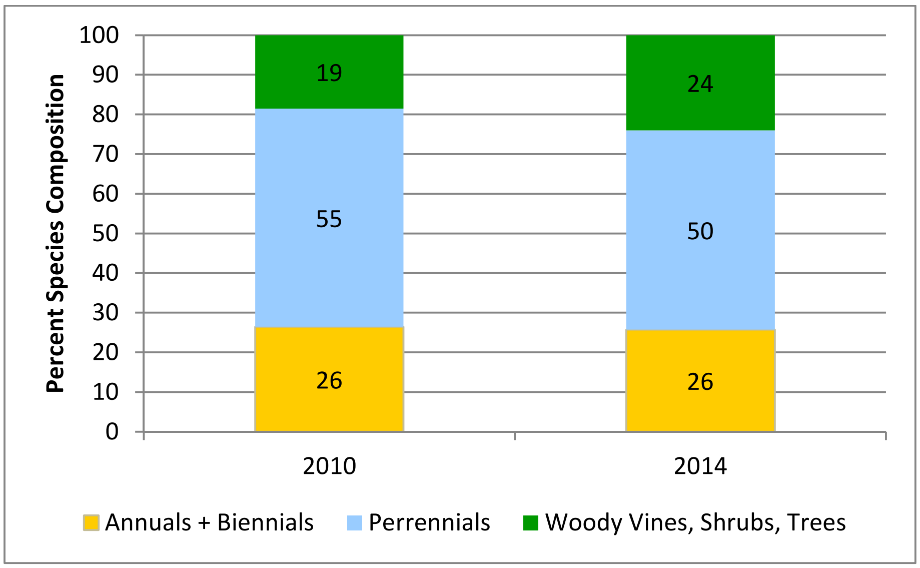


Figure 13b. The number of plant species by phsyiognomic class for all five plots, 2010 and 2014

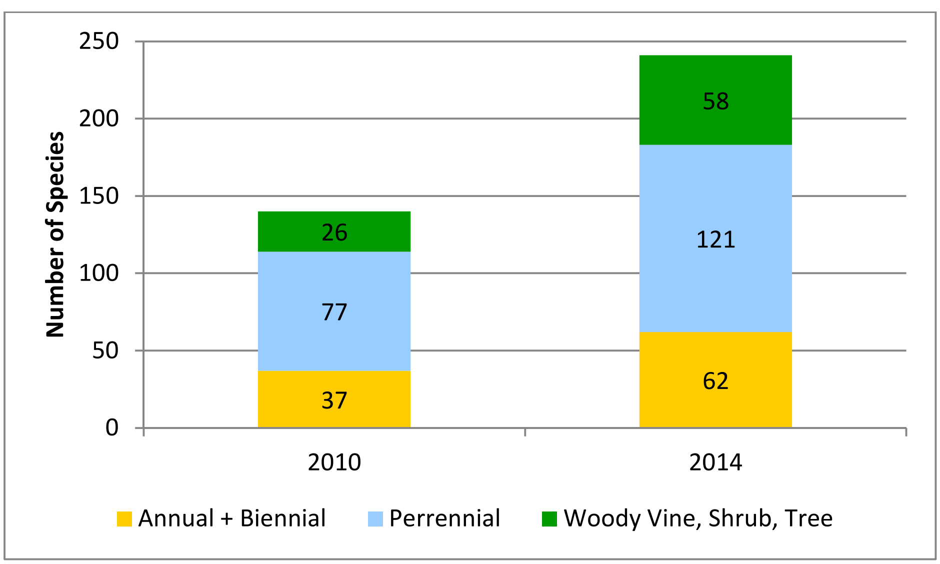


Figure 13c. The proportion of plant species by physiognomic class for plots 3 and 4, 2007 to 2014.

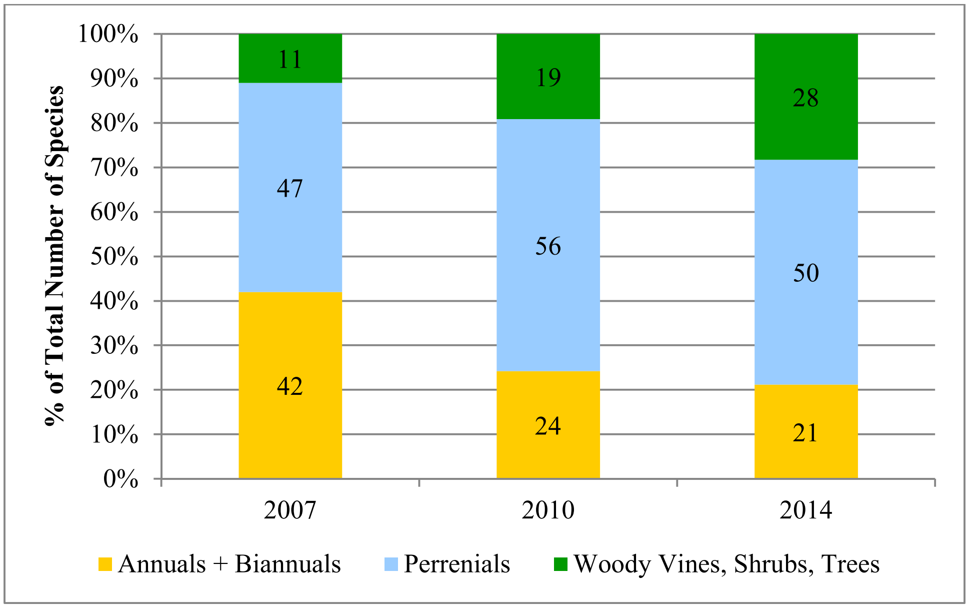
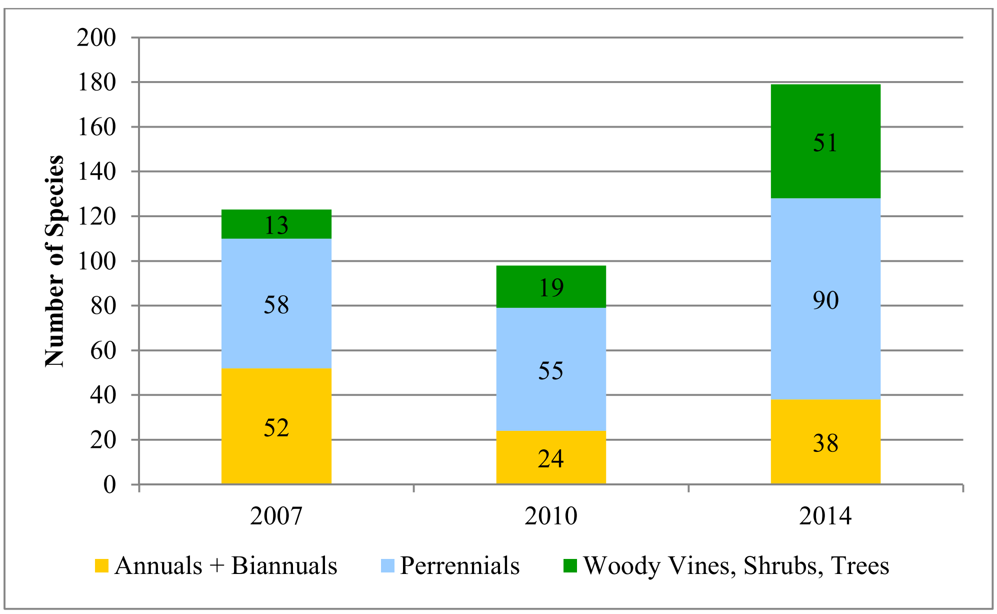


Figure 13d. The number of plant species by physiognomic class for plots 3 and 4, 2007 to 2014



Figures 13c and 13d shows the trends for plots 3 and 4 over the longer time period. The higher number and proportion of perennials is not surprising since, once established, they are able to spread vegetatively, an advantage in a disturbed environment. Perennials often survive in extreme environmental conditions since they have a deep and extensive root structure that is better able to access nutrients. The roots also bind the soil, preventing soil loss through erosion.

Over time, if the dam remains inoperable, the process of plant succession will continue in these shoreline areas. There will be a shift from generalist to specialist species and from annual plants to perennial and woody plants.

3.3.5 Average Coefficient of Wetness

The Average Coefficient of Wetness (CW) has varied slightly over time, but always within the range of -0.9 to -2.2 for the five plots, meaning they have a moderate predominance of native wetland species. Sites with CW scores close to 0 have an equal likelihood of containing native wetland or upland species. Sites with CW scores closer to -5 have a very strong predominance of native wetland species. The five plots include sloped banks as well as low beaches that are exposed to periodic inundations, so they include a range of wetness conditions. Figures 14a and 14b show that wetness scores were slightly lower (wetter) in 2010 compared to 2014. This is a very dynamic ecosystem with plant species appearing and disappearing depending on the weather conditions of the year (e.g., 2014 was a cooler, wetter year).

Figure 14a. Mean Wetness Scores by plot, 2010 and 2014

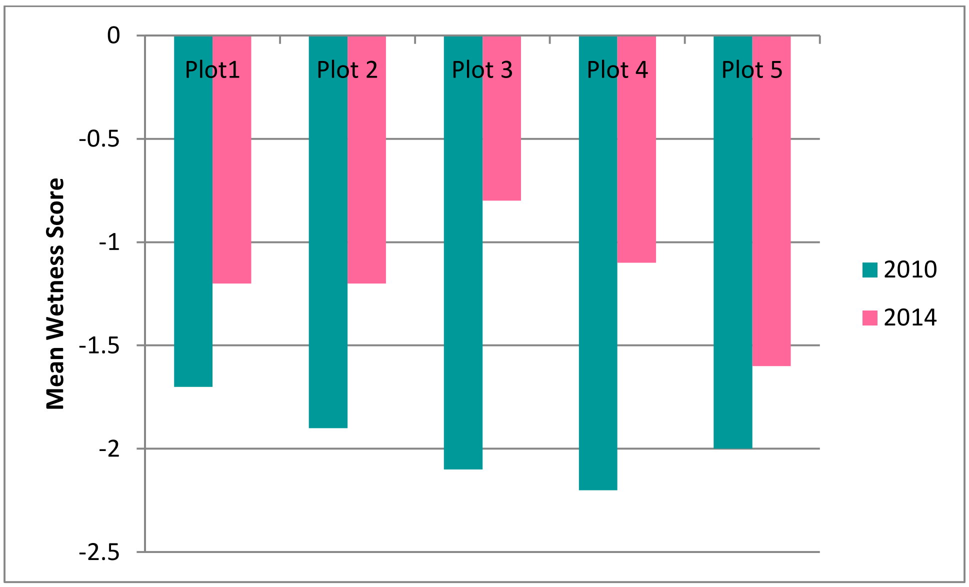
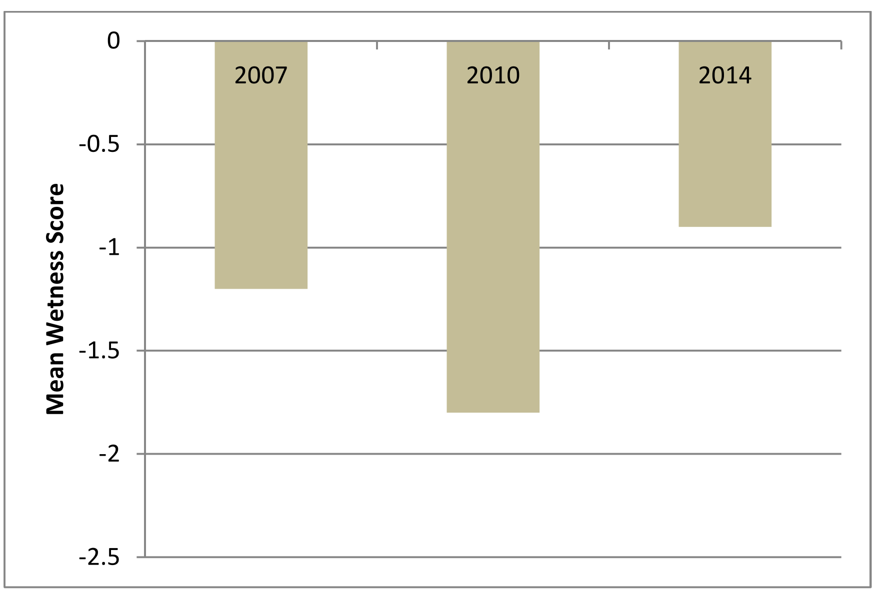


Figure 14b. Mean Wetness Scores for plots 3 and 4 combined, 2007 to 2014



3.4 Wildlife Observations, 2007 to 2014

A list of observed wildlife species is provided in Appendix F. The fauna were recorded as incidental observations. The field work was not timed to best find the wildlife, but instead to record the vegetation.

Birds

The most numerous group of species were the birds. All the birds seen were common species. There were 18 bird species seen in 2010 and 31 bird species in 2014. The larger number of species seen in 2014 is likely a reflection of the greater sampling time (two days of field work per plot in 2014 *vs* one day in 2010).

In 2014 the following birds were seen in each of the five plots: American Gold Finch, American Robin, Grey Catbird, and Red-winged Blackbird. The relatively large number of bird species recorded in such a small time frame and in small plots is indicative of the good riparian habitat that exists along this stretch of the Thames River. The plots are surrounded by more mature habitats.

In 2014, nesting behaviour was seen in the following species: Grey Catbird, Red-winged Blackbird (photos), Cliff Swallow and Rock Dove. Mating calls from other species were numerous. In 2010, nesting behavior was seen in Spotted Sandpiper, Killdeer, Yellow Breasted Vireo and Yellow Warbler.

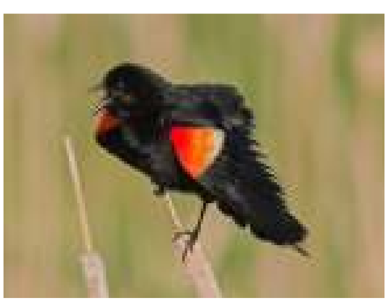
Other Wildlife

There were only a few insect and mammal sightings. Five mammals were seen (or their tracks) including: Eastern Chipmunk, Eastern Cottontail, Gray Squirrel, Racoon and White Tailed Deer, all common species.

Seven species of insects were recorded, most in 2014. There were three butterflies: Black Swallowtail, Cabbage White and Red Admiral, two damselflies (Bluet, Ebony Jewelwing), one moth (Cabbage) and Cicada.

The only herptile recorded was the Eastern American Toad.

While not part of this study, the authors conferred with Scott Gillingwater, Species at Risk Biologist with the UTRCA about the impact of lower water levels on the native river turtles such as the Spiny Softshell. According to Gillingwater, turtles have benefitted from additional habitat that would otherwise be under water during the summer egg-laying period. There have been increased areas of shallow water to provide more foraging areas by Species at Risk reptiles, since shallow water is generally clearer than the deeper water. According to Gillingwater there have been observations of Spiny Softshell, Northern Map, Midland Painted and Snapping Turtle along this stretch before and after 2006 when the Springbank Dam was last used.



Red-winged Blackbird. Photo Ron Ridout

4.0 Recommendations

The following recommendations are divided into two categories:

1) if the City of London decides to permanently decommission the dam and reservoir, or
2) if the City of London decides to resume operation of the dam and reservoir.

1. Recommendations if Springbank Dam and Reservoir is permanently decommissioned;

1a. Allow the vegetation to continue to naturalize with little active management, except in erosion prone areas.

Rationale

- The river acts as a natural transport system for seeds shed in the watershed upstream. Therefore, eradication of aggressive non-native species (e.g., species with a weediness score of -3) will be nearly impossible as non-native species will continue to populate the area from seed sources upstream.
- The river corridor is susceptible to natural fluctuations and flooding events. Plant species suited to these natural disturbance processes will naturally colonize the shorelines and banks (as they already have), many being spread from adjacent vegetated riparian areas. Thus, no planting is necessary.
- At certain erosion prone areas where vegetation does not appear to be establishing, the use of live staking of dogwood and willow cuttings (whips) may be advisable to assist with long-term stability. The cuttings will take root and assist to stabilize the banks.
- The riparian vegetation keeps erosion to a minimum. Any disturbance to the banks, especially steep banks, will impact erosion processes.
- Though the number of tree species is relatively low at present, there are a lot of individual saplings on many of the plots. These saplings will become larger trees in the future, providing shade to the water and increased input of organic matter (leaf litter fall) that impact fungus, bacteria and macro invertebrate communities in the soil and the river.
- The vegetation will increase the buffer zone from the existing trails to the water's edge. The existing trails and human activities along the river can be detrimental to sensitive wildlife, so the subsequent increase in buffer width may provide additional protection from disturbances and trap more sediment and pollutants from surface runoff.

1b. Monitor the five vegetation sample plots periodically.

Rationale

- Vegetation monitoring should take place during the summer season (June to September) to track the progression of vegetation change and succession, a unique natural history experiment in dam removal and ecosystem recovery.
- Tree diameter measurements should be added to the study methodology to track basal area changes.

1c. Monitor other related factors such as erosion, water quality, aquatic habitat and wildlife to provide a more complete physical and biological evaluation of the longer term changes to the area.

Rationale

- River flow dynamics may shift over time and new areas of erosion may need to be addressed.
- Documenting the changes to water quality (both the chemical composition and benthic organisms as indicators of water quality) is very beneficial to understanding the impacts of dam removal on the Thames and river systems in general. Seasonally operated dams are not common, so studying the changes from this dam are even more useful.

The biophysical environment has changed enough since the dam last operated to suggest that wildlife, including some Species at Risk that use the Thames River System, maybe using the resource differently so some monitoring will be helpful in evaluating that change.

2. Recommendations if Springbank Dam operation is resumed;

2a. Before proceeding with flooding the river channel and adjacent shorelines, remove the existing vegetation within the reservoir zone.

Rationale and Details

- The newly vegetated shorelines add up to about 10 ha of land, a substantial amount of vegetation that, if to remain, could negatively impact both the water quality and recreational use of the reservoir.
- A qualified chainsaw operator should oversee the cutting down of the young trees and shrubs. Leave the existing root structure to prevent disturbing the soil.
  - If they are not removed, most of the established trees and shrubs will die from having their roots under water all summer. The trees will decompose and potentially be pulled out by their roots during high water levels, causing shoreline erosion and other concerns.
  - Drowned trees and shrubs can create unseen hazards for canoeists and rowers.
  - Stumps should be cut as low as possible to minimize risks to recreational boats.
- A brush hog or weed whacker should be used to cut down the herbaceous plants.
- All cut vegetation (woody and herbaceous) should be removed so that it does not decompose in the water, robbing it of oxygen.

2b. In the fall of the first few years after the dam is back in operation, survey the shoreline areas to see if there are any bank erosion issues.

Rationale

- Loss of vegetation may increase near bank velocities and rehabilitation may be required.

2c. Continue with normal monitoring of water quality and erosion before and after operation of the dam is resumed.

Rationale

- Water quality monitoring near sewage plant outfalls provides long-term data on the quality of the river water and should continue to provide even longer-term coverage.
- Recognizing the former reservoir environment has changed over the last several years, it will be useful to record changes when the dam/reservoir operations return. Seasonal dams are uncommon so any information that can be gathered adds to the overall understanding of their impacts on the environment.

2d. Monitor the impacts of the dam and reservoir operation on river and nearshore wildlife, especially aquatic turtles, birds, fish, and freshwater mussels.

Rationale

- The river environment has changed enough since the dam last operated to suggest that wildlife are now using the resource differently, so monitoring the impact of dam and reservoir operation is needed.
- The timing of the reservoir filling will be later (June) than in the past (May) due to fisheries concerns and this change may impact the survival of the nests of other wildlife species such as aquatic turtles and shorebirds.
- The loss of beaches and gravel bars for nesting and basking turtles and the loss of clearer, shallow water areas for turtle foraging should be monitored as well.
- Action plans to move nests may need to be developed.

Killdeer guarding a nearby nest on the rocky shore near Plot 2, May 2015. Cathy Quinlan

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2014 aerial photo of the Springbank Dam. Photo UTRCA.

Appendices

A-1 Aerial Photo of Plot 1near Springbank Dam

A-2. Aerial Photo of Plot 2 near Thames River Golf Course

A-3. Aerial Photo of Plot 3 near upper parking lot

A-4. Aerial Photo of Plot 4 within Greenway park

A-5. Aerial Photo of Plot 5 near Cavendish Park and City depo

B-1. Cross section of Plot 1

B-2. Cross section of Plot 2

B-3. Cross section of Plot 3

B-4. Cross section of Plot 4

B-5. Cross section of Plot 5

C. Descriptive indices – Tools to assess the quality of vegetation communities

D. Annotated checklist of vascular plants, 2014

E. Annotated checklist of vascular plants, 2007 and 2010

F. Fauna observed in 2010 and 2014

G. History of Springbank Dam

H. Photos of the shoreline immediately upstream of the Springbank Dam, 2006 and 2008

I. Photos of Plots 2 and 5, May 2015

Appendix A-1. Aerial Photo of Plot 1 near Springbank Dam

Plot 1 as shown in 2007 ortho imagery (plot is incorrectly shown)

Plot 1 as shown in 2013 ortho imagery

Appendix A-2. Aerial Photo of Plot 2 near Thames River Golf Course

Plot 2 as shown in 2007 ortho imagery

Plot 2 as shown in 2013 ortho imagery

Appendix A-3. Aerial Photo of Plot 3 near upper parking lot

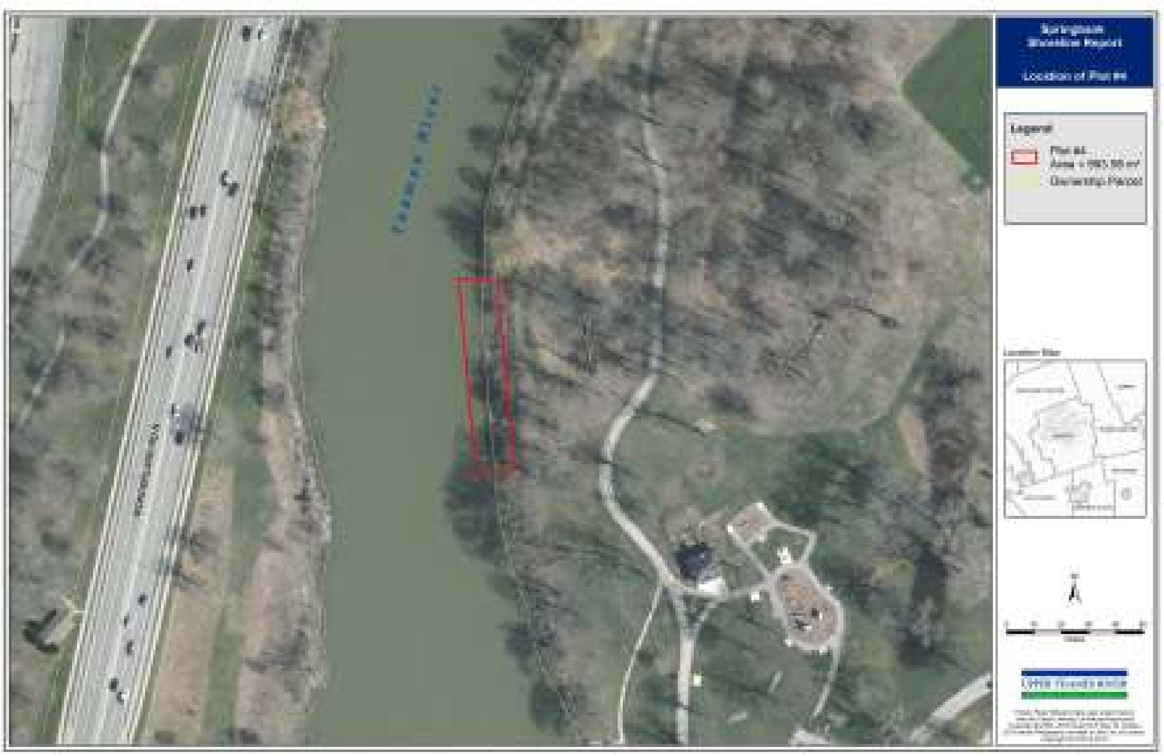
Plot 3 as shown in 2007 ortho imagery

Plot 3 as shown in 2013 ortho imagery

Appendix A-4. Aerial Photo of Plot 4 within Greenway Park

Plot 4 as shown in 2007 ortho imagery

Plot 4 as shown in 2013 ortho imagery

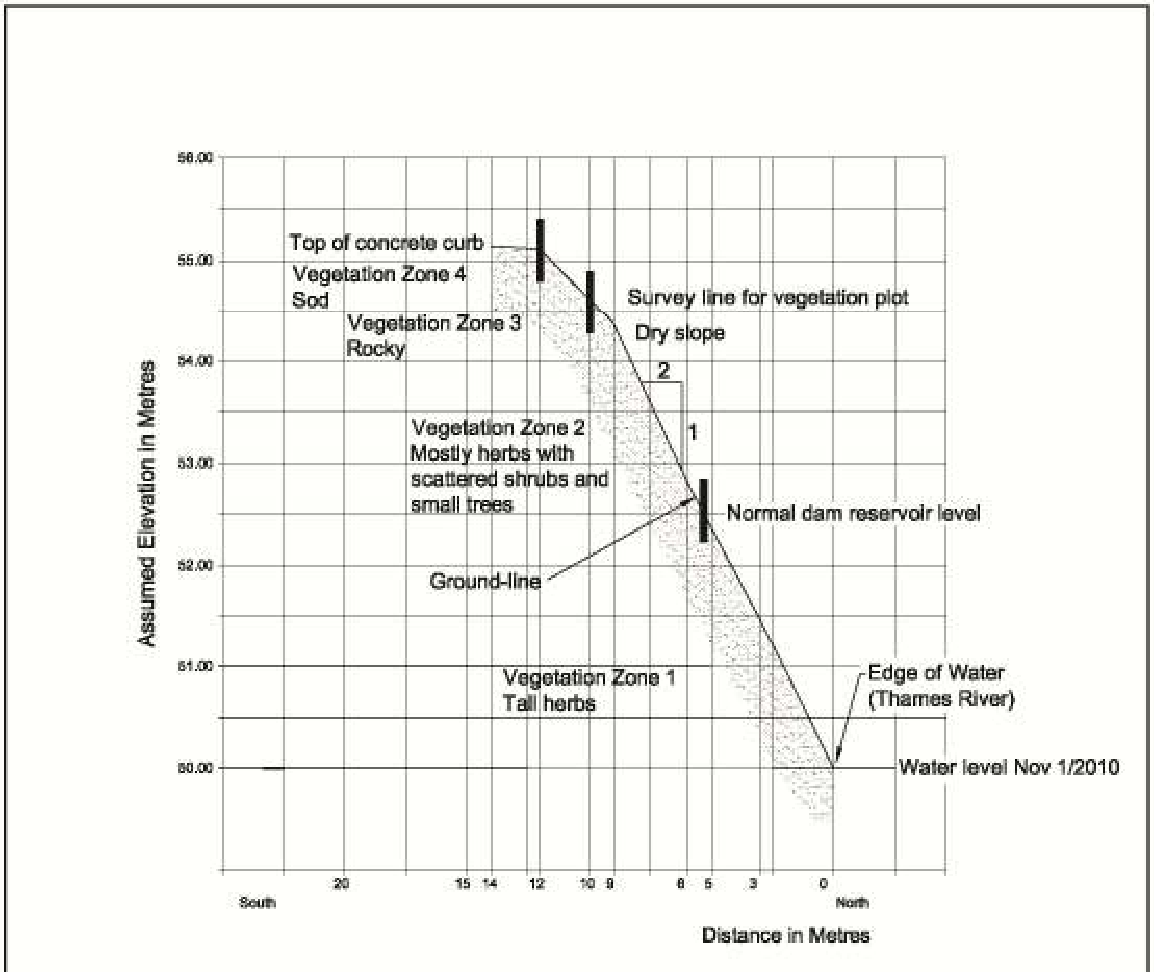


Appendix A-5. Aerial photo of Plot 5 near the Cavendish Dyke and City depo

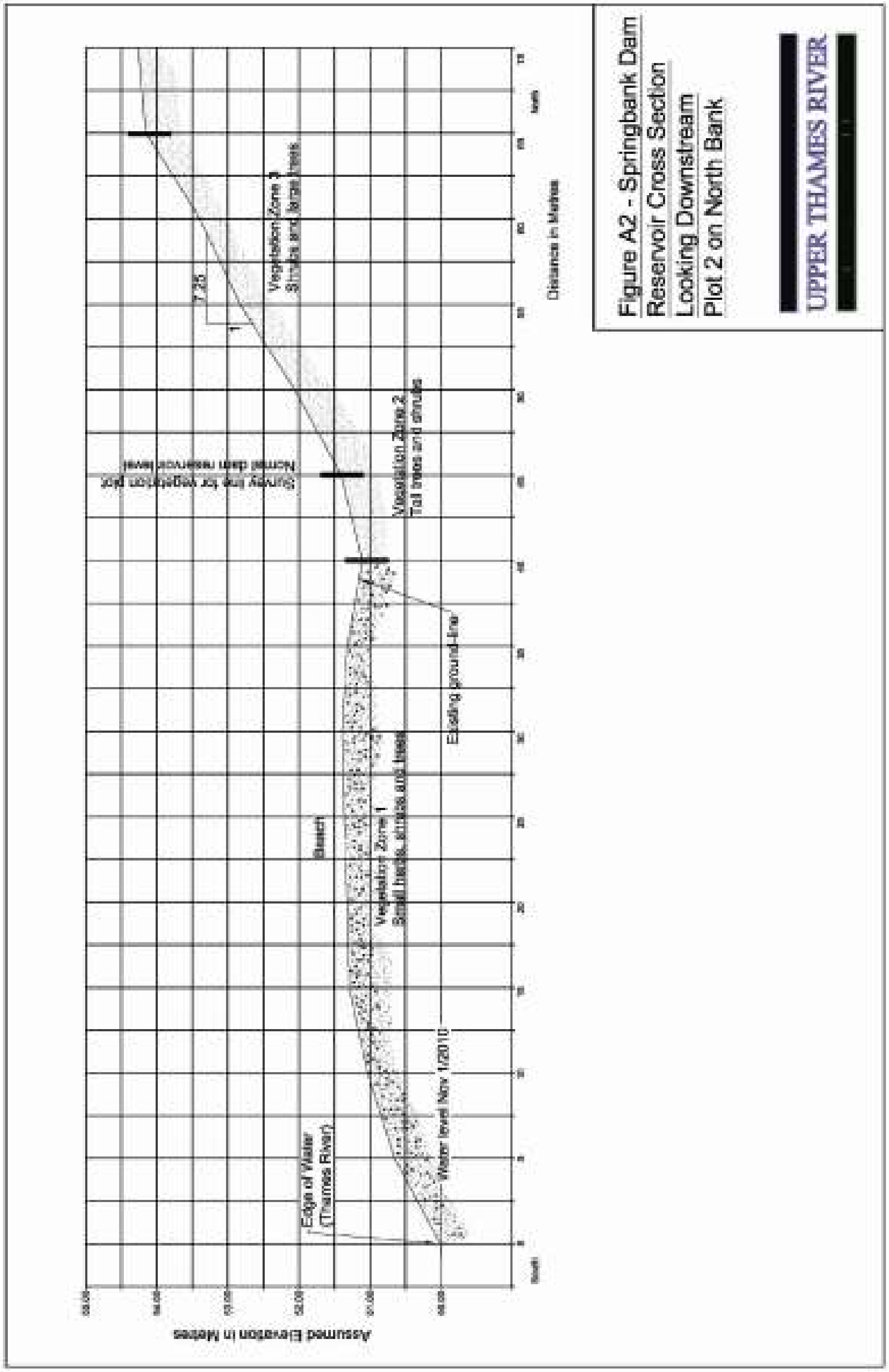
Plot 5 as shown in 2007 ortho imagery

Plot 5 as shown in 2013 ortho imagery

Appendix B-1. Cross Section of Plot 1



Appendix B-2. Cross Section of Plot 2



Appendix B-3. Cross Section of Plot 3

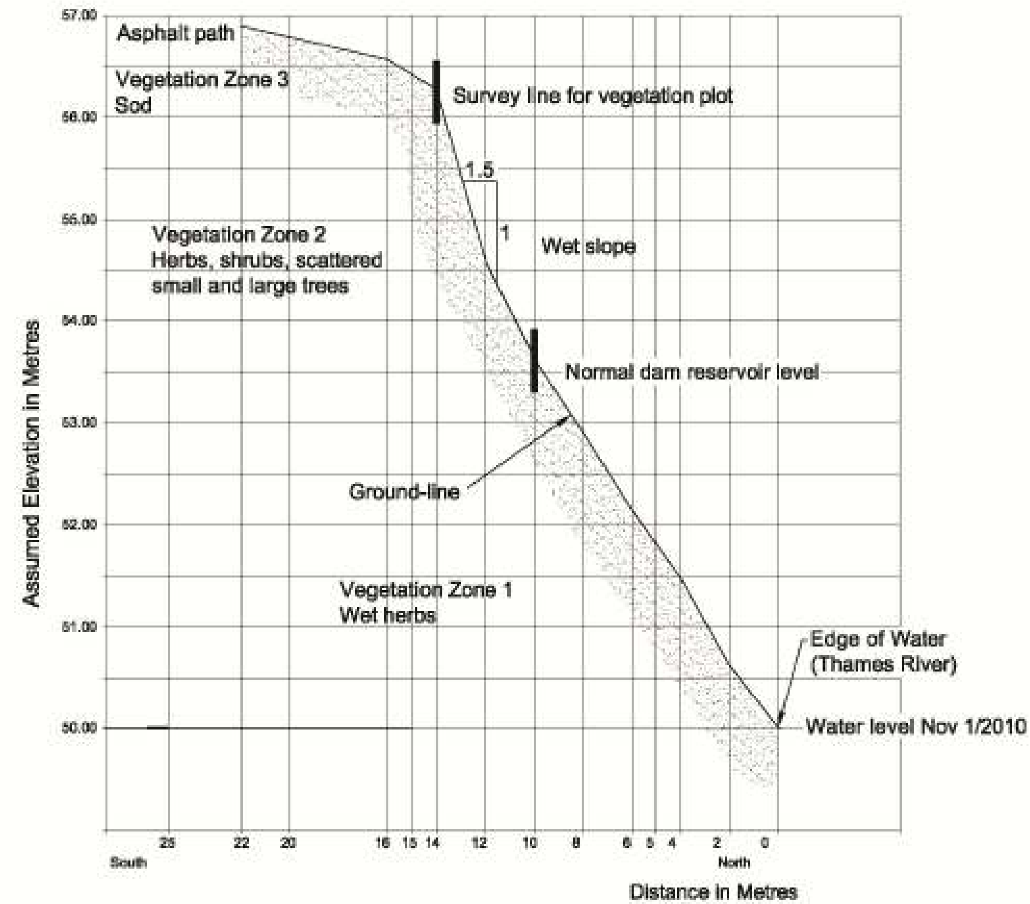


Figure A3 - Springbank Dam Reservoir Cross Section Looking Downstream Plot 3 on South bank

UPPER THAMES RIVER
CONSERVATION AUTHORITY

Appendix B-4. Cross Section of Plot 4

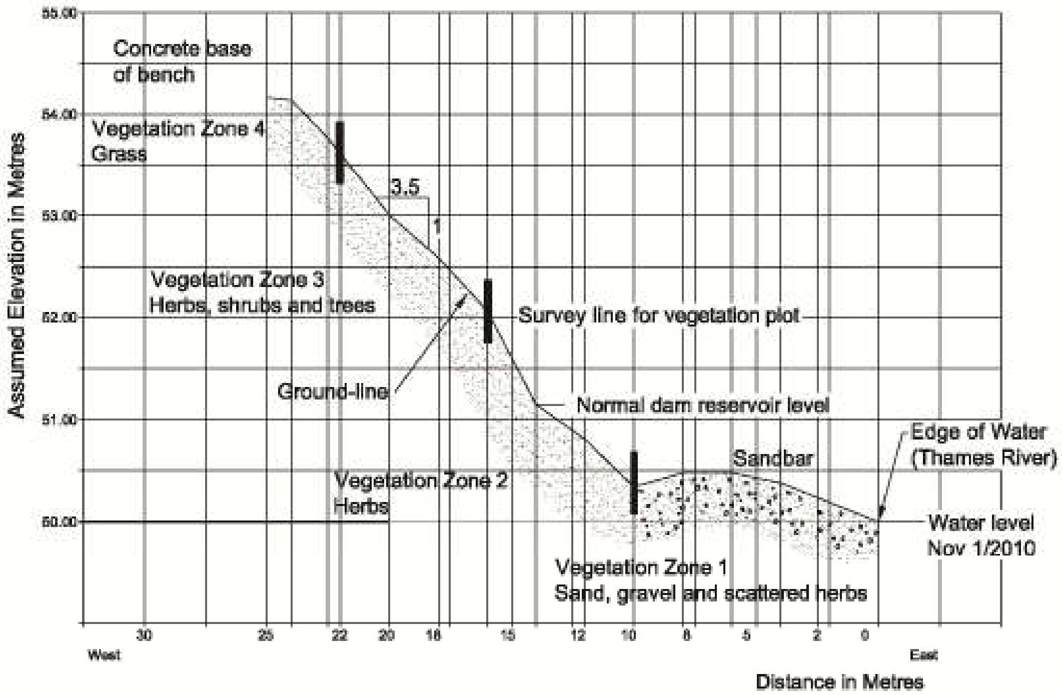
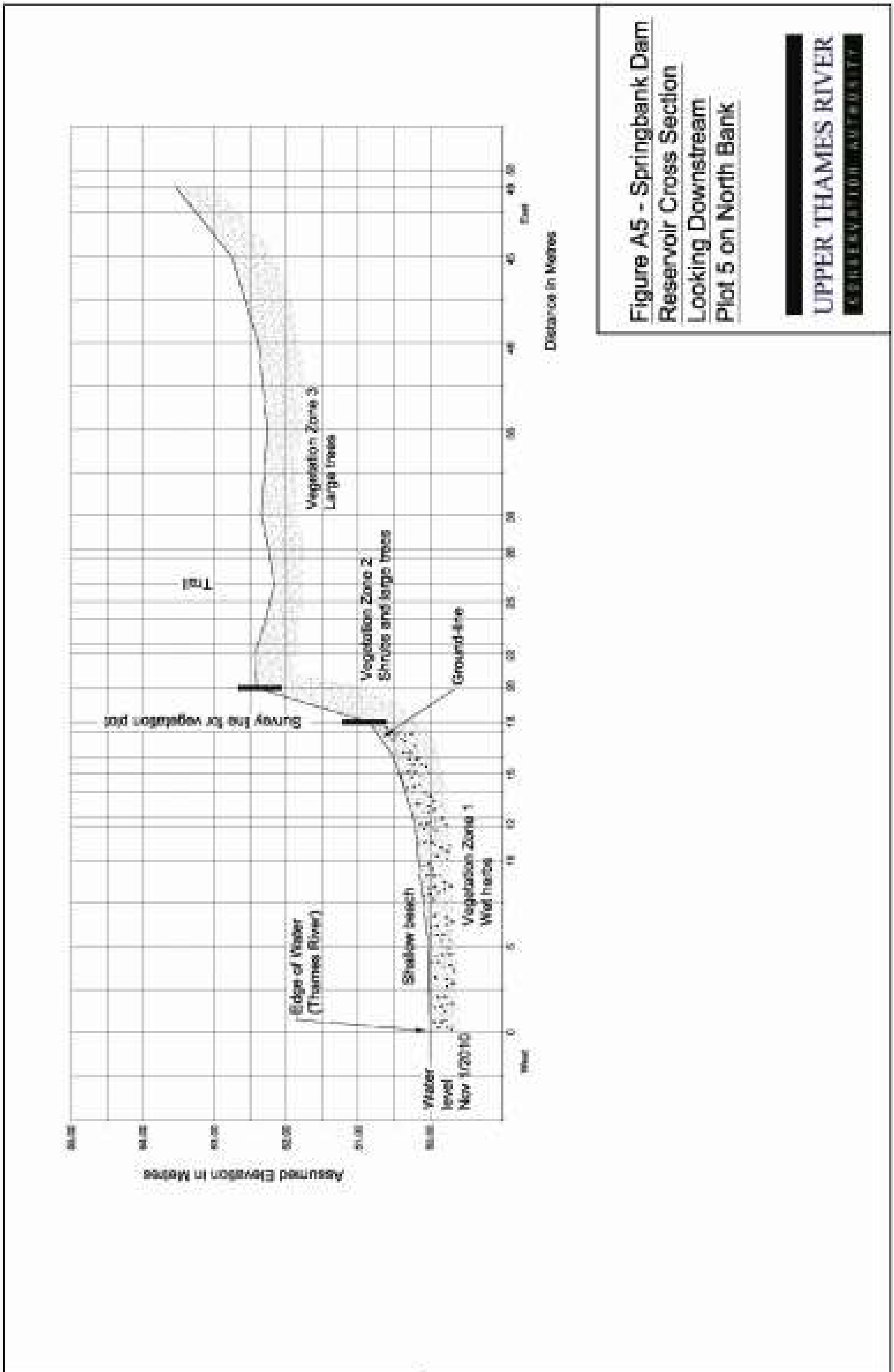


Figure A4 - Springbank Dam Cross Section Looking Downstream
Plot 4 on South Bank

UPPER THAMES RIVER
CONSERVATION AUTHORITY

Appendix B-5. Cross Section of Plot 5



Appendix C. Descriptive Indices – Tools to assess the quality of vegetation communities

Code and Measure	Description	Examples
CC **Coefficient of Conservatism** **(species level)**	Each native plant species is assigned a coefficient of conservatism (CC) score between 0 and 10 using the floristic quality assessment system for southern Ontario (Oldham *et al*., 1995) CCs represent an estimated probability that a plant species is likely to occur in a landscape relatively unaltered from what is believed to be pre-European settlement conditions (DNR Wisconsin 2001). Higher CCs are given to plants more specialized in habitat or condition and conserve themselves to very specific environments and communities (i.e., fidelity to a habitat).	0 to 3: Plants found in a wide variety of plant communities, including disturbed sites 4 to 6: Plants that typically are associated with a specific plant community but tolerate moderate disturbance. Most woodland species fall in this category 7 to 8: Plants associated with a plant community in an advanced successional stage that has undergone minor disturbance. 9 to 10: Plants with a high degree of fidelity to a narrow range of synecological parameters or habitat specialists.
MCC **Mean Conservatism Coefficient** **(site level)**	MCC is used as a measure of the pristiness or lack of disturbance of a site (Oldham *et al*. 1995). Communities or sites with high MCCs contain more plants unlikely to be found in disturbed habitat. Middlesex Natural Heritage Study (UTRCA 2003) found MCC scores of 3.0 to 5.0 in woodland sites. Burke *et al*. 2007 found MCC scores of 4.1 to 5.3 at 12 woodlots with 75 km of London. ***Formula***: Add all of the CC scores for a particular site or community and then divide by the number of species (native only).	3.0 to 5.0 MNHS, UTRCA 2003 4.1 to 5.3 Burke 2007 3.3 to 3.8 London Dykes (UTRCA 2013) London Subwatershed Study, thresholds for woodland protection: <4.0 low priority 4.0 to 4.5 medium priority >4.5 high priority
FQI **Floristic Quality Index** **(site level)**	FQI is an assessment of a particular site based on a comprehensive list of plant species found. Woodlands with the highest score have a combination of high native species diversity or richness and contain species with high CC scores (Wilhelm and Masters, 1995). ***Formula***: Multiply the MCC by the square root of the number of native species found. Multiplying the by the square root of the number of species is used to better compare large and small sites.	<20 sites with minimal significance from a natural quality perspective 20-35 sites with intermediate significance >35 sites that possess sufficient conservatism and richness that they are floristically significant statewide >50 sites that possess excellent floristic significance and are extremely rare *(Values above based on findings from Michigan)* 33.8 London Dykes (UTRCA 2013) 10 - 30 Urban areas such as Mississauga (North South Environmental, 2010)

Appendix C continued		
Code and Measure	**Description**	**Examples**
Conservative Species **(species level)**	The number of plant species with a CC of 8 to 10 gives an indication of site quality and highlights species of concern for management. Dr. Jane Bowls (pers. com) indicated that using CC of 8 to 10 for Conservative Plants is a combination of intuition, convention, experience and data. Species with 0 to 2 CC score are generalists, and 8 to 10 are specialists. The rest are the in-betweens. ***Formula***: Count the number of species with CC score of 8, 9 and 10.	The more species with scores of 8, 9 and 10 at a given site suggests the site is of higher quality.
WEED **Weediness Score** **(species level)**	Each non-native plant species has been assigned a weediness score between -1 and -3, where -1 represents a weed with low invasiveness and a -3 a very invasive species (Oldham *et al*, 1995). The Weediness Score represents an estimated probability that a non-native plant is likely to infest and negatively impact a natural area by displacing native plants.	-1 little or no impact on natural areas -2 occasional impacts on natural areas, generally infrequent or localized -3 major potential impacts on natural areas
MWS **Mean Weediness Score** **(site level)**	The mean weediness score can be used like MCC to measure the representation of weedy adventive (alien) species abundance in a site (Moc 2001). In combination with the percentage of non-native plants, this measure can be used as an indicator of disturbance. Also, it is an indication of the threat to native species from highly invasive adventive species. ***Formula:*** Add all the weediness scores from a particular site or community and divide by the number of non-native species.	-1.0 to -1.6 little or no impact on natural areas -1.7 to -2.3 occasional impacts on natural areas, generally infrequent or localized -2.4 to -3.0 major potential impacts on natural areas **The above is an estimation devised by C. Quinlan at UTRCA using equal divisions between -1 and -3.*

Appendix C continued

Code and Measure	Description	Values, Examples, Assessments
CW (CWet) **Coefficient of Wetness** **(species level)**	Each plant species is assigned a value from -5 to +5 based on the probability of being found in a wetland or not. Usually only native species are used, even though a CW exists for adventive species also.	-5 occurs in wetlands under natural conditions (obligate wetland species) -4 to -2 usually occurs in wetlands, but occasionally found in non-wetlands -1 to 1 equally likely to be occur in wetlands or non-wetlands (facultative) 2 to 4 occasionally occurs in wetlands, but usually occurs in non-wetlands 5 almost never occurs in wetlands under natural conditions (obligate upland)
WI **Wetness Index (Mean Wetness Coefficient)** **(site level)**	Wetness Index is an assessment of a plant community as to whether it has a predominance of wetland species or not. It is not an indication of site quality. The MNHS 2003 found mean wetness coefficients from individual woodland patches ranged from -2.5 to +2.1. Formula: Add all the CW scores (native species only) from a particular site or community and divide by the number of native species found (Michigan DNR).	Examples: -0.4 to -1.1 London Dykes -2.5 to 2.1 MNHS 2003 woodlands Overall: <0 site has a predominance of native wetland species >0 site has a predominance of native upland species
Physiognomy **(species level)**	Another measure for evaluating change is to use physiognomy. Physiognomy is the outward appearance or physical characteristics of a plant. The proportion of plants in various physiognomic classes can change over time without correlative changes in FQI or MCC. Physiognomy includes various forms of: • **Annuals** (germinates, flowers and dies within one year; seeds can survive in the soil until environmental conditions are appropriate), • **Biennials** (grows vegetative structures such as leaves, stems, and roots in the first year and flowers/ seeds in second year), and • **Perennials** (live > 2 years and reproduce primarily vegetatively thrugh bulbs, tubers, and roots; often grow in spring, die back in winter, and then return following spring), • **Woody vines** (e.g., Riverbank Grape) • **Shrubs** • **Trees**	

Appendix C continued

Descriptive indices such as Mean Conservatism Coefficient (MCC), Floristic Quality Index (FQI) and Wetness Index (CW) can decrease the variability that is caused by misidentification of species (Coles-Ritchie et al. 2004). This is because similar dominant species are often ecological equivalents, in that they are found in similar habitats and perform similar ecosystem functions. For this reason, taxonomic differences, which can be difficult to identify in the field, may not be important when trying to understand the functioning of the riparian ecosystem (Coles-Ritchie et al. 2004). Descriptive indices have the advantage of minimizing the influence of differences in species that are unimportant for the index. The most useful indices are those with many gradations that are based on scientific information about vegetation.

Appendix D. Annotated checklist of vascular plants, 2014

Plant Names		Plant Properties			Type		Plots (2014)				
Scientific Name	**Common Name**	**CC**	**CWET**	**WEED**	**N_A**	**Phys-iog**	**1**	**2**	**3**	**4**	**5**
Acalypha rhomboidea	Three-seeded Mercury	0	3		N	A	x	x	x	x	x
Acer negundo	Manitoba Maple		-2	-2	A	T	x	x	x	x	x
Acer platinoides	Norway Maple		5	-3	A	T	x			x	x
Acer pseudoplatanus	Sycamore Maple		0	-1	A	T	x				
Acer rubrum	Red Maple	4	0		N	T					x
Acer saccharinum	Silver Maple	5	-3		N	T	x	x	x		x
Acer saccharum	Black Maple	7	3		N	T	x		x	x	
Acer saccharum	Sugar Maple	4	3		N	T	x			x	
Achillea millefolium	Yarrow		3	-1	A	P	x	x	x	x	
Aegopodium podagraria	Goutweed		0	-3	A	P				x	
Agrimonia gryposedpala	Agrimony	2	2		N	P	x				
Alliaria petiolata	Garlic Mustard		0	-3	A	A	x	x	x	x	x
Alnus glutinosa	Black Alder		-2	-3	A	S	x	x	x	x	
Amaranthus hybridus	Smooth Pigweed		5	-1	A	A		x		x	x
Ambrosia artemisiifolia	Common Ragweed	0	3		N	A	x	x		x	x
Ambrosia trifida	Giant Ragweed	0	-1		N	A	x	x	x	x	x
Amphicarpaea bracteata	Hog-peanut	4	0		N	P					x
Anemone canadesis	Canada Anemone	3	-3		N	P	x	x	x	x	
Angelica atropurpurea	Angelica	6	-5		N	B	x	x	x		x
Anthemis cotula	Stinking Mayweed		3	-1	A	A		x			
Anthriscus sylvestris	Wild Chervil		5	-2	A	B	x	x	x	x	x
Apocynum androsaemifolium	Spreading Dogbane	3	5		N	P					x
Apocynum cannabinum	Indian Hemp	3	0		N	P	x	x			x
Arctium minus	Common Burdock		5	-2	A	B	x	x	x	x	x
Artemisia vulgaris	Mugwort		5	-1	A	P	x	x	x	x	
Asclepias incarnata	Swamp Milkweed	6	-5		N	P	x	x	x	x	x
Asclepias syriaca	Common Milkweed	0	5		N	P	x	x	x	x	x
Aster ericoides	Heath Aster	4	4		N	P		x			
Aster lanceolatus	Panicled Aster	3	-3		N	P	x	x	x		x
Aster lateriflorus	Calico Aster	3	-2		N	P	x	x	x	x	x
Aster novae-angliae	New England Aster	2	-3		N	P	x	x	x	x	x
Aster pilosus	Hairy Aster	4	2		N	P		x			

Appendix D (2014) continued											
Scientific Name	**Common Name**	**CC**	**CWET**	**WEED**	**N_A**	**Phys-iog**	**1**	**2**	**2**	**4**	**5**
Aster urophyllus	Arrow-leaved Aster	6	5		N	P	x	x	x	x	
Barbarea vulgaris	Winter Cress		0	-1	A	B	x	x	x	x	x
Bidens frondosa	Devil's Beggarticks	3	-3		N	A		x	x	x	x
Bidens tripartita	Beggarticks	4	-3		N	A	x				x
Boehmeria cylindrica	False Nettle	4	-5		N	P	x		x	x	
Brassica juncea	Indian Mustard		5	-1	A	A	x	x	x	x	x
Bromus inermis	Smooth Brome		5	-3	A	PG					x
Calystegia sepium	Hedge Bindweed	2	0		N	P	x	x	x	x	x
Carex cristatella	Crested Sedge	3	-4		N	P			x		x
Carex vulpinodidea	Fox Sedge	3	-5		N	P	x				
Celastrus orbiculatus	Oriental Bittersweet		5	-1	A	V			x		
Celastrus scandens	Climbing Bittersweet	3	3		N	V			x		
Celtis occidentalis	Common Hackberry	8	1		N	T	x		x	x	x
Chamaesyce maculata	Hairy-fruited Spurge		4	-1	A	A	x				
Chelidonium majus	Celandine		5	-3	A	B				x	
Chenopodium album	Lamb's-quarters		1	-1	A	A	x			x	
Chenopodium simplex	Maple-leaved Goosefoot	0	5		N	A	x		x		
Cichorium intybus	Chicory		5	-1	A	P	x	x		x	
Cicuta maculata	Spotted Water-hemlock	6	-5		N	P			x	x	
Circaea lutetiana	Enchanter's-nightshade	3	3		N	P			x		
Cirsium arvense	Canada Thistle		3	-1	A	P	x	x	x	x	
Cirsium vulgare	Bull Thistle		4	-1	A	B	x			x	
Clematis virginiana	Virgin's-bower	3	0		N	V	x	x	x	x	x
Clinopodium vulgare	Wild Basil	4	5		N	P			x	x	
Convolulus arvensis	Field Bindweed		5	-1	A	P		x		x	x
Conyza canadensis	Horseweed	0	1		N	A		x	x		
Cornus amomum	Silky Dogwood	5	-4		N	S	x	x	x	x	x
Cornus stolonifera	Red-osier Dogwood	2	-3		N	S	x	x			x
Coronilla varia	Crown-vetch		5	-2	A	P	x	x	x	x	
Cryptotaenia canadensis	Honewort	5	0		N	P	x			x	
Cuscuta gronovii	Common Dodder	4	-3		N	A	x	x	x	x	x
Dactylis glomerata	Orchard Grass		3	-1	A	PG	x	x	x	x	x

Appendix D (2014) continued

Scientific Name	Common Name	CC	CWET	WEED	N_A	Phys-iog	1	2	2	4	5
Daucus carota	Wild Carrot		5	-2	A	B	x	x	x	x	x
Dianthus armeria	Deptford Pink		5	-1	A	A	x				
Dipsacus fullonum	Teasel		5	-1	A	P		x		x	
Echinochloa crusgalli	Barnyard Grass		-3	-1	A	AG		x			x
Echinocystis lobata	Wild Cucumber	3	-2		N	A		x	x	x	x
Echium vulgare	Viper's-bugloss		5	-2	A	B	x				
Elymus repens	Quack Grass		3	-3	A	P				x	
Elymus virginicus	Virginia Wild-rye	5	-2		N	P		x		x	x
Epilobium ciliatum	Willow-herb	3	3		N	P	x				
Epilobium hirsutum	Great Hairy Willow-herb		-4	-2	A	P	x		x	x	
Epilobium helleborine	Helleborine		5	-2	A	P				x	
Erigeron annuus	Daisy Fleabane	0	1		N	A	x	x	x	x	
Erigeron philadelphicus	Philadelphia Fleabane	1	-3		N	P	x		x	x	
Erigeron strigosus	Narrow-leaved Fleabane	0	1		N	A		x			
Erysimum cheiranthoides	Wormseed Mustard		3	-1	A	A	x	x	x	x	x
Euonymus europaea	Spindle-tree		5	-1	A	S				x	
Eupatorium maculatum	Spotted Joe-Pye-weed	3	-5		N	P	x	x	x	x	x
Eupatorium perfoliatum	Boneset	2	-4		N	P		x			
Eupatorium rugosum	White Snakeroot	5	3		N	P	x	x	x	x	x
Euphorbia esula	Leafy Spurge		5	-2	A	P		x	x	x	
Euthamia graminifolia	Grass-leaved Goldenrod	2	-2		N	P		x	x		
Festuca pratensis	Meadow Fescue		4	-1	A	PG		x	x	x	
Fragaria virginiana	Wild Strawberry	2	1		N	P	x				
Fraxinus americana	White Ash	4	3		N	T		x	x		
Fraxinus excelsior	European Ash		0	-1	A	T	x		x		
Fraxinus pennsylvanica	Red/Green Ash	3	-3		N	T	x	x	x	x	x
Galium asprellum	Rough Bedstraw	6	-5		N	A		x			
Galium mollugo	Wild Madder		5	-2	A	P	x	x	x	x	x
Galium palustre	Marsh Bedstraw	5	-5		N	A	x	x			
Galium verum	Yellow Bedstraw		5	-1	A	P			x	x	
Geranium pusillum	Small-flowered Crane's-bill		5	-1	A	A	x				
Geum aleppicum	Yellow Avens	2	-1		N	P	x		x	x	

Appendix D (2014) continued											
Scientific Name	**Common Name**	**CC**	**CWET**	**WEED**	**N_A**	**Phys-iog**	**1**	**2**	**2**	**4**	**5**
Geum canadense	White Avens	3	0		N	P	x				x
Geum laciniatum	Cut-leaved Avens	4	-3		N	P	x	x	x	x	
Glechoma hederacea	Gill-over-the-ground		3	-2	A	P	x			x	x
Glyceria striata	Fowl Manna Grass	3	-5		N	PG		x			
Hedera helix	English Ivy		2	-2	A	V	x				
Helianthus tuberosus	Jerusalem Artichoke		0	-2	A	P		x		x	
Heliopsis helianthoides	Ox-eye	3	5		N	P		x			
Heracleum lanatum	Cow-parsnip	3	-3		N	B	x	x			
Heracleum sphondylium	Common Hogweed		0	-1	A	B			x	x	x
Hesperis matronalis	Dame's Rocket		5	-3	A	P		x	x	x	
Hieracium caespitosum	Field Hawkweed		5	-2	A	P	x				
Humulus lupulus	Common Hop		3	-1	A	V		x		x	
Hypericum perforatum	Common St. John's-wort		5	-3	A	P	x		x	x	x
Hypericum punctatum	Spotted St. John's-wort	5	-1		N	P			x		
Impatiens capensis	Spotted Touch-me-not	4	-3		N	A	x	x	x	x	x
Impatiens glandulifera	Purple Touch-me-not		-3	-2	A	A	x		x		
Iris pseudacorus	Yellow-flag		-5	-2	A	P	x		x		
Iris sp.	Iris species		-1	-1	A	P	x				
Jugulans nigra	Black Walnut	5	3		N	T		x	x	x	x
Juniperus virginiana	Red Cedar	4	3		N	T			x		
Laportea canadensis	Wood Nettle	6	-3		N	P				x	x
Lapsana communis	Nipplewort		5	-2	A	A	x	x	x	x	x
Lathyrus latifolius	Everlasting Pea		5	-1	A	P		x			
Leonurus cardiaca	Motherwort		5	-2	A	P				x	x
Lepidium campestre	Field Pepper-grass		5	-1	A	A		x			
Leucanthemum vulgare	Ox-eye Daisy		5	-1	A	P	x	x	x	x	
Ligustrum vulgare	Privet		1	-2	A	S		x		x	
Linaria vulgaris	Butter-and-eggs		5	-1	A	P	x	x	x	x	
Lonicera tatarica	Tartarian Honeysuckle		3	-3	A	S		x	x	x	
Lotus corniculatus	Birdfood Trefoil		1	-2	A	P	x	x	x		
Lycopus americanus	American Water-horehound	4	-5		N	P	x	x	x	x	x

Appendix D (2014) continued

Scientific Name	Common Name	CC	CWET	WEED	N_A	Phys-iog	1	2	2	4	5
Lycopus univlorus	Bugleweed	5	-5		N	P	x				
Lysimachia ciliata	Fringed Loosestrife	4	-3		N	P		x			
Lysimachia punctata	Spotted Loosestrife		0	-1	A	P		x	x		x
Lythrum salicaria	Purple Loosestrife		-5	-3	A	P	x	x	x	x	x
Malus pumila	Apple		5	-1	A	T				x	x
Medicago lupulina	Black Medick		1	-1	A	A	x	x	x	x	
Melilotus alba	White Sweet-clover		3	-3	A	B	x	x	x	x	
Melilotus officinalis	Yellow Sweet-clover		3	-1	A	B		x			
Mentha arvensis	Field Mint	3	-3		N	P	x	x	x	x	x
Mentha x piperita	(M. aquatica X M. spicata)		-5	-1	A	P				x	x
Morus alba	White Mulberry		0	-3	A	T	x	x		x	x
Myosotis scorpioides	Forget-me-not		-5	-1	A	P	x	x	x	x	x
Nasturtium officinale	Water Cress		-5	-1	A	P		x			
Nepeta cataria	Catnip		1	-2	A	P	x			x	
Oenothera biennis	Hairy Yellow Evening-primrose	0	3		N	B	x	x			
Origanum vulgare	Wild Majoram		5	-2	A	P		x			
Oxalis stricta	European Wood-sorrel	0	3		N	P	x	x	x	x	x
Parthenocissus inserta	Virginia Creeper	3	3		N	V		x	x	x	
Pastinaca sativa	Wild Parsnip		5	-3	A	B		x			
Phalaris arundinacea	Reed Canary Grass	0	-4		N	P		x	x	x	x
Phleum pratense	Timothy		3	-1	A	PG		x			
Phragmites australis	Common Reed	0	-4		N	P					
Physocarpus opulifolius	Ninebark	5	-2		N	S	x	x	x	x	
Pilea pumila	Clearweed	5	-3		N	A	x	x	x	x	x
Plantago lanceolata	English Plantain		0	-1	A	P	x	x	x	x	
Plantago major	Common Plantain		-1	-1	A	P	x	x	x		
Plantago rugelii	Rugel's Plantain	1	0		N	P		x	x	x	x
Platanus occidentalis	Sycamore	8	-3		N	T	x	x	x	x	x
Poa pratensis	Kentucky Blue Grass	0	1		N	P		x		x	
Polygonum hydropiper	Water-pepper	4	-5		N	A	x	x	x	x	x
Polygonum lapathifolium	Pale Smartweed	2	-4		N	A	x	x	x	x	x

Appendix D (2014) continued

Scientific Name	Common Name	CC	CWET	WEED	N_A	Phys-iog	1	2	2	4	5
Polygonum pensylvanicum	Pinkweed	3	-4		N	A	x	x			x
Polygonum persicaria	Lady's-thumb		-3	-1	A	A	x	x	x	x	x
Polygonum scandens	Climbing False Buckwheat	3	0		N	A		x			
Populus deltoides	Cottonwood	4	-1		N	T	x	x	x	x	x
Portulaca oleracea	Common Purslane	0	1		N	A	x				
Potentilla anserina	Silverweed	5	-4		N	P		x		x	
Potentilla norvengica	Rough Cinquefoil		0	-1	A	P	x	x	x		
Potentilla recta	Rough-fruited Cinquefoil		5	-2	A	P				x	
Prunella vulgaris	Heal-all	0	0		N	P	x	x		x	
Quercus marcrocarpa	Bur Oak	5	1		N	T			x		
Ranunculus acris	Common Buttercup		-2	-2	A	P		x	x	x	x
Ranunculus hispidus	Hispid Buttercup	8	0		N	P	x	x			
Ranunculus repens	Creeping Buttercup		-1	-1	A	P			x		
Rhamnus cathartica	Common Buckthorn		3	-3	A	S	x	x	x	x	x
Rhamnus frangula	Glossy Buckthorn		-1	-3	A	S	x	x	x	x	x
Rhus aromatica	Fragrant Sumac	8	5		N	S	x				
Rhus radicans	Poison-ivy	0	0		N	V		x		x	
Ribes americanum	Wild Black Currant	4	-3		N	S			x		
Ribes cynosbati	Prickly Gooseberry	4	5		N	S			x		
Ribes rubrum	Garden Red Currant		5	-2	A	S			x		
Robinia pseudo-acacia	Black Locust		4	-3	A	T		x		x	x
Rorippa sylvestris	Creeping Yellow Cress		-5	-1	A	P	x	x		x	x
Rosa blanda	Smooth Wild Rose	3	3		N	S			x		
Rosa multiflora	Multiflora Rose		3	-3	A	S		x	x	x	
Rubus idaeus	Wild Red Raspberry	0	-2		N	S	x		x		
Rubus occidentalis	Black Raspberry	2	5		N	S	x		x	x	
Rudbeckia laciniata	Cut-leaved Coneflower	7	-4		N	P	x		x	x	x
Rumex crispus	Curly Dock		-1	-2	A	P	x	x	x		x
Rumex obtusifolius	Bitter Dock		-3	-1	A	P	x	x	x	x	x
Sagittaria latifolia	Common Arrowhead	4	-5		N	P				x	
Salix alba	White Willow		-3	-2	A	T	x	x	x	x	x

Appendix D (2014) continued											
Scientific Name	**Common Name**	**CC**	**CWET**	**WEED**	**N_A**	**Phys-iog**	**1**	**2**	**2**	**4**	**5**
Salix discolor	Pussy Willow	3	-3		N	S	x				
Salix eriocephala	Heart-leaved Willow	4	-3		N	S	x	x	x	x	x
Salix exigua	Sandbar Willow	3	-5		N	S	x	x		x	x
Salix fragilis	Crack Willow		-1	-3	A	T	x			x	x
Salix nigra	Black Willow	6	-5		N	T	x	x	x	x	x
Sambucus sanadensis	Common Elder	5	-2		N	S			x		
Saponaria officinalis	Bouncing Bet		3	-3	A	P		x		x	
Scirpus atrovirens	Dark Green Bulrush	3	-5		N	P		x			
Senecio aureus	Golden Ragwort	7	-3		N	P				x	
Setaria viridis	Green Foxtail		5	-1	A	A	x	x			
Sicyos angulatus	Bur Cucumber	5	-2		N	A		x	x	x	x
Silene latifolia	White Cockle		5	-2	A	B		x		x	
Silene noctiflora	Night-flowering Catchfly		5	-1	A	A				x	
Silene vulgaris	Bladder Campion		5	-1	A	P	x	x			
Sinapis arvensis	Charlock		0	-1	A	A	x	x	x	x	x
Sisymbrium officinale	Hedge Mustard		5	-1	A	A		x			
Solanum dulcamara	Climbing Nighshade		0	-2	A	P	x		x	x	x
Solanum ptycanthum	Eastern Black Nightshade		0	-1	A	A		x		x	
Solidago altissima	Late Goldenrod	1	3		N	P	x	x	x	x	x
Solidago canadensis	Canada Goldenrod	1	3		N	P		x	x	x	x
Solidago gigantea	Tall Goldenrod	4	-3		N	P	x	x	x	x	x
Sonchus arvensis	Perennial Sow-thistle		1	-1	A	P	x	x			
Sonchus asper	Spiny-leaved Sow-thistle		0	-1	A	A	x				
Sonchus oleraceus	Annual Sow-thistle		3	-1	A	A	x				
Stellaria media	Common Chickweed		3	-1	A	A	x				
Symphytum officinale	Common Comfrey		5	-1	A	P				x	
Tanacetum vulgare	Tansy		5	-1	A	P	x	x	x	x	x
Taraxacum officinale	Common Dandelion		3	-2	A	P	x		x	x	x
Thalictrum pubescens	Tall Meadow-rue	5	-2		N	P	x	x	x	x	x
Thuja occidentalis	White Cedar	4	-3		N	T	x		x		
Tilia americana	Basswood	4	3		N	T		x	x	x	
Tilia cordata	Little-Leaf Linden		0	-1	A	T			x		
Trifolium hybridum	Alsike Clover		1	-1	A	P		x			

Appendix D (2014) continued

Scientific Name	Common Name	CC	CWET	WEED	N_A	Phys-iog	1	2	2	4	5
Trifolium pratense	Red Clover		2	-2	A	P	x		x		
Trifolium repens	White Clover		2	-1	A	P	x		x	x	
Tussilago farfara	Coltsfoot		3	-2	A	P	x		x		
Ulmus americana	American Elm	3	-2		N	T	x		x	x	
Ulmus pumila	Siberian Elm		5	-1	A	T	x	x	x	x	x
Ulmus rubra	Slippery Elm	6	0		N	T		x			
Urtica dioica	Stinging Nettle	2	-1		N	P	x	x	x	x	x
Valeriana officinalis	Heliotrope		2	-1	A	P				x	
Verbascum blattaria	Moth Mullein		4	-1	A	B	x	x		x	
Verbascum thapsus	Common Mullein		5	-2	A	B	x	x			
Verbena hastata	Blue Vervain	4	-4		N	P	x	x			
Verbena urticifolia	White Vervain	4	-1		N	P	x	x	x	x	x
Veronica anagallis-aquatica	Water Speedwell		-5	-1	A	P	x	x	x	x	x
Vibrunum lentago	Nannyberry	4	-1		N	S	x		x		
Vicia cracca	Cow Vetch		5	-1	A	P	x		x		
Viola cucullata	Marsh Violet	5	-5		N	P					x
Vitis riparia	Riverbank Grape	0	-2		N	V	x	x	x	x	x
Xanthium strumarium	Cocklebur	2	0		N	A	x	x		x	x
Zizia aurea	Golden Alexanders	7	-1		N	P	x				
Total		**413**	**144**	**-192**							
Count		**122**	**241**	**119**	**241**	**241**	**147**	**149**	**134**	**144**	**99**
Mean		**3.4**	**0.6**	**-1.6**							

Abbreviations:
CC – Coefficient of Conservatism
CW – Coefficient of Wetness
WEED – Weediness Index
Physiog – Physiognomy or Form (A-Annual, B-Biannual, P-Perennial, S-Shrub, T-Tree, V-Woody Vine

Appendix E. Annotated checklist of vascular plants, 2010 and 2007

Plant Names		Plant Properties			Type		2010 Plots					2010	2007
Scientific Name	**Common Name**	**CC**	**CWET**	**WEED**	**N_A**	**Phys-iog**	**1**	**2**	**3**	**4**	**5**	**Plots 3,4**	**Plots 3, 4**
Abutilon theophrasti	Velvet-leaf		4	-1	A	A							x
Acer negundo	Manitoba Maple		-2	-2	A	T	x	x	x	x	x	x	x
Acer platinoides	Norway Maple		5	-3	A	T	x						
Acer saccharinum	Silver Maple	5	-3		N	T	x				x		
Achillea millefolium	Yarrow		3	-1	A	P		x	x		x	x	x
Aegopodium podagraria	Goutweed		0	-3	A	P			x			x	
Ailanthus altissima	Tree-of-Heaven		5	-1	A	T							x
Alliaria petiolata	Garlic Mustard		0	-3	A	A	x		x	x		x	x
Alnus glutinosa	Black Alder		-2	-3	A	S	x	x	x	x		x	
Amaranthus hybridus	Smooth Pigweed		5	-1	A	A							x
Amaranthus retroflexus	Redroot Pigweed		2	-1	A	A							x
Ambrosia artemisiifolia	Common Ragweed	0	3		N	A	x	x			x		x
Ambrosia trifida	Giant Ragweed	0	-1		N	A	x	x		x	x	x	x
Anagallis arvensis	Scarlet Primpernel		4	-1	A	A		x					
Anemone canadesis	Canada Anemone	3	-3		N	P		x	x	x		x	
Angelica atropurpurea	Angelica	6	-5		N	B	x		x	x		x	x
Anthriscus sylvestris	Wild Chervil		5	-2	A	B			x	x	x	x	
Apocynum cannabinum	Indian Hemp	3	0		N	P		x					
Arctium minus	Common Burdock		5	-2	A	B	x	x	x	x		x	x
Artemisia biennis	Biennial Wormwood		-2	-1	A	P							x
Artemisia vulgaris	Mugwort		5	-1	A	P			x	x		x	x
Asclepias incarnata	Swamp Milkweed	6	-5		N	P	x	x	x	x	x	x	x
Asclepias syriaca	Common Milkweed	0	5		N	P		x		x	x	x	
Aster lanceolatus	Panicled Aster	3	-3		N	P		x	x	x	x	x	
Aster lateriflorus	Calico Aster	3	-2		N	P					x		
Aster novae-angliae	New England Aster	2	-3		N	P			x			x	x

Appendix E (2010, 2007) continued

Scientific Name	Common Name	CC	CWET	WEED	N_A	Phys-iog	1	2	3	4	5	2010 Plots 3,4	2007 Plots 3, 4
Aster pilosus	Hairy Aster	4	2		N	P							x
Aster urophyllus	Arrow-leaved Aster	6	5		N	P							x
Barbarea vulgaris	Winter Cress		0	-1	A	B	x	x	x	x	x	x	x
Bidens cernua	Nodding Beggarticks	2	-5		N	A							x
Bidens frondosa	Devil's Beggarticks	3	-3		N	A		x		x	x	x	x
Boehmeria cylindrica	False Nettle	4	-5		N	P	x		x	x		x	x
Brassica juncea	Indian Mustard		5	-1	A	A	x		x	x		x	
Calystegia sepium	Hedge Bindweed	2	0		N	P	x	x		x		x	
Carex cristatella	Crested Sedge	3	-4		N	P		x					
Carex retrorsa	Retrose Sedge	5	-5		N	P	x						
Catalpa Speciosa	Northern Catalpa		0	-1	A	T							x
Celtis occidentalis	Common Hackberry	8	1		N	T							x
Cerastium fontanum	Mouse-eared Chickweed		3	-1	A	A	x						x
Chelidonium majus	Celandine		5	-3	A	B							x
Chenopodium album	Lamb's-quarters		1	-1	A	A							x
Chenopodium simplex	Maple-leaved Goosefoot	0	5		N	A							x
Cirsium arvense	Canada Thistle		3	-1	A	P	x	x	x	x		x	x
Cirsium vulgare	Bull Thistle		4	-1	A	B	x	x	x			x	x
Clematis virginiana	Virgin's-bower	3	0		N	V	x		x			x	
Cleome hassleriana	Spider-flower		5	-1	A	P							x
Convolulus arvensis	Field Bindweed		5	-1	A	P		x					
Conyza canadensis	Horseweed	0	1		N	A							x
Cornus amomum	Silky Dogwood	5	-4		N	S		x					
Cornus stolonifera	Red-osier Dogwood	2	-3		N	S		x					
Coronilla varia	Crown-vetch		5	-2	A	P			x			x	
Dactylis glomerata	Orchard Grass		3	-1	A	PG	x	x	x	x		x	x
Daucus carota	Wild Carrot		5	-2	A	B	x	x	x			x	x
Dianthus armeria	Deptford Pink		5	-1	A	A		x					
Digitaria sanguinalis	Large Crab Grass		3	-1	A	AG							x

Appendix E (2010, 2007) continued

Scientific Name	Common Name	CC	CWET	WEED	N_A	Phys-iog	1	2	3	4	5	Plots 3,4	Plots 3, 4
Dipsacus fullonum	Teasel		5	-1	A	P	x		x	x		x	x
Echinocystis lobata	Wild Cucumber	3	-2		N	A							x
Epilobium ciliatum	Willow-herb	3	3		N	P							x
Epilobium coloratum	Purple-leaved Willow-herb	3	-5		N	P							x
Epilobium hirsutum	Great Hairy Willow-herb		-4	-2	A	P			x			x	x
Erigeron annuus	Daisy Fleabane	0	1		N	A	x	x		x	x	x	x
Erigeron philadelphicus	Philadelphia Fleabane	1	-3		N	P	x	x	x			x	x
Erigeron strigosus	Narrow-leaved Fleabane	0	1		N	A							x
Erysimum cheiranthoides	Wormseed Mustard		3	-1	A	A		x					x
Eupatorium maculatum	Spotted Joe-Pye-weed	3	-5		N	P	x	x	x	x	x	x	x
Eupatorium perfoliatum	Boneset	2	-4		N	P		x		x		x	
Eupatorium rugosum	White Snakeroot	5	3		N	P			x	x		x	x
Euphorbia esula	Leafy Spurge		5	-2	A	P		x		x		x	
Euthamia graminifolia	Grass-leaved Goldenrod	2	-2		N	P		x					x
Fraxinus pennsylvanica	Red/Green Ash	3	-3		N	T				x		x	
Galium mollugo	Wild Madder		5	-2	A	P	x	x	x		x	x	
Galium palustre	Marsh Bedstraw	5	-5		N	A		x					x
Geranium robertianum	Herb Robert		5	-2	A	A							x
Geum aleppicum	Yellow Avens	2	-1		N	P	x	x	x			x	
Glechoma hederacea	Gill-over-the-ground		3	-2	A	P	x			x		x	x
Helianthus annuus	Common Sunflower		1	-1	A	A							x
Helianthus tuberosus	Jerusalem Artichoke		0	-2	A	P		x		x		x	
Hesperis matronalis	Dame's Rocket		5	-3	A	P	x	x	x	x		x	
Humulus lupulus	Common Hop		3	-1	A	V	x	x		x		x	x
Hypericum perforatum	Common St. John's-wort		5	-3	A	P	x		x	x		x	
Hypericum punctatum	Spotted St. John's-wort	5	-1		N	P							x

Appendix E (2010, 2007) continued													
Scientific Name	**Common Name**	**CC**	**CWET**	**WEED**	**N_A**	**Phys-iog**	**1**	**2**	**3**	**4**	**5**	**2010 Plots 3, 4**	**2007 Plots 3, 4**
Impatiens capensis	Spotted Touch-me-not	4	-3		N	A	x		x	x		x	x
Impatiens glandulifera	Purple Touch-me-not		-3	-2	A	A	x						x
Impatiens pallida	Pale Touch-me-not	7	-3		N	A							x
Lactuca canadensis	Wild Lettuce	3	2		N	B		x					
Lactuca serriola	Prickly Lettuce		0	-1	A	B	x						x
Lapsana communis	Nipplewort		5	-2	A	A	x		x			x	
Lathyrus latifolius	Everlasting Pea		5	-1	A	P		x					
Leonurus cardiaca	Motherwort		5	-2	A	P							x
Lepidium campestre	Field Pepper-grass		5	-1	A	A		x					
Lepidium virginicum	Poor-man's Pepper-grass	0	4		N	A							x
Leucanthemum vulgare	Ox-eye Daisy		5	-1	A	P	x	x	x			x	x
Linaria vulgaris	Butter-and-eggs		5	-1	A	P		x	x	x		x	x
Lonicera tatarica	Tartarian Honeysuckle		3	-3	A	S			x			x	
Lotus corniculatus	Birdfood Trefoil		1	-2	A	P		x		x		x	
Lycopus americanus	American Water-horehound	4	-5		N	P	x	x	x	x	x	x	x
Lycopus univlorus	Bungleweed	5	-5		N	P							x
Lysimachia ciliata	Fringed Loosestrife	4	-3		N	P	x						
Lysimachia nummularia	Moneywort		-4	-3	A	P	x						
Lythrum salicaria	Purple Loosestrife		-5	-3	A	P	x	x	x	x	x	x	x
Malva neglecta	Common Mallow		5	-1	A	P							x
Medicago matricarioides	Pineapple Weed		0	-1	A	A							x
Matricaria lupulina	Black Medick		1	-1	A	A	x	x	x			x	x
Melilotus alba	White Sweet-clover		3	-3	A	B		x	x	x	x	x	x
Melilotus officinalis	Yellow Sweet-clover		3	-1	A	B		x					
Mentha arvensis	Field Mint	3	-3		N	P			x	x	x	x	x
Mentha x piperita	(M. aquatica X M. spicata)		-5	-1	A	P	x	x		x	x	x	x

Appendix E (2010, 2007) continued

Scientific Name	Common Name	CC	CWET	WEED	N_A	Phys-iog	1	2	3	4	5	2010 Plots 3, 4	2007 Plots 3, 4
Mimulus ringens	Square-stemmed Monkey-flower	6	-5		N	P		x			x		
Monarda fistulosa	Wild Bergamot	6	2		N	P	x						x
Myosotis laxa	Smaller Forget-me-not	6	-5		N	A	x	x	x	x		x	
Myosotis scorpioides	Forget-me-not		-5	-1	A	P							x
Nasturtium officinale	Water Cress		-5	-1	A	P							x
Nepeta cataria	Catnip		1	-2	A	P							x
Oenothera biennis	Hairy Yellow Evening-primrose	0	3		N	B	x	x	x	x		x	x
Panicum virgatum	Switch Grass	6	-1		N	PG							x
Parthenocissus inserta	Virginia Creeper	3	3		N	V			x			x	
Phleum pratense	Timothy		3	-1	A	PG		x					
Physocarpus opulifolius	Ninebark	5	-2		N	S	x			x		x	
Phytolacca americana	Pokeweed	3	1		N	P				x		x	
Pilea pumila	Clearweed	5	-3		N	A							x
Plantago lanceolata	English Plantain		0	-1	A	P	x	x	x			x	x
Plantago major	Common Plantain		-1	-1	A	P	x	x	x		x	x	x
Platanus ocidentalis	Sycamore	8	-3		N	T	x		x	x	x	x	
Polygonum aviculare	Prostate Knotweed		1	-1	A	A							x
Polygonum convolvulus	Wild Buckwheat		1	-1	A	A							x
Polygonum hydropiper	Water-pepper	4	-5		N	A	x		x	x	x	x	x
Polygonum hydropiperoides	Mild Water-pepper	4	-5		N	A							x
Polygonum lapathifolium	Pale Smartweed	2	-4		N	A							x
Polygonum pensylvanicum	Pinkweed	3	-4		N	A							x
Polygonum persicaria	Lady's-thumb		-3	-1	A	A	x	x	x	x	x	x	x
Polygonum scandens	Climbing False Buckwheat	3	0		N	A							x
Populus balsamifera	Balsam Poplar	4	-3		N	T		x					
Populus deltoides	Cottonwood	4	-1		N	T	x	x	x	x	x	x	x

Appendix E (2010, 2007) continued

Scientific Name	Common Name	CC	CWET	WEED	N_A	Phys-iog	1	2	3	4	5	2010 Plots 3, 4	2007 Plots 3, 4
Portulaca oleracea	Common Purslane		1	-1	A	A							x
Potentilla anserina	Silverweed	5	-4		N	P				x		x	
Potentilla norvengica	Rough Cinquefoil	0	0		N	P	x	x	x			x	x
Potentilla simplex	Common Cinquefoil	3	4		N	P							x
Prunella vulgaris	Heal-all	2	0		N	P	x						
Ranunculus acris	Common Buttercup		-2	-2	A	P		x	x			x	
Ranunculus hispidus	Hispid Buttercup	8	0		N	P		x					
Ranunculus repens	Creeping Buttercup		-1	-1	A	P		x					
Rhamnus cathartica	Common Buckthorn		3	-3	A	S		x	x	x		x	
Rhamnus frangula	Glossy Buckthorn		-1	-3	A	S	x	x	x	x	x	x	x
Robinia pseudo-acacia	Black Locust		4	-3	A	T		x			x		x
Rorippa sylvestris	Creeping Yellow Cress		-5	-1	A	P					x		
Rosa multiflora	Multiflora Rose		3	-3	A	S		x	x			x	
Rubus occidentalis	Black Raspberry	2	5		N	S	x		x			x	
Rudbeckia laciniata	Cut-leaved Coneflower	7	-4		N	P				x		x	
Rumex crispus	Curly Dock		-1	-2	A	P	x	x	x	x	x	x	x
Rumex obtusifolius	Bitter Dock		-3	-1	A	P					x		x
Sagittaria latifolia	Common Arrowhead	4	-5		N	P					x		
Salix alba	White Willow		-3	-2	A	T			x	x		x	x
Salix eriocephala	Heart-leaved Willow	4	-3		N	S							x
Salix exigua	Sandbar Willow	3	-5		N	S		x	x	x		x	
Salix fragilis	Crack Willow		-1	-3	A	T					x		x
Salix nigra	Black Willow	6	-5		N	T	x	x	x	x	x	x	x
Saponaria officinalis	Bouncing Bet		3	-3	A	P		x		x		x	x
Scrophularia marilandica	Carpenter's-square	7	4		N	P							x
Scutellaria lateriflora	Mad-dog Skullcap	5	-5		N	P							x
Sicyos angulatus	Bur Cucumber	5	-2		N	A				x		x	x
Silene latifolia	White Cockle		5	-2	A	B		x		x		x	
Silene vulgaris	Bladder Campion		5	-1	A	P		x					

Appendix E (2010, 2007) continued

Scientific Name	Common Name	CC	CWET	WEED	N_A	Phys-iog	1	2	3	4	5	2010 Plots 3, 4	2007 Plots 3, 4
Sinapis arvensis	Charlock		-1	-1	A	A	x	x			x		x
Sisymbrium altissimum	Tumble Mustard		3	-1	A	A							x
Solanum dulcamara	Climbing Nighshade		0	-2	A	P	x	x	x	x		x	x
Slanum ptycanthum	Eastern Black Nightshade		0	-1	N	A							x
Solidago altissima	Late Goldenrod	1	3		N	P	x	x	x	x	x	x	x
Solidago canadensis	Canada Goldenrod	1	3		N	P							x
Solidago gigantea	Tall Goldenrod	4	-3		N	P	x	x	x	x	x	x	
Sonchus arvensis	Perennial Sow-thistle		1	-1	A	P				x		x	x
Sonchus oleraceus	Annual Sow-thistle		3	-1	A	A							x
Symphytum officinale	Common Comfrey		5	-1	A	P		x		x		x	x
Tanacetum vulgare	Tansy		5	-1	A	P	x	x	x	x		x	x
Taraxacum officinale	Common Dandelion		3	-2	A	P		x	x		x	x	x
Thalictrum pubescens	Tall Meadow-rue	5	-2		N	P	x		x	x		x	
Tragoppgon pratensis	Yellow Goat's-beard		5	-1	A	B			x			x	
Trifolium pratense	Red Clover		2	-2	A	P	x	x					x
Trifolium repens	White Clover		2	-1	A	P		x					
Tussilago farfara	Coltsfoot		3	-2	A	P		x	x			x	x
Ulmus pumila	Siberian Elm		5	-1	A	T	x			x		x	
Urtica dioica	Stinging Nettle	2	-1		N	P	x	x	x	x	x	x	x
Verbascum blattaria	Moth Mullein		4	-1	A	B	x			x		x	
Verbascum thapsus	Common Mullein		5	-2	A	B	x	x					x
Verbena hastata	Blue Vervain	4	-4		N	P		x	x	x		x	x
Verbena urticifolia	White Vervain	4	-1		N	P	x	x		x	x	x	x
Veronica anagallis-aquatica	Water Speedwell		-5	-1	A	P		x	x			x	x
Vicia cracca	Cow Vetch		5	-1	A	P		x					
Vitis riparia	Riverbank Grape	0	-2		N	V	x	x	x	x	x	x	x

Appendix E (2010, 2007) continued

Scientific Name	Common Name	CC	CWET	WEED	N_A	Phys-iog	1	2	3	4	5	2010 Plots 3, 4	2007 Plots 3, 4
Xanthium strumarium	Cocklebur	2	0		N	A	x	x		x	x	x	x
Zizia aurea	Golden Alexanders	7	-1		N	P							x
	Total	**308**	**67**	**-161**									
	Count	**88**	**190**	**102**	**190**	**190**	**72**	**90**	**72**	**72**	**42**	**98**	**123**
	Mean	**3.5**	**0.4**	**-1.6**									

Abbreviations:
CC – Coefficient of Conservatism
CW – Coefficient of Wetness
WEED – Weediness Index
Physiog – Physiognomy or Form (A-Annual, B-Biannual, P-Perennial, S-Shrub, T-Tree, V-Woody Vine

Appendix F. Fauna observed in 2010 and 2014

	2010	2014
BIRDS		
American Crow		x
American Gold Finch		x
American Robin	x	x
Barn Swallow	x	x
Black Capped Chickadee		x
Blue Jay		x
Brown-Headed Cowbird		x
Canada Goose	x	x
Cedar Waxwing	x	x
Cliff Swallow		x
Common Grackle		x
Downy Woodpecker		x
Eastern Wood Pewee		x
European Starling	x	
Gray Catbird	x	x
Great Blue Heron		x
Great Crested Flycatcher		x
House Sparrow	x	x
House Wren		x
Killdeer	x	x
Mallard	x	x
Mute Swan		x
Northern Cardinal	x	x
Northern Flicker	x	x
Northern Oriole	x	x
Northern Rough-winged Swallow	x	
Red Winged Blackbird	x	x
Ring Billed Gull		x
Rock Dove		x
Song Sparrow	x	x
Spotted Sandpiper	x	
Tree Swallow		x
White Breasted Nuthatch		x
Yellow Warbler	x	x
Yellow-throated Vireo	x	
Total	**18**	**31**

	2010	2014
MAMMALS		
Eastern Chipmunk		x
Eastern Cottontail		x
Gray Squirrel		x
Raccoon		x
White Tailed Deer	x	x
Total	**1**	**5**
INSECTS		
Black Swallowtail	x	
Bluet Damselfly		x
Cabbage Moth		x
Cabbage White	x	x
Cicada		x
Ebony Jewelwing Damselfly		x
Red Admiral Butterfly	x	x
Total	**3**	**6**
HERPTILES		
Eastern American Toad	x	x
Total	**1**	**1**

Incidental wildlife observations made during the botanical inventory by Brenda Gallagher.

Appendix G. History of the Springbank Dam

Springbank Dam and Reservoir in the 19th and 20th Centuries

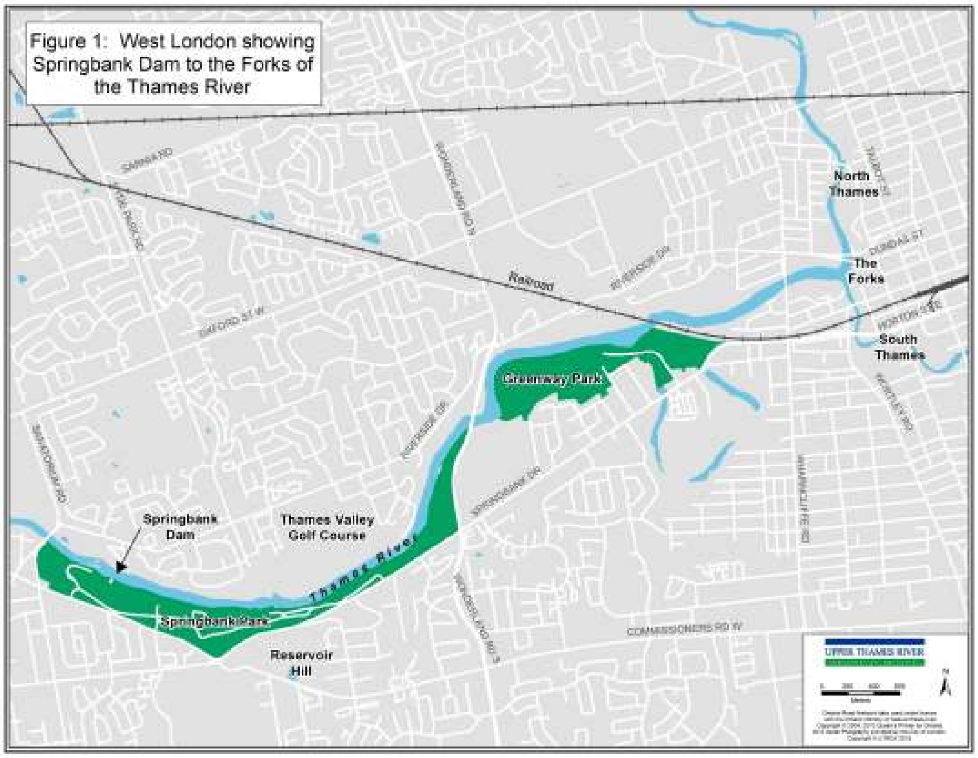
Since 1878 there has been a dam on the main branch of the Thames River in west London, originally west of London. The dam washed out several times (i.e., 1883, 1900, 1913 and 1917) but was always rebuilt. The locations of the current and historic dams are shown in Figures 1 and 2.

The original dam (1878) located at Coombe's Mill, was part of a water works system built to provide a clean and reliable source of drinking water to London (population over 18,000). The source of the drinking water was Coombs Spring (six springs that ran out of Hungerford Hill, now part of Springbank Park), which was channeled to various holding ponds through a series of underground drainage tiles. The spring water was then directed to a vast cistern underneath the pump house (now called Springbank Pumphouse) which was situated next to the dam, parts of which can be seen today. The river provided the hydraulic pressure to pump the water via a water wheel to the top of Reservoir Hill (then called Hungerford Hill) where the water was stored in an open-air basin. From that point, gravity was used to pipe the water to various points in the city some 3 to 4 miles away (City of London Heritage Plaque, City of London 2005).

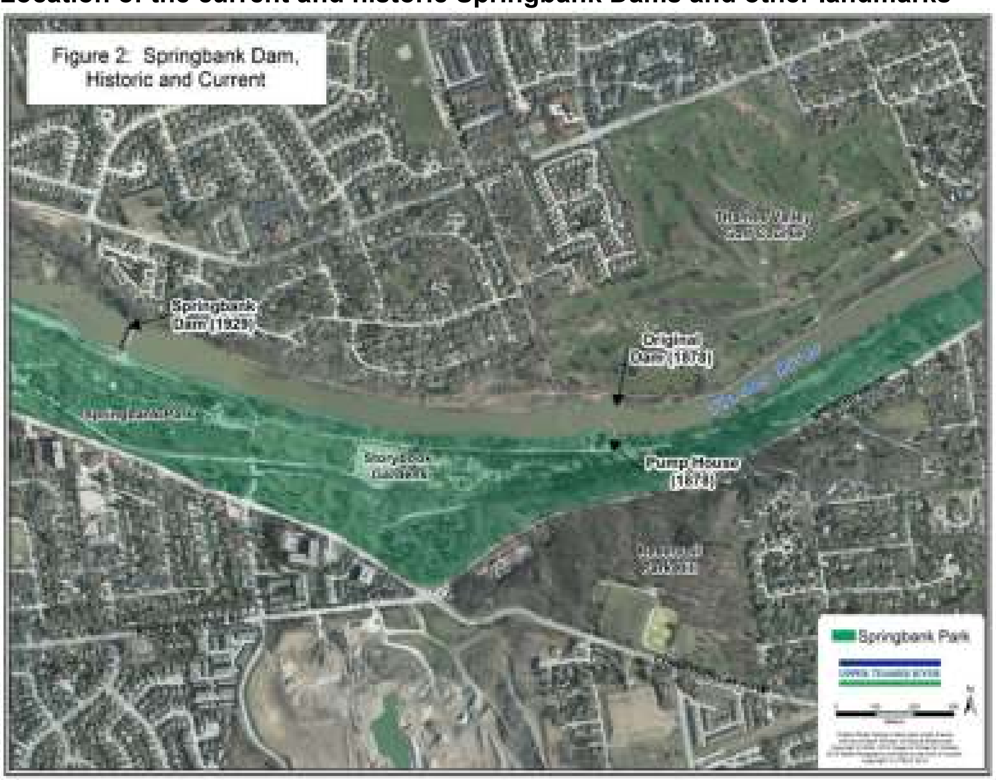
The land around Coombs Springs was purchased to protect the water source area from pollution and became Chestnut Park (1878) and was later renamed Springbank Park around 1894 (Closed Canadian Parks website, McTaggart 1996). The reservoir that was created behind the original dam provided seasonal opportunities for a variety of passive and active recreational uses including boating and fishing. The surrounding parkland was enhanced by the reservoir and attracted many visitors. The City was barren at that time with little greenery anywhere so Springbank Park was an ideal location for long walks and picnics. Since the roads were often impassible in the late 19th century, several steamship ferry businesses were established over time to take people from the Forks to the park. The shallowness of the reservoir and the lack of safety precautions on these ferries resulted in several accidents and loss of life. By 1900, with the improvements of roads and the construction of a trolley line to Springbank Park, the popularity of steamship travel faded, though smaller boats continued to use the reservoir.

The original Springbank Dam and Pumphouse (building at right of photo), circa 1878. Taken from "Pipes, Pavement and Pillars" (City of London 2005)

West London showing current Springbank Dam and the Thames River to The Forks



Location of the current and historic Springbank Dams and other landmarks



In 1881 a second building was added to the pumphouse to house the steam pumping equipment that was used as backup to the hydraulic power. In 1910 electric motors were installed to provide a more reliable pumping capacity than the water wheel due to repeated failures of the dam (City of London 2005). In 1909 the search for additional supplies of adequate water were sought and thoughts of reverting to the Thames River for water supply once again stirred debates. However, then Mayor (Sir) Adam Beck's initiative to focus on well water won over (City of London, 2005). By 1966 there were 18 well fields and London was the largest city in Canada to be solely on wells.

After the dam was washed out in 1917 and prior to the construction of the existing Springbank Dam in 1929, no dam existed in this area of the river (UTRCA website). When the 1929 dam was built, it was located about 500 m downstream of the previous dams. While the history of this time period is scant, it is very likely that the dam was built to provide recreational opportunities and its location in the west part of Springbank Park would have maximized its use.

The 1929 dam stood for 77 years until 2006. There is some evidence that the old dam and the 1929 dam existed together for a time, with one holding back water and the other to flush sewage from the river. Interestingly, the 1952 Upper Thames Valley Conservation Report (Department of Planning and Development 1952) noted:

> *The City has a great asset in Springbank Park. Although it lies three miles from the city, it is intensively used. It is attractively landscaped and has excellent playgrounds and ample shade. The only factor which seriously prevents full use of this park is the condition of the river, which is seriously polluted*."

The pumphouse ceased operations in 1967 when the Lake Huron pipeline came to London. The dam was extensively rehabilitated in 1968-1969 by the Upper Thames River Conservation Authority (UTRA). Deteriorated concrete was repaired, a new pier and sheet pile wall installed on the south bank and a number of mechanical components were upgraded. In 1971, the UTRCA signed a management agreement with the City of London to look after maintenance of the dam.

Canoeists paddle the Springbank Reservoir close to the dam alongside Springbank Park, circa 1990s.

Appendix H. Photos of the shoreline immediately upstream of the Springbank Dam taken in 2006 and 2008

Photo 1. May 10th, 2006 looking upstream from near Springbank Dam with the old pumphouse in the distance. Photo by John Schwindt,Fisheries Biologist, UTRCA.

Photo 2. May 10th, 2006 looking upstream from the dam at the north shore near Springbank Dam. Photo by John Schwindt.

Photo 3. May 10th, 2006 looking at the south shore from Springbank Dam. Photo by John Schwindt

Photo 4. April 30th, 2008 looking upstream from Springbank Dam. Photo by John Schwindt


Photo 5. April 30th, 2008 looking downstram from Springbank Dam. Photo by John Schwindt.

Appendix I. Photos of Plots 2 and 5, May 2015

Plot 2 looking south at the river near the stormwater outlet. Plot to the right hand side of the foot trail showing herbaceous plant and young trees.

Plot 2, size of sapling in the newly vegetated area.


Plot 2, rocky cobble beach substrate under newly established vegetation.


Plot 2. Looking south at the Thames River and vegetated shoreline. New condo tower in background.


Plot 5 near Cavendish Dyke, looking south at Thames River and the newly vegetated shoreline.