

# Nature and Ecosystems

Discussion Paper to support *Climate 2050* and the *Clean Air Plan*

Storing carbon and increasing climate resilience through nature and ecosystems in the Metro Vancouver region over the next 10 to 30 years

May 2020





## **Your feedback is valued.**

This paper was drafted in Spring 2020, and introduced for public, stakeholder, and government comment during the COVID-19 pandemic response. Metro Vancouver assesses work plans on a case by case basis to determine if the COVID-19 pandemic response requires an adjustment to any work plans, including engagement components. For air quality and climate change programs and initiatives, this means continuing with work plans that protect human health and the environment, but adjusting how we approach engagement.

Goals and targets in Metro Vancouver's climate-related plans are science-based and remain a priority. The interim target of a 45% reduction in greenhouse gas emissions below 2010 levels by 2030 has a time horizon of less than ten years. Pursuing a carbon neutral region by 2050 requires taking bold action now.

Across the globe, the pandemic response has had an unexpected benefit of significant environmental improvements. This provides a glimpse of what is possible and what we can achieve with coordinated efforts and common goals.

Public feedback is valued and project teams continue to seek input, create online feedback opportunities, and ensure feedback is reflected as policy development moves forward. Documents, feedback forms, and direct email links to the project team are all posted to the Metro Vancouver website, [metrovancover.org](https://metrovancover.org), search "Clean Air Plan" or "Climate 2050".

# Overview

Natural spaces provide ecosystem services that help the region respond to a changing climate—by capturing carbon, storing and cleaning stormwater, cooling our city streets, and protecting coastal communities. They also have tremendous cultural and spiritual importance, provide us with a sense of place, and enhance livability.

The region’s natural spaces and ecosystems are at risk. Human activities, including development and climate change impacts, result in ecosystem change and loss. This reduces the critical ecosystem services we can receive, now and in the future. To increase our resilience, we need to accelerate our climate actions to protect, restore, and connect ecosystems.

We are creating a roadmap to help us reach a low-carbon, resilient future. By 2050, we can expand the restoration and protection of natural areas and connect a regional green infrastructure network. We can also recognize—in all of our work—the value of natural assets as critical to human and ecosystem health.

**Please provide us with your feedback on these ideas by September 30, 2020.**



Widgeon Marsh Regional Park



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# Introduction

## Planning for the Future

*Climate 2050* and the *Clean Air Plan* will be the key climate change and air quality planning documents for Metro Vancouver to support a transition to a carbon neutral and resilient region, while continuing to improve air quality to protect public health and the environment.

*Climate 2050* is an overarching long-term strategy that will guide our region's policies and collective actions to transition to a carbon neutral and resilient region over the next 30 years. Metro Vancouver is implementing *Climate 2050* through 10 issue area *Roadmaps* (see Figure 1), which will describe how the region can reduce greenhouse gas emissions and adapt to climate change impacts. Implementation of the *Roadmaps* will be driven by Metro Vancouver's management plans and other policies, including *Metro 2050* and the *Clean Air Plan*.

*Metro 2050* will be the comprehensive update to *Metro Vancouver 2040: Shaping our Future (Metro 2040)*, the regional growth strategy, which is the region's collective vision for how growth will be managed to support the creation of complete, connected and resilient communities, protect important lands, and support the efficient provision of urban infrastructure like transit and utilities. Climate change considerations underpin many of the regional growth strategy's key goal areas, including *Goal 3: Protect the Environment and Respond to Climate Change Impacts*.

Underlined words are key concepts and are defined in the Glossary on [page 29](#).

**Key questions for feedback are shown in boxes marked **

The *Clean Air Plan* is the near-term action plan that will set Metro Vancouver's direction for air quality and greenhouse gas management for the next 10 years. The Plan will outline actions to reduce emissions of air contaminants, including greenhouse gases, from all regional sources and is closely linked with several of the *Climate 2050* issue areas in Figure 1.

This discussion paper is about the **nature and ecosystems** issue area, and is intended to promote dialogue and enable feedback that will be used in the *Climate 2050 Nature and Ecosystems Roadmap*, *Metro 2050*, and the *Clean Air Plan*. The feedback will also inform current and future directions for other planning documents such as the [Ecological Health Framework](#), as well as Metro Vancouver's corporate operations.



Figure 1: Issue areas for *Climate 2050* and the *Clean Air Plan*; overlapping issue areas are highlighted in blue.

# Nature and Ecosystems in the Metro Vancouver Region

The Metro Vancouver region’s rich and diverse natural environment is vital to the people and wildlife who live here. From the forests, wetlands, and watercourses to the urban trees and parks, these areas have tremendous cultural and spiritual importance, contribute to the region’s livability, and provide a sense of place. Nature and ecosystems also provide essential ecosystem services (see Figure 2), including storing carbon, which is an important part of Metro Vancouver’s strategy to becoming a carbon neutral region by 2050. They provide additional ecosystem services that can help the region adapt to a changing climate and improve our health and well-being (e.g., store and clean floodwater, cool our city streets, and protect coastal communities).

## Ecosystems

Ecosystems are all the plants and animals that live in a particular area together with the relationships between them and their environment.

The Nature and Ecosystems issue area is concerned with urban (e.g., street trees, backyards, green roofs) and natural (e.g., wetlands, forests, watercourses) ecosystems. Collectively, these natural, enhanced and engineered systems – known as green infrastructure (see Figure 3) – store carbon, help us adapt to climate change, and provide society with a range of other ecosystem services.



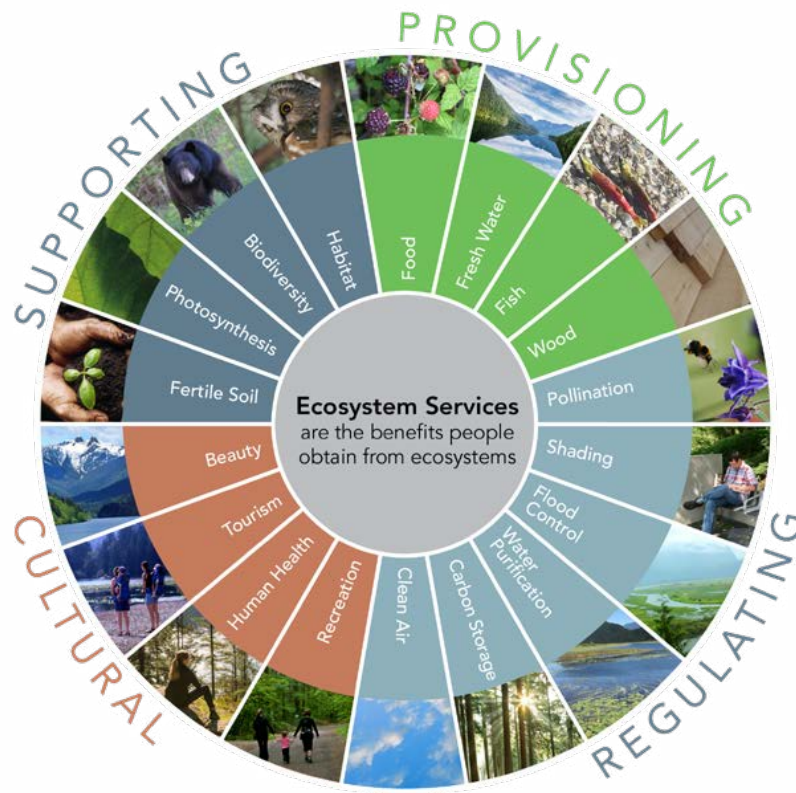


Figure 2: Ecosystem services wheel.

In order for nature and ecosystems to provide these ecosystem services, they must be resilient to the impacts of human activities, including climate change. Resilient ecosystems are those that are healthy and biodiverse – biodiversity is the variety of life. For example, a healthy forest that supports a wide variety of tree species will recover faster from disturbances, such as fire or pests, because not all species will be impacted to the same degree and some will rebound more easily. Protecting and enhancing biodiversity in nature and ecosystems maximizes their ability to provide climate change benefits.

## Nature-Based Solutions

Nature-based solutions are actions that protect, sustainably manage, and restore ecosystems, as well as address societal challenges such as climate change, thereby providing both human well-being and biodiversity benefits.

For example, seagrass meadows store carbon, reduce impacts of coastal storms on shorelines, and provide essential habitat for fish and other species. Protecting and restoring this ecosystem creates co-benefits for both humans and wildlife.



Figure 3: Types of green infrastructure.

However, the region's ecosystems are at risk. Human activities, including urban development and climate change, result in ecosystem change and loss which reduces the ability of nature and ecosystems to provide climate-related benefits, now and in the future.

Locally and internationally, there has been a growing understanding and recognition of the role ecosystems play as critical service-providing infrastructure, leading to the:

- emergence of nature-based solutions as a focus for climate action; and
- incorporation of ecosystem services into government decision-making to ensure our actions today do not compromise nature's ability to provide services for future generations.

These concepts are explored further in the Big Ideas section on [page 23](#).

## Ecosystem Loss in the Metro Vancouver Region

Metro Vancouver maintains an inventory of the region's most important ecological areas and monitors it for change. Between 2009 and 2014, 1,600 hectares of sensitive ecosystem loss was documented, including 1,000 hectares of forest, 120 hectares of wetland, and 100 hectares of riparian areas. Primary drivers of ecosystem loss were urban development and logging, occurring through land use plans and policies.

Tracking the tree canopy cover of urban forests by municipalities in the Metro Vancouver region has shown trees are being lost in urban areas. Currently, urban areas across the region have 32% tree canopy cover, and further declines are anticipated due to ongoing urban growth.

As we continue to lose these ecosystems, we lose the services they provide, including the ability to store carbon and adapt to climate change.



Clover and winter rye cover crop (Photo by Trevor Clark)

# Meeting Long-term Targets and Tracking Progress for the Region

Metro Vancouver, together with its member jurisdictions, has been taking action on greenhouse gases and air quality for decades. But actions must be accelerated to reduce our impacts on global climate change, and to protect human health and the environment we depend on. The region also needs to adapt to the anticipated impacts from a changing climate. Since ecosystems store carbon and help us adapt to climate change, tracking the health and extent of the region's urban and natural ecosystems helps us understand where we need to focus protection and restoration efforts.

## Climate Change Targets

Climate change is directly associated with greenhouse gases, primarily carbon dioxide. While emissions are global, we all have a shared responsibility to take local action. The major sources of greenhouse gases in this region are transportation, buildings and industry, with smaller contributions from waste and agriculture. Climate change projections for this region by the year 2050 include longer, hotter and drier summers, warmer and wetter fall and winter seasons with decreased snowpack, and more extreme weather.

Metro Vancouver has adopted the following regional climate change targets:

1. reduce regional greenhouse gas emissions by 45% from 2010 levels by 2030;
2. become a carbon neutral region by 2050; and
3. ensure our infrastructure, ecosystems, and communities are resilient to the impacts of climate change.

Metro Vancouver and its member jurisdictions have also amended *Metro 2040* to include these targets so they are the targets for all local governments in the region.

Although the region has made progress over the past 15 to 20 years, we need to significantly accelerate our climate actions to meet these targets and avoid dangerous impacts of climate change. Accelerated climate actions will also improve regional air quality, which protects public health and the environment. More information on climate change in our region is available on the [Climate 2050 website](#).

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We need to accelerate our climate actions to meet these targets and avoid dangerous impacts of climate change.

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## Ecological Health Indicators

Metro Vancouver monitors and reports on the region's ecological health through a number of plans including *Metro 2040*, the Ecological Health Framework, and Regional Parks' [Natural Resource Management Framework](#). The ecological health indicators developed through these plans help us understand the health and resilience of the region's ecosystems – and their ability to support community resilience through the ecosystem services they provide. Metro Vancouver will continue to measure the following indicators at a range of scales, and use the information to inform climate action:

- Percent tree canopy cover;
- Percent impervious surfaces (e.g., paved roads, buildings);
- Hectares of Sensitive Ecosystems and Modified Ecosystems;
- Percent of inventoried Sensitive and Modified Ecosystems rated high quality;
- Hectares of protected lands and waters;

- Hectares of ecological restoration areas in regional parks;
- Hectares of unprotected Sensitive or Modified Ecosystems;
- Green space connectivity index;
- Watershed and stream health index;
- Water quality index;
- Number of new invasive non-native species recorded and/or considered established; and
- Hectares of invasive non-native species treated, or kilograms or tonnes removed, from regional parks.

These indicators are not a complete picture of the region's ecological health. Metro Vancouver will continue to develop indicators as new information becomes available, and technological advances are made.

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Action is needed to ensure our ecosystems, infrastructure, and communities are resilient to climate change.

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# We Need Your Feedback

The purpose of this discussion paper is to enable feedback on the key climate change and air quality issues facing nature and ecosystems in the region, and the ways in which we can store carbon, reduce emissions and adapt to climate change using nature-based solutions. This discussion paper is intended for the public, stakeholders and other governments, including First Nations.

The goals, metrics, targets and actions identified herein are considered potential opportunities for the region's natural environment. We must take action to store carbon, reduce emissions and ensure people and ecosystems are resilient to a changing climate, and we need your help to figure out the best way forward.

Climate change and degraded air quality impact some neighbourhoods, households and individuals more than others. Also, some households are better able to prepare for and protect themselves from climate change and air quality impacts. A priority of *Climate 2050*, *Metro 2050*, and the *Clean Air Plan* is to incorporate the voices and needs of a full range of communities into program and policy design to ensure that fairness and equity are reflected in the actions that Metro Vancouver implements or advocates for. Policies and programs that reduce emissions, promote carbon storage, and increase resilience should support an equitable distribution of benefits and costs, such as the distribution of heat-reducing green spaces, increased economic opportunities in a low emission and carbon neutral economy, as well as the provision of a range of affordable housing and diverse transportation options. Issues of intergenerational equity will also be considered.

Specific opportunities to provide feedback are described under Feedback and Engagement Process, on [page 27](#).

## Linkages to Other Issue Areas

There are many links between nature and ecosystems and other issue areas. Metro Vancouver is exploring which linkages must be considered when developing climate policies and actions.

### **Land-use and growth management** –

policies that support more compact, complete communities, and protect ecologically important areas from development lead to increased resilience and carbon storage.

**Infrastructure** – green infrastructure such as green roofs and rain gardens improve building energy efficiency, and absorb rainfall and stormwater, which reduces the strain on built infrastructure and restores urban biodiversity.

**Energy** – nature and ecosystems cool urban areas, reducing the need for air conditioning and decreasing overall energy use.

**Human health and well-being** – nature-based climate change solutions (such as planting trees in urban areas) improve mental and physical health.

**Agriculture** – agricultural lands can be managed to protect natural areas, and enhance ecosystem services that build resilience to climate impacts and store carbon.

These issues will be explored in discussion papers of their own. As papers are developed, they will be made available on the [Metro Vancouver website](#).

# Nature and Ecosystems – Storing Carbon and Adapting to Climate Change

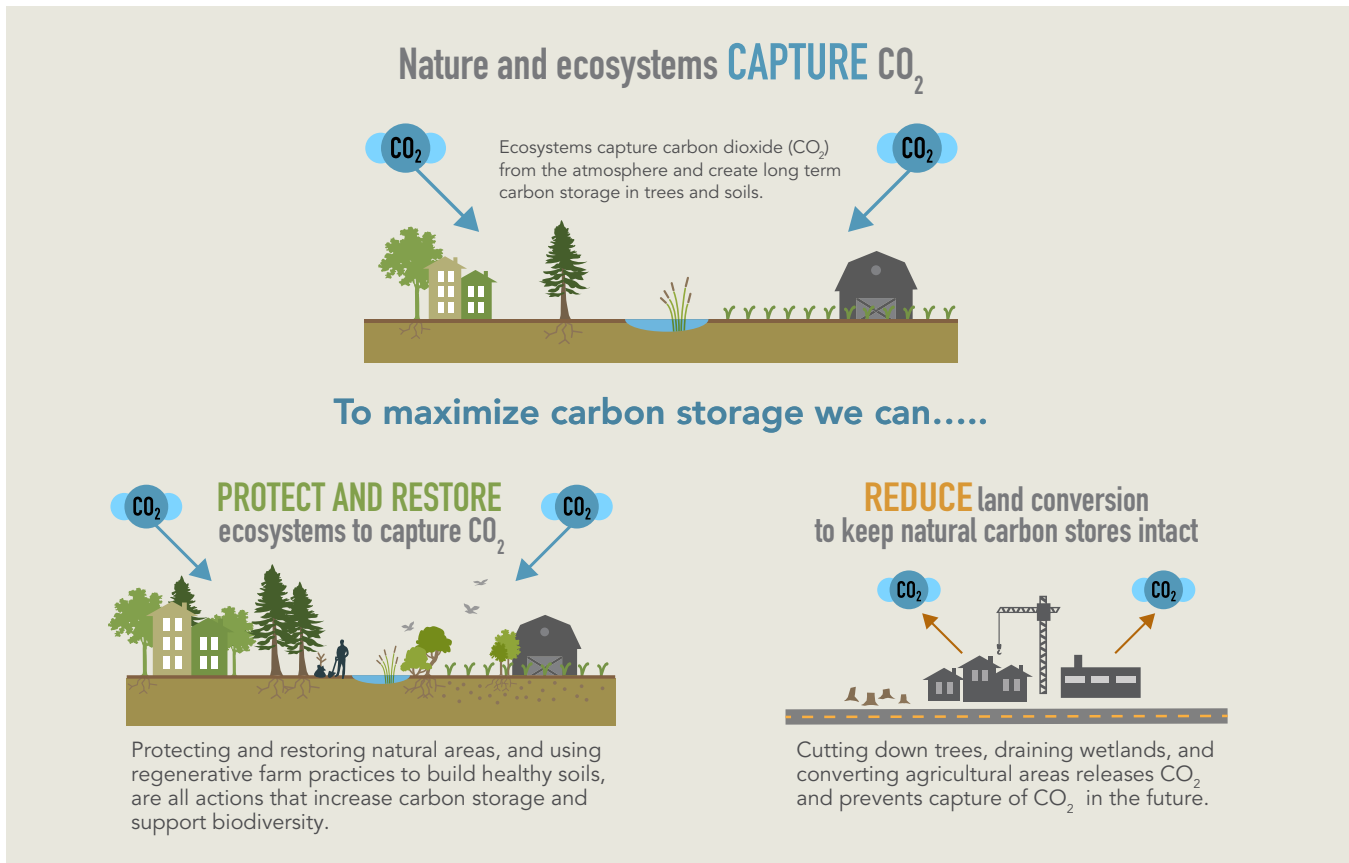


Figure 4: Nature-based solutions for storing carbon, and approaches to maximize carbon storage.

## Carbon Storage and Sequestration

Carbon stored in nature and ecosystems, including forests, wetlands and intertidal areas, takes thousands of years to accumulate. A conservative estimate of the total carbon stored in the vegetation and soils of the region's nature and ecosystems is 65 million tonnes<sup>1</sup>. Every year, these areas sequester additional carbon, removing carbon dioxide from the atmosphere and storing it away. The ecosystems that Metro Vancouver protects in the watersheds that provide the region's

drinking water, along with the regional parks system, store 22 million tonnes of carbon. Although carbon storage is not the primary function of these areas, ongoing protection of these significant carbon stores is critical to climate action in the region. Figure 4 describes the nature-based solutions available to store carbon, and Figure 5 shows the key natural carbon stores in the region.

<sup>1</sup> Estimate derived from Metro Vancouver's regional carbon storage dataset. The estimate applies to the full extents of the watersheds that supply the Metro Vancouver region's drinking water, along with estuarine and intertidal areas.

## Millions of tonnes of carbon is stored in vegetation and soil in the Metro Vancouver region.



Figure 5: Key natural carbon stores in the region and their impacts on regional climate resilience.

To ensure the carbon stored into the region's ecosystems remains in place requires that ecosystems are healthy and relatively undisturbed. Carbon is released from ecosystems when we cut down trees, disturb soils, and alter water cycles (e.g., draining wetlands). Becoming a carbon neutral region by 2050 will require more than just emission reductions, it will require that we increase the carbon storage

capacity of the region's ecosystems. This can be done by protecting functioning ecosystems, and restoring and enhancing others. When we lose ecosystems, we not only lose the carbon stored but also their ability to continue to remove carbon dioxide from the atmosphere, year after year.



## Nature and Ecosystems, Wildfire and Air Quality Concerns

Residents in the region generally experience good air quality, but additional emission reduction actions are needed to continue protecting human health and the environment. Some air contaminants, such as ground-level ozone, can damage plants and reduce vegetation growth, adding to the stress on nature and ecosystems due to climate change.

As temperatures rise and droughts become more frequent, forests in the Pacific Northwest are at increased risk to wildfires. Wildfires create significant amounts of fine particulate matter, the air contaminant with the greatest health impact in our region. This topic area will likely be addressed in more detail in the *Human Health and Well-being Roadmap*.

## Expected Climate Hazards and Impacts

While nature and ecosystems store carbon and help us adapt to climate change impacts, many natural areas are themselves at risk from a changing climate. Climate change impacts affect nature and ecosystems and the services that ecosystems provide. For example, trees store carbon, cool our streets, and absorb floodwater, but they are less able to provide these benefits if they are suffering from drought and extreme heat.

Many species and ecosystems in the region are at risk of being impacted or displaced entirely due to climate change because they cannot adapt fast enough – for instance, Pacific salmon will be affected by warming stream temperatures in the region (see the case study on [page 14](#)). Climate change adaptation must be considered when we manage urban and natural ecosystems. This should include emerging best practices supported by current climate science.

We can contribute to the region's collective climate resilience by monitoring the extent and health of urban and natural ecosystems, providing space in our communities for nature to adapt and flourish, and considering the natural environment as a critical part of climate action.

The region's nature and ecosystems may be affected by climate hazards – these hazards could cause impacts in numerous ways. However, nature and ecosystems can also minimize the impacts of climate change. These relationships are outlined in Table 1 below.

Table 1: Climatic changes and hazards and their potential impacts to nature and ecosystems.

| CLIMATIC CHANGES AND HAZARDS  | ANTICIPATED IMPACTS TO NATURE AND ECOSYSTEMS  | HOW NATURE AND ECOSYSTEMS CAN MINIMIZE IMPACTS   |
|---|---|--|
| <b>Sea level rise and flooding (coastal and riverine)</b>           |   |  |
| Rising water levels   | <ul style="list-style-type: none"> <li>Shoreline ecosystems will be lost as they are caught between rising waters and hardened shoreline infrastructure (known as <u>coastal squeeze</u>).</li> <li>Extreme flooding causes structural changes to rivers and shorelines, shifting ecosystems and impacting wildlife.</li> <li>Flood waters deposit excess sediment over fish habitat, including spawning areas, impacting fish health.</li> <li>During a flood, toxic substances from low-lying industrial areas, infrastructure or contaminated sites can be released, damaging ecosystems.</li> </ul> | <ul style="list-style-type: none"> <li>Natural shorelines reduce the impacts of riverine and coastal flooding by absorbing water and wave energy. They also provide space for ecosystems to adapt and move as water levels rise.</li> </ul>  |
| Changing salinity   | <ul style="list-style-type: none"> <li>Salt water will move further into rivers and coastal areas, which affects fish and ecosystems, and impacts drinking water and water supply for agricultural areas.</li> </ul>  |  |
| Combined hazard of sea level rise, storm surge and coastal flooding | <ul style="list-style-type: none"> <li>The ecological impacts of coastal storms and flooding will be exacerbated by sea level rise.</li> </ul>  | <ul style="list-style-type: none"> <li>Coastal and intertidal ecosystems (such as mudflats and seagrass beds) protect at-risk communities by reducing the impacts of waves and extreme tides, absorbing excess water, and buffering the impacts of coastal storms.</li> </ul>  |
| <b>Changing Precipitation</b>                                       |   |  |
| More extreme rainfall   | <ul style="list-style-type: none"> <li>Increased pollutant run-off, turbidity, and erosion, leading to poor water quality and impacts to freshwater and marine ecosystems.</li> <li>Increased risk of landslides, disrupting wildlife habitat and movement.</li> </ul>  | <ul style="list-style-type: none"> <li>Wetlands, riparian ecosystems and other vegetated areas reduce flooding, prevent erosion, and absorb and filter rainwater, reducing the strain on stormwater infrastructure.</li> </ul>   |
| Longer dry spells in the summer                                     | <ul style="list-style-type: none"> <li>Drought reduces annual tree growth and increases mortality rates.</li> <li>Warmer waters and less flow during the dry season, combined with an earlier freshet, will stress and limit migration of salmon and other aquatic species.</li> <li>Stress to newly planted restoration areas, increased risk of fire and disease, and increased likelihood that trees are blown over during high winds.</li> <li>Longer and more intense wildfire season, driven by both heat and drought, impacts ecosystems.</li> </ul>   | <ul style="list-style-type: none"> <li>Trees and other vegetation help to retain the little water available during drought conditions by reducing the loss of water from the soil, which also cools the air.</li> <li>Intact forests alongside streams and waterbodies provide shade, keeping waters cooler and reducing evaporation.</li> </ul> |
| Increased precipitation in winter, spring and fall                  | <ul style="list-style-type: none"> <li>Soils and forests will be damaged by heavy rain storms, resulting in flooding, slope instability and tree failure.</li> </ul>  | <ul style="list-style-type: none"> <li>Healthy, intact forests are better able to stabilize slopes and resist change.</li> </ul>   |

| Changing temperatures               |   |   |
|-------------------------------------|---|---|
| Extreme heat                        | <ul style="list-style-type: none"> <li>Heat sensitive ecosystems (e.g., wetlands) and species (e.g., salmon, bats, western red cedar) will be stressed by increased temperatures and drought conditions.</li> <li>Ecosystems and species are driven to move as conditions become less suitable; however, finding new locations that support their needs may not be possible. For example, cold climate, high-elevation ecosystems such as alpine tundra are restricted in where they can move.</li> </ul> | <ul style="list-style-type: none"> <li>Healthy trees and other vegetation help protect people from extreme heat, in part by reducing the <u>urban heat island effect</u>. When urban temperatures are cooler, there is less demand for air conditioning which reduces energy use and emissions.</li> <li>Trees adjacent to riparian and wetland areas support fish and other wildlife by keeping water cool.</li> </ul> |
| Warmer winters                      | <ul style="list-style-type: none"> <li>Increased spread of pathogens, pests and invasive species that were previously controlled by low winter temperatures.</li> </ul>   | <ul style="list-style-type: none"> <li>Healthy ecosystems are more resilient and better able to resist pathogens, pests and invasive species.</li> </ul>  |
| Seasonal shifts                     | <ul style="list-style-type: none"> <li>Shifts in seasonal temperatures (e.g., early spring/late fall) can disconnect species from their habitats or food sources. For example, migratory pollinators may return to their home habitat after flowers have already bloomed.</li> </ul>  | <ul style="list-style-type: none"> <li>Resilient, large, and connected ecosystems across the landscape help native species adapt to changing conditions.</li> </ul>   |
| Ocean warming and acidification     | <ul style="list-style-type: none"> <li>Impacts to marine and intertidal ecosystems, stress on native species due to changing conditions, and new incidences of invasive aquatic species.</li> </ul>   | <ul style="list-style-type: none"> <li>By reducing human-caused stressors such as over-fishing and ocean pollution, marine and intertidal ecosystems are more resilient to the impacts of ocean warming and acidification.</li> </ul>   |
| Wind storms                         |   |   |
| High winds exacerbate other hazards | <ul style="list-style-type: none"> <li>Wind storms, in conjunction with sea level rise, lead to greater storm surge.</li> <li>Trees blown down during wind storms increase the amount of fuel available during a wildfire and can accelerate the wildfire's spread.</li> <li>Insect pest infestations are exacerbated by high winds.</li> </ul>   | <ul style="list-style-type: none"> <li>Natural breakwaters such as reefs can reduce wave action.</li> <li>Contiguous forests are more resilient to wind damage. Buffer trees can also protect infrastructure and crops from wind.</li> </ul>  |

Note: These climate hazards can cause cascading impacts – for example, flooding tends to be more severe following a wildfire, landslides tend to occur following heavy rainfall, and coastal storms may become more frequent and severe when combined with sea level rise. Non-climatic hazards can also exacerbate climatic ones; for instance, subsidence can increase overall sea level rise, and earthquakes can disrupt flood protection infrastructure. Climate

change impacts will magnify existing stressors on ecosystems from other human activities. Our understanding of how ecosystems will be affected by cumulative impacts is incomplete, but we do know that large, healthy, connected, and biodiverse ecosystems are more resilient to climate change impacts.

## Species Case Study: Pacific Salmon

In the Pacific Northwest, salmon are a keystone species, supporting people, ecosystems and wildlife. Salmon have cultural, spiritual and food source significance in our region, particularly to First Nation communities. The Fraser River is one of North America's greatest salmon-producing rivers. The river and its main tributaries within Metro Vancouver - Kanaka Creek, Pitt River (Alouette River, Widgeon Creek), Coquitlam River and Brunette River - weave through the region, providing important habitats for salmon and other species.

Eagles, bears, and orcas all rely on salmon as a food source. As migrating salmon return to rivers and are eaten by other species, essential nutrients from their carcasses are transferred to forests and other ecosystems.

Salmon, and the habitats they thrive in, are at risk from climate change impacts. In the Metro Vancouver region, we are projected to experience warmer and wetter winters, hotter and drier summers, reduced snowpack, and more precipitation falling as rain and less as snow. These impacts may decrease the amount of water available in streams during dry periods, raising stream temperatures. Salmon are sensitive to warming temperatures – they may not enter streams until the water has cooled to a specific temperature, and warmer temperatures can affect both survival and reproductive success. The Fraser River summer water temperature has warmed by, on average, 1.5°C since the 1950s, and this trend is projected to continue.

We can take action to help salmon adapt to climate change impacts. Restoring riparian corridors with native vegetation can cool stream temperatures. Integrating fish passage into the design of flood control infrastructure will ensure salmon can continue to reach their spawning grounds. We can also identify and protect critical salmon spawning habitat – often this habitat provides other ecosystem services. For example, eelgrass serves as nursery habitat for salmon, but also reduces wave impacts from coastal storms, and stores carbon.



Sockeye salmon



# Current Actions to Store Carbon and Adapt to Climate Change

Metro Vancouver, together with its member jurisdictions and other agencies, has been taking action to reduce greenhouse gases and adapt to the expected impacts of climate change through nature and ecosystems. Some significant current actions in our region are outlined below. The list below is not an exhaustive list of actions occurring in the region; however, these examples were chosen because they highlight the wide range of approaches currently being implemented related to nature and ecosystems.

(Additional information on the actions is listed in the web links shown.)

1. **Advance natural asset management** by inventorying [natural assets](#), developing asset management strategies and plans, and incorporating the value of natural assets and the ecosystem services they provide into financial planning and reporting, asset management and capital budgeting processes ([West Vancouver](#), [Metro Vancouver](#)).
2. **Identify how current and future flood infrastructure may impact the natural environment** in the Lower Mainland region, which includes the Metro Vancouver region ([Fraser Basin Council](#)).
3. **Restore and enhance** natural shorelines and estuaries to buffer storm surge impacts, protect coastal infrastructure and minimize the habitat lost to coastal squeeze ([Surrey/Delta](#), [Stewardship Centre for British Columbia](#), [UBC](#)).
4. **Research the potential to store more carbon** in the forests, agricultural soils, and coastal areas of the Metro Vancouver region ([West Coast Environmental Law/SFU](#), [Parks Canada](#), [Metro Vancouver](#)).
5. **Commit to nature-based solutions** to support municipal climate change mitigation and adaptation goals ([Vancouver](#), [New Westminister](#), [Surrey](#), [District of North Vancouver](#)).
6. **Incorporate ecosystem-based approaches** when developing or upgrading coastal infrastructure ([Metro Vancouver](#), [Surrey](#), [West Vancouver](#)).
7. **Ensure a healthy and climate resilient urban forest** to maximize climate adaptation benefits ([Metro Vancouver](#), [New Westminister](#), [Vancouver](#), [Surrey](#)).
8. **Acquire and protect** significant areas of additional parkland ([Metro Vancouver](#)).
9. **Use green infrastructure** to support climate change mitigation and adaptation goals ([Vancouver](#), [Surrey](#), [SFU](#)).

10. **Manage invasive species** by developing and implementing best practices for existing invasive species, and research those that may become more prevalent in the region under future climate conditions ([Metro Vancouver](#), in collaboration with Invasive Species Council of Metro Vancouver and member jurisdictions).
11. **Reduce wildfire risk in managed natural areas** during periods of elevated fire danger and rapidly detect and suppress fires if they occur within the Metro Vancouver region (Metro Vancouver, BC Government and local authorities).
12. **Reduce methane emissions and improve carbon storage capacity** in bog ecosystems ([Metro Vancouver with University of Victoria, Richmond](#)).
13. **Implement new forest management practices** to adapt to climate change and enhance carbon storage ([BC Government](#)).
14. **Plant and restore seagrass in appropriate locations** to support biodiversity, protect shorelines, and store carbon ([Port of Vancouver, Seagrass Conservation Working Group](#)).



Rock fish and seagrass

## Roles and Responsibilities relating to Storing Carbon and Adapting to Climate Change through Nature and Ecosystems

Metro Vancouver has a range of functions relating to nature and ecosystems and their role in storing carbon and adapting to climate change.

Metro Vancouver is responsible for developing, implementing and stewarding *Metro 2040*, the regional growth strategy. The strategy represents the regional federation's ongoing commitment to building a compact metropolitan region where approximately two-thirds of the land in the region are designated for agricultural, recreational, and conservation uses.

Metro Vancouver secures land for regional parks to protect the region's natural areas and to connect people with nature. Metro Vancouver is also responsible for developing long range plans for managing our region's drinking water sources, including 60,000 hectares of restricted access, protected water supply lands. These lands include the most intact old-growth forest ecosystems in south-western BC.

Under authority delegated by the BC Government in the *Environmental Management Act*, Metro Vancouver is also responsible for managing and regulating air quality and greenhouse gases in the region.

As the regional federation, Metro Vancouver acts as a regional forum in facilitating collaboration with member jurisdictions and other organizations to create efficiencies and align climate change strategies and actions.

Nature and ecosystems do not adhere to administrative boundaries and their protection and management involves a wide range of groups including all governments, community groups, residents, and academic institutions. These roles are summarized below.

- **Government of Canada** is working with the provinces and territories to implement the Pan-Canadian Framework on Clean Growth and Climate Change which includes plans to build climate resilience, including investing in natural infrastructure. The Government of Canada is also responsible for protection and management of certain species and nationally significant wildlife areas. Responsibilities for environmental assessments are shared by the federal and provincial governments.
- **BC Government** manages forest and wildlife resources, as well as some protected areas within the region. The province is developing a climate preparedness and adaptation strategy through its role in supporting residents and communities to adapt to climate change.

- **First Nations** operating under a Treaty or Land Code can set land use policies that may influence nature and ecosystems. First Nations play an integral role in caring for the natural environment. As keepers of generational knowledge and stewards of nature, First Nations also have an intimate knowledge of how a changing climate has impacted local species and ecosystems.
- **Municipalities** have authority over local land use decisions, including those related to local parks and natural areas. Municipalities can protect ecosystems through various policy mechanisms, such as Official Community Plans, climate action strategies, biodiversity strategies, and urban forest management plans.
- **Environmental non-governmental organizations** map at-risk ecosystems, purchase land for conservation purposes, promote nature-based climate change solutions, monitor ecosystems through citizen science initiatives, restore and enhance ecosystem health, and lobby for more stringent ecosystem protection policies.
- **Health authorities** study the impacts of climate change on human health, and the role that green space can play in reducing these impacts and increasing resilience.
- **Academic institutions** in the region lead research on how ecosystems are both affected by, and a solution to, climate change.
- **Local businesses** develop and implement innovative solutions to environmental challenges, including green infrastructure in urban areas, certification programs (e.g., Salmon Safe), and other programs.
- **Local residents** can be environmental stewards – for example, a significant proportion of existing tree canopy and plantable areas for new trees in the region is on residential property, and the residents can also get involved in ecosystem restoration and environmental stewardship work through volunteer groups.



# Discussion: Storing Carbon and Adapting to Climate Change Through Nature and Ecosystems

The following sections outline proposed goals, example targets and metrics, example actions, and potential Big Ideas to store carbon and adapt to climate change through nature and ecosystems.

## Proposed Long-Term Goals for Carbon Storage and Adaptation

Long-term goals describe a desired future state where the ability of nature and ecosystems to contribute to a carbon neutral and resilient region has been maximized, by the year 2050 and beyond. Long-term goals will help identify and prioritize new actions to achieve increases in carbon storage and adaptation benefits from nature and ecosystems in the region.



*Please consider the following long-term goals proposed for nature and ecosystems in our region. Will these goals help us reach our desired future state?*

1. **Nature and ecosystems are resilient, protected, maintained, restored and connected, to maximize ecosystem services across the region.**
2. **Nature-based solutions that support biodiversity are prioritized in the region's response to climate change.**

## Example Carbon Storage and Adaptation Targets and Metrics

Near-term targets are milestones to support achievement of the long-term goals and will be included in the *Climate 2050 Nature and Ecosystems Roadmap* and the *Clean Air Plan*. Measuring resilience is an emerging field of research and our region will be learning alongside other local jurisdictions. Adaptation metrics will be included in the *Climate 2050 Nature and Ecosystems Roadmap*. Many jurisdictions and agencies have established targets and metrics relating to nature and ecosystems, and the following list highlights a number of ambitious examples.



*Please consider the following near-term targets and adaptation metrics. Are any of these the right milestones to help us reach our long-term goals? What should our near-term targets and metrics look like?*

(Additional information on the targets and metrics is listed in the web links shown.)

1. The [Nature Needs Half](#) initiative aims to protect 50% of the planet by 2030 to address the dual challenge of climate change and biodiversity loss.

2. The [Global Deal for Nature](#) recognizes the role native ecosystems play in meeting our global greenhouse gas reduction targets. This science-driven plan calls for 30% of Earth to be formally protected and an additional 20% to be designated as climate stabilization areas, by 2030, to stay below 1.5°C of warming.
3. The United Nations announced a [Decade of Ecosystem Restoration](#) and has set a target to [restore 350 million hectares](#) (approximately the size of India) by 2030 to simultaneously address climate change and reduce biodiversity loss.
4. [Melbourne's Urban Forest Strategy](#) has a target to increase tree canopy cover from 22% to 40% on public lands by 2040, with the goal of cooling the city by 4°C.
5. Citing the co-benefits of vegetated roofs for climate change mitigation and adaptation – as well as human health and biodiversity – [Portland](#) has a recommended green roof target of 15% of total area for the city centre by 2035.
6. Singapore's [City Biodiversity Index](#), used by 80 other cities across the world, contains an indicator for climate regulation. This indicator accounts for the carbon storage and cooling effects of vegetation.
7. [Surrey's Climate Adaptation Strategy](#) has proposed indicator measures for total area of protected riparian zones, as well as the proportion of the municipality's land base with vegetative coverage.
8. As part of a broader commitment to nature-based climate solutions, the [Government of Canada](#) has committed to plant two billion new trees over the next 10 years, and conserve 25% of Canada's land and 25% of Canada's oceans by 2025, working toward 30% of each by 2030.
9. To build resiliency to sea level rise, coastal storms, erosion, and flooding, [California](#) will work with partners to ensure an additional 10,000 acres (4,050 hectares) of coastal wetlands will be protected, restored or created by 2025, and increase the size of coastal wetlands in California by 20% by 2030 and 50% by 2040.
10. In order to protect biodiversity and bolster climate change resilience, [California](#) will work with partners to preserve the existing, known 15,000 acres (6,070 hectares) of seagrass beds and create an additional 1,000 acres (405 hectares) by 2025.

## Example Carbon Storage and Adaptation Actions

Actions are the policies and programs, including regulations, incentives and educational outreach campaigns, which will lead to increased carbon storage and resilience. Actions will be included in the *Climate 2050 Nature and Ecosystems Roadmap* and the *Clean Air Plan*. In addition to existing actions (see [page 15](#)) we need new actions to address the many opportunities we have to store additional carbon and meet our near- and long-term climate targets, while also adapting to the expected impacts of climate change.



*Please consider the following actions from other leading jurisdictions, which show a range of actions that could be implemented to increase carbon storage and resilience through nature and ecosystems. Could any of these actions help us reach our goals? What should new, additional actions look like?*

(Additional information on the actions is listed in the web links shown.)

1. **Municipal stormwater charges** incentivize residents to install green infrastructure on private property ([Halifax](#), [Mississauga](#), [Victoria](#)).
2. **Expand and connect green spaces** by creating a network of [greenways](#), urban parks and other green spaces to increase resilience to heat waves and flooding, while also supporting biodiversity ([Bilbao](#), [Berlin](#), [New England/Eastern Canada](#)).
3. **Restore coastal ecosystems and re-establish watershed connections** to provide habitat, protect important areas from flooding, and improve ecological health ([San Francisco](#), [Louisiana](#), [Singapore](#), [Nova Scotia](#)).
4. **Establish innovative carbon credit and offset programs** to protect, restore and enhance ecosystems ([Yokohama](#), [Austin](#), [New Zealand](#), [Great Bear Rainforest](#)).
5. **Include forests and trees** within greenhouse gas emissions accounting procedures ([ICLEI USA](#)).
6. **Encourage, incentivize, or mandate the installation of green roofs** on a large scale through policies and bylaws ([Amsterdam](#), [Denver](#), [Toronto](#)).
7. **Incorporate natural assets** into local government financial planning and asset management programs ([Municipal Natural Assets Initiative](#) and [pilot communities](#)).
8. **Implement large-scale tree planting initiatives** to meet climate change mitigation and adaptation goals ([India](#), [United Kingdom](#), [Moscow](#), [World Economic Forum](#)).

9. **Protect and maximize ecosystem services on agricultural lands** through protection of natural features and innovative best practices ([Farmland Advantage](#), [Delta Farmland and Wildlife Trust](#)).
10. **Incorporate climate change into protected area and wildlife corridor planning** and identify how species movements will shift due to climate change ([Pacific Institute for Climate Solutions](#), [Portland](#), [Edmonton](#), [Quebec](#), [Yellowstone to Yukon Conservation Initiative](#)).
11. **Invest in green infrastructure** to improve resilience to flooding at a large scale ([China](#), [Berlin](#), [Copenhagen](#), [New York City](#)).
12. **Research the potential of nature-based solutions** to meet greenhouse gas reduction targets and assess their viability on a large scale ([The Nature Conservancy](#)).
13. **Study the impacts of climate change** on park ecosystems and integrate adaptive management practices ([East Bay Regional Park District](#)).
14. **Research the air quality impacts** and benefits of urban trees ([Sacramento](#), [Louisville](#)).
15. **Develop new and innovative strategies for wildfire and forest management** that minimize carbon emissions ([Pacific Institute for Climate Solutions](#)), bolster resilience, and incorporate Indigenous cultural values and traditional knowledge ([First Nations' Emergency Services Society](#)).
16. **Conserve, restore and monitor seagrasses in key locations** to benefit biodiversity, improve food security and address climate change ([Project Seagrass](#)).



Belcarra Regional Park



## Potential Big Ideas to Store Carbon and Adapt to Climate Change Through Nature and Ecosystems

To achieve a cleaner, healthier, more equitable future and respond to the accelerating impacts of climate change, we need to think big and act quickly. Metro Vancouver has identified three **Big Ideas** to increase carbon storage in nature and ecosystems, and accelerate adaptation efforts. The Big Ideas were selected for different reasons, including potential for increasing carbon storage and/or improving climate resilience, as well as ease of implementation or their foundational nature (i.e., they are needed to support other actions).



*Please consider the following Big Ideas. Could any of these help us significantly increase carbon stored in nature and ecosystems, and advance climate resilience to reach our goals? What other Big Ideas should Metro Vancouver consider?*

**Big Idea 1:** *Accelerate and expand the restoration and protection of natural areas and urban ecosystems*

To become a carbon neutral and resilient region by 2050, we need to make substantial commitments that maximize carbon storage and adaptation through nature and ecosystems – at a larger scale than ever before. The key commitments are outlined below.

- **Protect 50% of the land base in the region:** Currently, about 40% of the region’s land base is protected by different governments and organizations. By protecting an additional 10%, the

Metro Vancouver region would reach the Nature Needs Half vision of 50% protected land (see page 19). Given that this region faces significant land use constraints, meeting this target would involve tradeoffs between competing priorities, and reducing the amount of land available for urban development and other uses.

- **Reverse the loss of the region’s sensitive ecosystems:** Approximately 1,600 hectares of sensitive ecosystems were lost between 2009 and 2014, and a similar amount of loss is expected between 2014 and 2020 due to land conversion and ecosystem degradation. Reversing this loss would require a commitment to ecosystem restoration and enhancement at a significant scale, as well as ensuring that our ecosystems are resilient to the impacts of climate change. Replenishing the region’s total hectares of sensitive ecosystems to 2009 levels (when the first regional inventory was conducted) would increase nature’s capacity to store carbon, bolster regional resilience, and provide other essential ecosystem services. As highlighted above, meeting this target would involve significant tradeoffs between competing priorities due to constraints on land in the region.
- **Increase urban tree canopy to 40%:** Tree canopy cover in the region’s urban areas is currently 32% and dropping. Many cities around the world have adopted a 40% tree canopy cover target; if adopted for Metro Vancouver’s urban areas, this would represent an ambitious but achievable target.

This Big Idea will require partnership and collaboration between Metro Vancouver and other governments and agencies, along with innovative funding sources (e.g., levies, fees, carbon credits).

To meet these targets, bold new directions in urban planning policy will need to be explored in order to minimize or mitigate ecosystem losses due to human activities (such as urban development).

Some examples of jurisdictions committing to large scale protection or restoration efforts are outlined below.

- **Toronto** has committed to one of the largest urban re-naturalization projects in North America as a way to reduce flood impacts via The Don Mouth Naturalization Plan.
- **Vancouver** has adopted the target that by 2030, restoration work will be completed on enough forest and coastal ecosystems in Vancouver and the surrounding region to remove one million tonnes of carbon dioxide annually by 2060.
- **Montreal**, with financial assistance from the Government of Canada, expanded an existing park to create the largest urban park in Canada, "Grand parc de l'Ouest". This 3,000-hectare park (8 times the size of Central Park in New York City) will provide access to nature and recreation for the community, as well as protection from flooding.

- **King County**, Washington, aims to preserve over 26,000 hectares of remaining high conservation value lands within 30 years, before the opportunity is lost to population growth and development pressure.

**Big Idea 2:** *Connect a regional green infrastructure network of natural areas, urban ecosystems and wildlife corridors*

Green infrastructure – which includes both natural and urban elements (see Figure 3) – provides a range of climate change, biodiversity and health benefits. These benefits are magnified when those individual elements are connected together into a network across jurisdictional boundaries. A regional green infrastructure network would maximize ecosystem services by linking natural and urban ecosystems through a robust system of greenways, aquatic blueways, and wildlife crossings and corridors.

Developing a green infrastructure network would necessitate creating a collaborative and cross-jurisdictional process, building on existing local networks, and identifying opportunities to maximize associated climate adaptation, ecological connectivity, and human health benefits. Novel mechanisms to



Spotted Towhee (Photo by Trevor Clark)

create partnerships and fund land acquisition to connect landscapes together are also needed.

Some examples of organizations that are connecting green infrastructure at broader scales are listed below.

- [Surrey](#) has adopted a green infrastructure network as part of their overall Biodiversity Strategy.
- The [Capital Regional District](#) aims to acquire and connect 100% of a system of natural areas from the Saanich Inlet to the Juan de Fuca Strait.
- Ontario's conservation authority governance structure is focused at the watershed scale and creates opportunities for multi-jurisdictional collaboration on green infrastructure (e.g., [Toronto and Region Conservation Authority](#)).

**Big Idea 3:** *Integrate natural assets into conventional asset management and decision-making processes*

The Metro Vancouver region is rapidly growing. Ecosystems are being lost to planned land use change and development, and climate change will cause additional impacts. Commonly referred to in this context as natural assets, ecosystems provide humans with many services that local governments rely on, including stormwater management, recreation, and flood and shoreline protection. Typically, natural assets and the services they provide are not acknowledged or accounted for through traditional asset management approaches. This lack of recognition can contribute to natural assets being lost, under-valued, and under-resourced (e.g., for maintenance or restoration).

Local governments are increasingly recognizing the need to acknowledge, measure and account for natural assets and the services they provide, and to incorporate this information into decision-making and asset management systems. Valuing natural assets will ensure we prioritize forests, wetlands

and other ecosystems for protection and restoration. It is important to note that nature and ecosystems also have inherent value and benefits that are impossible to quantify. Valuing the services provided by natural assets is simply a mechanism to account for the benefits nature provides that are often taken for granted.

Valuing natural assets and integrating the information into decision-making is an emerging practice. To standardize this practice within our region, we will need to explore the following:

- Potential changes to accounting standards and practices;
- The role of different governments and land ownership;
- Options to advocate for legislative requirements; and
- Natural asset valuation methods.

Some early adopters of this approach are listed below.

- The [Municipal Natural Assets Initiative](#) team provides scientific, economic and municipal expertise to support and guide local governments in identifying, valuing and accounting for natural assets in their financial planning and asset management programs.
- [Gibsons, BC](#) was North America's first community to experiment with strategies to integrate natural assets into asset management and financial planning. For example, Gibsons' Integrated Stormwater Management Plan leverages natural assets to provide stormwater services, as an alternative to building new infrastructure, and has resulted in millions of dollars saved in construction and maintenance costs.

- The [Region of Peel and Credit Valley Conservation](#) have inventoried and assessed stormwater services provided by wetlands, forests, and open green spaces for the whole region under current and future climates – valuing these services at over \$20 billion. This information will be used to develop a business case for natural asset management, maintenance and restoration.

If implemented, these three Big Ideas above will help us:

- **Store carbon** – protecting and restoring natural carbon stores (such as forests and wetlands) supports a path to a carbon neutral region. Integrating these assets into asset management and decision-making will help ensure their long term health and well-being, and therefore carbon storage capacity. Focusing on nature-based solutions will maximize carbon storage as well as other co-benefits.
- **Bolster resilience** – actions to protect and maintain natural assets will reduce the vulnerability of our communities to climate change impacts. Natural assets provide shading and cooling, absorb floodwaters, and reduce pressure on stormwater and energy infrastructure.

- **Enhance biodiversity** – protecting and enhancing habitat for wildlife and ecological connectivity supports biodiversity and helps species to migrate under changing climate conditions.
- **Promote human health and well-being** – natural assets provide cooling and shading from the sun, and opportunities to access green space. Nature and ecosystems are critical to mental and physical health, and this benefit has been underscored during the COVID-19 pandemic.
- **Promote equity** – greening efforts can be directed to neighbourhoods more at risk from climate change impacts to ensure the benefits from nature are distributed equitably.
- **Deliver sustainable services** – natural assets provide a resilient and cost efficient alternative to traditional built infrastructure.



A walk in Stanley Park (Photo by Trevor Clark)



# Feedback and Engagement Process

Metro Vancouver invites feedback from diverse viewpoints to help shape *Climate 2050*, *Metro 2050*, and the *Clean Air Plan* and will carefully consider all input. Feedback is welcome by email at [Climate2050@metrovancover.org](mailto:Climate2050@metrovancover.org), [RegionalPlanning@metrovancover.org](mailto:RegionalPlanning@metrovancover.org) (for *Metro 2050*), or [CleanAirPlan@metrovancover.org](mailto:CleanAirPlan@metrovancover.org), or by telephone at 604-432-6200.

To ensure your comments are considered please provide feedback by September 30, 2020.

## Participation Opportunities

Metro Vancouver will provide a variety of engagement opportunities to hear input on this discussion paper. The public, stakeholders, and other governments can participate via the following:

- online public questionnaire;
- open comments to a dedicated email account;
- public webinars; and
- direct feedback to Metro Vancouver staff.

Details about events will be posted on the *Climate 2050*, *Metro 2050* and *Clean Air Plan* websites (see blue box on the next page).

Feedback on any part of this discussion paper is welcome at any time through the engagement period. Events will focus on proposed goals, example targets and metrics, identification of potential actions, and consideration of the potential pathways need to reach carbon neutrality.

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To ensure your comments are considered please provide feedback by September 30, 2020.

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## How Feedback Will Be Used

With revisions, content from this discussion paper will form the basis of the nature and ecosystems section of the *Clean Air Plan* and the *Climate 2050 Nature and Ecosystems Roadmap*, both of which will be available for comment and feedback before they are finalized. (Note that actions identified in the final *Clean Air Plan* and any of the *Climate 2050 Roadmaps* that could result in significant changes to existing air emission regulations or new regulations may require an independent public engagement process before any regulations or amendments are adopted.)

Content from this discussion paper will also inform the development of *Metro 2050*, the update to the regional growth strategy. To provide feedback on this process directly, please fill out the [Metro 2050 Feedback Form](#).

Comments and suggestions will be compiled into a summary report for consideration by the Metro Vancouver Board, and will be made publicly available in 2020.

Metro Vancouver staff will treat personal information

with confidentiality; please note that comments you submit may be provided to a third party if a freedom of information request is made under the *Freedom of Information and Protection of Privacy Act*. If you have any questions or comments regarding the consultation process, please call 604-432-6200.

Thank you for taking the time to provide your valuable feedback.

For more information, visit [metrovancover.org](http://metrovancover.org) and search “Climate 2050”, “Metro 2050” or “Clean Air Plan”, or call 604-432-6200.

# Glossary

**Air contaminants** are any substances emitted into the air that do or could a) harm public health (including material physical discomfort) and property, b) damage the environment, including the climate, c) impede normal business operations, or d) impair visual air quality.

**Biodiversity** is the variety of species and ecosystems, and the ecological processes that they are part of.

**Blue carbon** refers to the carbon stored in coastal and marine ecosystems.

**Blueway** refers to a network of water bodies (such as rivers, creeks and lakes), often used for recreation.

**Carbon neutral region** is a region that has achieved the deepest greenhouse gas emission reductions possible across all economic sectors, and removes or captures sufficient carbon dioxide to balance any remaining regional greenhouse gas emissions.

**Climate change adaptation** means anticipating, planning for and responding to the adverse effects of climate change and taking appropriate action to prevent or minimize the damage it can cause, or taking advantage of opportunities that may arise. It has been shown that well planned, early adaptation action saves money and lives later.

**Climate resilience** describes the capacity of ecosystems, economies, infrastructure, and communities to absorb the impacts of climate change while maintaining essential services and functions needed to support health and well-being. In some cases, climate resilience involves changing services and functions so they are more sustainable.

**Coastal squeeze** occurs when rising sea levels push coastal habitats landward. Coastal habitats are often diminished in both size and function when caught

between rising sea levels and fixed infrastructure (such as a sea wall) or high ground.

**Ecosystems** describe all the plants and animals that live in a particular area together with the relationships between them and their environment.

**Ecosystem services** are the benefits people obtain from ecosystems. These services can be grouped into four main types:

- *Provisioning services* include material and energy outputs from ecosystems, including food, fresh water, and raw materials used for construction and energy like wood.
- *Regulating services* refer to the services provided by ecosystems in processing and assimilating pollution, stabilizing water flows and soil erosion, controlling local climates, and storing carbon.
- *Cultural services* are the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, recreation, and aesthetic enjoyment.
- *Supporting services* underpin all other ecosystem services. Ecosystems provide habitats for all plants and animals while depending on a diversity of species to maintain their own functions.

**Fine particulate matter (PM<sub>2.5</sub>)** is made up of tiny solid or liquid particles that float in the air and can penetrate deep into the lungs and even into the bloodstream. Fine particulate matter can damage people's health by aggravating existing lung and heart diseases, increasing the risk of cancer and reducing life expectancy.

**Green infrastructure** is a tool for providing biodiversity and climate benefits through nature-based solutions. It includes natural, enhanced, and engineered assets that collectively provide society with ecosystem services required for healthy living. Natural assets (e.g., forests, wetlands and soil) and enhanced or engineered systems (e.g., bioswales and green roofs) improve resilience and mitigate negative environmental impacts from urban development, benefiting both people and ecosystem function.

**Greenhouse gases** are air contaminants that trap heat and are the cause of climate change. Greenhouse gases include carbon dioxide and nitrous oxide, as well as short-lived climate forcers such as methane, halocarbons, black carbon and ozone. Limiting or preventing greenhouse gas emissions and removing these gases from the atmosphere is critical to avoiding catastrophic climate change (sometimes referred to as climate change mitigation).

**Greenway** refers to a linear corridor often used for recreation.

**Ground-level ozone** (O<sub>3</sub>) can have harmful impacts on everyone, especially children, seniors, and people with lung and heart conditions. It is primarily formed when nitrogen oxides and volatile organic compounds react in the air on hot and sunny days.

**Hazard** refers to a dangerous phenomenon, substance, human activity, or condition. In this context, hazards are caused or made worse by climate change. Examples include rainstorms, extreme weather, wildfires, storm surges, and landslides.

**Impacts** refers to the consequences of realized risks on ecosystems, economies, infrastructure and communities. Impacts may be referred to as consequences or outcomes, and can be adverse or beneficial.

**Keystone species** have a disproportionately large effect on the ecosystems in which they occur.

Keystone species help to maintain local biodiversity within a community either by controlling populations of other species that would otherwise dominate the community, or by providing critical resources for a wide range of species.

**Natural assets** are the stock of natural resources and ecosystems (including geology, soil, air, water and all living things) that provide benefits to people. Examples include forests, wetlands, and streams. It is from these natural assets that humans derive a wide range of services, often called ecosystem services, which make human life possible.

**Nature-based solutions** are actions that protect, sustainably manage, and restore natural or modified ecosystems but also address societal challenges (such as climate change), thereby providing both human well-being and biodiversity benefits.

**Riparian** refers to areas close to or on river banks.

**Sensitive Ecosystems** are ecosystems mapped by the [Metro Vancouver Sensitive Ecosystem Inventory](#). Sensitive Ecosystems are ecologically significant and relatively unmodified, and include wetlands, older forests and riparian areas. Some younger and more human modified ecosystems still have ecological value and importance to biodiversity (e.g., young forests), and are also included in the Sensitive Ecosystem Inventory.

**Sequester** is the removal of carbon dioxide from the air and the long-term storage of carbon to mitigate climate change.

**Subsidence** is the sudden sinking or gradual downward settling of the ground's surface. Subsidence is common in river deltas.

**Tree canopy cover** refers to the leaves and branches that form a visible layer if one is viewing the region from the air, and the extent to which they cover the ground.



**Urban forests** contain the trees within the public and private lands of a city, including the trees in parks, around buildings, along streets and in backyards.

**Urban heat island effect** refers to a phenomenon where built-up areas are hotter than nearby non-urban areas. The average air temperature of a city can be several degrees warmer than the surrounding landscape.

**Vulnerability** is the degree to which ecosystems, economies, infrastructure and communities are susceptible to, or unable to cope with, the adverse effects of climate change. Vulnerability varies based on exposure, sensitivity and adaptive capacity. Geographic location, socio-economic conditions, and other factors can impact susceptibility to harm and adaptive capacity.

**Metro Vancouver** is a federation of 21 municipalities, one Electoral Area and one Treaty First Nation that collaboratively plans for and delivers regional-scale services. Its core services are drinking water, wastewater treatment and solid waste management. Metro Vancouver also regulates air quality, plans for urban growth, manages a regional parks system and provides affordable housing. The regional district is governed by a Board of Directors of elected officials from each local authority.

Member jurisdictions of Metro Vancouver include:

- Village of Anmore
- Village of Belcarra
- Bowen Island Municipality
- City of Burnaby
- City of Coquitlam
- City of Delta
- Electoral Area A
- City of Langley
- Township of Langley
- Village of Lions Bay
- City of Maple Ridge
- City of New Westminster
- City of North Vancouver
- District of North Vancouver
- City of Pitt Meadows
- City of Port Coquitlam
- City of Port Moody
- City of Richmond
- City of Surrey
- Tsawwassen First Nation
- City of Vancouver
- District of West Vancouver
- City of White Rock

