AN EXPLORATION OF THE OPPORTUNITIES TO IMPROVE THE ECOLOGICAL FUNCTION OF THE SHORELINE AT NORTHEAST FALSE CREEK

by

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"One swallow does not make a summer, but one skein of geese, cleaving the murk of a March thaw, is the spring" - Aldo Leopold

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1 EXECUTIVE SUMMARY

This report explores the opportunities to improve the ecological function of the shoreline at Northeast False Creek (NEFC) with an emphasis on habitat restoration and human activity by reviewing local and global precedents to inform the Park Board of design options.

Vancouver's policy framework provides a strong justification to improve the ecological function of the shoreline at NEFC. More importantly, the necessity to mitigate climate change obligates policy makers to work in the interest of the planet and future generations by seeking innovative and challenging solutions. This report provides a review of urban shoreline restoration projects in Vancouver, Seattle, Staten Island, and Amsterdam and explores how these cities employed creativity and innovation to improve habitat, reintroduce species, reduce contamination, and partake in placemaking for people. Meetings and email correspondence with experts provided valuable insights into the design process and implementation of these projects.

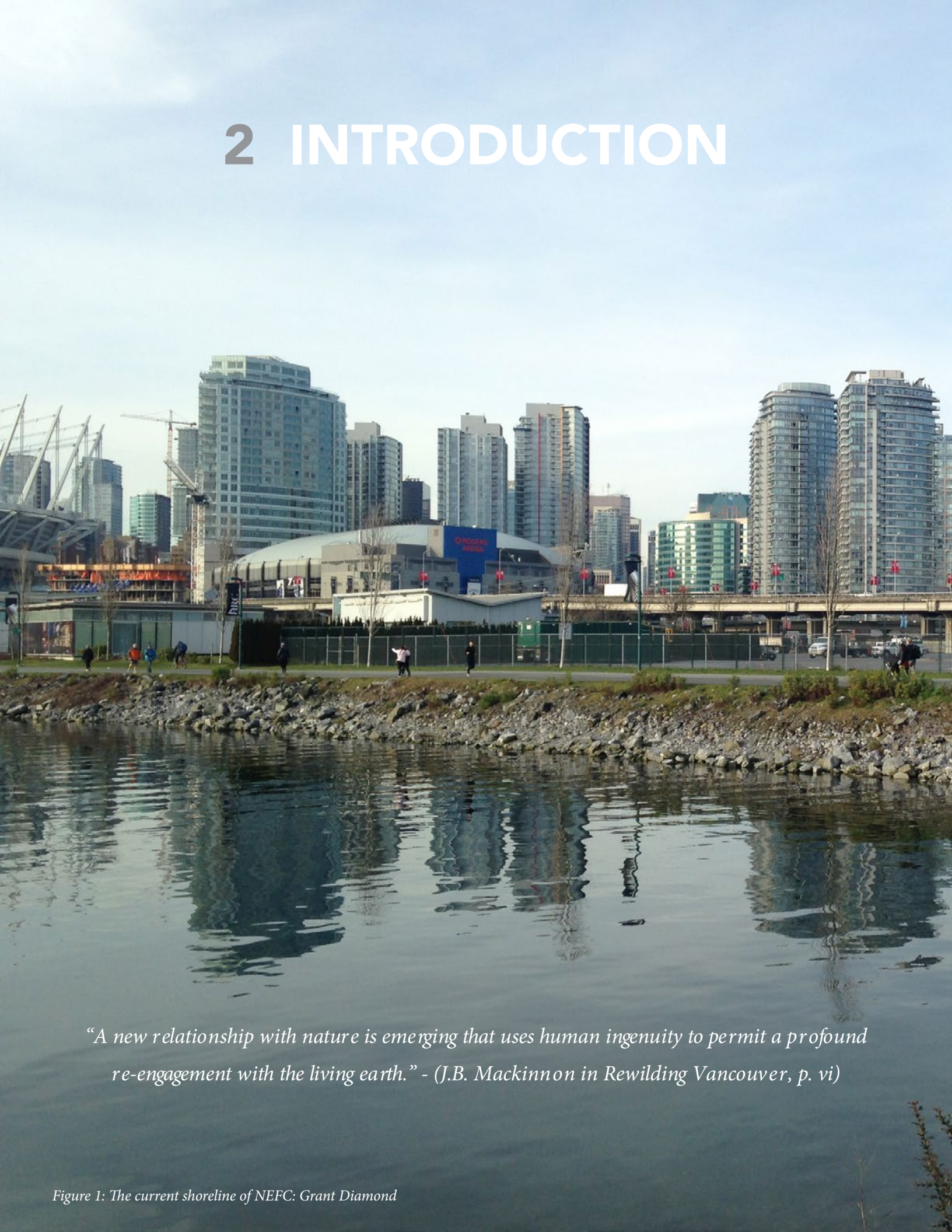
The decision to remove the Georgia and Dunsmuir Viaducts has presented the City of Vancouver with an unprecedented opportunity to create a natural haven for wildlife in the heart of downtown, restore species that were lost during our industrial past, and create a world-class space for people. Policy makers are obliged to future generations to make our city more livable for all living beings and the City must invest in this new green space for its people and the planet.

Recommendations

- Construct one or more habitat compensation islands and/or an inlet to increase the area of intertidal and terrestrial habitat
- Target the keystone species Pacific Herring (Clupea pallasii) for reintroduction through an education and volunteer habitat restoration program
- Construct an environmentally-focused fieldhouse on site or at nearby Science World to contribute classroom and wetlab space for environmental education, interpretation, storage space for water-based recreation activities, and sustainable wastewater capture and conversion
- Encourage human interactions with nature through design; use light penetrating surfaces when the Seawall passes over aquatic habitat and boardwalks in intertidal habitat
- Extend upland habitat to the Skytrain guideway and new Pacific Boulevard to maximize the area of productive habitat and encourage commuters' interactions with nature
- Ensure flexibility is incorporated into the design and implementation process to foster creativity and anticipate new knowledge
- Work with Concord Pacific to build a model sustainable community of the highest green standards adjacent to the park and encourage connections between park and neighbourhood systems

This project provides a theoretical orientation, situates the project within City of Vancouver Policy, outlines precedents from Vancouver, Seattle, Staten Island, and Amsterdam, and describes the above recommendations in detail.

2 INTRODUCTION



"A new relationship with nature is emerging that uses human ingenuity to permit a profound re-engagement with the living earth." - (J.B. Mackinnon in Rewilding Vancouver, p. vi)

Figure 1: The current shoreline of NEFC: Grant Diamond

2.1 Study Area

False Creek in Vancouver, British Columbia is a narrow and busy waterway surrounding nearly half of the downtown peninsula and has experienced massive change since the mid-19th century. What was once a productive coastal ecosystem stewarded by local First Nations was transformed to a marine industrial centre in just a few decades. Rapid deindustrialization in the last half of the 20th century saw the decline of these industries leaving behind vacant tracts of contaminated shoreline.

As industry departed new residential communities were built on the shores including the False Creek South Community, Concord Pacific, and the Olympic Village at Southeast False Creek. Today, False Creek connects Vancouverites to the water who regularly commute on three bridges, walk, run or bike along the Seawall, or participate in water-based recreation. Two large pieces of vacant land remain: one on the south shore east of Cambie Bridge, and the other on the northeast shore stretching from Creekside Park to Concord Pacific's land near BC Place and north to the Georgia and Dunsmuir Viaducts. This area is the focus of this study and will be referred to hereinafter as Northeast False Creek (NEFC).

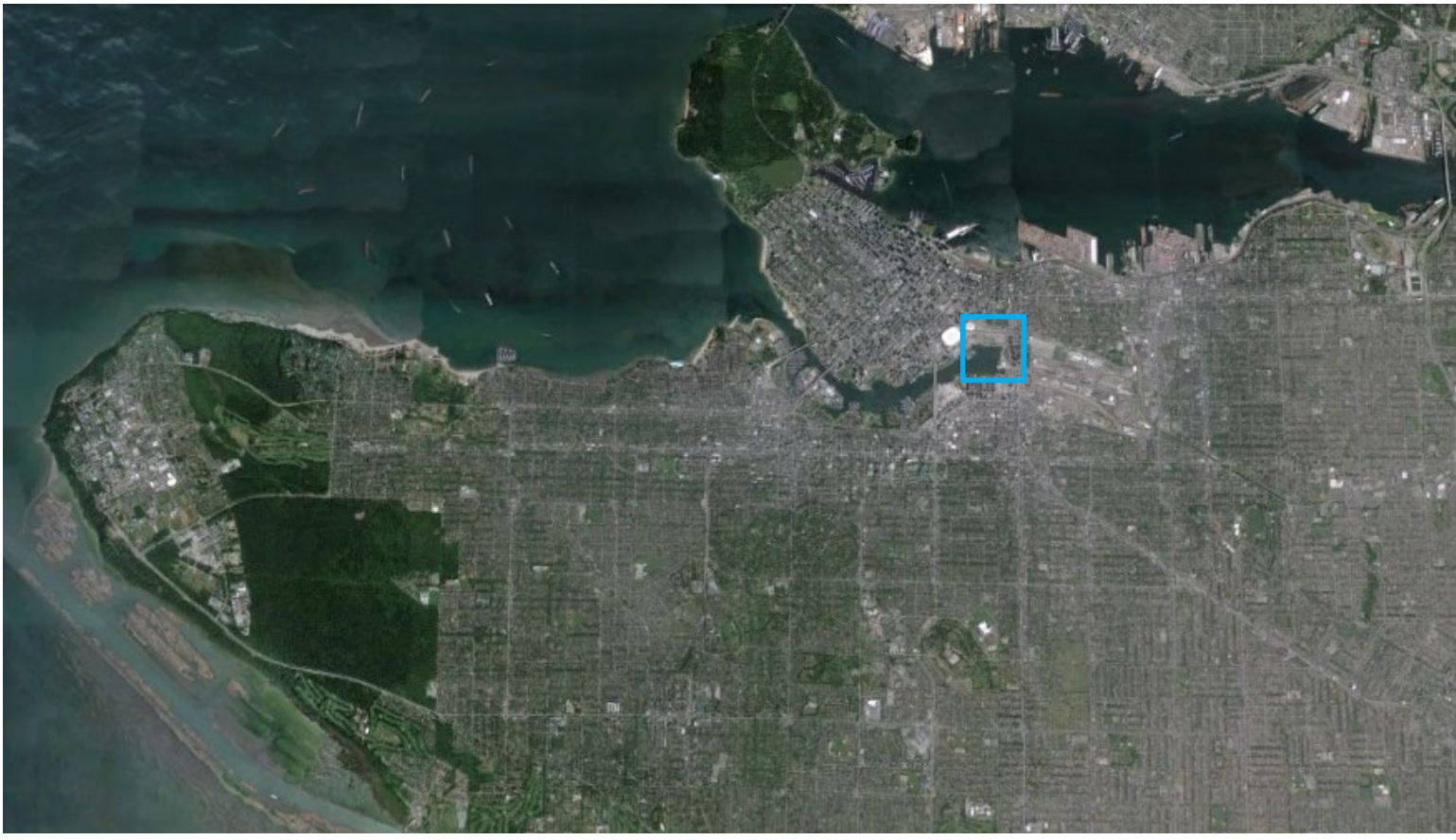


Figure 2: NEFC is located at the eastern end of False Creek: GoogleEarth (2016)

This area experiences high human use and is surrounded by vibrant communities including Chinatown, Gastown, and Yaletown. The Seawall transects the site providing recreational opportunities to citizens while other community assets abut the study area including Science World, Andy Livingstone Park, Creekside Park, BC Place, and Rogers Arena. Currently, the site consists of parking lots that are occasionally used as staging ground for concerts and a community garden, and the shoreline is steep and constructed of riprap.

2.2 Viaducts Removal and New Park

In Fall 2015 Vancouver City Council voted to remove the Georgia and Dunsmuir Viaducts and directed staff to work with the Vancouver Board of Parks and Recreation and citizens on planning for a new waterfront park and open space (City of Vancouver, 2015). The removal of the viaducts has created a rare occasion to practice city-making by fostering connections between neighbourhoods and to plan a 13-acre waterfront park expansion [see Figure 3]. This has presented an opportunity to conduct an ecological restoration of the shoreline at a scale that is rare in cities today and engage in placemaking for a world-class park. The City of Vancouver must build upon its reputation as one of North America's model green cities by integrating nature into the urban fabric in a unique and creative way.

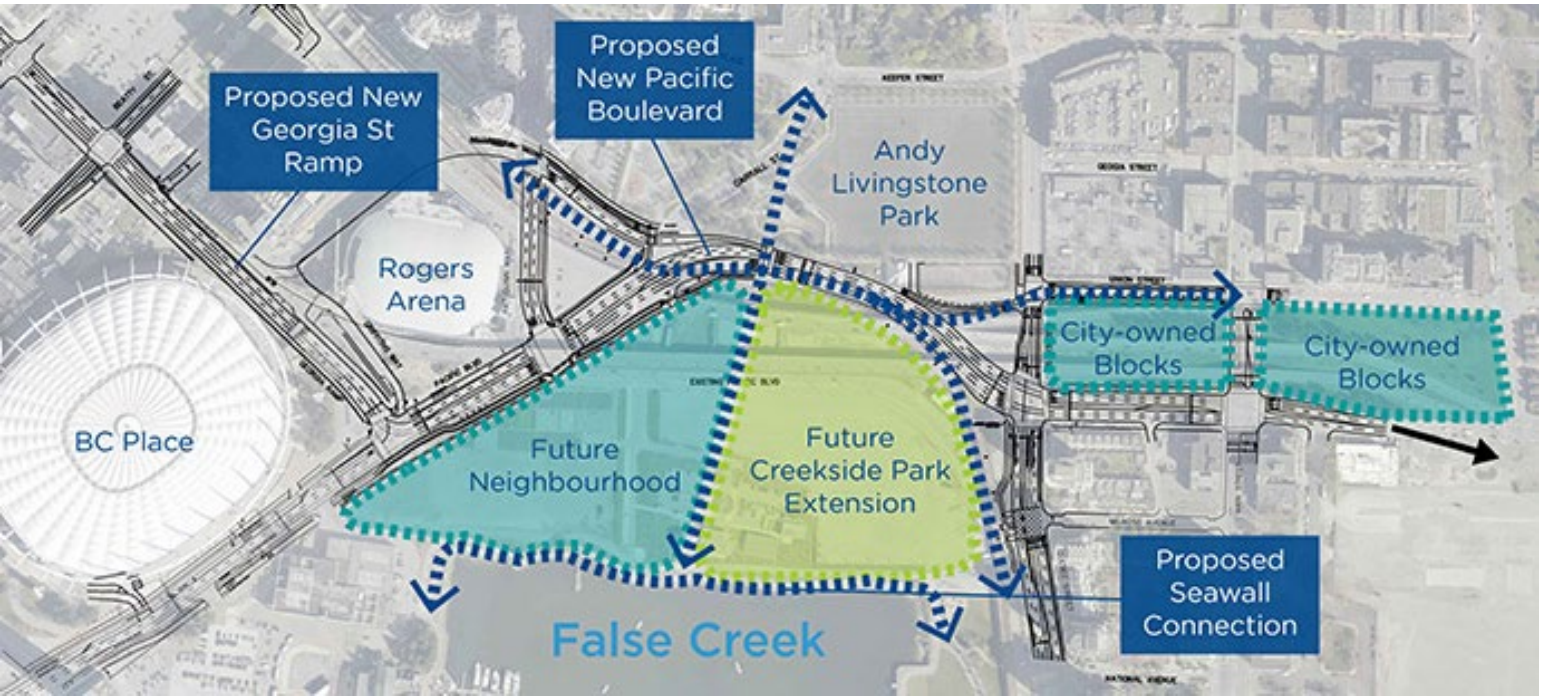


Figure 3: An overview of the Viaducts removal project including the new park: City of Vancouver (2015).

2.3 History

False Creek has a long and storied history as a productive temperate rainforest ecosystem teaming with wildlife. Since time immemorial the Musqueam, Squamish, and Tsleil-Waututh peoples were stewards of this ecosystem and in return the land and water supported a rich and diverse culture. Tidal marshes were abundant with clams, oysters, mussels, and crabs providing food and habitat for migratory birds on the Pacific Flyway. Pacific Herring (Clupea pallasii) stocks attracted predatory orca whales and other dolphins and a dense coniferous forest was home to bears, elk, cougars, and deer. Vancouver's Chief Archivist, Major JS Matthews (c. 1900) described False Creek as "a narrow sylvan channel, where at high tide the waters lapped the lower branches of towering trees which lined its shores; a placid marine corridor framed in forest green" (False Creek Watershed Society, 2007).

"a narrow sylvan channel, where at high tide the waters lapped the lower branches of towering trees which lined its shores; a placid marine corridor framed in forest green"

- Major JS Matthews (c. 1900)

Figure 4: This image shows development beginning to encroach on False Creek. It also provides a glimpse of what the intertidal habitat looked like prior to industrialization with shallow mudflats and marine grasses: Matthews, J. (1904). From Vancouver Archives

Figure 5: At present day the shoreline is constructed of riprap and fill such as broken concrete forms from days gone by: Grant Diamond

The arrival of Europeans in the late 19th century saw the advent of False Creek's industrialization and its rich ecosystem began to disappear as tidal marshes were filled in and the shoreline was moved to make it appropriate for development. Figure 8 illustrates how drastic these changes were as the entirety of False Creek Flats east of Main Street extending almost to Clark was filled in.

By the early 20th century its shores were subdivided and sawmills and shingle mills began to line the shores soon employing 10,000 people. The First World War years and roaring 20s saw shipyards and coal yards become established with Caughlan's shipyard becoming Vancouver's biggest employer.

Figure 6: Sawmills like this one lined False Creek for much of the 20th century.: Thomas, S. (1912). From Vancouver Archives

Industry peaked during the Second World War producing naval ships while mills processed resources including timber from the hinterlands. In the 1960s as factories became increasingly automated and cities began to deindustrialize False Creek's industry began its precipitous decline leaving behind a heavily polluted waterway and land contaminated with heavy metals. As in most cities in the global north, industrialism was supplanted by a service economy and False Creek is a microcosm of the post-industrial era (Scott, 2012). The City of Vancouver rezoned much of the shoreline and construction began on False Creek South, the first of what would be several residential communities to line the shore. Industry was completely cleared from the north shore of the creek in the early 1980s in preparation for Vancouver's first mega-event: Expo '86.

This land later became home to the glass towers of Concord Pacific who purchased the land for $321 million to be paid over 15 years in what critics believed to be a give-away (Bula, 2015). Today False Creek is lined by several residential neighbourhoods and parks and is undergoing constant remediation. In 2010 for the first time in decades a grey whale swam through the channel to Science World and Pacific Herring were successfully reintroduced in 2014. Most of the species that currently frequent the area are urban specialists found throughout the city including crows, pigeons, starlings, squirrels, coyotes, raccoons, skunks, rats, gulls and Canada Geese. Rarer species have begun to return however indicating an improving ecosystem including the healthy grey whale, herring, cormorants, and beavers have been spotted at Hinge Park and Granville Island. (This history was informed by The Challenge Series, 2010).

Figure 7: View of False Creek Flats east of Main Street as it was being filled in: W.J. Moore. (c. 1916). From Vancouver Archives

False Creek Stats

The pink areas represent the historical extent of water in False Creek.

355 ha historically
92 ha at present
263 ha loss
26% remains
(Nick Page)

Figure 8: False Creek's historic shoreline: Nick Page, Vancouver Park Board

3 RESEARCH DESIGN

The Vancouver Board of Parks and Recreation has requested that I conduct research into the options for improving the ecological function of the shoreline at NEFC by exploring local and global precedents. This project will provide a theoretical orientation, situate the project within City of Vancouver Policy, outline precedents from Vancouver, Seattle, Staten Island, and Amsterdam, and propose recommendations.

3.1 Research Questions

- What are the options to improve the ecological function of the shoreline at Northeast False Creek?

Subquestions

- How can the City blend ecological restoration with high human use?
- Does a habitat restoration need to look natural to improve ecological function?
- How have cities engaged in placemaking while improving habitat?

3.2 Research Objectives

This project is intended to inform the Vancouver Board of Parks and Recreation of how shoreline restoration projects in cities have successfully improved the ecological function of urban shorelines while blending this with a high level of human activity.

- Provide a theoretical orientation
- Identify key policy linkages from City of Vancouver strategies
- Identify local and global precedents of successful shoreline restoration in an urban context
- Identify natural and technological solutions employed by project designers
- Identify how humans were included in these designs to allow people and nature to exist harmoniously at NEFC
- Propose recommendations for the design of the NEFC park

3.3 Methods

Interviews and email correspondence with experts

I consulted with individuals with experience working on urban shoreline restoration projects to learn about their insights and the challenges they have faced. This included meetings and email correspondence with people who worked on the precedent projects.

Theoretical orientation

I conducted an introductory theoretical orientation using literature selected from the field of restoration ecology. The purpose of this exercise is to justify decisions that may be made around reference ecosystems and species composition. Due to the urban context of the study area and issues such as moving target syndrome it is possible that some or many aspects of a restoration may not mirror many peoples' ideas of what a previous ecosystem may have looked like.

Review of City of Vancouver policy to identify policy justifications for such a project at NEFC

I reviewed The City of Vancouver and Park Board's main policy documents to determine how an ecological restoration of the shoreline would address the City's goals.

Review of local and global precedents

Through a process including discussions with Nick Page, Dr. Jordi Honey-Rosés, experts in this field, and personal experience, I identified five precedents to be reviewed. These range from very urban examples to projects that appear more natural, local to global, and all precedents exist in similar temperate ecological contexts. Precedents were also selected by their relevance to City of Vancouver goals. For example, environmental education is a goal of the Park Board and aspects of the Living Breakwaters and de Ceuvel address this goal.

4 THEORETICAL ORIENTATION

The City of Vancouver will need to decide upon what they are trying to model at the new NEFC park. Is it to create a self-sustaining natural system that mirrors an ecosystem that may have existed at some point in the past? Or can technology and human intervention be used to create an even more productive shoreline to make up for more deficient areas in the city? The answers to these questions will change depending on the goals and values of the parks planners and community but the theory of restoration ecology, an ever evolving field, can inform parks planners of best practices in determining a reference ecosystem.

The goal of ecological restoration "ostensibly is to return ecosystems to a state or condition from which they can be self-sustaining thereafter" (Parker and Picket, 1997, p. 17). Parker and Picket (1997) later challenge this goal due to habitat fragmentation in human settlements but this will be described later. A fundamental assumption of ecological restoration is that since humans are responsible for degrading the natural environment, humans have the responsibility to repair it (Egan et al., 2011). The idea of returning land to an ecologically productive state is laudable but is complicated by the fact that ecology and reference ecosystems are influenced by multiple perspectives while human dimensions can and do greatly influence the success of restoration projects (Parker and Picket, 1997; Egan et al., 2011). The former of these complications must be understood prior to the commencement of planning of any ecological restoration to avoid the pitfalls of the now widely discredited succession-climax idea of ecology. Parker and Picket (1997) argue that the contemporary paradigm of ecology and its principles is the only valid approach for restoration. The latter can be ameliorated through open and dialectic planning processes that are flexible and emphasizes public education.

Restoration practice has often been based on the assumption that, when undisturbed by humans, nature is fixed and unchanging, existing in some climax state that should be preserved forever (Parker and Pickett, 1997). This idea stems from the tendency of humans to objectify and idealize nature while ignoring the fact that natural systems are very often affected by and responding to disturbances (Parker and Pickett, 1997). This can thwart successful restoration by assuming systems have a single range of characteristics to be preserved or rectified such as a static species composition, biogeochemical dynamics, or productivity (Parker and Pickett, 1997).

In terms of NEFC, when looking into the past we may have an image of a lush forested landscape surrounding a marine channel and mudflats teaming with salmon, herring, whales, and migratory birds. At many points in history this may have been true, but disturbances likely altered this ecosystem at other times so definite assumptions of what this area looked like cannot be made. Invasive species could have hitchhiked on migratory birds using the Pacific Flyway, drought could have decreased the input of freshwater to the system, or some disease could have affected the salmon population like the recent starfish blight in the Salish Sea. Viewing ecosystems in this way and recognizing that there is no "ideal" or "climax" state is part of the contemporary paradigm of ecology and this paradigm will be used to inform this project and its recommendations for NEFC.

The classic ecological paradigm assumes ecosystems reach stable successional endpoints, after which processes are in dynamic equilibrium (Parker and Pickett, 1997). This suggests that systems are closed and self-regulating, controlling the flow of minerals and energy. Under this view, ecosystems are seen as deterministic and processes that move the ecosystem away from equilibrium are

considered disturbances (Parker and Pickett, 1997). In the contemporary paradigm, ecosystems are open and regulated by external processes while disturbances are viewed as natural and a regular occurrence (Parker and Pickett, 1997). They can have multiple successions, equilibria, or may fail to reach these stages at all. Because this view recognizes that systems are open to external regulation, humans and their impacts must be incorporated in ecological models for restoration ecology to be effective (Parker and Pickett, 1997). For an urban project such as NEFC in Vancouver, this view provides a greater degree of freedom by ensuring human impacts are anticipated, accounted for, and people are encouraged to use the site. NEFC is located in downtown Vancouver with high population density and is subject to a plethora of human uses. This project strongly recommends that human use is an essential part of the planning of any restoration that takes place.

The growth of human populations and urbanization has resulted in fragmentation of habitat and shifts in the influence of processes (Parker and Pickett, 1997). Historical processes that operated over large scales are restricted or erased and species interactions with their environment are altered resulting in stark differences between past and current composition (Parker and Pickett, 1997). Therefore, restoration can only pretend to create self-sustaining ecosystems in small sites such as NEFC and will require human intervention throughout their lifespan. However, it is important to determine a set of restoration goals using reference states, target species, or indicator species, for example, keeping in mind there is no ideal community or ecosystem (Parker and Picket, 1997; van Andel and Grootjans, 2006). This will allow a certain degree of freedom in how the new NEFC park will look and can be thought of as a continuum ranging from natural, reflecting other ecosystems in the region, to more urban but with the same or higher level of ecological function. The precedents that follow have been selected because they reflect the range of this continuum.

Egan et al (2011) describe the human dimensions of ecological restoration and how the practice is inherently value laden, context driven, prone to be immersed in disagreement and compromise, and experiential. The authors outline various studies that highlighted how "determining restoration goals and best practices are value laden activities because they involve human perceptions, beliefs, emotions, knowledge, and, ultimately, behaviors" (as cited in Egan et al., 2011. p. 2). Restoration projects are immersed in cultural, political, and economic contexts that will strain the planning process (Egan et al., 2011). Furthermore, Harris and van Diggelen (2006) state restoration will not take place unless human society approves of the goals and objectives of restoration. Restoration will not persist unless society has sufficient esteem for the restored ecosystem to protect its integrity (Harris and van Diggelen, 2006).

In light of these insights, this project has evolved from taking a more scientific approach, viewing ecological function as free from humans, to an inclusive approach that views humans as an asset in urban ecological restoration. The selection of precedents reflects this approach. In following with Egan et al's (2011) ideas, this project will recommend that any restoration at NEFC should be open for educational possibilities, artistic interpretations, and spiritual and physical renewal. "Ultimately, people are innately part of restoration projects as experts, learned amateurs, or volunteers, or as the general public affected by the results of restoration projects" (Egan et al., 2011, p. 2).

5 KEY POLICY LINKAGES

An ecological restoration of the shoreline at NEFC that encourages human interactions with nature is consistent with the City of Vancouver's policy framework as identified by the following goals and objectives.

Park Board Strategic Framework

Objective 3: Green Operations

- 3.1 Sustainable Operations: Design, measure, monitor and manage operations, and implement new practices to minimize our environmental footprint
- 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

Objective 4: Healthy Ecosystems

- 4.1 Green Stewardship: Model and advocate for best practices in ecosystem enhancement and management
- 4.2 Local Food Systems: Support community-based food production by contributing to the development of neighbourhood and city-wide food infrastructure programs and assets
- 4.3 Green Education & Advocacy: Use Park Board expertise, programs, facilities and partnerships to increase awareness and knowledge of sustainable living

Objective 5: Partners

- 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 & Advocates: Appreciate and acknowledge the efforts of volunteers and advocates

Objective 6: Community

- 6.1 Active Community Participation: Encourage active participation in parks and recreation
- 6.2 Improved Communication & Engagement: Maintain and enhance relationships with users and the community
- 6.3 Open & Approachable Organization: Be accessible, transparent and accountable

Objective 9: Well Managed Infrastructure

- 9.1 Strategic Asset Management: Manage assets with a long-term horizon – build the right things, build them to last, make them easy to take care of
- 9.2 Flexible & Functional Facilities: Collaborate with community partners to co-locate and develop convertible, scalable, multi-use facilities
- 9.3 Sustainable Design: Integrate feasible sustainability concepts into design, construction, maintenance and operations

Greenest City 2020 Action Plan

Goal 2: Green Buildings

Note: While out of the scope of this project, opportunities exist for Concord to create a model green neighbourhood by taking advantage of connections to the new park. Energy use, GHG emissions, and impact on City water systems can be reduced by implementing rainwater capture and using park systems to purify and store water.

Goal 5: Access to Nature

Ecosystems like forests and wetlands provide many essential services including flood control, water purification, and temperature control. To ensure these ecosystem functions and associated benefits continue, cities can integrate networks of natural lands, working landscapes, and other open spaces as "natural infrastructure." (p. 37)

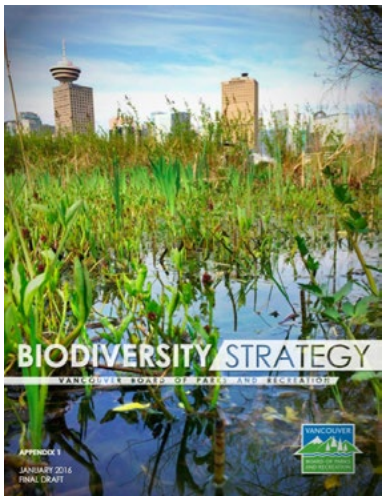
Goal 9: Green Economy

Secure Vancouver's International Reputation as a Mecca of Green Enterprise

Goal 10: Lighter Footprint

Achieve a one-planet ecological footprint

Biodiversity Strategy



Objective 1: Restore Habitats and Species

Objective 2: Support Biodiversity within City Parks and Streets

Objective 3: Protect and Enhance Biodiversity During Development

Note: While this goal refers to connections between parks on private lands, it is relevant to the adjacent Concord Pacific development that will likely be built up simultaneously with the park. The City should work with Concord to create habitat connections between the park and its buildings, residents, and streets.

Objective 4: Celebrate Biodiversity Through Education and Stewardship

Rewilding Vancouver: An Environmental Education & Stewardship Action Plan

Priority 1: Special Wild Places

The Park Board is responsible for caring for many remnants of Vancouver's ecological history– big trees, bird calls, streams and shorelines, coyote crossings, and the other sounds, smells, and sights of a wilder nature. Let's create opportunities for people to have rich experiences with nature in the special wild places in the city while protecting and enhancing them at the same time. (p. 24)

- Action 7: Explore the feasibility of a world-class nature centre at one of the high priority special wild places

Priority 2: Nature in Everyday Life

The Park Board plays host to the daily experiences of many Vancouverites – from a morning dog-walk through the neighbourhood park and an exercise class at the local community centre, to a senior's lunch and bridge game, an afterschool climb in the playground and an evening game of bocce. Let's integrate nature into the daily experiences of Vancouverites by allowing it back into public spaces and places. (p. 30)

- Quickstart Action 4: Pilot an environmentally-focused fieldhouse residency in a park

Climate Change Adaptation Strategy

Section 4.2.3: Habitat, Parks and Greenspace

The preservation and expansion of trees and greenspaces in Vancouver contributes to both climate change mitigation and adaptation. Vegetation absorbs carbon, helps keep the city cooler in the summer and increases the amount of groundwater re-charge, thereby lowering flood risk. (p. 17)

- Objective 1.1: Minimize rainfall related flooding and associated consequences

Note: Intertidal marshes and estuarian zones can process and store vast amounts of water during flood events. A 'tidal park' would collect and store stormwater from surrounding communities before discharging it to False Creek. Furthermore, this water could be reclaimed and used for toilet flushing and the irrigation of parks and rooftop gardens.

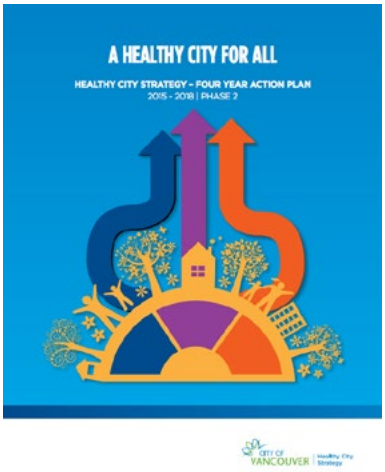
- Objective 2.1: Increase the resilience of Vancouver's infrastructure and assets to coastal flooding and erosion

- Objective 3.2: Increase Vancouver's capacity to respond to extreme weather events and recover effectively

Note: By mimicking natural systems the City does not need to rely on generators to power storm system pumps or the availability and ability to transport fuel. This frees up resources to be used in other areas of the city and minimizes our reliance on mechanical systems.

- Objective 5.1: Increase resilience of the built environment to future climate change conditions

Note: The proximity of the surrounding neighbourhoods will allow the park to be an asset in terms of water management and reducing urban heat island effect. This is particularly relevant to the adjacent future Concord development that has the opportunity to emulate and learn from examples such as Dockside Green in Victoria, or de Ceuvel (outlined later in this report) and to trail blaze new technologies and systems.



- Objective 5.2: Increase the Long-Term Health and Vigour of Urban Forests, Green Space and Trees

Healthy City Strategy

Goal 8: Active Living and Getting Outside

Note: This goal stresses the importance of accessible green spaces in Vancouver and how they not only build social cohesion but contribute to ecosystem functioning and the overall well-being of the planet.

Goal 12: Environments to Thrive In

Note: Healthy and livable communities are the focus of this goal, one aspect of which is a sustainable natural environment. One of its targets of relevance to NEFC is to increase biodiversity in the city.

6 PRECEDENTS

6.1 Jericho Beach Park, Vancouver

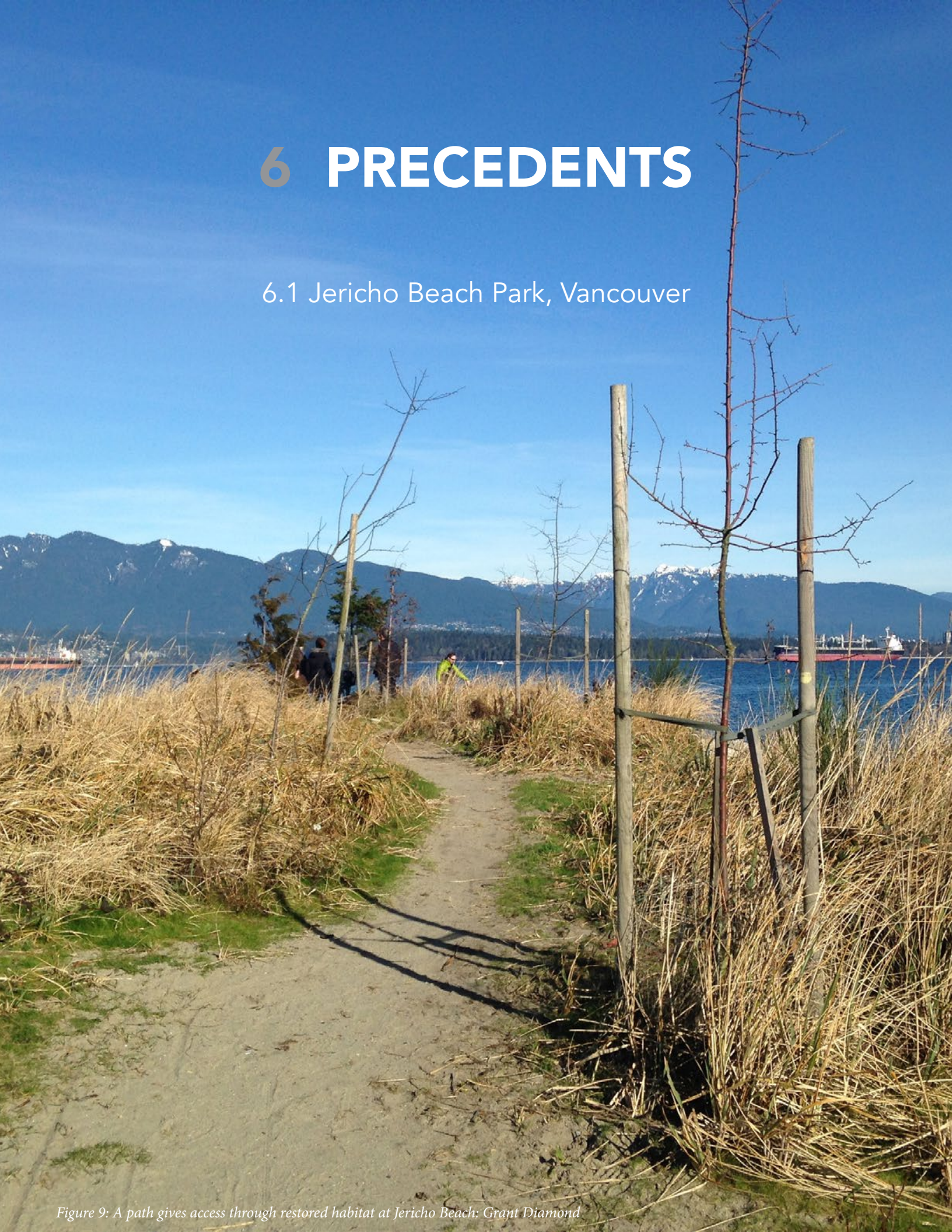


Figure 9: A path gives access through restored habitat at Jericho Beach: Grant Diamond

Figure 10: Jericho Beach Park features views of downtown and the northshore mountains: Grant Diamond

Jericho Beach Park

Jericho Beach Park is a well-used public space and the site of festivals, popular year-round beach access, the Jericho Sailing Club, and bike and footpath connections to Vancouver's extensive waterfront path network. Prior to its restoration, a large wharf called the Jericho Marginal Wharf covered much of the beach area. Constructed in the 1930s, the Marginal Wharf was used as a seaplane base during WW2 and hosted many other events over its lifetime (City of Vancouver, 2016). Condition and survey reports determined that it was nearing the end of its service life and required either extensive repair or removal to maintain public safety. After a four-year consultation process with the Sailing Centre, ecologists, veterans, First Nations, and more, it was determined the wharf would be removed and the beach restored (City of Vancouver, 2016).

The preferred option for the Jericho Beach restoration was a blend of a nature park and a park with gathering space. The Park Board commissioned Sharp & Diamond Landscape Architecture (now Connect Landscape Architecture) to create a design based on the goals they created in consultation with various stakeholders in the community.

The design of this project includes three ecosystems: foreshore, backshore, and riparian forest. Because of the difficulty of determining reference ecosystems, the species composition was determined by selecting native species that coexist well together and grouping these in specific zones. On-site soil was not contaminated and was able to be reused and moved during the construction phase after being screened to remove large objects (Mizrahi, personal communication, March 8, 2016).

Project Stats

Site area: approximately 2 ha

Area of restored beach: 2500m^2

Area of restored foreshore and backshore planting: 7150m

Length of new shoreline trail: 200m

Figure 11: The upland riparian habitat transitions to backshore and foreshore. Human activity is encouraged on the pathway and beach: Grant Diamond

The ecological goal was to "use this project as an opportunity to re-establish foreshore and backshore habitats, improve sediment quality, protect against shoreline erosion, and increase biodiversity" (Connect Landscape Architecture, 2014). Leymus mollis was planted in the foreshore areas and further upland in a manner meant to mimic natural areas. 5mm rounded rock with beach sand was used in the foreshore to create a porous and aerated substrate suitable for bottom dwelling fish such as Sand lance. This had the added bonus of improving beach stability and grading (City of Vancouver 2016; Mizrahi, personal communication, March 8, 2016). Edges were delineated with rope fencing to keep people out of planted areas while they became established.

Figure 12: Upland habitat is protected by logs allowing plants to become established. The Seawall meanders through the site accommodating many uses: Grant Diamond

Figure 13: "The Deck" at Jericho Beach Park features interpretive signage and references history with the old Lions Gate Bridge railing: Grant Diamond

Other important goals were placemaking and public realm improvements. Recreational and social uses are focused in several areas such as the wide bikeway and walking path and small gathering spaces like the deck structure with views of downtown. The deck references history with interpretive signage related to the wharf and old railings salvaged from the Lions Gate Bridge. Beach access was improved and interactions with nature are subtly encouraged. After only a few years since completion it connects well with the rest of Jericho Beach Park and many users may not even realize that they are passing through a recent restoration project (Mizrahi, personal communication, March 8, 2016).

This project provides many lessons for NEFC especially given the similar ecological context of the two sites. The species composition appears to be functioning well and could be emulated and built upon at NEFC. The structure of the foreshore and backshore can be replicated in some areas though NEFC should also include lower gradient zones to mimic mud flats associated with the calmer waters of False Creek. Flexibility of design must also be built into the process for NEFC as it was at Jericho Beach. Several aspects of the site including backshore wall height, tree placement, and paths were altered in the field.

Opportunities for NEFC

- A local example of building flexibility into design process
- Integration of Seawall and habitat
- Species composition is relevant to ecological context at NEFC

Figure 14 A mix of sand, 5mm rock, and boulders create niches for a variety of species including sand lance: Grant Diamond

6.2 Living Breakwaters, Staten Island

Figure 15: A depiction of the Living Breakwaters highlighting the interplay between habitat and humans: SCAPE Landscape Architecture

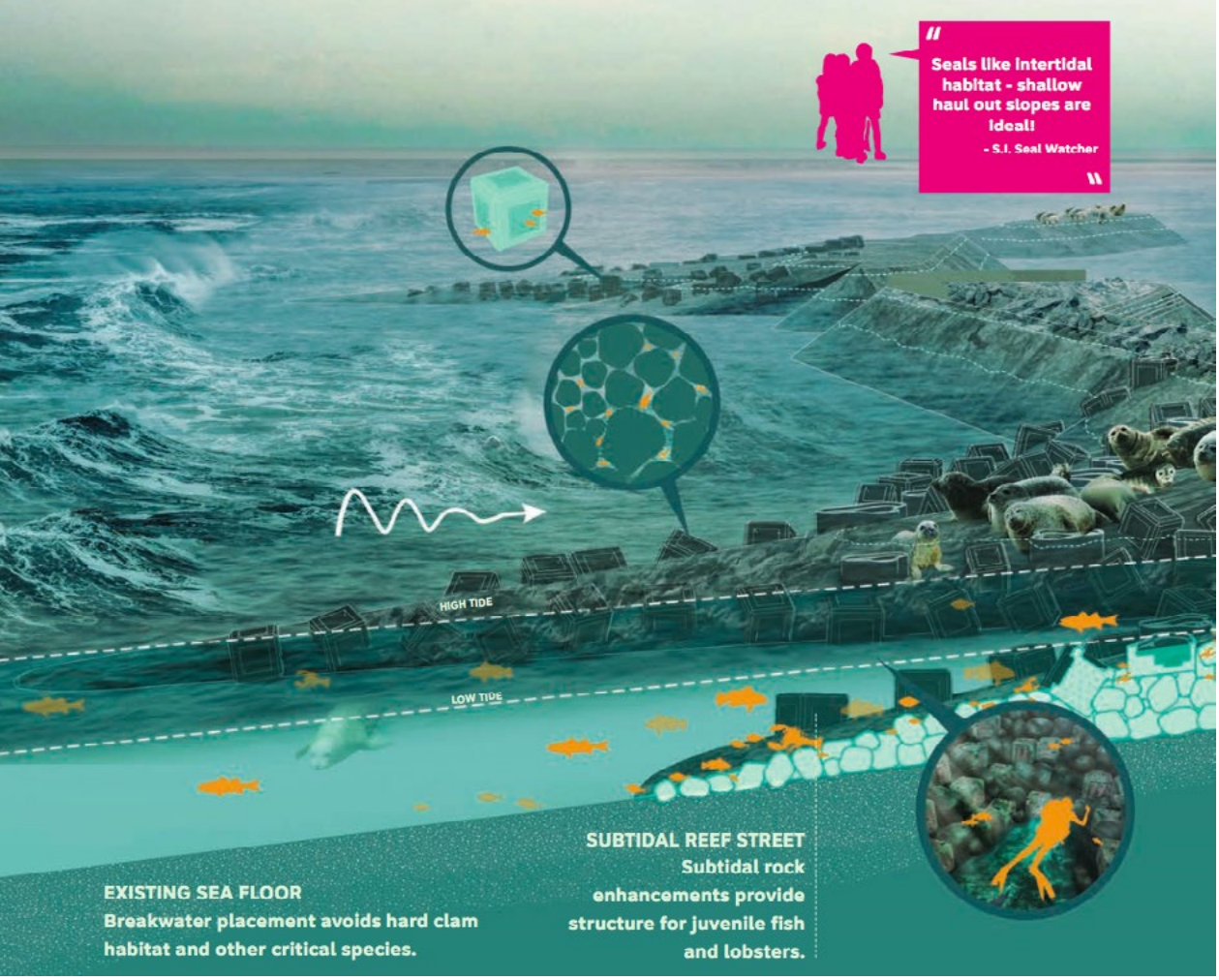


Figure 16: The Living Breakwaters are subtidal and intertidal structures designed to attenuate destructive wave action, encourage beach growth by deposition, while creating new habitat and experiences for people: SCAPE Landscape Architecture

The Living Breakwaters

The Living Breakwaters is a project in Staten Island, New York that "reduces risk, revives ecologies, and connects educators to the shoreline, inspiring a new generation of harbor stewards and a more resilient region over time" (SCAPE, 2014, p. 3). This project was a winner of many awards including the Rebuild by Design competition after Hurricane Sandy and the Fuller Challenge by the Buckminster Fuller Institute. While this project is more focused on risk reduction and community resiliency than ecological restoration, it provides many lessons on the design of sub-tidal infrastructure using biomimicry and on using education to increase public knowledge of local ecology.

This project was developed in the aftermath of Hurricane Sandy to build the resiliency of Staten Islanders to wave action and erosion. During Sandy, storm surge and high wave heights inundated the shore and caused massive erosion (SCAPE, 2014). The SCAPE team has devised a series of offshore breakwaters running parallel to the coast to reduce wave heights and create a buffer against wave damage, flooding, and erosion. This proposal is intended to connect Staten Islanders to the shoreline and to foster a relationship between them and the water whereas more traditional infrastructure such as large dykes and seawalls would create a physical and psychological barrier (SCAPE, 2014). NEFC does not experience high wave heights due to its sheltered location but the intertidal habitat aspect of the Living Breakwaters is relevant and replicable in this context.

To grow ecological resiliency the Living Breakwaters are designed to mimic rocky habitat that juvenile fish require before venturing out to see as adults. They are designed to maximize complexity for a diversity of marine species while exposed portions provide bird habitat (SCAPE, 2014). The species composition at NEFC is different but a

complex shoreline is required to provide spawning ground and hiding places for juvenile fish such as Pacific Herring or salmon fry that have begun to return to China Creek. Increased bird habitat could provide a haven for migratory birds on the Pacific Flyway. To construct the breakwaters, Econcrete is being used. This is an innovative low PH concrete that is ideal for maritime construction that can be textured and placed to create crevices and holes for ecological niches. Units of Econcrete are proven to increase biological recruitment and shelter filter-feeding organisms (SCAPE, 2014). Biogenic buildup will protect the structures, prolong their lifespan, and species native to Raritan Bay like oysters will filter water (SCAPE, 2014). As biogenic buildup occurs at NEFC, filter feeders would clean the waterway providing a natural filtration system for storm water potentially creating conditions suitable for sensitive species such as eelgrass to eventually return.

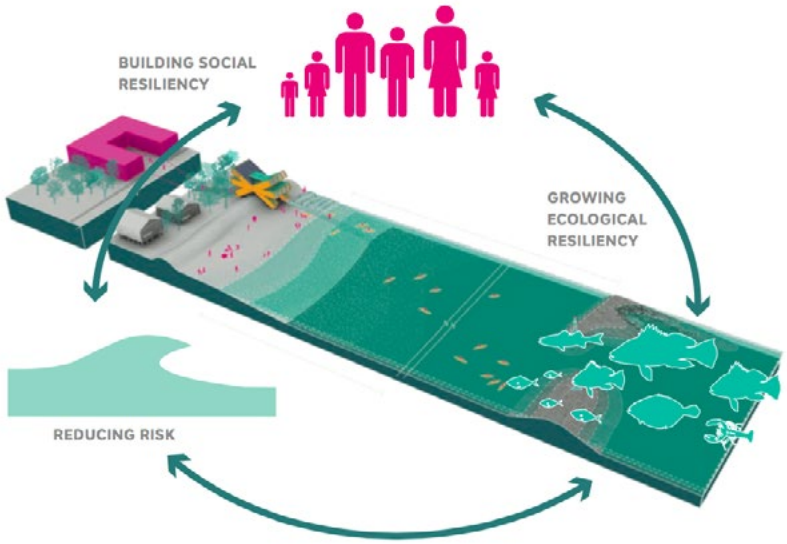


Figure 17: Living Breakwaters' guiding principles include people as equals with habitat: SCAPE Landscape Architecture

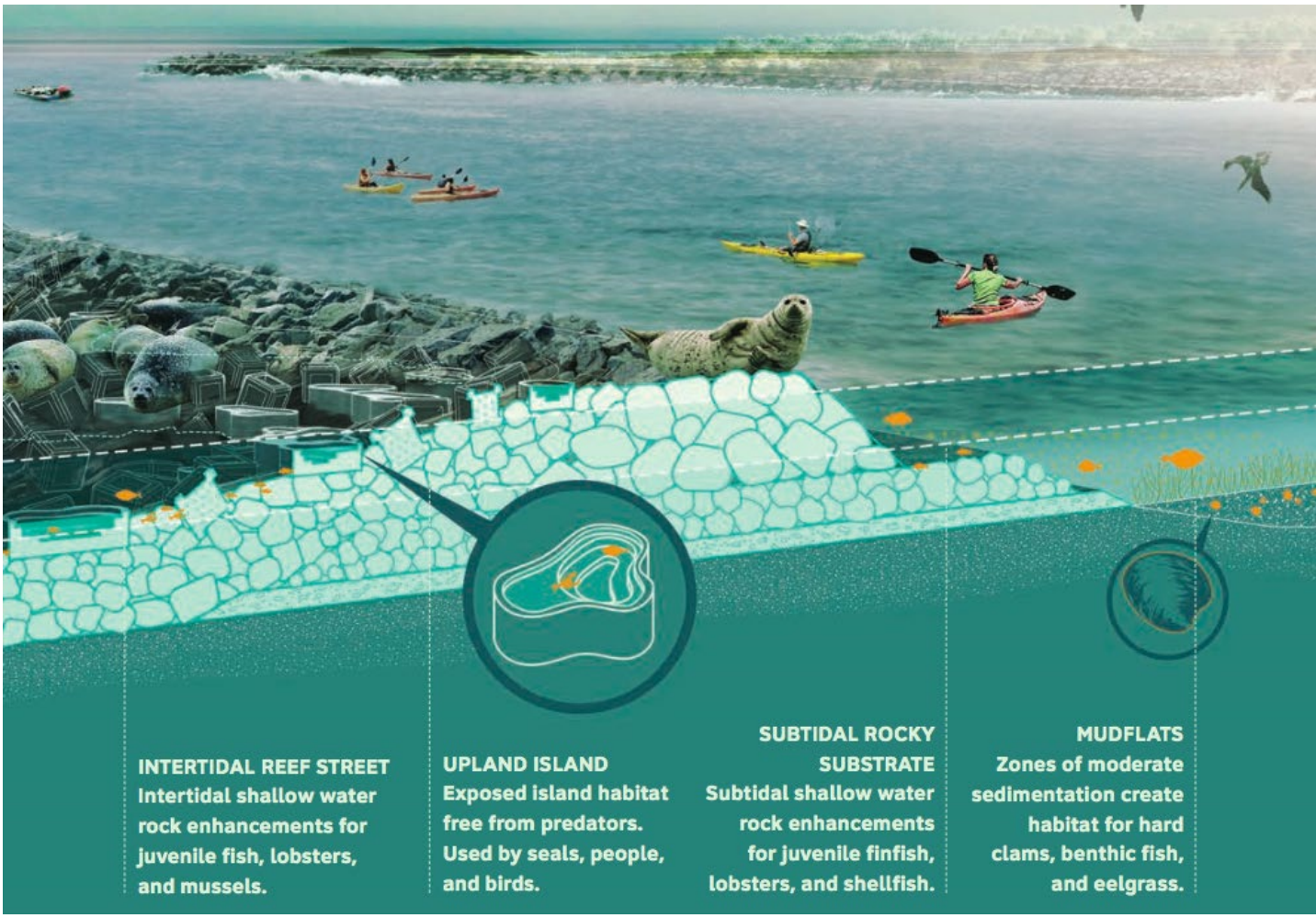


Figure 18: This rendering describes the construction of a breakwater: SCAPE Landscape Architecture

"reduces risk, revives ecologies, and connects educators to the shoreline, inspiring a new generation of harbor stewards and a more resilient region over time" (SCAPE, p. 3)

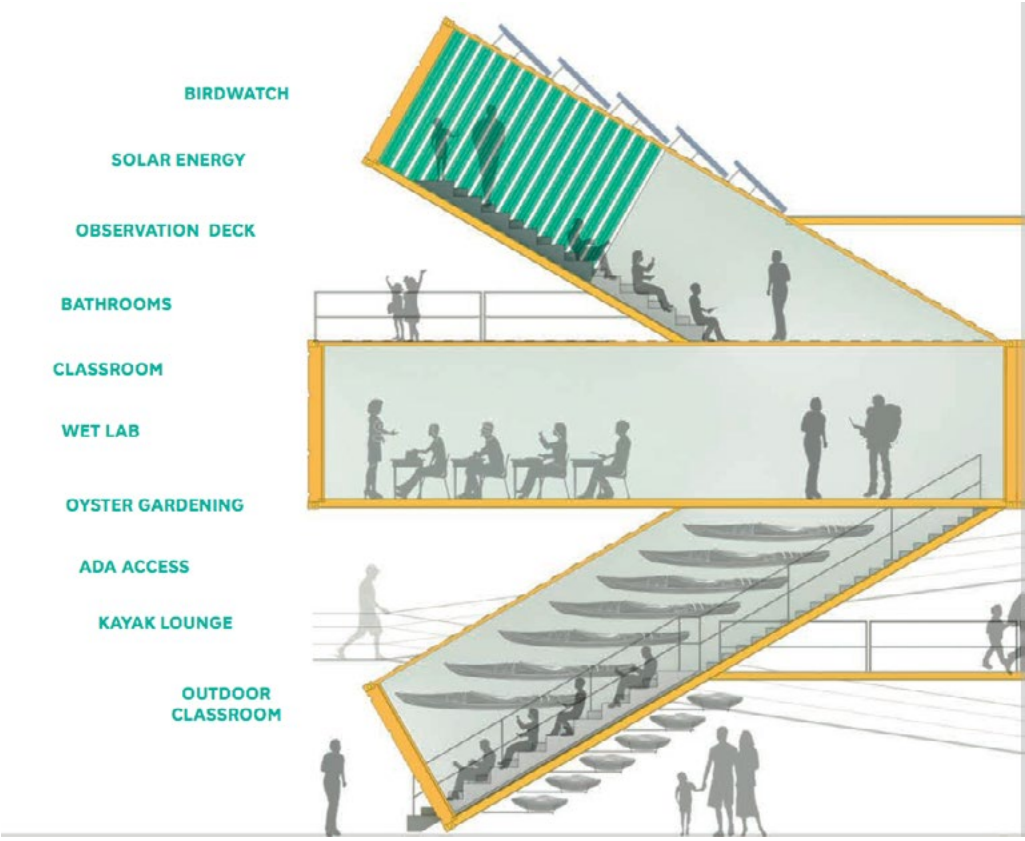


Figure 19: This section (along with Figure 21 on the following page) highlight the range or programs and facilities that can be housed in a Waterhub. A similar model at NEFC would be invaluable to the local community and visitors: SCAPE Landscape Architecture

Figure 20: Econcrete can be formed into any shape to fit any ecological context: SCAPE Landscape Architecture

Social resiliency is a main goal of the Living Breakwaters and a network of Waterhubs are planned to provide orientation, information, storage space, and group gathering spaces. Each one is programmed to be relevant to the context of the area in which it is situated. For example, one community group suggested kayak storage and wetlabs will be used by local high schools (Elachi, personal communication, March 2, 2016). The City of Vancouver's Environmental Education and Stewardship Action Plan identifies the goal of creating an environmentally-focused fieldhouse in a park and the Waterhubs are a model of how to achieve this. Vancouver's could include space for many of the activities that take place on False Creek including storage for kayaks and dragon boats. It should also include flexible space for educational workshops and classrooms or wetlabs for local schools. Environmental interpretation should also be included for Seawall users to educate citizens on the importance of fostering an ecologically sensitive city. The needs of schools and the community can be determined through the participation

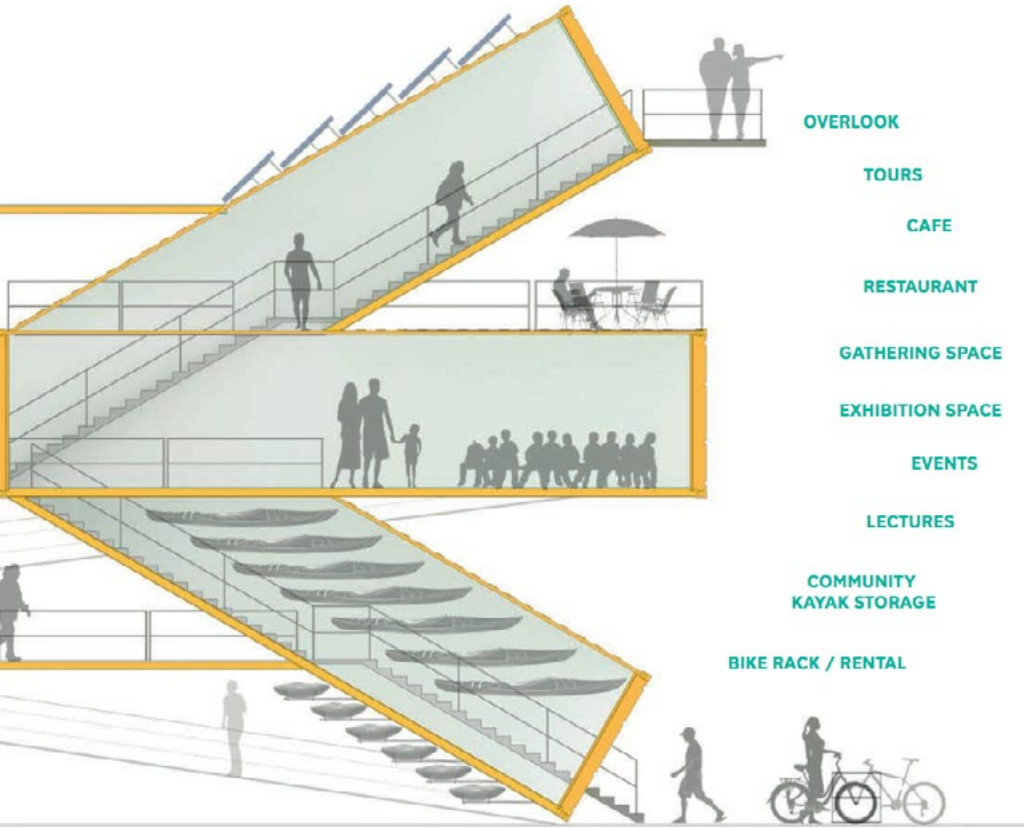


Figure 21: See description of Figure 15 on previous page

of teachers in a community advisory committee. SCAPE has done further school outreach through the Billion Oyster Project which works to foster environmental stewardship at schools via oyster gardening (Elachi, personal communication, March 2, 2016). Oysters are a keystone species in this ecosystem and provide an essential ecosystem service by filtering water. By targeting this species water quality in Raritan Bay can be improved creating a healthier ecosystem for other species. Pacific Herring are a keystone species in our region and a similar program targeting this species through educational programs would greatly improve not only False Creek's ecological function but also that of the Salish Sea where Herring are preyed upon by orcas and other large predators.

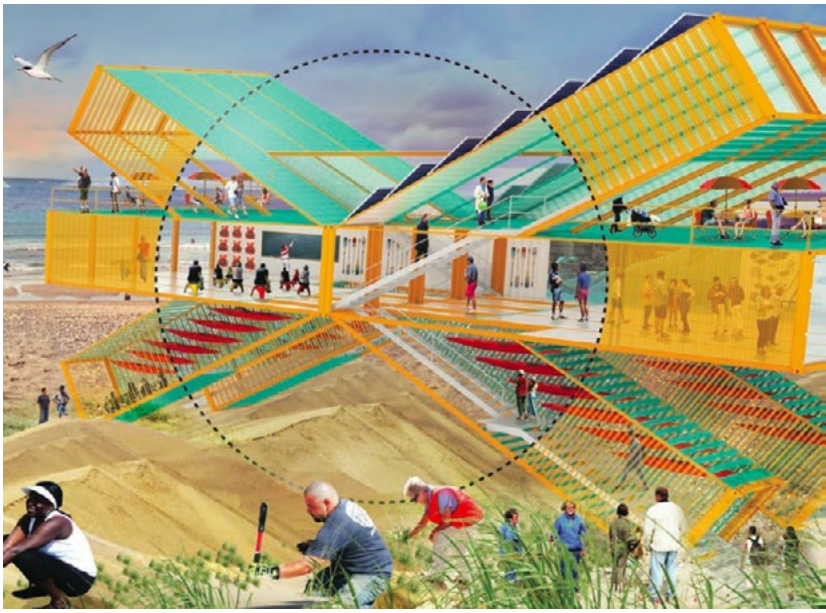


Figure 22: A Waterhub and how it fits into the coastal dune landscape: SCAPE Landscape Architecture

Opportunities for NEFC

- The constructed breakwaters can be used as a model for intertidal habitat at NEFC, specifically their use of Econcrete and creation of niches
- Creation of an environmentally-focused fieldhouse modeled off the Waterhubs
- Implementation of educational programs targeting Pacific Herring to spread knowledge of their importance as a keystone species and allow citizens to participate in habitat restoration

6.3 Waterfront Seattle Program

Figure 23: A rendering of a proposed habitat beach at Pioneer Square in downtown Seattle: Waterfront Seattle

Waterfront Seattle Program

The Waterfront Seattle Program is a large-scale project in downtown Seattle along the Elliot Bay shoreline that was spurred by the demolition of the Alaskan Way Viaduct and the need to replace the aging seawall. It spans from Pioneer Square to Belltown and includes a new seawall with improved salmon and foreshore habitat, better connections between downtown neighbourhoods, and new at-grade streets for all modes of transit (Waterfront Seattle, 2016). This project has stark similarities to NEFC in terms of both its urban and ecological context and being just a few years ahead will provide many lessons on how to improve ecological function. The project's goals for the waterfront are to "bring people to the water's edge to experience the water and ecology of Elliot Bay, to improve shoreline ecology while preserving and enhancing maritime activities, and to reflect Seattle's commitment to sustainability and innovation" (Waterfront Seattle, 2012, p. 2:148). These ambitious goals should be matched and built upon for the NEFC project.

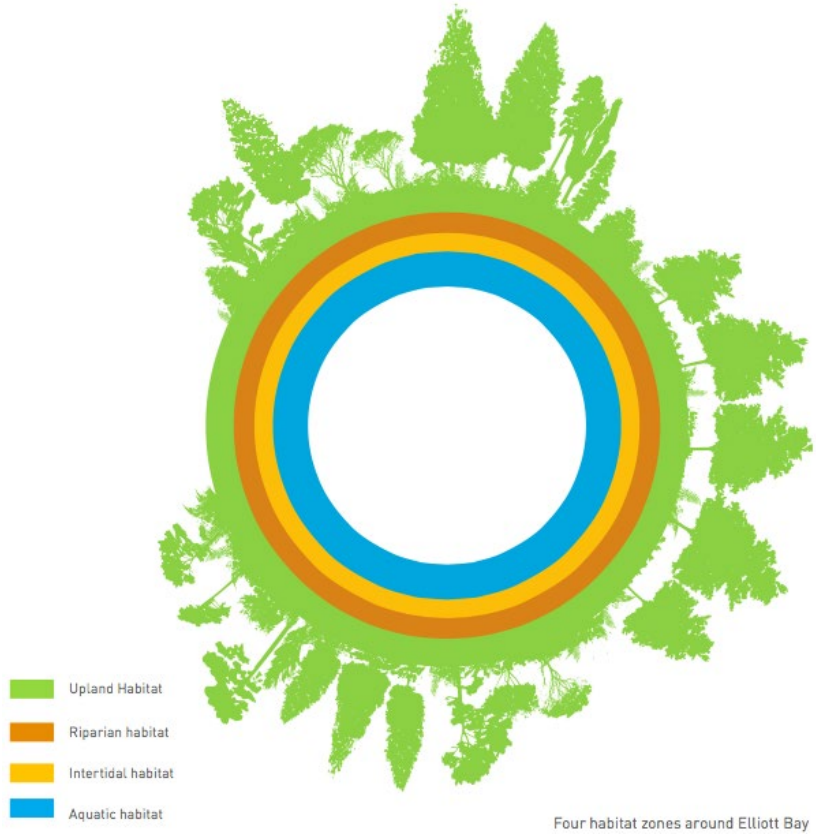


Figure 24: The Waterfront Seattle team identified four habitat zones around Elliot Bay that their project will emulate: Waterfront Seattle

To improve the function of waterfront ecosystems Waterfront Seattle describes four habitat zones that will be focused on during the course of the project: upland, riparian, intertidal, and aquatic. This framework is intended to focus priorities on enhancing each of these ecological communities and the connections between them (Waterfront Seattle, 2012). Similar to False Creek's waterfront, what was once home to a wealth of marine organisms has been replaced by urban structures such as a seawall, reducing the functions on the intertidal and riparian zones.

Figure 25: A rendering of Waterfront Seattle's proposed habitat enhancements and public spaces: Waterfront Seattle

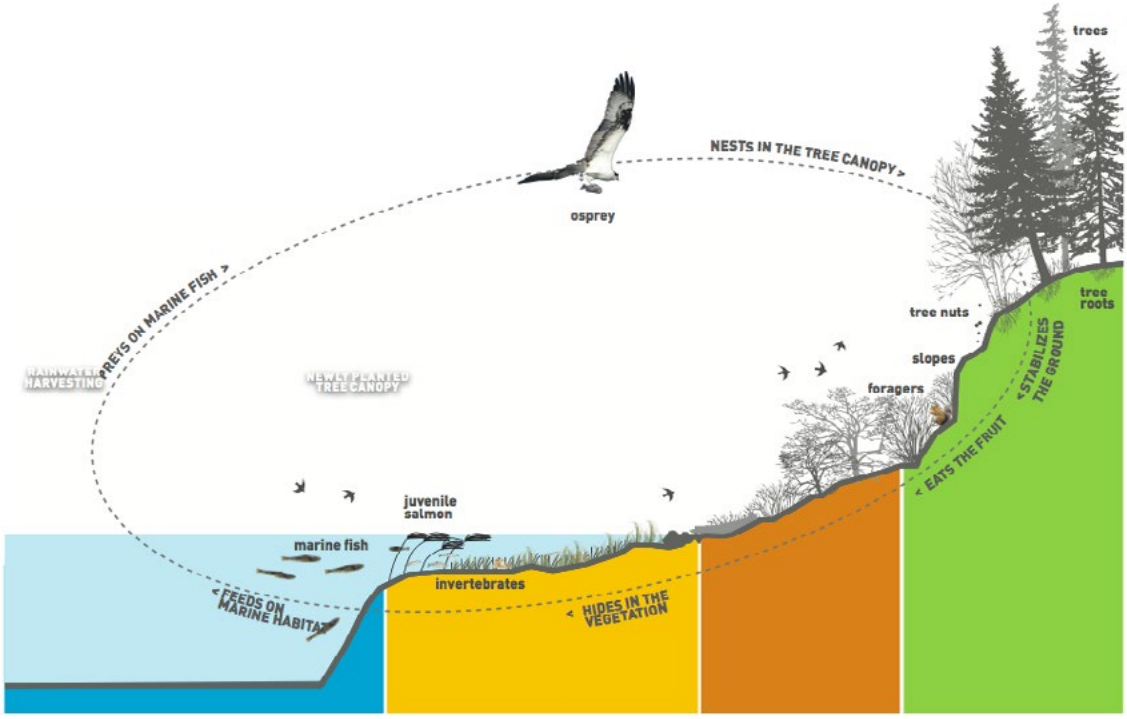


Figure 26: This figure describes the interactions between coastal habitats: Waterfront Seattle

An exploratory diagram Waterfront Seattle used in its Framework Plan [Figure 26] outlines a design strategy that could be used at NEFC should the Park Board prefer a natural option or a biomimicry option (though these are not mutually exclusive). The diagram highlights key relationships between the aquatic, intertidal, riparian, and upland zones and the interactions between organisms that facilitate healthy ecosystem function. This sort of exploratory exercise would be beneficial to the Park Board in determining species that should be focused on when deciding species composition. Waterfront Seattle has also taken a broader look at habitat connections in the downtown and how patches, corridors, and mosaics can be factored into the design, particularly corridors between other parks. The at-grade street network in Vancouver provides opportunities to create habitat corridors to facilitate better movement of species throughout the city.

The current Elliot Bay Seawall runs along a natural salmon migration corridor used by salmon fry as they leave the Duwamish River and head to the open waters of the Pacific (Waterfront Seattle, 2012). At this stage salmon prefer shallower waters that are penetrated by sunlight to avoid predators but dredging has resulted in a steep drop-off and several piers block sunlight. This forces salmon to swim around piers to stay in light exposing them to predators (Waterfront Seattle, 2012). To address this, the habitat restoration will feature habitat benches to make the nearshore shallower and the Seawall will feature a light penetrating surface (LPS), providing salmon with a route along the waterfront and between the shoreline and piers (Waterfront Seattle, 2012). If the design process for NEFC determines portions of the Seawall must pass over water, a similar LPS should be used to make a more hospitable habitat for Pacific Herring and an expected increase in the salmon stocks using China Creek as it is remediated.

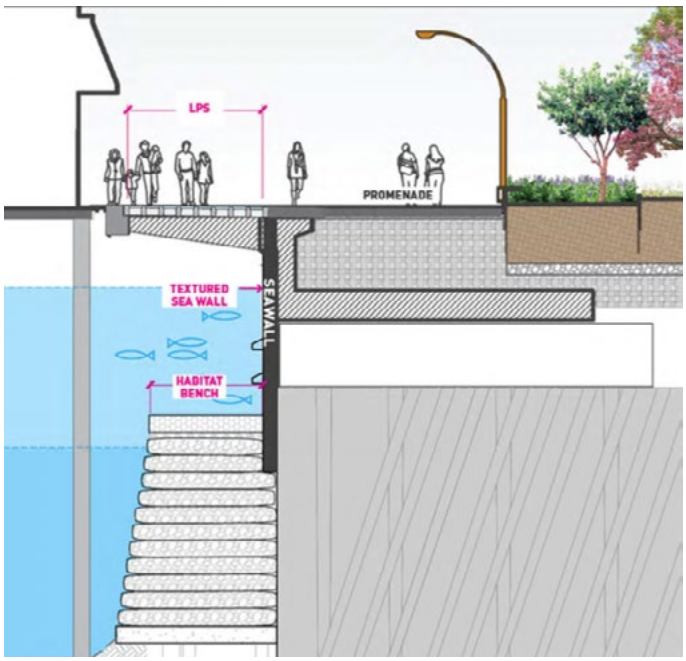


Figure 27: The habitat bench with Light Penetrating Seawall above: Waterfront Seattle

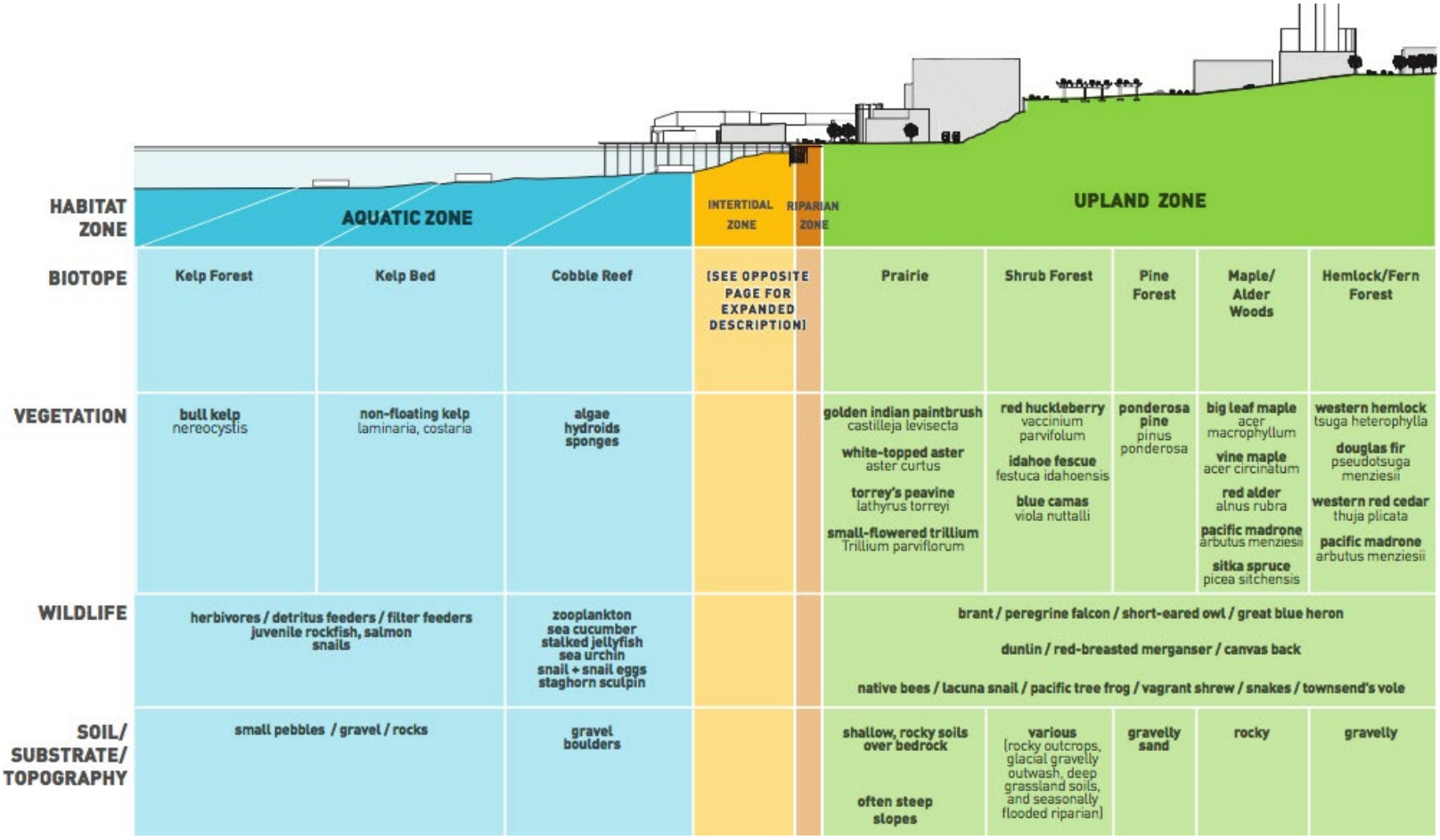


Figure 28: This diagram outlines an ecosystem structure that could be built upon at NEFC: Waterfront Seattle

This project will also feature beaches that may be more relevant to NEFC, as well as better stormwater management through the use of bioswales, porous concrete on the bikeway, and improvements to the current combined sewer system that regularly overflows into Elliot Bay (Waterfront Seattle, 2014). Project scientists had three reference beaches from previously restored beaches within Elliot Bay and 35 years of data on invertebrates and fish in Puget Sound to provide reference data (Cordell, personal communication, March 25, 2016). Based on these extensive studies, scientists have a good understanding of habitat components that comprise good ecosystem function for juvenile salmon (Cordell, personal communication, March 25, 2016). Preliminary information has indicated that juvenile salmon may venture beneath the LPS but this has yet to be proven (Cordell, personal communication, March 25, 2016). The LPS yields 2% of ambient light and a post-construction analysis will be required to determine its rate of success (Cordell, personal communication, March 25, 2016).

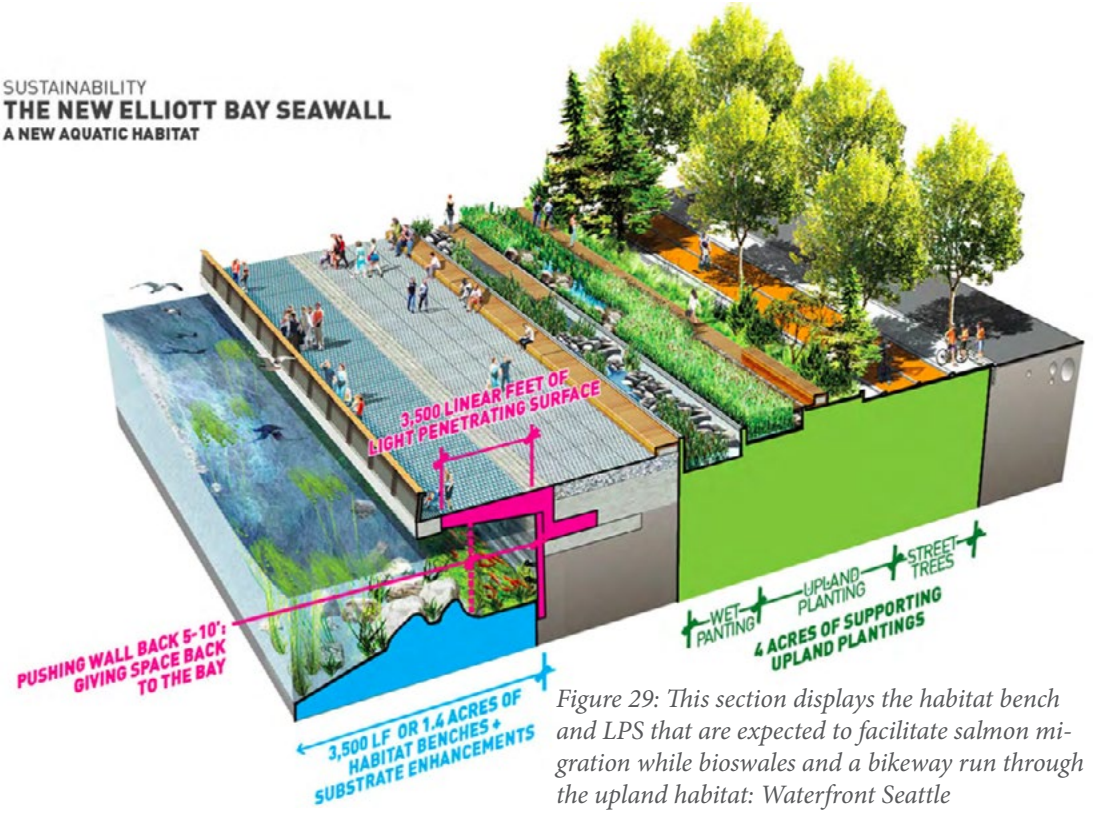


Figure 29: This section displays the habitat bench and LPS that are expected to facilitate salmon migration while bioswales and a bikeway run through the upland habitat: Waterfront Seattle

"The waterfront is separated from Elliott Bay by the Seawall. Due to a long history of industry and development, the environment in marine waters along the central waterfront has been degraded by pollution, combined sewer discharge, dredging, dumping and large surfaces of over-water coverage. The quality of marine water environments along the central waterfront depends on many factors which are beyond the scope of this project, but every effort will be made to coordinate with and encourage initiatives to improve the quality of water in the marine environment" (Waterfront Seattle, p. 160)

Figure 30: A mock up of the LPS: Waterfront Seattle

Figure 31: Seattle's waterfront prior to the demolition of the Alaskan Way Viaduct: Waterfront Seattle

NEFC is not constrained by the proximity of the new at-grade Alaskan Way and piers at Seattle's waterfront resulting in more land to work with and greater flexibility. Waterfront Seattle can act as a test ground for many options of what could be implemented at NEFC ranging from habitat and seawall design to improving stormwater management. The similar urban and ecological contexts make this project particularly worth learning from.

Opportunities for NEFC

- Blending of public realm improvements with ecological function through design such as Light Penetrating Surfaces in Seawall and stormwater capture
- Improving connections throughout the city by focusing on corridors between other green spaces
- Focus on coastal ecosystem structure and interactions between coastal biomes ranging from upland to aquatic
- Seattle's upland habitat will be constrained by the proximity of the new Alaskan Way to the waterfront but at NEFC upland habitat could extend as far north as the Skytrain guideway

6.4 De Ceuvel, Amsterdam

Figure 32: De Ceuvel in Amsterdam North: Natalie Mackenzie

Figure 33: De Ceuvel is located on a canal in Amsterdam North at a former shipyard. This photo gives an overview of the site on a busy summer evening: N. Boomkens

De Ceuvel, Amsterdam

De Ceuvel is a brownfield remediation project on a canal in Amsterdam across the River IJ in Amsterdam North; a hip area undergoing rapid development due to its relatively low real estate prices and accessibility to the city centre. Organizers received a 10-year lease from the City on land contaminated with heavy metals, oil, paint, and dredge as part of the "Broedplaats" or cultural "breeding ground" program (Metabolic, 2013). Broedplaats receive subsidies of 250.000 € from the City in exchange for providing low rent offices and studios for creatives; thus this project team had a relatively low budget to remediate this site while being obliged to provide work and cultural space. De Ceuvel now considers itself "one of the most sustainable and unique urban developments in Europe" (de Ceuvel, 2016). The ecological context of Amsterdam is not as relatable to Vancouver due to the fact that all of its land was reclaimed hundreds of years ago but this project provides several lessons for improving ecological function using biomimicry and engineered solutions while being a cultural hub.

De Ceuvel's goal is to employ a regenerative approach leaving behind cleaner soils and water, and producing rather than consuming resources (Metabolic, 2013). The driving principle behind the project was to create a lively community space that has low impact and low cost with a goal of placemaking for the neighbourhood (Monaghan, personal communication, February 24, 2016). For the City of Amsterdam, it is a way to save money (it has very little impact on municipal infrastructure) while driving up property values and doing interesting work on vacant land while the real-estate market recovers (Monaghan, personal communication, February 24, 2016). This brings up the question of the gentrification of Amsterdam North by hipster culture or creatives but that is for another research project (and research area that is widely studied in Amsterdam). The University of Ghent conducts low impact biomass production and purification making the project a test site and pilot project for graduate and doctoral studies (Holmes, 2014). It therefore acts as an educational space for cutting edge ecological restoration, a goal that should be strived for at NEFC.

Figure 34: A houseboat displays a message to visitors: Natalie Mackenzie

Mustard-based plants and willows that are known to take up heavy metals from soil were planted but this process is expected to be slow, taking 30-50 years to remediate the soil if using this method alone (Monaghan, personal communication, February 24, 2016). Boardwalks were built above this "Forbidden Garden" to allow the establishment of plants and to put a barrier between people and the contaminated soils. The design and plant selection was based around what could bring up hydrocarbons and other pollutants and not a specific reference ecosystem with a secondary consideration of migratory corridors and pollinators (Monaghan, personal communication, February 24, 2016). Creative industries are housed in houseboats that have been lifted onto the land and are intended to operate at the highest level of sustainability. Figure 37 describes the material flows associated with a houseboat being used by seven workers and how operators plan to close this loop. Systems such as these could be replicated for park facilities such as washrooms, concessions, and the environmentally-focused fieldhouse.

Figure 35: My friends and I hanging out on the boardwalk at de Ceuvel in July 2015. Boardwalks provide access to the whole site while allowing plants to become established: Natalie Mackenzie

The public realm at de Ceuvel is very vibrant and it has quickly become a popular place for Amsterdammers to visit and spend hours sitting on the docks eating, drinking, and relaxing. In addition to the creative space in the houseboats, there is a café, performance stage, and food trucks. While the houseboat half of the site is a creative workspace, the other half has a festival atmosphere and regularly hosts events and concerts.

"Our goal with the Cleantech Playground was to create a system that works similarly to an ecosystem: harvesting ambient energy and water for use on site, cycling nutrients locally, and creating an environment that is supportive of natural biodiversity. Our goal is to create a new blueprint for biobased cities, rooted in the strength of human community." (Metabolic, 2013, p. 13)

Figure 36: A dog enjoys a floating structure while patrons sit at the de Ceuvel Café: De Ceuvel

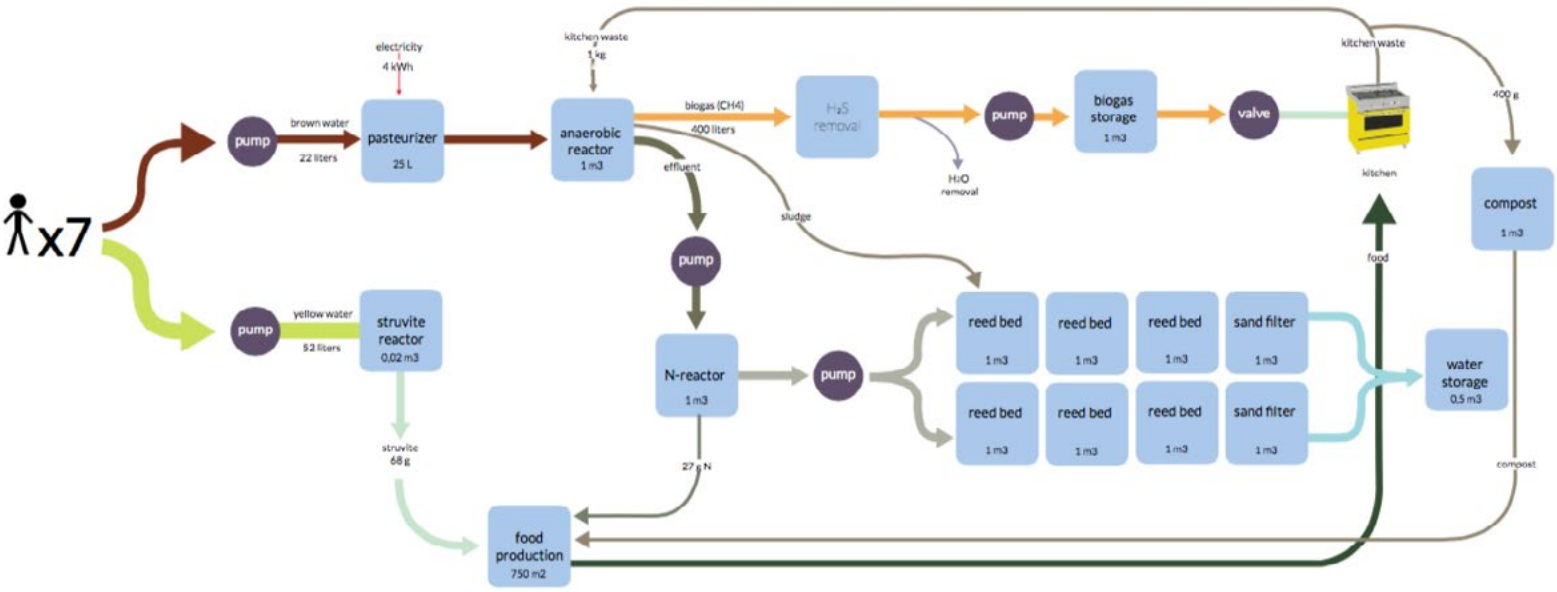


Figure 37: This diagram describes a closed-loop plan for a houseboat with the capacity for seven workers: Metabolic

The Park Board has expressed interest in exploring the possibilities of floating features for the park. During the development of de Ceuvel's Deployment Plan, Delva Landscape Architects investigated options for ecological materials that could be used as floating platforms (Metabolic, 2013). These gardens would support pollinating insects and create wetland structure, perhaps even providing space for food production. The team identified mushroom mycelium, a common agricultural waste product, as the most promising product due to the amount of air captured in their root structures. Mushroom mycelium blocks can be obtained for free from commercial mushroom farms and need to be treated with a saline solution and sealed with a natural rubber to prevent degradation in water (Metabolic, 2013). Ultimately the team did not end up going in this direction and instead use recycled material such as tires but the platforms have achieved their goal of supporting food production (Monaghan, personal communication, February 24, 2016).

To achieve the goal of being one of Europe's most sustainable developments, de Ceuvel aims to close material loops by growing food on site, generating electricity, and reducing waste. De Ceuvel uses composting toilets and urine separation (particularly from the café) to capture human feces and urine that is safely transformed into nutrients on-site for food production (Monaghan, personal communication, February 24, 2016).

Several lessons have been learned over the evolution of the project: urine separation at source is valuable for nutrient capture but requires infrastructure at the building level and some buy-in from the local water or sanitation utility adding a cost that needs to be mandated or subsidized (Monaghan, personal communication, February 24, 2016).

Figure 38: Houseboats are connected by a boardwalk that loops from the festival and gathering side of the site: Natalie Mackenzie

The environmental sustainability aspect was part of the project's evolution and wasn't as emphasized when the original stakeholders signed on looking for cheap and creative workspace. This added a challenge as only around half the stakeholders felt invested in the sustainability and community components as they were being explored. The team recommends having stakeholders sign a clear manifesto, having flexible contracts, and selecting community members wisely (Monaghan, personal communication, February 24, 2016). The latter will be less relevant for NEFC given the site will be a public park and de Ceuvel is privately run.

Figure 39: A floating structure for people to use and boats to dock at: Natalie Mackenzie

Vancouver can learn from de Ceuvel's blending of high ecological function with the creation of unique outdoor experiences for people. This resoundingly successful project highlights how informal gathering space in the city can exist in concert with a healthy functioning shoreline.

Opportunities for NEFC

- Use plants to take up contaminants over the long-term
- Engage in placemaking to encourage vibrancy and a creative culture in downtown by creating spaces for gathering and performances
- Encourage research in situ to test new technologies and capitalize on creativity
- Build floating habitat that rises and falls with tides

Figure 40: Floating gardens and gathering spaces provide access to the canal: De Ceuvel

6.5 Habitat Island and Hinge Park, Vancouver

Figure 41: Habitat Island in the middle of the city: Grant Diamond

Habitat Island, Vancouver

Habitat Island and Hinge Park are located at Southeast False Creek (SEFC) just across the water from NEFC and are a recent and very relevant case study due to their similar context and recent completion.

During the planning of SEFC the City determined that a portion of the shoreline needed to be filled (The Challenge Series, 2010). The Department of Fisheries and Oceans originally resisted the plan as the destruction of fish habitat would violate the Fisheries Act (The Challenge Series, 2010). In the end, a team of environmental consultants proposed building a small offshore island that replaced lost shoreline and resulted in a net increase in the area of intertidal fish habitat (The Challenge Series, 2010).

Habitat Island hosts aquatic, riparian, and upland habitats including native vegetation and a natural shoreline that has attracted a variety of waterfowl and herring spawn (The Challenge Series, 2010). Public access is over a chain of boulders on a narrow isthmus from the Seawall and a network of trails meander through the upland habitat. The City should emulate this practice by building one or more habitat compensation islands and justify this habitat compensation at a False Creek or city-wide scale rather than just a park-scale. In other words, much of Vancouver's shoreline is developed and has lost its ecological productivity. The City should maximize the area of intertidal habitat it can create at NEFC to compensate for these areas.

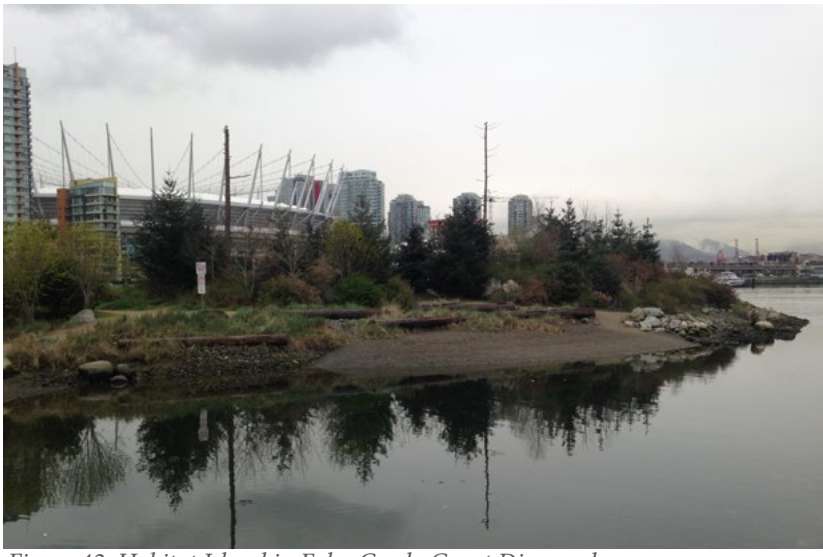


Figure 42: Habitat Island in False Creek: Grant Diamond

Figure 43: An isthmus provides a bridge for people to experience nature in the heart of the city: Grant Diamond

Figure 44: Trails meander through the forested landscape of Habitat Island: Grant Diamond

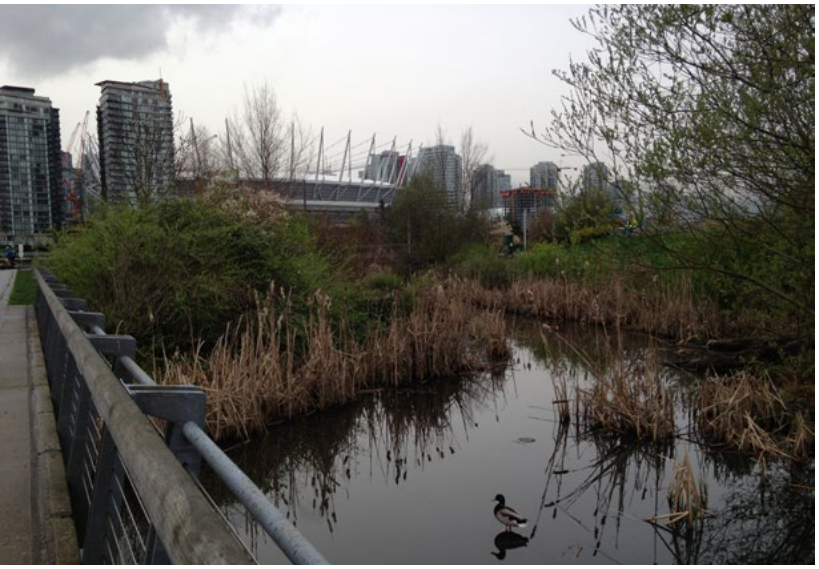


Figure 45: A duck enjoys a pond in Hinge Park: Grant Diamond

Figure 46 A bridge crosses a stormwater pond with the Olympic Village in the background: Grant Diamond

Habitat Island's unofficial moniker is Beer Island as it is a popular place for people to meet and enjoy a drink on the rocks while taking in views of downtown. It is clear that there is a desire among citizens for informal gathering space with the freedom to enjoy the outdoors in their own way. De Ceuvel is a good example of an informal space where people can gather, enjoy music, food, and drink. This sort of place is lacking in Vancouver and an opportunity exists to create a unique and flexible space though the province's archaic liquor laws may be a barrier. De Ceuvel is an example of how social gathering spaces can coexist with ecological function and Habitat Island makes it clear this type of space is desired by citizens.

Hinge Park, Vancouver

Hinge Park is a slightly inland riparian park featuring a constructed wetland to remediate and retain stormwater that treats runoff from the west side of Olympic Village (The Challenge Series, 2010). Bridges cross the water, meandering paths wind through the habitat, and a children's play area combines the function of a play park with rainwater remediation. Wildlife habitat, natural play, and aesthetic values have been merged (The Challenge Series, 2010). In a serendipitous moment in 2012 I had a conversation with an architect who was leading a tour through SEFC with a group of Skanska architects visiting from Sweden and he described the site's biggest success being public access to the water. Building in features that force interactions between people and aspects of their environment (such as water), even if the features are subtle, causes them to appreciate the environment and can potentially change behavior.


Figure 47: Habitat Island in False Creek boasts intertidal and upland habitat: The Challenge Series

Habitat Island and Hinge Park are examples of how seemingly wild spaces can exist in highly urbanized areas and connect urbanites with nature. Connections were made between the adjacent Olympic Village to treat stormwater, a practice that can be emulated and built upon for Concord Pacific's new neighbourhood west of the future NEFC park. The Habitat Island model also highlights the tradeoffs that occur when integrating human access and nature. While the provision of public access is an asset by encouraging interactions with nature, it is also a hindrance for many terrestrial species due to habitat disturbance (Page, personal communication, March 20, 2016). To address this, NEFC could feature areas that are reserved for habitat or only have seasonal access to some habitat. If multiple habitat compensation islands are constructed then one could have access while another does not or access could be dependent on the tides.

Figure 48: Stormwater purification at Hinge Park: Grant Diamond

Opportunities for NEFC

- Construct one or multiple habitat compensation islands with varying degrees of access to ensure undisturbed habitat can exist alongside humans
- Explore the mutual benefits that connections between Concord Pacific's new neighbourhood and the NEFC park can foster including but not limited to stormwater collection and purification
- Take advantage of the desire for informal and social gathering space by including this in the planning process for NEFC

7 RECOMMENDATIONS

Each of the above projects provides examples that can improve the ecological function of NEFC while including human use and engaging in placemaking. By using these projects as models the City can achieve its green goals as identified from its policy framework and create a park of unprecedented ecological quality. This would contribute to Vancouver's current status as a model green city while addressing climate change and restoring species that were lost during False Creek's industrialization. Furthermore, new outdoor spaces for people would create opportunities for education, gathering, and interactions with nature.

Figure 49: A small inlet at Habitat Island: Grant Diamond

- At least one habitat island should be constructed offshore of NEFC to increase intertidal habitat at the site. This would build off the expertise gained from the success of Habitat Island at Southeast False Creek and the Living Breakwaters at Staten Island. Just one island could increase the length of shoreline by more than double and this number could be even higher by constructing more islands, a larger island, or an inlet at the current shoreline. Intertidal edge habitat is very productive ecologically and an increase in this habitat could be considered compensation for less productive shoreline in other areas of False Creek and be used as a model for further restoration projects. Islands can have varying degrees of access to ensure there is space for terrestrial habitat to be undisturbed.

Figure 50: Clupea pallasii (Pacific Herring): WikiCommons

- Pacific Herring should be targeted through educational programs and restoration activities that can be modeled after the Billion Oyster Project at Staten Island. Pacific Herring are a keystone species for the health of intertidal habitats and are a food source for marine mammals, birds, salmon, lingcod, and halibut (Hemmera Envirochem, 2015). Herring prefer to spawn on smooth, rigid substrates in sheltered intertidal and subtidal environments and this can be created through the cultivation of intertidal grasses, reed beds, and boulders with rockweed (Hemmera Envirochem, 2015). Volunteers with Squamish Streamkeepers and False Creek Watershed Society already successfully reintroduced herring in 2014 at Granville Island by wrapping creosote soaked pilings in fabric (Pynn, 2014). These organizations could be key stakeholders in the development of a larger more permanent Pacific Herring reintroduction program based at NEFC.

- An environmentally-focused fieldhouse should be constructed at the site to provide classroom and wetlab space for schools, interpretation, storage space for recreational activities such as dragon boating, and sustainable waste capture. This facility could be in a new building on site but Science World should be a first priority due to its proximity to the site and expertise in science education and outreach. Opportunities for cross-pollination would be encouraged if the fieldhouse is located at Science World and more area would be available for habitat at NEFC.

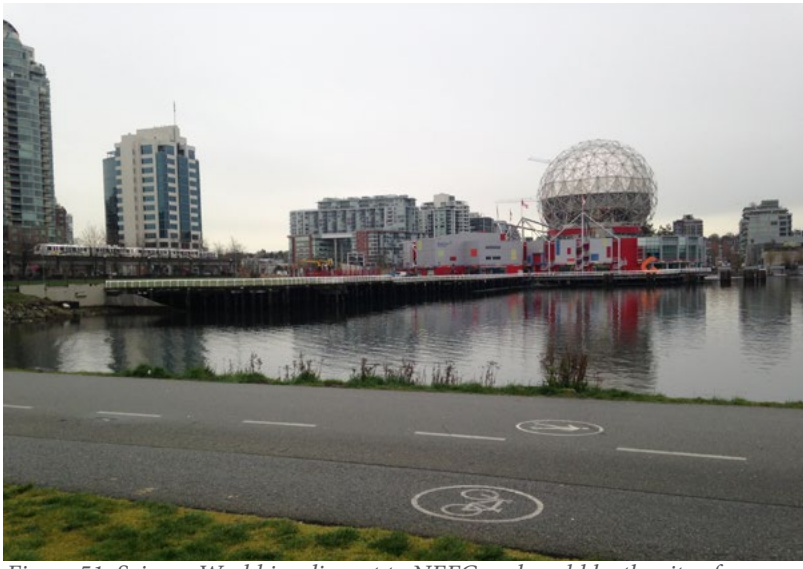


Figure 51: Science World is adjacent to NEFC and could be the site of an environmentally-focused field house: Grant Diamond

- Incorporate the Seawall with light penetrating surfaces over aquatic ecosystems and boardwalks through intertidal habitats. Light penetrating surfaces permit sunlight to penetrate aquatic habitat allowing fish to use habitat they would otherwise bypass to avoid predation if it is shaded. Boardwalks like the examples at de Ceuvel should be constructed over sensitive areas to allow people to enter and explore habitat without causing disturbances to species.

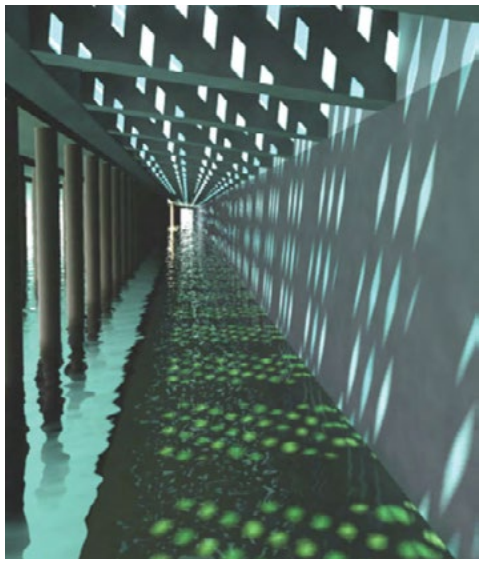


Figure 52: Beneath the light penetrating seawall: Waterfront Seattle

- Upland habitat should be extended to the Skytrain guideway and new Pacific Boulevard to encourage species diversity in the heart of downtown and encourage natural experiences for commuters on the Skytrain and new Pacific Boulevard. Many citizens will seek out natural experiences by visiting the park but others will avoid the site due to lack of interest or busy lifestyles; a condition of urban areas resulting in nature deficit disorder. By building natural experiences into the urban fabric of the city people can connect with nature when they may otherwise not.

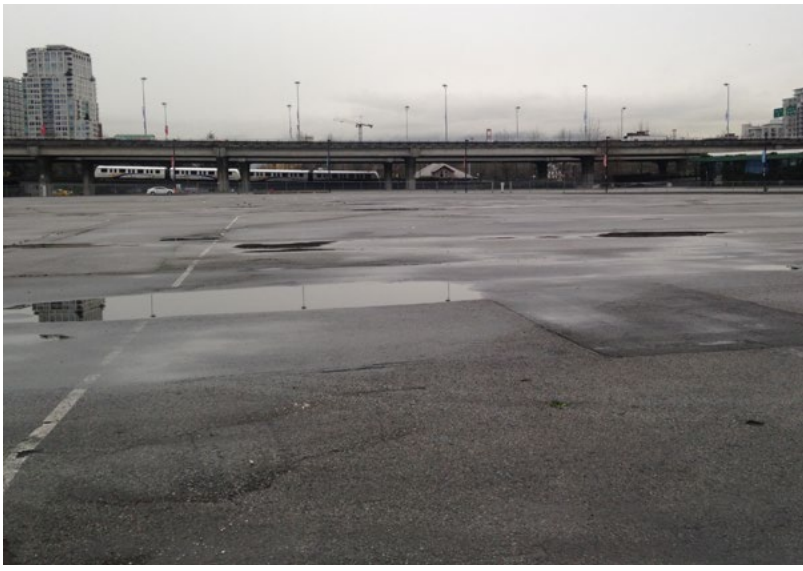


Figure 53: The Skytrain passes what could be future upland habitat at NEFC: Grant Diamond

Figure 54: Stakeholder engagement during de Ceuvel's design process: Metabolic

Figure 55: Dockside Green in Victoria features a large stormwater purification system: Grant Diamond

- Build flexibility into the design process and Terms of Reference to allow for the unanticipated and foster creativity. This came up in discussions with two interview participants as lessons learned from the Jericho Beach and de Ceuvel projects, respectively. During the Jericho project flexibility allowed for aspects of the design to be changed in the field such as tree placement or mound height (Mizrahi, personal communication, March 8, 2016). At de Ceuvel the sustainability and community aspects of the project came into being as the project evolved and not everyone who signed on at the beginning were onboard with the new philosophies (Monaghan, personal communication, February 24 2016). While this change was more fundamental than tree placement the participant recommended having stakeholders sign a "manifesto" early on to avoid this difficulty.

- Work with Concord Pacific to make the new neighbourhood west of the new park a model sustainable development. Cities must be the leaders of climate change mitigation and Vancouver is clearly motivated to do its part. The City should encourage Concord's new neighbourhood to be built to the highest sustainability standards and to take advantage of the park's proximity to build in connections between development and park infrastructure. For example, runoff can be directed to the park for storage and purification rather than into municipal infrastructure and park water could even be used as irrigation or toilet water. Dockside Green in Victoria provides good examples of how neighbourhood water features could run to the park. Habitat connections can be encouraged through building design and landscaping. Concord purchased the Expo land at a price that is considered a steal and has benefitted enormously from the growth of Vancouver. A world-class sustainable neighbourhood would allow Concord to showcase their commitment to the health of our city, its ecosystems, and citizens.

8 CONCLUSIONS

Figure 56: Access to Habitat Island: Grant Diamond

Figure 57: A winning submission from the City's re:CONNECT design competition featured marine grasses and shallows: Michael Jones, City of Vancouver (2012)

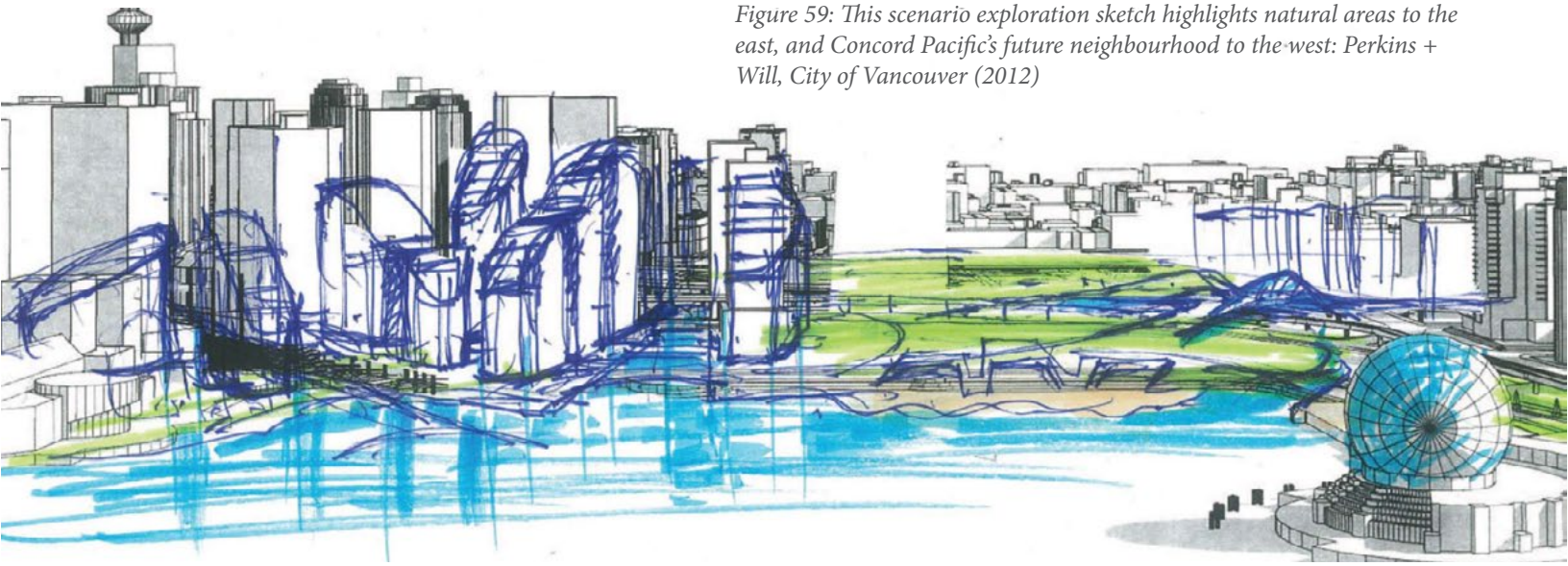
The City of Vancouver is now more than halfway toward its goal of becoming the greenest city in the world by 2020 and creativity and innovation are necessary to continue toward this goal. NEFC represents an unprecedented opportunity to create a productive intertidal habitat in the heart of the city and to engage in placemaking. This project is intended to provide the Park Board with an exploration of the options to improve the ecological function of the shoreline at NEFC by reviewing what efforts locally and in other cities have achieved. Given the urban context of NEFC, all these projects had a strong human dimension and may not necessarily look natural, such as Seattle's Seawall, but they improved ecological function in their cities.

The opportunities for NEFC are unique and each project outlined in this report has employed innovative solutions to improve their city's waterfront while addressing the fact that people must be included in their designs. In Seattle, a light penetrating seawall will connect citizens to the water while allowing salmon to once again migrate along the shoreline to the open Pacific. In Amsterdam, plants take up heavy metals and other pollutants while people sit on wharfs, enjoy local food and drink, and attend festivals, all while their waste is converted to nutrients. Productive intertidal habitat can be improved through the construction of one or more habitat islands with a species composition inspired by Hinge Park, Habitat Island, and Jericho Beach Park. Living Breakwaters and Habitat Island can inform the physical design through boulder placement, concrete forms, and sediment size. Human use can be accommodated by a Seawall inspired by Waterfront Seattle while boardwalks like at de Ceuvel can bring people safely into sensitive intertidal habitat. Stormwater can be captured and cleaned in bioswales while other wastes can be treated and nutrients extracted like at de Ceuvel. Community and environmental education can be achieved through an environmentally-focused fieldhouse like Living Breakwater's Waterhubs and a Pacific Herring restoration program similar to the Billion Oyster Project. It will not be feasible or resourceful to emulate every aspect of these precedents as the park must be context specific but a combination of what has been learned and an exploration of emerging design practices can achieve a unique and world-class park.

The key opportunity presented by NEFC is its tabula rasa status. The projects outlined in this report were constrained by their geography; in Seattle's case a new boulevard restricts upland habitat and the small footprint of de Ceuvel meant the site is compact (though the design and use take advantage of this). The NEFC park can take multiple forms due to its area that extends up to 220m to the Skytrain guideway. The shoreline's gradient can be decreased or moved inland and upland habitat can be expansive. This flexibility will allow Vancouver to create a unique park providing citizens and visitors the opportunity to connect with and learn from nature while building on the City's progress toward its Greenest City goal.

Figure 58: The site of future upland habitat, or perhaps a constructed inlet: Grant Diamond

Figure 59: This scenario exploration sketch highlights natural areas to the east, and Concord Pacific's future neighbourhood to the west: Perkins + Will, City of Vancouver (2012)



Opportunities for further research

- A design exercise using the above examples to create a rendering could explore how the features described in the precedents section could fit into NEFC.

- There are benefits that are harder to quantify and outside the scope of this project but warrant being mentioned. Biophillic response in cities is an emerging field of research that blends biopsychology and architecture by exploring how the built form of a city can generate responses akin to those we experience in nature . When human brains perceive a natural scene certain centres are activated resulting in lower stress levels. Imagine the cumulative effect of hundreds of thousands of commuters experiencing a biophillic response as they pass through NEFC on the Skytrain. A commuter train passing through a coastal ecosystem would be unprecedented in urban areas, would be emblematic of Vancouver's green goals, and could potentially have a measurable effect on the wellbeing of its citizens.

- Nature deficit disorder is an emerging area of study among urban populations, particularly children. By integrating nature with the city and encouraging children to interact with their environment through programs run out of the environmentally-focused fieldhouse, the City can ameliorate the effects of nature deficit disorder.

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