Director	CAO

COUNCIL AGENDA	
Date:	Item:

DISTRICT OF WEST VANCOUVER
750 17TH STREET, WEST VANCOUVER BC V7V 3T3

COUNCIL REPORT

Date:	June 10, 2019
From:	Isabel Gordon, Director, Financial Services
Subject:	Natural Capital in the District of West Vancouver
File:	0842-09

RECOMMENDATION

THAT as described in the report dated June 10, 2019 regarding natural capital in West Vancouver:

1. the inventory of West Vancouver's Natural Capital Assets, attached as Appendix A, be received for information; and
2. consideration of the value of natural capital and ecosystem services in the District of West Vancouver be incorporated into the District's financial planning, asset management, financial reporting, and capital budgeting processes and decisions.

1.0 Purpose

The District of West Vancouver has completed an inventory of natural capital assets in the District. The report titled West Vancouver's Natural Capital Assets, attached as **Appendix A**, provides that inventory, along with some of the implications and next steps implied by the creation of the inventory.

2.0 Bylaw

As natural capital and ecosystem services are a new area for municipalities, the District has no bylaws or policies which are directly related. The District does have many bylaws which contain provisions related to the preservation of features in the natural environment, including:

Creeks Bylaw No. 3013, 1982

Interim Tree Bylaw No. 4892, 2016

Parks Regulation Bylaw No. 4867, 2015

Watercourse Protection Bylaw No. 4364, 2005

In addition, the District's Environmental Strategy contains specific guidance on steps to be taken to promote and enhance creek habitat and corridors, promote tree and forest stewardship, and protect and enhance the foreshore, and its Parks Master Plan contains many statements and recommend actions which support natural capital principles.

3.0 Official Community Plan

The District's Official Community Plan supports the valuation of natural capital through restrictions on development to protect environmentally sensitive lands and includes policies that provide the community-wide framework and intent for ongoing protection and restoration of these assets, as well as directions for future reviews to address emerging issues such as climate change. The following sections also directly support natural capital valuation and inclusion:

2.5.15 Employ low-impact storm and rain water management techniques such as infiltration, absorbent landscaping and natural environment conservation to mimic natural conditions and preserve pre-development conditions.

2.5.17 Employ green infrastructure or naturalized engineering strategies where possible to help manage anticipated increases in frequent storm events and associated flood risks.

2.6.7 Manage land uses to protect the ecological value of watercourse and riparian corridors through development permit conditions.

2.6.8 Provide opportunities to vary development form and density to maximize the permanent protection of watercourse and riparian corridors while accommodating reasonable development potential.

2.6.10 Protect the shoreline and its significant environmental and cultural features through:

a. Seeking strategic land acquisition where appropriate;

b. Restricting private encroachment except where required for access; and

c. Regulating existing structures to minimize impact.

2.6.11 Update shoreline protection strategies and flood construction level requirements to further increase protection from sea level rise, reduce shoreline erosion, preserve and enhance habitat and improve public access.

2.6.12 Establish a foreshore development permit area to guide development and construction on or near the foreshore and to protect and enhance foreshore habitats.

4.0 Analysis

The concepts of natural capital, and of ecosystem services provided by natural capital, are just beginning to emerge as key considerations in municipal asset management. As one of the first municipalities in Canada to compile an inventory of natural assets, West Vancouver is on the forefront of the movement to acknowledge natural capital assets as valuable. While the specific methodology used for natural capital valuation continues to evolve, there is general agreement that ecosystem services have heretofore been undervalued (or even unvalued), and that this may have led to less than optimal decision-making in the provision of municipal services. (For additional information on valuation methodology, see **Appendix B**).

The attached report begins the process of identifying the stock of natural capital in the District, and giving a value to the ecosystem services it provides, so that its contribution can be more fully considered in the provision of municipal services.

4.1 The Importance of Natural Capital

Natural capital embodies the idea that, just as municipal constructed assets have value, require maintenance, and need to be carefully considered when any changes take place, so too natural assets have value and need to be maintained and considered. This idea comes from the realization that many of the services on which we rely are provided by nature, and cannot be replicated by human-created systems or structures, or can be replicated only at great cost. These ecosystem services, such as storm drainage management, flood control, erosion prevention, carbon sequestration and storage, air filtration, temperature moderation, and many others, all provided by natural assets, are disregarded at our peril.

On the other hand, if we understand, account for, value, and work with these natural assets, they can provide tremendous benefits. Natural assets frequently provide better services, at lower cost, and over longer periods than constructed assets. They often have little or no replacement cost, and may even appreciate, rather than depreciate, over time. Their maintenance costs can be lower, and they can provide aesthetic as well as service benefits.

This work aims to get consideration of natural capital and ecosystem services “into the mix” when decisions are made about how services shall be provided. However, it is not a justification for preserving everything natural in preference to anything constructed. As long as municipalities exist, they will be providing many municipal services using constructed structures, just as municipal residents will be living in constructed houses. The point is to make these constructed structures more compatible with the natural world, taking advantage of natural services as much as possible, and disturbing them as little as possible.

The next generation of infrastructure must be attuned to the realities of the 21st century and make use of all the best available strategies. That is why it's critical for decision-makers to systematically consider the role of natural systems and, where appropriate, integrate green, blue, and grey infrastructure. While incorporating green infrastructure will not make sense in every project, it's important to rely on facts rather than myths in making water management, forest and foreshore preservation, and development decisions.

4.2 Cautions to Keep in Mind

Natural capital is not constrained by municipal boundaries, but is shared across boundaries with many neighbours, including other municipalities, First Nations, the Province, and even across national boundaries. Therefore, the District's natural capital decisions need to consider north shore, regional, and worldwide issues as well as the needs of the District.

Natural features do not exist in isolation, in fact, the whole point of this work is that nature is a functioning system, whose parts all interact. Connectivity of habitat, proximity of trees to create tree canopy, and other connections between eco-system features are very important, but have not been valued in this preliminary first survey.

Consideration of natural capital is proposed as one of a number of factors to be taken into account in decision-making. In certain decisions, it may not be the most important factor. An example could be the Community Wildfire Protection Plan, where recommendations to remove trees to create fire breaks may have to be made, in order to protect the community from devastating fire spread. Climate change will no doubt bring more choices like this one to the fore, and this may make natural capital issues even more challenging.

The valuations in the report are in no way indicative of prices, for which natural capital could be bought and dispensed with if sufficient money was paid. Again, natural capital is a system, which, up until now, has been considered piecemeal, if at all. It is this disconnected mode of thinking that has led to the undervaluing of natural capital up to now.

Increasing development pressure will create conflicts of use, which will make an understanding of the contribution of natural assets more crucial. Finding a more creative and inclusive way to interact with natural features, valuing their contribution to our health, welfare and quality of life, should be a part of every development decision. West Vancouver is already working hard to concentrate development and preserve natural features in the forest, on the foreshore, and along watercourses. Placing value on these assets will enhance this work.

4.3 Staff Team

A large cross-divisional team worked on the natural capital inventory project. The Natural Capital Project Team members are listed in **Appendix C**.

4.4 Sustainability

Creating an inventory of natural capital assets, and attaching values to them will create a baseline against which future developments can be measured. This will provide valuable information for creating a sustainable future.

5.0 Options

5.1 Recommended Option

Staff recommend that this report be received for information and that consideration of the value of natural capital and ecosystem services in the District of West Vancouver be incorporated into the District's financial planning, asset management, financial reporting, and capital budgeting processes and decisions.

5.2 Considered Options

Council may refer the report back to staff for further consideration.

6.0 Conclusion

The District has taken a bold first step in compiling a natural capital inventory and placing values on natural assets. This first step needs to be followed by continuing this work, and integrating it into asset management, budgeting, development, and other decisions.

Author: _____
Isabel Gordon, Director, Financial Services

Appendices:
Appendix A: West Vancouver's Natural Capital Assets
Appendix B: Technical Appendix to West Vancouver's Natural Capital Assets
Appendix C: Natural Capital Project Team

Solstice
SUSTAINABILITY WORKS INC.

WEST VANCOUVER'S NATURAL CAPITAL ASSETS

A Preliminary Inventory

West Vancouver's Natural Capital Assets

Contents

Technical Appendix (separate document)

1. Introduction

West Vancouver is located on the traditional territory of Coast Salish peoples, including the Squamish, Tsleil-Waututh and Musqueam First Nations.

> *Our natural setting has shaped how we have developed and grown over a century, and it will also inform our opportunities and responsibilities as we plan for the future.*
>
> West Vancouver Official Community Plan, 2018

Forest trails, sparkling creeks, beaches, cliffs, tree-lined streets and open spaces – we enjoy a rich variety of natural features in West Vancouver, but do we ever think of them as assets? Perhaps we should. Our forests, foreshore, waterways and parks deliver important municipal services day in, day out.

Creeks, for example, with healthy, shady banks function as part of our stormwater management system. Healthy forests clean our air and keep us cool. Beaches buffer the coast, protecting the properties and infrastructure located inland. And our beautiful parks give our community its special character, drawing residents and visitors alike. Nature provides all these services and more, seemingly for free. That can lead people to take them for granted, to undervalue or neglect them.

This report provides an initial inventory of West Vancouver's natural capital assets, valued in terms of the vital services those assets provide. We see it as an opportunity to start a conversation in our community about how we look at, work with, and value nature's services.

Recognizing the value of nature's services

While we will never stop appreciating nature for its own sake, we can also start to see nature as the source of so many valuable services to our community. Just as we tally all our pipes, roads, buildings, vehicles and other capital assets, we may need to add a new category to our accounting – natural capital assets. In fact, communities in Canada and elsewhere are busy taking inventories of street trees, valuing their urban forest, adding natural capital assets to their infrastructure reports and even questioning current accounting practices. Driven by a desire to protect their vital water source, our neighbours across Howe Sound in Gibsons BC created a new approach to asset management that gives natural capital assets equal status with traditional infrastructure in financial management.[1]

Inspired by these efforts and by deep appreciation for our valuable natural heritage, we are moving towards inclusion of natural capital assets in our own financial management. We have used well-accepted economic methods to attach estimates of value to the flow of services our natural capital provides. Some people may be uncomfortable with placing monetary values on nature – it's priceless after all! We understand that there are risks with this approach, but the even bigger risk would be to perpetuate the notion that we can keep drawing on nature forever without the account ever coming due.

This report represents a high level inventory of natural capital assets within the boundaries of the District of West Vancouver, whether on District owned or private land. The range of values attached to them is a starting point that ensures we don't value them at zero. Estimates of value may change over time reflecting the assets' extent or condition, and our understanding of the services they provide. The next step will be to develop more detailed information so that we can incorporate natural capital assets into our asset register where they will be more visible. Lessons from other communities suggest that this is a critical step towards ensuring natural assets are tracked, monitored, and maintained with appropriate resources. This doesn't mean that we can never interfere with or develop natural assets, but we will continue to do so from a well informed position that increasingly incorporates an understanding of our natural capital.

Homes require regular maintenance to hold their value. Natural capital assets do too. Maintaining natural capital assets ranges from simply monitoring their health and function, to active protection or remediation. If we treat ecosystem services as free, we may fail to invest in maintaining the vital assets that deliver them and eventually be poorer for it.

This report provides the District's perspective on the value of West Vancouver's natural capital assets. It is a starting point for discussion and may support further work. Beyond an interdivisional staff group and a small advisory panel of specialists in the field of environmental economics, we have not yet sought other views.

Acknowledgements

We recognize that the areas described in the report form part of the unceded territory of the Coast Salish peoples. This report builds on a long history of work by local Indigenous People, District Council, staff and community partners, other governments, and non-governmental organizations to identify, describe, map, and protect significant natural features in West Vancouver. It also draws heavily on similar valuations from the region, especially *Sound Investment: Measuring the Return on Howe Sound's Ecosystem Assets* by Michelle Molnar. The section on Waterways recognizes research on a West Vancouver stream done as part of a pilot project for the Municipal Natural Assets Initiative[2]. We also wish to acknowledge the Town of Aurora, Ontario's report, *The Economic Value of Natural Capital Assets* by Jim Kyle, which provided inspiration and informed the methods for this project.

This report is the product of several project meetings and data preparation involving a range of District staff. It benefitted from review and expert advice from our panel of advisors, Michelle Molnar, Environmental Economist and Policy Analyst; Maya Kocian, Senior Program Director, Earth Economics; and Sara Justine Wilson, Principal Consultant, Natural Capital Research & Consulting. The project was managed, and the report drafted, by Susan Todd of Solstice Sustainability Works.

Disclaimers

The values in this report are necessarily approximations and are intended to provide a high level starting point for natural capital asset management in the District of West Vancouver. Many aspects of nature could not be valued in this way, but this does not make them any less important to us. The estimates in this report should not be interpreted as a basis for compensation. While the report includes all natural capital on public and private land, nothing in this report should be construed to imply any interference with rights of ownership or existing development rights.

2. Methods

The aim of our project was to calculate the economic value of natural capital in West Vancouver. Our approach takes the area in hectares of natural capital for each ecosystem type and applies an estimated value of the ecosystem services each type of ecosystem provides. Economic values per hectare have been transferred from other relevant studies. This is a well established approach that connects landcover analysis and ecosystem processes to economic value estimates of those processes.[3] More information on the methodology and supporting studies can be found in the Technical Appendix.

Characterizing our natural capital

Four main categories of natural capital can be found throughout West Vancouver and give the community its character – forests, foreshore, waterways, and parks and green space. The foreshore includes beaches and rocky waterfront areas. Waterways includes lakes, rivers, creeks and streams. To develop an appreciation for the extent and condition of our natural capital, we reviewed a wide range of reports, including for example, the Parks Master Plan, Upper Lands Working Group reports and various Integrated Stormwater Management Plans.

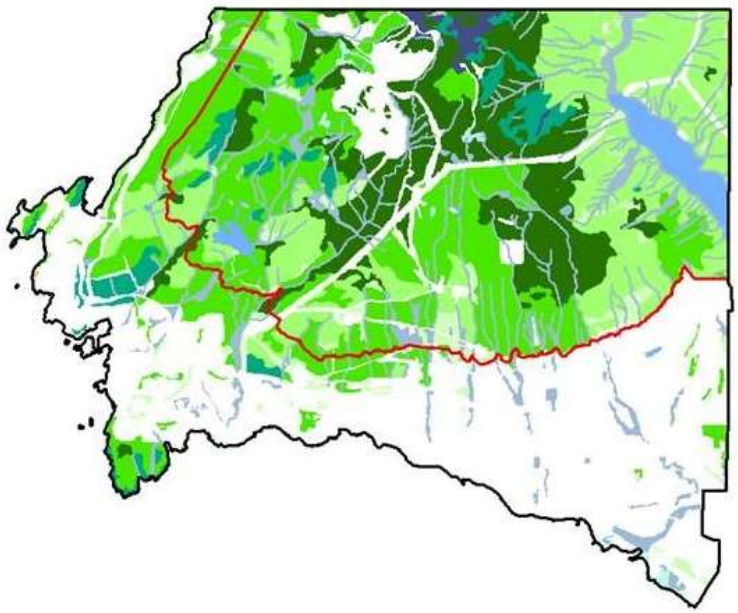
Calculating the area of natural capital

An essential element of this work was the District's Geographic Information System (GIS). Land cover data was integrated into ArcGIS mapping software to determine total area and distribution of ecosystem types across the District. Using these tools, we were able to calculate how many hectares we have of various landcover types, such as forests, shrubs, grass and beaches. We paired this with data from Metro Vancouver's Sensitive Ecosystem Inventory (SEI) to add information on lakes, waterways (rivers, creeks and streams) and their riparian borders.

Developing local service values

To place a value on natural capital, we first needed to understand what kinds of services nature is providing in West Vancouver. We drew on the concept of *ecosystem services* that has gained wide acceptance in the last two decades as the basis for valuation studies. Ecosystem services can be thought of as a stream of benefits into the future – benefits such as recreation, climate moderation, reduction of flood-risk, water storage and filtration, and many more.

Metro Vancouver Sensitive Ecosystems in West Vancouver Region



Economists use a range of techniques such as avoided costs, market-based proxies, and studies of user or resident preferences to estimate the value of nature's services (Table 1). Primary research can be time consuming and costly. When local data on economic values for ecosystem services is not available, researchers often use the value transfer method, which uses previously developed economic calculations from relevant valuation studies. Fortunately for our project, local valuations have already been done on the natural capital of the Lower Mainland and the natural capital of Howe Sound. We have relied most heavily on *Sound Investment: Measuring the Return on Howe Sound's Ecosystem Assets*[4]. It is a highly detailed report, which enabled us to compare West Vancouver's natural capital and ecosystem services with the ecosystem types and values in the report's underlying studies. We selected, from the values presented in that report, the most relevant low and high estimates of annual value per hectare for each service that our ecosystems deliver. In a few cases where the Howe Sound study did not have values for a specific ecosystem/service combination or we wanted to consider additional values, we transferred values from other studies.

Table 1: Valuation methods used in underlying studies

Valuation method	Explanation[5]
Avoided cost	Estimates value of ecosystem services based on the cost that would have been incurred in the absence of these services. Examples include costs of construction to control runoff and health care costs related to respiratory illness.
Contingent valuation	Estimates value of ecosystem service by posing hypothetical scenarios that involve some valuation of alternatives. For instance, people generally state that they are willing to pay for increased preservation of beaches and shoreline.
Hedonic pricing	Estimates value of ecosystem service based on ecological services that directly affect market prices. For example, housing prices along the coastline tend to exceed the prices of inland homes.
Opportunity cost	Estimates value of ecosystem services based on the next best alternative use of resources. For example, the value of preserving a wetland for municipal drinking water can be determined by comparing the cost of wetland preservation to the cost of obtaining water from an alternative source.
Production	Estimates values of ecosystem services based on the economic value of the service that contributes to the production of market goods. For example, water-quality improvements increase commercial fisheries catch and therefore fishing incomes.
Replacement cost	Estimates value of ecosystem services based on the costs of replacing ecological services or the cost of providing substitute services. For example, waste treatment provided by wetlands can be replaced with built treatment systems.
Travel cost	Estimates value of ecosystem service based on economic use values associated with an ecosystem. For example, recreation areas can be valued at least by what visitors are willing to pay to travel to it, including the imputed value of their time.

Calculating natural capital asset values

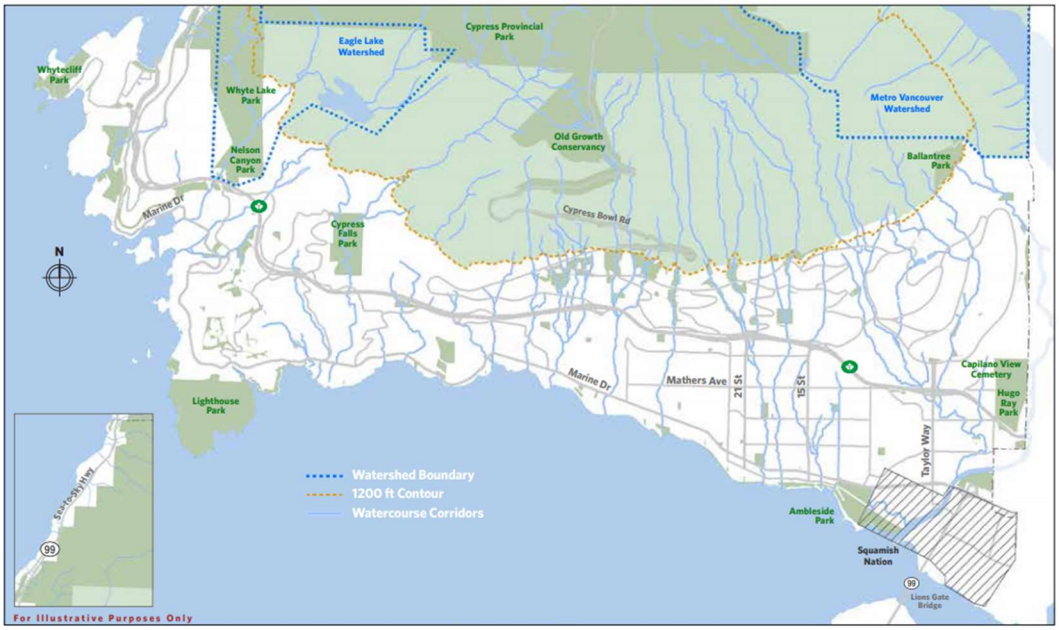
The District uses a 20-year time frame for capital budgeting. We used this as a starting point for valuing the stream of natural capital services, but also considered that natural capital may deliver ecosystem services in perpetuity if it is handled with care. If we want our natural capital to be functioning for future generations, it seems appropriate to value each asset class as a perpetuity. In each case we provide low and high ends of the range. In the Technical Appendix we also provide values limited to a 20-year budgeting horizon.

Services that were not included in the values

Nature provides West Vancouver with vital services related to health and well-being, culture, spirituality, aesthetics and sense of place that we can appreciate but are not yet able to quantify using current techniques. It is quite possible that these unvalued services could be the most significant of all! For this reason, the values in this report should be considered the lower limit of possible values.

3. Overview of West Vancouver's Natural Capital Assets

Environmental Resources Map (OCP Map 13)



From the air, West Vancouver displays many shades of green. At street or trail level the effect is even stronger. This is a place where you can hardly take a step without encountering nature, so it's easy to take it for granted. Over time that could lead to valuable natural assets becoming degraded and less able to provide the services we count upon. This inventory is a way of ensuring that we know what we've got so that we can take care of it.

For this initial inventory of natural capital values, we used data from Metro Vancouver and West Vancouver's GIS tools to map the location and extent of a few significant natural capital types: forests, lakes and watercourses, foreshore and parks. We have not included natural capital that is outside District boundaries, such as the marine ecosystem.

In the sections that follow we describe the assets we have inventoried, the services they provide and the range of values we determined. We look at the factors that will affect the service life of these natural assets and the implications for how we manage them.

Carbon Storage

In this section we look at the value of carbon storage because it is provided by several ecosystems and we treat it differently from other ecosystem services. Stored carbon represents all the carbon accumulated in plants and soils at a point in time. We valued carbon storage for forests, grasslands (including alpine meadows) and shrubs. There is also carbon in the plants and soils at the bottom of waterways. We have not valued waterway carbon storage though it could be significant.

While carbon is stored, it is not being released to the atmosphere, avoiding the damage that results from atmospheric carbon. As carbon storage is not an annual amount, we do not include it in the tables for each natural capital asset class. (Carbon *sequestration*, which represents the annual uptake of carbon, is included in the natural capital asset tables.)

Table 2 Value of Stored Carbon

Carbon storage	Area in hectares	Carbon per hectare (tonnes)	Value per tonne (2014)	Value of carbon storage (2014) $1,000s	Value of carbon storage (2019) $1,000s
Forests (trees and soils)	5765	564.5	$60.97	$198,417	$215,342
Shrubs (soils only)	459	240	$60.97	$6,716	$7,289
Grass and meadows (soils only)	661	142	$60.97	$5,723	$6,211
Total					**$228,842**

Forests, shrubs and grasslands store differing amounts of carbon per hectare as shown in Table 2. The value per tonne we have used is the *social cost of carbon*, calculated in the Howe Sound study, which is a measure of the total damage resulting from the release of an extra tonne of carbon. The value of carbon stored in West Vancouver's natural capital assets amounts to at least $228 million. Refer to the Technical Appendix for further discussion of how we valued carbon storage.

4. Forests

West Vancouver's forest consists of two distinct areas. Above Highway 1 to the west of the Operations Centre, and the 1,200 foot elevation level to the east, we have the "upper forest." This forest extends into the north shore mountains, bordering Cypress Provincial Park. Our other forest, below 1,200 feet in elevation, is the "urban forest", the less dense, but no less valuable, assortment of trees that grace our streets, parks and private properties.

Upper forest

The total area of the upper forest is 3,871 hectares. Hemlock, cedar and fir trees are common in this forest area. As most of the area was logged in the past, we refer to this forest as "second growth". There are some pockets of very old trees, "old growth" that were never logged. The forest is a popular site for recreation, especially trail-based activities such as walking, hiking, running, mountain biking, and snowshoeing. Other forest users include naturalists, birders, mushroom pickers, researchers, and education or youth programmers.[6]

The land above the 1,200 foot level is owned by The District of West Vancouver together with private landowners such as British Pacific Properties (BPP). BPP is the main landowner of the forested lands between Highway 1 and the 1,200 foot level.[7] In 2012, the Upper Lands Working Group was put in place to help the District consider the future of the area. The working group report identified core community values for this forest to be environmental features and systems, outstanding recreation opportunities, and a neighbourhood development model that "works with nature."[8] These process outcomes have been incorporated into the 2018 updated Official Community Plan (OCP).

Urban forest

West Vancouver's urban forest includes 1,894 hectares of forested parks, street trees and other trees on both District and private lands. The urban forest is very diverse since many of the trees were selected and planted for beauty, shade, fruit or other benefits and are not necessarily native to British Columbia. From large maples to ornamental cherry trees, the urban forest provides a changing pattern of colour throughout the year. The striking arbutus tree that gives coastal bluffs their distinct character is the only native broad-leaf evergreen tree in Canada.

Services provided by forests

Forests have been relatively well studied for the economic value of the ecosystem services they provide. BC coastal forest typically are high value forests. For example, the Gullchucks Estuary in the Great Bear Rainforest provides ecosystem services valued at $33,700 per hectare per year, including carbon sequestration and storage, water filtration and purification, flood control, and air filtration.[9]

Urban forests, while often smaller in area are no less important. The annual value of urban forests in London, England was assessed in 2015 at £132.7 million. The main benefit was air pollution removal while other benefits included avoided runoff from storm water, reduced building energy costs from shading, and carbon sequestration.[10] Closer to home, TD Economics estimated in 2014 that Toronto's urban forest provides $80 million in ecosystem services annually, and that the forest had a total value of $7 billion, or $700 per tree.[11]

Both of these urban forest studies used tools developed by the US Forest Service that are based on avoided costs. These tools do not work as well for aesthetic, spiritual and cultural services for which the values can be deeply personal and not suitable for market pricing[12].

The staff team for this project reviewed possible services to determine those most relevant to West Vancouver. These are discussed below. They include most of the same services valued in the London and Toronto studies, plus some others that are important for our community, whether they could be calculated or not.

Clean water

Forests and treed areas provide three essential water-related services – absorption, supply and filtration. Trees absorb rainwater through their leaves and root systems, slowing runoff so that there is less water flow for our stormwater infrastructure to deal

with during heavy rain events. The forest lets some of this intercepted water seep into soils, fill reservoirs and recharge groundwater, enhancing our stored water supply. Forests also filter runoff water, reducing the amount of pollution and sediment from erosion that would otherwise enter streams, drinking water reservoirs and eventually Howe Sound or Burrard Inlet. Watersheds with more forest cover may have lower water treatment costs.[13]

Clean air

Forests are sometimes called the lungs of the Earth for the role they play in absorbing carbon dioxide and releasing oxygen. They are also natural air filters! Trees remove pollutants from the air, either through absorption or by trapping particles on their leaves giving us better air quality.[14] Trees can help clean West Vancouver's airshed from the smoke caused by recent wildfires.[15] We valued the air purification services of our forests based on avoided human health costs.

Climate regulation

Forests play an important role in regulating climate. As trees grow, they take up carbon dioxide from the atmosphere and lock it up in their tissues. This process is called carbon sequestration. When trees burn, they release the carbon to the atmosphere. When they decompose, the carbon is stored in the forest debris and soil. A forest ecosystem, with trees at all stages of life, represents a large storage facility for carbon. By taking up carbon and storing it, forests help to mitigate the build-up of greenhouse gases in the atmosphere that contributes to climate change.

Older trees lock up proportionately more carbon annually than younger trees because their mass of both wood and leaves continues to grow as they age.[16] This was the finding of a global study of more than 670,000 individual trees across 403 species and every forested continent. Our upper forest includes 1,069 hectares defined as Old Forest in Metro Vancouver's Sensitive Ecosystems database. These older forests play a key role in taking up and storing carbon.

Urban trees also contribute to climate regulation by shading buildings in hot months and shielding them from wind in colder months, which can reduce building energy costs and indirectly greenhouse gas emissions. As these building factors are very situation specific, we have only estimated values for carbon sequestration and storage.

Habitat

The size of the upper forest and its connections to surrounding forest areas make it important for many species, especially larger ones that need expansive habitat areas. Deer and black bears are common here. Coyotes, bobcats, martens, raccoons and many species of birds, reptiles and amphibians also live here. Many bird species enjoy the trees of our urban forest for feeding, roosting, protection or nesting. The forest includes an Old Growth Conservancy park which contains trees that are up to 800 years old in an undisturbed forest setting.

The human benefits of habitat for other species are indirect. We appreciate songbirds and the presence of other wildlife for many reasons relating to culture, recreation, education, tourism and more. By improving downstream water quality, forests even protect salmon, with a clear economic benefit to BC. A 2010 study of habitat in BC's Lower Mainland found old, intact forests contributed $1.6 million to better salmon rearing conditions.[17]

Recreation and tourism

West Vancouver enjoys an extensive trail system through our forests, such as the Great Trail, the Baden Powell Trail, the Brothers Creek Trail, and celebrated mountain biking trails. None of these trails would be possible without the trees that hold the soil in place on our steep slopes and provide shade for active bodies.

Health and wellness

In urban areas, trees are especially helpful in reducing what is called the "heat island effect" in which built-up areas have higher temperatures than green space. Trees help by shading streets and buildings.[18] Heat islands affect the health of people who are at greater risk for heat-related illness.[19] In July 2017, anticipating several days of plus 30 degree temperatures, Vancouver Coastal Health issued health advisories for young people and the elderly.[20] In June 2018, Worksafe BC advised outdoor workers to take precautions.[21]

Researchers have also found health benefits in the form of stress reduction from soaking up the forest atmosphere, or "forest bathing" as the practice is recognized by the Japanese Ministry of Agriculture, Forestry and Fisheries.[22] This is a relatively new area of research. Other than the health effects associated with clean air and recreation, we have not attached any health values to forests, although we acknowledge that they could be significant.

Aesthetic and cultural

Our forests give West Vancouver its outdoor character, heritage and beauty. A range of sources from outdoor blogs to real estate photos attest to the popular appeal of our forests.[23] As evidence of the community connection to our forests, we saw the significant commitment of volunteer citizens and councillors participating in the Upper Lands Forests Working Group over a 30-month process. Heritage values include evidence of Indigenous peoples' historical occupation and the ski community and historic cabins that are still enjoyed today on the forested slopes of Cypress Mountain. For aesthetic values one need look no further than John Lawson Park when the cherry trees are blooming. There is also evidence that property values benefit from the aesthetics of nearby trees.[24]

We have not attempted to place an economic value on this group of services, but case studies (such as one from Auburn, Alabama, where a community reacted to the poisoning of beloved oaks) indicate that "these values are not trivial – indeed, they may be quite sizable."[25]

Valuation estimate

We plan our infrastructure renewals over a twenty year planning horizon, but natural capital assets don't tend to depreciate in the same way and may even appreciate. If we collectively maintain our forests so that they can continue to deliver the same level of service for future generations, we can anticipate a flow of services from our forest worth between $20 and $55 million annually, and between $0.6 and $1.8 billion as a perpetuity[i] (Table 3). The table also shows more conservative estimates aligned to the 20 year planning horizon, with and without discounting. Refer to the Technical Appendix for more discussion of our multi-year valuation approach.

This estimate excludes the services we have not valued – health and wellness, and aesthetic, spiritual and cultural. This valuation should therefore be considered a conservative estimate of the full value of ecosystem services from forests.

In Table 3 we split out the old forest that is included in the upper forest total. Older forests, with larger trees and more complex ecosystems have values that tend toward the higher estimates.

It is important to acknowledge that much of our forest area is on private land. To continuously enjoy the ecosystem services we describe in this report, we need the cooperation of everyone in West Vancouver to keep our forests healthy, so that they in turn can provide for us.

[i] Perpetuity values have been corrected to agree with Table 3.

Table 3 – Annual and cumulative values of services provided by West Vancouver forests

Please note that the values presented here are conceptual estimates and not an actual ledger. Estimates may change over time, reflecting the condition of the asset or our understanding of the value of services they provide.

		All monetary amounts in $1,000s Canadian			
Ecosystem service	**Area in hectares**	**Low annual estimate**	**High annual estimate**	**Low estimate perpetuity**	**High estimate perpetuity**
Upper forest					
Clean water supply and filtration	3871	$9,310	$23,531	$310,328	$784,363
Stormwater management	3871	$3,021	$7,377	$100,689	$245,910
Clean air	3871	$63	$2,437	$2,101	$81,223
Carbon sequestration	3871	$193	$857	$6,442	$28,566
Habitat	3871	$17	$143	$560	$4,761
Recreation	3871	$563	$2,853	$18,765	$95,087
Total upper forest		**$13,167**	**$37,197**	**$438,885**	**$1,239,911**
Old forest, in upper forest total	1069	*$3,636*	*$10,272*	*$121,201*	*$342,409*
Urban forest					
Clean water supply and filtration	1894	$4,555	$11,513	$151,837	$383,773
Stormwater management	1894	$1,478	$3,610	$49,265	$120,319
Clean air	1894	$31	$1,192	$1,028	$39,741
Carbon sequestration	1894	$95	$419	$3,152	$13,977
Habitat	1894	$8	$70	$274	$2,330
Recreation	1894	$275	$1,396	$9,181	$46,524
Total urban forest		**$6,442**	**$18,200**	**$214,737**	**$606,662**
Total forest	**5,765**	**$19,609**	**$55,397**	**$653,622**	**$1,846,573**

Table 1 in the Methods section explains the valuation methods used in this report. For forest related ecosystem services, the valuation methods were: replacement cost and travel costs for clean water; avoided construction costs for stormwater management; avoided health costs for clean air; avoided damage for carbon sequestration; fish production and willingness to protect threatened species for habitat; and travel costs for recreation. For greater detail on the underlying studies and values transferred, please refer to the Technical Appendix.

Factors that could affect the service life or value of this asset

Similar to traditional infrastructure, natural assets are susceptible to degradation from wear and tear, weather, and both private and public decisions. In this section we discuss some of the factors that could influence the size and health of the forest, affecting its ability to deliver services and consequently its value.

Climate change

The changing climate has important implications for our forests. In BC we can expect hotter, dryer summers and milder, wetter winters.[26] Trees hold soil, protecting slopes during extreme storms. During hot summer days shady forests and fully treed parks provide an appealing retreat, but climate change poses challenges for trees. A longer growing season could advantage some species at the expense of others. Winters may not be cold enough to keep familiar pests in check and other pests may migrate to a newly hospitable zone. Droughts weaken trees, especially newly planted ones. Some areas of forest may be at risk from wildfires, as we saw in the summer of 2018. The result is that just when we need our forests the most, they may be under stress and the forest ecosystem services we rely on could be affected.

Development

Our Official Community Plan anticipates approximately 10,000 more people living in West Vancouver in 2041 compared to 2016. We expect most of the growth to happen in already developed areas, with some growth to happen in the new neighbourhoods of Cypress Village and Cypress West in the Upper Lands[27].

Cypress Village and Cypress West Planning Areas (OCP Map 9)

Recreational use

West Vancouver's upper forest areas have seen increased use over the last few decades and we can expect this trend to continue with increasing population and growing awareness of the recreational opportunities in West Vancouver. While West Vancouver has an extensive network of forested parks and trails, recreation and trail-building also takes place on private land. Trail users and builders have been active stewards of north shore trails.[28] With the forest seeing increasing use, coupled with stress from climate change, collaboration with diverse users will be even more important to maintain the health of this asset.

Tree removal

Property owners sometimes remove trees as part of a redevelopment, to enhance their views or for other reasons. When a mature or significant tree comes down, neighbouring properties may feel the loss of the tree as if it were their own, and the neighbourhood as a whole loses the services of that tree. The cumulative effect of many tree removal decisions is a significant loss to our urban forest. Tree removals may still be needed on occasion – for public safety, to prevent the spread of pests or disease, or to mitigate wildfire risk. Sometimes removing a few trees in one area can spare a much larger number of trees somewhere else. District staff have to weigh many factors before approving a tree removal and consider the urban forest as a whole.

Actions and Implications

The District of West Vancouver has several plans, policies and initiatives to protect the health and future value of our forests. More can be done, which would require involvement of District residents, businesses, visitors and stakeholders. In this section we describe what we are doing to ensure the ongoing value of our forest assets and suggest other opportunities we could consider as a community.

Understanding our forest assets

This baseline inventory tells us how much forest we have and what it could be worth. As with any important asset class, we also need to know its condition. We are embarking on a study using remote sensing (LIDAR specifically) that will provide us with a forest cover study and better information for assessing the health of our forest. Other considerations could include a detailed tree inventory using the approach taken by London and Toronto that involves field sampling.

Planning for forest sensitive neighbourhoods

Our OCP sets the policies and expectations that guide planning for land use planning. By clustering new housing in compact neighbourhoods, we can have a much larger area of forest protected forever. Currently, most lands below 1,200 foot elevation within the Upper Lands area are zoned for single family housing development. The District, through our OCP, intends to concentrate the remaining development potential into the much smaller footprint of the future Cypress Village in order to minimize deforestation and protect important natural capital assets that the community values.

The District is undertaking an environmental scan of municipal upper lands in 2019. The project is supported by recommendations outlined in both the District of West Vancouver Parks Master Plan and Upper Lands Study Review Working Group Final Report, and the Trails Plan. The environmental scan will consist of baseline data collection of wetlands, vegetation, wildlife, and fish and fish habitat, and be comprised of desktop analysis, literature reviews, and field surveys. This baseline information will be used for any future planning and development within the upper lands, and for input into natural capital asset management.

Preparing for climate change

We are doing our part to reduce greenhouse gas emissions in our facilities and fleet. We completed a Corporate Energy and Emissions Plan in 2016[29] to guide us in meeting BC legislated targets. The plan is due for renewal in 2020. We recognize that the emissions that have already built up in the atmosphere mean that some climate change is inevitable, and we are also preparing for that. As wildfire is a key threat to our forests, we are developing a Community Wildfire Protection Plan. Keeping our forests healthy can be part of our strategy for adapting to climate change.

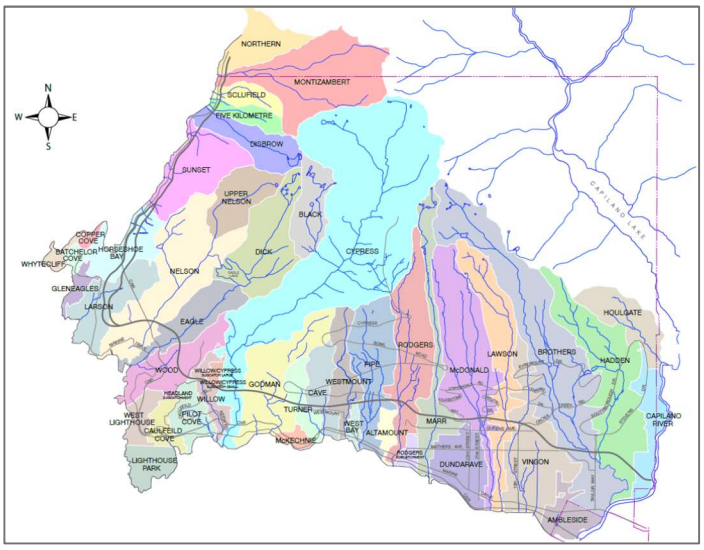
Protecting trees on private land

Since 2016, West Vancouver has had an Interim Tree Bylaw [30]to protect trees on private land. The bylaw regulates the removal of certain protected tree species and trees with diameters greater than 75cm. A working group was formed in early 2017 to review options, engage the community and make recommendations regarding the development of a bylaw to regulate trees on private property that balances tree management best practices with community interests. The working group concluded their work and staff provided Council with the working group's final recommendations report, staff analysis of the working group's recommendations and recommendations for proposed amendments to the Interim Tree Bylaw. Council directed staff to bring back a revised amendment bylaw to be considered this summer. In the meantime, the existing Interim Tree Bylaw regulations continue to be in effect. The District's Watercourse Protection Policy also regulates all tree removals from the riparian zone.

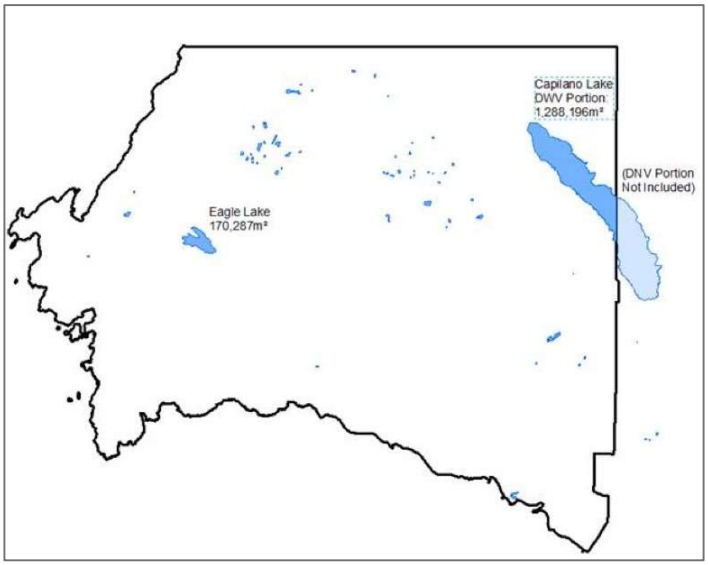
5. Waterways

Water defines our community. On our eastern edge, the Capilano Lake and River are shared with North Vancouver. The watersheds of our major creeks act as the organizing unit for the District's approximately 40 stormwater catchment areas. The names of many of these creeks – Brothers, Lawson, Rogers – evoke our heritage.

Map of water catchments



Map of reservoirs and small lakes



Our major waterways

In this report, the general term waterways includes both flowing water and open water wetlands such as lakes and ponds. In calculating the area, we had to leave out very small ponds, hidden streams and ditches. The valuation for waterways should therefore be considered a low estimate of true value.

Most of our waterways have a border of living vegetation that extends up the bank and some distance from the water's edge. This is called the riparian zone and is very important to the health of the waterway and the stability of the bank. We used Metro Vancouver's sensitive ecosystem dataset to determine the total area in riparian zones. Creeks are not distinguishable from their riparian buffer zones in this dataset, so we have valued them as a unit.

Capilano Lake is a natural reservoir and our primary source of drinking water. Eagle Lake is our secondary reservoir. Both of these are off limits to public use to protect the quality of the water. In addition to Capilano and Eagle Lakes, we have a few smaller lakes and ponds, such as Whyte Lake, Ambleside Pond and Larson Pond.

The Capilano River, which we share with North Vancouver in its lower reaches, is a regionally significant waterway for salmon, tourism and regulating reservoir levels.

West Vancouver has 31 major creeks and many smaller streams that together provide 26 km[31] of the District's system for managing stormwater. Many of these creeks provide habitat for trout and salmon. The vegetated ditches that border many of our roads are also part of our stormwater system.

As the creek system is so important to stormwater management, the District has commissioned Integrated Stormwater Management Plans (ISMPs) for ten major catchments and an overall assessment of the stormwater system in 2010.

- McDonald Lawson Creek Watersheds ISMP, 2004
- Pipe, Westmount, Cave, Turner, Godman Creeks ISMP, 2013
- Vinson, Brothers and Hadden Creeks 2016 Watershed Health Monitoring and 2017 ISMP

The studies looked at factors such as:

- Existence and health of riparian buffer (the strip of plant life at the edge of waterways)
- Bank stability or indications of erosion
- Obstructions or intrusions in the stream
- Pollutants
- Habitat for fish and other aquatic organisms

Results from the studies show that the health of the creeks varies but all creeks studied have been affected in some way by urban development over the years. Some have been buried, diverted or turned into concrete channels. Various pollutants ranging from metals to e-coli have been detected in some streams. Some streams have suffered the erosion of their banks, which can lead to downstream silting or even bank collapse. Some sections of streams have lost their riparian buffers that hold soil in place and shade the water. For details please see ISMP reports on westvancouver.ca.

Services provided by waterways

Clean water supply

Natural waterways are significant water supply assets for West Vancouver. Capilano Lake is the main drinking water reservoir for most households in West Vancouver. Eagle Lake provides a secondary drinking water reservoir while Montizambert Creek serves people north of Horseshoe Bay. While clean water has clear benefits beyond human consumption – to other species and for our own enjoyment, we have limited our valuation to fresh water supply for these reservoirs.

Water regulation/storm water management

All of our waterways from the smallest stream to the Capilano River and several small lakes and ponds function as a vital part of our water regulating system that stores, releases and carries water. Ditches play an important role in this system but as they are too small and numerous to capture with our GIS techniques, they are excluded from the valuation below.

The key municipal function for our creeks and river is carrying water. When winter rains lash the north shore, the first line of defence is our forests where trees and soils absorb what they can. Excess water collects in rivulets which feed small streams. Streams collect stormwater and channel it into ever larger creeks and eventually through culverts and pipes to its destination in Burrard Inlet or Howe Sound.

The riparian buffers of the creeks are also vital to the stormwater management function and we value the creeks and their buffers as a unit. The living plants and soils absorb some water so that the creek or river has less to manage. The roots of plants hold the soil in place and keep the banks stable which ensures that natural waterways can do their job without silting up or becoming obstructed.

Waste treatment/filtration

Riparian buffers perform another useful service by intercepting, filtering and cleansing water before it enters the creeks. We value filtration services by considering the cost of water treatment that would be needed in the absence of natural capital assets.

Habitat

Creeks, lakes and rivers are used by many species at different stages of life. Most of the relevant ecosystem valuation studies focus on salmon. This is a very conservative approach for habitat as it excludes all other wildlife that use our waterways to make their living.

Recreation

We have excluded Capilano Lake and Eagle Lake from the recreation calculation as they are closed to public access. The Capilano River is a major recreation and tourism asset. Local residents and tourist users enjoy the river for swimming, fishing, wildlife viewing, fishing and other activities. Whyte Lake is a popular hiking destination. Tourism and recreation values for lakes and rivers have been extensively studied with a wide range of values depending on location and activity. Recreation activities associated with creeks and small lakes are not well researched. For creeks and small lakes and ponds, we transferred values from wetlands and general nature based recreation studies.

Aesthetic and cultural

Who could dispute that humans are drawn to water? We enjoy the sight and sound of moving water and the peace it evokes. Children can amuse themselves for hours playing in creeks. While we recognize the importance of these values, we have not placed an economic value on the aesthetic and cultural services of our waterways for lack of data.

Education

In 2017, the District participated in a pilot program of the Municipal Natural Assets Initiative[32] to study the financial case for daylighting a stream, based on a tributary of Brothers Creek near Westcot Elementary School. While the study focused on stormwater management and fish habitat services, potential education benefits were identified relating to the creek's location near a school and the opportunity to engage students in a daylighting project. The research team estimated the education value in 2017 for the school's students and catchment population at $192,000[33].

Valuation estimate

Riparian areas which includes all creeks and streams and the riparian area bordering Capilano River are the highest value water assets. Their function of storing, releasing and conveying water as part of our stormwater management system ranges can be valued between $1.6 to $7.2 million per year (Table 4). Taken together our combined waterways deliver services worth $2.6 to $17.2 million annually and between $88 to $574 million in perpetuity.

Table 4 – Annual and cumulative values of services provided by West Vancouver waterways

Please note that the values presented here are conceptual estimates and not an actual ledger. Estimates may change over time, reflecting the condition of the asset or our understanding of the value of services they provide.

		All monetary amounts in $1,000s Canadian (2019)			
Ecosystem services	**Area in hectares**	**Low annual estimate**	**High annual estimate**	**Low estimate perpetuity**	**High estimate perpetuity**
Reservoirs					
Clean water supply	145.9	$19	$6,251	$633	$208,382
Small lakes, ponds					
Water regulation	14.2	$25	$114	$832	$3,800
Water filtration	14.2	$13	$34	$426	$1,138
Habitat	14.2	$0.4	$101	$15	$3,358
Recreation	14.2	$1.8	$10	$60	$349
Total lakes & ponds		**$59**	**$6,511**	**$1,967**	**$217,028**
River					
Water regulation	20.3	$27	$27	$890	$890
Habitat	20.3	$0.6	$21	$21	$698
Recreation	20.3	$0.9	$392	$32	$13,068
Creeks					
Water regulation	907.4	$1,595	$7,286	$53,179	$242,852
Water filtration	907.4	$817	$2,182	$27,246	$72,744
Habitat	907.4	$29	$131	$952	$4,366
Recreation	907.4	$115	$669	$3,841	$22,289
Total river & creeks		**$2,585**	**$10,707**	**$86,161**	**$356,907**
Total waterways		**$2,644**	**$17,218**	**$88,128**	**$573,935**

Table 1 in the Methods section explains the valuation methods used in this report. For waterways' ecosystem services, the valuation methods were: replacement cost and willingness to pay for clean water; avoided flood risk reduction costs for water regulation; replacement cost (with water treatment) for water filtration; fish production, hedonic pricing and avoided restoration costs for habitat; and travel costs, hedonic pricing and contingent valuation for recreation. For greater detail on the underlying studies and values transferred, please refer to the Technical Appendix.

Factors that could affect the service life or value of this asset

Development

Even with the most sensitive development approaches, when natural cover is replaced with hardened surfaces there is less opportunity for the ground to absorb and disperse rainwater. This increases runoff which can lead to flash flooding. The runoff that makes it into creeks over hard surfaces such as roads is also more likely to contain pollutants than water that has made its way through forests or other natural areas. The District's development permitting approach regulates runoff, ensuring that post development flows must equal or be less than pre-development flows.

Obstructions in stream and riparian encroachments

There is a great temptation for people living beside creeks to "enjoy" them too much by creating patios and lawns so close to the creek that they affect the stability of banks or allow garden chemicals to run off into them. To protect our waterways and regulate the amount of hard surface within the riparian area, the District requires land-owners to obtain an Environmental Development Permit for any development within 15 metres of the top of the watercourse bank. This helps keep streams clean and free-flowing so they can do their work as part of our water system.

Climate change

The climate changes described in the Forests section will also affect our waterways. Heavier deluges in the winter may overwhelm waterways, leading to flooding. Lower snow accumulation in the mountains and dryer summers means lower reservoir levels and reduced flow in rivers and creeks in the summer. Creek temperatures may rise as a result posing additional challenges for spawning salmon. This makes it even more important that we retain the trees that provide shade to creeks.

Invasive species in riparian areas

Invasive plants are ones that spread easily and quickly, outcompeting other plants. Some familiar examples in West Vancouver include English ivy, English holly and butterfly bush. Non-native species are ones that have been introduced from other regions. Non-native plants can often become invasive because the local ecosystem hasn't evolved the means to contain them. Some invasive plants such as giant hogweed pose a real health risk to humans. Invasive plants can also cause significant damage to parks and infrastructure. Some, such as Japanese knotweed, are tricky to eradicate and may required professional assistance. The District website has a list of the invasive plants of greatest concern.[34]

Actions and Implications

As our waterways provide essential services such as drinking water and storm water management, the District devotes considerable resources to planning, monitoring and maintenance. In this section we describe what we are doing to ensure the ongoing value of our waterways and suggest other opportunities we could consider as a community.

Implementing Riparian Area Regulations

The District has set watercourse protection policies to meet the BC Government's Riparian Area Regulations. These control the amount of development within 15 metres of the top of a watercourse bank. For the Upper Lands development, the District has gone further to mandate 30 metre set-backs. A challenge in the regulations is that the footprints of existing structures are grandfathered. It is not uncommon in the older parts of the District to see private developments right up to the edge or even spanning creeks. Where possible, we work with property owners to remove encroachments and restore the creek to a more natural state.

Encouraging green infrastructure

Green building practices – those that work in concert with nature or minimize harm – are growing in popularity. A fundamental principle is to retain as much rainwater as possible on site. This reduces runoff to other properties or the stormwater system. West Vancouver builders and property owners are trying new approaches such as green roofs (roofs with living plant communities on them), permeable surface materials (that let water percolate through to the soil below), and rain gardens (a landscaping technique to manage water on site). On steep slopes which are common in West Vancouver, retaining walls may be needed. Near creeks, vegetated walls are an alternative that allows the normal flow of water into the creek.

Balancing needs for water

Municipal government is often a balancing act. Restricting public access to reservoirs is a balance between recreation and drinking water supply. Similarly, maintaining a dam on Eagle Creek has to balance water supply for humans with water flows for fish. Sometimes the needs align as they do in the case of maintaining stable stream banks. This meets the needs of the Engineering Department for effective conveyance of water plus the needs of all the other users that enjoy healthy streams. However, there are costs associated with inspecting, maintaining and measuring the condition of waterway assets that may compete with other municipal priorities. Another balancing act!

Combatting invasive species

The District requires front-yard landscaping plans for development on private property and landscaping plans for riparian zones to minimize further planting of invasive and non-native species. We also encourage removal of invasive species through the development process.

6. Foreshore

West Vancouver is a coastal community with more than 30 kilometres of shoreline. The beaches, bluffs and sloping rocky coastline contribute to our quality of life and attractiveness as a community. Popular sea front parks offer diverse treats from sandy beaches to historic lighthouses. Sweeping coastal views make private property along the foreshore highly desirable. Public access is also important through the many roads that end at the foreshore and pathways such as the Centennial Seawalk that run along it.

The foreshore, where land meets water, is also an extremely important zone for non-human life, especially in the small estuaries where freshwater creeks mix with the sea[35]. Twice a day tides flood the lower portion of the shoreline, carrying nourishment to the marine life that exists in the zone between the high and low water marks. Small fish, crabs, birds and other wildlife rely on this intertidal buffet. Predator fish such as salmon spend part of their life in waters near shore. Higher up the beach or rocky shore, we find hardy plants such as beach pea that specialize in the windy, salty, low nutrient environment.

Services provided by the foreshore

In considering the services provided by foreshore assets we have focused on areas with natural cover – sand, pebbles, sloping rocks and vegetation. In some places the foreshore has been hardened to make it accessible to more people, for example along the 1.7 km Centennial Seawalk. Our method for calculating area excludes built or paved surfaces. It also excludes grassy lawns as these are captured in the Parks section. The value of foreshore parks, trails and open space is discussed in the Parks section.

Flood-risk reduction

Our community grew up along the waterfront and we have always had a mixed relationship with our coastal waters. Much as we enjoy the sight and sound of the waves, we don't want them intruding in our businesses and living rooms. The power of high tides and storm surges is well known in West Vancouver. In 2012, facilities at Ambleside were flooded by a storm surge[36]. A king tide and windstorm in December 2018 affected Batchelor Bay, ripping out a sewer line, uncovering another behind a retaining wall and damaging a nearby walkway.

The District's engineering department calculated an estimate of nearly $21 million for the total replacement cost of District sanitary infrastructure within 15 metres of the high water mark,[37] reasoning that without the protection of a healthy foreshore, this infrastructure could be vulnerable to storm surges. This estimate does not include parks, pathways, or private property that could also be exposed. This is a one-time estimate rather than an annual service value.

Erosion regulation

Healthy natural shorelines can regulate erosion with new material being deposited as old material is carried away. If beach erosion is significant the beach can advance inland. Paradoxically, some of the steps people take to protect themselves from storm damage can actually make situations worse. Seawalls and piers that alter the natural distribution of sand and sediments can result in the loss or retreat of beaches over time. Beach erosion and flood risk are related – a resilient natural foreshore protects inland property and infrastructure. Beaches and sloping rocky shores provide a natural barrier that absorbs the energy of incoming waves, greatly reducing the potential for damage.

> *The cumulative effects of hardening the West Vancouver shoreline through the installations of seawalls have led to some unintended consequences. These consequences include; loss of desirable beach profiles, diminished habitat potential, and increased wave damage.*
>
> Council Report, January 28, 2011

Habitat

An impressive range of marine and land based species make their home along the foreshore. Some, such as eagles and arbutus, enjoy the coastal bluff lifestyle. Others make a living on sand or pebble beaches, or in the intertidal zone. While we appreciate all the rich diversity of life in the foreshore region, available economic valuations of habitat tend to be driven by fishery species such as salmon which travel through the intertidal zone.

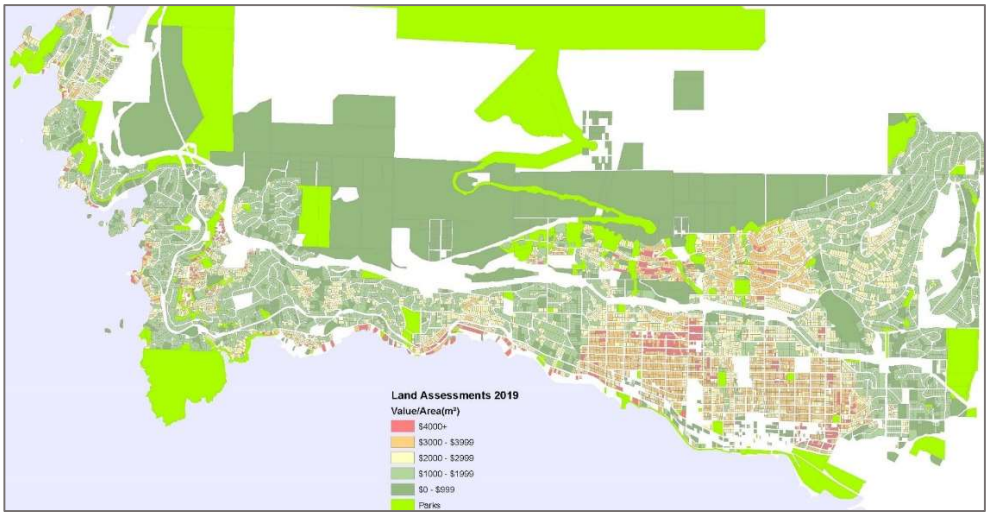
Recreation

The foreshore is a key area for recreation in West Vancouver as some of our most loved parks are found here, including Ambleside Park, Dundarave Park, Lighthouse Park, Whytecliff Park and Horseshoe Bay Park. At many places along the coast, road ends provide access to the shore[38]. Residents and visitors alike enjoy the foreshore area for walking, wildlife viewing, beach activities, picnicking, swimming, boating in large and small craft, paddle boarding and scuba diving[39]. Valuations for recreation are highly variable reflecting the diversity of opportunities at each location and the population that uses them. It is likely that the recreation value for the foreshore of a community within easy distance of Metro Vancouver would be towards the high end of recreation valuations.

Aesthetics and culture

The beauty of the foreshore enriches our quality of life. Professional artists and Instagram fans alike find inspiration in coastal views and driftwood covered beaches. The foreshore is also a gathering place for cultural festivals such as the Harmony Arts Festival and Coho Festival. While we have not attached economic values to aesthetic and cultural services, we acknowledge that there is likely a relationship that is reflected, for example, in the premium property owners pay for proximity to the foreshore. The map below shows where assessed values of properties are highest.

Map: Land Assessments 2019



Valuation

Our valuation of the foreshore should be considered a starting point as it includes only three ecosystem services – erosion regulation, recreation and habitat. Habitat value was calculated only for the portion of the beach that is intertidal as the valuation is driven by fishery species. A significant ecosystem service, the reduction in flood-risk from storm surges, could not be valued because suitable underlying studies do not exist.

Even with this limitation, annual foreshore services can be valued between $4.8 to $16.5 million annually and may be worth up to $0.5 billion when viewed in perpetuity (Table 5).

Table 5 – Annual and cumulative values of services provided by West Vancouver foreshore
Please note that the values presented here are conceptual estimates and not an actual ledger. Estimates may change over time, reflecting the condition of the asset or our understanding of the value of services they provide.

		All monetary amounts in $1,000s Canadian (2019)			
Ecosystem service	**Area in hectares**	**Low annual estimate**	**High annual estimate**	**Low estimate perpetuity**	**High estimate perpetuity**
Beach					
Storm surge protection		data not available			
Erosion regulation	59.8	$4,790	$4,790	$159,680	$159,680
Recreation	59.8	$32	$9,817	$1,058	$327,233
Habitat, intertidal area only	28	$9	$9	$294	$294
Total beach		**$4,831**	**$14,616**	**$161,032**	**$487,207**
Rock					
Storm surge protection		data not available			
Recreation	11.4	$6	$1,871	$202	$62,382
Total foreshore		**$4,837**	**$16,487**	**$161,234**	**$549,589**

Table 1 in the Methods section explains the valuation methods used in this report. For foreshore related ecosystem services, the valuation methods were: hedonic pricing for erosion regulation (this is a proxy in the absence of relevant avoided cost studies); hedonic pricing and contingent valuation for recreation; and production of intertidal species for habitat. For greater detail on the underlying studies and values transferred, please refer to the Technical Appendix.

Factors that could affect the service life or value of this asset

Foreshore encroachments

The foreshore faces a similar challenge to some creeks in the form of private structures that encroach on the foreshore or the access points that lead to it. The District has launched a Coastal Marine Management Plan Working Group which will consider this challenge as part of its terms of reference[40].

Climate change

Over the last few years, West Vancouver has experienced severe winter storms, with high winds and dramatic rainfall levels in short periods of time. In some cases, the storms have been accompanied by seasonal tides that together launched powerful storm surges against our foreshore. Provincial, Federal and global scientific agencies tell us we can expect more of these impacts as the climate continues to change.

In addition to the changes in temperature and precipitation that are affecting other natural asset classes, the foreshore faces the slow, inexorable rise in sea levels that comes with melting icecaps globally. The District of West Vancouver like other communities in BC is planning for one metre of sea level rise by 2100[41]. Researchers at the US National Oceanic and Atmospheric Administration suggest that seas are rising faster than predicted.[42] The extra volume of water will compound the threat of storm surges with water pushing further inland.

Private property and municipal infrastructure near the shore or in low lying areas will be most at risk. Beaches and estuaries could also be damaged by powerful storm surges or slow erosion.

Actions and Implications

Protecting and restoring the shoreline

The District's Shoreline Protection Plan[43] (SPP) builds on decades of work to protect and enhance one of the District's most valuable assets – the foreshore. The SPP brings together several strategies such as:

- Foreshore habitat restoration[44] – placing large boulders where they can act as a catalyst for natural reef building
- Improving trails to both protect riparian habitat and provide safe pedestrian access
- Removing culverts to "daylight" creeks

- Replacing sea walls with softer shoreline features such as reefs, berms and salt marsh

The most cost effective and environmentally sound strategy to protecting the shoreline is to recognize and re-establish the key restorative features of a natural coastline that have been altered by development.

Shoreline Protection Plan

Upgrading building and infrastructure standards

Based on climate change forecasts from the BC Government, the District is updating development guidelines and permit requirements to reflect BC flood construction levels. Infrastructure is also being upgraded as it is replaced. Pipes near the shoreline that were installed within the last five years are encased in concrete or sleeved in high density polyethylene (HDPE) plastic.

Planning for sea level rise

Sea level rise is widely recognized as a consequence of climate change. As a coastal community, West Vancouver is acutely aware of the hazards posed by sea level rise and is working with north shore neighbours and others to plan for it.

The District, in collaboration with the District of North Vancouver, the City of North Vancouver, Squamish Nation, North Shore Emergency Management, and the Vancouver Fraser Port Authority have commissioned a study of the risks associated with sea level rise and potential strategies to adapt to it. The study is based on current Province of B.C. planning recommendations of a linear rate of sea level rise from 2000 levels, resulting in half a metre of sea level rise by the year 2050, one metre by 2100 and two metres by 2200[45].

7. Parks

In this section we focus on the social services that parks, trails and open space provides, with an emphasis on recreation, health and cultural services. We also look at one land cover type – grass – that features prominently in parks and gardens and has not already been counted in other sections. Grass includes natural meadows, playing fields, grassy school yards and private yards. West Vancouver's grass cover includes urban lawns, alpine meadows and grassy vegetation along utility corridors.

Parks

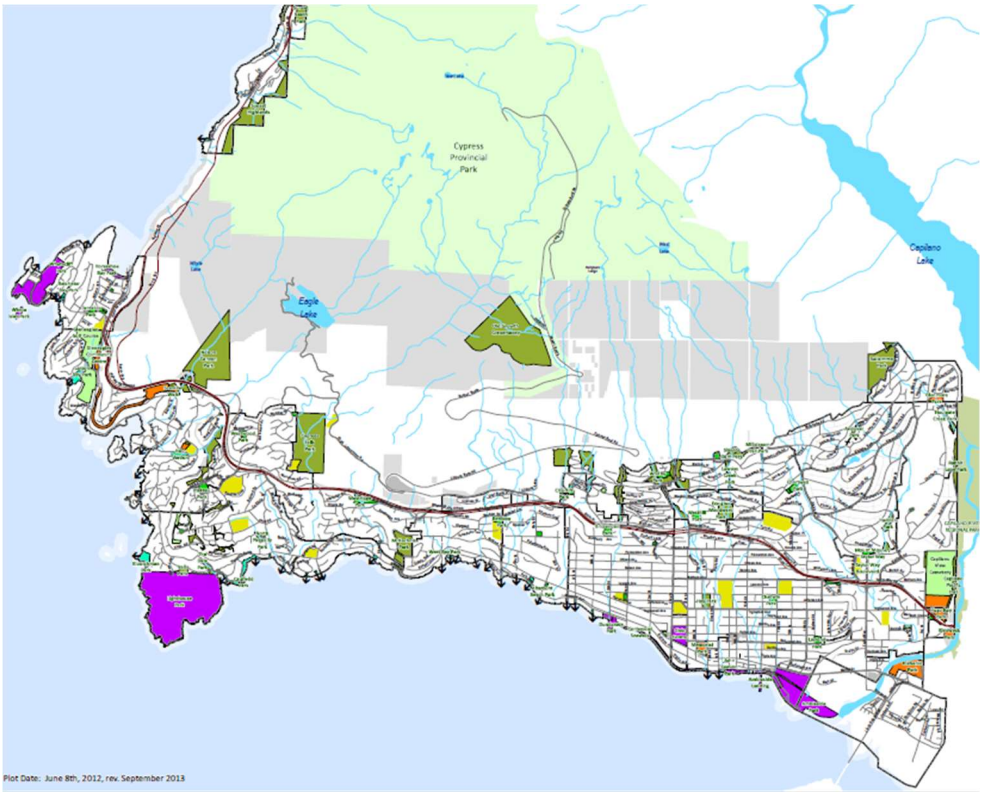
The District's park system offers a diverse range of outdoor opportunities across its 1,648 hectares, comprised of parks and District owned Upper Lands. Clearly some park areas are more "natural" than others. This distinction is important for natural capital services that depend on ecological processes, such as wildlife habitat. For other services, such as recreation and aesthetics, a less natural setting such as a playing field or bed of flowers can provide valuable services.

Table 6 Types of Parks

Type of Park[46]	Purpose	Examples
Destination parks	Destination parks are well known parks that draw people from far and wide.	Ambleside Park, Dundarave Park, public waterfront between Ambleside Park and Dundarave including the Seawalk, Lighthouse Park, Horseshoe Bay Park
Community parks	Community parks support recreation and social activities for multiple neighbourhoods.	Hugo Ray Park, Seaview Walk, Memorial Park
Neighbourhood parks	Neighbourhood parks are within walking distance and meet local needs.	Leyland Park, Altamont Park, Plateau Park
Natural area parks	Natural area parks protect forests and creeks and provide nature experiences.	Ballantree Park, McKechnie Park, Nelson Canyon Park, Whyte Lake Park
Shoreline access parks	Shoreline access parks provide the public the opportunity to reach the waterfront.	Altamont Beach Park, Sandy Cove Park
Open spaces	Open spaces are other District properties that are not "parks" in the classical sense.	Capilano View Cemetery, Gleneagles Golf Course and Taylor Way Boulevard and small remnants of green space within developments
School sites	School sites include the green space portion of public school sites.	Sport fields, play areas and green space on school sites support school and community sports, casual recreation, and social gathering
Upper Lands	Provide recreation, access and watershed protection.	District owned Upper Lands

The distribution of parks can be seen in a map from the Parks Master Plan.

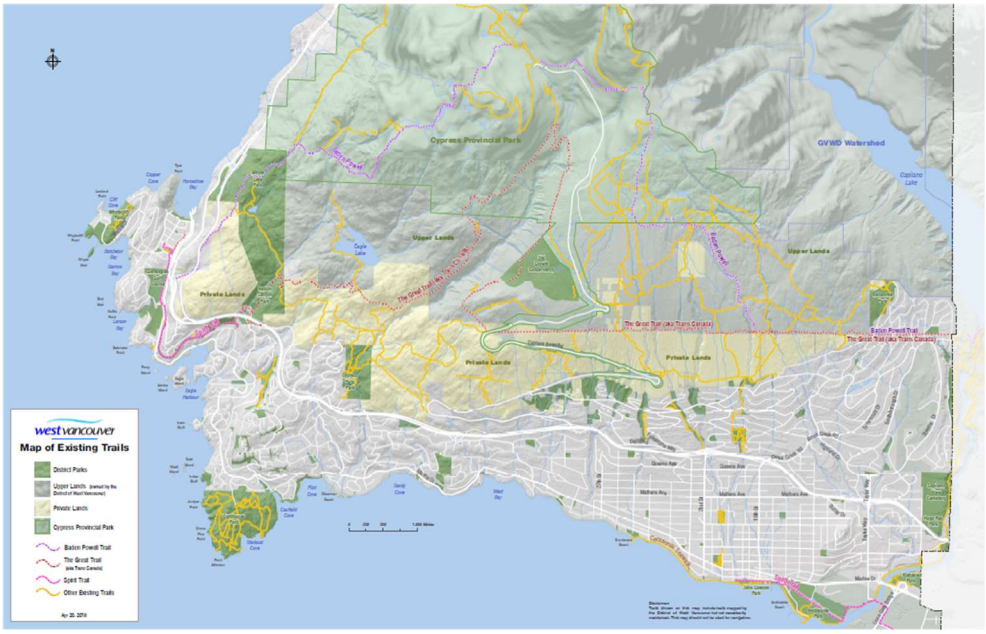
Map of Park Types



Trails

West Vancouver has more than 135 km of trails on public land and many informal trails on private land. Trails provide mobility, activity and social connection. They link our neighbourhoods and, in some cases such as the new Spirit Trail, north shore communities.

Map of Existing Trails



Services provided by parks and other green space

Recreation

We may not think of our parks and trails as "assets," but they play a role in attracting both residents and visitors. The most recent park user survey found that 95 per cent of households visited a West Vancouver park in the past year.[47] Some of the most popular activities in West Vancouver parks include walking, running, dog-walking and going to the beach. These are low cost, accessible activities that most people can enjoy.

The North Shore Mountain Biking Association surveyed users of north shore trails in 2016 and determined that 12,000 riders from outside Metro Vancouver came to experience the iconic trail system. The same survey found that 65 per cent of north shore residents said the trails were an important or very important factor in their decision to live on the north shore.

Residential yards and gardens offer another source of green space, with opportunities for activities such as gardening and bird watching. Bird watching is enjoying a burst of popularity with Vancouver Magazine calling it "The Next Big Thing".[48]

From the beach to the mountains to back yards, West Vancouver residents are using our green space to connect with nature. The Canadian Parks Council emphasizes that regular doses of nature, even in urban settings, have benefits that ripple out from the individual to their family, neighbourhood, community and society.[49]

Health

Urban green space has benefits for physical and mental health. The 2014 Canadian Parks Council report assembled an impressive list of studies linking proximity to or views of nature to improvements in obesity, stress reduction, surgical recovery and cognitive function, among others.[50] A more recent Canadian study based on almost 70,000 people who lived in urban areas found that urban greenness was associated with physical activity in all groups, and more strongly among younger adults.

Valuation

In this section we focus on the value of grasslands, which includes all forms of meadows in addition to turf. A significant portion of West Vancouver grasslands are in the higher elevations, along utility rights of way for instance. The value in the table for grasslands recreation greatly understates the total value of parks because parks with forest cover or on the beach have already been counted in other sections. This valuation also leaves out many social functions such as health, culture, and aesthetic values of parks that we have not been able to quantify.

Table 7 – Annual and cumulative values of services provided by West Vancouver grasslands
Please note that the values presented here are conceptual estimates and not an actual ledger. Estimates may change over time, reflecting the condition of the asset or our understanding of the value of services they provide.

		All monetary amounts in $1,000s Canadian (2019)			
Ecosystem service	**Area in hectares**	**Value per hectare**	**Convert to 2019$**	**Annual estimate**	**Estimate perpetuity**
Grasslands					
Recreation	661	$679	$737	$487	$16,237
Total grasslands				**$487**	**$16,237**

The recreation value per hectare above is transferred from the Howe Sound study which included an in-house calculation to adapt results from a Canadian survey of nature-based recreation to the Howe Sound region.

Factors that could affect the service life or value of this asset

Increased demand and conflicts in use

In a time of heightened concern about the health impacts of a sedentary lifestyle we should cheer the news that casual recreation is on the rise and West Vancouver is seeing increasing trail use.[51] However the popularity of trails comes with its challenges such as parking congestion, competing uses and environmental degradation. People use trails for a range of activities in terms of equipment, speed and expectations for public behaviour.

Degradation of sensitive ecosystems

Parks are a great place to absorb the benefits of nature, but just as there can be conflicts between users, there can also be a balancing act between providing access to nature for people and protecting sensitive ecosystems. Straying from trails or over-use can affect wildlife and sensitive areas. Over time, if an ecosystem becomes too degraded it can even lose its appeal for people and its value as a natural asset.

Invasive Plants

Invasive species affect our waterways, as discussed earlier. They are also a major concern in our parks, especially since there are so many areas that would be natural were it not for the invasive plants. The District developed a phased approach to address this issue with the 2014 Invasive Plant Strategy.

Actions and Implications

Parks Master Planning

The 2012 Parks Master Plan includes several core values that signal appreciation for natural capital assets, including their importance to sustainability and community well-being.

- Protection and stewardship of the natural environment and heritage resources
- Experience, appreciation, and understanding of the natural beauty, waterfront, creeks and forests
- Promotion and support of active living, health and social and spiritual well being
- Sustainability for future generations
- Parks as public land benefitting all people[52]

These core values guided the development of Parks Master Plan Goals (see box). Together, the core values and goals provide a foundation for all the ways we manage parks as natural capital assets. Outcomes of the Master Planning process include the creation of the 2014 District Invasive Plant Strategy and the 2018 Trails Plan whose respective recommendations are guiding District actions for the environment in these areas.

Parks Master Plan Goals with regards to Environmental and Cultural Resources[53]

1. Protect ecological integrity, species habitat and diversity, and heritage values.
2. Increase interpretation and education about the natural and heritage resources.
3. Protect areas with environmental values and historically significant parkland.
4. Embed environmental best practices within all Parks Department activities.

Adapting to climate change

Native plants that are adapted to our coastal environment usually require fewer resources, notably irrigation. Where possible, parks staff use native and resilient plants in parks plantings. The best example is the conversion of the ornamental plants along Centennial Seawalk to dune grass which requires no irrigation and can withstand the sea spray.

8. Conclusion

West Vancouver's natural capital delivers significant value to the municipality in the form of ecosystem services. Annually we enjoy benefits in the range of $27 to $90 million (Table 8). For context, District revenues in the form of property taxes provided $68 million in 2017. The natural assets that provide us with ecosystem services can be valued as a perpetuity worth $1 to $3 billion (Table 8). The District's Tangible Capital Assets had a net book value of $494 million at the end of 2017. This suggests that the natural capital that is not on our books is worth at least as much as the capital that is. This observation should lead us to take another look at our forests, waterways, foreshore and parks, and consider how we should be managing them to continue enjoying this impressive endowment of future benefits.

Table 8 Summary of Natural Capital Asset Values

	All monetary amounts in $1,000s Canadian (2019)			
Natural capital asset class	**Low estimate annual service**	**High estimate annual service**	**Low estimate asset**	**High estimate asset**
Upper forest	**$13,167**	**$37,197**	**$438,885**	**$1,239,911**
Urban forest	**$6,442**	**$18,200**	**$214,737**	**$606,662**
Total waterways (including riparian buffer)	**$2,644**	**$17,218**	**$88,128**	**$573,935**
Total foreshore	**$4,837**	**$16,487**	**$161,234**	**$549,589**
Total grasslands	**$487**	**$487**	**$16,237**	**$16,237**
Total carbon storage – forest, soils	**n/a**	**n/a**	**$228,842**	**$228,842**
	$27,577	**$89,589**	**$1,148,063**	**$3,215,176**

9. Next Steps

This high level inventory is a first step in thinking about West Vancouver's natural capital assets. Only a few ecosystem services have been valued for each asset class so we should consider the valuations as a low estimate. Even so, the inventory gives us a sense of how valuable some of those assets could be over the District's planning horizon.

There are several next steps the District could take:

1. Test and refine the inventory through engagement with subject matter experts
2. Monitor the developing field of natural capital asset valuation and update values as new data and best practices emerge
3. Drill down in the asset classes to develop a more granular inventory
4. Distinguish District owned assets
5. Introduce identifiable assets into the District's Asset Management Program where they can be monitored to the same standard as other assets
6. Consider natural assets in the capital budgeting process
7. To the extent that public accounting standards permit, incorporate natural capital assets into the District's financial reporting

[1] Town of Gibsons was the first municipality to include in its financial report a statement on natural assets, https://gibsons.ca/sustainability/natural-assets/gibsons-natural-asset-management-journey/

"The Town is fortunate to have many natural assets that reduce the need for man-made infrastructure that would otherwise be required. This includes the Gibsons aquifer (water storage and filtration), creeks, ditches and wetlands (rain water management) and the foreshore area (natural seawall). Canadian public sector accounting standards do not allow for the valuation and recording of such assets into the financial statements of the Town. As such, these natural assets are not reported in these financial statements. Nevertheless, the Town acknowledges the importance of these assets and the need to manage them in conjunction with man-made infrastructure."

[2] West Vancouver was part of the first cohort of communities to pilot an approach created by Gibsons, B.C. and developed by the Municipal Natural Assets Initiative, https://mnai.ca/media/2018/07/MNAI_WestVan-final.pdf.

[3] We used an approach that characterizes ecosystem services based on a model defined in The Economics of Ecosystems and Biodiversity (TEEB) Reports (http://www.teebweb.org/). It links human-valued services, such as carbon sequestration to the land that provides the service. These are considered supporting or intermediate services in ecosystem valuation terminology. Other approaches focus on final services. The final services approach requires analysis of the beneficiaries of the service and the quantity of service used. This would require additional data but could be considered for some assets where there is a case for it.

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West Vancouver's Natural Capital Assets

Technical Appendix

This appendix provides more detail on the methods we used to value natural capital assets in West Vancouver.

Source of values for ecosystem services

We used the value transfer approach, transferring values for ecosystem services, by ecosystem type, from previous studies. In most cases, we transferred values from Sound Investment: Measuring the Return on Howe Sound's Ecosystem Assets[i]. This study also used value transfer and provides considerable detail on methodology and the primary studies referenced. An analysis of common valuation methods used by researchers (replacement cost, travel cost, etc.) is also provided in the Howe Sound study and not repeated here. We recommend readers to review the limitations of these approaches as they would apply to any values transferred. The Howe Sound study is available at https://davidsuzuki.org/science-learning-centre-article/sound-investment-measuring-return-howe-sounds-ecosystem-assets/

We reviewed the description of the primary studies used and selected low and high values for the studies that appeared most relevant to West Vancouver. We prioritized studies with the best match of ecosystem type and ecosystem service, and then proximity in terms of location and time.

In the following tables we indicate the underlying study that was the source of the values transferred from the Howe Sound study and provide a page number for ease of reference. Where the page number is n/a, it indicates that we drew on research that was not included in the Howe Sound study and the reference to the research is provided at the end of this appendix. "Value per hectare per year" is the value in 2014 dollars for all Howe Sound sources or source study currency for some carbon values. We used the Bank of Canada's Inflation Calculator and Currency Converter to convert all values to 2019 Canadian dollars.

Forests

Ecosystem service	Howe Sound pg	Position in range	Author(s)	Year and province/ state	Valuation method	Value per hectare per year	Convert to 2019$	Notes on study methods
Forests								
Clean water	31	Low	Wilson, S.J.	2010, BC	Replacement cost	$2,216	$2,405	Wilson estimated the value of water filtration based on the cost to replace this service with water treatment for surface water if forest cover declined.
Clean water	31	High	Ribaudo, M. and Epp. DJ	1984, VT	Travel cost	$5,601	$6,079	Author used surveys to estimate value of water quality improvement for recreation.
Water regulation/ runoff control	33	Low	Wilson, S.J.	2010, BC	Avoided cost	$719	$780	Calculated based on construction costs for water runoff control in the absence of the forest.

Water regulation/ runoff control	33	High	Wilson, S.J.	2010, BC	Avoided cost	$1,756	$1,906	As above
Clean air	36	Low	Nowak, D.J. et al	2014, WA	Avoided cost	$15	$16	Authors estimated the rate at which leaves remove atmospheric pollutants and the associated reduction in costs from decline in human mortality and respiratory distress.
Clean air	36	High	Wilson, S.J.	2010, BC	Avoided cost	$580	$629	Wilson used CITYgreen software to estimate the value of trees removing airborne pollutants.
Carbon sequestration	35	Low	Wilson, S.J.	2010, BC	Avoided cost	$46	$50	Wilson used IPCC value for Social Cost of Carbon (SCC) of $52 in 2005$Cdn, which includes environmental, economic and social costs from impacts of climate change, to estimate value of damages avoided by trees taking up carbon.
Carbon sequestration	n/a[ii]	High	Nowak, D.J. et al	2013, US	Avoided cost	$150	$221	Authors used 2010 SCC of $78.50 US, applying it to urban tree data gathered at plots across the U.S. and input to I-Tree Eco software. We used the net sequestration rate for Washington state.
Habitat	41	Low	Knowler, D.J. et al	2003, BC	Production	$4	$4	Authors linked land use in watersheds to quality of fish habitat, to estimate the value of habitat to the coho salmon fishery
Habitat	41	High	Haener, M.K. and Adamowicz, W.L.	2000, AB	Contingent valuation/ production	$34	$37	Authors estimated passive protection of biodiversity based on willingness to pay (WTP) for protecting a threatened species in the study area, and the opportunity costs of timber foregone.
Recreation	44	Low	Knowler, D.J. and Dust, K.	2008, BC	Contingent valuation	$134	$145	For a study of the value of protecting old growth forest, this survey of consumers measured how much they value outdoor recreation beyond the amount they spend on it.
Recreation	44	High	Molnar, M.	2015, BC	Travel cost	$679	$737	Adapted from multi-jurisdictional Canadian survey of nature-based recreation. General estimate for all forms of recreation and all ecosystem types in Howe Sound study area.

Waterways

Ecosystem service	Howe Sound pg	Position in range	Author(s)	Year and province/ state	Valuation method	Value per hectare per year	Convert to 2019$	Notes on study methods
Reservoirs, excluding riparian area								
Clean water supply	31	Low	Hauser, A. and Van Kooten, G.C.	1993, BC	Contingent valuation and	$120	$130	Value of improved water quality in Abbotsford was estimated using outlays on bottled water and water filters, and through survey of willingness to pay for improvements.

					replacement cost			
Clean water supply	31	High	Gupta, T.R. and Foster, J.H.	1975, MA	Opportunity cost	$39,480	$42,848	Study compared cost of providing municipal water supply from preserved wetlands with supply from an alternative source.
River, including riparian buffer								
Water regulation/ flood reduction	33	No range	U.S. Army Corp. of Engineers	1971, MA	Avoided cost	$1,212	$1,315	Authors estimated the value of the loss of valley storage on flood flows.
Habitat	41	Low	Knowler, D.J. et al.	2003, BC	Avoided cost and production	$29	$31	Authors linked land use in watersheds to quality of fish habitat, to estimate the value of habitat to the coho salmon fishery.
Habitat	41	High	Streiner, C. And Loomis, J.	1996, CA	Hedonic pricing	$950	$1,031	Study valued stream restoration measures that reduced flood damage and improved fishing habitat, with reference to increase in property values.
Recreation	44	Low	Kealy, M.J. and Bishop, R.C.	1986, MI	Travel cost	$43	$47	Authors surveyed anglers in Michigan about their willingness to spend time and out of pocket costs for recreational fishing.
Recreation	45	High	Duffield, J.W. et al.	1992, MT	Contingent valuation and travel cost	$17,794	$19,312	Study examined willingness to pay for recreational trips related to stream-flow levels.
Creeks, including riparian area								
Water regulation/ flood reduction	33	Low	Leschine, T.M. et al	1997, WA	Avoided cost	$1,620	$1,758	Study analyzed the cost of engineered alternatives to flood reduction currently provided by wetlands.
Water regulation/ flood reduction	33	High	Leschine, T.M. et al	1997, WA	Avoided cost	$7,398	$8,029	As above
Water filtration (riparian buffer)	38	Low	Zhongwei, L.	2006, OH	Replacement cost	$830	$901	Study valued riparian forest buffer zones based on cost of wastewater treatment.
Water filtration (riparian buffer)	31	High	Wilson, S.J.	2010, BC	Replacement cost	$2,216	$2,405	Wilson estimated the value of water filtration based on the cost to replace this service with water treatment for surface water if forest cover declined.
Habitat	41	Low	Knowler, D.J. et al.	2003, BC	Avoided cost and production	$29	$31	Authors linked land use in watersheds to quality of fish habitat, to estimate the value of habitat to the coho salmon fishery.
Habitat	41	High	Streiner, C. And Loomis, J.	1996, CA	Hedonic pricing	$950	$1,031	Study valued stream restoration measures that reduced flood damage and improved fishing habitat, with reference to property transactions.
Recreation	45	Low	Mahan, B.L. et al.	2000, OR	Hedonic pricing	$117	$127	Authors estimated the value of urban wetlands as amenities, using property transactions.
Recreation	45	High	M. Molnar	2015, BC	Travel cost	$679	$737	Adapted from multi-jurisdictional Canadian survey of nature-based recreation. General estimate for all forms of recreation and all ecosystem types in Howe Sound study area.

Small lakes and ponds								
Water regulation/flood reduction	33	Low	Leschine, T.M. et al	1997, WA	Avoided cost	$1,620	$1,758	Study analyzed the cost of engineered alternatives to flood reduction currently provided by wetlands.
Water regulation/flood reduction	33	High	Leschine, T.M. et al	1997, WA	Avoided cost	$7,398	$8,029	As above
Water filtration	38	Low	Zhongwei, L.	2006, OH	Replacement cost	$830	$901	Study valued riparian forest buffer zones based on cost of wastewater treatment
Water filtration	31	Low	Wilson, S.J.	2010, BC	Replacement cost	$2,216	$2,405	Wilson estimated the value of water filtration based on the the cost to replace this service with water treatment for surface water if forest cover declined.
Habitat	41	Low	Knowler, D.J. et al.	2003, BC	Avoided cost and production	$29	$31	Authors linked land use in watersheds to quality of fish habitat, to estimate the value of habitat to the coho salmon fishery.
Habitat	41	High	Wilson, S. J.	2008, ON	Avoided cost	$6,537	$7,095	Wilson estimated and annualized the cost of restoring wetland habitat in the Great Lakes region.
Recreation	45	Low	Mahan, B.L. et al.	2000, OR	Hedonic pricing	$117	$127	Authors estimated the value of urban wetlands as amenities, using property transactions.
Recreation	45	High	M. Molnar	2015, BC	Travel cost	$679	$737	Adapted from multi-jurisdictional Canadian survey of nature-based recreation. General estimate for all forms of recreation and all ecosystem types in Howe Sound study area.

Foreshore

Ecosystem service	Howe Sound pg	Position in range	Author(s)	Year and province/ state	Valuation method	Value per hectare per year	Convert to 2019$	Notes on study methods
Beach								
Erosion regulation	33	No range	Parsons, G.R. and Powell, M.	2001, DE	Hedonic pricing	$73,811	$80,107	Authors estimated the cost of beach retreat inland in terms of land and structures lost.
Recreation	44	Low	Edwards, S.F. and Gable, F.J.	1991, RI	Hedonic pricing	$489	$531	Recreation value of public beaches estimated from nearby property values.
Recreation	44	High	Kline, J.D. and Swallow, S.K.	1998, MA	Contingent valuation	$151,261	$164,164	Authors estimated demand for beach activities and willingness to pay for beach access.
Habitat, intertidal area only	41	No range	Johnson, R.J. et al	2002, NY	Production approach	$290	$315	Study examined the value of sand/mud bottoms, intertidal marsh and eel grass to fish, shellfish and bird species.
Rock								
Recreation	44	Low	Edwards, S.F. and Gable, F.J.	1991, RI	Hedonic pricing	$489	$531	Recreation value of public beaches was estimated from nearby property values.

Recreation	44	High	Kline, J.D. and Swallow, S.K.	1998, MA	Contingent valuation	$151,261	$164,164	Adapted from multi-jurisdictional Canadian survey of nature-based recreation. General estimate for all forms of recreation and all ecosystem types in Howe Sound study area.

Parks and Green Space

Ecosystem service	Howe Sound pg.	Position in range	Author	Year and province/ state	Valuation method	Value per hectare per year	convert to 2019$	Notes on study methods
Recreation	44	No range	Molnar, M.	2015, BC	Travel costs	$679	$737	Adapted from multi-jurisdictional Canadian survey of nature-based recreation. General estimate for all forms of recreation and all ecosystem types in Howe Sound study area.

Valuation of Carbon Storage

Carbon storage differs from other ecosystem services in that it is a stock value rather than an annual service. The total carbon stored in biomass and soils has not been released to the atmosphere. By applying the social cost of carbon (SCC), we can calculate the avoided cost of damage that would result from the release of this carbon. Some valuations annualize this service over several years, but since that would require several assumptions about the rate of release, the future growth rate of biomass, discount rates and other factors, we chose to represent it as a total value. We used the amount of carbon stored per hectare by ecosystem type from the Sara Wilson's 2010 Lower Mainland study[iii]. As the social cost of carbon is updated regularly, we used the SCC from the more recent Howe Sound study, which uses the figure from the Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report.

				$1,000's of Canadian dollars	
Carbon storage	**Area in hectares**	**Carbon per hectare (tonnes) (1)**	**Social cost of carbon/tonne (2)**	**Value of carbon storage (2014)**	**Value of carbon storage (2019) (3)**
Forests (trees and soils)	5765	564.5	$60.97	$198,417	$215,342
Shrubs (soils only)	459	240	$60.97	$6,716	$7,289
Grasslands (soils only)	661	142	$60.97	$5,723	$6,211
Total					**$228,842**
(1) Wilson, S.J. 2010					
(2) Molnar, M. 2015					
(3) Bank of Canada factor					

Approach to calculating multi-year values

We aim to maintain the District's natural capital assets so that they can provide the same level of services in perpetuity. The tables in this section reflect that assumption in the final column titled "estimate perpetuity". If we adjusted our expectation to a 20 year service life to match our capital planning horizon, we could value the natural capital assets as a straight 20 year multiple of the annual service value ("estimate 20 years"). If we value services in the early years of that 20 year period more highly than the future, we might discount the results to get the present value of 20 years of services ("estimate PV 3%"). For both the present value and perpetuity calculations, we used a discount rate of 3%. At the time this study was done, the long term lending rate for B.C. municipalities from the Municipal Finance Authority was 2.99% for terms of 20 years or more[iv].

Forests

Ecosystem service	Area in hectares	Low annual estimate	High annual estimate	Low estimate 20 years	High estimate 20 years	Low estimate PV 3%	High estimate PV 3%	Low estimate perpetuity	High estimate perpetuity
Upper forest									
Clean water supply and filtration	3871	$9,310	$23,531	$186,197	$470,618	$138,507	$350,080	$310,328	$784,363
Stormwater management	3871	$3,021	$7,377	$60,413	$147,546	$44,940	$109,756	$100,689	$245,910
Clean air	3871	$63	$2,437	$1,260	$48,734	$938	$36,252	$2,101	$81,223
Carbon sequestration	3871	$193	$857	$3,865	$17,139	$2,875	$12,750	$6,442	$28,566
Habitat	3871	$17	$143	$336	$2,857	$250	$2,125	$560	$4,761
Recreation	3871	$563	$2,853	$11,259	$57,052	$8,375	$42,440	$18,765	$95,087
Total upper forest		**$13,167**	**$37,197**	**$263,331**	**$743,946**	**$195,885**	**$553,402**	**$438,885**	**$1,239,911**
Old forest, in upper forest total	1069	*$3,636*	*$10,272*	*$72,720*	*$205,445*	*$54,095*	*$152,825*	*$121,201*	*$342,409*
Urban forest									
Clean water supply and filtration	1894	$4,555	$11,513	$91,102	$230,264	$67,769	$171,287	$151,837	$383,773
Stormwater management	1894	$1,478	$3,610	$29,559	$72,191	$21,988	$53,701	$49,265	$120,319
Clean air	1894	$31	$1,192	$617	$23,844	$459	$17,737	$1,028	$39,741
Carbon sequestration	1894	$95	$419	$1,891	$8,386	$1,407	$6,238	$3,152	$13,977
Habitat	1894	$8	$70	$164	$1,398	$122	$1,040	$274	$2,330
Recreation	1894	$275	$1,396	$5,509	$27,914	$4,098	$20,765	$9,181	$46,524
Total urban forest		**$6,442**	**$18,200**	**$128,842**	**$363,997**	**$95,842**	**$270,768**	**$214,737**	**$606,662**
Total forest	**5,765**	**$19,609**	**$55,397**	**$392,173**	**$1,107,944**	**$291,727**	**$824,170**	**$653,622**	**$1,846,573**

Waterways

		All monetary amounts in $1,000s of Canadian dollars (2019)							
Ecosystem services	**Area in hectares[v]**	**Low annual estimate**	**High annual estimate**	**Low estimate 20 years**	**High estimate 20 years**	**Low estimate PV 3%**	**High estimate PV 3%**	**Low estimate perpetuity**	**High estimate perpetuity**
Reservoirs									
Clean water supply	145.9	$19	$6,251	$380	$125,029	$283	$93,006	$633	$208,382
Small lakes, ponds									
Water regulation	14.2	$25	$114	$499	$2,280	$371	$1,696	$832	$3,800
Water filtration	14.2	$13	$34	$256	$683	$190	$508	$426	$1,138
Habitat	14.2	$0.4	$101	$9	$2,015	$7	$1,499	$15	$3,358
Recreation	14.2	$1.8	$10	$36	$209	$27	$156	$60	$349
Total lakes & ponds		**$59**	**$6,511**	**$1,180**	**$130,217**	**$878**	**$96,865**	**$1,967**	**$217,028**
River									
Water regulation	20.3	$27	$27	$534	$534	$397	$397	$890	$890
Habitat	20.3	$0.6	$21	$13	$419	$10	$311	$21	$698
Recreation	20.3	$0.9	$392	$19	$7,841	$14	$5,832	$32	$13,068
Creeks									
Water regulation	907.4	$1,595	$7,286	$31,908	$145,711	$23,735	$108,391	$53,179	$242,852
Water filtration	907.4	$817	$2,182	$16,348	$43,646	$12,161	$32,467	$27,246	$72,744
Habitat	907.4	$29	$131	$571	$2,620	$425	$1,949	$952	$4,366
Recreation	907.4	$115	$669	$2,304	$13,374	$1,714	$9,948	$3,841	$22,289
Total river & creeks		**$2,585**	**$10,707**	**$51,697**	**$214,144**	**$38,456**	**$159,296**	**$86,161**	**$356,907**
Total waterways		**$2,644**	**$17,218**	**$52,877**	**$344,361**	**$39,334**	**$256,161**	**$88,128**	**$573,935**

Foreshore

		All monetary amounts in $1,000s of Canadian dollars (2019)							
Ecosystem service	**Area in hectares[vi]**	**Low annual estimate**	**High annual estimate**	**Low estimate 20 years**	**High estimate 20 years**	**Low estimate PV 3%**	**High estimate PV 3%**	**Low estimate perpetuity**	**High estimate perpetuity**
Beach									
Storm surge protection		data not available							
Erosion regulation	59.8	$4,790	$4,790	$95,808	$95,808	$71,269	$71,269	$159,680	$159,680
Recreation	59.8	$32	$9,817	$635	$196,340	$472	$146,052	$1,058	$327,233
Habitat, intertidal area only	28	$9	$9	$176	$176	$131	$131	$294	$294
Total beach		**$4,831**	**$14,616**	**$96,619**	**$292,324**	**$71,872**	**$217,452**	**$161,032**	**$487,207**
Rock									
Storm surge protection		data not available							
Recreation	11.4	$6	$1,871	$121	$37,429	$90	$27,843	$202	$62,382
Total foreshore		**$4,837**	**$16,487**	**$96,740**	**$329,753**	**$71,962**	**$245,295**	**$161,234**	**$549,589**

Parks and Open Space

Parks comprise many ecosystem types and the values associated with forest, foreshore and aquatic parks have been captured in other areas. The remaining ecosystem types of grasslands and shrubs fit in this category, but the only service we were able to value for these ecosystems (apart from carbon storage which is addressed below) was recreation. The value for recreation is also a general value for all forms of recreation throughout Howe Sound. A study of turf fields for sports or grass-cover in school yards would likely yield a higher valuation.

Ecosystem service	**Area in hectares[vii]**	**Value per hectare**	**Convert to 2019$**	**Annual estimate**	**Estimate 20 years**	**Estimate PV 3%**	**Estimate perpetuity**
Grasslands							
Recreation	661	$679	$737	$487	$9,742	$7,247	$16,237
Total grasslands				**$487**	**$9,742**	**$7,247**	**$16,237**

Further research opportunities

The estimates we developed in this report are suitable for raising awareness and informing broad policy direction, but more detailed and location-specific work may be needed to support District actions to maintain natural capital assets. The value transfer approach relies on previously completed research that may not match West Vancouver's situation in some respects. We found gaps in the literature in terms of location (more east coast studies than west coast), ecosystems (wetlands were well represented but urban creeks/streams were not), and ecosystem services (more coastal habitat studies are needed for species other than commercially significant fish species). Despite a thorough search of their database by one of our technical advisors, we did not find a suitable study valuing the important role of the foreshore in storm surge protection. By focussing any further research in areas of local significance, the District may also be able to fill some gaps in the science of ecosystem service valuation.

[i] Molnar, M. (2015), Sound Investment: Measuring the Return on Howe Sound's Ecosystem Assets, David Suzuki Foundation, https://davidsuzuki.org/science-learning-centre-article/sound-investment-measuring-return-howe-sounds-ecosystem-assets/

[ii] Adapted from Nowak et. al (2013), Carbon storage and sequestration by trees in urban and community areas of the United States, Environmental Pollution 178, 229-236.

[iii] Wilson, S.J. (2010), Natural Capital in BC's Lower Mainland: Valuing the Benefits from Nature, David Suzuki Foundation, https://davidsuzuki.org/science-learning-centre-article/natural-capital-b-c-s-lower-mainland-valuing-benefits-nature/

[iv] https://mfa.bc.ca/long-term-lending-rates

[v] Area of waterways was taken from Metro Vancouver's SEI database – fresh water and riparian categories and allocated to the assets in this report by referring to the District's landcover analysis.

[vi] Area of beach and rocky foreshore was determined using District landcover analysis. Intertidal area was taken from Metro Vancouver's SEI database.

[vii] Area of grassland was determined using District landcover analysis.

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