

The Toronto Ravines Study: 1977-2017

Long-term Changes in the Biodiversity and Ecological Integrity of Toronto's Ravines



TORONTO RAVINE REVITALIZATION

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UNIVERSITY OF TORONTO
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8 July 2018

As Dean of the Faculty of Forestry and a member of the University of Toronto whose President's house sits on one of Toronto's inner ravines, I welcome the completion of this *Report of the Toronto Ravine Revitalization Study, 2015-2018*.

This work was conducted by graduate students under the supervision of academic staff in the Faculty of Forestry and guided by a steering committee of researchers, faculty members, and community ravine leaders. It was also community funded through the efforts of the Steering Committee, with the assistance of the university administration.

The study, which breaks new ground in urban forestry, has signal importance in updating a baseline study of the Rosedale ravines done in 1977, also conducted by University of Toronto graduate students under faculty supervision, and similarly funded by the community. The methodology enabled systematic and dramatic depiction of changes over time in the subject ravines.

I share the basic assumption of the study, which was also recently adopted as policy direction by the Toronto City Council, that Toronto's ravines should continue to be "*fundamentally natural areas*." The study's principle findings are unfortunately that the ravines are in long-term ecological decline. Its recommendations for action to reverse this decline deserve and require urgent attention.

I think this work is especially commendable as a model for university-community research and interaction. It shows what can be done in partnership with the public to bring university knowledge and science to important applications within our host communities.

Well done TRRS!

A handwritten signature in blue ink, reading "Rob Wright".

Professor Rob Wright,
Dean

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EXECUTIVE SUMMARY

The Toronto ravines are one of world's largest 'urban ecosystems'. They cover an astonishing 17% of Toronto, for a total area of over 11,000 hectares (27,000 acres). In addition to offering 2.8 million citizens the opportunity to enjoy nature, they are the primary source of habitat for Toronto's terrestrial biodiversity, and they provide billions of dollars' worth of ecosystem services. To ensure the continuation of these benefits, the ecological health of the Toronto ravines must be monitored, restored, and stewarded with a scientific framework and expertise. However, it will be the citizens of Toronto who will make this happen – its citizens, business leaders, philanthropists, and corporations, its politicians, sports legends, and rock stars – all recognizing the importance of these natural spaces and playing a vital role in bringing them back to health.

This Report, *The Toronto Ravines Study: 1977-2017*, summarizes a 3-year citizen-science effort to re-survey one of the few known historical studies of biodiversity in the Toronto ravines: *The 1977 Rosedale Ravines Study*. As summarized here, over the past 40 years the biodiversity and ecological health of Toronto's ravines has declined to a critical level and is now likely on the edge of ecological collapse. Today, invasive plants dominate large expanses of the understory, mid-story, and canopy of these ravines, and Toronto's native biodiversity is fast disappearing. Since it is the native plants that host biodiversity, ecosystem health suffers. However, if widespread, science-based action is taken soon, then it is possible that the Toronto ravines can be restored to a healthy state.

The overarching goal of *The Toronto Ravines Study: 1977-2017* is to accelerate the process of integrating 'Science' into ravine 'Policy, Practice, and Community Engagement'. We outline how the scientific frameworks of 'Adaptive Management' and 'Ecological Integrity (EI)' can be used to improve the effectiveness of ravine Policy, Practice, and Citizen Engagement by allowing for 'Evidence-Based Decision-Making'.

New York City (NYC)'s recent launch of its Natural Areas Conservancy provides an impressive model for Toronto to follow. For an area roughly half the size of the Toronto ravines, the NYC has budgeted \$385 Million over 25 years to fund a massive science-based program to inventory, restore, and steward its natural areas. With global standards of conservancy in hand, Toronto could do the same and restore its ravines within 10-20 years, making it one of the world's greatest urban ecosystems – an outdoor Louvre of wilderness and biodiversity.

Study Achievements

Throughout the project, our team has worked in both the public and private realms, with government agencies, NGO's, and citizen groups to initiate a collaborative process to develop an 'Adaptive Management' framework that can guide the inventory, restoration, and stewardship of the Toronto ravines. The following is a list of our key efforts and achievements.

Science

- Adopted ‘Adaptive Management’ and ‘Ecological Integrity’ (EI) as the scientific frameworks for monitoring, restoring, and stewarding the Toronto ravines.
- Assembled international, national, and provincial protocols for measuring EI.
- Began developing custom protocols for monitoring, restoring, and stewarding the biodiversity and EI of the Toronto ravines.
- Re-surveyed ***The 1977 Rosedale Ravines Study***:
 - 2015 - Field Survey& one Master (MFC) research project
 - 2016 - Field Survey& one Master (MFC) research project
 - 2017 - Field Survey& three Master (MFC) research projects
 - 2018 - Final Report: ***The Toronto Ravines Study: 1977-2017***

Our **key ‘Science’ finding** is the requirement for an ‘Adaptive Management’ framework to monitor, restore, and steward the biodiversity and ‘Ecological Integrity’ of the Toronto ravines. In creating this framework, we must ensure the protocol is also applicable to Policy, Practice, and Citizen Engagement.

Policy

- Conducted Policy Analysis: Integrating ‘Ecological Integrity’ (EI) into Toronto’s ravine policy.
- Member of City of Toronto’s Ravine Advisory Group.
- Made formal presentations at City of Toronto Committee Meetings (Appendix A).
- Successfully advocated for the adoption of EI as the guiding approach to implement the first principle of the City of Toronto’s Ravine Strategy; *i.e.* that the ravines be maintained as “*fundamentally natural areas*”¹

Our **key ‘Policy’ finding** is the need for ‘Ecological Integrity’ as the guiding framework for implementing Toronto’s ravine policy, as well as using ‘Adaptive Management’ and ‘Evidence-Based Decision-Making’ to direct implementation of future ravine policy.

¹ See Executive Committee Meeting EX27 item EX27.8 on September 26, 2018, available at: <http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2017.EX27.8>

Practice

- Started two pilot projects to field test methods for monitoring, restoring, and stewarding the ‘Ecological Integrity’ of the Toronto ravines. These pilot projects were collaborative efforts between UoT-Forestry, the City of Toronto, and the citizens of Toronto.
- Pilot Project 1) *Native Plant Map & Seed Bank*: Citizen-science project to map native plants and use them as a source of locally-adapted seeds for restoring the Toronto ravines.
- Pilot Project 2) *Invasive Plant Mapping & Removal*: Citizen-science project to map invasive plants and field-test methods for their removal.

Our **key ‘Practice’ finding** is the need for ‘Best Practice Guidelines’ to monitor, restore, and steward the ‘Ecological Integrity’ of the Toronto ravines.

Citizen Engagement (Citizen Science)

- Conducted public events on using ‘Ecological Integrity’ as a guiding principal for monitoring, restoring, and stewarding the Toronto ravines.
- Worked with five Resident Associations to raise awareness, educate, and engage citizens in restoring ravine health.
- Appeared in ten Media stories (Appendix B).
- Presented ten Public talks (Appendix C).
- Led two Public walks (Appendix C).
- Received two Awards (Appendix C).
- Held a Ravine Stewardship Workshop for donors and citizens at the University of Toronto President’s Residence (Appendix C).

Our **key ‘Citizen’ engagement finding** is that a citizen-science program should be created for monitoring, restoring, and stewarding the ‘Ecological Integrity’ of the Toronto ravines.

BACKGROUND

The Toronto Ravines - An Extraordinary Urban Ecosystem

Viewed from above, it is clear that Toronto has been built over, through, and around a massive ravine ecosystem. After more than 300 years of development, the Toronto ravines still cover 17% of the City, collectively totaling over 11,000 hectares, of which 40% is privately held. If you were to walk all of Toronto, 1 in 5 footsteps would fall within a ravine. This is an extraordinary ecosystem to have within any city, and it defines the ecological character of the Greater Toronto Area. It offers recreation to almost 3 million people, it generates hundreds of millions of dollars in ecosystem services every year, and it is home to a vast array of biodiversity. Given the extraordinary benefits of this ecosystem, it should be managed with the utmost care to ensure these benefits continue into the future.

However, while there is a great deal known about the non-living aspects of the Toronto ravines – their extent, ownership, and where the roads, trails, bridges, and utilities are - there is remarkably little known about their terrestrial biodiversity. Surprisingly, there are very few scientific publications on the terrestrial biodiversity of the Toronto ravines. Little scientific information exists regarding: (1) the current state of biodiversity in the Toronto ravines, (2) how it has changed over time, or (3) where it is heading into the future.

Fortunately, it is easy to answer these important questions about Toronto's terrestrial biodiversity. All that is needed is a scientific protocol to 'inventory', 'monitor', 'restore', and 'steward' the biodiversity of the Toronto ravines. Data derived from the inventory and monitoring efforts allows the determination of the most effective way to 'restore' and 'steward' the ravines. This iterative scientific process is termed 'Adaptive Management' and uses a framework discussed in more detail throughout this report.

Exploring the biodiversity of the Toronto ravines will produce many important discoveries and will provide great adventure to those who get involved. Given the massive size of the Toronto ravines, it will be essential to harness the power of 'Citizen Engagement' in order to fix them. In the future, we look forward to the Toronto ravine system becoming one of the world's most exciting and valuable 'Citizen-Science' projects.

Toronto's Indigenous People –The Origins of Land Stewardship

The Toronto ravines are the traditional lands of the Huron-Wendat, the Seneca, and the Mississaugas of the Credit River, and we acknowledge the origins of land stewardship that began with these Indigenous peoples. As ecologists interested in the conservation of biodiversity and the stewardship of ecosystems, we honour and respect this Indigenous traditional knowledge and mark its quintessential contribution to land stewardship.

We recommend John Riley's 2013 book, *The Once and Future Great Lakes Country: An Ecological History*, to readers, wherein he describes the fascinating history of Indigenous land stewardship in the Great Lakes region. This is an inspirational guide about the greater value that traditional knowledge can bring to modern land conservation and stewardship. We are dedicated to working with Indigenous people to bring this knowledge to the forefront of conservation practice in the ravines.

Looking to the future, we see the history and lessons of Indigenous land stewardship as the way forward, and as a powerful tool for learning and reconciliation.

Toronto's Faculty of Forestry - A Century of Ecosystem Science

Founded in 1907, The University of Toronto's Faculty of Forestry (UoT-Forestry) is Canada's first and longest-running forestry school. Over the past 111 years, UoT-Forestry has been at the forefront of developing scientific methods for ecosystem inventory, management, and landscape-scale conservation.

Many Canadians will be familiar with UoT-Forestry's *Trees of Canada* books that have served as Canada's official tree identification guide. This series of guides embody the ethos of forest stewardship, one that begins with tree identification, and flows through the more challenging stages of forest inventory, restoration, and stewardship. By learning tree identification, one can develop the ability to 'see' how forests ebb and flow over time, and to 'understand' how these changes produce different types of ecosystems, which host different communities of biodiversity. Ultimately, the goal of stewardship is to help guide a forest over time to ensure that the rich variety of plants and animals who call a forest home, endure.

As Aldo Leopold, Conservationist and Forester, once remarked, the goal of forestry extends beyond the production of lumber to "...*propagating owls, woodpeckers, titmice, goshawks, and other useless wildlife*".

Toronto's Faculty of Forestry exists to educate, innovate, and apply its expertise to the conservation of Canada's trees and forests. The present report, *The Toronto Ravines Study: 1977-2017*, provides one such example - envisioned by its professors, conducted by its students, and done for the City of Toronto. Being a "*City within a Forest*", Toronto is fortunate to have one of the world's best Forestry schools – ready, willing, and able – to help inventory, restore, and steward the health of Toronto's forests and biodiversity.

The fascinating history of University of Toronto's Faculty of Forestry is told in Mark Kuhlberg's centennial book, *One Hundred Rings and Counting: Forestry Education and Forestry in Toronto and Canada, 1907-2007*.

Toronto's Citizen Science - A Century of Citizen Science

The loudest and most passionate efforts to conserve the beauty and biodiversity of the Toronto ravines has always come from its citizens, from the establishment of 'natural history clubs' in the 1920's and 1930's, to generations of outspoken citizens who have trumpeted their reverence for Toronto's nature, and rallied community and political efforts for its conservation.

The Brodie Club (1921), The Toronto Field Naturalists (1923), The Toronto Ornithological Club (1937), The Toronto Entomologists' Association (1969), and The Mycological Society of Toronto (1973), are just some of the groups that have championed the discovery of Toronto's biodiversity and the engagement of its citizens.

The biological records of these nature clubs are a treasure trove for understanding how the biodiversity of the Toronto has changed over time. However, due to the historical constraints of limited funding and the recent advent of modern database technology, many of these biological records exist today only in paper format and have yet to be consolidated or scientifically analyzed. A select group are summarized here in Appendix D.

The present report, *The Toronto Ravines Study: 1977-2017*, is a re-survey of one of these historical studies: *The 1977 Rosedale Ravines Study*. The goal of the original report was to show that a small group of citizens and scientists – when provided with a modest amount of funding – could produce a useful scientific report on the status of biodiversity in the Toronto ravines.

The expertise of Toronto's nature clubs, along with their treasure troves of biological records, remain well poised to play a leading role in the conservation of the Toronto ravines, through this continued, albeit expanded, practice of Citizen Science.

The Project Goal

The main goal of the present project has been, and continues to be, to integrate modern ecological science into Toronto's Ravine Policy, Practice, and Citizen Engagement in order to restore the health of its ravines and ecosystems.

The Theme - Adaptive Management

Climate change, land development, and the introduction of non-native invasive species have caused major damage to ecosystems worldwide. Consequently, the field of conservation biology has had to shift its approach from passively 'protecting' ecosystems, to actively 'restoring' and 'sustainably' managing them. Many conservation efforts and policies still focus on passive management where words such as 'protection' and 'conservation' do little to illuminate the critical nature of active forest management.

Policies aiming to conserve and protect can sometimes do more harm than good when addressing complex urban forest health issues. There are far too many external forces and variables that impact urban forests for the simple word ‘protect’ to be sufficient.

Because ecosystem threats are complex and constantly emerging, the scientific process of ‘Adaptive Management’ must be used to ensure that conservation efforts are effective and efficient. ‘Adaptive Management’ is simply a process of ‘trial and error’; *i.e.* if a method works, it is retained; if it fails, it is discarded. This iterative process ensures that the management of ecosystems improves over time – always getting better, faster, and cheaper.

There are four main components of the ‘Adaptive Management’ cycle: ‘Science’, ‘Policy’, ‘Practice’, and ‘Citizen Engagement’. The ‘Science’ improves the understanding of the ecosystem and management strategy over time. The ‘Policy’ guides it, the ‘Practice’ does it, and the ‘Citizens’ both benefit from it and contribute to it. We have used this key framework to guide our study findings and recommendations.

The Timeline - The Past, Present & Future of Toronto’s Ravines

Past: In 1977, a group of citizens teamed up with scientists at the University of Toronto and conducted the *1977 Rosedale Ravines Study*. In it, they surveyed trees, wildflowers, birds, mammals, and other biodiversity, and found that the ecological health of the Toronto ravines was poor and fast declining. Their main recommendation was to start a citywide, science-based program to monitor, restore, and steward the Toronto ravines. This never came to be. Looking back, it is easy to see why – there were simply no precedents to follow. The benefits of healthy ecosystems to people, the economy, and biodiversity had yet to be established back then. Even the term ‘biodiversity’ did not exist. However, the study helped lead to development of the City's first ravine control by-law entitled By-law 332-81 “*To Regulate and Prohibit the Destruction of Trees or Other Natural Vegetation and to Prohibit the Excavating or Other Altering of Contours Within Ravines*”, enacted May 21, 1981.²

Present: In June 2015, the founding members of the 1977 Study teamed up with UoT-Forestry and began a three-year process to re-survey the 1977 study sites. The current report, *The Toronto Ravines Study: 1977-2017*, summarizes these efforts and points out the widespread decline of biodiversity in the Toronto ravines over the past 40 years. We are now at the point where this ecosystem is likely on the edge of ecological collapse. Today, invasive plants dominate large expanses of the understory, mid-story, and canopy of the ravines, and native biodiversity is rapidly declining. So, while the recommendation of the 1977 Study is repeated here – to start a citywide, science-based program to monitor, restore, and steward the Toronto ravines – the urgency of this call has intensified. If we do not immediately get serious, align all our efforts with supportive City policy, then the ravines will decline beyond recovery.

²Available at: <https://www.toronto.ca/legdocs/pre1998bylaws/toronto%20-%20former%20city%20of/1981-0332.pdf>

Future: New York City just approved a 25-year program totalling \$385 Million to inventory, restore, and steward a natural area half the size of the Toronto ravines. Toronto could do the same – no need to re-invent the wheel. Using the now standard practices of ‘Adaptive Management’, ‘Evidence-Based Decision-Making’, and ‘Ecological Integrity’, we can start to work together to restore local biodiversity and eradicate the invasives that continue to erode our landscapes. Within 10-20 years, Toronto could be home to the world’s greatest ‘urban ecosystems’ – an outdoor Louvre of wilderness, biodiversity, and recreation. They could be our constant reminder that we are a part of nature and that nature – entwined within our city streets – is part of us. Wildflowers, birds, butterflies, and thousands of other marvellous species could once again thrive in the Toronto ravines.

We hope our report inspires Torontonians to come together and start a citywide, citizen-empowered, science-based program to monitor, restore, and steward the remarkable biodiversity of the Toronto ravines.

MAIN FINDINGS

Component Studies Findings - An Ecosystem in Decline

The present report provides some of the first estimates of long-term change in the biodiversity and ecological health of the Toronto ravines. These estimates were obtained by re-surveying one of the only known historic studies of the Toronto ravines, *The 1977 Rosedale Ravines Study*, in a series of research projects. Our findings and recommendations are based on these individual components, all which can be viewed at: <https://torontoravines.org/reports/>.

Comparison of the 1977 and 2017 data clearly demonstrates a severe and widespread decline in native trees, wildflowers, birds, and mammals over the past 40 years. Our work has also shown that the Toronto ravines are experiencing rapid and widespread growth of many invasive species. Along with other non-native trees, the highly invasive Norway maple, originally planted as a street tree, has increased its canopy cover from about 10% in the 1970’s to 40% in 2017. Invasive herbaceous plants – such as garlic mustard, Japanese knotweed, and dog-strangling vine (DSV) – are now present in over 95% of the forest floor surveyed.

If one were to compare such statistics to human health, it would be like finding a healthy-looking person lying on the ground, clearly unable to function. While you might not know the precise medical cause of the health condition, you would know that the person needed immediate assistance. The Toronto ravines are in a similar situation. They are showing clear signs of rapid decline at all levels of the ecosystem, and without immediate assistance, they will likely suffer irreparable damage. ***The ravines need help.***

The following is a list of the Major Findings from the five Master-level research projects that comprise the individual components of the 2017 re-survey:

1. Low ‘Ecological Integrity’ in the ravine forests

The First Component Study completed was “*Ecological Integrity in the Park Drive Ravine: 1977 to 2015*” by Anqi Dong, 2015. A partial canopy re-survey was conducted in 2015, followed by a complete canopy re-survey in 2016. The main findings in this study were originally collected in 2015 and have been updated here using the complete dataset from 2016 (*i.e.* stats here may differ slightly from those in Dong’s report).

Historically, 73 woody species are native to Toronto, but 30 of them have now been extirpated – not actually extinct, yet locally absent in Toronto. The 1977 canopy survey found 20 native woody species across the three surveyed Rosedale ravines while 19 were found in 2016. It is clear then that the health of native tree species in the ravines has declined. Low or no evidence of regeneration was found; meanwhile increasing evidence of invasive species such as the Emerald Ash Borer and Beech Bark Disease was observed.

Invasive tree species, especially Norway maple (*Acer platanoides* L.), were found to have increased significantly. Many areas on the ravine slopes are now populated by Norway maples whose dense shade promotes only bare soil and exposed roots underneath.

2. Low ‘Ecological Integrity’ in ravine small mammal and breeding bird communities

The Second Component Study in our project was “*Ecological Integrity of Mammals and Birds in Toronto’s Ravines*” by Alex Stepniak, 2017.

While the complete mammal collection data in the Royal Ontario Museum reports 16 small mammal species in the Greater Toronto Area between 1866 and 2015, both the 1977 and 2017 surveys in the Rosedale ravines showed a surprisingly low diversity of small mammals in similar areas (only three species were found in each of these two studies).

Environment Canada’s Canadian Wildlife Service lists 43 area-sensitive bird species found in the forests of Toronto. Unfortunately, both the 1977 and 2017 reports recorded only 5 area-sensitive bird species in each of the two ravine surveys.

Out of the 118 possible native forest breeding bird species present in Toronto, the 1977 ravine study recorded only 30 species across the four Rosedale ravines surveyed, while our 2017 survey found only 31 species in similar ravine areas.

3. Low ‘Ecological Integrity’ in ravine understory vegetation

The Third Component Study completed in our project was “*Assessing Understory Vegetation Communities as Indicators of Ecological Integrity in the Toronto Ravine System*” by Jose M. Kabigting, 2017.

Unfortunately, because no understory vegetation data were available from the original 1977 ravine study, 1977 and 2017 results could not be compared directly. Thus, for our work, we divided sample plots into 10x10m grids in order to collect both canopy and understory vegetation and then colour-coded each grid according to the proportion of

native and non-native species present. Out of the 340 grids surveyed in 2017, 63% were ‘code red’ with low ecological integrity (*i.e.* had less than 60% native ground cover); 30% were ‘code yellow’ with medium ecological integrity (60-99% native ground cover); and 7% were ‘code green’ with high ecological integrity (100% native ground cover).

The proportion of non-native ground cover was also recorded and found to be significantly higher at the top of the ravine slopes than at the bottom, however, no significant differences were found among high slope, low slope or bottom slope.

In our 2017 survey, 61 ground-cover plant species were found, of which 30 were non-native (50%). The coverage of native species was generally low across all the sampling plots, with some comprising only bare soil and serious erosion. Garlic mustard (*Alliaria petiolata*) and Japanese knotweed (*Fallopia japonica*) were widespread in many areas.

4. Ravine policies need more explicit language and stronger enforcement

The Final Component Study in our project was “*An Analysis of Toronto’s Urban Ravine Policies and the Achievement of Ecological Integrity*” by John (Jack) Richard, 2017.

The City of Toronto’s website hosts a number of sources on its official ravine policy. In analyzing these documents, we found an obvious lack of specificity and explicit requirements regarding ravines in the City of Toronto’s Official Plan. This led to one clear recommendation to amend the current policy and include measurable criteria with specific reference to soil and groundwater contamination.

While the City’s Ravine and Natural Feature Protection By-law restricts removal and damage of ravine trees and alteration of ravine landscape and grade, it does not consider one of the most critical components of ecological integrity, namely species composition. This gap in the By-law leaves a major opening for long-term ecological damage.

Recommendation was made that the recently-adopted City of Toronto Ravine Strategy require specific implementation steps and activities rather than be simply a statement of general principals and directions for the ravines.

In Summary, we must note that our individual study findings on the ecological health of the Toronto ravines should be taken as preliminary. Only a relatively small proportion of the actual ravines were able to be measured, and the survey itself was conducted by professional Master-level students, each over a single season.

Much more extensive sampling and analysis need to be undertaken in order to understand the long-term dynamics of this unique and fragile ecosystem. Nevertheless, because our results provide some of the only available estimates for the ecological health of the Toronto ravines, we clearly have the foundation needed to build recommendations for future ravine work.

RECOMMENDATIONS

1. Adopt ‘Ecological Integrity’ as the guiding principal and policy of the Toronto Ravines Strategy.

The first of the five ‘guiding principles’ in the Toronto Ravine Strategy is to “*Protect*” the ravines as “*fundamentally natural areas*”³. Thus, our first recommendation is that the City of Toronto adopt the conventional scientific framework of ‘Ecological Integrity’ (EI) to monitor, restore, steward, and protect the Toronto ravines.

Since first being proposed by Aldo Leopold in his 1949 book, *A Sand County Almanac*, ‘Ecological Integrity’ has been adopted both provincially and federally and is now globally recognized as the number one guiding principal and standard scientific framework for monitoring, restoring, and sustainably managing the world’s ecosystems (Table 1).

Table 1. Application of ‘Ecological Integrity’ (EI) by a range of authorities.

Year	Literature	Author
1972	The Federal Water Pollution Control Act amendments	United States Environmental Protection Agency (US EPA) ⁴
1981	Assessment of biotic integrity using fish communities	James Karr ⁵
2000	Canada National Parks Act	Parks Canada ⁶
2006	Provincial Parks and Conservation Reserves Act	Ontario ⁷
2010	CANADA: National Report to the Ninth Session of the United Nations Forum on Forests	Natural Resources Canada – Canadian Forest Service ⁸
2017	Toronto Ravine Strategy	City of Toronto ³

³City of Toronto. (2017). *Toronto Ravine Strategy*. Retrieved from

<https://www.toronto.ca/wp-content/uploads/2017/10/9183-TorontoRavineStrategy.pdf>

⁴ US Environmental Protection Agency. 1972. *The Federal Water Pollution Control Act Amendments PL 92-500*.

⁵ Karr, JR. 1981. *Assessment of biotic integrity using fish communities*. *Fisheries*, 6(6), 21–27.

⁶ Minister of Justice. 2000. *Canada National Parks Act*.

⁷ Ontario. 2006. *Provincial Parks and Conservation Reserves Act*.

⁸ Natural Resources Canada – Can. Forest Service. (2010). *CANADA: National Report to the Ninth Session of the United Nations Forum on Forests (November 2010)*. Retrieved from <http://www.un.org/esa/forests/wp-content/uploads/2013/03/Canada.pdf>

*“A thing is right when it tends to preserve the integrity,
stability, and beauty of the biotic community.”*
— Aldo Leopold, *A Sand County Almanac*⁹

2. Restore ‘Ecological Integrity’

We have significant potential to restore the ‘Ecological Integrity’ of Toronto’s ravines as many components of her ecological systems remain intact. Despite the extent of disturbance due to urbanization and invasive species that we have found, the ravines still preserve considerable numbers of old native trees with much of their natural seed banks. The ravine corridors also still have much of their natural soils in place, thus setting the stage for potentially effective restoration plans.

a) Increase ecological connectivity and buffers for biodiversity

The concept of connectivity is very simple: if you chop up an ecosystem into small parts that are disconnected, it cannot function. Moreover, as ecosystems are chopped up into small patches, the increased amount of ‘edge’ habitat causes rapid decline in overall ecosystem health – primarily through the loss of ‘interior-forest species’ and the invasion of ‘edge species’.

Fortunately, the process of re-connecting ecosystems and rehabilitating the composition of their ‘interior forest’ species makes it possible to restore the health and function of ecosystems within decades.

Biodiversity hotspots as well, such as old native tree species, endangered species, and rare habitat types, all require high conservation priority. Buffer zones need to be delineated around hotspots, and surveyed regularly, not just on an *ad hoc* basis. In this way, ‘Environmentally Sensitive Areas’ (ESAs) can be best protected from invasion by non-native species.

b) Regenerate and reintroduce: Seed forecasting and collection

Healthy forest structure and composition are the foundation of healthy ravines. However, our re-survey of the Rosedale ravines showed no or only poor evidence of regeneration by the native plants, while invasive species such as Norway maple continue to expand their range (Dong, 2015)¹⁰. Native birds, small mammals, invertebrates, and other native plants are not able to establish effective populations in ecosystems dominated by these invasive species.

⁹ Leopold A. 1949. *A Sand County Almanac: And Sketches Here and There*. Oxford University Press, USA.

¹⁰Dong, A. (2015). *Ecological integrity in the Park Drive Ravine: 1977 to 2015*. Unpublished manuscript. Retrieved from https://torontoravinesdotorg.files.wordpress.com/2016/04/anqi-dong_ecological-integrity-in-the-park-drive-ravine_1977-to-2015.pdf

Since 2015, the TRRS team has been inventorying and mapping old, native trees across Toronto's ravine system. These heritage 'mother trees' are scattered throughout the ravines and have adapted to Toronto's climate and soil. Their seeds are the biological material needed to help re-generate a healthy, resilient urban forest in Toronto.

So far, we have only been able to inventory and map these old trees on public ravine land. Collaborations among the City, TRCA, ravine homeowners, and the TRRS team are highly recommended so privately-owned trees can be brought into the broader conservation plans.

c) Plant 'local' native species

Native plants are known to host biodiversity – most importantly, native insects – which in turn allows ecosystems to function. Insects, by eating plants, and then being eaten themselves – by birds, mammals, reptiles, amphibians etc. – allow energy to flow through ecosystems. This is the single most important aspect of ecosystem health. As E.O. Wilson, the famous biologist who coined the term 'biodiversity' in 1988 once said "...insects *are the little things that run the world*". Without insects, ecosystems simply fall apart.

The idea of using truly 'local' native plants is a new best practice for ecosystem restoration. The rationale behind using 'local' native plants is quite simple: local ecosystems tend to be unique in their abiotic characteristics (*e.g.* climate, soil type, etc.) as well as their biotic characteristics (*e.g.* biodiversity). The uniqueness of local systems tends to drive biodiversity to become 'locally-adapted'. For example, local adaptation means synchrony with the local climate; *i.e.* matching the 'timing' of annual life cycles such as leaf-out or flowering to that of local climate such as last and first frost. Local adaptation also works with local biotic factors, such as pollinators where some plants rely on specialized insects for pollination. Both must be locally adapted in timing to ensure matching of their respective cycles.

Given the complexity of local ecosystems, it is very dangerous to assume that non-local plants can be introduced into local ecosystems and function properly. That would be like assuming a bunch of random car parts from different makes and models could be assembled into a functioning vehicle – it would be foolish and futile. However, while using local plant stock is now widely promoted, the stock itself is not widely available. Fortunately, this new demand has driven a surge of efforts to re-tool nurseries and allow verified 'local' plant stock to be produced. Unfortunately, the supply is still years away from being able to meet the demand. Given this lack of local plant stock availability, many local conservation groups are starting to collect and propagate their own local seed, and these efforts should be greatly expanded.

The ***Toronto Ravines Study: 1977-2017*** has worked on numerous fronts to help local groups get engaged in the collection and propagation of local plants. Our major efforts have been on starting a pilot project aimed at mapping local, old-growth trees, studying their seed biology, collecting their seeds, and growing them. To date, we have mapped

over 900 such trees, and grown over 10,000 seedlings. Moving forward, this pilot project will become available on a cell-phone platform to engage citizens in mapping, seed forecasting, collecting, and propagating. As citizens get engaged in the coming years, this project will have the capacity to produce hundreds of thousands of local trees per year for Toronto ravine restoration projects.

d) Rank ‘invasiveness’ and remove invasive species

Non-native plants are known to be poor hosts for native biodiversity, and therefore prevent ecosystems from functioning in a healthy way. The dangers of non-native plants to ecosystems are well known, and new negative effects are constantly being discovered. For example, many non-native plants toxify the soil, killing-off soil microorganisms that are essential for native plant growth and communication. Additionally, when non-native plants become invasive, they damage ecosystems by turning them into ecological deserts. Given the great complexity of ecosystems, and the tremendous damage that can be caused by non-native plants, it is best to avoid planting non-native species in natural areas, such as the Toronto ravines, or in adjacent habitats.

The Toronto and Region Conservation Authority (TRCA) has ranked the ‘nativeness’ of 681 flora and fauna species within its jurisdiction using a specific “*ranking and scoring protocol*” (TRCA, 2017)¹¹. In it, native species are ranked from L1 to L5, with L1 species having the highest conservation concern and L5 the lowest (*i.e.* currently not of conservation concern). All non-native species are ranked as L+, and we recommend designing similar criteria to rank ‘invasiveness’ in Toronto’s ravines.

With a proper ecosystem-monitoring program, new invasive species can be detected and removed with relative ease. Where small patches of invasive species are found, they can be eliminated as early as possible to avoid larger environmental and financial costs. Through inventorying and mapping, the boundaries, coverage, density, *etc.* of invasive species can be used to develop optimal methods for large-scale eradication and prevent their further expansion into Environmentally Sensitive Areas (ESAs).

Unfortunately, the Toronto ravines do not currently have an ecosystem-monitoring program specifically for terrestrial invasive species, and this means that invasive plants are free to invade and grow exponentially as over the past decades. Today, there are large sections of the Toronto ravines dominated by highly invasive non-native plants - in the groundcover, mid-story, and canopy. The more prevalent these invasive species are, the more time, cost, and effort needed to remove them. With enactment of Ontario’s recent Invasive Species legislation, the exponential challenge now is to meet the new mandatory requirements for their eradication on both public and private land.

¹¹ Toronto and Region Conservation Authority (TRCA). (2017). *Scoring and Ranking TRCA’s Vegetation Communities, Flora, and Fauna Species*. Retrieved from <https://trca.ca/app/uploads/2017/03/Ranking-Scoring-Protocol-Final.pdf>

Starting an ecosystem-monitoring project in the Toronto ravines would allow new invasive species to be detected and immediately removed before they become problematic. It would also allow the distribution and abundance of already established invasive plants to be determined, which would then allow the development of comprehensive control strategies.

“An evaluation mechanism is required to objectively assess whether selected management approaches are indeed conserving ecological integrity, and to provide critical evaluation and feed-back for adjustment or abandonment of the approach. Without a mechanism to assess success, the management strategy becomes untestable and largely unscientific.”

— Rempel et al.¹²

3. Develop a comprehensive scientific protocol to monitor, restore, and steward the ‘Ecological Integrity’ of the Toronto ravines.

In September 2017, the TRRS team made its deputation at the City of Toronto Executive Committee Meeting recommending that the draft Toronto Ravine Strategy use ‘Ecological Integrity’ (EI) to measure and monitor ravine health. The Strategy was amended to include EI, and a biological inventory and an EI report were assured during the City Council in October 2017 (Appendix A).

Unfortunately, despite the international recognition of the concept of ‘Ecological Integrity’ and the complexity of addressing this in an urban environment, comprehensive protocols are still lacking in Toronto. Here, we have shown how to effectively use a very simple protocol to measure invasive understory, which builds on similar precedents in other cities. Through adaptive management, these protocols can continuously be improved.

Without a proper protocol, key issues in the ravines cannot be identified and management efforts cannot be evaluated. Such a protocol would help develop standards for remedial action - in effect, it would serve to regulate actions on various individual natural elements in the way a building code governs the human-built environment. For example, simply cutting invasive plants above-ground without dealing with their underground root system can actually accelerate their eventual spread, pointing out the need for specific recommendations and actions.

¹² Rempel, R. S., Naylor, B. J., Elkie, P. C., Baker, J., Churcher, J., & Gluck, M. J. (2016). An indicator system to assess ecological integrity of managed forests. *Ecological Indicators*, 60, 860-869.

While the Ecological Monitoring and Assessment Network (EMAN) protocol in Canada and the Vegetation Sampling Protocol (VSP) in Ontario have both been widely used for monitoring terrestrial ecosystems, ravines need a tailored protocol to assess invasive plants specifically as well as represent their unique biotic and abiotic heterogeneity (*e.g.* conditions along the slope, high level of human disturbance, and erosion).

A well-designed ravine sampling protocol should be replicable over time across all Toronto's ravines in order to record temporal and spatial changes. Parks Canada recommends national parks produce a 5-year 'State of Reports'¹³, and this is the minimum that the TRRS team also recommends for re-surveying ravine sites. Periods longer than this will likely fail to capture the real dynamics of ravine systems.

4. Change mindsets with a new vision

Ravines are Toronto's natural heritage rather than simply a pass-through of recreational paths. They are different from parks and other public greenspace. The ecosystem and passive recreational services provided by ravines should not be taken for granted. Every ravine user has the responsibility to conserve the natural state of the ravine wilderness.

a) Re-engineer law-making and enforcement

We suggest updating the Ravine and Natural Feature Protection By-law to restrict further planting of invasive species across all ravines, on both public and private land, including the buffer zones. Existing invasive species need to be controlled in both public and private property. Private landowners need to be educated regarding this responsibility. By-law revision to align with provincial invasive species legislation needs to be enforced so that the ravines can be returned to their natural healthy state.

b) Foster collaboration and partnership

Shared ownership and limited resources have always constrained ravine management. With the official release of the Toronto Ravine Strategy, formal collaboration is needed among City planners, policy makers, engineers, scientists (especially ecologists and foresters), indigenous people, NGO's, citizen scientists, philanthropists, stewardship groups, private ravine property owners, educators, and activists, *etc.* Managing the ravines involves tasks at different scales and timeframes. The aforementioned groups and individuals can play different roles in the stewardship of our urban ecosystem and all need to be engaged in a constructive way.

¹³Parks Canada. (2014). Internal Audit and Evaluation Documents: Evaluation of Parks Canada's National Parks Conservation. Retrieved from https://www.pc.gc.ca/leg/docs/pc/rpts/rve-par/89/index_e.asp

Toronto is home to tremendous cultural wealth, world-class institutions, intellectuals, artists, philanthropists, sports legends, rock stars, and 2.8 million Canadians who love nature. Over the years, the City of Toronto has worked hard to facilitate collaboration and citizen engagement by hosting public events to bring people together.

c) Create a new funding and operational model

While our Final Report was being written, New York City (NYC) launched a new Natural Areas Conservancy for revolutionizing how its urban ecosystems would be managed, funded, and enjoyed. This new initiative – from its team, to its vision, to its accomplishments – is so impressive that it literally changes the fields of urban planning and ecosystem management. The NYC plan calls for \$385-million over 25 years for about half as much land as the Toronto ravines.

Our team has reviewed the NYC plan, and it has inspired us to update our vision and recommendations for the Toronto ravines and natural areas in general. Our main recommendation is to thoroughly review New York City’s Natural Areas Conservancy as a model for Toronto, and then to establish a Toronto Ravine Conservancy along the lines of the NYC model.

The Faculty of Forestry at the University of Toronto collaborated with NYC in a ‘Growing Green’ initiative of exchange during 2014/15 and is now planning to host the NYC Natural Areas Conservancy team this fall (2018) to learn more about their experience. Their expertise would be invaluable in helping develop a similar plan for the City of Toronto’s ravine ecosystems.

We extend our applause to the NYC Natural Areas Conservancy team, and to New York City as a whole for providing us with the inspiration, and most importantly, a roadmap for restoring Toronto’s unique ravine forests.



TORONTO RAVINE REVITALIZATION

TRRS PARTNERS - A CITY OF COLLABORATORS

This project has benefited greatly from the wisdom, time, and efforts of many citizens, nature groups, and especially the City of Toronto. Below is a list of the many citizens who have contributed to making our ravines a better place.

The Rosedale Ravines Study 1977

A.	Gotfryd
Roger	Hansell
Michael	Hough
Robert	Jefferies
J.	Kaiser
R.	King
A.	Petrie
G.	Renfrey
Paul	Scrivener
Dale	Taylor
B.	Wilson

1977 Data Retrieval

Ken	Abraham
Emma	Horrigan
Susan	Jefferies

City of Toronto Staff

Norman	DeFraeye
Jessica	Iraci
Janie	Romoff
Richard	Ubbens

City of Toronto Councillors

Mayor John	Tory
Shelly	Carroll
Glenn	De Baeremaeker
Sarah	Doucette
Mary	Fragedakis
Jessica	Iraci
Josh	Matlow
Mary-Margaret	McMahon
Gord	Perks
Jaye	Robinson
Kristyn	Wong-Tam

Field Work

Anna	Almero
Andrew	Avsec
Jennifer	Baici
Lucas	Champigneulle
Rhoda	deJonge
Richard	Dickinson
Quentin	Fiers
Laetitia	Foulquier
Mary	Grunstra
William	Harding
Kaho	Hayashi
Florent	Hendrycks
Karen	Jiang
Ian	Kennedy
Professor Sally	Krigstin
Mathilde	Kropin
Leo	Lepiano
Vincent	Lepoivre
Professor Jay	Malcolm
Remi	Mauxion
Jonathan	Schurman
Emilien	Soulat
Stanley	Szwagiel
Professor Sean	Thomas
Fai	Udom
Tony	Ung

Photography

Susan	Drysdale
David	Grant
Jane	Michener

Ravine Friends

Susan	Aaron	Nancy	Dengler	Mark	Peck
David	Agro	Richard	Dickinson	Peter	Quinby
Lloyd	Alter	Sarah	Fraser	Jason	Ramsay-Brown
Craig	Applegath	Andrew	Gayman	Theresa	Reichlin
David	Beadle	Meric	Gertler	Daniel	Riley
Catherine	Berka	Carla	Grant	The	Sheff's
John	Bossons	Mary	Grunstra	Derk	Sluiter
Barb	Boysen	Anne	Koven	Stephen	Smith
Linda	Brett	Chris	Lowry	James	Somerville
Colleen	Cirillo	Erika	Machtinger	Robert	Spindler
Jennifer	Coggen	Bryn	MacPherson	Lydia	Wong
Dana	Collins	Tim	Mathers	Chris	Woods
Kevan	Cowcill	Esther	McNeil	Joan	York
Paula	Davies	Gavin	Miller	Bob	Yukich
Dawn	Davis	Faisal	Moola	Karen	Yukich

Organizations

Ancient Forest Exploration & Research (AFER)
Bloor Street East Neighbourhood Association
Canadian Institute of Forestry (CIF)
Deer Park Residents Group
Downsview Park
Evergreen Brickworks
Forest Gene Conservation Association
Local Enhancement & Appreciation of Forests (LEAF)
Moore Park Resident's Association
Mount Pleasant Cemetery
Mycological Society of Toronto
Nature Area Conservancy, NYC
North American Native Plant Society (NANPS)
North Rosedale Residents' Association
Ontario Invading Species Awareness Program
Ontario Invasive Plant Council
ProtectNatureTO
Royal Ontario Museum
Somerville Nurseries
South Rosedale Residents' Association
Summerhill Resident's Association
Toronto Botanical Gardens
Toronto Entomologists' Association
Toronto Field Naturalists
Toronto Ornithological Club

Appendix A - Motions to City by TRRS

1. Executive Committee, Meeting 27, September 26, 2017

Source: <http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2017.EX27.8>

Motion to Amend Item (Additional) moved by Councillor Jaye Robinson

That City Council requests the General Manager, Parks, Forestry and Recreation to consider incorporating the following in the final Toronto Ravine Strategy:

- The internationally recognized concept of "Ecological Integrity" to measure the state and health of ravines;
- Using science available at the University of Toronto's Faculty of Forestry or similar centres of research to develop baseline information and address the capacity of the City and its partners to get the work done;
- Incorporate the Ontario Invasive Species Act into the Strategy.

2. City Council, October 2, 2017

Source: <http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2017.EX27.8>

Motion to Amend Item (Additional) moved by Councillor Glenn De Baeremaeker

That City Council direct the General Manager, Parks, Forestry and Recreation, in consultation with the Chief Planner and Executive Director, City Planning and the General Manager, Toronto Water, to report during the 2018 Ravine Strategy Implementation Plan on the funding required to create and complete a biological inventory and an ecological integrity report of Toronto's 10,500 hectares of ravine system.

3. Parks and Environment Committee, Meeting 23, November 17, 2017

Source: <http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2017.PE23.3>

Motion to Amend Item moved by Councillor Josh Matlow

That:

- City Council requests the General Manager, Toronto Water, to expand the Yellow Creek Geomorphic Systems Master Plan Environmental Assessment to include assets beyond geomorphic systems and erosion-impacted infrastructure, as well as a long-term maintenance plan. This must include, at a minimum, an inventory and state of good repair of all existing facilities, including the trail network, an analysis of ecological integrity, and identification of the departments or agencies responsible for implementing and maintaining all planned improvements.

- City Council request the General Manager, Toronto Water, develop the Yellow Creek Geomorphic Systems Master Plan Environmental Assessment in consultation with a working group comprised of relevant community stakeholders and that this working group be formed at the earliest opportunity to inform the Environmental Assessment process for its full duration.
- City Council request the General Manager, Parks, Forestry and Recreation, use the Yellow Creek Geomorphic Systems Master Plan Environmental Assessment as a template for future ravine studies and as a costing model for what is required to bring Toronto's entire ravine system into a good state of ecological repair.

4. Parks and Environment Committee, Meeting 29, July 12, 2018

Source: <http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2018.PE29.2>

Motion to Amend Item moved by Councillor Mike Layton

That the Parks and Environment Committee request the Chief Planner and Executive Director, City Planning to integrate “ecological integrity” as a policy, management, and scientific framework for the final recommended Biodiversity Strategy.

Appendix B - News articles and media exposure of the Toronto Ravine Revitalization Study (TRRS) team

	Media	Title	Journalist	Date
1	CBC Metro Morning	Forest ecologist Eric Davies on Toronto's oldest trees	Matt Galloway	Apr 17, 2018
2	CBC News	Toronto has big plans for its ravines but official strategy has no city funding yet	Muriel Draaisma	Oct 10, 2017
3	CBC Metro Morning	Toronto decides to inventory its ravines	Matt Galloway	Oct 3, 2017
4	CBC News	How much would an inventory of trees in Toronto's ravine system cost? City will find out	Muriel Draaisma	Oct 3, 2017
5	Metro	Meet the man on a mission to map Toronto's oldest trees	Genna Buck	Sept 18, 2017
6	Star	Life on the ravine's edge full of surprises	Patty Winsa	Oct 2, 2016
7	Metro	Researchers warn of 'very dangerous' invasive species spread around Toronto's ravines	Gilbert Ngabo	Aug 16, 2016
8	CBC Metro Morning	Forest Professor Sandy Smith on the health of Toronto's ravines	Matt Galloway	Apr 22, 2016
9	Novae Res Urbis Toronto Edition	Ecological study of ravines: Tracking changes	Leah Wong	July 22, 2016
10	UofT News	Saving Toronto's ravines: forestry researchers track ecological changes	Noreen Ahmed-Ullah	July 20, 2016

Appendix C -Public events that the Toronto Ravine Revitalization Study (TRRS) team organized and/or participated in:

- 1. Parks and Environment Committee, Meeting 29, July 12, 2018**
Eric Davies gave deputation regarding PE29.2, A Draft Biodiversity Strategy for Toronto.
- 2. Deer Park Residents Group (DPRG) AGM, June 14, 2018**
Anqi Dong spoke about native vs invasive species in Toronto's ravines.
- 3. Moore Park Residents' Association (MPRA) AGM, May 24, 2018**
Anqi Dong and *Catherine Berka* presented on our pilot projects.
- 4. City of Toronto Parks and Environment Committee, Meeting 23, November 17, 2017**
Eric Davies and *Catherine Berka* gave deputation regarding PE23.3 Yellow Creek/Vale of Avoca emphasizing the importance of conducting inventory using Ecological Integrity as the framework (*Fig. 1a, b*).
- 5. 2nd Annual Ravine Symposium, Toronto Botanical Garden, November 3, 2017**
Professor *Sandy Smith* presented on invasive species control.
Eric Davies sat on the Seed Panel and co-led the discussion about seed conservation.
- 6. Bloor East Neighbourhood Association (BENA) AGM, October 26, 2017**
Anqi Dong and *Catherine Berka* presented on the risks and opportunities in the Rosedale ravines.
- 7. Park Drive Ravine Fall Walk, October 21, 2017**
Eric Davies led the walk and talked about tree identification and seed forecasting (*Fig.3*).
- 8. City of Toronto Executive Committee, Meeting 27, September 26, 2017**
Paul Scrivener, *Anqi Dong*, and *Catherine Berka* gave a deputation regarding EX27.8 Toronto Ravine Strategy (*Fig. 2a, b*). We recommended using the globally recognized concept Ecological Integrity to measure ravine health, using the knowledge and resources of University of Toronto's Faculty of Forestry, and incorporating the Ontario Invasive Species Act into the Strategy. Councilor Jaye Robinson and Councilor Mary-Margaret McMahon helped put our recommendations into a motion. The motion was carried, and the draft Strategy was amended.
- 9. Ravine Stewardship Workshop, June 17, 2017**
Eric Davies, and Professors *Sandy Smith* and *Jay Malcolm* spoke to homeowners and TRRS donors about ravine ecosystem and stewardship opportunities (*Fig. 4*).

10. Jane's Walk in the Nordheimer Ravine, May 7, 2017

Eric Davies was invited by the walk leader as a guest speaker (*Fig. 5*).

11. Park Drive Ravine Spring Walk, March 17, 2017

Eric Davies led the walk and talked about winter tree identification and old-growth tree conservation (*Fig. 6*).

12. Aster Awards, Toronto Botanical Garden, November 17, 2016

Eric Davies won the Rising Star Award of Aster Award 2016 for his work in urban forestry and forest conservation.

13. 1st Annual Ravine Symposium, Toronto Botanical Garden, October 28, 2016

Eric Davies presented on ravine conservation. *Anqi Dong* presented the study results of TRRS.

14. Royal Ontario Museum (ROM) Science Weekend, September 17-18, 2016

Jane Michener displayed our study (*Fig. 7*).

15. Jane's Walk in the Nordheimer Ravine, May 7, 2016

Anqi Dong was invited by the walk leader as a guest speaker.

16. Fred G. Jackson Prize, 2015

Anqi Dong's ravine canopy resurvey project received the Fred G. Jackson Prize for the best research project of the year.

See following pages for event photos.

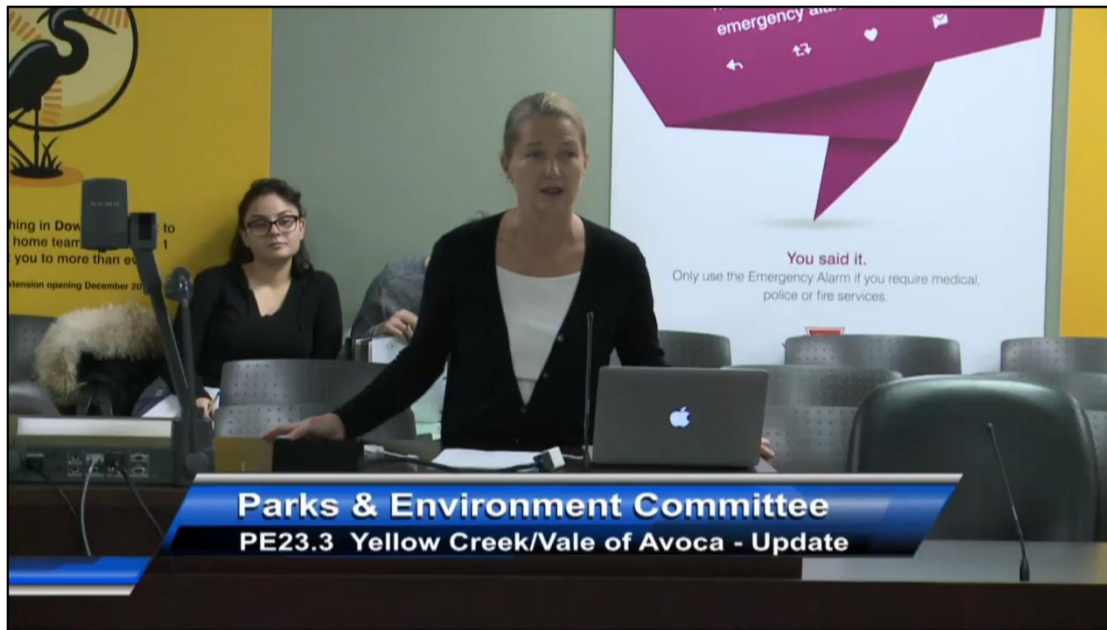


Figure 1a. Catherine Berka (right) presented at the City of Toronto Parks and Environment Committee, Meeting 23, November 17, 2017 (Credit: City of Toronto)
 Image retrieved from <https://www.youtube.com/watch?v=DNpOmS8pgbo>

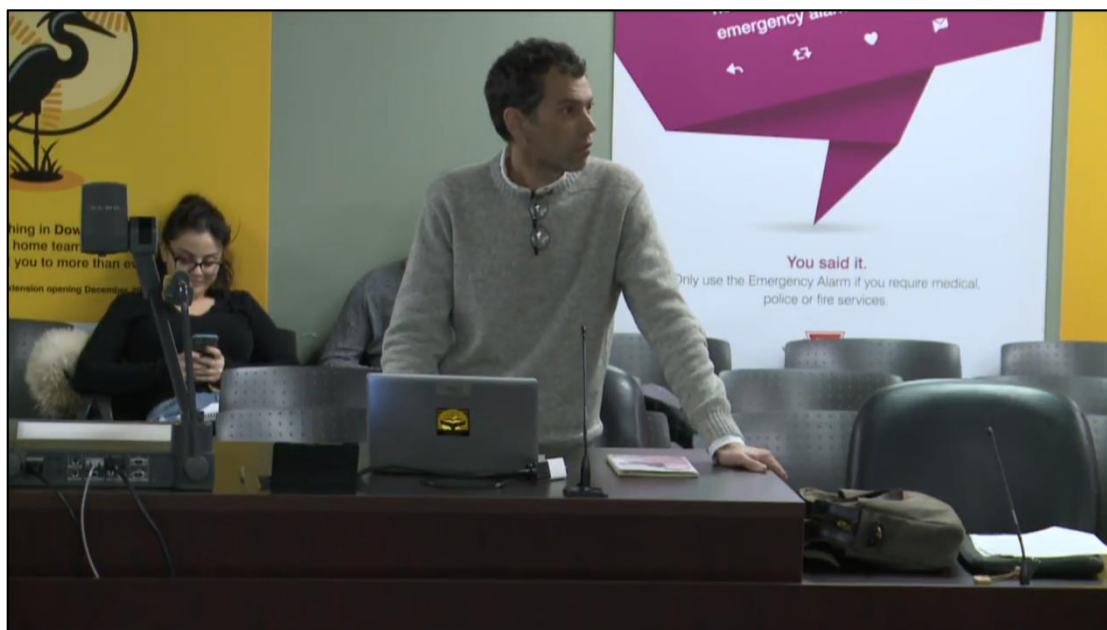


Figure 1b. Eric Davies (right) presented at the City of Toronto Parks and Environment Committee, Meeting 23, November 17, 2017 (Credit: City of Toronto)
 Image retrieved from <https://www.youtube.com/watch?v=DNpOmS8pgbo>



Figure 2a. Catherine Berka (left), Paul Scrivener (middle), and Anqi Dong (right) giving deputation at the City of Toronto Parks and Environment Committee, Meeting 23, November 17, 2017 (Credit: City of Toronto)
 Image retrieved from <https://www.youtube.com/watch?v=jOYZkCjcfZk>



Figure 2b. Catherine Berka (right), Paul Scrivener (middle), and Anqi Dong (left) giving deputation at the City of Toronto Parks and Environment Committee, Meeting 23, November 17, 2017 (Credit: City of Toronto)
 Image retrieved from <https://www.youtube.com/watch?v=jOYZkCjcfZk>



Figure 3. Eric Davies (beside the tree in the centre) Park Drive Ravine Fall Walk, October 21, 2017 (*Photo credit: Jane Michener*)



Figure 4. Ravine Stewardship Workshop, June 17, 2017 (*Photo: Jane Michener*)



Figure 5. Eric Davies (left) speaking at the annual Jane's Walk in the Nordheimer Ravine, May 7, 2017 (Photo credit: Anqi Dong)



Figure 6. Eric Davies (left) leading the Park Drive Ravine Spring Walk, March 17, 2017 (Photo credit: Alex Stepniak)



Figure 7. Royal Ontario Museum (ROM) Science Weekend, September 17-18, 2016
(Photo credit: Jane Michener)



TORONTO RAVINE REVITALIZATION

Appendix D— Historic ecological studies in the Toronto ravines (Tables 1, 2; L. Wong*)

Theme	Threats	Ravine												Totals
		Chatsworth 1973 ¹	Glen Stewart 1973 ²	Moore Park 1973 ² & 1977 ⁷	Vale of Avoca 1973 ²	Brookbanks 1974 ³	Chapman Creek 1975 ⁴	Wigmore Park 1975 ⁵	Park Drive 1976 ⁶ & 1977 ⁷	Burke 1977 ⁸	Rosedale 1977 ⁷	Sunnybrook 1978 ⁹	Cedarvale 1980 ¹⁰	
Hydrology	Bank erosion													6
	High silt burden													7
	Flooding													7
	Gabion basket collapse													3
	Pollution (chemical)													7
	Pollution (physical)													3
Slope / Soil	Algal growth													2
	Erosion/Landslides													9
	Bare/Compact soil													4
	Poor quality soil													4
Vege- tation	Invasive plants	*				*	*							12
	Lack of understory													4
	Lack of tree regeneration													1
	Conifer decline													6
User misuse & overuse	Foot-traffic													5
	Bicycles & Motorbikes													3
	Littering													6
	Children cutting branches													2

(Table 1 continues on the next page)

Theme	Threats	Ravine												Totals
		Chatsworth 1973 ¹	Glen Stewart 1973 ²	Moore Park 1973 ² & 1977 ⁷	Vale of Avoca 1973 ²	Brookbanks 1974 ³	Chapman Creek 1975 ⁴	Wigmore Park 1975 ⁵	Park Drive 1976 ⁶ & 1977 ⁷	Burke 19778	Rosedale 1977 ⁷	Sunnybrook 1978 ⁹	Cedarvale 1980 ¹⁰	
Private land- owners	Construction on slopes													3
	Garden escapees													3
	Birdfeeders attract squirrels													1
Other	Domestic cats													4
	Over-mowing													2
	Salt-drift													3
	Totals	10	5	6	6	9	11	8	11	12	10	11	8	

Table 1. Matrix showing factors that threaten the environmental health of 12 ravines in the City of Toronto. Red boxes indicate presence. The year surveyed is indicated (some were surveyed more than once by different authors). Asterisks denote surveys where plants considered invasive by the Ontario Invasive Plant Council (OIPC) were not mentioned. 1) Cranmer-Byng, J., Hamilton E. and Hiltz, S. 1973. Toronto Field Naturalists' Ravine Survey: Study No. One Chatsworth Ravine. Toronto Field Naturalists' Club; 2) Wainio, A., Price, G., Jew, K., Haniwka, W., Wilson, L. and West, P. 1973. General Biological Survey of Three Ravines Within the City of Toronto: Moore Park Ravine, Vale of Avoca, Glen Stewart Ravine. General Foods Limited [Ministry of Natural Resources]; 3) Cruickshank, B. and Parker, B. Toronto Field Naturalists' Ravine Survey: Study No. Two Brookbanks Ravine. Toronto Field Naturalists' Club; 4) E, C. and Goodwin J.E., 1975. Toronto Field Naturalists' Ravine Survey: Study No. Three Chapman Creek Ravine, Etobicoke. Toronto Field Naturalists' Club; 5) Kelly, D. and Greenbaum, A., 1975. Toronto Field Naturalists' Ravine Survey: Study No. Four Wigmore Park Ravine. Toronto Field Naturalists' Club; 6) Taylor, D. and Scrivner, P., 1976. Toronto Field Naturalists' Ravine Survey: Study No. Five The Park Drive Ravine Rosedale. Toronto Field Naturalists' Club; 7) Goffryd, A., Kaiser, J., King, R., Petrie, A., Renfrey, G. and Wilson, B. 1977. A quantitative ecological study of Toronto ravines 1977: Rosedale Ravine, Park Drive Ravine, Moore Park Ravine, Burke Brook Ravine. University of Toronto; 8) Cranmer-Byng, J., Cunningham, R. and Hamilton, E. Toronto Field Naturalists' Ravine Survey: Study No. Six Burke Ravine. Toronto Field Naturalists' Club; 9) Bamville, D. and Cardini, L. 1978. Toronto Field Naturalists' Ravine Survey: Study No. Eight Est Don River Valley 1974-1978: Sunnybrook Park to Rosedale Golf and Country Club. Toronto Field Naturalists' Club; and 10) Goffryd, A. and Smith, P. 1980. Cedarvale Ravine: An Ecological and Human Use Study. Toronto, Ontario Ministry of the Environment.

Table 2. Matrix showing plants considered invasive by the Ontario Invasive Plant Council (*Credit Valley Conservation 2010*). Red boxes indicate presence.

Invasive Plant	Ravine												Totals
	Chatsworth 1973	Glen Stewart 1973	Moore Park 1973 & 1977	Vale of Avoca 1973	Brookbanks 1974	Chapman Creek 1975	Wigmore Park 1975	Park Drive 1976 & 1977	Burke 1977	Rosedale 1977	Sunnybrook 1978	Cedarvale 1980	Totals
Norway Maple <i>Acer platanoides</i>													9
European spindle tree <i>Euonymus europaeus</i>													1
Non-native bush honeysuckles <i>Lonicera</i> spp.													9
Common & glossy buckthorn <i>Rhamnus cathartica</i> & <i>R. frangula</i>													7
Dog-strangling vine <i>Cynanchum rossicum</i> & <i>C. nigrum</i>													5
Garlic mustard <i>Alliaria petiolate</i>													9
Japanese knotweed <i>Polygonum cuspidatum</i>													7
Goutweed <i>Aegopodium podagraria</i>													5
English ivy <i>Hedera helix</i>													2
Periwinkle <i>Vinca minor</i>													4
Totals	4	5	7	6	2	1	1	6	7	6	6	7	

*Source: Wong, Lydia. 2018. Restoring Toronto's Ravines: a management tool for system-wide approaches. Undergrad paper to Sandy M Smith.



TORONTO RAVINE REVITALIZATION



Map credit: *Mary Grunstra*
Map data: *City of Toronto*

Source: *ESRI, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community*