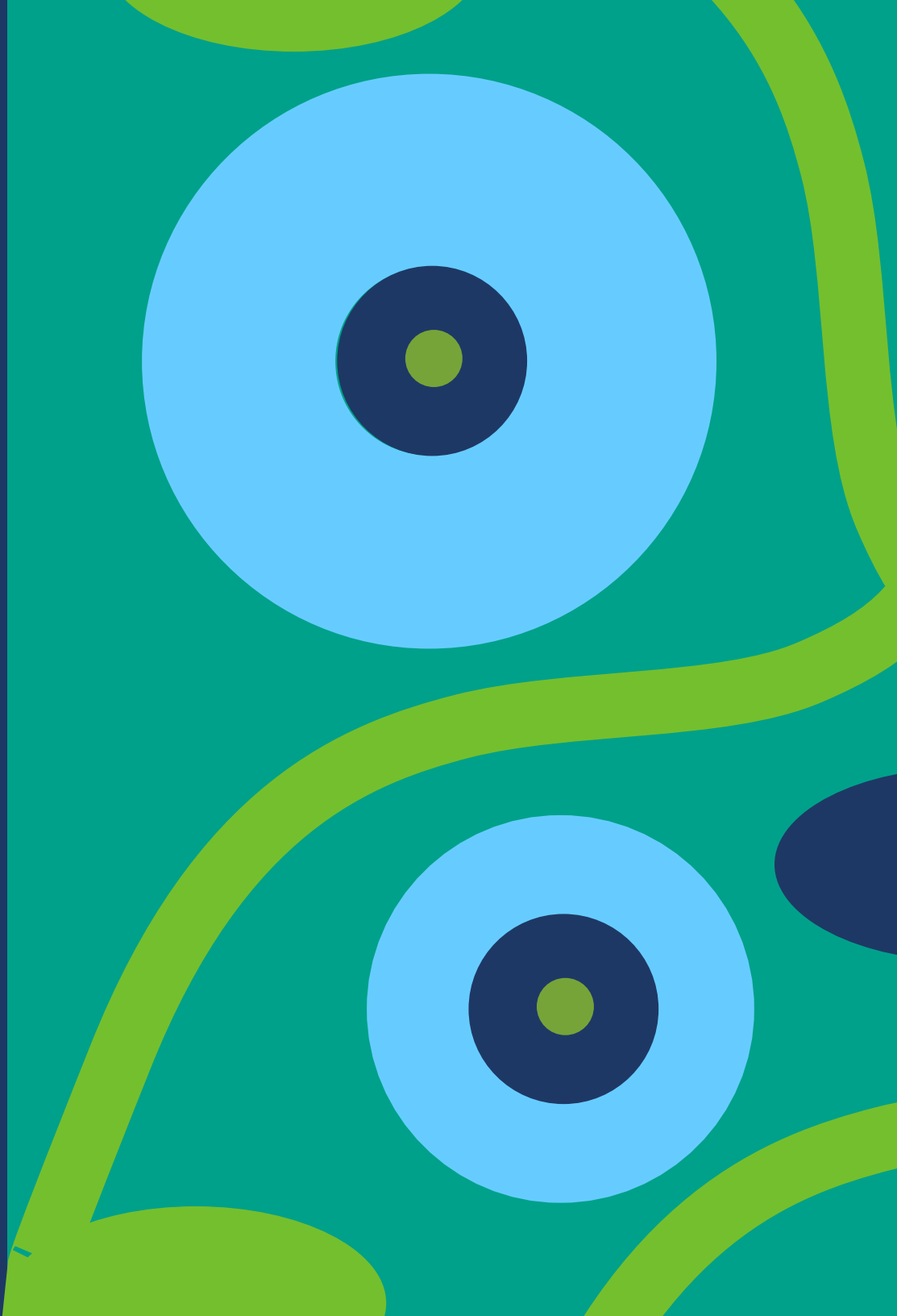
UNIVERSITY OF TORONTO | SCHOOL OF CITIES

Urban Parks: Parks Are for the City



City Research Insights
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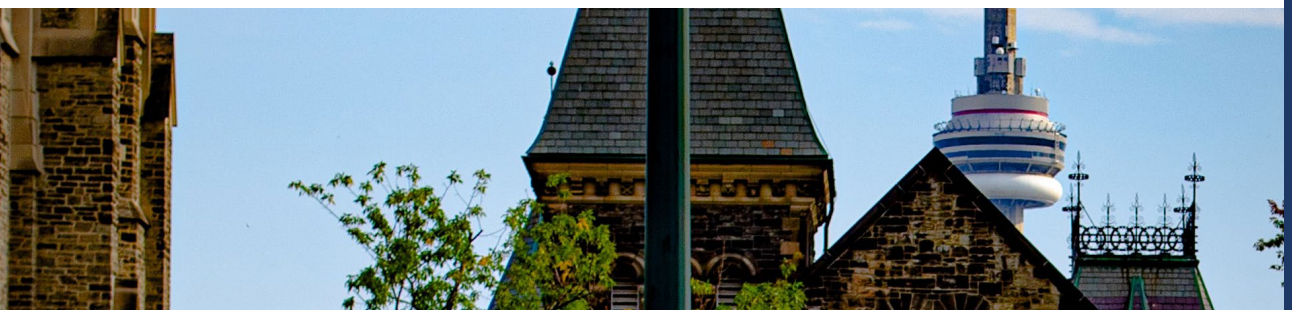
Executive Summary

The report emphasizes the importance of investment in GPS data for parks management. Accurately measuring park accessibility and human activity is crucial in understanding its impact on wildlife connectivity, monitoring changes in park usage, and identifying sought-after paths and areas of interest for efficient park management that benefits both people and wildlife. Increasing investment in these initiatives would be highly beneficial for the park's wildlife and visitors alike.

Parks provide an essential breathing space within our cities. With the strict protocols imposed by the COVID-19 pandemic, there has been a significant shift in visitation patterns to green spaces, emphasizing their role as places of respite. Urban parks also play a crucial role in supporting ecosystem services, such as pollination, pest regulation, and reducing urban heat island effect. They also contribute to human health by providing areas for socialization and exercise. Moreover, urban parks offer economic benefits by improving property values, contributing to biological conservation by supporting wildlife, and promoting social equity through affordable recreation and public amenities.

While urban parks provide numerous advantages, further research is necessary to understand how people utilize, navigate, and engage with these areas. The absence of clear boundaries in publicly accessible spaces poses challenges in studying these dynamics. Leveraging anonymized GPS data collected from smart devices presents a promising approach to quantifying human activity in green spaces. However, additional investigation is required to to fully grasp this new data type's potential applications.

Formulating urban park policies is vital to guide the designation and management of green spaces. These policies establish a foundation and guidelines to ensure equitable access to green spaces and the fair distribution of their critical functions in enhancing physical and mental well-being.



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Policy Recommendations & Implications

Managing parks is a multifaceted challenge that requires knowledge of human activity. Using anonymized GPS data from smart devices can have broad implications for the policy and management of urban green spaces, including:

Revising park amenities or resources: With estimates of human activity in green spaces, land managers have the opportunity to dedicate more resources – such as funding, maintenance or staff – to areas that are overused.

Identifying desire lines and points of interest: Observing areas of high human activity can be useful when revising trail networks or creating designated lookout areas at specific points of interest.

Quantifying park accessibility to residents: Knowledge about the human activity can help identify barriers to entrance or reasons parks are underused.

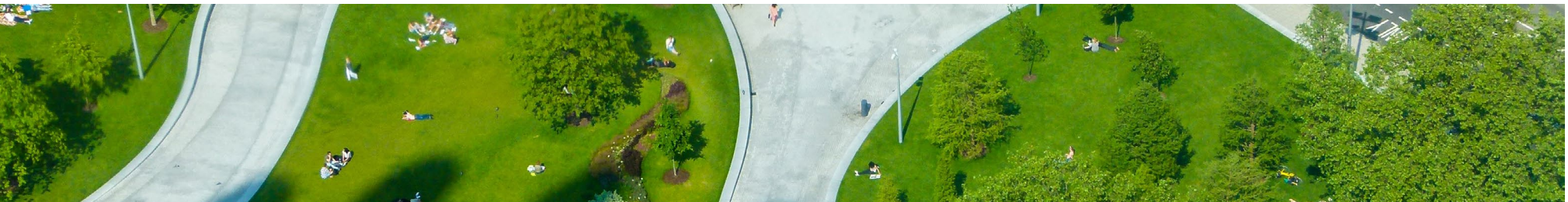
Improving safety and security: By monitoring human activity in parks, stakeholders can identify areas prone to crime or safety incidents. They can then take steps to increase safety of visitors, such as installing security cameras, adding lighting, or closing low traffic areas at night.

Determining wildlife connectivity between green spaces: Human activity, especially road traffic, is a significant barrier to wildlife movement, and using anonymized mobility data can identify resistance that animals may encounter as they move through the city landscape.

Contributing to park design: Improve the user experience by identifying areas of the park that are frequented and ensure these areas have appropriate facilities, such as restrooms, seating, shade, and information areas.

Predicting changes in park use with urban development: Many areas of the GTA are rapidly urbanizing, and having access to estimates of human activity over time can help predict how the use of some green spaces will change.

Understanding human-wildlife interactions: Many green spaces support a wide variety of plants and animals that can both positively (e.g., connection to nature, pollination) and negatively (e.g., coyote attacks, deer-vehicle collisions) affect humans. Quantifying human activity can help support decision-making regarding these interactions.



Methodology

Dr. Filazzola and colleagues used anonymized smart-device data from Mapbox to understand how people use urban green spaces in the Greater Toronto Area. They conduct two case studies to understand human-nature interactions for urban green spaces, the first in collaboration with Conservation Halton and the second with the City of Toronto and the Toronto and Region Conservation Authority.

The research team analyzed park visitation patterns, distinguishing popular areas and quantifying on-trail vs. off-trail activity. They assessed the influence of park-specific amenities on visitation and identified frequently visited properties. Howe`ver, anonymized smart-device data has limitations. For instance, people are less likely to enable location services in parks compared to when they are driving on highways. Anonymization processes, like Mapbox, may remove low-activity park spaces, prioritizing roads and commercial areas. Therefore, the study required a methodology and validation protocol to effectively utilize this data for managing urban green spaces.

In the following two case studies, the research team set out to answer two sets of questions specific to two distinct green spaces: Conservation Halton and the City of Toronto's green space.

These inquiries are made specifically for each environment and are meant to elicit details about the activities. It is essential to create particular inquiries to each site because each space has its attributes and characteristics.

1) Conservation Halton

a) How does the anonymized activity index (comprising both activity density and activity coverage) compare to traditional measures of human activity in urban green spaces, such as reservation data or trail density?
b) What are the challenges associated with using the activity index to infer human presence in green spaces, particularly for land managers?
c) Can the activity index be used to correlate patterns of human activity to landscape features and tree composition?

2) City of Toronto

a) How does accessibility of green spaces relate to housing demographics?
b) Does public activity in green spaces relate to accessibility and available amenities?
c) Can the activity in green spaces be described by the daily air temperatures, and can these be used to determine differences in behaviour on hot summer days?

In finding the answers to these questions, the research team explores patterns of demography, greenspace density, and greenspace use for both Conservation Halton and the City of Toronto.

Conservation Halton is home to over a million people and has some of the fastest-growing municipalities in Canada. The Greater Toronto Area is the fourth largest municipality in North America, with a rapidly growing population and a high level of urbanization. Consequently, it is a region susceptible to injustice as park access is often unequally distributed, and the effects of climate change, such as extreme heat events, often impact disadvantaged groups. Therefore, these two regions were excellent candidates for understanding human activity in urban green spaces.

Mapbox Data

Mapbox provides average daily activity patterns based on smart devices for 100 x 100 m grid cells. The methods Mapbox uses to create the activity index can be broken down into four steps:

1) Collection
2) Calibration
3) Anonymization
4) Normalization

The collection includes location data from any smart device that uses the Mapbox software development kit. Location data can come from the GPS within the device, cell tower triangulation, or router indexation if the device connects to a wireless network.

A significant challenge encountered when using smart device activity for green spaces was the inadvertent inclusion of activity outside the designated green areas. Roads and highways near property boundaries posed a particular challenge, as they often exhibited high activity patterns that were not necessarily indicative of actual activity within the green spaces. To mitigate this issue, the research team implemented a filtering approach to exclude grid cells containing human activity between 12-6 am from outside the parks. This step aimed to remove activity unrelated to the green spaces from the reported data. This approach's effectiveness was validated by comparing estimated activity patterns with reservation data from each green space, as well as visual inspections of activity patterns in relation to local features.

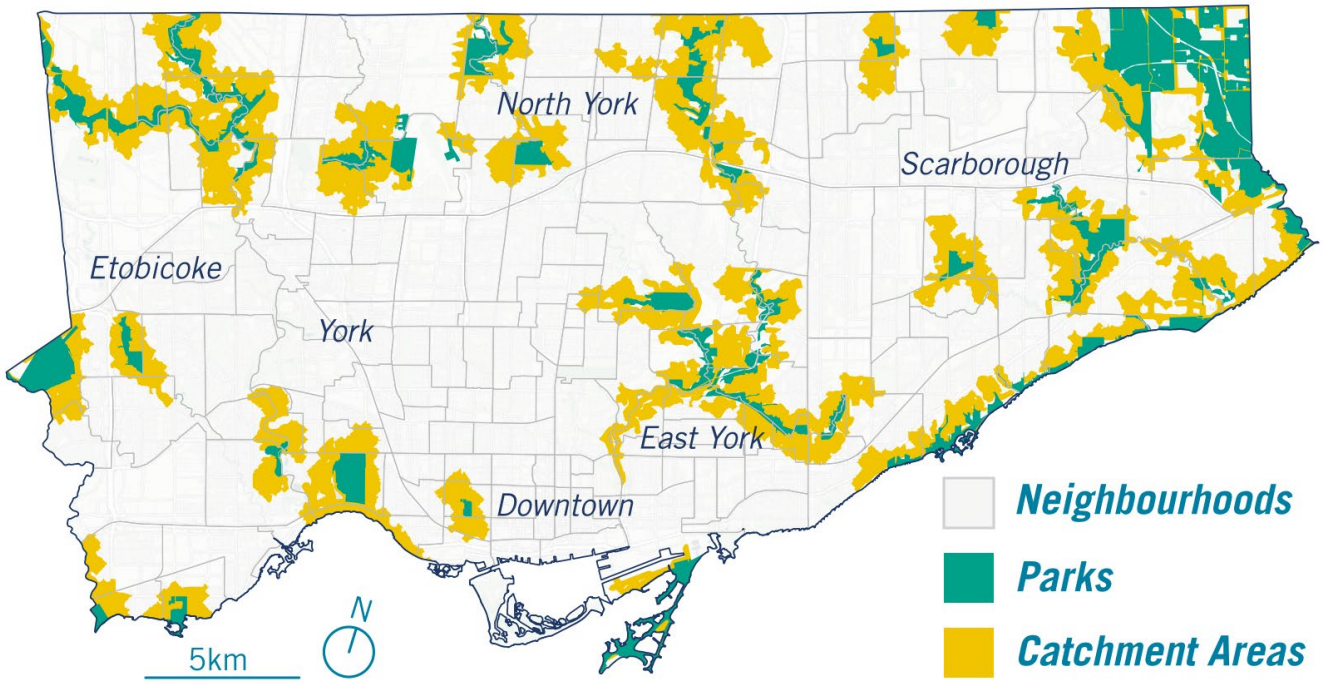


Figure 1: The boundaries for the City of Toronto with the selected parks used within this study and their associated catchment areas. The parks were selected as the largest ones within the city that could support multiple Mapbox grid cells (100 x 100 meter). Shaded catchment areas around the parks are within a 15-minute walk of the park.

Conservation Halton

As a case study for using anonymized GPS data from smart devices with green spaces, the team selected 53 green spaces managed by Conservation Halton in Ontario, Canada. The team compared land cover and tree composition in different green spaces to test the relationship between human activity and local landscape features. Land cover was obtained from an Ecological Land Classification conducted by Conservation Halton.

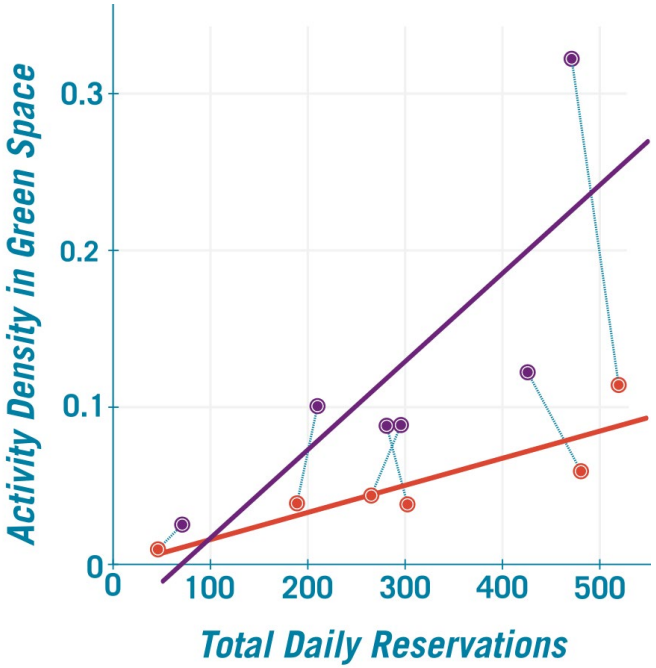


Figure 2: The total daily reservations for Conservation Halton Conservation Areas with reservation-only entrances were strongly positively associated with human activity derived from anonymized data from smart devices.

City of Toronto

Demographic data is typically anonymized at a census level. The study utilized the 2021 census data to explore the relationship between house dwelling type and car ownership with park accessibility. The City of Toronto offers many green spaces, including small parkettes and the large Rouge National Urban Park. The analysis focused on the largest parks in Toronto, encompassing multiple 100 x 100 m grid cells from Mapbox. A total of 33 unique parks were selected for study. Additionally, daily temperature and rainfall data from Environment and Climate Change Canada were collected to examine the impact of weather on park activity.

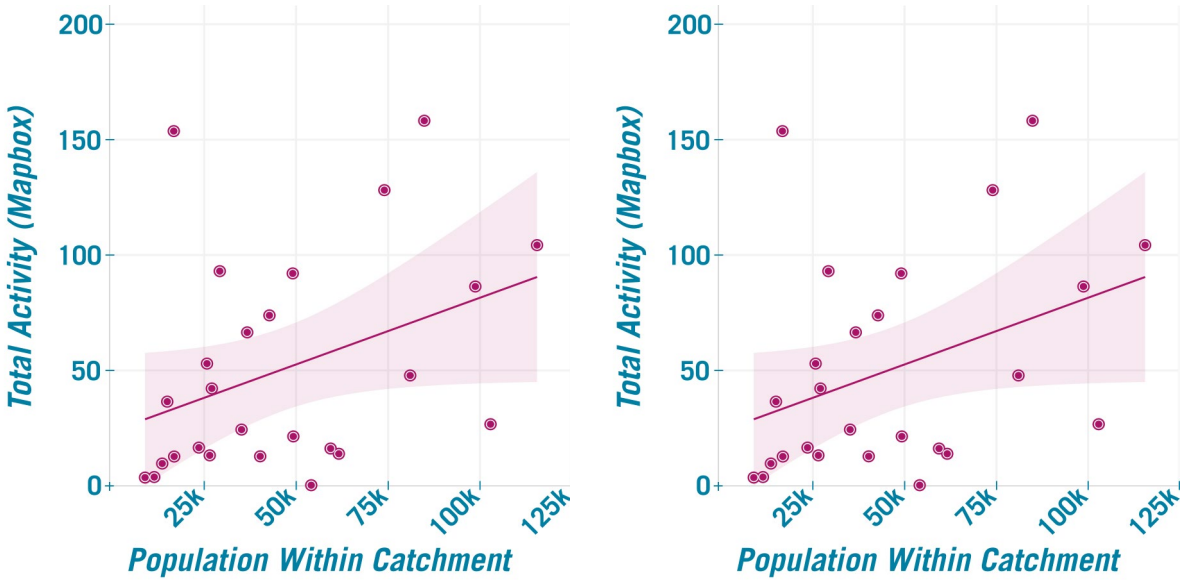


Figure 3: The total activity observed within a park as identified using anonymized location data from smart devices was higher in parks with more amenities and in catchments with a higher population of residents within walking distance. Shaded area represents the standard error associated with mean fit.

The research team conducted an analysis of anonymized GPS data from smart devices to investigate the utilization of urban green spaces, specifically parks managed by the City of Toronto and Conservation Halton. The study incorporated Canadian Census data and park information as a starting point, enabling the team to gain insights into visitor timing, locations, and representations within city parks.

Notable Statistics

Activity in parks was **20% higher** on weekends than during the week.

Holidays have some of the highest activity patterns, with the **August Civic Holiday** having the **highest daily activity** in green spaces and **Canada Day** having the **fifth highest activity.**

Warmer days on the weekend correlated with higher park activity, with on average a 30° C day having **26% more park activity** than a 20° C day.

Of the selected parks, the parks with the most significant **ratio of area to population** had, on average, a **significantly higher proportion of single-detached homes** (>50%) and people who use a car as their primary method of transportation (>70%).

Parks with **twice** as many **amenities** had, on average, **68% more activity.**

On average, parks with **twice** the density of trails had **ten times** the amount of park activity.

In Conservation Halton properties, **forest** was the most commonly visited land type, with over **20% of all activity** occurring in a forested area.

Areas with rock features (i.e., bluff, cliff, cave, talus), while relatively few in number, are very popular with guests and were visited disproportionately more than any other area relative to their coverage. **Approximately 75%** of all lands with rock features had some activity. Only 25% of all land cover with rock features has no human activity.

Defining Key Terms

Term	Definition	Examples
Smart device	Any electronic device with a built-in GPS unit that is able to transmit the location of the user	Smartphones, smart-watches, tablets
Conservation Authority	Non-profit organizations responsible for watershed management in Southern Ontario	Toronto and Region Conservation Authority, Conservation Halton
Ecosystem services	A series of benefits provided by nature to people	Pollination pest management, air purification, recreational experiences
Urban green space	Open-space areas with minimal development in cities	Parks, golf courses, cemeteries, riparian areas
Park amenity	Features within the park intentionally placed or naturally occurring that are likely to attract visitors	Rivers, parking lots, sports fields, splash pads

Key Findings

A new method for managing parks

1 Dr. Filazzola and Professors Johnson and MacIvor pioneered a methodology that overcomes many of the challenges in the context of analyzing human activity in urban green spaces. For validation, the team compared an adjusted activity index derived from the Mapbox data with reservation data for select parks managed by Conservation Halton and found a strong correlative relationship. This shows that harnessing anonymized data from smart devices represents a new and powerful tool in park management.

The park composition heavily influences human activity in parks

2 They also found human activity in parks was largely predictable and occurred near points of interest, along trail networks, and in more popular parks. In the Conservation Halton case study, the team found that most activity occurs on trails. People were disproportionately more likely to visit rock features relative to the forest, grassland, or other land types. In the City of Toronto case study, they observed a strong relationship between park activities and available amenities (e.g., parking lots, sports fields, water features), highlighting that the design of parks is an important element of park use. These findings can assist park managers in encouraging park use and investing resources to support areas of higher human activity.

Park accessibility is unequal for city residents.

3 Another key finding was for the City of Toronto, downtown has the least amount of green space per person, with most residents only having access to between 0.169 and 1.289 square meters of park space. Areas with the most significant green space are within Toronto's inner suburbs, where higher proportions of single-detached homes and car ownership are also present. Due to their lower population density and larger parks, Toronto's inner suburbs offer less competition for park space. Torontonians will have more equitable access to green space if possibilities are found to improve amenities and accessibility in densely populated city regions.

What's Next?

The novel methods developed by the team and research findings will be of significant use for city planners, park managers, housing developers, and communities advocating for equitable park access. Urban parks are places where people and nature interact. For some people, the biodiversity present in cities is the only relationship with nature they experience. These findings are timely as many cities worldwide struggle with congestion, aging infrastructure, and increasing population densities. The tools from our work will help us make more informed decisions with respect to creating sustainable urban parks that support the myriad of services provided. By accurately understanding park use and predicting how people access them as populations rise, actions can be taken to add amenities, adjust trail circulation, or create habitat with greater efficacy and impact.

Anonymized data from smart devices can also help with monitoring activity in green spaces. For instance, Milton, a city in the Halton Region, has been the fastest-growing municipality in Canada in five of the last ten years, meaning many housing developments are being rapidly built around greenspaces - lands previously occupied by farmland. Monitoring park usage in near real-time enables decision-makers to respond quickly to manage park resources more efficiently. These data can also help city planners track the success of new park features and improvements, allowing them to make data-driven decisions about ongoing and future park management. One area of research the team is currently exploring is the potential of leveraging the activity patterns surrounding green spaces as a proxy for wildlife connectivity. Understanding barriers to animal movement or human-assisted movement of invasive species would be an essential step toward supporting biodiversity. Lastly, the data can be used to predict potential influxes of activity and higher park use based on local patterns of development. We are working on further developing usable analytics for stakeholders and building tools using the Mapbox datasets to support the sustainable management of urban green spaces in support of city residents and biodiversity.

This City Research Insight features the work of three University of Toronto researchers – Professor Marc Johnson, Assistant Professor Scott MacIvor and Postdoctoral Research Fellow Alex Filazzola – who have been collaborating on the project "Urban Parks for People: Anonymized movement data to determine access and equity" from our Urban Challenge Grant 2.0 cohort.

The work also builds on the work of Professor Marc Johnson and an extensive team of researchers from our Urban Challenge Grant 1.0 cohort, "UrbEnNet: An Urban Environmental Network to understand the impacts of urbanization on our environment."

The team is currently working with other municipalities and researchers to develop new questions, methods, and findings supporting park management in Canada.

Project Team:

- **Scott MacIvor** (Dept. of Biological Sciences, UTSC)
- **Alessandro (Alex) Filazzola** (ApexRMS and Centre for Urban Environments, UTM)
- **Namrata Shrestha** (Watershed Planning and Reporting, Toronto and Region Conservation Authority)
- **Danny Brown** (Parkland Strategy Implementation, City of Toronto)

The work also builds on the work of Professor Marc Johnson and an extensive team of researchers from our Urban Challenge 1.0 Cohort, "UrbEnNet: An Urban Environmental Network to understand the impacts of urbanization on our environment."

Interview with Alessandro Filazzola and Kim Barrett

Alex, how did the conservation partnership originate?

Alessandro Filazzola: I connected with the local conservation authorities during my Postdoctoral Fellowship at the School of Cities. We discovered that the increasing number of park visitors was a concern. To address this, we sought a solution to capture visitor data and partnered with Halton.

What challenges did you face in managing park use?

Kim Barrett: COVID-19 posed challenges in ensuring safe access to nature. We adapted our operations and implemented smart gates and park passes to manage visitor flow and safety. However, we needed more precise data on visitor distribution and park movements.

How did the Mapbox program address the data gaps?

Alessandro Filazzola: The Mapbox program allowed us to monitor multiple properties, especially those without attendance monitoring systems or staff present. It provided insights into visitor activities without tracking individuals, complementing the attendance data.

Can you explain how this data set influenced park management?

Kim Barrett: We used the data to identify areas with high visitor activity and sensitive species. This information helped focus monitoring efforts and plan guided hikes to direct visitors away from sensitive areas, ensuring the conservation and visitor enjoyment.

Were there any barriers to data adoption or privacy concerns?

Kim Barrett: Privacy concerns were addressed through anonymization. The complexity of the dataset was challenging, but the research team helped make sense of it.

Alessandro Filazzola: Anonymization and data quality were addressed, and privacy concerns shouldn't be a worry. Computational challenges and adjusting for biases were obstacles, especially in urban parks.

Kim Barrett is Associate Director, Science & Partnerships with Conservation Halton

Alessandro Filazzola is a data scientist with ApexRMS

Where do you see this collaboration heading, and what advice would you give researchers partnering with conservation authorities?

Alessandro Filazzola: The collaboration has been fantastic, benefiting both sides. It can be applied to other park management teams. Collaboration with conservation practitioners allows research to have a real-world impact.

Do you expect any policy recommendations to emerge from this work?

Alessandro Filazzola: The data's usefulness is encouraging and can be shared with other park managers for similar analyses. Other conservation authorities have shown interest. We were recently contacted by another Conservation authority who said, "We love what you did for Halton. Can you copy-paste it for us?" Sharing the knowledge and replicating the approach can lead to valuable policy recommendations.

Kim Barrett: Collaboration and sharing among conservation authorities can benefit from this data. The partnership has been mutually beneficial, generating practical park management and conservation results. It has been an exciting project that opened up new possibilities, and the data has proven valuable.

About the School of Cities

The School of Cities is a unique multidisciplinary hub for urban research, education, and engagement creating new and just ways for cities and their residents to thrive. Based at the University of Toronto and in a fast-growing, culturally diverse, and economically dynamic urban region, the School of Cities supports leading scholars, practitioners, and community members spanning disciplines and lived experiences to co-create new understandings, policies, and practices.

The future is urban, with close to 70% of the world's population expected to live in cities by the year 2050. The School of Cities fosters opportunity, collaboration, insight, and knowledge exchange with a global reach, playing a critical role in addressing climate change and justice, migration and belonging, inequality and democracy, and the world's collective ability to address urgent urban challenges.

About City Research Insights

Urban Parks: Parks Are for the City is the fourth issue in the second volume of the City Research Insights series, designed to link the urban research being conducted at the University of Toronto with the public, other institutions, and decision-makers.

With this series, the School of Cities seeks to leverage our extraordinary community of urbanists and urban-oriented researchers to create a rich, multidisciplinary community of urban faculty, researchers, and students across disciplines and perspectives. In addition to facilitating interdisciplinary research projects, partnerships and funding opportunities, we provide a hub for urban-focused interdisciplinary and collaborative learning.

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Myhal Centre, Suite 853
55 St. George Street, Toronto, ON
M5S 0C9
Canada

General Inquiries:
Contact us at schoolofcities@utoronto.ca or 1-416-946-7534
Learn more about us at schoolofcities.utoronto.ca

Media Relations:
Contact us at communication.sofc@utoronto.ca or 416-978-0100
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Taylor Brydges

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Amira Babeiti

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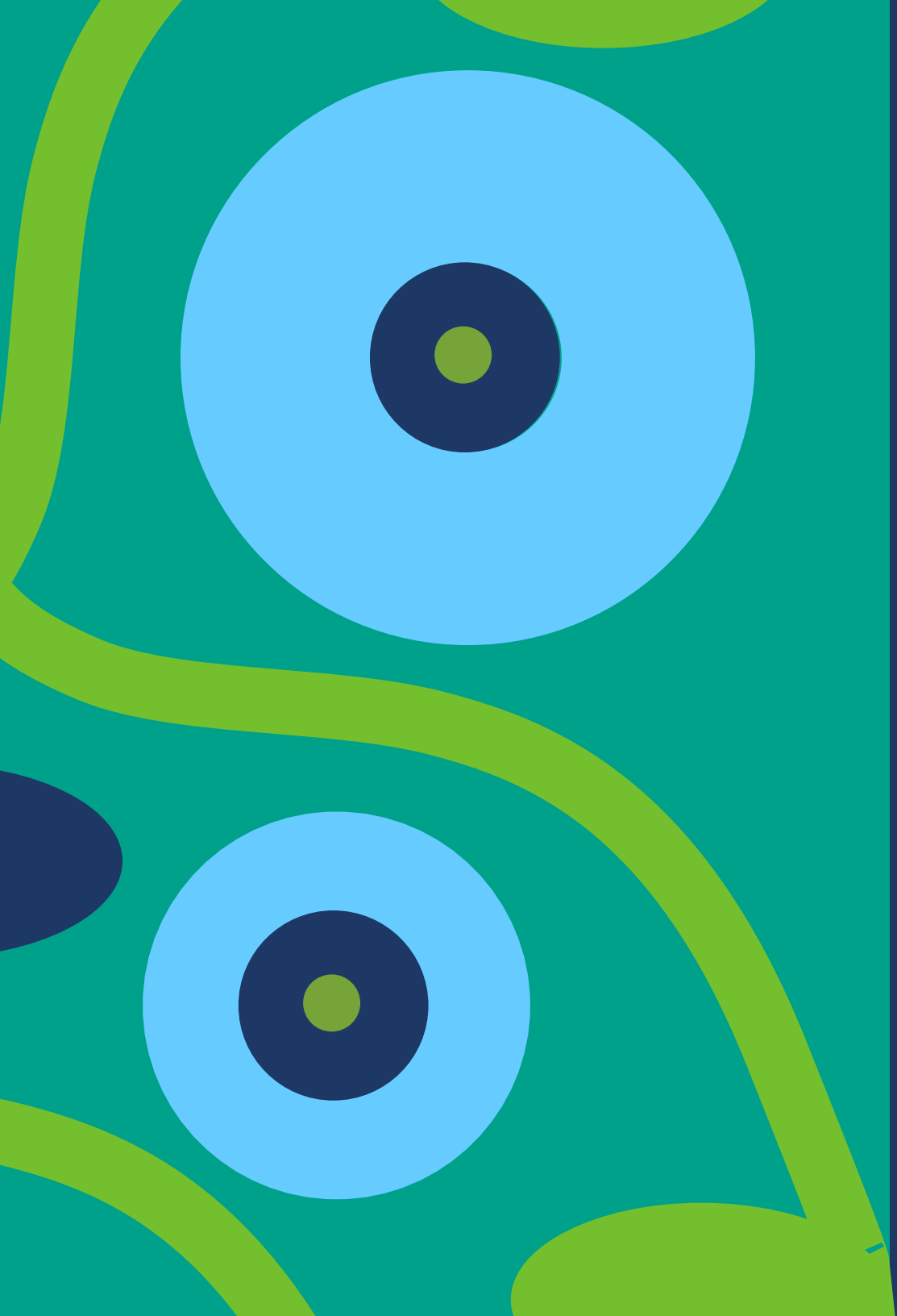

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