Metro Facts in Focus | Policy Backgrounder

Green Infrastructure in Metro Vancouver

metrovancouver
SERVICES AND SOLUTIONS FOR A LIVABLE REGION

Introduction

Green infrastructure refers to the natural vegetation, soils, and bioengineered solutions that collectively provide society with a broad array of products and services for healthy living. Natural areas such as forests, wetlands and floodplains, and engineered systems like green roofs and rain gardens conserve natural resources and mitigate negative environmental effects, benefiting both people and wildlife. When green infrastructure is connected as part of a larger framework, a green infrastructure network is created.

This policy backgrounder describes the role that green infrastructure can play in fostering a highly livable and sustainable metropolitan region.

Metro Vancouver has a spectacular natural environment, which supports and is enjoyed by over 2.4 million residents. However, the grey infrastructure – pipes, culverts, and impervious surfaces like roads and roofs – that accompanies our growing population has created many challenges for the region, including sustainably managing waste streams and a loss of biodiversity.

Harnessing nature to store and purify water, moderate climate, protect against extreme weather events, and support biodiversity is a green infrastructure alternative to the conventional grey infrastructure commonly used today. Large and small green infrastructure components work collectively to improve the condition of urban environments, and support healthier, more livable and sustainable communities in Metro Vancouver.

Green infrastructure can be a cost-effective and lower-maintenance solution that is more beneficial than grey infrastructure for people and the environment.

This *Facts in Focus* Backgrounder describes different forms of green infrastructure, how it provides integrated benefits across the regional landscape, how those benefits are maximized when green infrastructure is connected as part of a regional network, and the role it could play in land use planning.

The *Metro Vancouver Facts in Focus* series is designed to promote a broad understanding of the key issues and opportunities that frame Metro Vancouver's implementation of the regional growth strategy and its mandate for delivering services and solutions for a livable region.

Metro Vancouver is a political body and corporate entity operating under provincial legislation as a 'regional district' and 'greater boards' that deliver regional services, policy, and political leadership on behalf of 23 local authorities. These local authorities comprise 21 municipalities, one electoral area, and one Treaty First Nation. Providing timely research and analysis of regional issues is an important service provided by Metro Vancouver.

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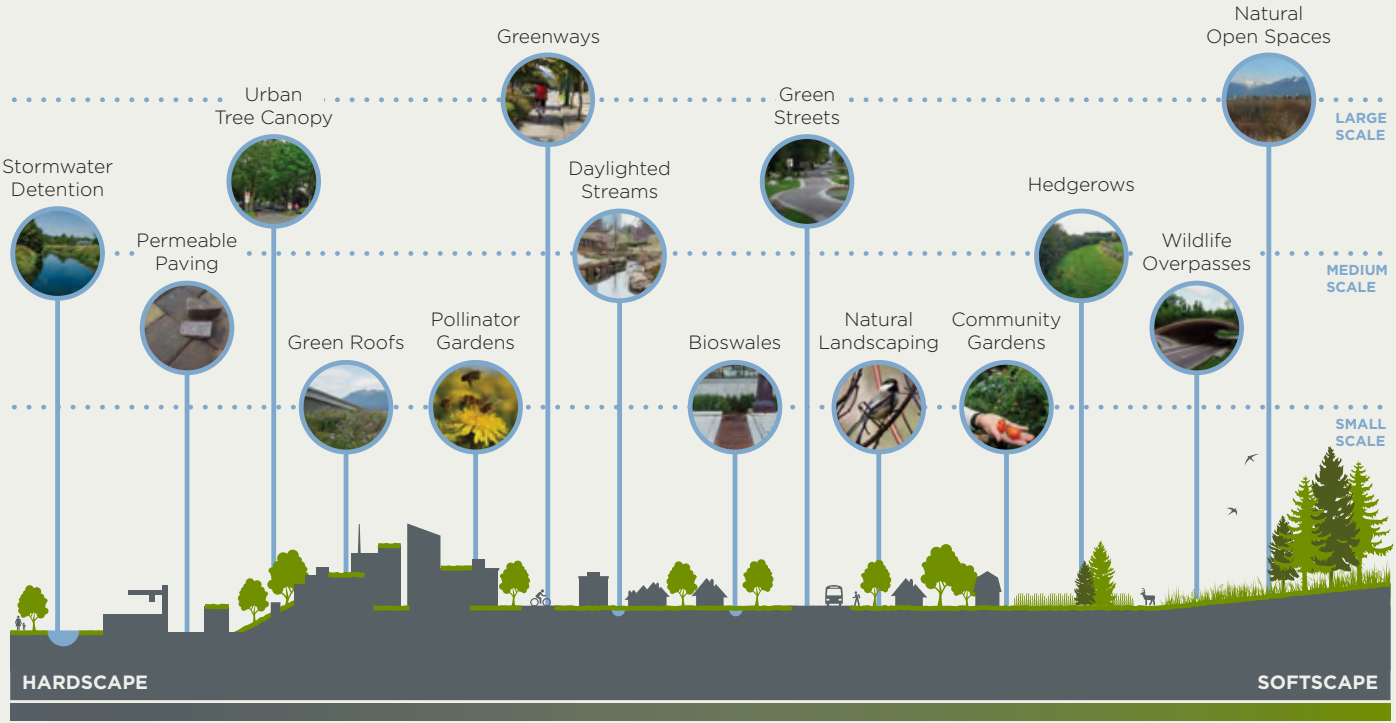
A. Green Infrastructure Overview

Green infrastructure refers to the natural vegetation, soils, water, and bioengineered solutions that collectively provide society with a broad array of products and services that are crucial to health and livability. Natural areas such as forests, wetlands and floodplains, and engineered systems like green roofs and rain gardens conserve natural resources and mitigate negative environmental effects, benefiting both people and wildlife. Green infrastructure has the following characteristics:

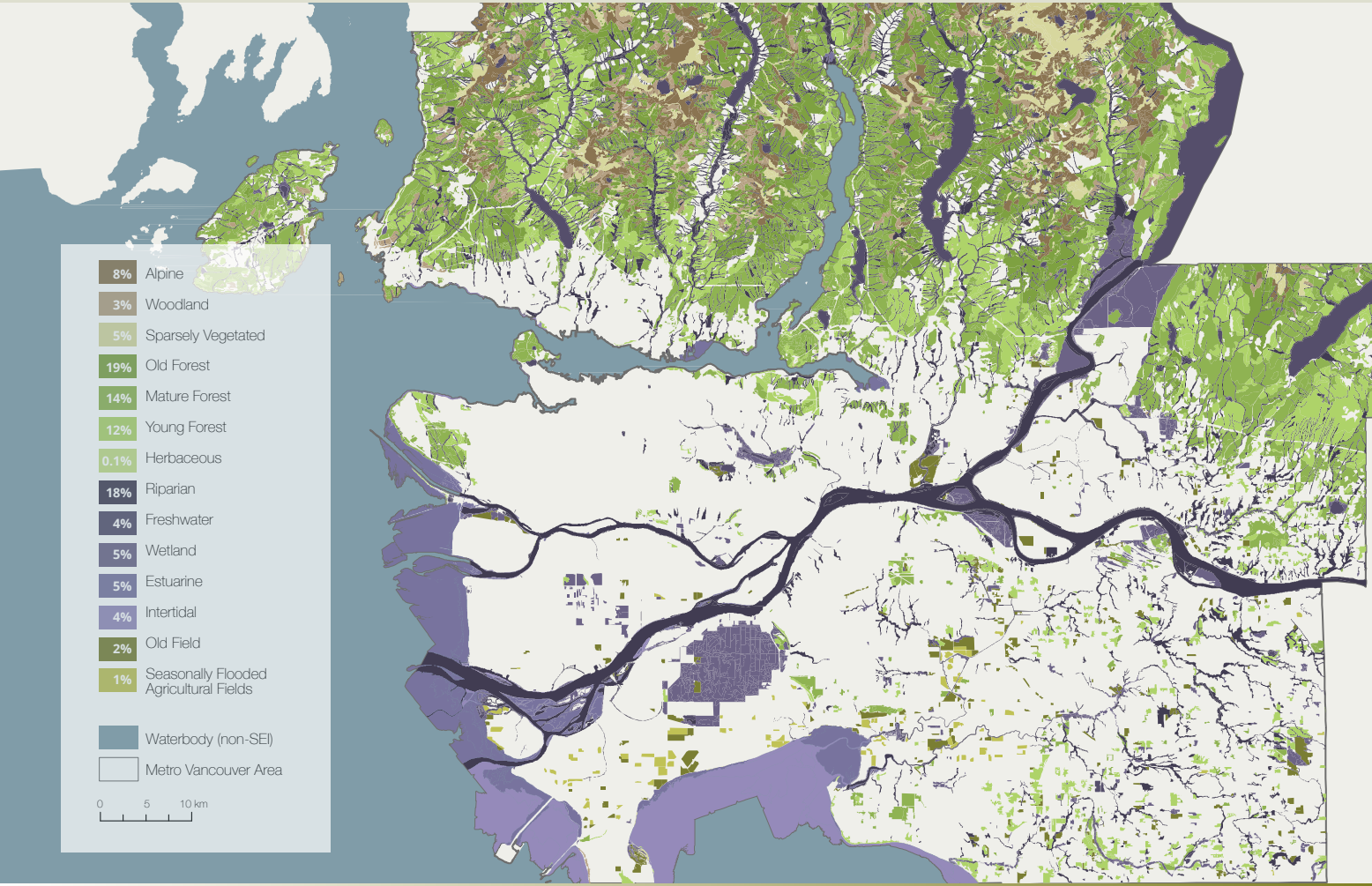
- Multifunctional: Green infrastructure provides a variety of benefits and 'free' ecosystem services to people and wildlife.
- Adaptive: Green infrastructure includes both natural and constructed forms, and can be implemented at different scales and surfaces (hard-scape to soft-scape).
- Sustainable: Green infrastructure supports broad-based community sustainability goals, including social well-being, community health, and ecological and environmental sustainability. It can also provide economic benefits by reducing the capital, maintenance, and replacement costs of conventional grey infrastructure.

Green infrastructure includes both natural ecosystem components and human-made components.

GREEN INFRASTRUCTURE OPPORTUNITIES ACROSS THE URBAN LANDSCAPE



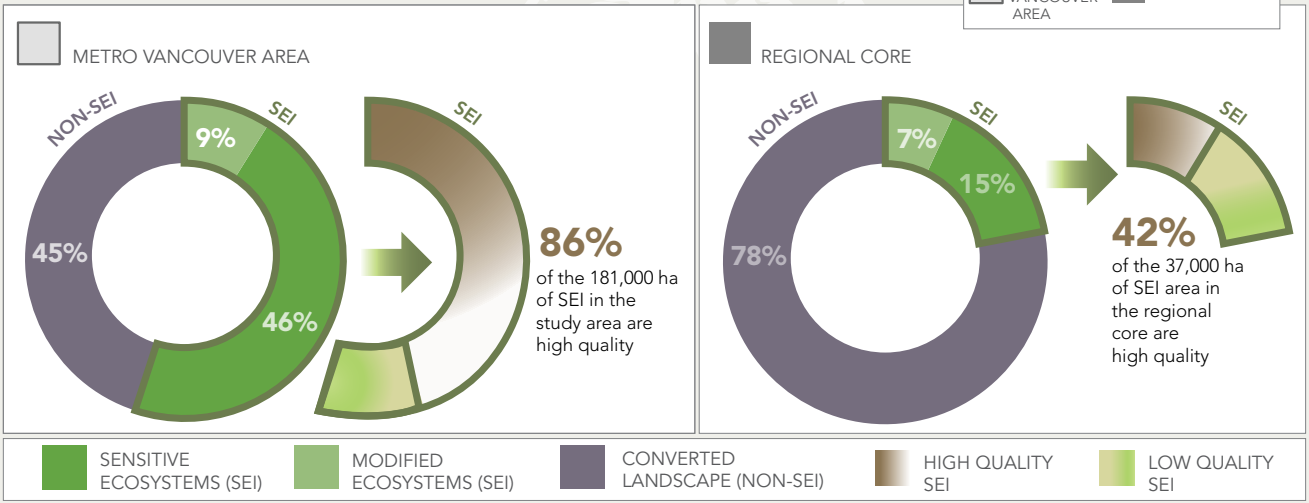
SENSITIVE ECOSYSTEM INVENTORY– REGIONAL ECOSYSTEM DISTRIBUTION



Natural Ecosystem Components

Natural ecosystem components of a green infrastructure network include forests, wetlands, and floodplains. These elements are often significantly impacted by land development, however, large areas of intact ecosystems often remain. The Metro Vancouver Sensitive Ecosystem Inventory (completed in 2012) identified 181,000 hectares of sensitive or modified ecosystems, which represents 55 percent of the region.

The map on page six shows the different classes of sensitive and modified ecosystems, and their distribution throughout Metro Vancouver. The graphics below indicate how the area of sensitive ecosystems drops to 22 percent in the regional core, which comprises the more-urbanized southern part of the region.



Human-made Components

Human-made components of green infrastructure mimic pre-disturbance processes, including infiltration, filtration, storage, evaporation, and transpiration processes as well as shading and reflecting energy from the sun. The intent of these features is to emphasize conservation, use on-site natural features, and integrate site planning and stormwater management practices into project design. This type of green infrastructure includes trees, rain gardens, permeable pavements, green roofs, blue roofs, and rainwater harvesting. In addition to the stormwater management and cooling functions of such features, these technologies can simultaneously help filter air pollutants, reduce energy demands, mitigate urban heat islands, and sequester carbon while also providing people with a more beautiful community.

Examples of Human Made Green Infrastructure

GREEN ROOFS AND RAIN GARDENS

Vegetated open channels and landscaped areas designed to manage stormwater runoff from hard surfaces such as roofs, roads and parking lots. These features can also provide important wildlife habitat.

DAYLIGHTED STREAMS

Uncovered streams that had previously been diverted into pipes and culverts, and buried underground. These restored streams provide valuable urban green space, stormwater management benefits, and habitat for fish and wildlife. They can also provide important habitat corridors and links between larger natural areas.

GREEN ROOFS AND GREEN WALLS

Green (or living) roofs are specially designed vegetated building roofs that better manage stormwater, improve energy efficiency and provide wildlife habitat. Green walls are essentially vertical gardens, some include specialized modular elements secured to building walls.

PERMEABLE PAVING

A type of hard surfacing that allows rainfall to percolate through to underlying soil substrate or be removed by a subsurface drain. Permeable paving can replace conventional asphalt and concrete for sidewalks, driveways, parking areas and road surfaces.

URBAN TREE CANOPY

The urban tree canopy includes dense stands of trees in parks, street streets, and trees on private property. Collectively, the urban tree canopy provides numerous health and environmental benefits, including air filtration, shading and cooling, stormwater retention and detention, carbon sequestration, wind-breaks, urban beautification and habitat for birds, animals and insects.

BIOSWALES AND RAIN GARDENS

DAYLIGHTED STREAMS

GREEN ROOFS AND GREEN WALLS

PERMEABLE PAVING

URBAN TREE CANOPY

B. Green Infrastructure and Ecosystem Services

Green infrastructure, both in its natural form (e.g. forests, riparian areas, wetlands etc.) and human-made forms (e.g. street trees, green roofs etc.), provides 'free' ecosystem services that support sustainable development and livable communities. For example, ecosystem services that benefit the region include clean air and water, crop pollination, and carbon sequestration.

Green Infrastructure Benefits

- **QUALITY OF LIFE:** Green spaces improve livability, enhance the character of local communities, and provide access to nature.
- **HUMAN HEALTH:** Interaction with nature is essential to human health. A large and growing body of research demonstrates that physical, social, and psychological well-being are positively influenced by our views of and access to nature.
- **RECREATION:** Connected and expanded green networks increase both passive (e.g. sitting in nature, bird watching) and active (e.g. jogging, cycling) recreation opportunities.
- **FOOD PRODUCTION:** Green infrastructure supports a diversity of insects, plants, animals, and other organisms, many of which are beneficial to local food production. Community and household gardens contribute to livability and provide an affordable local food source.
- **ENVIRONMENTAL EDUCATION:** Urban green space creates more opportunities for people to experience, engage with, and learn about nature and ecosystem services.

David Suzuki Foundation, Natural Capital in BC's Lower Mainland: Valuing the Benefits From Nature (2010): The total value for all benefits provided by the study area's natural capital is estimated at $5.4 billion per year. The top three benefit values are climate regulation ($1.7 billion), water supply ($1.6 billion) and flood protection/ water regulation ($1.2 billion).

- **FINANCIAL:** Greener environments can attract businesses and employees, and provide jobs in tourism, agriculture, and other sectors. Green infrastructure can also minimize capital requirements, and reduce long-term maintenance and replacement costs associated with traditional infrastructure.
- **STORMWATER MANAGEMENT:** Green infrastructure can mimic and replace conventional grey infrastructure such as stormwater pipes and tanks, resulting in reduced capital and maintenance costs. Trees and vegetation increase rainwater interception and infiltration, reducing the risk of storm sewage overflows and flooding.
- **ENERGY EFFICIENCY:** Trees and vegetation shade and cool buildings in the summer, and help insulate buildings in the winter.
- **AIR QUALITY:** Trees help cool the atmosphere, reducing the production of harmful pollutants.Trees and vegetation also absorb and store carbon dioxide, and release oxygen into the atmosphere.
- **WATER QUALITY:** Vegetation and healthy soils clean urban runoff and allow water to be absorbed into the ground, replenishing streams and groundwater.
- **HAZARD REDUCTION:** Landscapes with vegetation absorb water and stabilize slopes, helping to protect the built environment against hazards like flooding and landslides.
- **BIODIVERSITY:** Restored natural vegetation, streams, lakes, and wetlands provide habitat, including food and shelter for a diversity of species. Natural corridors allow plants and animals to move between larger habitat areas, overcoming the effects of habitat fragmentation, and helping to diversify the gene pool.
- **RESILIENCE:** Actively managing for biodiversity, and buffering ecosystems supports future recovery from negative external forces.
- **FACILITATION:** Assisting species migration, and daylighting streams helps natural systems shift from one state to another.

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Photo by Payton Chung, Creative Commons, Flickr

Overcoming Challenges

Although the benefits of green infrastructure are becoming more widely known, challenges continue that impede the adoption of green infrastructure approaches. These challenges are:

- technical and physical.
- legal and regulatory.
- community-based and institutional.
- financial.

Technical and physical barriers can include greater space requirements for green infrastructure, lack of trust in the supporting science and technology, new and different maintenance needs, and challenges associated with incorporating green infrastructure into existing grey infrastructure systems. Some of these barriers can be overcome by incorporating green infrastructure objectives early in design processes, developing and expanding training programs for staff, and improving documentation of maintenance activities

Legal and regulatory challenges in Metro Vancouver are not the result of lack of authority, but the need for a suite of regulatory tools that fit each government appropriately. There is no single responsible authority, and there are many tools needed to implement a network of green infrastructure. An approach that includes education, collaboration and commitment can overcome these challenges.

Community and institutional barriers include a lack of general knowledge and misperceptions about green infrastructure, landowner preferences, existing development plans, and resistance to change. These challenges require easier to understand information for decision makers, government staff, private developers, and the public about green infrastructure and its benefits.

Financial challenges largely stem from a fear that green infrastructure will cost more in the short or longterm. A growing body of research and experience demonstrates, however, that when the longterm environmental, social, and economic benefits of green infrastructure are weighed against the costs, significant savings can be made compared with grey infrastructure. Green infrastructure savings are also realized by:

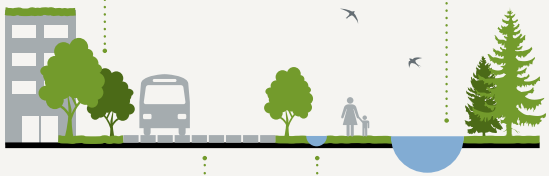
Photo by Ruth Hartnup, Creative Commons, Flickr

COST COMPARISON OF GREEN STREET INFRASTRUCTURE VS GREY INFRASTRUCTURE

GREEN ROOFS
According to Portland's Green Roof Program, green roofs can cost one and a half times more than conventional roofs to install. However, a green roof will last twice as long before needing to be replaced, and will reduce annual stormwater volumes by over 50%.

PERMEABLE PAVING
Permeable pavement in alleys can have a life expectancy of 30 – 35 years and runoff reductions of 70 – 90%.

TREES
Economic benefits related to stormwater management, improved air quality, reduced energy consumption, carbon sequestration, and better aesthetics can be $1.50 - $3.00 per tree for every $1 invested in planting/maintenance.



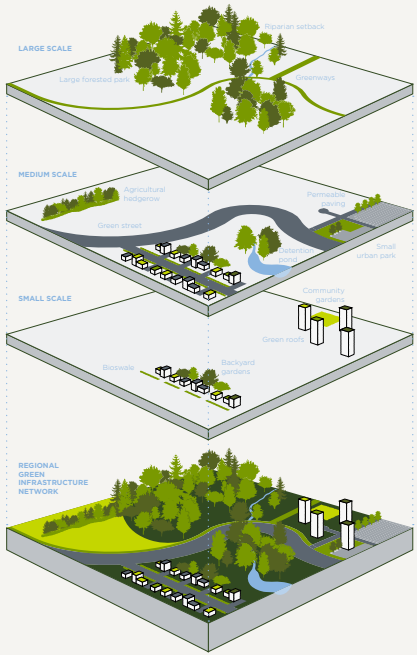
WETLANDS AND DETENTION PONDS
Building a wastewater treatment system using constructed wetlands costs about $5 per gallon of capacity compared to roughly $10 per gallon of capacity for a conventional advanced treatment facility.

BIO-SWALES
The City of Portland found vegetated bio-swales reduced 25 year peak storm flows by 88% and total flow into local sewers by 85% compared to conventional infrastructure.

- **DIRECT COST SAVINGS:** Building and maintenance costs for green infrastructure can be less than those for conventional grey infrastructure as municipalities and developers can save money through reduced capital and land acquisition costs. And, green infrastructure typically has a longer lifespan than conventional systems, reducing replacement costs.
- **INDIRECT COST SAVINGS:** The up-front costs of green infrastructure are recouped over time by the benefits and services they provide. For example, green roofs and trees can help to save money by reducing energy costs. In many municipalities, permeable pavement is being used to replace aging hard surfaces. Although initial installation costs can be higher than conventional paving, these costs are recouped over time through savings in maintenance, and stormwater management.
- **MULTIPLE BENEFITS:** The economic value of green infrastructure projects is compounded given the multiple functions they perform. For example, green infrastructure stormwater management projects often provide concurrent recreation, ecological, transportation (e.g. bike and pedestrian paths), health, urban design, and beautification benefits.

C. Toward a Regional Green Infrastructure Network

When green infrastructure is connected as part of a larger framework, a green infrastructure network is created.



A Connected Network

While individual, isolated elements of a green infrastructure network all provide some benefit, a certain critical mass and connectivity potential are needed to effectively contribute ecosystem services to a network. An individual tree may be a component of green infrastructure, but its greatest value is realized when it forms part of a larger network.

Many organizations are actively involved in protecting and developing green infrastructure in the region. The City of Surrey's Biodiversity Conservation Strategy and Green Infrastructure Network, and the City of Richmond's Ecological Network are examples of policies that value and are focused on increasing local green infrastructure. Having a regional green infrastructure network can foster collaboration and support work already underway across Metro Vancouver.

Opportunities

There are many opportunities available for implementing green infrastructure in the region, and a variety of planning tools and mechanisms can be employed to help protect existing green infrastructure, and to develop new projects of all sizes. Examples include:

- Expanding and buffering existing protected natural areas can significantly increase existing ecosystem service values.
- Aging or under-performing grey infrastructure can be replaced or supported by multi-functional green infrastructure during redevelopment.
- Planning and design of new developments can establish green infrastructure objectives to minimize grey infrastructure and hard-scape.
- Regional infrastructure projects (e.g. sewer, water, and transportation) can contribute to protecting and developing green infrastructure, and improving connectivity for a green infrastructure network.

CONCEPTUAL REGIONAL ECOSYSTEM CONNECTIONS

Benefits

Implementing a regional green infrastructure network would achieve a number of benefits:

1. Decrease the amount of rainwater conveyed to treatment plants and outflows by infiltrating more water to the ground.
2. Increase biodiversity across the region, and in areas with degraded habitats.
3. Improve and enhance connectivity between smaller natural sites and larger hubs.
4. Increase shading on built-up and paved areas.
5. Improve air quality by strategically locating and increasing vegetation appropriate for the area.
6. Improve water quality in regional waterways with natural detention and filtration of stormwater.
7. Protect existing habitat outside the Metro 2040: Shaping Our Future Urban Containment Boundary.
8. Increase natural areas closer to where people live and work by increasing small-scale habitat such as pollinator gardens and riparian corridors inside the Metro 2040 Urban Containment Boundary.
9. Limit the spread of invasive species across the region.
10. Ecological protection and restoration work that is adaptive and responsive to climate change.

D. Legal and Regulatory Framework

The jurisdictional and regulatory context for regional green infrastructure networks in British Columbia is complex. However, background research conducted on the topic has revealed a diverse set of legal tools is currently available. These tools create a comprehensive platform to promote the key concepts of a connected green infrastructure network with roles for local and senior governments.

For example, in Metro Vancouver, the federal government's regulatory power over fisheries and species at risk, and management of federal lands could facilitate the creation and protection of a regional green infrastructure network. Although federal lands are not plentiful in the Metro Vancouver region, they are located in key ecological areas like the foreshore.

Provincial government jurisdiction in Metro Vancouver could support the implementation of a regional green infrastructure network, including regulation of agricultural land, riparian areas, water use, and control of Crown lands. Provincial lands are extensive in the region, and comprise a key part of the regional green infrastructure network.

Local governments can adopt land use plans, regulate land uses, determine environmentally sensitive areas, and employ other legal tools to protect the environment and support the creation of a green infrastructure network. For example, the Local Government Act explicitly allows Official Community Plans to include policies relating to the "preservation, protection, restoration and enhancement of the natural environment, its ecosystems and biological diversity", and enables the designation of development permit areas for the "protection of the natural environment, its ecosystems and biological diversity". It is up to each local government to choose the most-appropriate and effective legal tools to support a green infrastructure network in their jurisdiction.

AREAS OF LEGAL AUTHORITY AVAILABLE TO LOCAL GOVERNMENTS FOR ENVIRONMENTAL PROTECTION	
Regional Growth Strategies	Tree Protection Bylaw
Official Community Plans, including Local Area and Watershed Plans	Soil Removal & Deposit Bylaw
Zoning, including Amenity Zoning, Density Bonusing, and Parking	Landscaping Bylaw
Surface Runoff, Storm Water and Impermeable Materials	Pesticide Use Bylaw
Development Permit Areas	Invasive Species Bylaw
Riparian Tax Exemption	Security
Development Approval Information Bylaw	Subdivision Servicing Bylaw
Development Process	Services
Watercourse Protection Bylaw	Roads
Rainwater Management Bylaw	Development Cost Charges

E. Regional Plans and Resources

Many local plans, strategies, and actions have played an important role in creating the landscape we value today. Examples of the work that Metro Vancouver has produced include the following documents:

Metro Vancouver 2040 – Shaping our Future (the regional growth strategy).

GOAL 3: Protect the Environment and Respond to Climate Change Impacts

Strategy 3.2: Protect and enhance natural features and their connectivity

Metro 2040 guides Metro Vancouver and its member municipalities to "protect, enhance and restore ecologically important systems, features and corridors and establish buffers along watercourses, coastlines, agricultural lands, and other ecologically important features".

Metro Vancouver's *Ecological Health Action Plan* identifies 12 projects to maintain and enhance ecosystem services in the region, and helps to realize the commitments articulated in the Sustainable Region Initiative. One of the Action Plan's 12 projects is advancing a regional green infrastructure network.

Metro Vancouver's *Connecting the Dots Resource Guide* provides important information about green infrastructure to support the work of municipalities, government agencies, planners, developers, stewardship and community groups, to implement a regional green infrastructure network.

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F. A Regional Dialogue

This section identifies issues and questions that need to be considered within a broad, regional conversation about how best to work together to maintain, and augment, a regional green infrastructure network.

Issue 1: Connecting the Building Blocks of a Regional Green Infrastructure Network

Metro Vancouver's existing forests, parks, wetlands, riparian areas, and greenways provide important elements of a regional network, but they must be connected to achieve the benefits associated with a network. To achieve the vision of a regional green infrastructure network, we must identify opportunities, and put tools and incentives in place. The following questions can help guide a process for linking individual components into a regional green infrastructure network:

1. How do we identify the best opportunities to expand green infrastructure and connect it?
2. What are the most-effective legal and policy tools available to expand existing green infrastructure hubs and corridors?
3. What incentives can be used to encourage broader use of green infrastructure?

Issue 2: Protecting and Valuing Ecosystem Services

Creating a regional green infrastructure network offers many benefits to the region, however, trade-offs and a shift in values are also required. In urban areas, trees and vegetation may be seen as limiting the development potential of a lot by interfering with preferred views or building sites. Privately held lands in a natural state are often viewed as ripe for development without a thorough understanding of the ecological services provided by the site's natural features. The following questions can help foster greater public awareness of the fundamental role of green infrastructure in sustaining a livable region.

1. What types of ecological services provided by green spaces are most valuable to communities? How do we increase public awareness of ecological services?
2. What areas or ecosystems should be prioritized for conservation or augmentation to secure key natural capital assets and improve regional livability?
3. How can the development community participate as a partner in protecting ecosystem services?
4. What tools and incentives can be used to protect natural features on individual lots while still allowing development to occur?

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Issue 3: Optimizing the Role of Green Infrastructure for Climate Adaptation

Green infrastructure supports climate adaptation strategies by helping to moderate extreme precipitation, and the effects of intense temperature variations. The following considerations underscore the importance of green infrastructure:

1. How can Metro Vancouver communities optimize the adaptation benefits of green infrastructure?
2. What locations and land uses are priority spaces for a green infrastructure approach to adaptation?
3. What information gaps need to be filled for work to proceed in helping urban ecosystems adapt to climate change?
4. How can initiatives to assist urban ecosystems adapt to climate change be incorporated into existing programs?


Photo by Waferboard, Creative Commons, Flickr

Definitions

Green infrastructure: Green infrastructure refers to the natural vegetation, soils, and bioengineered solutions that collectively provide society with a broad array of products and services for healthy living. Natural areas such as forests, wetlands and floodplains, and engineered systems like green roofs and rain gardens conserve natural resources and mitigate negative environmental effects, benefitting both people and wildlife. When green infrastructure is connected as part of a larger framework, a green infrastructure network is created.

Grey infrastructure: Conventional or traditional infrastructure including manufactured components such as pipes, culverts, and impervious surfaces (roads, sidewalks, roofs) as well as many sewer, water, drainage, and road systems.

Ecosystem Services: The aspects of ecosystems used actively or passively to contribute to human wellbeing. These include the provision of clean water and air, crop pollination, mitigation of environmental hazards like flooding, pest and disease control, and carbon sequestration.

Natural Capital: Renewable and non-renewable natural resources, ecosystem services, and land.

Sensitive Ecosystems: A Sensitive Ecosystem is one that is at-risk or ecologically fragile in the provincial landscape (Provincial SEI Standards 2006). A Sensitive Ecosystem Inventory (SEI) maps ecosystems that are: at-risk (red or blue listed), rare, ecologically fragile or ecologically important because of the diversity of species they support.


Photo by Ikan1711, Creative Commons, Flickr

References

Connecting the Dots: A Regional Green Infrastructure Network Resource Guide, Diamond Head Consulting, 2014

Legal and Policy Framework: Regional Green Infrastructure Network Implementation, Deborah Curran and Company, 2014.

Metro Vancouver
4330 Kingsway
Burnaby, BC V5H 4G8

metrovancouver.org

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