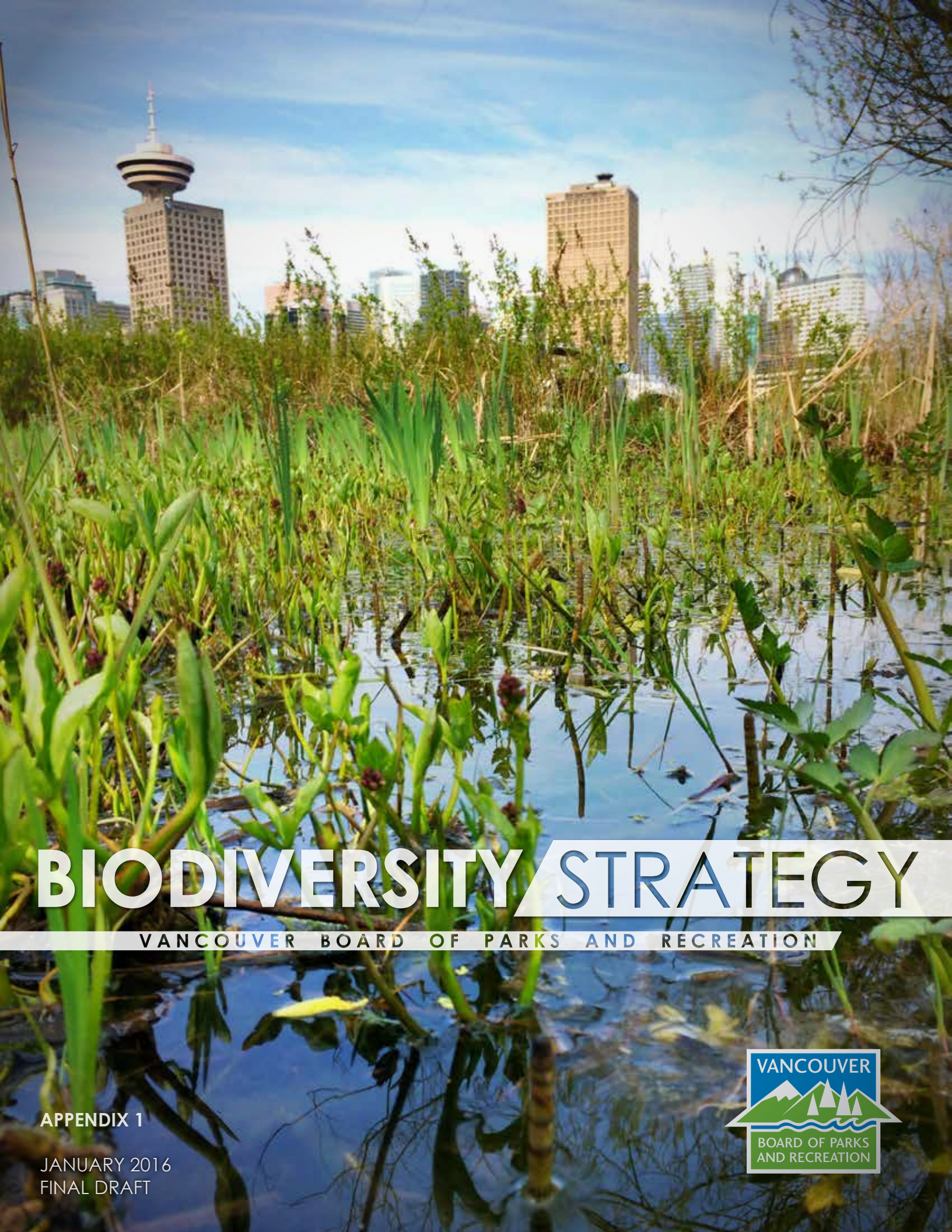


BIODIVERSITY STRATEGY

VANCOUVER BOARD OF PARKS AND RECREATION

APPENDIX 1

JANUARY 2016
FINAL DRAFT

VANCOUVER BOARD OF PARKS AND RECREATION, 2016

Citation: Vancouver Board of Parks and Recreation. 2016. Biodiversity Strategy. Vancouver, BC. 53 pp.

Cover photo: Wetland in Crab Park (photo by Nick Page)

There is a person within us who would like to hear birdsong spill out of the forest like a wave, watch spawning fish turn a blackwater river to silver, or walk a road beaten into the savannah by herd animals. It's that same person who would take some unexplainable satisfaction from the sound of a whale's deep breathing as it sleeps at the surface of the sea, and who is able to grasp that a lichen that clings to the slopes of a single mountain is a metaphor for our own dependence on this lone earth in outer space.

The Once and Future World
J.B. MacKinnon, 2013

The last muskrats caught in the swamp back of Kitsilano Beach were caught in the slough where Creelman Street now is, just prior to the filling in of this swamp by the pumping of sand from False Creek in 1913. Salmon swam up this slough as far as the corner of Third Avenue and Cedar Street and up to Eighth Avenue in Mount Pleasant. The creek at Bayswater Street was infested with trout, and also the slough which ran about under the Henry Hudson School. In 1900, hundreds of thousands of salmon were caught, more than the canneries could handle, were thrown away, and littered the beach at Kitsilano with stinking decaying fish, which illuminates the quantity of fish available for food before the white man came. Smelts could be gathered in the fingers, an old hat, a tin dish, or raked up the sand with a garden rake.

Recollections of Mrs. Harriett George
Early Vancouver, Volume 2
Major J.S. Matthews, 1933

TABLE OF CONTENTS

FOREWORD

For final report

1 SUMMARY

Musqueam Marsh, on the edge of the city, is critical for juvenile salmon migrating from the Fraser River (photo by Nick Page)

The Vancouver Park Board's Biodiversity Strategy presents a goal, target, objectives, and actions for supporting biodiversity in parks, and on other public and private lands, across the City of Vancouver. Together with the Urban Forest Strategy, the Rewilding Action Plan, and the Vancouver Bird Strategy, it provides a foundation for protecting and restoring natural areas, species, and ecological processes, and for improving access to nature in all of Vancouver's neighbourhoods. It describes strategies to restore priority habitats such as forests, wetlands, and shorelines as part of a city-wide ecological network, to change the Park Board's operations to better support biodiversity, and to celebrate biodiversity as an important part of city life.

GOAL

Increase the amount and ecological quality of Vancouver's natural areas to support biodiversity and enhance access to nature.

OBJECTIVES

1. Restore habitats and species.
2. Support biodiversity within parks, streets, and other City-owned lands.
3. Protect and enhance biodiversity during development.
4. Celebrate biodiversity through education and stewardship.
5. Monitor biodiversity to track change and measure success.

TARGET

Restore or enhance 25 ha of natural areas by 2020.

METRICS

1. Amount (hectares) of natural areas.
2. Ecosystem health of important aquatic ecosystems (False Creek, Still Creek, and Musqueam Creek).
3. Percent of residents within a 5-minute walk of natural spaces (>0.5 ha) by neighbourhood.
4. Number of volunteers involved in biodiversity projects.

PRIORITY ACTIONS

1. Use park acquisition, tree planting, and the development planning process to expand and connect parks and build the city's ecological network.
2. Develop a city-wide Invasive Species Action Plan, and control priority invasive species in parks.
3. Partner with Port Metro Vancouver to restore shoreline and shallow subtidal habitats along Burrard Inlet, English Bay, and the Fraser River.
4. Incorporate smaller natural areas and features such as pollinator meadows into new and redeveloping parks and city-owned lands.
5. Use the Urban Forest Strategy to restore native forests in Stanley, Jericho Beach, Musqueam, Everett Crowley, Renfrew Ravine and other large parks.
6. Create a Biodiversity Advisory Committee composed of public members, technical experts, and staff to guide the Park Board's biodiversity conservation efforts.
7. Hire a Stewardship Coordinator to assist community groups in the planning and implementation of biodiversity and urban forest projects.
8. Assist landowners in increasing biodiversity values on private property through education and stewardship.
9. Improve the ecosystem health of False Creek, Still Creek, and Musqueam Creek.
10. Develop a city-wide biodiversity monitoring plan.

2 INTRODUCTION

Musqueam Creek supports the last wild coho salmon population in Vancouver (Nick Page photo)

WHAT IS BIODIVERSITY?

Biodiversity is the richness of plant and animal species, their habitats, and the ecological processes that sustain them. It includes both marine and terrestrial ecosystems within the City of Vancouver and includes portions of English Bay, False Creek, the north arm of the Fraser River, and the upslope areas of Point Grey and the downtown peninsula.

While this strategy emphasises the importance of native ecosystems and species, it also recognizes the value of urban habitats such as green roofs, stormwater wetlands, and pollinator meadows in supporting biodiversity within the city.

WHY IS BIODIVERSITY IMPORTANT?

Biodiversity is interwoven into Vancouver's urban landscape: migrating songbirds nest in our forests, salmon spawn in our remaining streams, and tall trees define some of our most important parks. The capture of rainfall in the canopy of urban forests and the pollination of fruit trees by native bees are examples of ecosystem services supported by biodiversity. Similarly, coastal wetlands and growing forests capture and store large amounts of carbon, and natural shorelines increase the city's resilience to sea level rise associated with climate change.

Biodiversity is also part of a healthy city, and access to nature sustains the mental and physical health of Vancouver's citizens. Opportunities to hear songbirds in Queen Elizabeth Park, fish for crabs from the Jericho Pier, or catch a fleeting glimpse of a river otter along the Fraser River provide daily connections to nature in an increasingly urban world. These experiences are as important as access to art and music for many of Vancouver's residents and visitors.

Biodiversity also has intrinsic values unrelated to its utility or economic value to human society. Indeed, we have a responsibility, enshrined in our federal and provincial laws and international commitments, to protect biodiversity in all its variety.

BIODIVERSITY INITIATIVES IN VANCOUVER AND THE REGION

The Vancouver Park Board and the City of Vancouver strive to be world leaders in sustainability. Actions are guided by the Park Board's Strategic Plan (2012) and the Greenest City 2020 Action Plan. Other important strategies and plans that support biodiversity are the Urban Forest Strategy (in process), Vancouver Bird Strategy (2015), Rewilding Vancouver: Environmental Education and Stewardship Action Plan (2014), and the Green Operations Plan (2013).

Metro Vancouver Regional District completed its regional Biodiversity Strategy between 2001 and 2006 and more recently a Sensitive Ecosystem Inventory mapped important natural areas across the region, including Vancouver. These documents show that biodiversity values in Vancouver are highest in Stanley Park and at the western boundary adjacent to Pacific Spirit Regional Park. Smaller natural areas and marine ecosystems were not mapped at the regional scale. Metro Vancouver also developed an Ecological Health Action Plan (2011) focused on three areas: 1) supporting green infrastructure; 2) restoring salmon in urban areas; and 3) supplementing ecological services. Mapping of marine and intertidal habitats has also been completed by the Fraser River Estuary Management Program (FREMP) for the Fraser River, and for

Burrard Inlet by the Burrard Inlet Environmental Action Plan (BIEAP).

Many biodiversity projects in Vancouver are completed by stewardship groups, researchers, students, and dedicated volunteers. Projects include monitoring seabird populations by the BC Coastal Waterbird Survey, forest restoration by the Jericho Stewardship Group, pollinator conservation by the Environmental Youth Alliance, and environmental education by the Stanley Park Ecology Society and Everett Crowley Park Committee.

BIODIVERSITY SUCCESS STORIES

STANLEY PARK FOREST RESTORATION

Stanley Park is one of the most important urban forests in the world. It has been the focus of many successful biodiversity projects including tree planting; public education; monitoring and research on amphibians, shorebirds, and forests; invasive species control, and wetland restoration. Over $8 million was spent on replanting trees, improving public safety, and addressing long-term forest health following the 2006 windstorm (see photo above). The Stanley Park Ecology Society plays a key role in managing and promoting biodiversity in the park.

STANLEY PARK HERON COLONY

Stanley Park is also home to one of the largest urban great blue heron nesting colonies in North America, with 83 active nests in 2015 producing about 175 fledglings. Herons have been nesting near the Parks Board's office on Beach Avenue since 2001 and have nested in other locations in Stanley Park since 1921. Herons feed on the rich intertidal zone of Stanley Park and English Bay. Interestingly, the nesting herons may receive protection from predators from a nearby eagle nest; the territoriality of bald eagles wards off other avian predators.

HINGE PARK AND HABITAT ISLAND

A new island with adjacent intertidal habitat and a stormwater-fed wetland in Hinge Park were created in southeast False Creek as part of the Olympic Village. These features create a variety of habitats – freshwater wetland, rocky intertidal zone, and shoreline forest – and provide a precedent for incorporating novel habitats for biodiversity into dense urban neighbourhoods. Herring now spawn on the shores of False Creek, including the cobble intertidal zone of Habitat Island (shown above). And a pair of beavers made the Hinge Park wetland their home in 2015.

SALMON RETURN TO STILL CREEK

Ongoing work to restore Still Creek has been rewarded by the return of over 20 chum salmon each year since 2012. Now salmon and trout are found in five streams in the city: Still Creek, Musqueam Creek, Beaver Creek, Vivian Creek, and Spanish Bank Creek. Work on Still Creek has focused on riparian zone restoration, creation of more complex stream channels and floodplain wetlands, and removing culverts that have prevented upstream fish passage. Future restoration projects are planned by Engineering, Planning, and Parks as part of the Still Creek Rehabilitation and Enhancement Study (2002).

JERICHO PARK SHORELINE RESTORATION

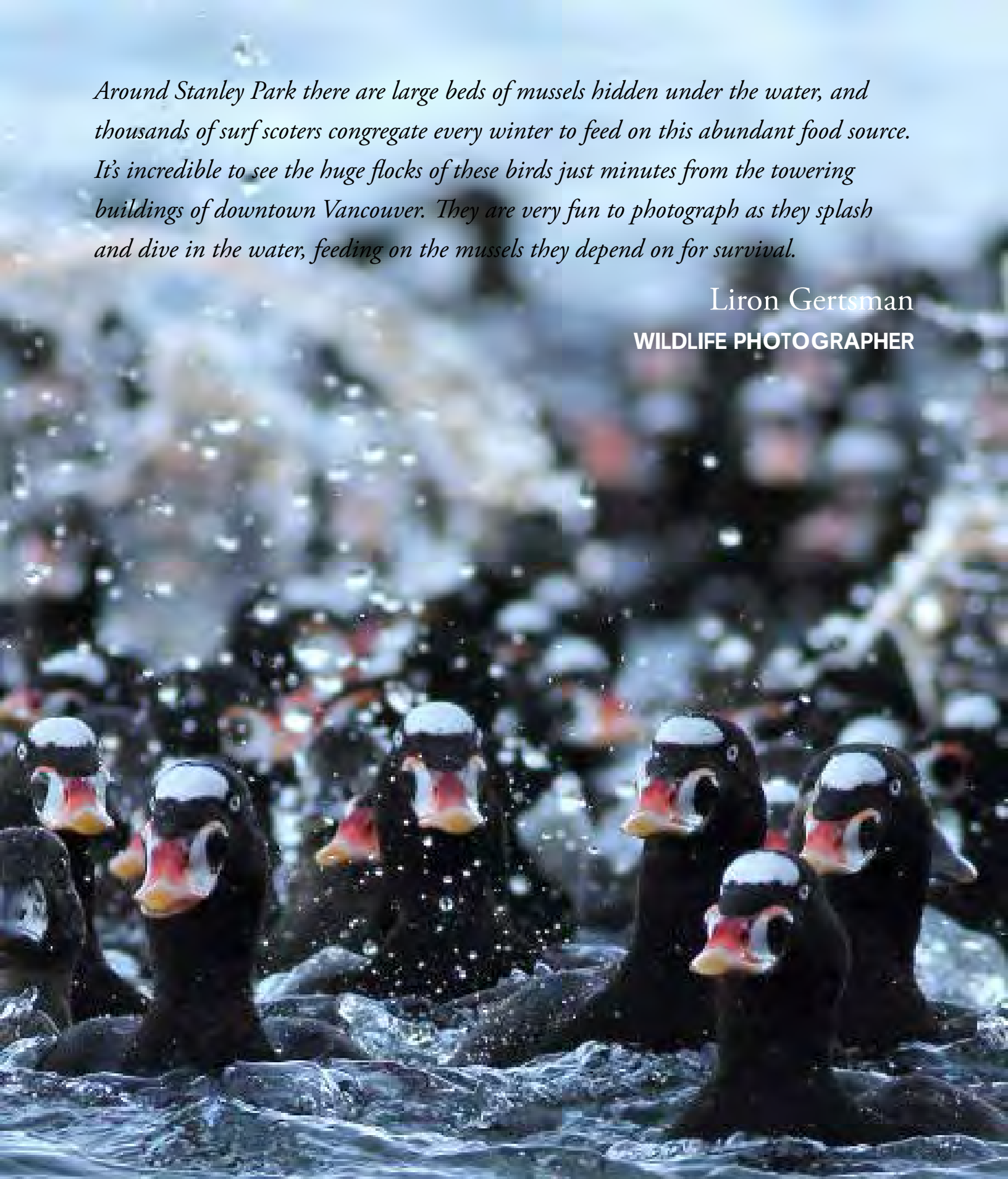
The restoration of a 185 m section of shoreline on the western edge of Jericho Beach Park is one of Vancouver's most significant increases in shoreline habitat in decades. The project demolished a derelict wharf that had degraded habitat for fish, invertebrates, and marine birds. The project created a new sand beach for swimming and sailing, restored intertidal habitats for surf smelt and other spawning fish, and planted beach meadows and shoreline forests. The project was certified as one of BC's first Green Shores projects.

VANCOUVER CONVENTION CENTRE

The 4.5 ha green roof on Vancouver's waterfront convention centre is a noteworthy example of an urban habitat. It supports undulating meadows of native grasses and wildflowers, which provide habitat for native bees, honey bees, and birds. An innovative "habitat skirt" extends 50 m from the building's foundation into Burrard Inlet and provides habitat for a rich community of marine species such as lingcod, sculpins, Dungeness crabs, sea urchins, seaweeds, and starfish (like this leather star. above)

Around Stanley Park there are large beds of mussels hidden under the water, and thousands of surf scoters congregate every winter to feed on this abundant food source. It's incredible to see the huge flocks of these birds just minutes from the towering buildings of downtown Vancouver. They are very fun to photograph as they splash and dive in the water, feeding on the mussels they depend on for survival.

Liron Gertsman
WILDLIFE PHOTOGRAPHER



Congregation of surf scoters on the Stanley Park shoreline (photo by Liron Gertsma)

3 POLICY CONTEXT

PARK BOARD STRATEGIC PLAN

The mission of the Vancouver Park Board is to provide, preserve, and advocate for parks and recreation to benefit all people, communities, and the environment. The vision is to be a leader in parks and recreation by connecting people to green space, active living, and community.

The Park Board's five-year Strategic Plan framework was adopted in May 2015, and several goals and objectives provided guidance to the Biodiversity Strategy.

1 GREAT EXPERIENCES

Our culture is inclusive and service oriented. We strive to deliver extraordinary experiences for everyone.

1.3 Enhanced Participation & Active Living: Encourage active and healthy lifestyles and promote community involvement.

2 RELEVANT PROGRAMS & SERVICES

We plan and deliver parks and recreation services that meet the needs of our communities both now and in the future.

2.1 Proactive Service Planning & Delivery: Assess parks and recreation needs and provide diverse and inclusive services that reflect Vancouver's current and future requirements.

2.3 Vibrant Arts & Culture Experiences: Actively facilitate public participation in and access to the arts.

3 GREEN OPERATIONS

We are green in all that we do; we strive to minimize our footprint through green policies and practices that reduce carbon dependency, enhance energy conservation, and reduce waste.

3.2 Greener Spaces: Preserve, restore, and expand green space. Use the Park Board's horticultural expertise to support plant conservation, landscape restoration, garden design and local food production.

4 HEALTHY ECOSYSTEMS

We grow green neighbourhoods by providing our communities with easy access to nature and advocating for healthy and sustainable environments.

4.1 Green Stewardship: Model and advocate for best practices in ecosystem enhancement and management.

4.3 Green Education & Advocacy: Use Park Board expertise, programs, facilities, and partnerships to increase awareness and knowledge of sustainable living.

5 PARTNERS

We seek, build, and maintain relationships to benefit Vancouver by being an open and accountable partner.

5.1 Effective Partnerships: Partner to deliver programs and services and further strategic objectives.

5.2 Productive Collaborations: Build positive and open relationships.

5.3 Valued Volunteers and Advocates: Appreciate and acknowledge the efforts of volunteers and advocates.

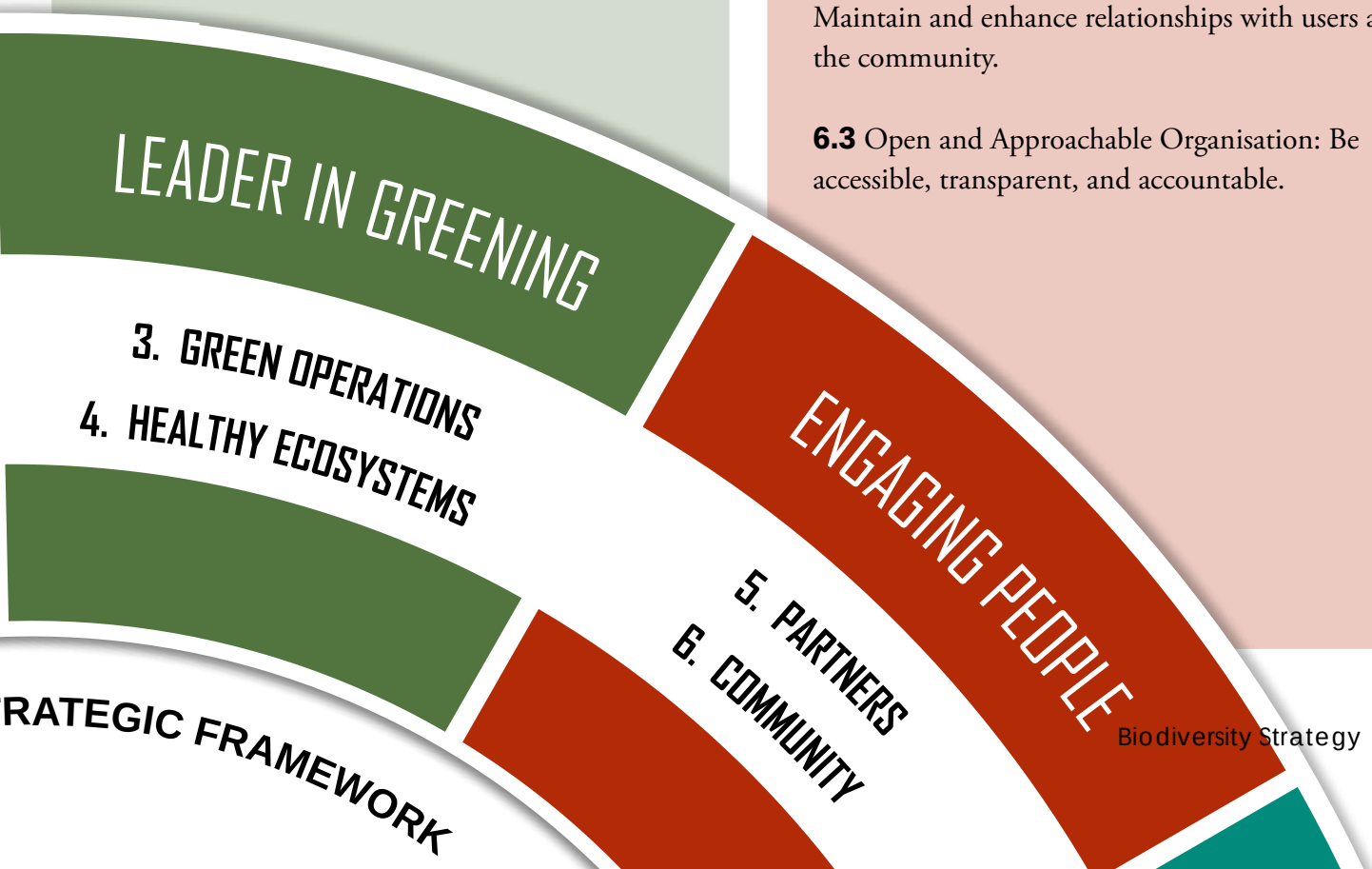
6 COMMUNITY

We are committed to connecting people. We facilitate healthy lifestyles and enrich communities. We actively promote collaboration and participation.

6.1 Active Community Participation: Encourage active participation in parks and recreation.

6.2 Improved Communication and Engagement: Maintain and enhance relationships with users and the community.

6.3 Open and Approachable Organisation: Be accessible, transparent, and accountable.



4 THREATS TO BIODIVERSITY

Marathassa oil spill in English Bay, April 2015

HISTORICAL HABITAT AND SPECIES LOSS

Vancouver's development history is unique in Metro Vancouver and influences the current patterns of biodiversity aross the city. Unlike developing cities such as Surrey and Coquitlam, most of the land development and land use decisions in Vancouver were made before environmental regulations were enacted or public concern for these issues developed. Many coastal wetlands, such as the marshes, mudflats, and tidal channels of False Creek and Lost Lagoon, were destroyed by early development, and all but 9 km of Vancouver's estimated 105 km of streams were buried before stream protection regulations were established. Many wildlife species disappeared during Vancouver's early development: the last Roosevelt elk was hunted from the False Creek flats in the 1890s and grey wolves and cougars disappeared before the start of the twentieth century. While black-tailed deer occasionally visit the city, the last persistent population disappeared from Pacific Spirit Regional Park in the 1980s as adjacent habitats were developed.

INVASIVE SPECIES

According to the World Conservation Union, invasive species are the second most significant threat to biodiversity after habitat loss. They compete with native species for resources such as light and water, disrupt ecological processes, hybridize with native species, and homogenize distinct native ecological communities. Important invasive species in Vancouver include English ivy, Japanese knotweed, Himalayan blackberry, American bullfrog, common carp, varnish clam, European rabbit, and eastern grey squirrel. Even in Vancouver's large natural areas such as Stanley Park, invasive species are often common.

DISRUPTION TO ECOLOGICAL PROCESSES

Natural ecological processes, such as flooding, fire, windstorms, insect outbreaks, and disease, sustain biodiversity by increasing habitat variation, allowing new species to establish and re-sorting

Intertidal marshes were still present in False Creek in 1902 (photo from Vancouver Archives)

resources and nutrients. Many of these processes disturb ecosystems in predictable ways, yet they are unpredictable in their timing, extent, and intensity. Coastal forests, for example, contain dead trees and downed logs that are the product of tree death from disease, fire, wind, or competition for light. Dead trees are essential for cavity-nesting birds, and downed logs provide habitat for small mammals such as Douglas squirrel and Oregon vole and amphibians like red-backed salamander.

Natural disturbance processes have been replaced by human-driven disturbances such as mowing and cultivation. Maintaining biodiversity depends on allowing ecological processes to occur or finding comparable ways of periodically disturbing ecosystems. For example, wetlands can be flooded seasonally, and meadows can be mowed to reduce shrub and tree establishment.

ENVIRONMENTAL CONTAMINANTS

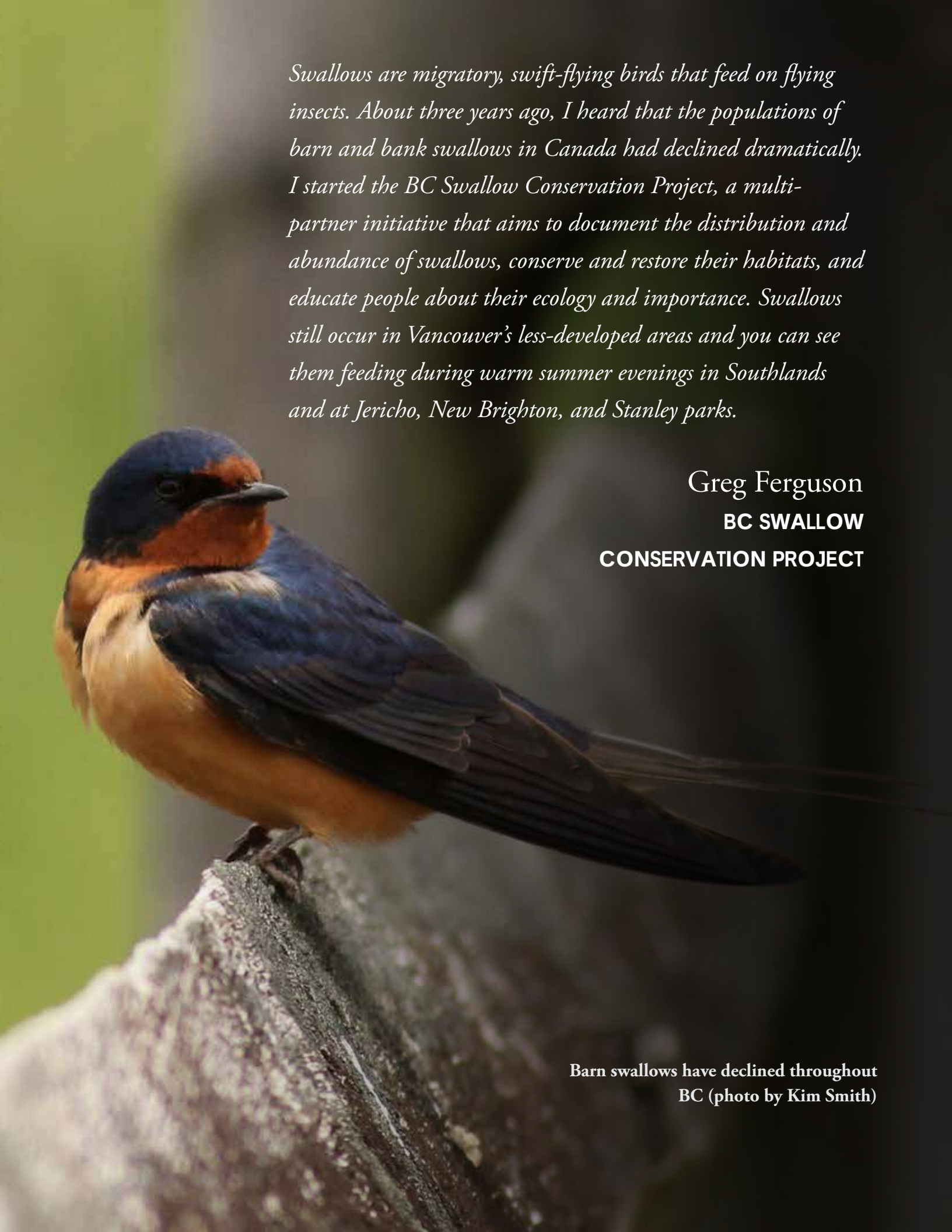
Biodiversity is exposed to a range of contaminants in air, water, and soil that can cause mortality, poor health, or reduced reproductive success. Stormwater runoff in Still Creek affects populations of cutthroat trout and aquatic invertebrates, and contaminated marine sediments in False Creek and Coal Harbour are transferred through the food web to river otters and harbour seals. Even lichen diversity growing on urban trees is influenced by air quality. Toxins used for pest control cause mortality in urban wildlife: rat poison may be injested by predators such as coyotes or raptors, and the decline of bumble bees has been linked to the widespread use of pesticides. Oil spills are an increasing threat to marine ecosystems in English Bay and Burrard Inlet as shipping traffic increases.

CLIMATE CHANGE

Rising sea levels, ocean acidification, increased air and water temperatures, and changes to seasonal precipitation will have negative effects on many components of biodiversity. Food webs are likely to be affected, leading to widespread changes to populations of both rare and common species. By 2100, sea level around Vancouver could be over 1 m higher than it is now, which will reshape the city's shoreline. More prolonged summer droughts may change forest composition to favour Douglas-fir and other drought-tolerant species, while western redcedar and western hemlock decline. Streams and wetlands may have less summer water and the use of potable water to support Vancouver's ponds may be unacceptable as reduced snowpack intensifies water restrictions. Many changes associated with climate change will have cumulative and unpredictable effects on already stressed urban ecosystems.

DIRECT IMPACTS TO WILDLIFE

Mortality from roads (road-kill), bird strikes with windows, predation from cats, marine oil spills, harvesting for food, disturbance from recreation, trapping, and poisoning all contribute to the loss or disturbance of birds, small mammals, fish, and other wildlife in Vancouver. Almost two million birds die annually in Canada from cat predation and collisions with windows, vehicles, and powerlines; domestic and feral cats account for about 72% of these deaths. Dogs disturb migrating shorebirds on Spanish Bank. The City of Vancouver recorded the deaths of 674 raccoons, 261 squirrels, 21 coyotes, and 9 skunks since 2001; most died or were euthanized after collisions with vehicles. Other issues of concern are noise and light pollution, which can disrupt nesting, foraging, and other activities in some birds and invertebrates.



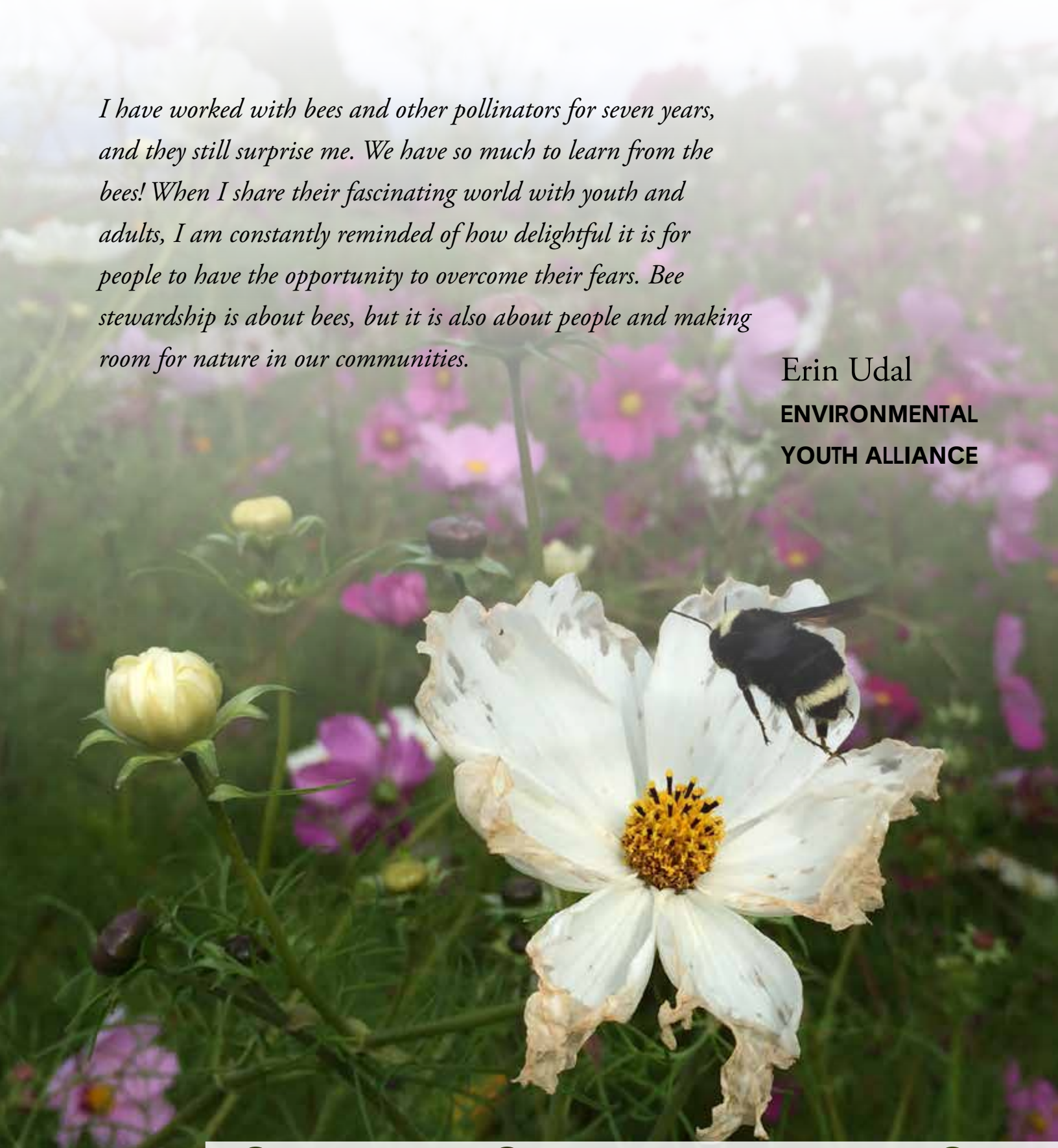
Swallows are migratory, swift-flying birds that feed on flying insects. About three years ago, I heard that the populations of barn and bank swallows in Canada had declined dramatically. I started the BC Swallow Conservation Project, a multi-partner initiative that aims to document the distribution and abundance of swallows, conserve and restore their habitats, and educate people about their ecology and importance. Swallows still occur in Vancouver's less-developed areas and you can see them feeding during warm summer evenings in Southlands and at Jericho, New Brighton, and Stanley parks.

Greg Ferguson
BC SWALLOW CONSERVATION PROJECT

Barn swallows have declined throughout BC (photo by Kim Smith)

I have worked with bees and other pollinators for seven years, and they still surprise me. We have so much to learn from the bees! When I share their fascinating world with youth and adults, I am constantly reminded of how delightful it is for people to have the opportunity to overcome their fears. Bee stewardship is about bees, but it is also about people and making room for nature in our communities.

Erin Udal
ENVIRONMENTAL YOUTH ALLIANCE



5 STATUS & TRENDS

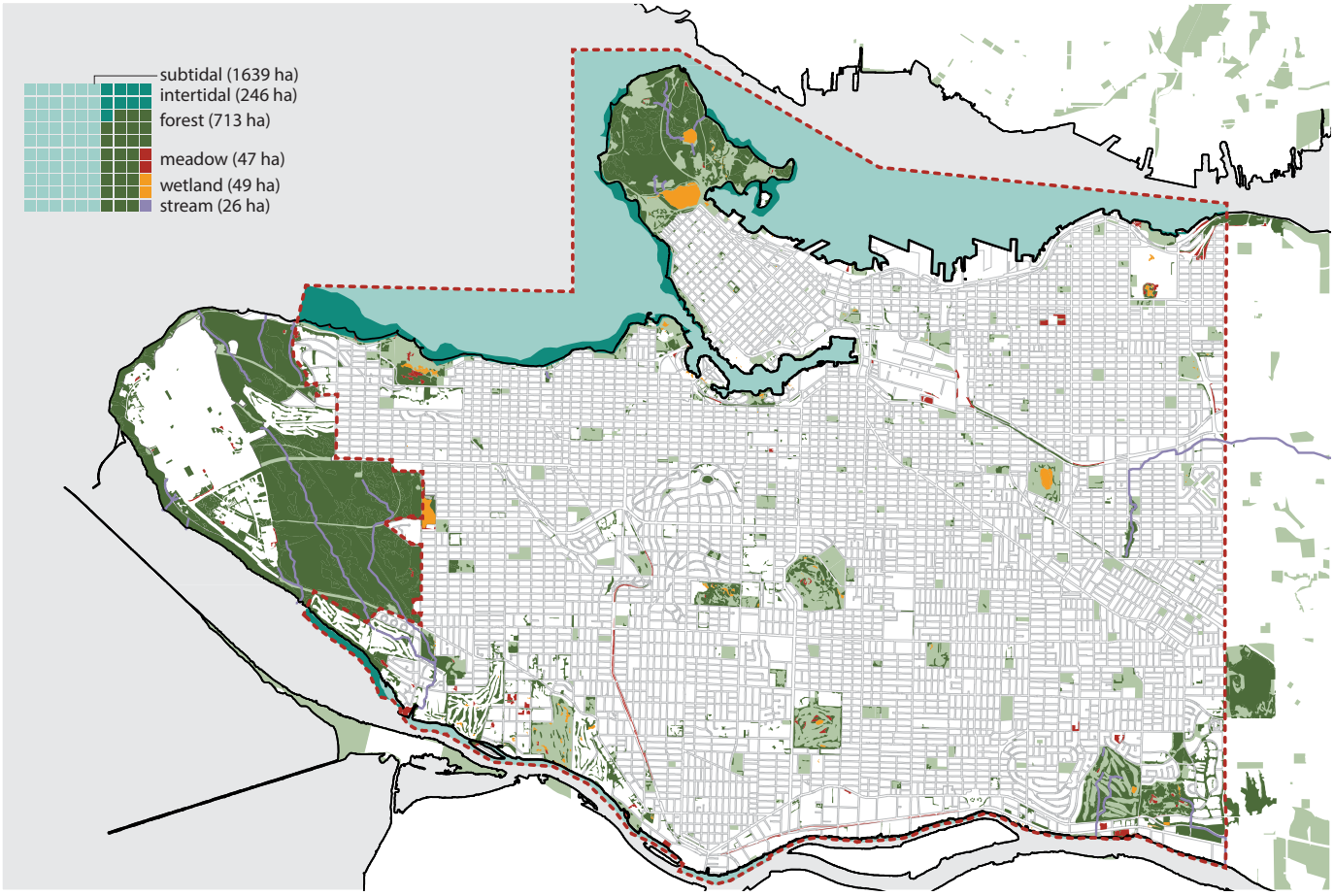
Yellow-faced bumblebee in Oak Meadows Park (photo by Nick Page)

PRIORITY HABITATS

Biodiversity in urban landscapes depends on maintaining a network of connected natural areas anchoured by larger patches such as Stanley Park, the Fraser River, and Pacific Spirit Regional Park. We call it the "ecological network", which reflects how it functions as a connected system.

To identify the ecological network in Vancouver, we mapped six priority habitats (forests, wetlands, streams, meadows, intertidal and subtidal zones) across the city. Their distribution is shown in Map 1. It includes some areas adjacent to the city such as Pacific Spirit Regional Park in Point Grey and Central Park in Burnaby because of the habitat connections across boundaries.

The status of these priority habitats varies. Forests and marine habitats are still relatively abundant, but streams, wetlands, and meadows are rare because of Vancouver's history of urban development. Many intertidal habitats have been filled or modified by shoreline development, but most subtidal habitats are still intact. The status of each priority habitat is described more fully in the following sections.



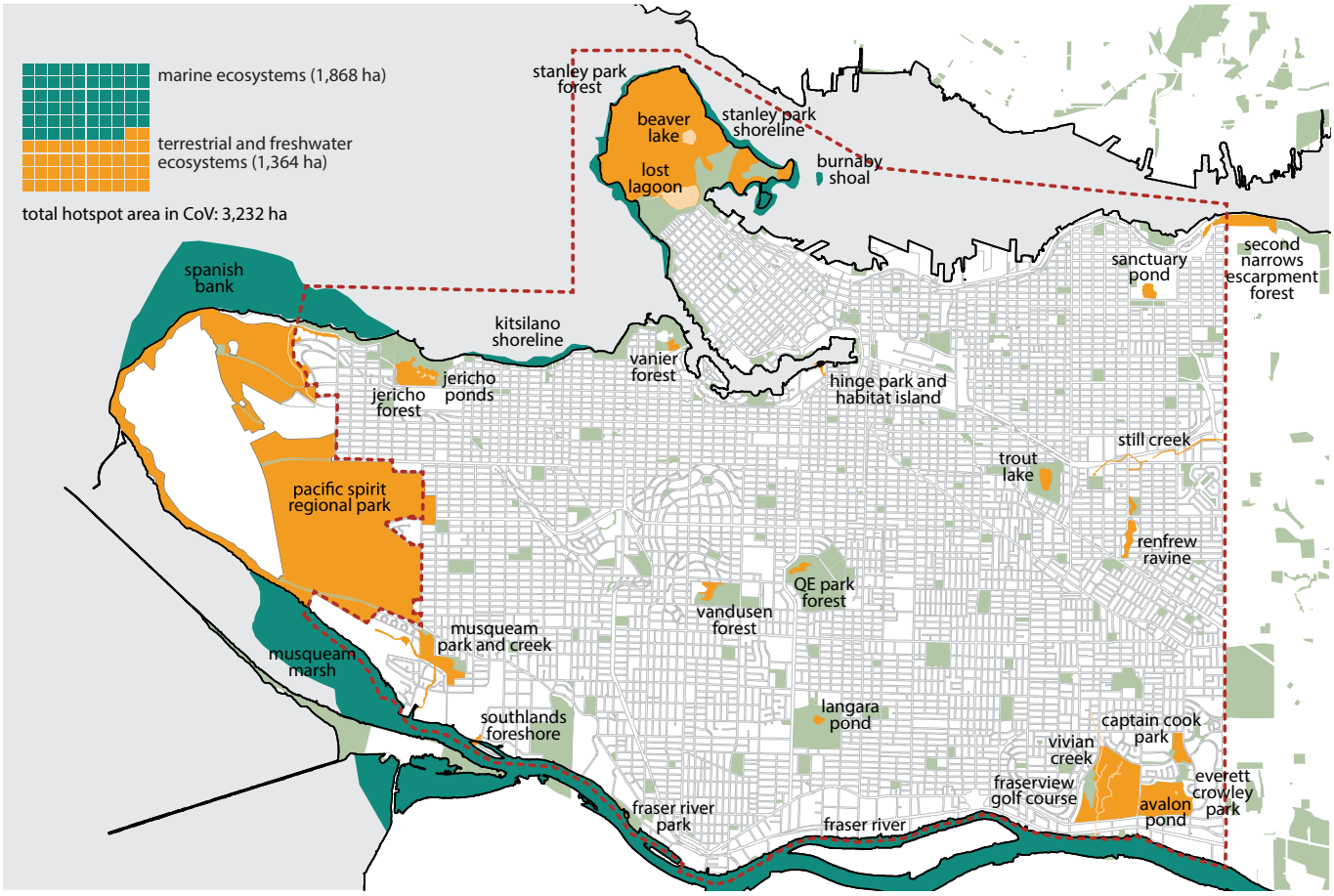
Map 1. Distribution of priority habitats in the City of Vancouver and adjacent areas.

BIODIVERSITY HOTSPOTS

We used mapping of priority habitats and suggestions from stewardship groups to identify Vancouver's biodiversity hotspots. Biodiversity hotspots are natural areas that support noteworthy components of biodiversity in the City of Vancouver. Often they are representative of regionally rare ecosystems, such as intertidal wetlands, that were more widespread historically or are unique to the City of Vancouver. Some support species or ecological communities at risk.

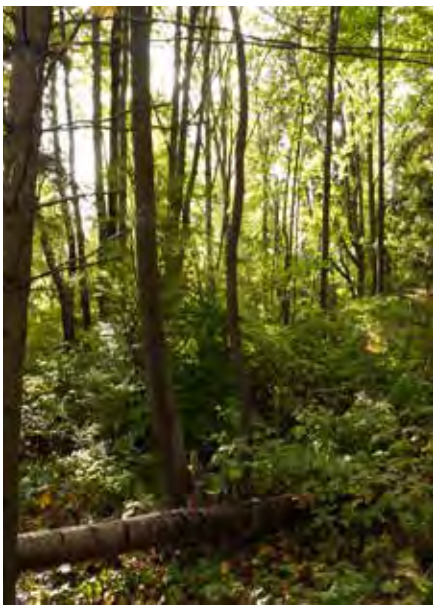
Map 2 shows the location of biodiversity hotspots. Most are not afforded special protection for their biodiversity values (although many are in city parks); and the purpose of this map is to draw attention to their location, value, and sensitivity.

The largest biodiversity hotspots in the City of Vancouver are Stanley Park (which accounts for over half the total area), Fraserview Golf Course, Spanish Bank, Everett Crowley Park, Musqueam Marsh, Musqueam Park, and Jericho Park. Pacific Spirit Regional Park is the largest natural area on the Point Grey peninsula, but only a small portion is located within the City of Vancouver.



Map 2. Biodiversity hotspots in the City of Vancouver.

STATUS OF PRIORITY HABITATS



LARGE NATIVE FORESTS ARE STABLE

While recent surveys have documented an overall decline in the urban forest canopy, most large native forests (>0.5 ha; dominated by native trees and shrubs) are contained within parks and are generally stable or increasing in area. Forests cover about 713 ha (6% of the city), of which 474 ha are classified as native forest. The largest areas of native forest are found in Stanley Park, Fraserview Golf Course, Everett Crowley Park, Musqueam Park, and Jericho Beach Park. Stanley Park accounts for over 75% of the native forests in the city, and together these five parks account for 66% of the city's entire urban forest.

FRESHWATER WETLANDS ARE RARE BUT STABLE

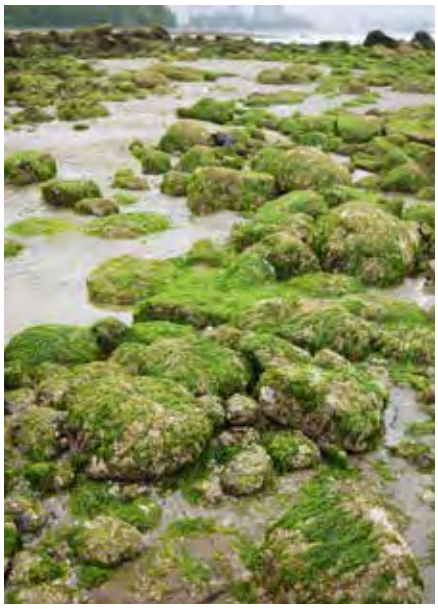
Freshwater wetlands are rare in Vancouver because of sloping topography and historical development. About 53 ha of freshwater wetlands are currently found in the city. The largest freshwater wetlands are Lost Lagoon, Beaver Lake, Trout Lake, Jericho Ponds, and Sanctuary Pond in Hastings Park. Wetland creation and restoration, such as enlargement of Avalon Pond in Everett Crowley Park, has resulted in a minor increase in the extent of wetlands over the past 10 years.

STREAMS ARE RARE BUT STABLE

There are only about 9 km of permanently flowing streams remaining: Musqueam Creek, Vivian Creek, Still Creek, Spanish Bank Creek, and Beaver Creek. This is less than 9% of the 105 km of streams that were present in the city historically. Ongoing restoration of Still Creek and proposed projects to daylight Hastings Creek in Hastings Park, Salmonberry Creek in Spanish Bank, and Tatlow Creek in Kitsilano are slowly increasing the amount of stream in the city.

MEADOWS ARE UNCOMMON

Meadows were not part of Vancouver's predominantly forested landscape 150 years ago but have developed in parks, roadsides, and abandonned sites. Meadows are grass-dominated habitats that are not mowed or are mowed infrequently. They support tall grasses, weedy forbs, and wildflowers. Meadows are important for birds and insects because they provide food and cover in proximity to each other. They are important for native bees and other pollinators because they provide abundant flower resources.



INTERTIDAL SHORELINES ARE STABLE BUT UNDER THREAT

Vancouver has about 70 km of intertidal shoreline of which 22 km (31%) are considered predominantly natural. There are about 241 ha of intertidal habitat, which includes Spanish Bank, Stanley Park shoreline, and portions of the Musqueam Marsh. The richest intertidal habitats are in Stanley Park where tidal currents enhance intertidal life, and in the marshes at the mouth of the North Arm of the Fraser River. Mudflats, such as Spanish Bank, are important for fish and marine birds which feed on the abundant worms, shrimp, and clams found in soft sediments. Shorelines are under threat from industrial development, oil spills, shoreline armouring, intensive recreation use, and sea level rise.

SUBTIDAL HABITATS ARE STABLE BUT POORLY SURVEYED

Subtidal habitats (shallow marine habitats below the intertidal zone) are critical for marine biodiversity. Their condition in Vancouver ranges from poor in areas of historical industrial use like False Creek and Coal Harbour, to healthy near First Narrows and Brockton Point. Bull kelp, an important component of biodiversity in shallow subtidal habitats with rock substrates, is recolonising some areas of Burrard Inlet. Dense Eelgrass is generally rare but small patches are present in some areas such as Jericho Beach.

STATUS OF PRIORITY SPECIES

While the Biodiversity Strategy emphasizes habitat as the primary focus of biodiversity management, species are also important. Some species play a key role in maintaining ecosystem function by structuring food webs or creating habitat that supports other species (e.g., native squirrels are critical for health owl populations; forests of bull kelp are spawning and nursery areas for rockfish, perch, and lingcord). The following species or species groups were selected because they represent the range of biodiversity in Vancouver, are suitable for citizen science monitoring programs, are a often a key part of food webs.

SALMON AND TROUT ARE STABLE OR INCREASING

Remnant populations of salmon and/or trout are still present in Still, Musqueam, Vivian, Spanish Bank, and Beaver creeks. Musqueam Creek supports the only native population of coho salmon in Vancouver, and over 20 chum salmon have spawned in Still Creek in East Vancouver each year since 2012, which, prior to this, had not occurred for over 50 years! A small population of cutthroat trout resides in Vivian Creek in Fraserview Golf Course.

MANY NATIVE BIRDS ARE DECLINING

Migrating songbirds are abundant in forested parks during late spring, 12 pairs of bald eagles nest in the city, and the Stanley Park heron colony had 83 active nests in 2015. But populations of many shorebirds, insectivores (like swallows and nighthawks), and forest-dependent birds are declining. Barn swallows have declined by more than 90% in BC since the early 1970s, and populations of ruffed grouse, yellow-billed cuckoo, and band-tailed pigeon are no longer found in Vancouver.

NATIVE FROGS ARE RARE AND DECLINING

Native frogs are rare in the city. Pacific tree frogs are still relatively abundant in ponds and ditches in Southlands and in Jericho Beach Park, but there are no native frogs in Stanley Park despite wetland habitat in Beaver Lake and smaller forested wetlands. Similarly, Trout Lake does not support native frogs. There are no recent records of the provincially-threatened red-legged frog (above) in Vancouver or Burnaby.

SOME NATIVE MAMMALS ARE INCREASING

No populations of large native mammals (deer, elk, bear, wolf, cougar) remain in the city, except for occasional strays from North Vancouver or Burnaby Mountain. The top predator is now the coyote. However, Vancouver supports healthy populations of coast mole, striped skunk, raccoon, and coyote, and American mink and river otter are seen occasionally. Beaver populations are also increasing, and whales and dolphins are more frequent visitors to Burrard Inlet and English Bay.

FORAGE FISH ARE DECLINING

Forage fish (Pacific herring, surf smelt, Pacific sand lance, and eulachon) are an essential part of the marine food web. The surf smelt population in English Bay has collapsed to less than 5% of its historical level. Herring spawned in False Creek in 2009 for the first time in many decades but are still at remnant levels. The Fraser River eulachon run has also collapsed and is considered endangered.

NATIVE BEES ARE DECLINING

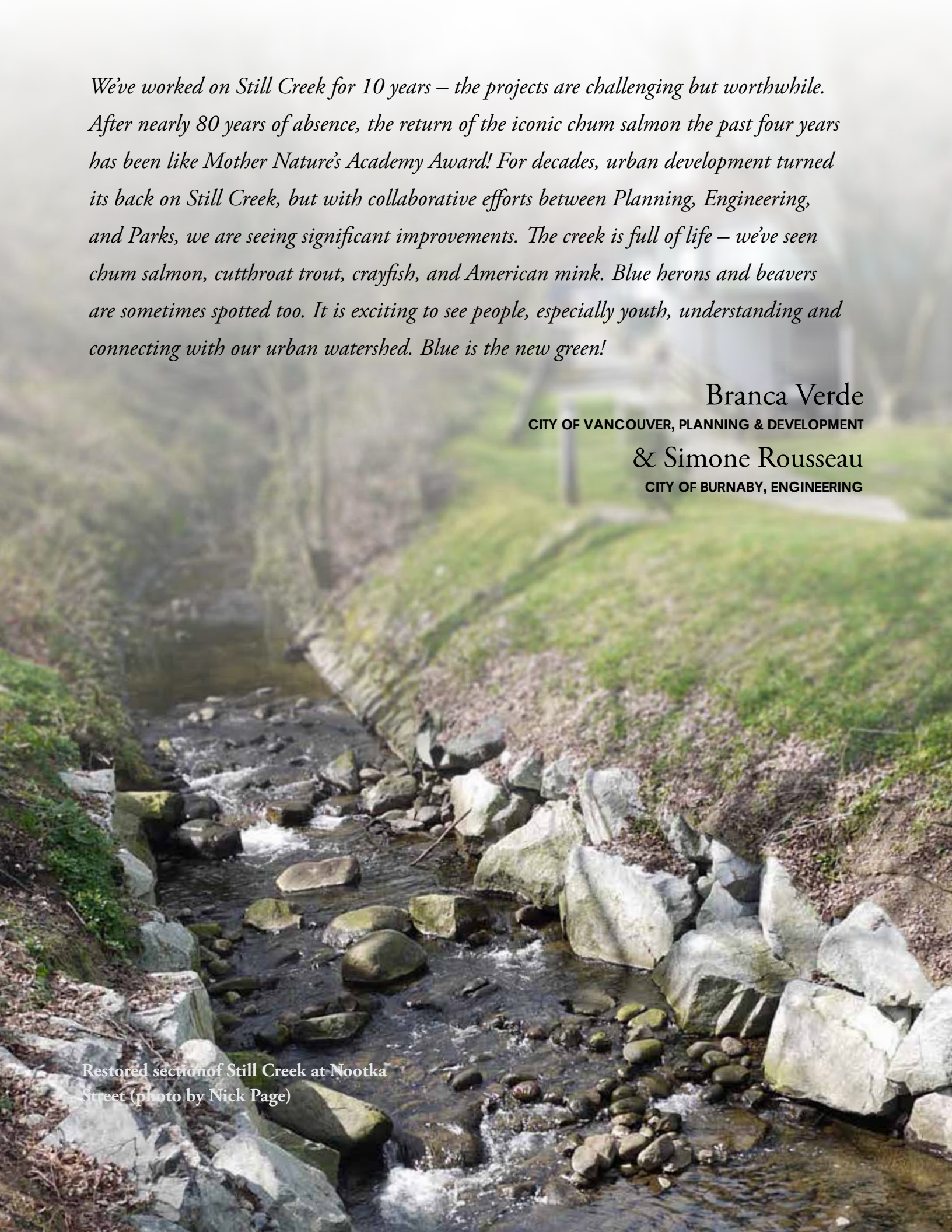
Populations of native bees are declining and some species, such as the western bumble bee, are now very rare or have been extirpated in Vancouver. Native bees are affected by habitat loss, pesticides, disease, and competition for resources from non-native honey bees. Native bees are important pollinators of fruit trees, backyard vegetable crops, and native plants.

SPECIES AT RISK ARE POORLY SURVEYED

Species at risk are those plants and animals designated by the federal or provincial government as having high conservation concern because of rarity, restricted range, and/or population decline. Approximately 20 species at risk occur in the city, including Johnson's hairstreak butterfly (a forest butterfly), Vancouver Island beggarticks (a wetland sunflower), and western painted turtle. Information on their distribution and status is generally poor and more surveys are needed.

We've worked on Still Creek for 10 years – the projects are challenging but worthwhile. After nearly 80 years of absence, the return of the iconic chum salmon the past four years has been like Mother Nature's Academy Award! For decades, urban development turned its back on Still Creek, but with collaborative efforts between Planning, Engineering, and Parks, we are seeing significant improvements. The creek is full of life – we've seen chum salmon, cutthroat trout, crayfish, and American mink. Blue herons and beavers are sometimes spotted too. It is exciting to see people, especially youth, understanding and connecting with our urban watershed. Blue is the new green!

Branca Verde
CITY OF VANCOUVER, PLANNING & DEVELOPMENT
& Simone Rousseau
CITY OF BURNABY, ENGINEERING



Restored sectionof Still Creek at Nootka Street (photo by Nick Page)

6 PRINCIPLES OF BIODIVERSITY MANAGEMENT

Supporting biodiversity in Vancouver is a complex task. Populations of plants and wildlife depend on large, interconnected ecosystems that can be difficult to maintain in cities. Biodiversity changes seasonally as vegetation grows and declines, and also over decades and centuries as forests mature and wetlands fill in. Natural disturbance and other ecological processes, such as flooding and forest succession, shape the function and diversity of the city's ecosystems but may conflict with other values such as flood protection, recreation, aesthetics, and safety. Similarly, urban wildlife such as coyotes, skunks, and geese are part of our urban ecosystem but create challenges in how we both perceive and manage wildlife.

TEN PRINCIPLES

1. MANAGE BIODIVERSITY AT A CITY-WIDE SCALE

Biodiversity management builds on the city's existing network of natural areas and biodiversity hotspots, also recognizing that backyard gardens, neighbourhood parks, green roofs, and other urban habitats sustain biodiversity.

2. FOCUS ON HABITAT

The protection and restoration of natural habitats is the foundation of biodiversity management. However, restoring ecological function should be a priority over rigid interpretations of naturalness. Non-native species, while generally undesirable, can contribute to biodiversity values in urban areas. Similarly, urban ecosystems such as green roofs, rain gardens, and wildflower meadows that have a mix of native and non-native species can be essential for enhancing urban biodiversity and providing access to nature.

3. PARK BOARD LEADERSHIP

Following the Park Board's Strategic Plan, the Greenest City 2020 Action Plan, and other policies, the Park Board and other City of Vancouver departments provide leadership on biodiversity management by implementing precedent-setting habitat restoration projects and improving their own operations to support biodiversity.

4. CONSIDER BIODIVERSITY A CULTURAL ASSET

Biodiversity supports the mental and physical health of Vancouver's residents. Opportunities to enhance the cultural and experiential values of biodiversity through education, celebration, and participation will be incorporated into all projects.

5. MAINTAIN ECOLOGICAL PROCESSES

Biodiversity depends on diverse ecosystems that are sustained by natural processes such as forest succession, windthrow, and beaver-caused flooding. Biodiversity management incorporates natural variability and tolerates ecological complexity.

6. USE SOUND SCIENCE

Management decisions are based on sound science and knowledge while also considering local expertise.

7. WORK WITH NEIGHBOURING LOCAL GOVERNMENTS

Biodiversity does not recognize political boundaries; the Park Board and the City of Vancouver collaborate with neighbouring governments and jurisdictions to protect and restore biodiversity.

8. INCORPORATE CLIMATE CHANGE PREDICTIONS

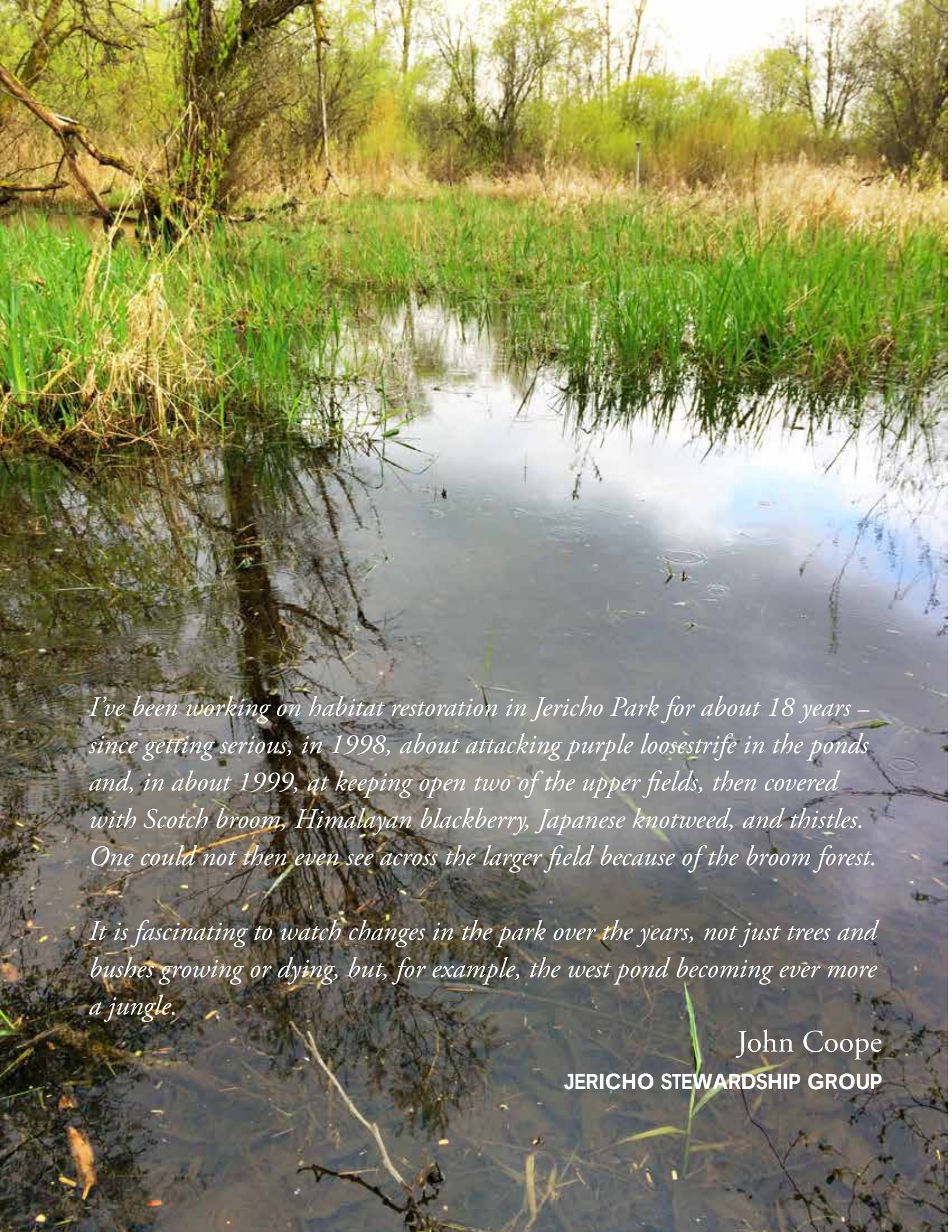
Climate change predictions, including increased summer drought, rising sea level, and more intense rainfall, are incorporated into all biodiversity projects such as tree planting and wetland restoration.

9. COLLABORATE WITH A BROAD RANGE OF PARTNERS

The public, community groups, academics, students, businesses, and environmental organizations participate in biodiversity projects, including citizen science approaches to monitoring.

10. MEASURE SUCCESS

The status of biodiversity and the success of biodiversity management programs and projects are measured using monitoring and other methods.



I've been working on habitat restoration in Jericho Park for about 18 years – since getting serious, in 1998, about attacking purple loosestrife in the ponds and, in about 1999, at keeping open two of the upper fields, then covered with Scotch broom, Himalayan blackberry, Japanese knotweed, and thistles. One could not then even see across the larger field because of the broom forest.

It is fascinating to watch changes in the park over the years, not just trees and bushes growing or dying, but, for example, the west pond becoming ever more a jungle.

John Coope

JERICHO STEWARDSHIP GROUP

7 GOAL, TARGET & METRICS

GOAL

Increase the amount and ecological quality of natural areas, including forests, wetlands, streams, shorelines, and meadows, to support biodiversity.

BIODIVERSITY TARGET

Restore or enhance 25 ha of natural areas by 2020 (the following page illustrates the target in relation to parks in Vancouver).

BASELINE

There were approximately 847 ha of natural areas in Vancouver in 2010, including forests, shorelines, streams, wetlands, and meadows.

METRICS

Metrics are used to track progress in meeting a goal or target. Four metrics are proposed to track the biodiversity target:

1. Amount (hectares) of natural areas
2. Ecosystem health of important aquatic ecosystems (False Creek, Still Creek, and Musqueam Creek)
3. Percent of residents within a 5-minute walk of natural spaces (>0.5 ha) by neighbourhood
4. Number of volunteers involved in biodiversity projects

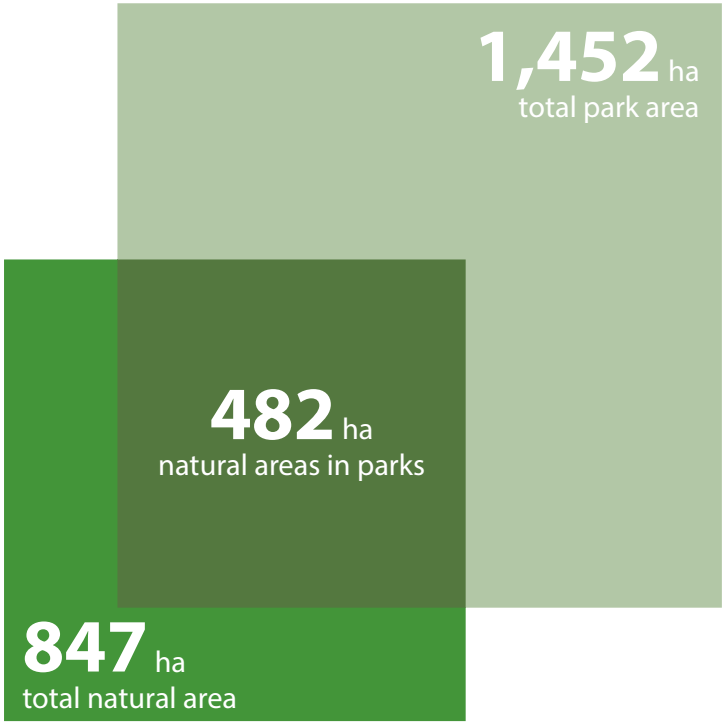
MEETING THE TARGET

The target will be met by creating and restoring a variety of natural areas on both public and private land. It will include habitat restoration in parks, such as salt marsh creation in New Brighton Park or daylighting Tatlow Creek. Smaller projects, including native plant gardens in neighbourhood parks, pollinator meadows in community gardens, rain gardens on street edges, and backyard bird habitats will also contribute to meeting the target.

VISUALIZING THE TARGET

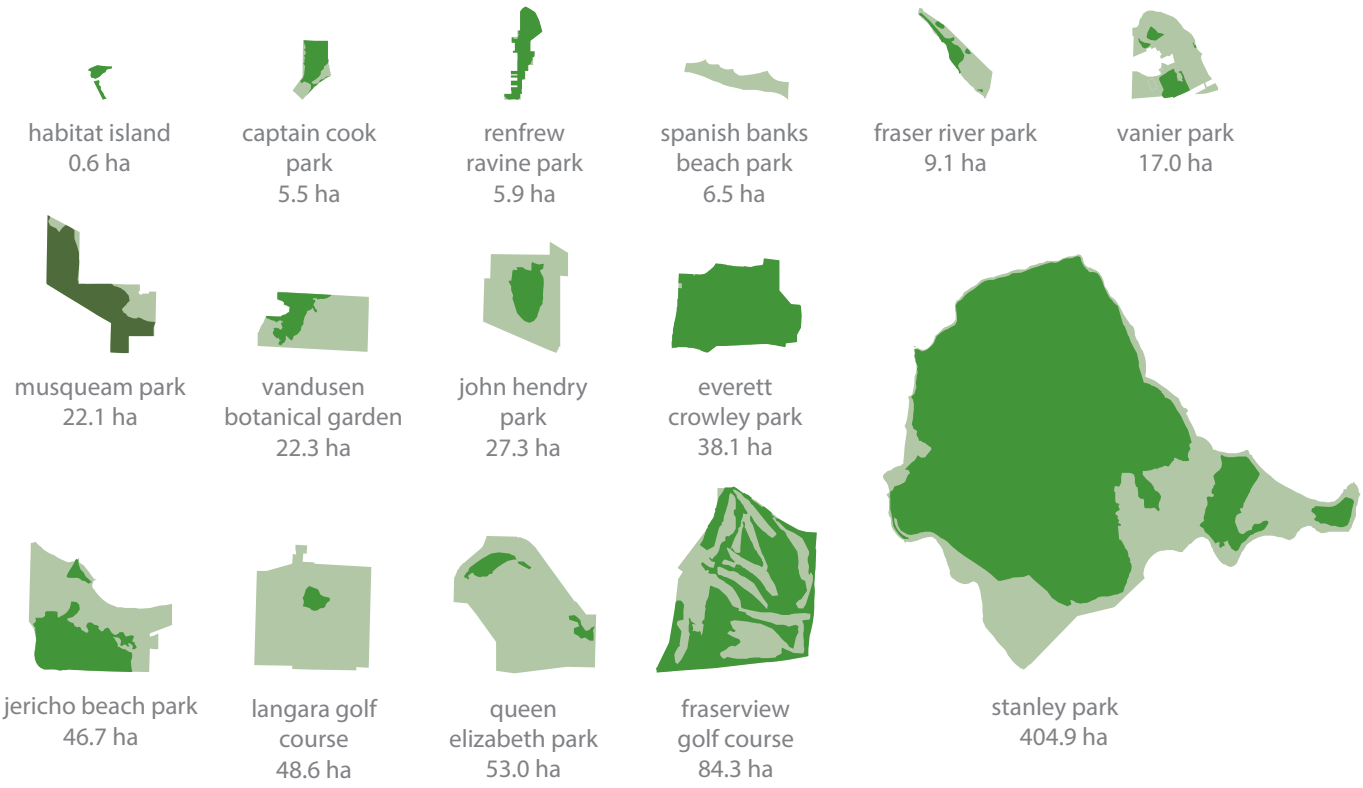
How big is 25 ha? It's about the size of VanDusen Botanical Garden or half the size of Langara Golf Course. It represents about 1.7% of the total area of parks in Vancouver.

The graphics below show the relative sizes of parks in the City of Vancouver, as well as the amount of natural area they contain. Stanley Park accounts for 28% of the total area of parks in Vancouver, but about 67% of all natural areas.



Biodiversity Target
Restore or enhance 25 ha of natural areas by 2020

25 ha



WHAT ARE NATURAL AREAS?

Natural areas are forests, wetlands, streams, and other ecosystems that are composed primarily of native plants and animals. For example, older forests in Stanley Park, wetlands in Jericho Beach Park, the Still Creek corridor, and Trout Lake are considered natural areas. Similarly, smaller habitats such as pollinator meadows and rain gardens form part of the network of natural areas across the city.

WHY FOCUS ON NATURAL AREAS?

The target focuses on natural areas for four reasons:

1. The amount and quality of natural areas are the most effective measures of biodiversity value, particularly in urban areas where most natural areas are small and fragmented. A tenet of conservation biology is that larger and more-connected habitats support more species than smaller, fragmented habitats.

2. Projects to create or restore natural areas benefit a broad range of species by reinforcing the city's existing ecological network, increasing connectivity, and ensuring habitat for sensitive species like forest-dependent birds, native squirrels, and native frogs.

3. The amount and condition of natural areas is easier to measure and monitor than that of species (e.g., bird or salmon abundance).

4. The concept of "natural areas" can be effectively communicated to the public, as well as landowners, developers, consultants, and city staff.

Forests in Stanley Park (N. Page photo

Northwestern salamanders are relatively abundant in Stanley Park (photo by Nick Page)

8 OBJECTIVES, STRATEGIES & ACTIONS

Restored shoreline in Jericho Beach Park (photo by Nick Page)

OBJECTIVE 1 RESTORE HABITATS AND SPECIES

Habitat restoration is the process of renewing ecological health. In urban areas this may include the creation of new ecosystems, such as the Vancouver Convention Centre's green roof or False Creek's Habitat Island, as well as more traditional projects like replanting conifer forests in Jericho Park and restoring Still Creek.

Habitat restoration often occurs at a variety of scales – ranging from small projects, like a pollinator garden in a neighbourhood park created by a community group, to a large forest restoration project directed by foresters and biologists. Both types of projects are needed to support Vancouver's biodiversity. Neighbourhood-scale projects often increase access to nature on a daily basis and provide opportunities for citizens to be directly involved. Large projects reach the critical mass necessary to support a broader range of biodiversity and provide ecosystem services (such as carbon storage or flood control) not typically provided by smaller projects. Opportunities for habitat restoration exist on both public and private land.

Actions to support specific species or populations are also needed. Science-based planning is needed for effective species at risk recovery, and the active reintroduction of key species such as native frogs and squirrels is an essential part of restoring functioning ecosystems.

STRATEGY 1-1
Build the city's ecological network.

1. Use park acquisition, tree planting, and the development planning process to expand and connect parks and build the city's ecological network.

2. Identify opportunities for habitat restoration in boulevards, road ends, road right-of-ways, and other city-owned lands.

3. Partner with Port Metro Vancouver to restore shoreline and shallow subtidal habitats along Burrard Inlet, English Bay, and the Fraser River.

STRATEGY 1-2
Restore populations of important plants and animals.

4. Restore ecologically important species, such as native squirrels, surf smelt, native bees, salmon, and Pacific tree frog, in collaboration with BC Ministry of Environment, stewardship groups, and others.

5. Assist the BC Ministry of Environment, South Coast Conservaton Program, Environment Canada, Fisheries and Oceans Canada, and others on species at risk recovery.

6. Reduce direct impacts to biodiversity, including inappropriate recreation use, predation from cats, exposure to pesticides or other toxins, light and noise pollution, and road-related mortality.

Douglas-fir and bigleaf maple ready for forest planting in Jericho Beach Park (photo by Nick Page)

OBJECTIVE 2 SUPPORT BIODIVERSITY WITHIN CITY PARKS AND STREETS

The Vancouver Park Board and the City of Vancouver own, operate, and maintain a large and complex system of parks, streets, recreation facilities, buildings, and water and drainage networks that influence the distribution and health of natural areas and biodiversity. Much of the City's infrastructure was built before ecosystem health and biodiversity were considered important values. For example, portions of the City's combined sewer and storm drainage system still discharge untreated waste into Burrard Inlet during heavy rainfall, although sewer separation has reduced this impact substantially. Many neighbourhood parks have low biodiversity values because mowed lawn and pruned non-native trees have been the traditional focus of park design and maintenance. There are also many examples where the City has updated its infrastructure and operational practices to reduce ecological impacts – separating sewers, treating stormwater, planting park and street trees, avoiding pesticide use, and using green operations in park maintenance.

STRATEGY 2-1

Enhance biodiversity in parks and other City-owned lands.

7. Incorporate smaller natural areas, including meadows, rain gardens, wetlands, and bird habitats, into new and redeveloping parks, streets, and community gardens.

8. Create wildflower meadows for bees and other pollinators in parks, streets, the cemetery, and golf courses.

9. Develop a city-wide Invasive Species Action Plan, and control priority invasive species in parks.

10. Incorporate biodiversity values into all master and design plans for new and redeveloped parks.

STRATEGY 2-2

Enhance urban forests to support biodiversity.

11. Restore native forests in Stanley, Jericho Beach, Musqueam, Renfrew Ravine, Everett Crowley and other large parks.

12. Develop a guidebook for managing natural forests as part of the Urban Forest Strategy.

13. Update tree selection, tree density, and maintenance guidelines to increase the value of the urban forest for birds and other species.

Everett Crowley Park hosts the longest running Earth Day celebration in Vancouver. It's an event that shows how community and the City can work side by side to restore a small patch of "urban wilderness" in southeast Vancouver. Kids, families, Scouts, dog-walkers, and park neighbours all help out. Together we planted almost 750 native trees and shrubs on a sunny Saturday in April 2015 and received the most compliments about the park reforestation since the effort started.

David Yule

CHAMPLAIN HEIGHTS COMMUNITY ASSOCIATION PRESIDENT

STRATEGY 2-3

Manage water to improve ecological health and enhance biodiversity.

14. Use the city-wide Rainwater Management Plan to prioritize enhanced stormwater management activities in ecologically important catchments.

15. Continue to restore Still Creek, and work to daylight or enhance other streams, including Hastings, Musqueam, Beaver, Tatlow, and Salmonberry creeks.

16. Develop a collaborative action plan for improving the health of False Creek.

17. Work with other City departments to improve capacity and resources to respond to oil spills and other environmental emergencies.

18. Reduce or eliminate potable water use for ponds and fountains in parks, and increase the use of rainwater to sustain ponds, lakes, and wetlands in parks.

STRATEGY 2-4

Support biodiversity within the street network.

19. Use the Green Streets program and greenway design to support pollinator and bird habitat and improve connectivity between parks and natural areas.

20. Assess where street rights-of-way can be used to better support biodiversity, including restoring the shoreline of the Fraser River at road ends or better connecting adjacent parks.

Yes, the Downtown Eastside is wild, but not the way some people think. It actually hosts one of North America's most successful volunteer-run biodiversity hotspots. The Strathcona Community Garden is home to growers raising organic crops, a herb garden, a community orchard, and a wildlife habitat area that will feature a solar-powered, aquifer-fed pond for birds, fish, frogs, and more.

David Tracey
TREE CITY CANADA

Strathcona Community Garden (photo by Jason Hsieh)

OBJECTIVE 3 PROTECT & ENHANCE BIODIVERSITY DURING DEVELOPMENT

Biodiversity is not confined to parks. Research has shown that the character, structure, and diversity of gardens, buildings, and trees on private land strongly influences biodiversity values in urban landscapes. Private lands can function as corridors to allow wildlife to move between parks, or provide habitat for species tolerant of developed neighbourhoods such as eastern grey squirrels, coyotes, and Cooper's hawks. In Vancouver, private land accounts for about 90% of the city's land base.

There are two components to biodiversity management on private land. First "backyard habitat" has an essential role in sustaining birds and invertebrates such as native butterflies and bumble bees as well as increasing access to nature in urban neighbourhoods. Opportunities to see birds at backyard feeders is an excellent example of the day-to-day engagement with biodiversity that increases physical and mental health.

Second, activities to protect and enhance biodiversity during urban development are critical. This includes incorporating the ecological network into neighbourhood plans to connect natural areas across the city. Biodiversity management during the development process must ensure that existing biodiversity features such as large trees are protected, buildings are designed to reduce bird collisions, and green roofs and landscaping enhance habitat for birds and pollinators. Large development sites often have more opportunities to incorporate biodiversity features than smaller sites because of both their scale and the expertise provided by architects, landscape architects, and other professionals.

STRATEGY 3-1

Protect and enhance biodiversity during development.

21. Improve the development review and permitting process, including the Rezoning Policy for Sustainable Large Developments, Protection of Trees Bylaw, and Green Building Policy for Rezonings, to better protect and enhance biodiversity during development.

22. Incorporate biodiversity enhancement into new development and new parks along the Fraser River.

STRATEGY 3-2

Encourage biodiversity enhancement on private land.

23. Work with stewardship organizations to support private landowners with biodiversity enhancement through landscaping, habitat features, and other elements (see the Vancouver Bird Strategy landscape guidelines for one component of this action).

Fishing for shiners in Trout Lake (photo by Nick Page)

OBJECTIVE 4 CELEBRATE BIODIVERSITY THROUGH EDUCATION & STEWARDSHIP

The 2014 Rewilding Vancouver: Environmental Education and Stewardship Action Plan was developed to engage Vancouver's residents and visitors in the vibrant natural world that defines part of Vancouver's identity. The plan identified 49 actions to improve and enhance experiences of nature for all Vancouverites, and to increase understanding and awareness of nature in the city. The plan includes three priorities that connect directly with the Biodiversity Strategy:

1. Create opportunities for people to have rich experiences with nature in the city's natural areas.

2. Integrate nature into the daily experiences of Vancouverites by allowing it back into public spaces and places.

3. Refine the role of the Park Board in managing thriving natural spaces and providing opportunities for people to engage with nature.

Successful projects and actions to engage people with wild places include creating outdoor learning opportunities, building interpretive signs and public art, and celebrating seasonal festivals. Successful projects in Vancouver include Bird Week, Green Club walks, Wild About Vancouver Outdoor Education Festival, and the education and research undertaken by the Stanley Park Ecology Society.

STRATEGY 4-1
Connect citizens to natural areas in the city.

24. Develop collaborations with non-profits, schools, community centres, and others at biodiversity hotspots to enhance education and stewardship oppportunities.

25. Build partnerships with First Nations to collaborate on biodiversiy management.

26. Explore opportunities to use Park Board infrastructure and resources to support activities, programming, and outdoor learning in natural areas.

STRATEGY 4-2
Promote nature in everyday life.

27. Use digital media, common branding, maps, and wayfinding to promote biodiversity hotspots and their seasonal patterns (e.g., spawning salmon, arrival of migrating songbirds, calling of spring frogs).

STRATEGY 4-3
Improve Park Board leadership.

28. Create a Biodiversity Advisory Committee composed of public members, technical experts, and staff to guide the Park Board's biodiversity conservation efforts.

29. Support stewardship groups and volunteers in biodiversity-related activities in parks and other public land.

30. Hire a Stewardship Coordinator to assist community groups in the planning and implementation of biodiversity and urban forest projects.

31. Provide funding to stewardship groups to support high-priority biodiversity projects.

Biologists look at the diversity of bees collected in Vancouver parks (photo by Nick Page)

OBJECTIVE 5 MONITOR BIODIVERSITY

Monitoring is the consistent and repeated collection of data to measure status and trends over time. In the context of urban biodiversity, it often measures changes in habitat availability and quality (e.g., city-wide forest cover), species richness and abundance (e.g., the number of nesting herons in Stanley Park), and environmental health (e.g., summer water temperature in Still Creek). Monitoring is essential for understanding changing patterns of biodiversity in Vancouver and for measuring the success of actions such as improved stormwater management and habitat enhancement. Some biodiversity monitoring has already been undertaken by the Stanley Park Ecology Society, Environmental Youth Alliance, Wild Research, and others.

Citizen science is a developing component of monitoring programs that involves citizen volunteers in the collection of data (e.g., salmon monitoring by streamkeepers, bird counts). Citizen science can be used to increase the intensity and coverage of monitoring, as well as improve local knowledge and instill a passion for biodiversity.

STRATEGY 5-1
Develop a practical and collaborative approach to monitoring biodiversity.

32. Develop a biodiversity monitoring plan that that includes species, habitats, and environmental health.

33. Monitor and report metrics to measure progress in meeting the biodiversity target.

34. Partner with stewardship groups and other organizations to use citizen science to monitor priority species.

STRATEGY 5-2
Encourage research that contributes to biodiversity management in the city.

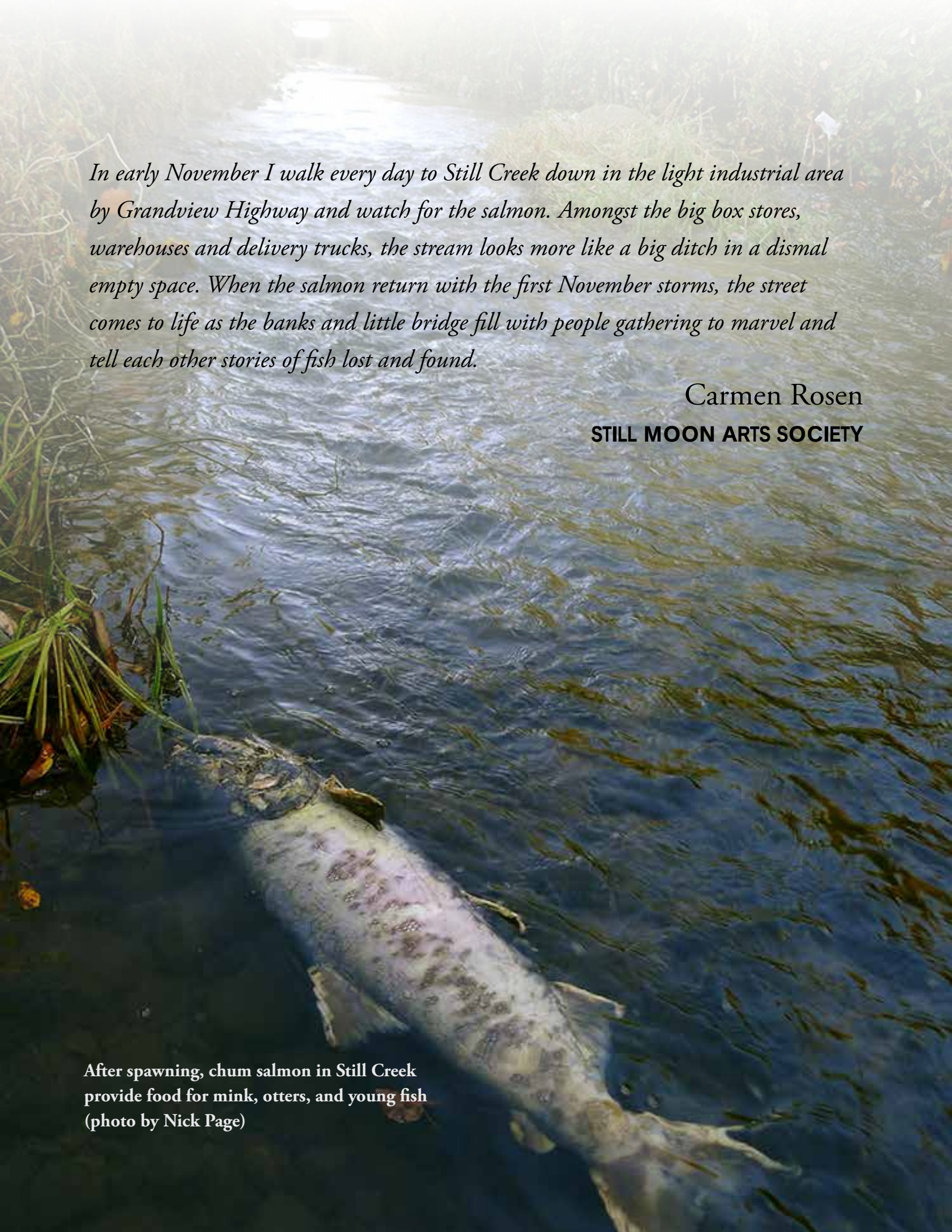
35. Facilitate access to sites, data, and existing resources to support the use of parks and other public land for appropriate biodiversity research.

36. Identify research gaps in biodiversity knowledge and partner with academic institutions (including the Greenest City Scholar Program) to undertake biodiversity research.

37. Provide funding to address research gaps using existing grant programs or CityStudio.

STRATEGY 5-3
Share biodiversity information.

38. Collect and share relevant biodiversity information (e.g., published and unpublished reports, monitoring data, spatial data, etc.) with the public using the Open Data catalogue.



In early November I walk every day to Still Creek down in the light industrial area by Grandview Highway and watch for the salmon. Amongst the big box stores, warehouses and delivery trucks, the stream looks more like a big ditch in a dismal empty space. When the salmon return with the first November storms, the street comes to life as the banks and little bridge fill with people gathering to marvel and tell each other stories of fish lost and found.

Carmen Rosen

STILL MOON ARTS SOCIETY

After spawning, chum salmon in Still Creek provide food for mink, otters, and young fish (photo by Nick Page)

ACKNOWLEDGEMENTS

This strategy was developed by **NICK PAGE, DAVE HUTCH, LINDSAY COLE, JASON HSIEH**, and **TILO DRIESSEN** (retired) of the Vancouver Board of Parks and Recreation, with assistance from **SEAN PANDER, DOUG SMITH**, **TAMSIN MILLS,** and **BRAD BADELT** from Sustainability, **ANDREW LING, MARK SCHWARK**, and **BRIAN CROWE** from Engineering, and **KRISTEN ROBINSON** from Planning and Development Services.

Early development of this strategy was assisted by:

ANDREW APPLETON – Jericho Stewardship Group
BILL KINKAID – Nature Vancouver
DR. BRIAN KLINKENBERG – UBC Geography
CARRIE BROWN – Port Metro Vancouver
ERIN EMBLEY – Metro Vancouver
DR. KAI CHAN – UBC Sustainability (IRES)
KYM WELSTEAD – BC Ministry of Environment
DR. PETER ARCESE – UBC Conservation Biology
ROBYN WORCESTER – Stanley Park Ecology Society
TERRY SLACK – Fraser River advocate
DR. VAL SCHAEFER – UVIC Environmental Studies
MARKUS MERKENS – Metro Vancouver Parks

The final version was reviewed by:

CARMEN ROSEN – Still Moon Arts Society
CELIA BRAUER – False Creek Watershed Society
DANA MCDONALD – Evergreen Canada
DAVID COOK – Nature Vancouver
DAVID TRACEY – Tree City Canada
DAVID YULE – Everett Crowley Park Committee
DR. STEVE MITCHELL – UBC Forestry
ERIN UDAL – Environmental Youth Alliance
GREG FERGUSON – BC Swallow Conservation Project
JACK TUPPER – graduate student
JOHN COOPE – Jericho Stewardship Group
JOSEPH LIN – Green Club
LYDA SALATIAN – Green Teams of Canada
MICHELLE MOLNAR – David Suzuki Foundation
PAMELA ZEVIT – South Coast Conservation Program
ROBYN WORCESTER – Stanley Park Ecology Society
SARAH NATHAN – Wild Research
SUSANNE SLOBODA – EDI Environmental Dynamics
TERRY SLACK – Fraser River advocate

REFERENCES & RESOURCES

Austin,M.A., D.A. Buffett, D.J. Nicolson, G.G.E. Scudder and V. Stevens (eds.). 2008. Taking Natures Pulse: The Status of Biodiversity in British Columbia. Biodiversity BC, Victoria, BC. 268 pp. Available at: www.biodiversitybc.org.

Axys Environmental Consulting. 2006. Assessment of Regional Biodiversity and Development of a Spatial Framework for Biodiversity Conservation in the Greater Vancouver Region. Biodiversity Conservation Strategy Partnership, Burnaby, BC.

Benedict, M. and E.T. McMahon. 2006. Green Infrastructure: Linking Landscapes and Communities. Island Press, Washington. 299 pp.

City of Edmonton. 2007. Natural Connections Strategic Plan. 48 pp. Available here.

City of Vancouver. 2015. Vancouver Bird Strategy. 37 pp + appendices. Available here.

City of Vancouver. 2009. Greenest City 2020 Action Plan. 82 pp. Available here.

City of Vancouver and Vancouver Park Board. In preparation. Urban Forest Strategy.

City of Vancouver Archives. Major Matthews' Early Vancouver, 7 vols. Available through City of Vancouver Archives website here.

HB Lanarc and Raincoast Applied Ecology. 2011. City of Surrey Ecosystem Management Study: Books 1 and 2. 79 pp.

Jacques Whitford AXYS Ltd. 2008. Burrard Inlet Environmental Indicators Report: Public Consultation Document. Report prepared for Burrard Inlet Environmental Action Program, Burnaby BC by Jacques Whitford AXYS Ltd. Burnaby BC. 47 pp. Available here.

Jongman, R.H.G., M. Külvik, I. and I. Kristiansen. 2004. European ecological networks and greenways. Landscape and Urban Planning 68: 305–31.

Kheraj, Sean. 2013. Inventing Stanley Park: An Environmental History. Vancouver: UBC Press.

MacDonald, B. 1992. Vancouver: a Visual History. Talon Books, Vancouver. 84 pp.

MacKinnon, J.B. 2014. Our Once and Future World. Random House Canada. 272 pp.

Meidinger, D., J. Clark, and D. Adamoski. 2014. Sensitive Ecosystem Inventory Technical Report for Metro Vancouver & Abbotsford 2010-2012. Prepared for Metro Vancouver. 162 pp.

Metro Vancouver Regional District. 2011. Metro Vancouver Ecological Health Action Plan. 46 pp. Available here.

Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being:

Biodiversity Synthesis. World Resources Institute, Washington, DC.

North American Bird Conservation Initiative Canada. 2012. The State of Canada's Birds, 2012. Environment Canada, Ottawa, Canada. 36 pp.

Raincoast Applied Ecology. 2012. Mammals of Vancouver and Point Grey: Summary of Historical and Current Occurrence Records and Observations. 12 pp. Available here.

Simberloff, D., R.N. Mack, W.M. Lonsdale, H. Evans, M. Clout, and F. Bazzaz. 2000. Biotic invasions: Causes, epidemiology, global consequences and control. Issues in Ecology No. 5, Ecological Society of America.

Stanley Park Ecology Society (SPES). 2010. State of the Park Report for the Ecological Integrity of Stanley Park. 229 pp. + appendices. Available here.

Vancouver Park Board. 2014. Rewilding Vancouver: An Environmental Education and Stewardship Action Plan. 54 pp.

GLOSSARY

Biodiversity: the richness of plant and animal species, including their genetic diversity, the ecosystems they inhabit, and the ecological processes that sustain them.

Connectivity: the ability of the landscape to support the movement of biodiversity and other ecological components. Connectivity is often highly impaired in urban landscapes because of fragmentation.

Corridor: a linear habitat feature such as a stream corridor that allows the movement of wildlife or other biodiversity components between habitat patches.

Ecological Network: the inter-connected system of natural spaces across the city. It is composed of both terrestrial and marine (shoreline and intertidal) areas. Large natural spaces, called hubs, are the critical part of the ecological network.

Ecosystem Services: "the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth". From Millenium Ecosystem Assessment (2005).

Forest: Tree-dominated vegetation with a shrub understorey, and composed mainly of native species. They are sustained by windthrow, competition for resources such as light, nutrient cycling, and vegetation succession.

Fragmentation: the process of separating habitats that were once contiguous into smaller and isolated patches. Smaller and more isolated habitat patches typically support less biodiversity than larger and more connected habitat patches.

Green Infrastructure: the components of the natural and built environment that provide ecosystem services such as drainage, water filtration, green space, and wildlife habitat; they are often smaller than components of the Ecological Network.

Greenway: linear transportation routes that link the city's neighbourhoods; many provide ecological values related to the urban forest and habitat for pollinators.

Habitat: the area of type of environment in which a species of plant or animal lives such as a woodpecker in a forested habitat or tidepool sculpin in an intertidal marine habitat.

Highwater Mark: a line defining the highest elevation of inundation from water under normal tides or floods; it is often the lowest point for rooted woody vegetation; it defines the boundary between the terrestrial and intertidal or marine realms.

Invasive species: an organism that is not native and has negative effects on economic, environment, and health. Not all non-native species are considered invasive, and only a small number cause harm.

Marine: the physical and biological environment found in the ocean ranging from deepwater (below the penetration of light) to intertidal (defined by high and low water elevations under normal tides). The City of Vancouver's marine area is 2,024 ha (15% of the city); 241 ha is intertidal and 1,783 ha subtidal (below low water).

Matrix: in an Ecological Network, the matrix is the developed portion of the landscape (e.g., houses, farms, developed parks) that surrounds the main components of the Ecological Network; it also provides ecological values and ecosystems services and influences the function of the network.

Meadow: grass dominated non-forested habitats that often support wildflowers and shrub patches. They were not common in the Vancouver area historically but have value for birds, bees, butterflies, and small mammals.

Natural Area: large and small patches of the urban landscape which support nature such as forests, wetlands, and shorelines, but also including green roofs, constructed wetlands, and rain gardens.

Rewilding: the process of making the environment more wild again, including rebuilding natural ecosystems and food-webs, and re-introducing species which are absent. Rewilding often has the connotation of bringing large mammals back to the landscape but in many cases it focuses on the social and ecological benefits of restoring functioning ecosystems.

Riparian Zone: the land area bordering watercourses or shorelines with distinctive vegetation, topography, and soils related to its proximity to watercourses; riparian zones are important for biodiversity, watercourse health, and other values (shading, bank stabilization, etc).

Shoreline: the intertidal zone and adjacent terrestrial area (within 30 m of the highwater mark) of tidal shorelines including the Fraser River. They support a mix of grasses, shrubs, or trees, and are influenced by waves and tides, variable salinity, and sediment transport.

Stormwater: water that originates as rain or snow, which flows through surface and shallow subsurface areas into streams, wetlands, or the marine environment. In the urban environment, stormwater typically flows through a network of catch-basins, pipes, and ditches.

Stream: permanently or seasonally flowing watercourses with a defined channels and unvegetated substrates. They are sustained by groundwater flow, surface runoff, and the movement of sediment, wood, and organic matter.

Terrestrial: the physical and biological environment found on land (above the high water elevation under normal tides). The City of Vancouver's terrestrial area is 11,630 ha (or 85% of the total area).

Urban Forest: the network of trees across the city including single trees or patches of trees on streets, parks, and private properties. Urban forests have important cultural and ecosystem service values.

Wetland: permanently, seasonally, or tidally flooded ponds, marshes, swamps, and mudflats with native vegetation. They are sustained by daily or seasonal flooding, saturated soils, sediment deposition, and good water quality.

Wildlife: typically includes all vertebrate species including birds, mammals, amphibians, reptiles, and fish, and excluding plants. Under the BC Wildife Act, wildlife is defined as raptors, species at risk, game animals, fish, and other species of vertebrate prescribed by regulation.

BIODIVERSITY INDEX

Number of streams in Vancouver that still support salmon or trout: 5 (Musqueam, Spanish Bank, Still, Beaver, and Vivian creeks).

Best place to see spawning salmon in East Vancouver: Still Creek at Natal Street and Cornett Avenue in mid November.

Amount of intertidal habitat lost during industrial development of False Creek before 1940: 263 ha; only 23% of the inlet remains unfilled.

Oldest trees in the Vancouver region: Many Douglas-fir and western redcedar trees in Stanley Park are more than 300 years old (a 13.5 m diameter western redcedar that blew down in 2007 was over 900 years old).

Largest bigleaf maple in BC: A 29 m tall tree with a trunk circumference of almost 11 m is located near Second Beach in Stanley Park.

Loss of large mammals in Vancouver (by date): Roosevelt elk (1880s); grey wolf (before 1900); cougar (1911); black bear (1920s); black-tailed deer (1980s).

Top predator in Vancouver now: coyote.

Best place to hear Pacific tree frogs in the spring: Jericho Beach Park or golf courses in Southlands.

Number of bald eagle nests in Vancouver: in 1960s: <3 nests; 12 active nests in 2015.

Place to see a nesting colony of the endangered Pelagic cormorant in Vancouver: Granville and Burrard bridges above False Creek.

Decline of surf smelts in English Bay between 1950 and 2000: -95%, caused by overfishing, habitat loss, and changes to ocean productivity.

% of global population of Barrow's goldeneye, a distinctive white and black seaduck, that overwinters in Burrard Inlet: 2% to 5%.

Best place to see Vancouver feather duster, a strikingly beautiful intertidal tube worm: Brockton Point in Stanley Park during a summer low tide.

Year beaver returned to Beaver Lake in Stanley Park: 2008, after a absence of more than 60 years.