NATURAL CAPITAL VALUATION OF VANCOUVER'S PARKS

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August 2020

This report was produced as part of the Greenest City Scholars (GCS) Program, a partnership between the City of Vancouver and The University of British Columbia, in support of the Greenest City Action Plan.

This GCS project was conducted under the mentorship of City staff. The opinions and recommendations in this report, and any errors, are those of the author, and do not necessarily reflect the views of the City of Vancouver or The University of British Columbia.

The following are the official partners and sponsors of the Greenest City Scholars Program:

Acknowledgements

Chad Townsend, Senior Planner, Vancouver Park Board: for your invaluable mentorship and all the professional opportunities you generously offered me through this project.

Jake Kuyer, Senior Consultant, eftec UK: for your patient guidance, critical eye and constructive input throughout all stages of the project.

Members of the Environment and Sustainability team within the Planning, Policy & Environment Department of Vancouver Park Board: **Dana McDonald, Krista Voth, Rebecca Till, Katelyn Ling, Alan Duncan, Navjot Hundle,** and fellow Sustainability Scholar **Uuganbadrakh Oyunkhishig**: for your highly valuable feedback and willingness to connect me with other staff members who could contribute to the project.

Pouyan Keshtkaran, Katherine Howard, Eliana Macdonald, Alexandre Man-Bourdon, Reagan Stinson, Joe McLeod, Wendy de Hoog, Alexandra Couillard, Cabot Lyford, Emily Schultz, Leila Todd: for generously availing your time and sharing your expertise and resources to support my research process.

Cover photo: Fall colours in Stanley Park. Photographed by the author in Nov 2019.

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Executive Summary

Urban parks offer a range of benefits, from promoting physical and mental health to improving our air quality. However, many of these benefits are often "invisible" and difficult to attribute a dollar value to. Yet, the ability to articulate the economic value of parks is critical for justifying the use of public funds for park protection, especially when competing against more tangible assets and land uses.

This report provides a broad literature review of natural capital valuation followed by preliminary recommendations on how to calculate the economic value of Vancouver's parks. Possible valuation methods and sample calculations are proposed for three key benefits: tourism, recreation, and physical health; with four other benefits including property premiums, stormwater management, air quality and temperature regulation briefly covered. Preliminary calculations show that the tourism value of Vancouver's parks ranges between $198 million to $1.3 billion per year, their recreation value is worth at least $31 million per year, and their physical health value is worth at least $47 billion. Each of these values represents annual revenue rather than asset value, and if multiplied over the asset life of parks and added to the value of all other park benefits, will likely be higher than the equivalent market value of residential or commercial land use. Hence, efficient management of urban greenspace, including funding for maintenance and enhancement of environmental assets, can provide a sustainable revenue stream of economic value through ecosystem service provision, which in many cases far outstrips the economic value, or opportunity cost, of the land as a residential or commercial asset.

Due to limited time and data availability, these seven benefits were selected chiefly based on the scope covered by precedent studies and the availability of Vancouver-specific data, and thus do not necessarily reflect the most important or most valuable benefits of Vancouver's parks. Moreover, for those benefits with sample calculations, assumptions and adjustments to transfer values had to be made where data was lacking. The reader is thus encouraged to read each proposed valuation method and sample calculation (where applicable) carefully, to fully understand what the final values reflect. All calculations in this report should also be treated as preliminary and require further analysis and verification, especially as more nuanced and relevant data becomes available. Ultimately, this project lays the critical groundwork for future researchers to further research and refine the proposed valuation methods for Vancouver's parks, and for Park Board to secure funding for park maintenance, planning, and future development.

Stanley Park | Photo credit: the author

Reader's Guide to this Report

This report serves as a guidance document for Vancouver Park Board by providing a range of possible methods to quantify the value of Vancouver's parks. The research process leading to this report was brief and mostly exploratory, and is intended mainly to lay the groundwork for future research and refinement. Hence, researchers and policy-makers reading the proposed valuation methods in here are encouraged to conduct further analysis before applying them to the policy context. Nonetheless, this report provides an adequate starting point and also points the reader to other useful references where Vancouver-specific research or data may currently be lacking.

This report contains three key sections:

Section 1: Background

This section provides a broad overview of natural capital valuation, including a review of valuation methods that case studies around the world have used, as well as the key lessons learnt from these precedent studies. It then explains the project objectives and scope in the context of the City of Vancouver and Vancouver Park Board's policy needs.

Section 2: Results & Recommendations

Synthesising the key lessons from Section 1, Section 2 then presents the key recommendations for Park Board. It outlines the proposed valuation methods that Park Board may consider using for seven key park benefits: tourism, recreation, physical health, property premiums, stormwater regulation, air quality, and temperature regulation. For each park benefit, a brief introduction on why the benefit is important and the common methods to measure its economic value is first given. This follows with a description of the chosen method for Vancouver Park Board's usage and the rationale behind this choice. For the first four benefits, a box is also included showing an example of how to apply the proposed method to Vancouver's parks, with the resulting economic value of the given park benefit shown at the end of the box. All details on input data, strengths, caveats, and limitations of this proposed calculation process are written within the box. Following the box, the section concludes with further recommendations for measuring the given benefit (e.g. with more available data in future). For the final three benefits, more data and analysis would be needed for robust calculations; hence, worked examples are omitted, but a brief statement on possible valuation methods, as well as reference case studies and guidance documents, is given.

Section 3: Next Steps

Following the proposed valuation methods in Section 2, 'Future Recommendations' lays out the key action items that Park Board can take next, including examining other benefits that were beyond this project's scope. A list of useful resources, including policy guides, case studies and data sources, is then provided for further reading and application. The references section then provides the full list of works cited, while the appendices give full details of the research process and findings made within this project, for readers who might be interested in finding out more.

Section 1: Background

John Hendry Park | Photo credit: the author

Introduction

The value of urban parks and greenspaces is less understood compared to other more tangible or more frequently traded land uses, such as commercial or residential spaces and other public assets. This is largely due to the prevailing paradigm of "value" being necessarily calculated in economic terms. Paired against commercial, industrial and residential land uses, parks are often deemed low-value because they do not generate economic revenue as directly, or to as great an extent. Given the extremely high real estate values and pressures of both economic development and population growth so inherent in cities, parks and green spaces often bear the brunt of governmental budget cuts and land entitlement (Olbińska, 2018). In dense cities like Vancouver, park parcels are at increasing risk of being targeted for utility upgrades and expansions. This can have short term and long term impacts on parks' abilities to adapt to serve basic park needs (Man-Bourdon, pers. comm., 2020). As a result, park advocates often find that framing the value of parks in economic terms becomes advantageous, if not necessary, to seek political support (Harnik & Crompton, 2014). However, it is challenging to articulate the value of parks and greenspaces in economic terms, as many of their benefits are difficult, impossible, or controversial to monetize (More et al, 1988).

At the same time, researchers, policy-makers and the public are increasingly recognizing the value of urban parks. In 1999, Bolund & Hunhammar published a paper on "ecosystem services in urban areas" that has now received over 3000 citations on Google Scholar. While their study encompasses all urban natural spaces (e.g. wetlands, streams, street trees) rather than parks alone, they list five key ecosystem services generated by lawns/parks and urban forests: air filtration, micro-climate regulation, noise reduction, rainwater drainage and recreation/cultural value. These benefits corroborate well with studies on benefits of urban parks. In a review by Konijnendjik et al (2013), the authors highlighted the following benefits of urban parks: positive health outcomes, social cohesion, tourism, housing prices, biodiversity, air quality, water regulation and temperature reduction. Additionally, Bertram & Rehdanz (2011) mention cultural ecosystem services such as aesthetic enjoyment, spiritual experiences, inspiration and education. This broad range of benefits brought about by urban parks is summarized in Figure 1.

To date, there has been extensive research on the role of public parks in improving human health, both physically and mentally (Buckley & Brough, 2017; Wolf & Robbins, 2015). Moreover, with the COVID-19 pandemic of 2020, parks have received more media attention than ever before for the value that they offer to city-dwellers' well-being (e.g. Mackres, 2020; Saffron, 2020; Surico, 2020). In urban environments, the ability of parks, green spaces and trees to sequester carbon and reduce temperatures is all the more important for mitigating the Urban Heat Island effect. Moreover, with climate change and global warming, many cities are expected to experience hotter summers and greater heat stress. This makes parks and greenspaces all the more valuable as natural sources of cooling.

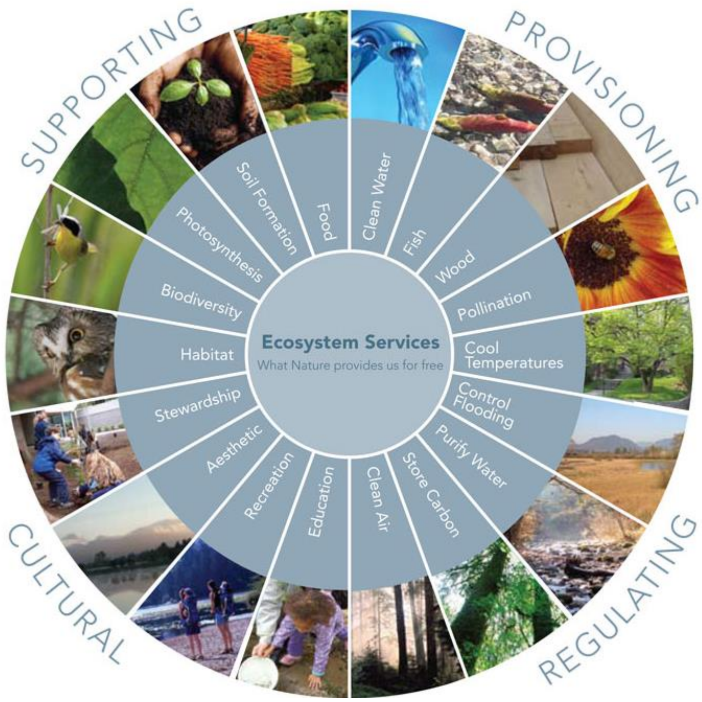


Figure 1: The range of ecosystem services that urban parks can provide. (Image credit: Fermilab Ecology)

Hence, there is an urgent need for cities like Vancouver to assess the value of their greenspaces, even if not economically, at least quantitatively. While it is certainly true that not all values associated with nature can be (or should be) quantified, an attempt to do so would at least provide a commensurable language to argue for the protection of urban natural spaces at the policy level, especially when pitted against other perceivably more economically valuable land uses. As argued by Harnik & Crompton (2014, p.188), "if no economic measure of their value is offered, [park services] will often be discounted and misprioritized." To that end, the objective of this project is to come up with a Vancouver[1]-specific methodology for quantifying the value of parks. This methodology will contribute to Vancouver Park Board's ability to quantifiably justify the protection, maintenance and enhancement of the park network to both Park Board Commissioners and City Councillors, especially in light of increasing pressures from civic budgets, other land use demand, and population growth. Given the very short time span of this project, this report is meant to be introductory rather than comprehensive. It lays the foundation for the Park Board to further develop and refine the proposed calculation methods, as well as add on more ecosystem services to be quantified.

[1] In this report, "Vancouver" refers to the city of Vancouver as defined by municipal boundaries. This should not be confused with "Metro Vancouver", which includes the city of Vancouver as well as other municipalities like West Vancouver, North Vancouver, Burnaby and Richmond. Additionally, "City of Vancouver" in this report refers to the municipal government body, whilst "city of Vancouver" refers to the city as a socio-physical entity, comprising the land and citizens within its municipal boundaries.

Background on Natural Capital Valuation

The topic of natural capital valuation is relatively new in both Vancouver and Canada. Searches on both Google Scholar and the UBC Library database turn up fewer than 20 case studies based within Canada, and most of them focus on non-urban sites, such as wetlands, forests, or national parks.

Nonetheless, there are a few Canadian studies notably relevant for this project. For instance, Millward & Sabir (2011) calculated the value of services provided by trees in Allan Gardens, Toronto using the Street Tree Resource Assessment Tool for Urban Forest Managers (STRATUM). Measuring the contributions of park trees to air quality, energy savings, carbon sequestration, stormwater mitigation, and aesthetic value, they found that park trees provided approximately USD $26 000 of benefits annually. A study of Ontario's Greenbelt suggested that its ecosystem services are worth over CAD $2.6 billion per year, based on a comprehensive list of benefits including carbon storage, oxygen production, air pollution mitigation, water filtration, flood regulation, biodiversity value, recreation value and agricultural value (Brown & Mooney, 2013).

There are also a few Canadian organizations specializing in and contributing to the growing research on natural capital valuation within this region, such as the David Suzuki Foundation, Smart Prosperity Institute, and the Municipal Natural Assets Initiative (MNAI). MNAI "provides scientific, economic and municipal expertise to support and guide local governments in identifying, valuing and accounting for natural assets in their financial planning and asset management programs and developing leading-edge, sustainable and climate resilient infrastructure" (MNAI, 2020). Based in Vancouver Island, BC, their team has produced case studies of natural capital valuation in a few municipalities like Gibsons (Sahl et al, 2016) and West Vancouver (MNAI, 2018). The Adaptation to Climate Change Team at Simon Fraser University, BC, also very recently published a guideline to accounting for natural assets (ACT, 2020). The recency of these publications and the development of organizations like these both highlight the newness of natural capital valuation practice in Canada. Nonetheless, they provide very useful preliminary guidance on how the process of natural capital valuation could look like in British Columbia.

In comparison, research on natural capital accounting in the UK is more advanced. This is seen most evidently through the mainstreaming of natural capital accounting in the public sector. At the national level, the Office for National Statistics and the Department for Environment Food and Rural Affairs (DEFRA) has had a team dedicated to analyzing and publishing statistical data on the value of ecosystem services throughout the UK since 2011 (Bright et al, 2019). Full reports on their natural capital accounts and case studies can be found on their website (Office for National Statistics, 2019).

Closer in context to Canada, there have been numerous studies of parks and green spaces in the USA conducted by the Trust for Public Land. These studies occurred at various scales including counties (e.g. Mecklenberg), cities (e.g. Colorado Springs, San Francisco, Seattle), and metropolitan regions (e.g. Cleveland). Cities they most recently studied include San Francisco (2014), San Jose (2016), and Colorado Springs (2017). For all these cities, they measured seven benefits of parks: tourism, recreation, physical health, property premiums, stormwater regulation, air pollution removal, and community cohesion. The same method was applied for each of these benefits across the studies, and can be found in Harnik and Crompton's peer-reviewed article (2014).

For a comprehensive list of natural capital valuation methods, the reader is invited to refer to **Appendix 1**.

Key Lessons from Precedent Studies

USA studies by the Trust for Public Land (2009 – 2018)

The studies produced by the Trust for Public Land provide a highly useful reference for simple, straightforward methods suitable for policy contexts when time, data, and/or resources may be limited.

Benefit	Method	Strengths	Weaknesses
Recreation	Direct use value, using Unit Day Value	Simple to apply, as long as data is available.	Based on assumed rather than measured values.
Tourism	Tourist spending	Used actual survey data of tourists' motivations to visit the city (rather than educated guesses, which are necessary where data on visitor motivations is lacking).	Percentages have limited transfer value to Vancouver, since every city's park network and park characteristics are unique.
Physical health	Avoided medical costs	Reliable and widely accepted method; uses reliable data on economic burden of physical inactivity.	Only included adults and not children in their calculations.
Property premiums	Hedonic pricing	Reliable and widely accepted method; data on property prices usually relatively easy to attain.	The Trust for Public Land studies only applied the property tax rate, which masks various other benefits of living near a park and leads to a seemingly low value (only a percentage) compared to the full value that property owners and/or renters can derive. May double-count other benefits e.g. aesthetic, recreation and health value.
Stormwater regulation	Avoided maintenance costs	Reliable and widely accepted method	Used modelled rather than actual runoff values. Model was also developed in Davis, California and thus may have limited transferability to Vancouver.
Air quality	Using externality values of air pollutants	The Urban Forest effects (UFORE) model which they used is relatively low-cost, easy to use, and location-specific within US cities.	Model was developed for US cities and may thus have limited transferability to Vancouver.

Community cohesion	Monetizing volunteer hours	Attempts to measure an important value that is not easily (and thus not often) quantified.	The Trust for Public Land studies measured community cohesion by financial contributions and assumed monetized values of volunteer hours, which only acts as a proxy and not real value.

Below is an example of the results from one of their studies in San Francisco (Trust for Public Land, 2014). Based on these numbers, the total economic value of San Francisco's parks and recreation system came up to USD $959 million a year. As the authors note, it is not customary in economics to mix public and private financial gains or to combine revenue with savings, but this number gives a broad indication of the total value of San Francisco's park network. Given the similarities in level of economic development, land use density, and population density between Vancouver and San Francisco, it is conceivable that Vancouver's park network would be of comparable total economic value. Nonetheless, other variables such as park provision, level of physical activity amongst residents, and characteristics of the parks themselves would also affect the total value, reinforcing the importance of using a Vancouver-specific methodology for calculation. physical activity amongst residents, and characteristics of the parks themselves would also affect the total value, reinforcing the importance of using a Vancouver-specific methodology for calculation.

Table 1: The economic value of San Francisco's parks (Source: Trust for Public Land, 2014).

Revenue producing factors for city government	
Tax receipts from increased property value	$24,674,897
Tax receipts from increased tourism value	$46,909,727
Estimated total, municipal revenue-producing factors	**$71,584,624**
Cost-saving factors for city government	
Stormwater management value	$1,916,937
Air pollution mitigation value	$3,117,747
Community cohesion value	$66,567,569
Estimated total, municipal cost-saving factors	**$71,602,253**
Cost-saving factors to citizens	
Direct use value	$211,904,399
Health value	$49,221,673
Estimated total, citizen cost-saving factors	**$261,126,072**
Wealth-increasing factors to citizens	
Additional property sales value from park proximity	$122,522,833
Profit from park-related tourism	$431,083,800
Estimated total, wealth-increasing factors	**$553,606,633**

Barnet, London, UK study by eftec (2017)

Compared to the Trust for Public Land studies in the USA, this study takes a more detailed accounting approach, including price adjustments and sensitivity analyses. This approach is recommended if more time and resources are available.

Benefit	Method	Strengths	Weaknesses
Recreation	Estimation of welfare values, using Outdoor Recreation Value (ORVal) tool	ORVal is a well-established and frequently used tool to calculate recreation value in the UK.	ORVal was created for the UK context, so transferability to Vancouver may be limited.
Physical health	Avoided healthcare costs	Reliable and widely accepted method; used reliable data on economic burden of physical inactivity.	This study assumed that those who use parks to meet their exercise requirements would not do so elsewhere in the absence of parks.
Property premiums	Hedonic pricing	Reliable and widely accepted method; data on property prices usually relatively easy to attain.	May double-count other benefits e.g. aesthetic, recreation and health value.
Climate regulation	Applying total amount of carbon sequestered for three main habitat types to central non-traded carbon values	Used developed guidelines by the UK government's Department of Energy & Climate Change to calculate carbon prices. The Government of Canada has similar carbon pricing guidelines as well (see 'data sources for Vancouver' under the Useful Resources section in this report).	

A key finding in this study was that **the cost of managing the 200 parks and open spaces in Barnet was less than 10% of the benefits they provide**.

London green space study by Vivid Economics (2017)

Unlike the Barnet study above which focused on one borough within London (similar to a municipality in Metro Vancouver), this study included public parks in the entire metropolitan area of Greater London.

Benefit	Method	Strengths	Weaknesses
Health (physical & mental)	Avoided healthcare costs	Reliable and widely accepted method; uses reliable data on economic burden of physical inactivity.	This study faced a lack of evidence linking variation in access to parks to physical activity (which the authors addressed using sensitivity analysis).
Recreation	Travel cost method, using Outdoor Recreation Value (ORVal) tool	ORVal is a well-established and frequently used tool to calculate recreation value in the UK.	ORVal was created for the UK, so transferability to Vancouver may be limited.
Property premiums	Hedonic pricing	Reliable and widely accepted method; data on property prices usually relatively easy to attain.	May double-count other benefits e.g. aesthetic, recreation and health value.
Carbon storage	Calculation of carbon storage values in trees and soil, applied to non-traded carbon values	Used developed guidelines by the UK government's Department for Business, Energy & Industrial Strategy to get monetary values of carbon. The Government of Canada has similar carbon pricing guidelines as well (see 'data sources for Vancouver' under the Useful Resources section in this report).	
Temperature regulation	Avoided healthcare costs (by monetizing value of avoiding premature death)	Relatively easy to calculate.	Indirect way of measuring temperature regulation benefits.

Case study: Vancouver

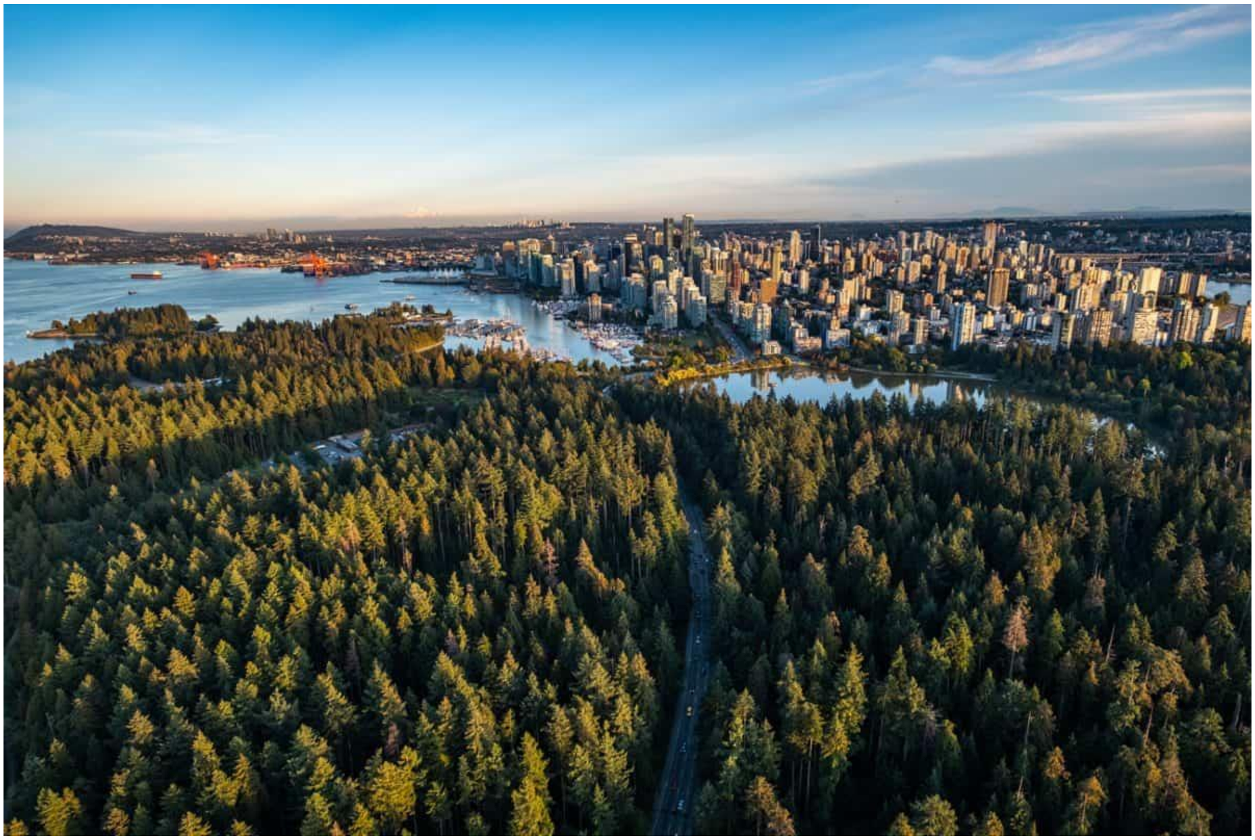


Figure 2: Aerial photo of Stanley Park and downtown Vancouver. (Photo credit: Tourism Vancouver)

Located on the west coast of Canada between the North Shore mountains to its north and the Fraser river delta to its south, Vancouver has often been heralded as one of the world's most beautiful cities. Unlike most cities, it offers uninterrupted public access along almost its entire seafront (City of Vancouver, 2020a), where users can enjoy views of the Burrard inlet in the foreground and the North Shore mountains in the distance. This accessible seafront stretches for 28km and houses many of Vancouver's popular beach parks, including Spanish Banks, English Bay and Kitsilano Beach. Moreover, few cities around the world boast as large an area of nearly completely isolated urban forest like Vancouver's Stanley Park, which sits on a peninsula stretching out from the downtown core. Vancouver's natural assets are thus unique and valuable, but their continued protection cannot be taken for granted.

Striving to strengthen Vancouver's commitment to sustainability and to become a global leader in addressing climate change, then Mayor Gregor Robertson launched the Greenest City Action Plan (GCAP) in 2010 to turn Vancouver into the "greenest city in the world" by 2020 (City of Vancouver, 2012). One of the GCAP's ten goals is to have all Vancouver residents living within a five-minute walk of a park, greenway or other greenspace. This goal was created in recognition of the physical and mental health benefits, as well as the biodiversity value, of urban greenspaces. Currently, 11% of the city's land area (11 497 ha) is parkland (Vancouver Park Board, 2019a), 38%

(482 ha) of which is natural area (Park People, 2020), which is commendable. However, in 2019 access to nature had only increased by 0.1% from the 2010 baseline, from 92.6% to 92.7% (City of Vancouver, 2019a), which suggests that bolder steps need to be taken to improve access. Moreover, this 92.6% value is calculated "as the crow flies" and does not account for how exactly people will walk to the park or greenspace. In reality, only 73% of residents live within a five-minute walk (Vancouver Park Board, 2018a). In 2019, park provision stood at 2 ha parkland per 1000 people, which was the lowest of 23 Canadian cities surveyed in Park People's Canadian City Parks Report (Garrett, 2019), though comparable to other dense cities like Montreal (2.4 ha per 1000 people) and Toronto (2.7 ha per 1000 people). With the population of Vancouver growingly rapidly at around 400 new residents every month, it is critical that every resident gets equitable access to the environmental, economic and social benefits of parks and greenspaces (Vancouver Park Board, 2019a).

Hence, this project supports the GCAP by providing a means for Vancouver Park Board to quantifiably value urban parks and thus support the protection and maintenance of such valuable spaces into the future. In particular, this project supports GCAP Goal 5 of Access to Nature (City of Vancouver, 2012), and the Healthy City Strategy Goals of Active Living & Getting Outside, and Environments to Thrive in (City of Vancouver, 2014).

Methodology

This project was conducted in three key stages: 1) literature review; 2) data collection; 3) proposal of valuation methodology. The first stage involved looking for existing guidelines and case studies of natural capital valuation of parks elsewhere in the world. A bottom-up approach was employed, i.e. first a search for case studies within British Columbia, then Canada, then USA, then the rest of the world, in order to collect data and case studies that would be most relevant and similar to Vancouver's context.

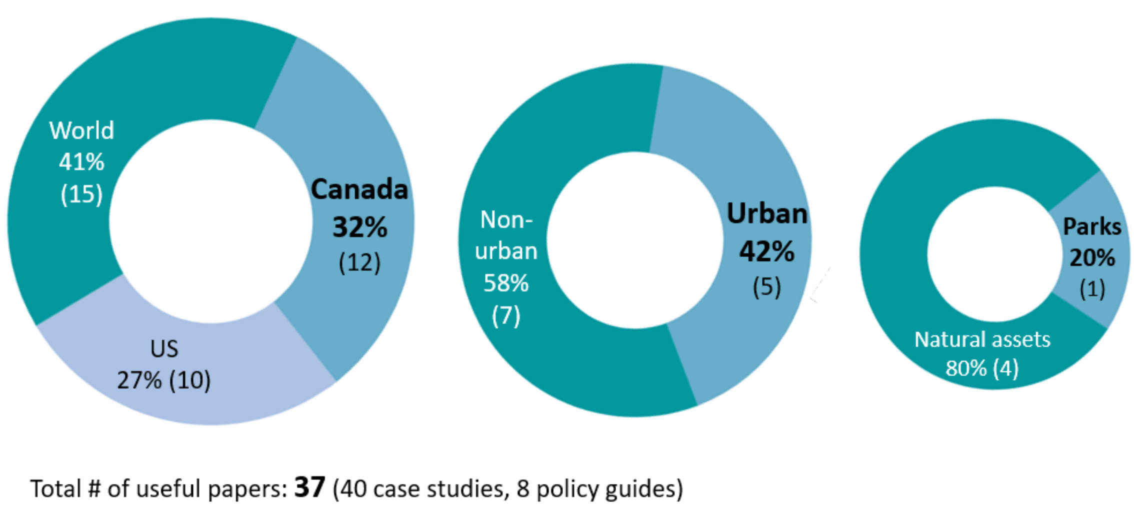
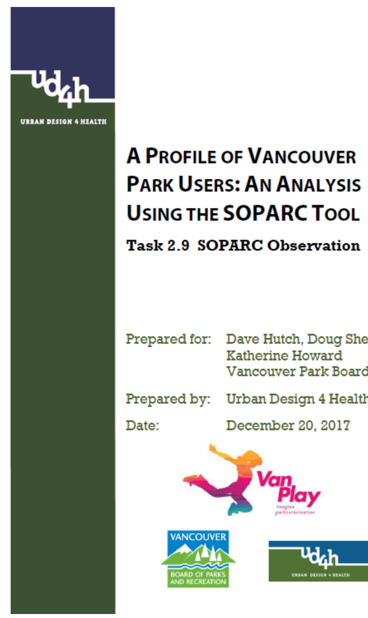


Figure 3: Overview of case studies reviewed, in numbers

The second stage included both primary and secondary data collection. Given the short time span of this project (3.5 months in total), most of the research was of secondary data sources, with primary research being used only to collect crucial information unavailable from secondary sources. Secondary sources included published government reports such as tourism and park recreation statistics, as well as data that Vancouver Park Board had previously collected and made available to the author internally. Primary data collection involved observing a set list of aspects in 30 parks around Vancouver on two weekdays and two weekends in June and July 2020. The aspects observed were selected based on factors that would affect the value of parks, adapted from Fox et al's 2017 'System of Observing Play & Recreation in Communities' (SOPARC) study of Vancouver's parks, and developed in consultation with Vancouver Park Board staff. These aspects are:

- Physical area
- Amenities available
- Degree of management
- Canopy cover
- Presence & type (if present) of water body
- Level of use ("snapshot" head count within a 10 minute timeframe)
- Cleanliness (litter, graffiti)

The detailed methods for primary data collection can be found in **Appendix 2**.


ud4h
URBAN DESIGN 4 HEALTH

A PROFILE OF VANCOUVER PARK USERS: AN ANALYSIS USING THE SOPARC TOOL

Task 2.9 SOPARC Observation

Prepared for: Dave Hutch, Doug Shearer, Katherine Howard
Vancouver Park Board

Prepared by: Urban Design 4 Health

Date: December 20, 2017

Figure 4: The SOPARC study of recreation use in Vancouver's parks.

The third stage was mostly an iterative process involving selecting a few benefits and methods to value them, testing out these methods, and further refining these methods. Both the selected benefits and methods were gradually modified based on the available data and the time and resources required to perform the calculations. Though seemingly tedious and repetitive, this process proved both necessary and valuable. Given the novelty of natural capital valuation in Vancouver's academic and political circles, the exploratory nature of this project was inherently necessary.

Scope & Limitations

Parks covered in this report only include all parks managed by Vancouver Park Board (VPB), that is, only municipal parks and not regional, provincial or national parks that may lie within the City of Vancouver's physical boundaries (e.g. Pacific Spirit Regional Park, which is managed by the regional government of Metro Vancouver). Based on VPB's Master Plan VanPlay (Vancouver Park Board, 2018a), there are currently over 230 municipal parks (Fig 5).

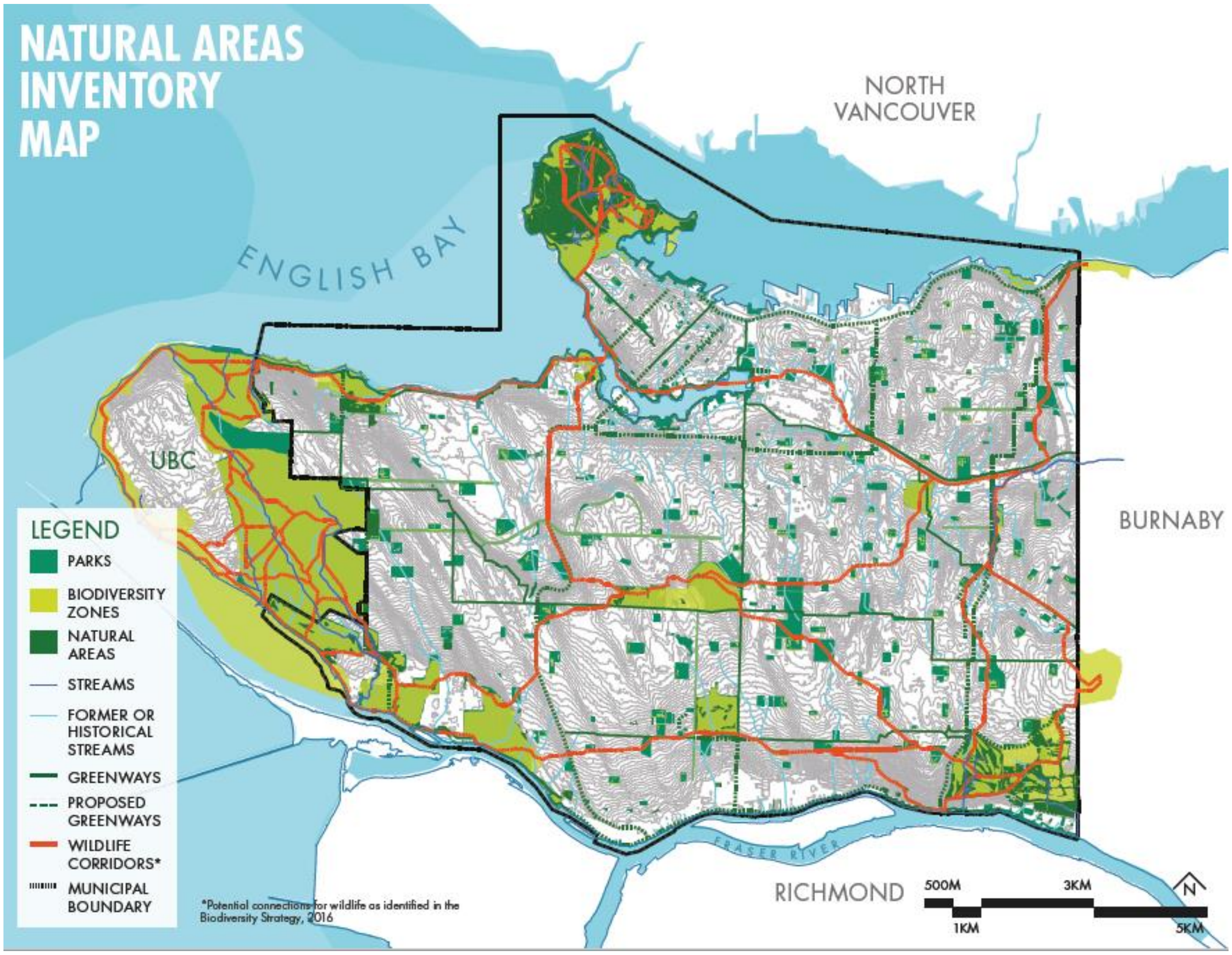
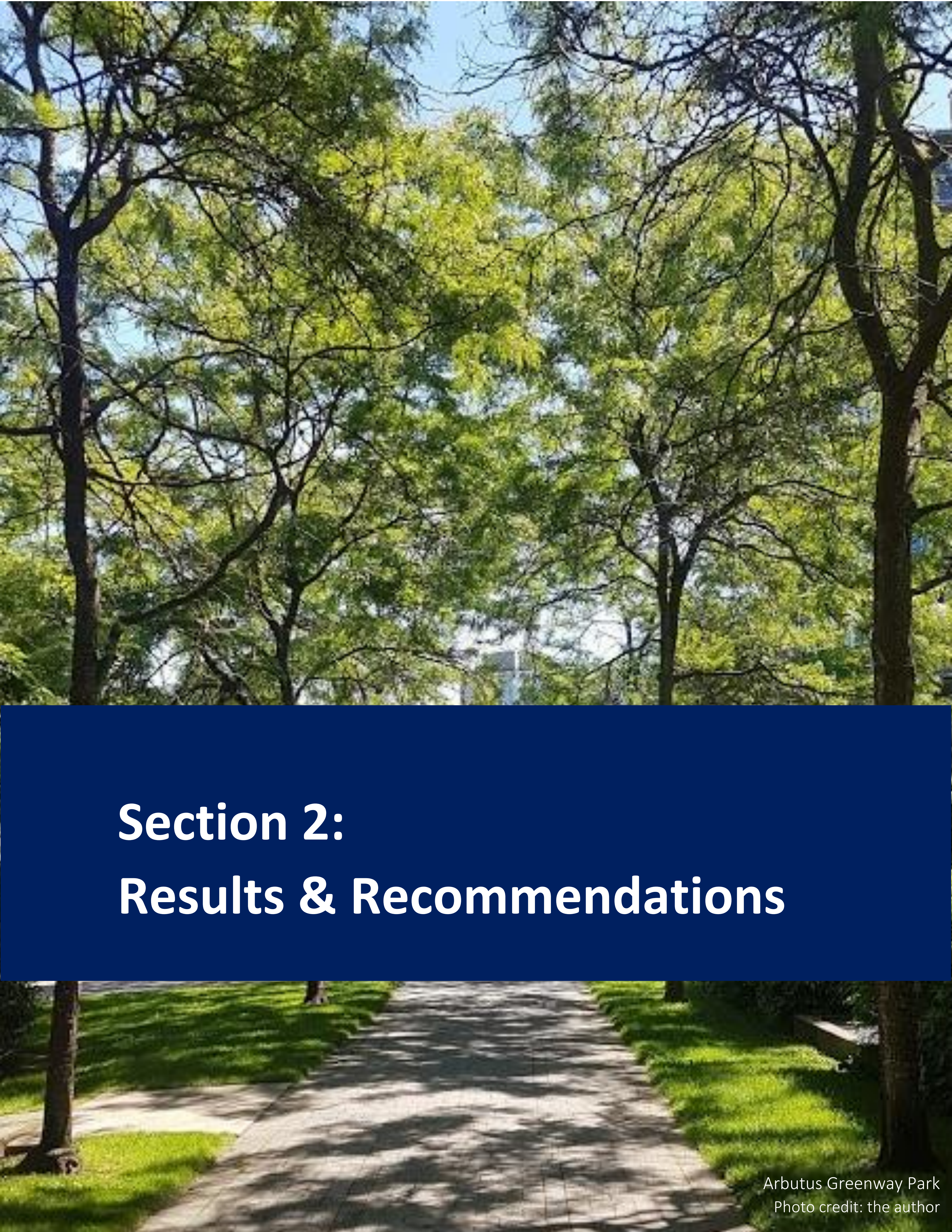


Figure 5: Map of Vancouver's natural areas, including parks. Extracted from Van Play Report 1 (Vancouver Park Board, 2018).

This report covers the proposed methodology and example calculations for four key benefits in detail: tourism, recreation, physical health, property premiums; and three benefits in brief: stormwater regulation, air quality, and temperature regulation. These seven benefits were chosen chiefly based on data availability. Data availability here refers to both accessibility of datasets as well as their usability for the calculations required. For example, data on the total number of visitors in destination parks would be less usable for calculating tourism value than data on the total number of visitors disaggregated into tourist visitors and local visitors. Similarly, data on the number of park users in a given park would not be usable for calculating physical health value unless this data includes specifics on the kinds of activity park users are engaging in, and the level of vigour involved in each activity. Hence, this report only includes example calculations for park benefits that have sufficient input data to perform calculations from. Moreover, because only some of the existing data fits the necessary calculations perfectly, adjustments and assumptions had to be made where data was lacking. Thus, the example calculations in this report present what is *possible* to be calculated given existing data, rather than what is necessarily the *most robust* method to measure the value of a given benefit. The reader is also encouraged to read each calculation method carefully to fully understand what the final values reflect.



Section 2:
Results & Recommendations

Arbutus Greenway Park
Photo credit: the author

Recommended Valuation Methods

This section covers the proposed methods that Vancouver Park Board might use to quantify the value of seven key benefits:

1. Tourism
2. Recreation
3. Physical health
4. Property premiums
5. Stormwater management
6. Air quality
7. Temperature regulation

Before delving into this section, it is important for readers to first understand what the results presented here imply and do not imply:

Firstly, the proposed methods and example calculations included are meant only to provide a range of possible options, and should not be added together to get a total economic value of Vancouver’s parks as there would be double counting in some areas and incomplete or unrepresented values in other areas. In order to calculate the total economic value of Vancouver’s parks, there is a need for much more nuanced data, which future researchers can aim to collect. For a list of data needed, readers may refer to the summary table on page 39.

Secondly, the values calculated by these valuation methods represent the gross value of parks, rather than the net value, since there are costs involved in park maintenance, operations and development as well. While it is common practice for natural capital valuation studies to calculate only the gross value, readers can refer to the eftec (2017) report on Barnet for an example where the economic value of their open spaces was compared against the cost of maintaining these spaces, and found the cost to be less than 10% of the benefits provided.

Moreover, the economic value of parks’ benefits is an annual value, akin to revenue, rather than asset value. Hence, the comparable value to other land uses (e.g. residential or commercial) would be the annual rental income achievable from that land use, rather than the property value. Therefore, to compare the value of park land to the 'opportunity cost' of it being sold on the residential or commercial market, one would need to add up the annual value over a number of years, and apply economic discounting to reflect the depreciation of the park’s value over time. In most cases, if we take the annual value of a park’s benefit (e.g. recreation) and multiply it by a 50 to 100 year asset life, then apply an economic discount rate, the ‘asset value’ of the park would be very high. For example, if we take the finding below that recreation use is valued at $31 million per year, and apply a 3.5% discount rate (a fairly standard rate), its asset value over a 50 year and 100 year period comes up to $753 million and $887 million respectively. If we then add the value of other park benefits, such as tourism, physical health, and air quality, the final asset value will be even higher, and very likely higher than the equivalent market value of a residential or commercial property. Hence, efficient management of urban greenspace, including funding for maintenance and enhancement of environmental assets, can provide a sustainable revenue stream of economic value through ecosystem service provision, which in many cases far outstrips the economic value, or opportunity cost, of the land as a residential or commercial asset (Kuyer, pers. comm., 2020). In BC Assessment's 2020 calculation of all of Vancouver's parks' equivalent property value, the total amount came to over $13 billion (note however that this figure is largely based on residential zoning and hence redevelopment potential, and is still undergoing internal review by the Park Board). Once sufficient data becomes available for future researchers to estimate the total asset value of Vancouver's parks (by applying the multiplication of annual value and applying the discount rate, as explained above), it would be useful to compare that value against the equivalent property value suggested by BC Assessment.

Finally, because the seven benefits covered in this report were chosen based on current available data, they do not necessarily represent the benefits that are the most important in Vancouver, or that VPB should focus on measuring. More rigorous analysis would need to be conducted for each benefit to determine what the most important or economically valuable benefits are. For a full list of the valuation methods that were considered for this study (which thereby informed recommendations here), the reader is invited to view **Appendix 3**.

Tourism

Tourism contributes one of the greatest sources of revenue for the City of Vancouver, generating approximately $4.8 billion in direct spending to the Metro Vancouver economy every year and supporting over 70,000 full time jobs (Tourism Vancouver, 2020). Although existing data on the demographics of visitors in Vancouver's parks is not split into tourists and locals, it is evident from tourism websites (e.g. Tourism Vancouver, Trip Advisor) and guidebooks (e.g. Lonely Planet, Rough Guides) that parks like Stanley Park and Queen Elizabeth Park, as well as the parks along the seawall, such as English Bay Beach Park and Sunset Beach Park, are popular tourist destinations.

Figure 6: Part of the popular seawall route in Stanley Park, a key tourist destination in Vancouver (Photo credit: Tourism Vancouver).

Figure 7: The off-leash dog park in Queen Elizabeth Park, another popular tourist destination in Vancouver. (Photo taken by the author in Jun 2020).

The tourism value generated by parks can be calculated indirectly via visitor spending attributable to parks. The most robust way to calculate this would be

Figure 8: Parks along the seawall, such as Kitsilano Beach Park, attract a high number of visitors especially in summer. (Photo taken by the author in May 2020).

to randomly survey a very large sample (at least a few thousand) of tourists in Vancouver, asking them for their main motivations for visiting Vancouver, main activities they engaged in while in the city, and their total expenditure during their trip (including both the cost of travelling here and their expenses during their stay). The attributable spend to parks can then be determined by finding out the proportion of their time and money spent during their trip on park-related activities. The UK study on 'ecosystem contribution to tourism and outdoor leisure' produced by eftec et al (2019) provides a relevant example of a possible methodology for doing so. In their study, they used data from a survey which asked respondents about the extent to which being able to undertake a given activity contributed to their decision to undertake that holiday trip and gave them scaled options from "sole reason" to "of no importance at all", then weighted each of these activities against the total number of activities undertaken during their trip. This method is highly recommended for Park Board's consideration in future, as it is robust and takes into account actual visitor motivations based on self-reporting.

In the absence of such survey data, however, as in the case of the current project, tourism spending attributable to parks can instead be estimated using assumptions from existing data. While not as robust as the method suggested above, this process can nonetheless give an indicative range of values, which can be tested and verified later as more data becomes available. The worked examples in Box 1 provide two possible methods of calculating tourism value of Vancouver's parks based on existing data.

Box 1: Example calculation of tourism value of Vancouver's parks

How this calculation works:

The calculations in this box work from the assumption that at least 15% of tourists (i.e. overnight visitors, not day visitors) to Vancouver are motivated by a desire to visit parks within the city. This 20% number was derived from a few sources pertaining to tourism in British Columbia or specifically Vancouver:

- Firstly, four out of the top 10 motivations of overnight visitors to British Columbia are nature-related (nature viewing (top reason), hiking (ranked 3rd), national/provincial parks (ranked 5th), and other outdoor recreation activities (ranked 10th) based on Destination BC's City Stays survey (2014; Fig 9). This suggests that nature-related activities constitute a popular motivation for tourists to Vancouver, even if "nature-related" does not equate to "park visits", and provincial or national parks would probably attract more visitors than city parks. If we add up the percentage of all visitors motivated by those four reasons (a detailed breakdown can be found in the City Stays survey), we get 62%. If we then multiply that by 25% to avoid double counting, the percentage comes up to 15%, suggesting that the attribution factor would be in the range of 15%.

- Secondly, Stanley Park alone receives 8 million visitors annually (Tourism Vancouver, 2020a), while the City of Vancouver receives 11 million visitors annually (Tourism Vancouver, 2020b). [4] Queen Elizabeth Park, arguably the second most popular destination park in Vancouver, receives 6 million visitors annually according to a Travel US News report (2020).[5] 8 million or 6 million divided by 11 million equates to 72% and 55% respectively, which is much higher than 15%. Moreover, this calculation does not include tourists visiting the parks along the seawall and False Creek area (e.g. English Bay Beach, Sunset Beach, Hinge Park), which is another of Vancouver's highly popular tourist destinations. At the same time, these visitor numbers reflect every individual who went to Stanley Park and/or Queen Elizabeth Park without necessarily basing their decision to visit Vancouver on a desire to visit those parks. Hence, to be conservative the attribution percentage should probably fall at the lower end of the range between 15% to 72%.

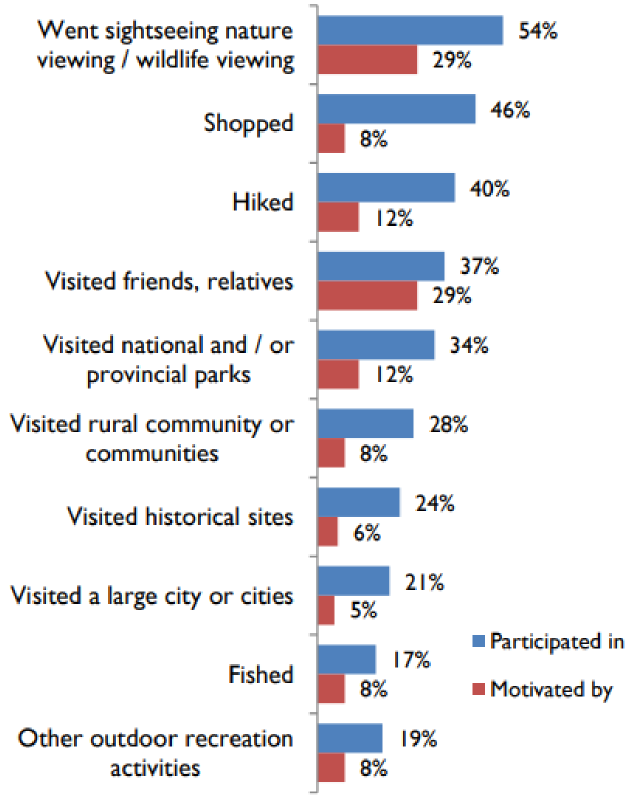


Figure 9: Top 10 activities among visitors to British Columbia (Source: DestinationBC, 2014)

- Finally, the 15% was cross-checked against the attribution factor used in the Trust for Public Land studies. The attribution factor was between 5% for San Diego (Trust for Public Land, 2009), 15% for San Francisco (Trust for Public Land, 2014), and 10% for Boston (Trust for Public Land, 2008), with the authors of the San Francisco and Boston studies stating that the percentage was conservative.
- Given the range of possible attribution percentages above, to keep the calculation conservative the final attribution percentage decided upon was 15%.

[4] Although the website does not specify whether these "visitors" to Stanley Park include only tourists or both tourists and locals, it is safe to assume that these are tourists since the number is published on a tourism website.

[5] No data published by a City of Vancouver or Canadian source could be found specifically for Queen Elizabeth Park tourist numbers, hence the use of a US source. Again, the number is assumed to be of tourists only and not a combination of tourists and local visitors, since it is a tourism website.

Data for the calculations below come from various sources:

- Market research on tourism within the city of Vancouver, conducted by Tourism Vancouver (ongoing)
- City Stays survey conducted by DestinationBC (2014)
- Vancouver, Coast and Mountains regional tourism profile by DestinationBC (2017)

Calculation process:

Method 1: using total no. of overnight visitors to Vancouver per year

- Total no. of overnight visitors to CoV per year is on average 11 million (Tourism Vancouver, 2020).
- Assume that overnight visitors only visit a park on one day of the entire trip.
- Average spending per overnight visitor per night was CAD $111 in 2014 (Destination BC, 2017). Adjusted to 2020 value based on the Bank of Canada's inflation calculator = CAD $120.09.
- Apply assumption of 15% attribution to parks.
- Therefore, total visitor spending attributable to parks = 11 million * CAD $120.09 * 20% = **~CAD $198 million per year**

Method 2: using total no. of non-local visitors to Stanley Park and Queen Elizabeth Park per year

- Total no. of visitors to Stanley Park per year = ~8 million (Tourism Vancouver, 2020)
- Total no. of visitors to QE Park per year = ~6 million (Travel US News, 2020)
- Assume that at least half of the QE Park visitors also visit Stanley Park, and omit them from the calculation to avoid double counting. Thus visitors to be included = (8 + 6) – (6 / 2) = 11 million visitors.
- Like Method 1, assume that overnight visitors only visit a park on one day of the entire trip.
- Average spending per visitor per night = CAD $120.09.
- Therefore, total visitor spending attributable to parks = 11 million * CAD $120.09 = **~CAD $1.3 billion per year**

Method 2 assumes that the majority of the visitors who visit Vancouver's parks visit either Stanley Park and/or Queen Elizabeth Park, the top two destination parks. Compared to Method 1, this may reflect tourist visits to parks more accurately (if the assumption that numbers provided on the tourism websites indeed reflect only tourist and not local visits) uses actual numbers of park visitors rather than an assumed 20% proportion out of total tourist numbers. However, this method includes everyone who visited the two parks regardless of whether their decision to visit Vancouver was *dependent* on the parks, thus giving a much higher final value than Method 1. If one is interested in knowing only the attributable spending of tourists who came to Vancouver solely or primarily because of parks, Method 1 would be more accurate, especially if more data is available to determine the attribution percentage. Finally, Method 2 is also less complete as it excludes all other parks in Vancouver. Given the two methods, it is safe to estimate that the tourism value of Vancouver's parks lies in between the two final values, i.e. between $198 million per year and $1.3 billion per year.

Recreation

Urban parks provide a popular spot for all levels of recreational activity, from sitting and picnicking to high-intensity exercise, and for all group sizes from individuals to families to large gatherings or team sports. One common way to estimate recreation value is the "willingness to pay" method. This method is often used to quantify the value of ecosystem services that people can tangibly experience, e.g. landscape views, recreational use. Data is usually collected via "stated preference" surveys that pose hypothetical scenarios involving the valuation of various alternatives (e.g. a view of a forest vs. beach vs. urban site), where the difference in participants' stated costs for the different options reflects the price premiums they are willing to pay for a more desirable option (ACT, 2020; Brown & Mooney, 2013). It is also important to note that recreation value should apply only to local users not tourists, since the value of parks attributable to tourists would have been calculated under the 'tourism' component.

In the absence of survey data, however, the value of each park visit can be estimated using market pricing of the equivalent usage in a private facility. This is called the "unit value" method, which was used in the Trust for Public land studies in the US. For instance, running on a track would be free in a public park, but cost $3 in a gym; playing tennis in a tennis court would cost $3 in a public park but $5 in a private court. Park users' "willingness to pay" can be assumed to be the difference between the private and public prices (Harnik & Welle, 2009). Hence, this value ultimately represents cost savings by the user.

In the Trust for Public Land studies, the method they adopt for calculating recreation value splits park usage into three categories: general park use, sports facilities, and special uses (Table 3).

Table 3: The value of recreational use in San Francisco parks, calculated by adding up the value of three categories of usage: general use, sports facilities use and special uses (Trust for Public Land, 2014), The same method is adopted across the Trust for Public Land studies.

FACILITY/ACTIVITY	PERSON-VISITS	AVERAGE VALUE PER VISIT	VALUE
General park use (playgrounds, trails, dog walking, picnicking, sitting, etc.)	52,876,548	$1.92	$101,657,864
Sports facilities uses (tennis, team sports, bicycling, running, etc.)	18,862,433	$5.02	$94,695,216
Special uses (fishing, kayaking, gardening, festivals, concerts, attractions, etc.)	3,631,015	$4.28	$15,551,319
Total			**$211,904,399**

For Vancouver, the Trust for Public Land's method needs to be adapted because the existing datasets do not cleanly disaggregate Vancouver's park users into these three categories. Currently, there is data on number of park users and their activity types in selected parks from the 2017 SOPARC survey (Fox et al, 2017) and data on number of bookings for facilities with booking fees across all of Vancouver's parks for at least the last five years (Activenet data available internally within Park Board's server). However, the number of users from these two datasets cannot simply be added together as there would be overlaps and thus some double counting.

Thus, the example calculation below adapts the Trust for Public Land's method to fit data from the existing SOPARC survey. This survey noted the number of park users engaged in three levels of activity (sedentary, moderate and vigorous) in 24 parks around Vancouver on two sunny weekdays and two sunny weekends in the summer of 2017. Of the 24 parks, there were eight of each park type (community, neighbourhood and local). These park types follow the Park Board's park classification of all 230+ parks into five categories depending on size, popularity, how far away users tend to travel from, and number of amenities (Table 3).

Table 4: Park classification of Vancouver's parks (Source: Vancouver Park Board, 2019a)

	CRITERIA	EXAMPLES	#	PERCENT
Destination	• Large in size (>20 hectares) • Large number of amenities (>15); venue for events, concerts, weddings. • Attracts tourists and populations from the region, in addition to local residents • Maintained at a higher level to meet user expectations, keep up with higher use and to ensure space is suitable for programming	Stanley Park Queen Elizabeth Park Hastings Park	5	44%
Community	• Medium to large in size (< 20 ha, average of 6.4 ha) • Large number of amenities (6-15); includes sports hubs and beach parks • Attracts populations from across the City of Vancouver	John Hendry Park English Bay Beach Park	101	22%
Neighbourhood	• Medium in size (<10 ha, average of 2.6 ha) • Medium number of amenities (3-7) • Attracts neighbourhood residents	Maple Grove Park Aberdeen Park	50	31%
Local	• Small in size (<2.5 ha, average of .54 ha) • Select amenities, mostly passive (four or less) • Attracts neighbourhood residents	Ash Park Foster Park	63	2%
Urban Plaza	• Small in size (less than .4 ha) • Select amenities (three or less); low in landscape cover • Located in areas with high day-time population - attracts daytime users	Pioneer Place Yaletown Park	9	<1%

Figure 10: Balaclava Park, an example of a community park with various amenities including two large open fields, a running track, a playground, a fieldhouse. (Photo taken by the author in Jun 2020).

Figure 11: Devonshire Park, an example of a neighbourhood park with few amenities and nested deep within a suburb. (Photo taken by the author in Jun 2020).

Box 2: Example calculation of recreation value of Vancouver's parks

How this calculation works:

This worked example calculates the total recreation value of all of Vancouver's community, neighbourhood and local parks as well as the three public golf courses per year. It aims to calculate the recreation value for local users, not tourists. Destination parks were excluded because a large proportion of their users are likely to be tourists, whose contribution to park value would have been calculated in the tourism value component and should be excluded from the present calculation. Urban plazas were also excluded from this study because of the lack of detailed data on user numbers. Furthermore, urban plazas are small (<0.4 ha), have fewer than three amenities, and are low in landscape cover, and only constitute nine out of the 230+ parks in Vancouver, implying that their contribution to total number of park users would be small. Given that community, neighbourhood and local parks constitute 93% of the number of parks in Vancouver, and are the most likely among the five park categories to attract local residents for recreation, data from only these three park categories was deemed sufficient for the present calculation. Moreover, the inclusion of only these three park categories allows for data to be easily transferred from the SOPARC survey results.

Recreation types for parks are divided into two categories: sedentary and active, and follow the coding used in the SOPARC survey. Sedentary activities include lying down, sitting, or standing. Active use includes both moderate activities (i.e. walking) and vigorous activities (e.g. brisk walking, running, team sports, weight-lifting and other activities typically classified as sports or exercise). These activities can take place for "free" (i.e. the user does not pay an upfront fee) in park areas like open fields and running tracks, or with a small booking fee for facilities like tennis courts, baseball diamonds, volleyball courts, basketball courts, artificial turf and other sports facilities.

For golf courses, all activity was calculated using Park Board's data on average annual rounds (Vancouver Park Board, 2019b); hence, there was no distinction in activity types for golf courses.

Calculation process:

Step 1: Determine the total number of users per day for each activity type and for each park type.

The SOPARC survey provides data on the total number of users over four days in eight community parks, eight neighbourhood parks, and eight local parks. It also disaggregates the number of park users by level of activity (sedentary, moderate and vigorous). Hence, we can get the average number of users per activity type per day for each park type. However, the SOPARC survey was only conducted on sunny days in summer, and the number of users can reasonably be expected to be lower on non-sunny summer days and during other seasons. Hence, for this calculation, the number of users on non-sunny days in summer and on all days in other seasons was indirectly derived from other data sources. From the author's observations of park visitor numbers during primary data collection, the number of park users on a non-sunny summer day appeared to be on average 40% of the number on a sunny summer day. For winter usage, data from Gehl's study of three downtown parks in Vancouver: English Bay Beach, Yaletown Park and Cathedral Square suggests that the number of users in winter is on average 24% of the number in summer (Gehl, 2018). We can thus apply the 40% and 24% to the average number of users on sunny summer days to get the average number of users on non-sunny summer days and both sunny and non-sunny days in other seasons. To keep the calculations simple, we can combine spring and summer into one category, and fall and winter into one category.

	No. of sedentary users per day				No. of active users per day			
Park type	Summer / Spring sunny	Summer / Spring non-sunny	Fall / Winter sunny	Fall / Winter non-sunny	Summer / Spring sunny	Summer / Spring non-sunny	Fall / Winter sunny	Fall / Winter non-sunny
Community	262	105	63	25	177	71	43	17
Neighbourhood	66	26	16	6	48	19	11	5
Local	10	4	2	1	9	4	2	1

Step 2: Determine the total number of users per year for each activity type and for each park type.

The total number of users per year for each activity type and park type can be calculated by multiplying the per-day user numbers by the estimated number of such days in a year.

Using the average percent of sunshine per month, we can estimate the number of sunny and non-sunny days in each season. According to the Weather and Climate website (2019), the average percent of sunshine in spring and summer (i.e. April to September) is 50% while the average percent of sunshine in fall and winter (i.e. October to March) is 30%. Applying these percentages to the number of days in each season, we get:

- Average number of sunny days in spring & summer in Vancouver per year = 50% * 183 = 91.5
- Average number of non-sunny days in spring & summer in Vancouver per year = 50% * 183 = 91.5
- Average number of sunny days in fall & winter in Vancouver per year = 30% * 182 = 54.6
- Average number of non-sunny days in fall & winter in Vancouver per year = 70% * 182 = 127.4

Hence, the total number of users per activity type per park type is as follows:

Park type	Total no. of sedentary users per year	Total no. of active users per year
Community	40185	27220
Neighbourhood	10050	7336
Local	1501	1381
Golf courses	0	53333

Step 3: Determine the average value of each activity type.

The average value of an active park visit was estimated using the average cost of using a private gym in Vancouver, and then using the assumption that a park user would be willing to pay at least 50% of the cost of doing the same exercise in a private facility. The author acknowledges that not all types of active recreation use in a park can be replaced in a gym (e.g. team sports). However, the cost of a private gym visit is used as the average value here for simplicity in the calculation process. The average cost of a low- to mid-range gym membership in Vancouver = CAD $50/month (Money Coaches Canada, 2019; corroborated against membership prices listed on the website of popular gyms like Anytime Fitness and Spartacus Gym). If we assume that each gym user goes to the gym an average of twice a week, for the entire year, the cost of each gym visit = CAD $50/8 = CAD $6.25. Hence, we will assume that park users are willing to pay at least CAD $6.25 / 2 = CAD $3.13 per visit for active recreation.

The average cost of a sedentary park visit was estimated by transferring values from the Trust for Public Land's studies. For San Francisco, this value was USD $1.92 (Trust for Public Land, 2014); for San Diego it was USD $1.91 (Trust for Public Land, 2009); when adjusted to 2020 values and converted to CAD this value becomes CAD $2.80.

While the facility standards may not be equal, the average cost of a round of golf in Vancouver is approximately CAD $80 in a private course (Vancouver Sun, 2016), and CAD $28 in a public course (Vancouver Parks Golf, 2020).

Step 4: Multiply the number of users by the average value of each visit.

Park type	Total no. of sedentary users per year	Average value per sedentary use	Total value of sedentary use per year	Total no. of active users per year	Average value per active use	Total value of active use per year
Community	40185	$2.80	$112,519.20	27220	$3.13	$85,063.19
Neighbourhood	10050	$2.80	$28,139.87	7336	$3.13	$22,925.26
Local	1501	$2.80	$4,202.18	1381	$3.13	$4,315.34
Golf course	0	$0.00	0	53333	$52.00	$2,773,333.33

Step 5: Add the value of sedentary use to value of active use for each park type.

Park type	Total value of sedentary use per year	Total value of active use per year	Total value of use per year
Community	$112,519.20	$85,063.19	$197,582.39
Neighbourhood	$28,139.87	$22,925.26	$51,065.13
Local	$4,202.18	$4,315.34	$8,517.53
Golf course	0	$2,773,333.33	$2,773,333.33

Step 6: Multiply the total value of use in each park type by the number of such park types.

Park type	Total value of use per year	Total no. of parks of this type	Total value of all parks of this type
Community	$197,582.39	101	$19,955,821.55
Neighbourhood	$51,065.13	50	$2,553,256.30
Local	$8,517.53	63	$536,604.21
Golf course	$2,773,333.33	3	$8,320,000.00

Step 7: Add the values for all the park types together.

Park type	Total value of use per year	Total no. of parks of this type	Total value of all parks of this type
Community	$197,582.39	101	$19,955,821.55
Neighbourhood	$51,065.13	50	$2,553,256.30
Local	$8,517.53	63	$536,604.21
Golf course	$2,773,333.33	3	$8,320,000.00
Total			***$31,365,682.06***

Therefore, the total recreation value of all parks in Vancouver is **at least CAD $31 million per year.**

Figure 12: According to Vancouver Park Board's SOPARC study in 2017, majority of park users engage in sedentary activities like sitting, standing, or lying down. (Photo taken by the author in June 2020).

Figure 13: Some of the highest use parks are in the Downtown Urban Core, such as David Lam Park. (Photo taken by the author in June 2020).

It should be noted that the methods used to calculate recreation above are kept simple and straightforward for the sake of feasibility within this project's scope. For future studies with similar time and resource constraints, researchers can apply similar methods as they are sufficient to give an indicative economic value of individual parks based on Park Board's existing categorization of parks, and they approximate published studies like those by the Trust for Public Land. However, for a more rigorous calculation, future researchers can consider factoring in more aspects that would influence park values, such as amenities available (e.g. washrooms, food & beverage outlets, community centre), noise level, safety level (e.g. lighting, openness), and level of management (e.g. natural vs manicured). A simple index could be developed where factors are weighted and values added or reduced based on a linear or logarithmic scale. Note that such a method would be more useful at the local scale, i.e. valuing individual parks, rather than for an entire park network. Moreover, future researchers should also take into account diminishing returns from repeated park usage (that is, a user gets less pleasure or reward from using a park for the fourth time in a week compared to the first). Thus, calculations should include a factor to correct for diminishing value (see the Trust for Public Land's San Francisco study in 2014 for example).

Physical health

Urban parks offer valuable space for residents to engage in physical activity, which can translate to improved physical health. Various studies have even shown a correlation between proximity of one’s residence to a park and level of physical activity (Cohen et al, 2007; Han et al, 2014; Kaczynski et al, 2009). At the same time, the economic burden of physical inactivity has been well documented at various scales, from the international scale (e.g. World Health Organization 2018) to the national scale (e.g. Katzmarzyk et al, 2004; NICE, 2020; Pratt et al, 2014) and the city scale (e.g. Bird, 2004).

Figure 14: Parks provide space for residents to engage in various forms of exercise. From left to right: a group of men play soccer in Andy Livingstone Park; two boys play badminton in John Hendry (Trout Lake) Park; a jogger and two cyclists along the seawall route in Stanley Park. (Photos taken by the author in 2019-2020.)

Hence, the economic value of parks for physical health can be calculated via the “avoided healthcare cost” method, which measures the cost savings to both residents and their healthcare system from using parks for exercise. This is the most common method for valuing the health benefit of urban parks, and has been used in many precedent studies including the Barnet London study (eftec, 2017), the Trust for Public Lands studies (2009 to 2018), and the London green space study (Vivid Economics, 2017). It is important to note that this method assumes that these park users would not physically exercise in the absence of parks, which might not be true (for example, they may exercise at home or in a private facility instead). At the same time, it is conceivable that at least some of these park users are more motivated to exercise than they otherwise would without the availability of open spaces, greenery, fresh air and other associated benefits of public parks. Hence, this method reflects the health benefits supported by public parks and is considered acceptable for accounting purpose (eftec, 2017:36).

According to the British Columbia Centre for Disease Control (BCCDC, 2018), physical inactivity contributed $983 million (13%) to the economic burden in British Columbia in 2015, with the average cost of inactivity per person being $595. In the same report, approximately 37.5% of the population in Vancouver was considered physically inactive. Here, being physically active means meeting the minimum requirement of 150 minute of moderate exercise per week, or 75 minutes of vigorous exercise per week (City of Vancouver, 2018). Using these statistics on physical activity amongst Vancouverites, along with data on Vancouverites' park usage, we can arrive at a reasonable estimate of the avoided healthcare costs from Vancouverites using parks to meet their physical activity requirements.

Box 3: Example calculation of physical health value of Vancouver's parks

Calculation process:

- Average cost of physical inactivity per person: CAD $595 in 2015 (BCCDC, 2018). Adjusted to 2020 using the Bank of Canada's inflation calculator = CAD $638.14.
- Percentage of Vancouver residents who meet weekly recommended physical activity requirements: 62.5% (BCCDC, 2018) or 45% of adults (City of Vancouver, 2018).
- To date, the percentage of these residents who use parks and green spaces for their physical activity has not been directly calculated yet. However, we can estimate this percentage from other relevant sources or use transfer values from studies in comparable cities elsewhere. For example, a factsheet on social trends and activities in Vancouver indicated that more than 30% of Vancouverites used a Park Board facility or program in 2013. The Barnet, London study (eftec, 2017) reported that 50% of Barnet's physically active residents use parks and green spaces for their exercise. In Los Angeles, 28% of residents reported using parks as their main place of exercise (Cohen et al, 2014). Using these numbers as a benchmark, we can conservatively estimate that at least 25% of Vancouverites use parks to engage in physical activity.
- Population size of Vancouver in 2020 = estimated 660 000 (based on 2016 census and growth rate of 4.6%; Statistics Canada, 2017)
- Total number of Vancouver residents who use parks to keep physically active = 25% * 45% * 660 000 = 74 250
- Therefore, total avoided healthcare costs per year from Vancouverites using parks to stay physically healthy = 74 250 * CAD $638.14 = **at least CAD $47 million**.

Property premiums

There has been extensive research on the effect of proximity to parks on property value. Living close to a park can provide scenic views, access to a recreational space, cleaner air, and reduced traffic noise. Hence, it is unsurprising that these benefits would be reflected in property value uplifts. In 2004, John Crompton captured this theory in a book entitled *The Proximate Principle: The Impact of Parks, Open Space and Water Features on Residential Property Values and the Property Tax Base.* In it, he drew evidence from over 30 empirical studies in the USA since the 1930s to show that residential property prices increase with decreasing distance to parks. Since then, many other studies have supported this theory. For example, Brander and Koetse (2011) found from a contingent valuation study that housing prices can increase by about 0.1% when located 10 metres closer to an urban greenspace. Another study in Hong Kong showed that neighbourhood parks could increase property values by 16.88% (Jim & Chen, 2010). At the same time, undesirable characteristics of parks, such as homelessness or drug and alcohol usage, can also decrease property values.

The property uplift value generated by parks is usually measured using the hedonic pricing method. This method involves estimating the economic values of given ecosystem services that directly affect the quality of a property, which is reflected in the property's price (Barton & Madsen, 2017). The Barnet, London study used a property uplift value of 3% for non-residential properties and 5% to 10% for residential properties within a 300 metre radius around a greenspace (eftec, 2017), whilst the Trust for Public Land studies use an average value of 5% for all housing properties within 500 feet (approximately 150 metres) of parks (e.g. Trust for Public Land, 2009), and did not calculate property premiums for non-residential properties.

For Vancouver, the hedonic pricing method can be applied relatively easily once all the necessary data has been collected. This report does not contain a worked example due to inaccessibility to data on property prices, but researchers who have access to that data can calculate the impact of Vancouver's parks on property values via the following steps:

Step 1: Using Geographic Information Systems (GIS) or other mapping software, identify all properties within a 150 metre radius from a park.

Step 2: Obtain the total assessed value of these properties (from BC Land Assessment data).

Step 3: Apply the average property premium of 5% to the total assessed value.

Step 4: Apply the effective annual property tax rate to the amount calculated in Step 3. This gives the total annual property tax capture from value of property attributable to parks.

It is important to remember that property premiums tend to reflect benefits to the seller and not the buyer, the public, or the government, because the increased property value realistically creates wealth only for the seller. However, benefits to the government can be calculated through the property tax revenue, which is how the Trust for Public Land studies framed this benefit. Another caution is that some of the value reflected in them may double-count other benefits, such as aesthetic, health, and recreational value that the property owner expects to receive by living close to a park (eftec, 2017). Hence, readers should be aware of this possibility when interpreting values.

Stormwater management

Parks can help to regulate urban stormwater flows via two ways. Firstly, they increase the perviousness of the ground cover compared to paved streets, parking lots, and building surfaces. Vegetation within parks can intercept and absorb rainwater, thus reducing the volume reaching the ground and generating runoff. Greenspace in parks also promote infiltration, thereby reducing the volume and rate of runoff as well. This helps to decrease the likelihood of flooding in urban areas. Secondly, plants act as a natural filter against pollutants that may be picked up by rainwater flowing over impervious surfaces. In cities where this runoff flows directly into waterways, such pollution can significantly disrupt aquatic ecosystems (Trust for Public Land, 2009). In cities where this runoff is combined into the same sewer system with household, industrial and commercial wastewater and channeled into a sewage treatment facility, there is often a risk of overflow during heavy rains, leading to untreated water polluting waterways as well. Most areas within Vancouver have a combined sewer system and are thus susceptible to the latter problem (City of Vancouver, 2020c).

The economic value of stormwater management by parks can thus be calculated by the avoided costs of building and maintaining engineered stormwater treatment facilities. This requires data on the perviousness of parkland compared to the rest of the city, the total area of each surface type, the cost of managing stormwater in treatment facilities, and the volume of rainfall within the city. The Trust for Public Land studies used a stormwater retention model developed by the US Forest Service for their calculations. The technical details of the model can be found in the Boston report (Trust for Public Land, 2008), which may be considered for use in Vancouver.

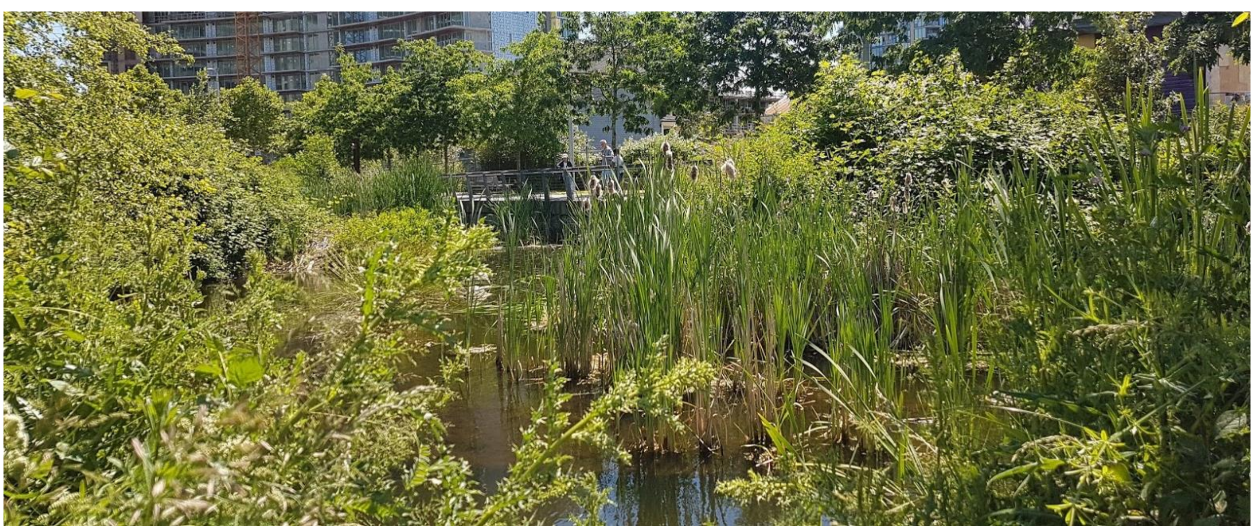


Figure 15: This wetland feature at Hinge Park helps to regulate stormwater flows and capture pollutants from runoff before draining into the Burrard inlet. (Photo taken by the author in Jun 2020).

Air quality

Urban environments often experience significant levels of air pollution from vehicular transport, domestic electricity usage, and industrial activities. The resulting effect on health and productivity can be costly. On the other hand, vegetation within parks can remove air pollutants such as nitrogen dioxide, sulphur dioxide, carbon monoxide, ozone, and particulate matter (Zupancic et al, 2015), thus reducing the associated healthcare costs and costs of removing these pollutants via other means (Tempesta, 2015).

There have been various attempts to monetise the costs of individual air pollutants using models. For example, a study of a forested urban park in Toronto used the Street Tree Resource Assessment Tool for Urban Forest Managers (STRATUM) model (Millward & Sabir, 2011), while the Trust for Public Lands studies use the Urban Forest Effects (UFORE) model developed by the US Forest Service (see for example Trust for Public Land, 2014). For Vancouver, more analysis of the usability of either of these models is needed before deciding on a valuation method for parks here. Nonetheless, future researchers may use these studies as a starting reference.

Temperature regulation

Figure 16: Trees provide shade on warm summer days, and can double up as prime picnic spots. (Photo taken by the author in George Wainborn Park, Jun 2020).

Street trees, parks and other greenspaces within a city can help to cool temperatures and mitigate the urban heat island (UHI) effect. Trees help to sequester carbon from the atmosphere and store it in the form of biomass. They also provide shade over pavements, buildings, and the ground. For instance, Doick et al (2014) found that a large (111 hectares) park in London, UK, generated cooling effect in the evenings from 20 metres to 440 metres beyond park boundaries. An oft-cited study in Addis Ababa showed that the temperature dropped by 0.02°C for every percent increase in tree canopy cover in parks (Feyisa et al, 2014). Wilby (2003, p.259) also writes that "urban parks and bodies of water can create `cold islands' within the thermal landscape". With the City of Vancouver's Council declaring a Climate Emergency in 2019, actions such as greenspace protection can go a long way in addressing rising temperatures and reducing heat stress.

The ways in which previous studies have measured the economic value of parks' temperature regulating benefits are varied. Two common methods are avoided healthcare cost and avoided energy cost. The first method involves estimating the healthcare costs associated with heat stress and related health impacts, and attributing the possibility of avoiding these costs to the reduction in temperatures by urban parks. This was the method used in the London study by Vivid Economics (2017), and provides a simple and straightforward way of putting a dollar value on this benefit. However, this is a highly indirect method of measuring temperature regulation, and evidence of the links between parks and heat-related health burdens is still lacking (Zupancic et al, 2015). Hence, this method should be used with caution. The second method involves estimating the cost of using energy cooling facilities (e.g. air-conditioning, fans), and again attributing the ability to avoid these costs to the reduction in temperatures by urban parks. For this method, the Trust for Public Land's white paper on quantifying the relationship between greenhouse gas emissions and urban greenspaces can provide useful guidance (see Groth et al, 2008). More analysis is needed before making recommendations for Park Board's usage.

Summary of recommended methods for Vancouver

Park benefit	*Recommended method*	*Strengths of method*	*Limitations of method*	*Data needed*	*Data availability (Yes / No / Partial / Maybe)*	*Remarks on data (source, edits needed)*	*Next steps needed*	*Precedent / Reference studies*
Tourism	Attributable tourist spending	Relatively straightforward Minimal additional data needed	Accuracy of calculations depends highly on quality of data on tourist motivations. Survey participants tend to over-report desirable behaviour.	Survey data on extent to which urban parks contribute to tourists' decision to visit Vancouver	Partial	Current data on tourist motivations is not specific to city of Vancouver	Collect survey data on extent to which urban parks contribute to tourists' decision to visit Vancouver	Trust for Public Lands studies in the US
				Total number of tourist visits to Vancouver per year	Yes	Tourism Vancouver	-	
				Total number of tourist visits to Vancouver's parks	Partial	Current data on visitor numbers in parks doesn't include all parks, and doesn't disaggregate tourists and locals	Estimate the proportion of tourist vs local visitors within each park through visitor surveys	
Recreation	Unit day value	Relatively straightforward (once unit values are determined)	Multiple factors affecting cost of private and public facilities, making comparison difficult. Data from multiple sources needed, reducing accuracy.	Relative cost of the same recreational activity in a private facility vs public park	Yes	Rental/booking fees can be found online for both private and public facilities	Estimate the unit value for "free" park uses (i.e. those that do not require rental fees)	Trust for Public Lands studies in the US
	Stated preference / Willingness to pay	Established & commonly used method	Subjectivity of participants' responses	Survey data on park users' willingness to pay for various recreation uses	No	No known surveys conducted for Vancouver park users thus far	Collect survey data on park users' willingness to pay for various recreation uses	
Physical health	Avoided healthcare costs	Established & commonly used method	Data on % of residents who use parks and green spaces for their	Direct costs of inactivity and associated healthcare	Yes	The Economic Burden of Risk Factors in British Columbia, by the BC	Review current calculations	Trust for Public Lands

		Relatively straightforward to calculate Data on economic costs of inactivity already available & up to date	physical activity not directly available now	costs (average cost per person)		Centre for Disease Control (2018)	Update calculations yearly based on latest data	studies in the US Barnet, London, UK study
				Percentage of Vancouver residents who meet weekly recommended physical activity requirements	Yes	My Health, My Community survey results of Vancouver residents (2013-14)		
				Percentage of these residents who use parks for their physical activity	No	-	Collect survey data on Vancouver's residents to estimate the proportion who use parks for their physical activity	
*Property premiums**	Property premiums	Established & commonly used method Relatively easy to calculate	Need to apply different premiums to different property types (e.g. residential / industrial / commercial) Nuanced data needed to differentiate between parks of different quality levels (e.g. safety, lighting, aesthetic value, level of maintenance)	Total value of properties within 150m radius of a park	Maybe	Not publicly available	Gather data on property values within 150m radius of parks in Vancouver	Trust for Public Lands studies in the US Barnet, London, UK study
				Property premiums associated with being near a park, for various property types	Maybe	More research needed	Gather data on property premiums associated with parks in Vancouver Test calculations on Vancouver's park system and compare against values found in precedent studies	
*Stormwater management**	Replacement cost	Stormwater models currently exist, though need to be developed further and adjusted for Vancouver's context	Tedious & resource-intensive data collection Heavily simplifies perviousness of various land use types (by taking only the average	Annual rainfall over city of Vancouver	Yes	Environment Canada website	Gather data on perviousness of parks vs rest of city land Gather data on estimated stormwater costs per cubic metre	Trust for Public Lands studies in the US
				Average perviousness (%) of parks vs rest of city land	Maybe	Not publicly available		
				Estimated stormwater costs per cubic metre (derived from city's annual expenditure	Maybe	Not publicly available		

			across parks and across other land uses)	on stormwater treatment divided by volume of rainfall landing in impervious surface)			Analyse applicability of existing stormwater models to Vancouver's context Test calculations on Vancouver's park system and compare against values found in precedent studies	
Air quality*	Avoided healthcare costs	Models to measure the externality costs of common pollutants exist	Models may have limited applicability to Vancouver: e.g. STRATUM was developed for street trees rather than parks; UFORE was developed for the US.	Total area of tree cover in park network	Yes	Park Board's GIS/LiDAR data	Further analyse methods in precedent studies Gather necessary data Test calculations on Vancouver's park system and compare against values found in precedent studies	Millward & Sabir (2011)
				Total volume of pollutants removed by parks	Maybe	More research needed		
				Externality value of each air pollutant	Yes	Carbon pollution pricing guidelines for Canada		
Temperature regulation*	Avoided energy costs	Links park benefit directly to a monetizable effect		Carbon sequestration rates of trees within parks	Maybe	More research needed	Further analyse methods in precedent studies Gather necessary data Test calculations on Vancouver's park system and compare against values found in precedent studies	Brack (2002)
				Average cost of cooling devices within buildings	Yes	More research needed		

**Deeper analysis needed for the valuation methods of these benefits. This report offers preliminary recommendations based on brief research, but future researchers should refer to precedent studies, further analyse the strengths, limitations and suitability of these methods for Vancouver, and tailor these methods for Vancouver.*

Section 3: Next Steps

Renfrew Ravine Park | Photo credit: the author

Future Recommendations

In the short term, Vancouver Park Board staff members, consultants or future researchers are strongly encouraged to review the methods and calculations proposed in this report and conduct deeper analysis before applying them to policy decisions. The summary table from page 39 – 42 indicates the status of the current research on Vancouver's parks, the data and/or analysis gaps that need to be filled, and the precedent studies that can be referred to.

In the longer term, researchers can also explore the possible ways to value benefits not included in this report. For example, this project could not calculate the more intangible benefits (e.g. mental health, aesthetic, cultural, spiritual and heritage value), or benefits that required time- and resource-intensive data collection (e.g. stormwater management, air quality, temperature regulation and biodiversity). However, these benefits are highly important and should be considered in future calculations, where feasible.[9] The mental health value of urban parks, for instance, has become extremely evident during the COVID-19 pandemic of 2020, with thousands of articles espousing the benefits that spending time outdoors can have on mental well-being (e.g. Mackres, 2020; Saffron, 2020; Surico, 2020). Moreover, there is a growing body of academic research exploring the mental health benefits of urban parks (e.g. Buckley et al, 2019; Sturm & Cohen, 2014; Wolf & Robbins, 2015). For references on quantifying the mental health benefits of parks, future researchers can look at Vivid Economics' study of parks in London, UK (Vivid Economics, 2017) as a start. Another benefit of parks that is especially unique to Vancouver and that should be acknowledged is that of First Nations cultural and historical practices. While there is presently sparse literature on how to quantify the value of such practices, the growing recognition of the importance of reconciliation within Canada would ideally spark more research on this in future.

Future research could also consider examining the relationship between various park characteristics and park values. Other factors that can influence park value include size/area, level of management, presence and type of amenities available, surrounding land use, location and accessibility, user profiles, lighting, perception of safety, noise level, cleanliness, and more. These factors may influence both the type and amount of value attributed to a park. For instance, a park comprising mostly natural features (e.g. stream, forest) would probably have greater biodiversity value but possibly lower recreational value than a park with well-maintained lawns and sports facilities.

[9] See Appendices 1 and 4 for guidance documents and case study examples of how other cities calculated these benefits.

Useful Resources

This section includes the top 3-5 resources, in terms of relevance and usefulness for Vancouver Park Board's future research, for each category. For the full list of resources compiled for this project, see Appendix 4.

Guides for policy-makers & practitioners

1. Brown & Mooney's guide on valuing natural capital in the urban region (2013)
2. MNAI's key documents on valuing natural assets at the municipal level (2017-2019)
3. ACT's guide on accounting for natural assets (2020)

Case studies

1. The Trust for Public Land's reports on the economic value of urban parks in various cities across the USA (2009 – 2018)
2. Barnet, London, UK natural capital account report by eftec (2017)
3. Natural Capital in BC's Lower Mainland report by David Suzuki Foundation (2010)
4. Natural capital accounts for public green space in London, by Vivid Economics (2017)
5. Sutton, P. C., & Anderson, S. J. (2016). Holistic valuation of urban ecosystem services in New York City's Central Park. *Ecosystem Services*, *19*, 87-91.

Background literature

1. Harnik, P., & Crompton, J. L. (2014). Measuring the total economic value of a park system to a community. *Managing Leisure*, *19*(3), 188-211.
2. Kareiva, P., Tallis, H., Ricketts, T.H., Daily, G. and Polasky, S. (2011). *Natural capital: theory and practice of mapping ecosystem services*. Oxford University Press.
3. Dickie, I., & Neupauer, S. (2019). Natural capital accounts: nations and organizations. *Journal of Environmental Economics and Policy*, *8*(4), 379-393.

Data sources for Vancouver

Tourism

1. Research on tourism in Vancouver, from the Tourism Vancouver website
2. City Stays tourism profiles for cities within British Columbia, by Destination BC (2014)
3. Vancouver, Coast & Mountains regional tourism profile, by Destination BC (2017)

Recreation

1. VanPlay System for Observing Play & Recreation in Communities (SOPARC) study (2017)
2. Places for People Downtown summary report and data appendix (2018)
3. Activenet data on bookings made for Vancouver park facilities; available internally within Vancouver Park Board

4. Recreation Use Values Database (2016), developed by Oregon State University based on over 420 economic studies in the USA and Canada from 1958 – 2015. May be used for transfer values or estimated values in the absence of data.

Physical health

1. My Health, My Community survey results of Vancouver residents (2013-14)
2. The Economic Burden of Risk Factors in British Columbia, by the BC Centre for Disease Control (2018)
3. VanPlay recreation highlights, by Vancouver Park Board (2018)
4. The City of Vancouver's Healthy City Strategy Phase I (2014-2025) and Phase II (2015 – 2018) documents have summary metrics in them.

Property premiums

1. City of Vancouver property tax rates for various property classes, by City of Vancouver
2. How to calculate property tax in British Columbia, by BC Land Assessment

Air quality

1. Carbon pollution pricing guidelines for Canada, by the Government of Canada
2. Urban Forest Effects (UFORE) model methods and other urban forestry and ecology resources, by i-Tree

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Appendices

Renfrew Ravine Park | Photo credit: the author

Appendix 1: Broad overview of natural capital valuation methods

Category / Approach	Method	Description	Strengths	Weaknesses	References
Market-based					
	Pricing	Uses prices of products or value of sales from harvests.	• Convenient, uses existing price mechanisms which are thus easy to translate into economic value	• Difficult to apply to ecosystem services that are not conventionally measured in monetary terms (e.g. aesthetic value, cultural value)	Brown & Mooney (2013)
	Avoided cost	Estimates the value of ecosystem services based on the cost that would have been incurred in the absence of these services. E.g. cost of construction to control runoff; cost of healthcare for respiratory illnesses.	• One of the best indirect methods to value an ecosystem service using costs incurred elsewhere • Widely accepted and used		ACT, 2020; Brown & Mooney (2013)
	Replacement cost	Estimates the value of ecosystem services based on the cost of replacing and maintaining an engineered alternative. E.g. the cost of a water filtration plant to replace a forested watershed	• Like avoided cost method, one of the best indirect methods to value an ecosystem service using costs incurred elsewhere • Widely accepted and used		ACT, 2020
	Opportunity cost	Estimates the value of ecosystem services based on the next best alternative use of resources. E.g. cost of wetland preservation for drinking water vs. cost of obtaining water from an alternative source.		• Less easy to quantify compared to avoided cost and replacement cost	
	Production function	Estimates the value of ecosystem services based on the economic value of the service that contributes to a product or enhances productivity. E.g. higher fish catch and fishing incomes as a result of water quality improvements.		• Limited applicability: can only be used for ecosystem services that have a production function	Brown & Mooney (2013)

Non-market based					
Revealed preference	Travel cost	Estimates value of recreational services by estimating travel and related costs to visit and use them.	• Relatively easy to calculate	• Indirect, doesn't reflect the "true" value of the activity itself	Brown & Mooney (2013); Solstice (2019)
	Hedonic pricing	Estimates the value of an environmental good based on how it influences demand for a marketed commodity. Commonly used to estimate property premiums in relation to proximity to natural assets (e.g. a park).	• Widely accepted and used • Evidence-based (plenty of evidence supporting the effect of proximity to natural spaces on property prices)	• Usually only applicable to property pricing and not other benefits of natural assets	Brown & Mooney (2013); Sutton & Anderson (2016)
Stated preference: monetary methods	Contingent valuation (willingness to pay)	Estimates the value of ecosystem services by posing hypothetical scenarios that involve valuation of alternatives. E.g. asking people their willingness to pay to preserve a beach, forest or landscape view.	• Directly measures users' preferences using self-reporting techniques	• Highly subjective, less reliable	Brown & Mooney (2013)
	Choice experiment	People are given choices between actions/expenses in hypothetical scenarios.	• Directly measures users' preferences using self-reporting techniques	• Highly subjective, less reliable • Not easily translatable into economic terms	Brown & Mooney (2013)
Stated preference: non-monetary methods	Contingent ranking	People rank the order of or weight/score the importance of different ecosystem services.		• Highly subjective, less reliable • Not easily translatable into economic terms	Brown & Mooney (2013)
	Group valuation	Various participatory or deliberative approaches where groups of people review and select or rank choices.		• Highly subjective, less reliable • Not easily translatable into economic terms	Brown & Mooney (2013)
Other					
	Value transfer	Applying previously estimated values from a geographically different site to the given site. Adjustments are usually made to accommodate local conditions.	• Useful when site-specific data is lacking	• Limited accuracy due to site-specific differences, even after adjustments (which tend to rely on theoretical assumptions).	

	Ecological Accounting Process	Estimates the value of a natural asset by multiplying the total land area of the asset by the value of the land underlying the asset			ACT, 2020
	Total Economic Valuation	Measures the total value of a natural asset by its use value, option value, and non-use value	• All-encompassing • Takes into account both direct and indirect use, and both present and potential/future use		ACT, 2020; Pascual et al, 2010

Appendix 2: Primary data collection methods

Following the 2017 SOPARC study's survey method, the author observed parks' and park users' characteristics in 17 parks on 2 weekdays and 2 Sundays in June and July 2020.

Parks observed:

- Trimble
- Connaught
- Arbutus Greenway
- George Wainborn
- David Lam
- Coopers
- Andy Livingstone
- Creekside
- Hinge
- Charleson
- Quilchena
- Prince of Wales
- Balaclava
- John Hendry (Trout Lake)
- Renfrew Ravine
- Everett-Crowley
- Valdez

Park characteristics observed:

- Physical area
- Amenities available
- Degree of management (on a 3-point scale, 1 being naturally managed and 3 being highly manicured)
- Canopy cover (sparse vs dense; scattered vs concentrated)
- Presence & type (if present) of water body
- Level of use ("snapshot" head count within a 10 minute timeframe)
- Cleanliness (litter, graffiti)
- Noise level (on a 5-point scale, 1 being the lowest noise level)

Other notes:

- Weather condition (sunny, cloudy, rainy)

Appendix 3: Full list of valuation methods for park benefits

Note: difference between Appendix 1 and Appendix 3:

Appendix 1 gives a high-level overview of the common calculation methods involved in natural capital valuation, and involves benefits and natural assets that extend beyond urban parks. On the other hand, Appendix 3 gives a detailed description of valuation methods specific to urban park benefits, and has been curated by the author to suit Vancouver Park Board's specific needs. Appendix 3 thus serves as a reference for Park Board to 1) understand the full range of options in natural capital valuation; 2) consider in the longer term should they wish to quantify the value of other natural assets within the city, e.g. street trees, wetlands, rain gardens, bioswales, etc.

Table A1: Possible valuation methods for tourism benefits

No.	Method	Input data needed	Calculations needed	What the value represents	Strengths	Caveats / Limitations	Verdict
1	**Tourism spending**	• Total no. of park visits by tourists per year • Survey of tourists' motivations to visit Vancouver: in particular the extent to which urban parks influenced their decision to visit Vancouver • Average spending per visitor per day (including both direct spending in parks and indirect spending on meals, transport, accom etc) • Tax rates for sales, meals and *Adapted from TPL 2009 p.3-4*	Average spending per day x attribution % x total number of visitors per year	• Revenue for City		• Tedious & resource-intensive data collection (have to pull data from wide variety of sources)	Recommended, esp. for destination parks

Table A2: Possible valuation methods for recreation value

No.	Method	Input data needed	Calculations needed	What the value represents	Strengths	Caveats / Limitations	Verdict
1	**Direct use value**	• Total no. of park visits per year • For free facilities, cost of the same activity usage in private market • For rented facilities, cost per booking in parks, and cost per booking in commercial facilities • For special events, cost of event (ticket sales, venue booking fees etc.) *Adapted from: TPL 2009 p.6*	Total no. of park visits per year x average value of each visit	• Cost savings for park users • Revenue for City	• Relatively straightforward to calculate (input data already has dollar values attached)	• Tedious & resource-intensive data collection; data may not be as detailed as needed • Park users may include tourists whose healthcare costs wouldn't affect City of Vancouver • Existing data on park usage not as detailed as needed	Recommended
2	**Contingent valuation / Willingness to pay**	• Survey data on citizens' willingness to pay a premium for a house that's located nearer to a park				• Requires extensive surveying for data collection • More subjective than other methods	Recommended
3	**Discrete choice experiment**					• More subjective than other methods	Not recommended

Table A3: Possible valuation methods for physical health benefits

No.	Method	Input data needed	Calculations needed	What the value represents	Strengths	Caveats / Limitations	Verdict
1	**Avoided healthcare costs (physical)**	• Direct costs of inactivity and associated healthcare costs (average cost per person) • Percentage of Vancouver residents who meet weekly recommended physical activity requirements • Percentage of these residents who use parks and green spaces for their physical activity • Total number of Vancouver residents who use parks to keep physically active *Adapted from Barnet report + TPL 2009*	Total number of Vancouver residents who use parks to keep physically active x average cost of inactivity per person	• Cost savings for residents • Reduced economic burden on City's healthcare system • Reduced social burden on society	• Relatively straightforward to calculate • Data on economic costs of inactivity already available & up to date	• Data on % of residents who use parks and green spaces for their physical activity not directly available now	Recommended
2	**Avoided healthcare costs (mental)**	• Direct costs of healthcare for mental health issues per year (average cost per person)		•	• Plenty of evidence for and public attention to the benefits of park usage for mental health → assigning a dollar value to this benefit can further strengthen case for conserving parks	• Much harder to quantify than physical health benefits	Recommended if time / resources are available

Table A4: Possible valuation methods for enhanced property values

No.	Method	Input data needed	Calculations needed	What the value represents	Strengths	Caveats / Limitations	Verdict
1	**Hedonic pricing**	• Property premiums (%) for residential and non-residential properties within 300m from a good quality park • Total value of these surrounding properties ($) • Effective annual residential tax rate (%) *Adapted from Barnet report + TPL 2009 p.1-2*	Property premium (%) x Total value of surrounding properties ($) x Effective annual residential tax rate (%)	Tax revenue for the City Further benefits (not quantified here) e.g.: • Attracting & retaining affluent retirees • Attracting skilled workers & talent to live and work • Attracting homebuyers	Relatively easy to calculate	•	Recommended
2	**Park land appraisal**	*From convo with Reagan & Stuart*	Cost of acquiring a parcel of land to be turned into a park	Value of land parcel acquired		• Not the most accurate representation of a park's value (since cost of purchase reflects property value of different use – e.g. resi/commercial)	Not recommended
3	**Contingent valuation / Willingness to pay**	Survey data on citizens' willingness to pay a premium for a house that's located nearer to a park				• Need to collect new data (public surveys) • Subjectivity of data	Not recommended

Table A5: Possible valuation methods for stormwater regulation

No.	Method	Input data needed	Calculations needed	What the value represents	Strengths	Caveats / Limitations	Verdict
1	**Replacement cost**	• Annual rainfall over city of Vancouver • Average perviousness (%) of parks vs rest of city land • Reduction of runoff from parks' perviousness (derived from runoff if parks didn't exist and the area were covered with land use of same permeability as rest of city minus amount of actual runoff from parks) • Estimated stormwater costs per cubic metre (derived from city's annual expenditure on stormwater treatment divided by volume of rainfall landing in impervious surface) *Adapted from TPL (2009) p.12*	Reduction of runoff from parks' perviousness x estimated stormwater costs per cubic metre	Cost savings for the City from using natural rather than engineered means to manage stormwater		• Tedious & resource-intensive data collection • GIS + modelling expertise required • Heavily simplifies perviousness of various land use types (by taking only the average across parks and across other land uses)	Recommended, but more analysis needed

Table A6: Possible valuation methods for air quality enhancement

No.	Method	Input data needed	Calculations needed	What the value represents	Strengths	Caveats / Limitations	Verdict
1	**Avoided cost, using the Street Tree Resource Assessment Tool for Urban Forest Managers (STRATUM) model**	• Total area of tree cover in park network • Dollars saved per kg removed / externality value (i.e. cost of otherwise preventing that pollutant from entering the atmosphere) *Adapted from Millward & Sabir (2011) Allan Gardens Toronto, see p.180 for pricing*	Pollutants removed (kg) x dollars saved per kg removed for each pollutant; add up all the totals saved for each pollutant	Cost savings for the City from not having to use other means to remove pollutants	• Model already exists (no need to reinvent wheel) • Prior study was also done in a Canadian city	• Developed for street trees – less accurate for parks • Lack of current data on pollution removal by trees in Vancouver • GIS + modelling expertise required	TBC; more analysis needed
2	**Avoided cost, using the Urban Forest Effects (UFORE) model**	• List of pollutant types (e.g. carbon dioxide, nitrogen dioxide, ozone, particulate matter, sulphur dioxide) • Tons of pollutant removed for each pollutant type • Total area of tree cover in park network • Dollars saved per ton removed / externality value (i.e. cost of otherwise preventing that pollutant from entering the atmosphere) *Adapted from TPL (2009); [UFORE guide]*	Pollutants removed (tons) x dollars saved per ton removed for each pollutant; add up all the totals saved for each pollutant	Cost savings for the City from not having to use other means to remove pollutants	• Model already exists (no need to reinvent wheel)	• Lack of current data on pollution removal by trees in Vancouver • GIS + modelling expertise required	TBC; more analysis needed

Table A7: Possible valuation methods for temperature regulation

No.	Method	Input data needed	Calculations needed	What the value represents	Strengths	Caveats / Limitations	Verdict
1	**Avoided energy costs**	• Carbon sequestration rates of trees within parks • Cost of air-conditioning and other cooling devices in buildings	TBC; more research needed	• Cost savings for citizens	• Relatively simple to calculate if models exist		Recommended, but more analysis needed
2	**Avoided healthcare costs**	• Carbon sequestration rates of trees within parks • Healthcare costs associated with heat stress	TBC; more research needed	• Cost savings for citizens • Cost savings for the City/Province's healthcare system		• Indirect measure • Evidence of link between temperature increase and health effects is still lacking	Not recommended

Appendix 4: Full database of useful resources

Title	Author (last name)	Year	Region	Sub-region	Spatial scale	Type*	Urban / Non-urban*	Urban parks / urban natural assets*	For case studies: No. of locations covered
Town of Aurora: The Economic Value of Natural Capital Assets	Kyle	2013	Canada	Aurora, Toronto	Local	CS	U	NA	1
Natural Capital in BC’s Lower Mainland: VALUING THE BENEFITS FROM NATURE	Wilson (David Suzuki Foundation)	2010	Canada	BC Lower Mainland	Regional	CS	NU	-	3
Benefits of a forested urban park: What is the value of Allan Gardens to the city of Toronto, Canada?	Millward & Sabir	2011	Canada	Allan Gardens, Toronto	Site	CS	U	P	1
Municipal Natural Assets Initiative: District of West Vancouver, British Columbia	MNAI	2018	Canada	West Vancouver, BC	Municipal / City	CS	B	both	
West Vancouver’s Natural Capital Assets	Solstice	2019	Canada	West Vancouver, BC	Municipal / City	CS	B	both	
Economic valuation of the stormwater management services provided by the Whitetower Park ponds, Gibsons, BC	Sahl et al	2016	Canada	Gibsons, BC	Local	CS	NU	-	
The Value of Natural Capital in Settled Areas of Canada	Olewiler	2004	Canada		National	CS	NU	-	
Canada's Wealth of Natural Capital: Rouge National Park	Wilson (David Suzuki Foundation)	2012	Canada	Ontario	Site	CS	NU	-	1
Defining and Scoping Municipal Natural Assets	MNAI	2017	Canada		Municipal	PG	B	NA	
Ecosystem Services, Natural Capital & Nature's Benefits in the Urban Region: Information for Professionals & Citizens	Brown & Mooney	2013	Canada		City	PG	U	NA	

Primer on the Ecological Accounting Process (EAP): Methodology for Valuing the Water Balance Services’ Provided by Nature	The Partnership for Water Sustainability in BC	2019	Canada	BC	Regional	PG	NU	-	
Accounting for Natural Assets: A Low Carbon Resilience Approach	ICABCCA	2019	Canada	null		PG, CS	NU	-	5
The social and economic values of Canada's urban forests: A national synthesis	Nesbitt et al	2016	Canada		National	R	NU	-	
The value of urban ecosystem services in New York City: A spatially explicit multicriteria analysis of landscape scale valuation scenarios	Kremer et al	2016	US	New York City	City	CS	U	NA	
Measuring the total economic value of a park system to a community	Harnik & Crompton	2014	US		City	TF	U	P	12
Economic Benefits of Parks	Pennsylvania Land Trust Association	2012	US			CS	B	P	20
Holistic valuation of urban ecosystem services in New York City's Central Park	Sutton & Anderson	2016	US	New York City	Site	CS	U	P	1
How Much Value Does the City of Wilmington Receive from Its Park and Recreation System?	The Trust for Public Land	2009	US	Wilmington	City	CS	U	P	1
The Economic Benefits of San Francisco’s Park and Recreation System	The Trust for Public Land	2014	US	San Francisco	City	CS	U	P	1
The Economic Benefits of the Park & Recreation System in San José, California	The Trust for Public Land	2016	US	San Jose	City	CS	U	P	1
The economic benefits of parks and recreation in Colorado Springs	The Trust for Public Land	2017	US	Colorado Springs	City	CS	U	P	1
The economic benefits of Cleveland Metroparks	The Trust for Public Land	2018	US	Cleveland	City	CS	U	P	1
Measuring the Economic Value of a City Park System	The Trust for Public Land	2009	US		City	CS	U	P	5
The Impact of Parks on Property Values: A Review of the Empirical Evidence	Crompton	2001	US	null		R	U	P	
Economic value of protected areas via visitor mental health	Buckley et al	2019	World	null		CS	B	P	

London Borough of Barnet Corporate Natural Capital Account	Eftec	2017	World	Barnet, London, UK	Local	CS	U	P	1
Using iTree STRATUM to estimate the benefits of street trees in Melbourne, Victoria	Fairman et al	2010	World	Melbourne	City	CS	U	NA	1
Ecosystem services: Urban parks under a magnifying glass	Mexia et al	2018	World	Almada, Lisbon	Site	CS	U	P	1
Improving nature's visibility in financial accounting	Capitals Coalition	2020	World			PG	NU	-	
The Economic Value of Natural Capital in the Built Environment	Paladino		World			PG	U		
Introduction to Natural Capital	Eftec	2017	World			PG, CS			
Natural capital and ecosystem services informing decisions: From promise to practice	Guerry et al	2015	World			R	NU	-	
Metro Nature, Environmental Health, and Economic Value	Wolf & Robbins	2015	World			R	B	NA	
Conservation for Cities (book)	McDonald	2015	World			R, PG			
Economic Value of Parks via Human Mental Health: An Analytical Framework	Buckley & Brough	2017	World	null		TF	B	P	
Classifying and valuing ecosystem services for urban planning	Gomez-Baggethun & Barton	2013	World		City	TF	U	NA	
Valuation of Urban Parks	More et al	1988	World			TF			
Natural capital accounts: nations and organizations	Dickie & Neupauer	2019	World	UK		TF, CS	NU	null	4
THE PROXIMATE PRINCIPLE: The Impact of Parks, Open Space and Water Features on Residential Property Values and the Property Tax Base	Crompton	2004	World			R	U		
Natural capital: theory and practice of mapping ecosystem services	Kareiva et al	2011	World			TF, R, CS (book)	NU	-	
Integrated assessment and valuation of ecosystem services Guidelines and experiences	Barton et al	2017	World	EU		PG	B	both	

*Coding legend:

- Type: CS = case study; P = policy/practitioner guide; R = review; TF = theoretical framework
- Urban/Non-urban: U = urban; NU = non-urban; B = both
- Urban parks / urban natural assets: P= parks; NA = natural assets