

# PITT MEADOWS ENVIRONMENTAL INVENTORY AND MANAGEMENT STRATEGY

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PREPARED AND REVIEWED BY

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**SUBMITTED TO** City of Pitt Meadows

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#### ACKNOWLEDGEMENTS AND FOREWORD

The Pitt Meadows Environmental Inventory and Management Strategy (EIMS) is the first of its kind, forming a foundation for moving the City through various growth phases in an environmentally sustainable and pragmatic way. The report benefited greatly by many thoughtful conversations with knowledgeable individuals, City staff, and diverse committees within the City of Pitt Meadows and Metro Vancouver, as listed in Appendix A – Engagement Summary. Each person and group whom we spoke with was knowledgeable and passionate about diverse natural assets within the City, their benefits, and current or future developmental pressures and stressors that could affect their sustainability. Many individuals also shared valuable insight about the management strategies needed to ensure that the City of Pitt Meadows retains the functional integrity of its natural assets.

This report also benefitted greatly from input from the citizens of Pitt Meadows, many of whom graciously took time out of their busy lives, during a global pandemic, to participate in the online engagement and mapping process. The voices of many within the community have contributed an important lens to this report. Zoetica especially thanks Colin O'Byrne and Alex Wallace from the City of Pitt Meadows, who provided feedback and input throughout the development of this report and preceding memos. And, to all of the important voices that were not able to engage during the difficult time period during which this study was conducted, we hope your voices will be integrated as this overarching plan becomes refined into focused directives.

The City of Pitt Meadows is a unique place within Metro Vancouver. It is endowed with a plethora of natural assets that provide vital functions needed by humans, animals, fish, plants, croplands, and invertebrates alike. Because these natural assets are existing components of the natural landscape or flora and fauna that inhabit it, they are often overlooked in planning. Yet, to engineer these functions, once lost, would cost millions if feasible. Natural assets within the City act naturally to reduce flood risk, store and distribute water for agriculture, improve water and air quality, improve human health, regulate air and water temperatures, reduce air pollution, limit erosion and washouts, absorb and store carbon, act as the stage for outdoor recreation, and provide habitat for species with intrinsic value and/or importance to humans (e.g., fish for fisheries, pollinators for agriculture, plants for harvesting).

The City of Pitt Meadows has many natural assets to showcase. Many of the assets in the City were found to have baseline values that are considered optimal on the international stage. Others can be improved to reach this goal if desired. The citizens of Pitt Meadows, along with the Mayor and Council, can be proud to call this unique local gem of a community "The Natural Place".

#### **LIMITATIONS**

Zoetica emphasizes that all recommendations included in this report may require additional considerations by City and Council that are over and above the scope of this project. Land ownership and jurisdiction issues, partnership opportunities, financial cost of implementation, and local resident and First Nations feedback will further inform the importance or feasibility of various recommendations made. Further, as additional information is collected over time, new and more pressing needs regarding the environment may emerge. Zoetica suggests that this document be used as a roadmap by the City, where the costs, benefits, and feasibility of implementing various recommendations are examined as they are unrolling, within the current context of an emerging City, and as feasibility and partnerships are further explored.

#### **GLOSSARY AND ABBREVIATIONS**

AAC Agricultural Advisory Committee

AEP Annual Exceedance Probability

ALR Agricultural Land Reserve

ALUI Agricultural Land Use Inventory

ARMS Alouette River Management Society

BCSEE British Columbia Species and Ecosystems Explorer

BMP Best Management Practice

CBI City Biodiversity Index (also known as the Singapore Index on Cities' Biodiversity; Chan

et al. 2014)

CDC British Columbia Conservation Data Centre

CE (City of Pitt Meadows' Draft OCP) Climate and Energy

COSEWIC Committee on the Status of Endangered Wildlife in Canada

DFO Fisheries and Oceans Canada

DPA Development Permit Area

eDNA Environmental DNA

EIMS Environmental Inventory and Management Strategy

ENA (City of Pitt Meadows' Draft OCP) Environment and Natural Areas

ESA Environmentally Sensitive Area – landscape element that is vital to the long-term

maintenance of biological diversity, soil, water, or other natural resources.

FLNRORD British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural

Development

GIN Green Infrastructure Network – connected system of natural areas and corridors that

provide important benefits to both people and wildlife.

GIS Geographic Information System

IAPP Invasive Alien Plant Program

ISCMV Invasive Species Council of Metro Vancouver

LS (City of Pitt Meadows' Draft OCP) Local Systems

MOE British Columbia Ministry of Environment

NLSA North Lougheed Study Area

NuSEDS New Salmon Escapement Database System

OCP Official Community Plan

PMEN Pitt Meadows Environmental Network

PR (City of Pitt Meadows' Draft OCP) Parks and Recreation

PRRG Pitt River Regional Greenway

QEP Qualified Environmental Professional

RAPR / RAR Riparian Areas Protection Regulation / Riparian Areas Regulation

ROW Right-of-way

SARA Federal Species at Risk Act

SCC Species of Conservation Concern — species that are Extirpated, Endangered,

Threatened, or of Special Concern provincially or federally. Can include mammals, fish, birds, reptiles, amphibians, insects, molluscs, vascular plants, mosses, and lichens.

SEI Sensitive Ecosystem Inventory

UFS Urban Forest Strategy

WMA Wildlife Management Area

Biodiversity The variability of life on earth and the habitats and ecological processes that support it.

Blue-listed A species of ecosystem is assigned to the Blue List by the CDC if its conservation status

rank is of Special Concern.

Blueway Trail corridor established on navigable waterways that permits use of non-motorized

watercraft (e.g., kayaks, canoes) and sometimes motorized vessels.

Conservation Unit A group of wild Pacific salmon sufficiently isolated from other groups that, if extirpated,

is very unlikely to recolonize naturally within an acceptable timeframe (e.g., human

lifetime, specific number of salmon generations).

Corridor A travel route that connects areas of plant and wildlife habitat and provides food,

shelter, and protection from predators for organisms.

Critical Habitat The habitat that is necessary for the survival or recovery of a listed wildlife species and

that is identified as the species' critical habitat in the recovery strategy or action plan for the species. The prohibition on destruction of critical habitat applies to Endangered

and Threatened species; species of Special Concern are not covered.

Ecosystem Services The variety of benefits that nature provides to people. Includes provisioning services

(e.g., food, water, raw materials, medicine), regulating services (e.g., shading, carbon sequestration, water filtration, erosion control), supporting services (e.g., nutrient cycling, soil formation, habitat for wildlife), and cultural services (e.g., recreation,

spirituality).

Endangered A species facing imminent extirpation or extinction, as designated by the BC Wildlife

Act and/or COSEWIC.

Extinct A species that no longer exists, as designated by COSEWIC.

Extirpated A species or ecological community that no longer exists in the wild in British Columbia,

but does occur elsewhere.

Freshet A sudden rise or overflow as a result of heavy rains or rapidly melting snow.

Green Infrastructure Includes natural assets such as forests, streams, and foreshores, and also the

engineered structures (e.g., bioswales, green roofs, constructed wetlands) that mimic

natural functions and processes.

Greenway Trail corridor established on land that has been reserved for recreation purposes (e.g.,

hiking, biking) and/or protection of natural habitat.

Habitat The environment (including air, soil, water, food, and cover) that a species lives in and

relies on, directly or indirectly, to carry out its life processes such as eating, staying safe

from predators, and reproducing.

Invasive Species Undesirable species, usually found in disturbed areas, that invade and replace native

species. Undesirable plants are typically weed species classified as noxious or restricted

by the Weed Control Act.

Metabarcoding DNA barcoding is a method of species identification using a short gene sequence.

Metabarcoding allows for simultaneous identification of multiple species within the same (environmental) sample by using a conserved gene sequence that is shared by

different species or species groups.

Native Species Species that naturally occur in an area. From the BC Wildlife Amendment Act 2004, a

species that is (a) indigenous to BC, or (b) has extended its range into BC from another part of North America, unless the species was introduced by human intervention or activities, or any part of the extension of its range within North America was aided by

human intervention or activities.

Natural Asset Natural assets include forests, streams, aquifers, soil, and other natural/environmental

features that provide beneficial ecosystem services to people through their natural

functions and processes.

Net Gain Improvement in ecological condition following restoration activities. Development

activities may require net gain provisions where natural areas lost during development must be compensated for at a specified ratio greater than 1:1 during subsequent

restoration.

Not at Risk A species that has been evaluated and found to be not at risk; as designated by

COSEWIC.

Noxious Weed From the BC Weed Control Act, a weed designated by regulation to be a noxious weed,

and includes the seeds of the noxious weed; specified in the Weed Control Regulation, Schedule A. Noxious weeds are typically non-native plants that have been introduced

to BC without insect predators and plant pathogens to keep them under control.

Phyto-remediation Treatment of contaminated areas (including soil, water, and air) using living plants.

Polygon A spatial unit that comprises relatively similar habitat and continuous habitat.

Recovery Strategy A document that outlines the overall scientific framework for species recovery. Recovery strategies may be mandated under the federal Species at Risk Act. Red-listed A species or ecosystem is assigned to the Red List by the CDC if it is at risk of being lost (conservation status rank of Extirpated, Endangered, or Threatened). Riparian Vegetated area along a stream edge that acts as a transition between the water and upland areas. Salmon Escapement Salmon escapement is the number of salmon "escaping" fisheries (i.e., not harvested) (Productivity) that return to each spawning watercourse. Also termed salmon productivity. Special Concern A species that may become Threatened or Endangered because of a combination of biological characteristics and identified threats, as designated by COSEWIC. Stream Under the BC Water Sustainability Act, a "stream" means: (a) a natural watercourse, including a natural glacier course, or a natural body of water, whether or not the stream channel of the stream has been modified, or (b) a natural source of water supply, including, without limitation, a lake, pond, river, creek, spring, ravine, gulch, wetland, or glacier, whether or not usually containing water, including ice, but does not include an aquifer. **Threatened** A species that is likely to become Endangered if nothing is done to reverse the factors leading to its extirpation or extinction, as designated by the BC Wildlife Act and/or COSEWIC. Urban Matrix The developed area (e.g., residential, commercial, industrial, agricultural) outside of the green infrastructure network; these areas may still include natural assets but typically these natural assets are not connected and exist at a smaller scale.

of being lost.

Yellow-listed

#### 1.0 PROJECT INTRODUCTION

The Environmental Inventory and Management Strategy (EIMS) is a starting point and framework for the inventory of natural assets, the valuation and weighing of those assets for prioritization purposes, and managing and monitoring those assets into the future. Natural assets are defined as naturally occurring living and non-living entities of the Earth, together comprising the bio-physical environment, which jointly deliver ecosystem services to benefit current and future generations. Ecosystem services, in turn, are any positive benefit that ecosystems or living creatures provide to people or other living creatures.

This report begins with a summary of stakeholder and public feedback supplied in response to our online engagement and videoconference meetings (Section 3.0). It is important that the EIMS reflects the values and interests of the constituents, alongside best practices and science. In some cases, feedback received about natural assets of importance dictated the types of data collected during field work, or the ways that maps and data were interpreted. This ensured that Zoetica focused the EIMS on natural assets of importance to the people of Pitt Meadows. Public and stakeholder feedback was invaluable in deciding the natural assets to map and assess, information gaps to fill during field work, and data gaps to recommend filling in the future. Feedback from engagement was also helpful in developing methodologies to assign relative values to different natural assets across the City, and for developing recommendations for managing them to benefit a wide array of stakeholder and public interests.

Following the summary of stakeholder and public feedback, Section 4.0 of the report presents the "natural asset inventory", which is a summary of existing natural assets, maps, information, and data collated from various sources, along with data that were collected and/or "mined" and analyzed by Zoetica. Each natural asset/habitat type is discussed in relation to features, quality, data collected, and uses. These data provide information to answer the first of the three overarching questions: "What natural assets does the City have?" In some cases, the collected data also enabled a quantitative or qualitative evaluation of the current condition of those assets. However, in other cases, the data were insufficient for enabling an evaluation of the present condition of the asset. In the latter cases, data deficiencies were noted, and the filling of those deficiencies were included in recommendations. The natural asset inventory provided in Section 4.0, along with information received from public and stakeholder engagement, were building blocks in the relative valuation and assessment of those assets, and developing recommendations on how best to manage them.

This report also includes analytical maps in Section 4.0 and Appendix F – Habitat Quality Assessment: Analytical Maps, which were developed to assist the City in interpreting the relative values of natural assets in an objective way. These analytical maps are meant to address the second of the three overarching questions: "What are the relative values of those natural assets?" These maps are meant to assist the City in making informed prioritization and trade-off decisions. To move from data maps to analytical maps, Zoetica applied transparent methodologies that are detailed in Appendix B – Habitat Quality Assessment and SEI Verification and Appendix C – 2020 Field Surveys and Desk-based Research. The ranking methods were first applied to layer-specific maps that focus on each attribute separately (e.g., which waterways should be the highest to lowest priority areas for the protection of spawning salmon, or which wetlands are priorities for conservation to prevent flooding) to create heat maps. However, in some cases, heat maps for various natural assets could be combined to provide a simplification of underlying complex information. This process was meant to assist the City in quickly identifying high priority areas that are particularly important relative to others, and to begin the process of prioritization. The assessed

information found within this section can be fed into a future revision of the Official Community Plan (OCP) and other plans and strategies (e.g., Parks, Recreation and Culture Master Plan, annual business planning, operational planning) to help integrate natural asset management more explicitly into the OCP.

Finally, the information from the natural asset inventory and valuation (Section 4.0) and stakeholder and community engagement (Section 3.0), including supplemental information in the appendices, are considered holistically when answering the third of the three overarching questions: "What do we do with these natural assets?" Section 5.0 provides recommendations for policies and actions that can be undertaken over the short-, medium-, and long-term to manage the natural assets and collect additional information to inform any future plans. Section 6.0 provides recommended indicators and monitoring benchmarks that will allow the City to measure their current and future success in reaching clearly laid out objectives. In many cases, these benchmarks are internationally recognized, which means that Pitt Meadows will be able to speak a language used by cities around the world, and will be able to measure the degree to which they are currently at or reaching their goal of being Metro Vancouver's "Natural Place".

The appendices of this report provide more detailed information about the desk-based and field-based work conducted by Zoetica for the EIMS project (**Table 1-1**). Several of these appendices were previously submitted as memoranda to the City of Pitt Meadows during the course of the project. Feedback from the City was incorporated into revisions and helped inform subsequent work conducted for the project. As the memoranda on *Potential Policies and* Actions and *Performance Indicators and Benchmarks* are integral to the EIMS, they have been included as Sections 5.0 and 6.0 of the main body of this report, respectively, but can be made available as standalone documents if requested.

**Table 1-1.** Memoranda and supplemental information included in this Pitt Meadows EIMS report.

Section/Appendix	Report/Memorandum Title
Section 5.0	EIMS Management Framework: Policy and Action Recommendations
Section 6.0	Monitoring: Performance Indicators and Benchmarks
Appendix A	Pitt Meadows EIMS – Engagement Summary
Appendix B	Pitt Meadows EIMS – Habitat Quality Assessment and SEI Verification
Appendix C	Pitt Meadows EIMS – 2020 Field Surveys and Desk-based Research
Appendix D	Pitt Meadows EIMS – Policy Summary and Gap Assessment
Appendix E	Pitt Meadows EIMS – Roles and Responsibilities for Implementation Framework
Appendix F	Habitat Quality Assessment: Analytical Maps
Appendix G	Matrix of Habitat Suitability for Species of Conservation Concern

#### 2.0 NATURAL ASSETS AND ECOSYSTEM SERVICES

This EIMS begins with a natural asset inventory, which provides an initial inventory of the key natural assets and values associated with nature and biodiversity that will require management as part of an environmentally-aware City planning process. The EIMS is considered 'a living document' and may require periodic updates and additions as more environmental data are collected to fill existing information gaps, and as more stakeholder, rights-holder, and public feedback is provided. Further, management plans such as those recommended as part of this EIMS may also change due to the implementation of adaptive management, where plans can be modified when they are not functioning as intended.

The benefits drawn from ecosystem services can be direct or indirect, small or large; these services are often overlooked or taken for granted, as they function naturally in the background without interference. However, as a city expands and the population grows, natural assets and the services they provide must be recognized, mapped, valued, and managed to prevent a decrease in the health and well-being of a community. The intrinsic loss of the natural feel of an area is difficult to undo, and the subsequent need for engineering to replace functions previously performed by nature is costly. For example, wetlands, vegetated and pervious/permeable surfaces, and agricultural land currently absorb rainwater, which is strongly increasing in volume during the winter months as a result of climate change. When such natural areas are paved over, there is less absorption and more surface water runoff that will require more stormwater infrastructure to compensate for that loss of ecosystem services.

The Millennium Ecosystem Assessment, a major United Nations-sponsored effort to analyze the impact of human actions on ecosystems and human well-being, identified four major categories of ecosystem services: provisioning, regulating, cultural, and supporting services.

- <u>Provisioning Services</u> include any type of tangible product that can be extracted from nature.
   Along with food, other types of provisioning services include drinking water, timber, agricultural products, wood fuel, natural gas, oils, plants that can be made into clothes and other materials, and medicinal benefits.
- <u>Regulating Services</u> are basic services that make life possible for people. For example, plants clean
  air and filter water, bacteria decompose wastes, bees pollinate flowers, and tree roots hold soil
  in place to prevent erosion. All these processes work together to make ecosystems clean,
  sustainable, functional, and resilient to change.
- <u>Cultural Services</u> are non-material benefits that contributes to the development and cultural advancement of people, including how ecosystems play a role in local, national, and global cultures; the building of knowledge and the spreading of ideas; creativity born from interactions with nature (music, art, architecture); and recreation.
- <u>Supporting Services</u> allow the Earth to sustain basic life forms, let alone whole ecosystems and people. Without supporting services, provisional, regulating, and cultural services would not exist. For example, ecosystems themselves could not be sustained without supporting services such as photosynthesis, nutrient cycling, the creation of soils, and the water cycle.

While there are many forms of green infrastructure that provide ecosystem services, including natural, enhanced, and engineered assets (**Figure 2-1**), the present study primarily focuses on the first of these, the natural assets. Enhanced and engineered assets are used to address some of the planned and unintended impacts of human habitation and activities. These assets are intended to help mitigate

undesirable impacts to natural assets and to preserve or restore the ecosystem functions and services that may be lost or altered. Certain enhanced assets such as urban trees/forests and urban parks were noted as valuable by stakeholders and the community for ecosystem connectivity and the ecosystem services that they provide. Therefore, these urban green spaces were also included in the EIMS project.



**Figure 2-1.** The relationship of natural assets, enhanced assets, and engineered assets as green infrastructure. Reproduced from Municipal Natural Assets & Initiative, 2019.

At the broadest level, the EIMS seeks to explore and answer three key questions regarding natural assets:

- 1. What natural assets does the City of Pitt Meadows have and what is their condition? (i.e., the inventory)
- 2. What are the relative values of those natural assets? (i.e., establishing relative values of those assets, where possible, to assist in prioritization and planning decisions)
- 3. What do we do with these natural assets? (i.e., how to we plan for, manage, and monitor natural assets over time?)

As the City of Pitt Meadows grows in population, it will face difficult planning decisions with potentially far-reaching and long-lasting consequences. The current report is a first product to lay the framework for moving the City through various short-, medium-, and long-term goals related to natural asset management to realize and maintain the goal of being Pitt Meadows, "The Natural Place".

#### 3.0 SUMMARY OF STAKEHOLDER AND COMMUNITY ENGAGEMENT

Wherever possible, there was an attempt to integrate community and focus group feedback into the EIMS. The full report summarizing stakeholder and community engagement, including groups contacted, methods, questions asked, and feedback received, is provided in Appendix A – Engagement Summary, which should be read for a more complete understanding of methods, participation levels, feedback, and context. Engagement results highlighted in this current section of this report are based on: 1. Feedback from a focus group with particular investments, interests, and specialized knowledge for informing the EIMS (see Appendix A – Engagement Summary); and 2. Feedback from the general public. Due to COVID-19 coinciding with this project, engagement had to be modified to use online questionnaires and phone or videoconference meetings. Key concepts of "what we heard" are highlighted below.

As rights-holders with their traditional territory encompassing Pitt Meadows, Katzie First Nation was invited to participate but were unable to at the time the EIMS study was conducted. Therefore, the City will look for future opportunities to engage with Katzie First Nation on natural assets and management strategies.

#### 1. Ecosystem services are of primary importance

The most frequently expressed topics among focus group respondents, as well as community members, were regarding ecosystem services. Ecosystem services refer to the 'free' values and functions that healthy ecosystems provide; these include regulating, provisioning, supporting, and cultural services. Many of these ecosystem services were noted as beneficial to agricultural landowners, including drainage, irrigation, soils, and habitat for pollinators and beneficial insects. Urban trees/forests and riparian areas, which provide a variety of ecosystem services, were commonly mentioned as important natural assets. The community recognized these functions as well as the services that support habitat for fish and wildlife, and recreation; in particular, the importance of salmon and their habitat (including migration routes) were specifically and repeatedly mentioned by community respondents. The next most frequently expressed concepts were about riparian areas and urban trees/forests. Protection, restoration, and/or enhancement of these natural assets are linked to the regulating and supporting services that they provide to the City's residents and biodiversity.

Zoetica has highlighted these ecosystem services provided by various natural assets in Sections 4.1 through 4.5.

#### 2. Aquatic, riparian, and urban forest assets are particularly valued

The Pitt-Addington Marsh area (including Pitt Polder Ecological Reserve) was arguably the most highly regarded natural asset in its present state; as such, it is recommended for protection<sup>1</sup> and restoration/enhancement by the community. Hoffmann Park, a mature, urban forest in the heart of Pitt Meadows, was frequently mentioned by the community as one of the most valuable assets in Pitt Meadows and a popular spot to visit. Urban forests and green spaces were ranked among the most at risk and degraded habitats (generally due to development and invasive species), and they also have the

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<sup>&</sup>lt;sup>1</sup> The Pitt-Addington Marsh area is already protected by more than one provincial authority (see Section 4.4.1 and **Figure 4-30**). Zoetica interprets the community feedback to mean that the area should continue to be protected from disruptive activities and not opened up for development in the future. However, further engagement may identify specific concerns.

potential to harbour species of conservation concern (SCC). As such, urban forests/green spaces are ranked as high priority for protection and restoration/enhancement. Two community members mentioned natural assets that were technically outside of the City boundaries: Blaney Bog Reserve (City of Maple Ridge), Douglas Island (City of Port Coquitlam), and Widgeon Creek (Electoral Area A). Blaney Bog was noted as providing water storage and flood protection for farmers, and all three locations were identified as important nesting habitat for sandhill cranes.

Phone meetings were conducted with representatives from the City of Pitt Meadows and Metro Vancouver. The City noted the importance of agriculture, vegetated boulevards, urban and rural forests, riparian areas, and watercourses. Metro Vancouver emphasized the importance of ecosystem connectivity and described their proposed vision for the Codd Wetland Ecological Conservancy Area and surrounding wetlands, and extension of the Pitt River Regional Greenway (PRRG) with other connecting greenways. Metro Vancouver also recommends increasing riparian buffer widths, wherever possible.

Community responses about prioritizing environmental protection and stewardship included preserving wetlands, waterways, and associated biodiversity. One survey respondent recommended working with Katzie First Nation to rehabilitate wetlands. The City should continue to reach out for meaningful discussions and explore collaborative opportunities with Katzie First Nation as environmental planning and implementation move forward.

#### 3. Rare species and key biodiversity groups are valued and need protection

Species of conservation (or other) concern, as noted by focus group respondents, included sandhill crane, great blue heron, bald eagle, painted turtle, western toad, red-legged frog, and Pacific water shrew. Focus group members also noted bears and salmon (as keystone species) and general species groups such as migratory birds, owls and raptors, and native fish and invertebrates. Species of conservation (or other) concern, as noted by the community, include Pacific salmon, white sturgeon, eulachon, steelhead, barn swallow, common nighthawk, red-tailed hawk, sandhill crane, bald eagle, and great blue heron.

Due to the importance of rare bird and aquatic species expressed by the community and focus groups, as well as an interest in general species groups and salmon, Zoetica included bird surveys and aquatic sampling for environmental DNA (eDNA) in their field program.

The results of these bird and eDNA surveys, which include rare (and common) species and salmon detected, are found in Section 4.5 and Appendix C – 2020 Field Surveys and Desk-based Research of this report.

Due to the importance of salmon, which were mentioned repeatedly by community members and focus group members, Zoetica conducted an analysis of the New Salmon Escapement Database System (NuSEDS) data (historical data from 1938-2017, provided by Fisheries and Oceans Canada (DFO), and quality control corrected through a collaboration between Tracy Cone of DFO and Zoetica) to create maps of average relative salmon numbers during spawning over a wide temporal lens.

Maps produced are included in Section 4.1.2.2 and Appendix C-2020 Field Surveys and Desk-based Research, and represent the potential value of various systems that flow through Pitt Meadows.

#### 4. The Katzie Slough and Alouette River need management attention

The Katzie Slough and Alouette River ranked highest in terms of management priorities. For these waterways, focus group respondents were referring to both the watercourse (wetted area) and surrounding riparian areas — these habitat types were noted as high priority for protection, restoration, and/or enhancements. These systems were also noted during responses about invasive species, with a specific concern about the overgrowth of parrot's feather in the Katzie Slough, among other invasive species invading the shorelines of these water features. Representatives from the Pitt Meadows Environmental Network (PMEN) emphasized the importance of the Katzie Slough as (historical) salmon rearing and wintering habitat, and their desire for fish-friendly pumps, clean-up efforts (for invasive species such as parrot's feather) to improve water flow, and restoration plantings to provide shade. While the Katzie Slough was not as frequently mentioned by the community, community members recognized its degraded state and potential value.

Sloughs and rivers are discussed in Sections 4.1.1.3 and 4.1.1.4. Values related to rivers, sloughs and other water features are evaluated in Section 4.1.2; specifically, relative values of waterways for salmon are evaluated in Section 4.1.2.2.

#### 5. Invasive species are degrading natural areas

Invasive species repeatedly mentioned as management priorities included: parrot's feather, Japanese knotweed, Himalayan blackberry, policeman's helmet, and purple loosestrife, all of which are also considered priority species by Metro Vancouver. Other invasive species noted include reed canarygrass (which is prevalent along the City's watercourses), Scotch broom, largemouth and smallmouth bass, green frog, and American bullfrog. Only one community participant responded to the mapping question about invasive species and noted the abundance of parrot's feather in the Katzie Slough. Although the City of Pitt Meadows does not currently have an invasive species management strategy, City staff undertake efforts to control invasive species and also complete native planting/replanting projects throughout Pitt Meadows.

Due to their recognized importance, Zoetica recorded invasive plant species during a habitat quality assessment used to field check and verify Metro Vancouver's Sensitive Ecosystem Inventory (SEI), analyzed invasive aquatic species presence from eDNA data, and recorded other incidental observations of invasive species in the field.

Methods and results with respect to invasive species are included in Section 4.5, Appendix B – Habitat Quality Assessment and SEI Verification, and Appendix C – 2020 Field Surveys and Desk-based Research.

#### 6. Community members make frequent use of natural areas

Community respondents indicated that they make use of the City's parks, trails, and open spaces at least once a week or daily. The most common activities noted by respondents include nature appreciation, biking, and dog walking. Most respondents either agreed or strongly agreed to the statement that "the City's parks, trails, and open spaces provide sufficient opportunities for nature appreciation"; however, seven community members disagreed (8%), and one strongly disagreed (1%). From the community's perspective, the most valued feature of the City's existing natural assets is related to accessibility (convenience and walkability), especially the dike trails along various riverfronts. Many respondents also

mentioned the value of farmland, open spaces, and the "rural feel" of Pitt Meadows. Overall, community responses emphasized various cultural services that the City's natural assets provide.

#### 7. Community members are concerned about water quality

Many community respondents had concerns about pesticide and herbicide use, especially on blueberry farms, and their effects on human health and biodiversity. Comments included banning, regulating, restricting, and controlling the use of toxic pesticides, herbicides, and fungicides; and promoting ecofriendly alternatives such as biological control and companion farming<sup>2</sup>. The City of Pitt Meadows has indicated that any such measures would require consultation with the agricultural sector to assess the feasibility of shifting to alternative measures.

During conversations with multiple focus group members, water quality issues were discussed in the context of a degraded ecosystem. Linkages were made between water quality (including increasing water temperature, decreased flow rates/stagnation, decreased oxygen, and urban and agricultural runoff) and the propagation of parrot's feather and other invasive species over native species. It was noted that annual removal of invasive plant species would need to go on into perpetuity (and would be expensive); instead (or alongside this practice for a time), various focus group members emphasized long-term solutions, such as riparian tree planting to provide for shading of water (to buffer against water temperature spikes), encouraging flow (such that water remains well-oxygenated), and preventing runoff and nutrient inputs such that native species can be re-established. These restoration activities would decrease the need for frequent invasive species management activities.

Zoetica was contacted by email by an individual who expressed concerns about potential groundwater quality impacts from lead-based ammunition (since banned from use) previously used at the Pitt Meadows Gun Club. Zoetica also received a phone call from a member of the gun club, emphasizing the green space and wildlife habitat provided by the club. As contamination concerns are provincially regulated, considerations of the gun club's impacts and benefits were determined by the City of Pitt Meadows to be out of scope for the present EIMS project. However, recommendations for water quality sampling on City-owned land (see Section 5.0), if implemented, may help to resolve whether there are impacts to surface water and/or groundwater.

#### 8. People have ideas for managing natural assets

Tax incentives (or other incentive programs) were recognized as one of the most effective means of encouraging private landowners to take positive environmental actions. Tree retention and protection, which can be promoted/legislated through development of a tree bylaw<sup>3</sup>, was noted as important by both the community and focus group respondents.

The most important way that the City could encourage private landowners to increase biodiversity, as identified by both focus group respondents and the community, is to provide public education and resources. Educational topics noted include preferred plantings (trees, native species, pollinator- and wildlife-friendly species), invasive species and their negative impacts on ecosystem health and

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<sup>&</sup>lt;sup>2</sup> Companion farming/planting is a gardening strategy that maximizes growth and crops by planting mutually beneficial plants next to each other. This strategy aids in pest control and pollination, provides habitat for beneficial insects, maximizes the use of space, and increases crop productivity.

<sup>&</sup>lt;sup>3</sup> At the time of writing, the City of Pitt Meadows has planned to develop a tree protection bylaw.

biodiversity, benefits and values of biodiversity, and how to grow a home garden. Two community respondents suggested demonstration areas to showcase native plants and regenerative farming<sup>4</sup>. Some respondents also recommended removing or discouraging grass lawns.

Focus group respondents recommended a few additional ways to increase biodiversity on private lands, including protection of (critical) habitat for SCC and minimizing excessive noise and light pollution/disturbance. For all recommended actions, focus group members consistently discussed working with and supporting landowners, such as through incentives, project funding, and connecting landowners with supportive organizations (e.g., Farmland Advantage).

Focus group members noted a few additional mitigation options, including moving certain dikes to create new off-channel habitat to increase flood capacity and fish and wildlife habitat, maintaining trees on steep slopes to improve stability during extreme weather events, and the City working together with other municipalities to improve ecosystem connectivity through a regional green infrastructure network (GIN). The benefits of climate change adaptation/mitigation can be maximized by connecting green infrastructure (natural, enhanced, and engineered assets) within and across municipal boundaries.

Many community responses were about maintaining and improving the City's existing natural and built assets, including green spaces, parks, planted trees, trails, playgrounds, and sports fields. Recommended upgrades include more and bear-proof garbage cans in populated/popular areas, washrooms, seating and lighting, and general improvements. The need for monitoring and enforcement of existing bylaws, to preserve the enjoyment of natural assets, was also commonly expressed as a concern by the community. These comments were related to bylaws outlining dog control (no. 2735), traffic (no. 2260), property maintenance (no. 1400), and nuisance abatement (no. 2739), as well as City policies regarding illegal dumping and littering. In addition to controlling industrial/quarry truck speed for cyclist and pedestrian safety, a few participants recommended additional single- or multi-use trails along popularly used roads (e.g., south of Lougheed from Baynes to Kennedy).

#### 9. People have concerns about developments impacting natural assets

One of the biggest concerns expressed by community respondents is large developments (e.g., warehouses, townhouse complexes, and high-rises) that are being planned for areas that currently support trees and wildlife. Specific locations of concern include the forested area within the North Lougheed Study Area (NLSA)<sup>5</sup>, Airport Way, Pitt Meadows Community Garden and surrounding natural area, and Baynes Road Study Area.

The PMEN is particularly concerned about increased flooding due to development, noting that previous developments in Hammond Hill (near Meadowtown Shopping Centre) may have resulted in increased runoff and flooding in nearby residential areas. As such, the PMEN recommends protecting wetlands to serve as flood buffers and raising public awareness about the importance of wetlands. The PMEN is also

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<sup>&</sup>lt;sup>4</sup> Regenerative farming/agriculture refers to farming and grazing practices that mitigate against climate change by rebuilding soil organic matter and restoring degraded soil biodiversity. These practices help improve the water cycle and contribute to carbon sequestration.

<sup>&</sup>lt;sup>5</sup> The NLSA is located on the north side of the Lougheed Highway between Meadow Gardens Golf Club and Harris Road and is the site of a proposed mixed-use community development: <a href="https://www.pittmeadows.ca/our-community/city-planning-projects/north-lougheed-area-plan-nlap">https://www.pittmeadows.ca/our-community/city-planning-projects/north-lougheed-area-plan-nlap</a>. The remnant patch of mature coniferous forest occurs in the southeast corner of the NLSA.

concerned about the proposed development projects in the NLSA and the Harris Road underpass (next to Hoffmann Park) – both of which could impact two of the remaining mature forest stands within the City's population centre. Although the Harris Road underpass is not expected to directly impact Hoffmann Park, and will instead potentially impact an adjacent parcel of land to Hoffmann Park, the public may not distinguish between these land parcels and perceive that construction activities may result in direct or indirect impacts (e.g., sensory disturbance) for humans and wildlife using the park.

In light of these concerns, and to assist the City in determining natural assets in various areas that should be slated for development versus conserved or perhaps improved in some way, Zoetica conducted a field- and desk-based habitat quality assessment to compare the relative values of areas for performing various functions; mapping results are presented in Section 4.2.2 and Appendix F – Habitat Quality Assessment: Analytical Maps. The Habitat Quality Assessment methodology is presented in Appendix B – Habitat Quality Assessment and SEI Verification.

#### 10. Climate change requires more environmental planning

Both community and focus group respondents expressed that the City of Pitt Meadows needs to improve its planning for climate change impacts. Examples of City planning responsibilities include emergency preparedness, integrated stormwater management, climate action, greenhouse gas (GHG) emissions targets, budgeting and investing in flood infrastructure, setting development requirements, urban forest management, and an agricultural plan. Suggestions from the community for development requirements included tree retention, sustainable long-term plantings, drainage, rainwater infiltration and management, green spaces, grey water re-use, and other eco-friendly options. As part of the EIMS study, Zoetica also reviewed existing City policies and identified gaps that can be filled to improve environmental management and sustainability (Appendix D – Policy Summary and Gap Assessment).

With respect to climate change mitigation and resilience planning, the most frequent community comment was about upgrading and maintaining the dikes, pump stations, and drainage ditches. These comments relate to the susceptibility of Pitt Meadows to climate change induced flooding, *which is a focus of Section 4.1.2.1 of the EIMS*. A few community and focus group respondents also encouraged installing fish-friendly pump stations when pump station upgrades are done. (Note: alternative engineering measures may also be available to facilitate fish access to/from the drainage network.) Other methods to reduce flood risk were also commonly noted, including adding more permeable surfaces/green infrastructure for stormwater management (e.g., green roofs, rain gardens, bioswales, and planted boulevards, as well as roof leader disconnection), building codes to stop development on floodplains (and diversion/destruction of sloughs/wetlands and ditches), and managing/enhancing riparian areas and wetlands. There are existing policies to address some of these concerns, including the provincial Riparian Areas Protection Regulation (RAPR) and the City's Floodplain Designation and Construction Control Bylaw, Subdivision Servicing Bylaw (see Appendix D – Policy Summary and Gap Assessment).

Urban and rural forests, though brought up in the context of several topics, also provide a range of ecosystem services, one of which is their important role in providing climate resilience (e.g., carbon storage and sequestration, shading to buffer against increasing temperatures, holding soil in place to protect against flood-induced washouts and erosion and wind-induced loss of soils). Retention and planting of trees were noted by both the community and focus group members for the purposes of climate change resilience.

## 11. Members of the agricultural community value and need healthy ecosystem services but do not want the ALR to be used for purposes other than farming, and are concerned about measures that may further impact the viability of agriculture

For an agricultural perspective on the EIMS, phone meetings were conducted with the Pitt Meadows Agricultural Advisory Committee (AAC) and a representative from the BC Ministry of Agriculture. There was a strong opinion, from both members of the AAC and the community, that the Agricultural Land Reserve (ALR) should only be used for farming. The AAC highlighted the unique soil and soil structure of the region as an important natural asset of value for crop production. Additional priorities noted by the AAC included protection of waterways (quantity and quality of water for irrigation) and flood management (dike system and pump upgrades).

Many AAC members are concerned about invasive aquatic plant species (e.g., parrot's feather) clogging up drainage and water access – the health of Pitt Meadows waterways is a shared concern of all focus group members and should be considered a management priority by the City. Members discussed existing efforts made by agricultural landowners to encourage biodiversity (e.g., promoting birds, which in turn control insect pests) and potential future efforts that the City could undertake, such as planting wildflower and natural meadows on City land (without removing farmland from the ALR). Some members of the AAC thought of the promotion of biodiversity as a trade-off, as they lose crops to birds and wildlife; although they recognize the value of biodiversity and were willing to accommodate more if they were subsidized in some way for their crop and productivity losses. Zoetica also heard that farmers generally support environmental measures such as carbon sinks, wildlife corridors, and pollinator strips, provided that they do not negatively impact the economics of farming.

A major topic of discussion during the AAC meeting was about conflicts between agricultural viability, practices, and wildlife. Many AAC members noted conflicts with bears and waterfowl eating their berries and crops. Focus group members also noted conflicting needs between farmers and wildlife habitat with respect to waterways. From conversations with various focus group members (including the AAC), one of the main conflicts is about the extra regulations (e.g., habitat protection) regarding salmon habitat. The presence of salmon limits agricultural activities within areas adjacent to salmon-bearing waterways. Beaver management appears to be a controversial topic – the PMEN criticized the current beaver management and trapping practices used by the City and spoke about the value of beavers as ecosystem engineers, creating biodiverse wetland habitat. However, the AAC noted that beavers are detrimental for agriculture as they build dams and decrease water flow in rivers/sloughs, and they forage on trees on tree farms.

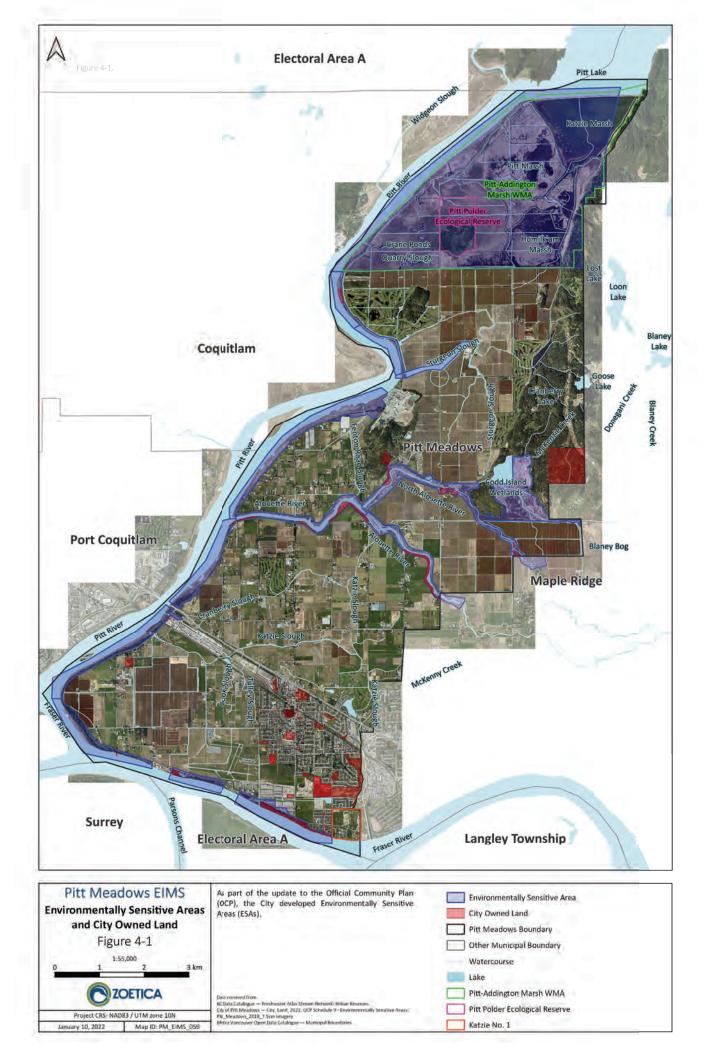
The AAC also noted conflicts with other humans, including people trespassing on private agricultural property for recreation or hunting and illegally dumping/littering on farmland (including shotgun shells), which can impact food safety. The AAC and the BC Ministry of Agriculture recommended more public education to showcase the values and services provided by farms and farmers in the region (including the ways in which farmers promote biodiversity) and to clear up misconceptions about agricultural practices. The BC Ministry of Agriculture also suggested that the City could improve the 'red tape' for farmers and save them time and money by devoting resources (website, knowledgeable liaison, funds collected from fines on polluters) for helping farmers to efficiently move through both provincial and local application processes for environmental permits.

#### 4.0 NATURAL ASSET INVENTORY

Prior to the EIMS project, information about valued natural assets within the City of Pitt Meadows was relatively limited. The City's draft 2020 OCP includes a map of Environmentally Sensitive Areas (ESAs), which is a useful starting point for making management decisions. According to the draft OCP, ESAs include wildlife habitat areas, steep slopes, wetlands, and prime agricultural lands, all of which provide a variety of ecosystem services that benefit wildlife, farmers, businesses, and Pitt Meadows residents. As shown in **Figure 4-1**, the mapped ESAs primarily include waterways, riparian areas, and wetlands. Some of these areas are protected under municipal, regional, and/or provincial regulations. BC Parks and Metro Vancouver manage the Pitt-Addington Marsh area, and Metro Vancouver also manages the Codd Wetland Ecological Conservancy Area and the PRRG. The City currently owns only a small proportion of the mapped ESAs, including disconnected patches of riparian habitat along the Alouette, Fraser, and Pitt rivers. The remaining ESAs are on private land and environmental protections for these areas may be limited at present; however, draft Development Permit Areas (DPAs) for the Natural Environment and Riparian Areas are proposed for the City of Pitt Meadows (see Appendix D – Policy Summary and Gap Assessment).

The natural asset inventory and valuation component of the EIMS project aimed to provide more detailed information about habitats of importance to biodiversity and the community within these ESAs, and to identify areas of importance for protection, enhancement, or restoration that are not captured within the current ESA dataset. Mapping of natural areas began with the use of the Sensitive Ecosystem Inventory (SEI) from Metro Vancouver, which was refined to encompass additional areas within the City. The minimum polygon size used by Metro Vancouver overall was 0.5 ha, except for young forest class (1.0 ha), old field class (2.5 ha), and mature forest class (5.0 ha); and for regional parks where smaller polygons were already mapped (Meidinger *et al.* 2014). As Metro Vancouver's SEI data consisted only of natural habitat types, polygons were also created for semi-natural, vegetated areas that could still have value for moderating ecosystem functions, such as farms and manicured parks. Semi-natural areas add environmental value to the City and their loss could have negative environmental consequences to surrounding areas (e.g., such areas host ground surfaces that absorb rainwater). Finally, predominantly built polygons were classified as urban and were not considered in the EIMS natural asset inventory.

Within each habitat type, polygons were assigned to a habitat class and subclass(es). For the purposes of this report, only the dominant subclass is described and presented on maps. For example, a patch of mature coniferous forest, such as Hoffmann Park, was classified as natural (type), mature forest (class), coniferous (subclass). Another urban park with fewer trees, such as North Bonson Park, was classified as semi-natural (type), park (class), sports field (subclass). Further details about polygon classification and mapping are presented in Appendix B – Habitat Quality Assessment and SEI Verification.



The resulting map of natural, semi-natural, and built polygons is shown in **Figure 4-2**. The proportion of each habitat class within the City of Pitt Meadows overall, and the proportion of the habitat amongst all natural habitat types (i.e., rarity), are shown in **Table 4-1**. Refer to the report section indicated in the table for more details on the inventory and value(s) of each habitat class. Management recommendations for these natural assets are found in Section 5.0, and performance indicators and benchmarks for recommended monitoring programs are found in Section 6.0.

**Table 4-1.** Types and amounts of habitat classes within the City of Pitt Meadows. Original data from Metro Vancouver SEI, updated by Zoetica through interpretation of satellite imagery and field verification.

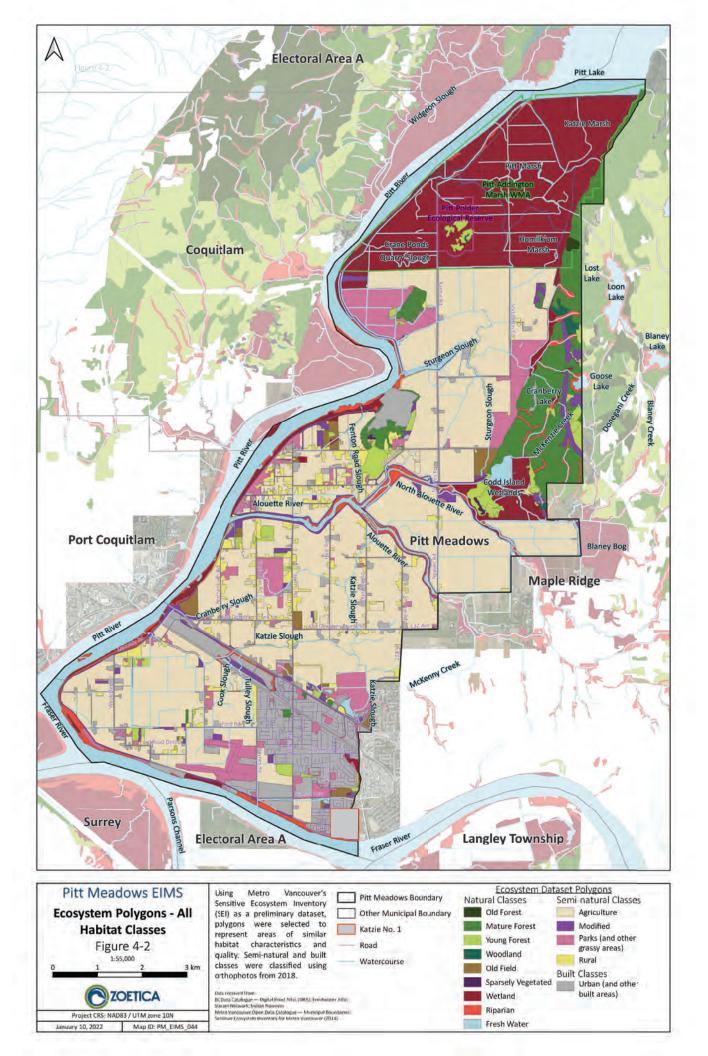
Habitat Type	Habitat Class	Area (ha)	% of City (Land and Water)	% of Natural Habitat (Rarity)	Details about Inventory and Values
Semi-natural	Agriculture	3830.0	39.6%	-	Section 4.3
Natural	Wetland	1624.4	16.8%	44.6%	Section 4.1
Natural	Riparian <sup>1</sup>	1034.4	10.7%	28.4%	Section 4.1
Built	Urban	1023.9	10.6%	-	-
Semi-natural	Park	557.8	5.8%		Section 4.4
Natural	Mature Forest	528.1	5.5%	14.5%	Section 4.2
Semi-natural	Modified <sup>2</sup>	349.3	3.6%	-	-
Semi-natural	Rural	287.2	3.0%	-	-
Natural	Young Forest	202.3	2.1%	5.6%	Section 4.2
Natural/ Semi-natural	Fresh Water <sup>1</sup>	118.5	1.2%	3.3%	Section 4.1
Natural	Old Field	84.3	0.9%	2.3%	Section 4.2
Natural	Woodland	19.7	0.2%	0.5%	Section 4.2
Natural	Old Forest	7.9	0.1%	0.2%	Section 4.2
Natural	Sparsely Vegetated	4.4	0.05%	0.1%	Section 4.2

<sup>&</sup>lt;sup>1</sup> In the SEI data, Fresh Water habitats refer only to lakes and ponds and do not include watercourses. River is a subclass within the Riparian class; of the 1,034.4 ha of Riparian habitats, watercourses encompass 792.0 ha (76.6%). An additional Fresh Water subclass was created for reservoirs (semi-natural).

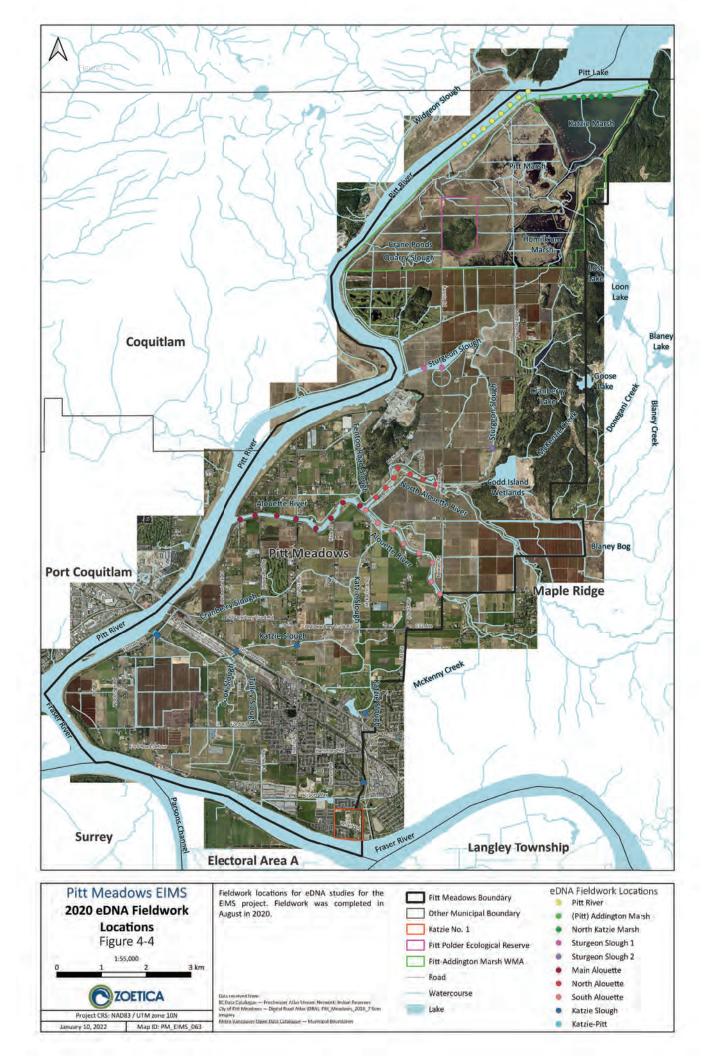
This ecosystem mapping exercise informed site selection for the 2020 field surveys conducted for the EIMS project (see Appendix C – 2020 Field Surveys and Desk-based Research). The field survey locations for habitat quality assessments and breeding bird surveys are shown in **Figure 4-3**, and the eDNA sampling locations are shown in **Figure 4-4**. Desk-based research and field survey results will be summarized for each natural asset described in the following sections of this report (Sections 4.1 through 4.5), as applicable.

All spatial files for the EIMS project have been supplied to the City for use in GIS software; this will allow the City to complete further GIS analysis and create detailed maps of targeted areas.

<sup>&</sup>lt;sup>2</sup> Modified habitats refer to previously disturbed/modified areas that have since regenerated and are not actively maintained, such as empty lots. Modified and Rural habitats are not described in detail as natural assets in this report, but were included in the ecosystem rankings described in Section 4.2.2.3.







#### 4.1 Aquatic, Wetland, and Riparian Habitats

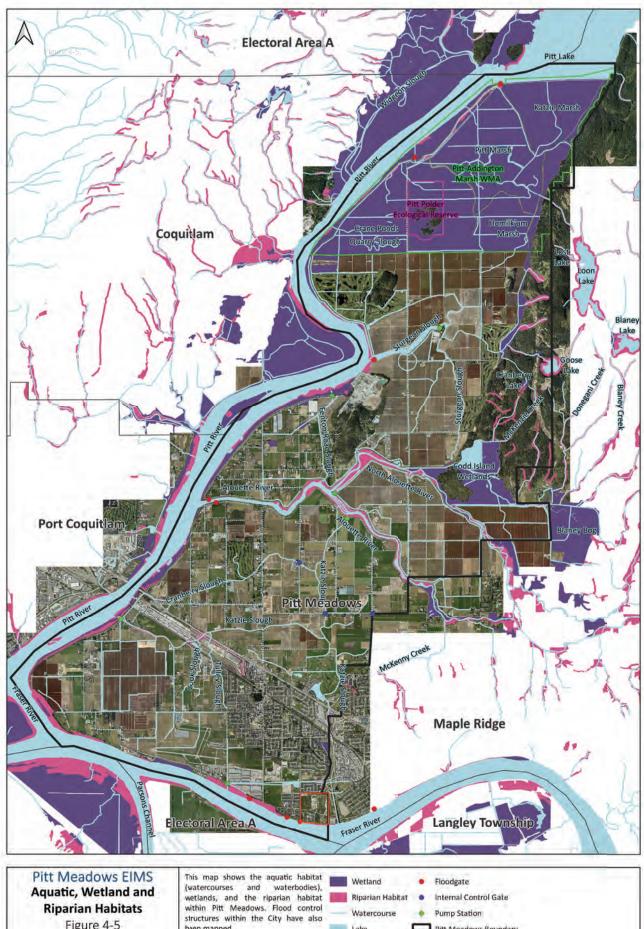
#### 4.1.1 Inventory of Aquatic, Wetland, and Riparian Habitats

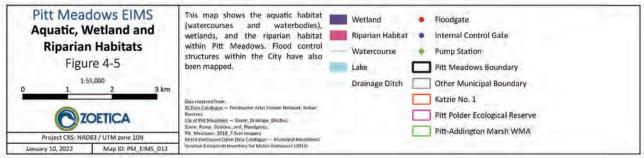
The City of Pitt Meadows is endowed with many important aquatic habitats and waterfront vistas. As shown in **Table 4-1**, wetlands are the second most prevalent habitat class, in terms of area, in Pitt Meadows (1,624 ha, 16.8% of the City). Riparian areas and watercourses comprise the third largest area at 1,034.4 ha (10.7%). Other natural and semi-natural fresh water habitats (e.g., lakes, ponds, reservoirs) make up 118.5 ha (1.2%) of the City. **Figure 4-5** provides a map of major aquatic systems and riparian areas within and abutting Pitt Meadows. These systems are extremely important to the surface hydrology and water storage capacity of Pitt Meadows. They act to increase the City's resilience to floods and decrease the damage caused by floods, which will be increasingly important given the increased flood risks associated with future climate change scenarios (Fraser Basin Council 2019).

Aquatic systems, alongside with their streamside vegetation, provide important habitat for many fish, birds, wildlife, and invertebrate species. Our analysis indicates that some of the existing aquatic habitat in Pitt Meadows is among the most important in Metro Vancouver for many species (see Section 4.1.2.2 and Appendix C – 2020 Field Surveys and Desk-based Research).

Aquatic systems such as watercourses are also often coupled with various recreational or land uses by humans, as people walk along streamside paths, ride horses along the dikes, or kayak along the rivers. These surface water systems also provide a critical resource for agriculture in the region by storing and distributing water for irrigation throughout the year. Often, the width of the vegetation adjacent to these waterways is paramount in ensuring that water is clean, oxygenated, and protected from heavy sedimentation.

There are four performance indicators associated with three management objectives (ENA 8.9.3, LS 6.7.1, ENA 8.1.1) related to aquatic, wetland, and riparian habitats that are recommended for use in this EIMS (see Section 6.0). Indicators include water quality guidelines and monitoring, and flood risk as related to the amount of permeable surface in the City. In many cases, the current baseline conditions are unknown due to a lack of a wide-scale, ongoing, long-term water quality monitoring program. The key wetlands, waterbodies, and watercourses that fall within the boundaries of Pitt Meadows are discussed individually in the following sections. Recommended policies and actions that can assist with managing aquatic, wetland, and riparian habitats are found in Section 5.0.





#### 4.1.1.1 Wetlands

#### 4.1.1.1.1 Pitt-Addington Wildlife Management Area

The Pitt-Addington Wildlife Management Area (WMA) is located in the area north of Koerner Road and includes the Pitt Polder Ecological Reserve, multiple marshes (e.g., Pitt Marsh, Homilk'um Marsh, Katzie Marsh), sloughs (Catbird Slough, Quarry Slough), and ponds (e.g., Crane Ponds) (Figure 4-5). Located on the north side of Pitt Meadows, the Pitt-Addington WMA is generally a flat, alluvial floodplain made up of diked and undiked areas; it is managed by the provincial Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD). The Pitt Polder Ecological Reserve is an area of sedge bog and two forested granitic outcrops rising above the floodplain. A rare reverse delta exists at the mouth of the Pitt River, which is the result of deposition that occurs when rapidly flooding tides push back on, and reverse, the main Fraser River outflow back up into Pitt Lake.

The Pitt-Addington WMA is 2,972 hectares and was designated for the management of important wetland habitats near Lower Mainland urban populations. This WMA supports over 200 bird and 29 mammal species, and it acts as important wintering, migration, and breeding habitat for waterfowl, shorebirds, raptors, songbirds and upland species. The Pitt-Addington WMA is considered a birding "hotspot" (166 species observed); specific points of interest include Grant Narrows (190 species), Catbird Slough (143 species), and Katzie Marsh (99 species)<sup>6</sup>. This WMA is one of two nesting sites in the Lower Fraser Valley for sandhill crane. Other bird species that use the WMA include Canada goose, mallard, American wigeon, blue-winged teal, northern pintail, and wood duck. Raptors such as northern harrier, sharp-shinned hawk, red-tailed hawk, bald eagle, American kestrel, turkey vulture, and osprey occur in the WMA, most commonly during the winter. Black bear, mule deer and coyote are seen regularly, and cougar are reported occasionally. Rare plant species identified in the WMA include pointed broom sedge, two-edged water-starwort and sessile-leaved sandbar willow.

In December 2020, a search was conducted via the BC Species and Ecosystems Explorer (BCSEE) for potentially occurring SCC<sup>7</sup> within the City of Pitt Meadows and then vetted to remove species that require habitat conditions or topography/elevation ranges not represented in the City (see Appendix G – Matrix of Habitat Suitability for Species of Conservation Concern). Based on the marsh habitats present within the Pitt-Addington WMA, it could host up to 31 SCC, including two mammals, 18 birds, one reptile, one fish, three amphibians, one insect, and five vascular plants.

Field work for the EIMS project was planned to be conducted in May 2020; however, park closures due to COVID-19 prevented access to the Pitt-Addington WMA beyond the gate on Rannie Road. Furthermore, trails within the Pitt Polder Ecological Reserve were closed due to the sandhill crane nesting season (March 15 – August 15). As such, 11 planned sites for bird surveys could not be completed within the Pitt-Addington WMA. After the park closures were lifted in July 2020, Zoetica completed habitat quality assessments and eDNA sampling within the Katzie Marsh and Pitt Marsh, and incidental bird observations

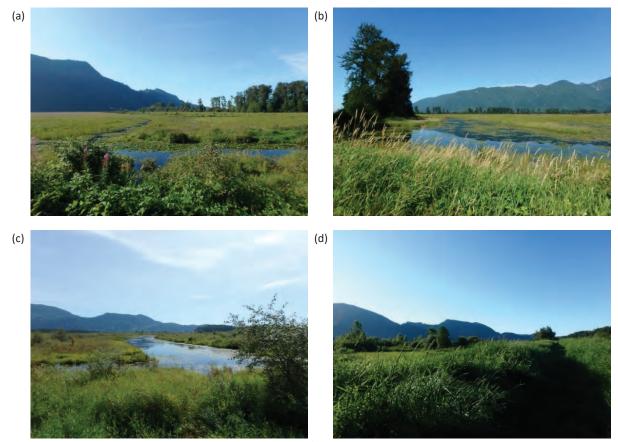
<sup>&</sup>lt;sup>6</sup> eBird Canada data from 2010-2020 (past 10 years) were downloaded and analyzed on July 17, 2020. Entries that were not positively identified to the species level (e.g., "hawk sp.", "Cackling/Canada Goose") were censored out for the total species counts presented in this report and Appendix C – 2020 Field Surveys and Desk-based Research.

<sup>&</sup>lt;sup>7</sup> The BCSEE search was restricted to species that are Red-listed (Extirpated, Endangered, or Threatened) or Bluelisted (Special Concern) in BC, or assessed to be at-risk (Endangered, Threatened, or Special Concern) by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Search results were then manually vetted for species likely (or unlikely) to occur in Pitt Meadows.

were noted at this time. However, a black bear on the dike trail prevented access to survey locations at the southern end of Katzie Marsh and Homilk'um Marsh. Select field photos of the Pitt-Addington WMA are shown in **Figure 4-6**.

In May 2020, bird surveys were conducted at five locations within the Pitt-Addington WMA: plots 44, 47, CC01, D1, and D2 (see **Figure 4-3** and Appendix C – 2020 Field Surveys and Desk-based Research). A total of 26 bird species were observed during systematic surveys, including two SCC (evening grosbeak and great blue heron, *fannini* ssp.). Incidental wildlife observations (including those made during July and August field work) included eight additional bird species (none of which were SCC), black bears, and beavers (animals and lodges). Among the target invasive plant species (see Appendix B – Habitat Quality Assessment and SEI Verification), reed canarygrass was commonly observed along the Pitt-Addington WMA dike trails. Himalayan blackberry, purple loosestrife, and Canada thistle were also recorded at multiple locations; and yellow iris was observed in the slough near the gate on Rannie Road.

eDNA samples were collected in the Pitt Marsh off the western segment of the Katzie Marsh Loop trail, as well as in the Katzie Marsh off the northern segment of the Katzie Marsh Loop (see **Figure 4-4** and Appendix C – 2020 Field Surveys and Desk-based Research). A total of eight fish species were found in these samples, all of which were invasive/introduced species. While five of the introduced fish species were present in both locations, common carp and bullheads were only detected in Katzie Marsh. eDNA from several bird and mammal species (both wild and domestic animals) were also detected.



**Figure 4-6.** Photos of Pitt-Addington WMA during spring/summer field surveys in 2020. Photos taken from (a) Rannie Road facing south toward Katzie Marsh; (b) Swan Dike Trail, facing west into Katzie Marsh; (c) Pitt River dike trail facing east toward Quarry Slough; (d) trail into Pitt Polder Ecological Reserve (closed for sandhill crane nesting season).

#### 4.1.1.1.2 Codd Island Wetlands

The Codd Island Wetlands are comprised of approximately 100 ha of undiked wetlands in the Alouette River watershed. As one of the last undiked wetlands in the Pitt Meadows area, this habitat resembles what large areas of Pitt Meadows once looked like prior the 1880s, after which widespread agricultural settlement of the area began. Flooding occurs on a regular basis within the Codd Island Wetlands due to regular tidal action, and in spring during the Fraser River freshet (Gebauer and Associates Ltd. 2001). The areal cover of vegetation types and other features of the wetland are described in Ward *et al.* (1992); at the time of Ward *et al.*'s (1992) writing, the wetlands were mainly comprised of grass (50%), low rush (10%), tall rush (10%), sedge (5%), tall shrub (5%), forbs (5%), submerged aquatic (2%), non-vegetated (2%), and floating aquatic (1%).

Gebauer and Associates Ltd. (2001) reported that the Codd Island Wetlands were considered by the DFO and the previously named Ministry of Water, Land and Air Protection (now referred to as the BC Ministry of Environment and Climate Change Strategy) to be an environmentally sensitive area. Combined with other wetland areas of the Pitt River Valley, it is one of the largest areas of fen habitats in the Lower Fraser region (Ward *et al.* 1992). The Codd Island Wetlands are abutted to the west by a minor hill dominated by mixed woodlands. An open wetland in the northwest corner of the subject property (i.e., Polder Ridge Marsh) is now designated as a protected area. The northern and eastern boundaries of the Codd Island Wetlands are dominated by upland mixed deciduous and coniferous forests (Gebauer and Associates Ltd. 2001).

The extensive wetland habitats provide breeding habitat for rare and endangered wildlife species, a high diversity of species, and that acts as critical off-channel salmon rearing habitat. A survey and desktop study by Gebauer and Associates Ltd. (2001) of these wetlands recorded the potential for 160 species of birds to occur within or immediately adjacent to the Codd Island Wetlands. The proximity of forest and riparian shrublands to wetlands and marshlands in this area provides nesting opportunities for a wide variety of birds.

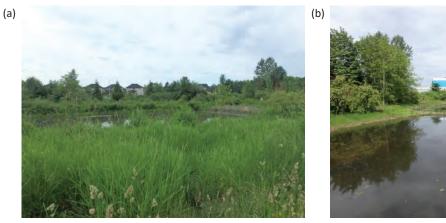
In December 2020, a search was conducted via the BCSEE for potentially occurring SCC<sup>7</sup> within the City of Pitt Meadows and then vetted to remove species that require habitat conditions or topography/elevation ranges not represented in the City (see Appendix G – Matrix of Habitat Suitability for Species of Conservation Concern). Based on the types of habitats present within the Codd Island Wetlands, this area could host up to 53 SCC, including six mammals, 28 birds, one reptile, four amphibians, one fish, five insects, two molluscs, and six vascular plants.

As the Codd Island Wetlands are not accessible to the public, the 2020 field surveys could only be conducted from a distance (from the dike trail on the other side of the North Alouette River). One bird survey was conducted at plot 43 (see **Figure 4-3** and Appendix C – 2020 Field Surveys and Desk-based Research). Six bird species were observed during the survey and one species was observed incidentally, none of which were SCC. Green frogs were heard at this survey location; no invasive plant species were noted. eDNA sampling of the North Alouette River commenced west of Neaves Road and did not extend into Blaney Creek, which runs through the Codd Island Wetlands. However, if it is assumed that eDNA from organisms that use the Codd Island Wetlands gets transported into Blaney Creek and downstream into the North Alouette River, these eDNA fragments may be detected using the high-throughput sequencing employed for metabarcoding analyses (see Appendix C – 2020 Field Surveys and Desk-based Research). The eDNA results for the North Alouette River showed 10 native fish species, six

invasive/introduced fish species, American beaver, and domestic animals. A more detailed aquatic biodiversity eDNA study could be conducted for the Codd Island Wetlands using the methods employed by Zoetica during the 2020 field work, if desired.

#### 4.1.1.1.3 Other Wetland Habitats

Aside from the Pitt-Addington WMA and Codd Island Wetlands, there are wetland habitats along or associated with waterways throughout the City (see **Figure 4-5**). During the 2020 field work for the EIMS project, habitat quality assessments were conducted at five SEI wetland polygons (plots 22, 33, 62, 64, and D8; see Appendix B — Habitat Quality Assessment and SEI Verification). Three additional wetland habitats were identified on the ground: MacLean Park (plot 25) was designated as riparian habitat in the SEI but contains a pond in the middle; the property on the southwest corner of Bonson Road and Airport Way (plot D10) includes wet meadow habitat; and the area between Wildwood Crescent Trail and Airport Way (plot 17) may have converted the Katzie Slough into wet meadow habitat (see **Figure 4-3** and **Figure 4-7**).



(c)





**Figure 4-7.** Photos of wetland habitats within urban areas of the City of Pitt Meadows. (a) between Wildwood Crescent Trail and Airport Way, (b) MacLean Park, and (c) southwest corner of Bonson Road and Airport Way.

Wildwood Crescent Trail is noted as an eBird hotspot, with 104 species observed<sup>6</sup>. Bird surveys were conducted at plots 17, 25, and D10 (see Appendix C – 2020 Field Surveys and Desk-based Research); a total of 17 species were observed during systematic surveys, including two SCC (barn swallow and great blue heron, *fannini* ssp.). Five additional species were observed incidentally, including a pair of green herons (SCC). Of note, several bird species were observed only at plot D10 and nowhere else in the City during the 2020 field work, including blue-winged teal, sora, and merlin. Other incidental wildlife observations included coastal black-tailed deer and beaver sign. A variety of the target invasive plant species (see Appendix B – Habitat Quality Assessment and SEI Verification) was observed within the surveyed wetland habitats, including reed canarygrass, Himalayan blackberry, Japanese knotweed, Scotch broom, and yellow iris. Four of these species were present at MacLean Park.

#### 4.1.1.2 Waterbodies

#### 4.1.1.2.1 Pitt Lake

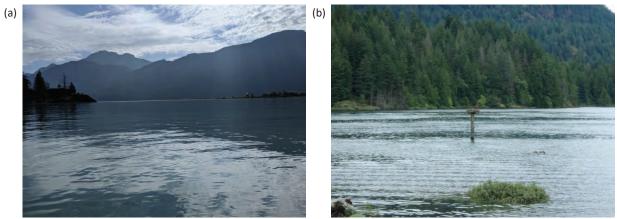
The southern tip of Pitt Lake is 20 km upstream from the confluence of Pitt River and the Fraser River. Pitt Lake originally formed within a glacial valley in the Pacific Ranges of the Coastal Mountains. The Wisconsin glaciation event, which was the most recent in North America, caused the ground to become depressed to an elevation far below current sea level. After the initial glacial retreat of the Cordilleran Ice sheet around 13,000 years ago, a saltwater fjord began to fill this depressed basin. This fjord basin eventually became partly cut off from tidal waters over time, as the Lower Fraser River transported and deposited large amounts of sediments.

In present day, Pitt Lake is considered a tidal fjord lake. Most of Pitt Lake is located within Electoral Area A; however, it is still discussed in this document as Pitt Meadows acts as the gateway to access this lake. Pitt Lake has a general north-south orientation and is about 25 km long and 4.5 km wide, at its widest. Pitt Lake is over 53 km², making it the second largest lake by surface area in Metro Vancouver. Pitt Lake is the second largest of a series of north-south oriented fjord-lakes that incise the Pacific Ranges of the Coastal mountains (the largest being Harrison Lake, which is 60 km to the east). The other fjord-lakes in the Lower Fraser region include Coquitlam Lake, Alouette Lake, Stave Lake, and Chehalis Lake.

As one of the few existing tidal lakes in the world, Pitt Lake is extremely unique. The tidal cycles from the Pacific Ocean move through the Strait of Georgia and extend up Pitt River, causing large fluctuations in water levels. Tides in Pitt Lake can cause water levels to change by roughly three feet on average. As Pitt Lake is relatively shallow, the change in tidal position can vastly increase the waterline to many more metres. Canoeists and kayakers who are familiar with Pitt Lake know that they should calculate the tide charts prior to paddling, to avoid attempting to paddle against a strong current. Likewise, experienced individuals that utilize the free camp sites along the shores of Pitt Lake learn to pull their canoes or kayaks far up the shore and to secure them to ensure that they will not lose their boat to high tide.

The northern section of Pitt River (i.e., "upper" Pitt River) drains into the north end of Pitt Lake, which subsequently drains from the south end into the "lower" Pitt River and into the Fraser River. The western shore of Pitt Lake is currently protected by Pinecone Burke Provincial Park, while most of the eastern shore is protected within Golden Ears Provincial Park. The southern end of Pitt Lake features an extensive marshland associated with the Pitt-Addington WMA. While most of this marshland has been drained for agricultural use, the northernmost portion remains as a conservation area to provide critical habitat for migratory birds.

Pitt Lake is popular with boaters, kayakers, canoeists, walkers, bikers, and birdwatchers. There is a dike network that allows walkers and bikers to navigate along the south side of the lake, where a bird viewing tower can be found. Boating is affected by heavy winds and rains, shallow areas and sandbars that must be avoided, and big waves (due to its great depth and the allowance of speed boats in close proximity to boats without motors). The Upper Pitt, meaning the valley upstream from the lake, is considered one of BC's best fly-fishing rivers as well as one of its best steelhead salmon streams. This area also contains one of the region's few natural hot springs. Select photos of Pitt Lake are shown in **Figure 4-8**.



**Figure 4-8.** Photos of (a) Pitt Lake facing upstream near the Pitt Lake Boat Launch, and (b) an osprey perched on artificial nest platform in Grant Narrows.

In December 2020, a search was conducted via the BCSEE for potentially occurring SCC<sup>7</sup> within the City of Pitt Meadows and then vetted to remove species that require habitat conditions or topography/elevation ranges not represented in the City (see Appendix G – Matrix of Habitat Suitability for Species of Conservation Concern). Based on the lake and riparian habitats present in and around Pitt Lake, this waterbody could host up to 49 SCC, including six mammals, 28 birds, one reptile, four amphibians, four fish, four insects, and two vascular plants.

As Pitt Lake is technically within Electoral Area A and not the City of Pitt Meadows, field work in 2020 (bird surveys and eDNA sampling) was not conducted within the lake. However, raptors, waterfowl, and other waterbirds observed at survey points focused on the Katzie Marsh likely use the wetland and waterbody habitats on both sides of the Pitt Marsh dike trail. Ospreys were observed using the artificial nest platforms and other posts; their presence is a big draw for nature/bird photographers in Metro Vancouver. There is an eBird hotspot at Grant Narrows Regional Park (190 species observed<sup>6</sup>); records of waterfowl and waterbirds likely include observations on and around Pitt Lake.

# 4.1.1.3 Watercourses (Rivers and Streams)

The City abuts the Fraser River to the south and the Pitt River to the west (**Figure 4-5**). While Pitt Meadows does not have jurisdiction over these waterways, management of the shorelines of these rivers on the Pitt Meadows side can influence the health of these systems. On the other hand, the City has a far greater influence on the overall health of the Alouette River system, which snakes through the City of Pitt Meadows from Maple Ridge; two arms of the river, the North Alouette River and south arm of the Alouette River (hereafter 'South Alouette River') enter Pitt Meadows, adjoin, and continue to Pitt River

(**Figure 4-5**). In its route through Pitt Meadows, it meanders through forested buffers, farmlands, and natural areas.

The shorelines of all three river systems have been important recreational corridors for residents of the area throughout the years. Residents of Pitt Meadows walk, bike, or ride horses along dike paths associated with these rivers to take in views that are unimpeded due to the agricultural landscape. Residents also fish, boat, float, collect crayfish, and swim in these rivers, particularly the Alouette River; these activities make it essential that water quality is not negatively impacted such that thresholds for aquatic and human health are surpassed (see Section 6.0).

The Fraser, Pitt, and Alouette rivers are of great importance to First Nations that consider Pitt Meadows part of their Traditional Territory. Many Katzie First Nation archaeological sites, for example, have been found along these rivers, as people located their settlements close to salmon and other fish and along important travel and trade routes. Rivers played all of these roles for local First Nations. First Nations that have used these areas as part of their traditional territories have depended on salmon, eulachon, and sturgeon of these rivers, and have maintained spiritual, cultural, and economic ties to these rivers to the present day.

#### 4.1.1.3.1 Fraser River

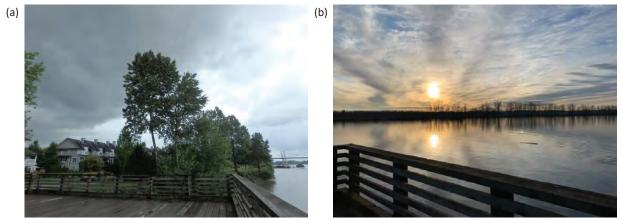
The Fraser River is the longest river in BC and it sustains one of the world's greatest salmon fisheries. It flows from the Rocky Mountains to the Pacific Ocean, over 1,375 km in length, and drains a total area of 220,000 km². The Lower Fraser River begins at Yale, where it begins to flatten and widen its course, winding through the communities and farmlands of the Fraser Valley, before emptying into the Pacific Ocean at the Fraser River estuary, south of Vancouver. The Fraser River is known for being sediment rich, and it transports vast amounts of sediments, which has led to it developing several islands and a large delta.

The Lower Fraser River supports a rich diversity of wildlife and fish species, including the culturally important Pacific salmon (chinook, coho, chum, pink, sockeye, steelhead, and cutthroat), eulachon, and white sturgeon, along with 53 other documented fish species (BC MOE 2017). The Fraser River is the migratory route for hundreds of Fraser watershed salmon stocks, many of which also using it for rearing. The Fraser River has some of the largest Pacific salmon runs in the world, and is the largest producer of sockeye salmon in the world (Cohen 2012). It is also a major producer of pink, chum, chinook, coho, and steelhead salmon. Each of these species have undergone substantial declines over the past 125 years.

The Fraser River is also subject to flooding, particularly during spring freshet when fast snowmelt in the mountains can overrun the holding capacity in the river. The last Great Fraser Flood of 1948 had devastating repercussions to Metro Vancouver, including Pitt Meadows. This flood destroyed railways and highways and led to thousands of people losing their homes. Climate change models produced by the Fraser Basin Council predict an increased risk and frequency of both minor and major Fraser River floods that will have major implications to Pitt Meadows (see **Figure 4-16**).

The Fraser River is popular for fishing and boating, although public access to the water is currently limited to the trail at the southern end of Baynes Road. The nearest public access launch ramp for motorized boats is at the Pitt Meadows Marina at the confluence of the Alouette and Pitt rivers. The Fraser River foreshore comprises a section of the PRRG and is highly valued for recreation. The PRRG is a multi-use trail that allows for walking, cycling, and horseback riding. Two piers have been constructed near Osprey

Village, and the trail abuts a variety of habitats, including patches of riparian forests, wetlands, and agricultural fields, making the greenway a popular place for birdwatching and nature appreciation. Select photos of the Fraser River and foreshore area in Pitt Meadows are shown in **Figure 4-9**.



**Figure 4-9.** Photos of the Fraser River foreshore in Pitt Meadows taken from the pier at Shoreline Park: (a) Small buffer of riparian trees between Osprey Village residences and the Fraser River; (b) Fraser River at sunset.

In December 2020, a search was conducted via the BCSEE for potentially occurring SCC<sup>7</sup> within the City of Pitt Meadows and then vetted to remove species that require habitat conditions or topography/elevation ranges not represented in the City (see Appendix G – Matrix of Habitat Suitability for Species of Conservation Concern). Based on the river and riparian habitats present in and around the Fraser River, this watercourse and surrounding area could host up to 51 SCC, including six mammals, 27 birds, one reptile, four amphibians, six fish, four insects, and three vascular plants.

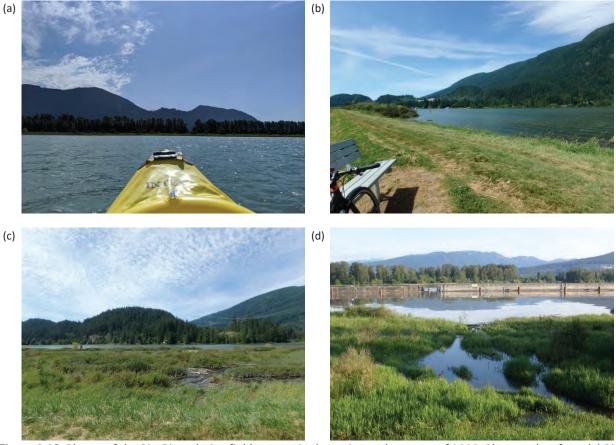
During the 2020 field work for the EIMS project, bird surveys were conducted at eight locations within wetland and riparian areas along the Fraser River: plots 1, 2, 3, 4, 5, 7, 8, and 9 (see **Figure 4-3** and Appendix C – 2020 Field Surveys and Desk-based Research). A total of 26 bird species were observed during systematic surveys, none of which were SCC. Five additional bird species were observed incidentally, including one SCC (barn swallow). The only other incidental wildlife noted was a grey squirrel. There is an eBird hotspot noted at the PRRG west of Harris Road (115 species observed<sup>6</sup>); records of waterfowl and waterbirds likely include observations on the Fraser River. Among the target invasive plant species (see Appendix B – Habitat Quality Assessment and SEI Verification), Himalayan blackberry was observed at multiple survey points along the Fraser River, and reed canarygrass was noted at one location along the PRRG. As Pitt Meadows has no jurisdiction over the Fraser River itself, no eDNA samples were taken from the Fraser River.

# 4.1.1.3.2 Pitt River

The Pitt River is a major tributary to the Fraser River, which hosts a similar suite of species to the Fraser River. However, the Pitt River also leads to important overwintering habitat for white sturgeon that use the upper Pitt Lake system and provides a corridor for fish and wildlife to access a vast array of interconnected wetlands in the north. These wetland/marsh destinations, connected by the Pitt River, are important in promoting biodiversity. As Pitt River is also influenced by Fraser River floods and tidal conditions, it is also prone to flooding, and that risk will increase due to climate change (BC FLNRO 2014). The vast network of wetlands to the north provides an important ecological service in its functional ability

to store large amounts of water, which naturally mitigates the extent of flood risks, reducing the severity and spatial area of flooding that would otherwise threaten Pitt Meadows.

Similar to the recreational values of the Fraser River, the Pitt River waterway is popular for fishing and boating, and the adjacent dike trails are popular for walking (including dog walking), cycling, horseback riding, birdwatching, and nature appreciation. The PRRG currently extends to the Pitt River Bridge; however, dike trails continue along the Pitt River until it reaches Pitt Lake, with only a gap at the Pitt River Quarries. Select field photos of the Pitt River are shown in **Figure 4-10**.



**Figure 4-10.** Photos of the Pitt River during field surveys in the spring and summer of 2020. Photos taken from (a) Pitt River facing east toward Pitt-Addington WMA; (b) Pitt River dike trail on west side of Pitt-Addington WMA; (c) Pitt River dike trail north of Swaneset Bay Resort and Country Club; (d) Pitt River dike trail between Pitt River Bridge and Harris Road.

In December 2020, a search was conducted via the BCSEE for potentially occurring SCC<sup>7</sup> within the City of Pitt Meadows and then vetted to remove species that require habitat conditions or topography/elevation ranges not represented in the City (see Appendix G – Matrix of Habitat Suitability for Species of Conservation Concern). Based on the types of habitats present in and around the Pitt River (including stream/river, riparian, and agricultural habitats), this watercourse and surrounding area could host up to 55 SCC, including six mammals, 30 birds, one reptile, four amphibians, six fish, five insects, and three vascular plants.

During the 2020 field work for the EIMS project, bird surveys were conducted at six locations within wetland and riparian areas along the Pitt River: plots 10, 26, 27, 34, 60, and CC02 (see **Figure 4-3** and Appendix C – 2020 Field Surveys and Desk-based Research). A total of 30 bird species were observed during systematic surveys, including one SCC (great blue heron, *fannini* ssp.). Five additional bird species were observed incidentally, including two SCC (double-crested cormorant and a pair of barn swallows). In the marsh habitat at the confluence of the Katzie Slough and Pitt River (plot CC02), tree swallows nest in the remaining pier posts. A nature photographer passerby indicated that this area has lots of wildlife, including river otters and mergansers that come to feed on fish coming out of the slough. In fact, an eBird hotspot exists at Kennedy Road; the 91 species observed likely include birds at the confluence and in and around the Katzie Slough farther inland. In addition to the hotspots at Catbird Slough and Grant Narrows (noted in Section 4.1.1.1.1), which likely include bird observations within the Pitt-Addington WMA and along Pitt River, there is another eBird hotspot at the Harris Road dike trail, with 70 species observed in and around the Pitt River in this area<sup>6</sup>.

Other incidental wildlife observations along the Pitt River included a harbour seal and river otter trails into the marsh habitat north of the Pitt River bridge. Among the target invasive plant species (see Appendix B – Habitat Quality Assessment and SEI Verification), Himalayan blackberry, reed canarygrass, and yellow iris were observed at multiple survey points along the Pitt River.

As there was interest in comparing aquatic species composition on either side of the pump stations that segregate sloughs from the Pitt River, eDNA samples were taken from the Pitt River between the Pitt Lake Boat Launch and the dike access point at Rannie Road (see **Figure 4-4** and Appendix C – 2020 Field Surveys and Desk-based Research). These samples contained detections of seven native fish species and three invasive/introduced fish species. Compared to samples collected nearby in the Pitt-Addington WMA, the Pitt River harbours greater native biodiversity and fewer introduced species.

#### 4.1.1.3.3 Alouette River

The City of Pitt Meadows hosts the terminal segments of the Alouette River. The north and south arms of the Alouette River flow from Alouette Lake in Maple Ridge, cross into Pitt Meadows and join together into a single river, which then connects with Pitt River. This tributary river that ultimately empties into the Fraser River drains a mountain watershed in the Coast Mountains.

The South Alouette River historically supported all five species of salmon plus populations of sea-run cutthroat trout, steelhead, Dolly Varden, and resident rainbow trout. The decline of salmon within the South Alouette River watershed was largely due to development beginning in the late 1800s, which saw an expansion of farming and logging (including floating of logs down the Alouette River to New Westminster) in Ridge Meadows. Agricultural development in the area, including diking and draining of the tidal estuary, gravel mining, and urban development all had negative impacts during this time. The hydropower potential of the river and its proximity to major urban populations led to the construction of a dam in 1924-1926 at the outlet of Alouette Lake (Cope 2015).

This dam has had two major persistent effects on salmon populations in the South Alouette River. First, spawning populations of sockeye, chinook, coho, and chum salmon were prevented from entering upstream habitats and historical spawning grounds in Alouette Lake and tributaries. Second, flows were also strongly impacted due to the dam and the diversion of water from Alouette Lake into the Stave River system. The creation of the Alouette Dam blocked downstream river flow other than tributary flows; at times, the dam created large floods in the Alouette River. As a result of these impacts, populations of

chinook, sockeye, and pink salmon became locally extinct (extirpated) (Cope 2015). This decline included the extirpation of a unique run of Alouette sockeye salmon, which used Alouette Lake as their spawning grounds.

BC Hydro has helped to improve fish stocks in the Alouette since the 1970s by slowly increasing the amount of water it released from the dam during critical spawning and rearing periods (Cope 2015). Alongside these efforts, from 1979 onwards, the BC Ministry of Environment (MOE) annually stocked the South Alouette River with steelhead smolts and anadromous cutthroat smolts (Cope 2015). The DFO Salmonid Enhancement Program (SEP) began funding the Alouette River Hatchery Project in 1979 and is operated by the staff of the Fraser Regional Correction Centre (FRCC) and Alouette River Management Society (ARMS). Currently, the FRCC-ARMS Hatchery (also known as the Allco Fish Hatchery) annually stocks chinook fry, coho fry and smolts, steelhead smolts, and cutthroat trout (Cope 2015). The North Alouette River, a tributary of the Alouette River, is also stocked with chum fry from the Allco Fish Hatchery (Cope 2015).

Sockeye salmon began to return to the Alouette Watershed in 2007 after the release of smolts from the Alouette Lake Reservoir in 2005. Over the past 15 years, sockeye salmon have unexpectedly continued to return to the Alouette River, and they are enumerated by BC Hydro (Cope 2015). These Alouette River sockeye are presently caught in a fish fence in the lower South Alouette River and trucked above the dam and released into the lake. To assess the feasibility of anadromous sockeye salmon re-introduction into the Alouette Reservoir, a four-year study was planned to be concluded in 2020 by ARMS in collaboration with BC Hydro, DFO, local First Nations including Katzie First Nation, MOE, and LGL Ltd., to determine the return success of sockeye adults to the Allco Fish Fence. ARMS and other volunteer groups have and continue to do a great deal of work to restore fish habitat along the river and educate the public about river conservation; however, a much higher proportion of the effort is focused within Maple Ridge compared to Pitt Meadows.

While Zoetica was unable to find public records of water quality monitoring in the Alouette River in Pitt Meadows, there is evidence of ecosystem degradation in this area. The water within this river slows considerably as the South Alouette River crosses beneath the bridge at 216<sup>th</sup> Street. West of this bridge, there is also increasing evidence of riparian vegetation loss and degradation, with large streamside areas dominated by invasive species such as Japanese knotweed and Himalayan blackberry, both of which take over disturbed sites where shading trees are removed. Both species are of low ecological value and Himalayan blackberry tends to render shorelines impenetrable, eventually reducing their ecological and recreational/aesthetic potential. Metro Vancouver and the Invasive Species Council of Metro Vancouver (ISCMV) have developed a number of Best Management Practices (BMPs)<sup>8</sup> for invasive species, including dominant species found along the Alouette River shorelines.

The Alouette River, west of 216th St to its confluence with Pitt River, also hosts large mats of Eurasian water-milfoil that grows in the riverbed. Eurasian water-milfoil is an aquatic invasive species that outcompetes and replaces native aquatic vegetation with its dense stands. These stands also create pools of stagnant water, increasing mosquito breeding grounds and inhibiting water flow of waterways, irrigation

<sup>&</sup>lt;sup>8</sup> http://www.metrovancouver.org/services/regional-planning/conserving-connecting/invasivespecies/Pages/default.aspx

ditches, and drainage canals, ultimately increasing maintenance costs to the City (City of Pitt Meadows 2020a). Select field photos of the Alouette River are shown in **Figure 4-11**.



**Figure 4-11.** Photos of the Alouette River during field surveys in July 2020. (a) South Alouette River with osprey perched amongst riparian trees. (b) "Main" Alouette River (downstream of confluence of north and south arms) with great blue heron, *fannini* ssp. (a species of conservation concern) foraging along the shore. (c) North Alouette River with dense mats of invasive Eurasian water-milfoil. (d) Invasive reed canarygrass growing in riparian areas of North Alouette River.

In December 2020, a search was conducted via the BCSEE for potentially occurring  $SCC^7$  within the City of Pitt Meadows and then vetted to remove species that require habitat conditions or topography/elevation ranges not represented in the City (see Appendix G - Matrix of Habitat Suitability for Species of Conservation Concern). Based on the types of habitats present in and around the Alouette River (including stream/river, riparian, and agricultural habitats), the database search for potential SCC returned the same results as for Pitt River (Section 4.1.1.3.2).

During the 2020 field work for the EIMS project, bird surveys were conducted at six locations within wetland and riparian areas along the Alouette River: plots 31, 40, 43, 59, 61, and T3 (see **Figure 4-3** and Appendix C – 2020 Field Surveys and Desk-based Research). A total of 22 bird species were observed during systematic surveys, including one SCC (barn swallow). Ten additional bird species were observed incidentally from land and on the water (i.e., during eDNA sampling), including one SCC (great blue heron, *fannini* ssp.). Three eBird hotspots exist along the Alouette River, including at Harris Road (119 species observed) and both the north and south arms at Neaves Road (94 and 85 species, respectively). There is

another hotspot at the Connecting Road Area south of the Alouette River where its tributaries flow (124 species observed)<sup>6</sup>.

Other incidental wildlife observations included coyote, beaver, river otter, dragonflies, and invasive green frogs and American bullfrogs. Invasive Eurasian watermilfoil was frequently observed along the north and south arms of the Alouette River, from where the rivers cross Neaves Road to the eastern end of Fenton Road after the two branches converge. Other invasive plant species recorded from land-based survey points included reed canarygrass and yellow iris.

eDNA samples were collected along the Alouette River between the crossings at Neaves Road to the confluence with the Pitt River (see **Figure 4-4** and Appendix C – 2020 Field Surveys and Desk-based Research). A separate analysis was conducted for each of the North Alouette River, South Alouette River, and "Main Alouette"; this was done to enable assessment of the aquatic biodiversity for each river 'segment', which may help the City make prioritized management decisions. Overall, 12 native fish species were detected in the Alouette River system and species compositions were similar between the three segments. Differences include coho salmon being detected in only the Main Alouette, cutthroat trout being detected in the Main and South Alouette but not the North, and mountain whitefish being detected in the North and South Alouette but not the Main. Invasive/introduced fish species composition was also similar between the Main and North Alouette (5 shared species; common carp was only detected in the North Alouette), whereas only two invasive/introduced fish were detected in the South Alouette.

#### 4.1.1.4 Sloughs

Sloughs form part of the City's internal drainage network and are vital for the conveyance of water and protection of adjacent land from flooding. Pitt Meadows contains three major sloughs: the Katzie Slough (to which Cook and Tulley sloughs are connected), Sturgeon Slough, and Cranberry Slough (Figure 4-5). These sloughs were historically formed as side-channels from a river, inlet, or natural channel that only sporadically fills with water. With construction of the City's drainage and flood control measures, the sloughs in Pitt Meadows are now channel-like and are characterized by water that tends to be stagnant or flows slowly and on a seasonal basis. Each of these three sloughs and their connected channels provide drainage and an important source of water to agricultural activities, while providing fish and wildlife habitat and some adjacent walking paths for human use.

# 4.1.1.4.1 Katzie Slough (Including Cook, Tulley, and Cranberry Sloughs)

The Katzie Slough (**Figure 4-5**) traverses across the entirety of Pitt Meadows, from west to east, with Cook Slough and Tulley Slough bifurcating off Katzie Slough to the south. Cranberry Slough, which runs from west to east, north of Lougheed Highway, also connects to the Katzie Slough through an arm that runs from north to south (**Figure 4-5**). This complex forms the only slough system in the southern portion of Pitt Meadows.

The Katzie Slough has significance as a traditional Katzie First Nation site. Historically, the slough was used as a travel route, for traditional agriculture where bog plants such as cranberry and wapato were harvested, and as a fishing site for steelhead, eulachon, and white sturgeon (Jenness 1955). The Katzie Slough once provided side-channel fish habitat (salmon rearing habitat and sturgeon habitat) through a wetland (Porter 2017).

However, the Katzie Slough and its connected sloughs are now degraded and stagnant, traversing through agricultural lands and urban areas. Flood control pumps installed for flood protection have reduced

natural tidal flow mixing in the Katzie Slough, and now limit the safe movement of fish in and out of this slough. These disturbances, in combination with sewage outflows (originating from the City of Maple Ridge) and runoff (Porter 2017), have resulted in a stagnant, polluted system that promotes invasive plant and fish species able to survive in conditions of low oxygen, warm water, physical disturbance, and minimal to no shading. Select field photos of the Katzie Slough are shown in **Figure 4-12**.



**Figure 4-12.** Photos of the Katzie Slough during field surveys in July 2020. Photos taken from (a) Kennedy pump station; (b) Lougheed Highway multi-use trail, facing south toward railroad (a great blue heron can be seen foraging on the left); (c) at Meadow Gardens Golf Club; (d) off Wildwood Crescent Trail.

The Katzie Slough is now primarily used for drainage, flood protection, and as a water source for farming irrigation. Farmers that participated in the engagement process noted clean (quality), available (quantity) water as an important ecosystem service that they require for the maintenance of safe and productive farming practices. The availability of such water will likely grow in importance, as late summer droughts are predicted to increase due to climate change (Metro Vancouver 2019). The greenbelt lands along the Katzie Slough are also part of a planned Regional Greenways network (City of Pitt Meadows 2020b).

Historical biological records for the Katzie Slough are available in Jenness (1955). Fish species in the slough once included all of the West Coast salmon species (pink, chinook, coho, chum, sockeye; also steelhead), white sturgeon, and eulachon. Plant species included salal, huckleberry, wapato, cranberry, cedar trees, cottonwood trees, blueberry, and peat. The slough now hosts mainly invasive, non-native species like Oriental weatherfish, pumpkinseed, and American bullfrogs, all of which are adept at surviving in low

oxygen and warm water systems (Porter 2017). The most abundant native species found was threespine stickleback, which are consumed by some salmonids and birds.

Many problematic aquatic invasive plant species now dominate the Katzie Slough, including parrot's feather, smartweeds, water-milfoil, and waterlily. Along the shores of the slough, invasive plant species include Japanese knotweed, Himalayan blackberry, and reed canarygrass (Porter 2017). These species establish themselves or spread into areas where native vegetation has been disturbed or cut, and where there is low shading; once established, they can be difficult to eradicate and replace with native vegetation.

Porter (2017) measured and reported on water quality in the Katzie Slough, which showed generally poor results. Large amounts of phosphorus (P) and nitrogen (N) were recorded, with more phosphorus in agricultural areas, and more nitrogen in urban areas. This may suggest that the nutrient enrichments are due to agricultural and urban runoff. Some water samples exceeded guideline levels of P and N for aquatic health (Porter 2017). High levels of these nutrients, along with higher water temperature and low circulation, cause green algae blooms in front of the closed pump gates. As more algae and plants grow, others die; this dead organic matter becomes food for bacteria that decompose it. With more food available, the bacteria increase in number and use up the dissolved oxygen in the water. When the dissolved oxygen content decreases, many fish and aquatic insects cannot survive. Algal blooms may also produce neurotoxins, which can have severe impacts to fish, wildlife, and livestock.

High levels of copper and aluminum have also been detected in the Katzie Slough (Porter 2017), both of which can be toxic to fish and the invertebrates that they feed on (Yanong 2019). Porter (2017) reported that raw sewage also enters the Katzie Slough through an overflow pipe from the City of Maple Ridge, which has led to water within the slough to exceed *Escherichia coli* (*E. coli*) guidelines for irrigation of raw crops. This is a poignant issue for food safety, which could have serious economic impacts to local farmers, in addition to causing potential impacts to human and aquatic health.

As the Katzie Slough is so highly modified by the combination of flood control and drainage infrastructure, adjacent riparian soil compaction, and high densities of invasive species, Zoetica could not perform a meaningful search for potentially occurring SCC in this habitat feature as the BCSEE does not include similar, highly modified habitats in the search features. Nevertheless, Appendix G – Matrix of Habitat Suitability for Species of Conservation Concern presents a list of SCC that could potentially occur within the City's sloughs (i.e., stream habitat) and agricultural habitats surrounding the sloughs if water quality, flow, temperature, and oxygen levels were brought back in line with those needed to support them. In the presently degraded state, however, the numbers of SCC included in Appendix G for systems within Pitt Meadows are likely to be overestimates.

Bird surveys were not specifically conducted at the Katzie Slough or other sloughs. Aside from the Pitt-Addington WMA, there are very few SEI polygons surrounding sloughs in the urban, suburban, and rural areas of the City (see **Figure 4-2**); and bird surveys were typically conducted at the same locations where SEI field verification and habitat quality assessments were performed (see Section 4.2.1 and Appendix C – 2020 Field Surveys and Desk-based Research). However, two survey sites were located close to the Katzie Slough: plot CCO2 at the confluence of the Katzie Slough and Pitt River, and plot 17 at the wetland habitat connected to the Katzie Slough between Wildwood Crescent Trail and Airport Way. The bird survey results and eBird hotspot data for these locations were described in Section 4.1.1.3.2 and Section 4.1.1.1.3, respectively. Six bird species were observed incidentally during eDNA sampling in the Katzie

Slough in July, including two SCC (great blue heron, *fannini* ssp., and barn swallow). In addition, there is hotspot at Hale Road where it crosses Cranberry Slough; 82 species have been observed in and around this area<sup>6</sup>.

Among the target invasive plant species (see Appendix B – Habitat Quality Assessment and SEI Verification), Himalayan blackberry, reed canarygrass, and parrot's feather were the most commonly observed. Parrot's feather was most prevalent at Kennedy Landing but was also found under the multiuse trail bridge (between the railroad and Lougheed Highway), along with Japanese knotweed. Zoetica staff conducting a site visit in September found that the parrot's feather had spread quickly along the southern bank of the Katzie Slough (see Appendix C – 2020 Field Surveys and Desk-based Research).

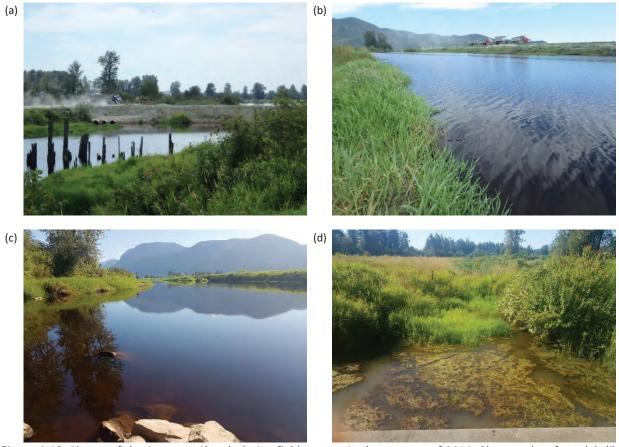
Water sampling was undertaken in Katzie Slough by Zoetica as part of the current project to collect eDNA from various waterways across the City of Pitt Meadows. Two analyses were conducted – one for water samples collected on the Pitt River side of the pump station at Kennedy Road, and one for water samples collected from the Katzie Slough between the Kennedy pump station and Wildwood Crescent Trail (see Figure 4-4 and Appendix C – 2020 Field Surveys and Desk-based Research). These analyses were done to help assess the differences in aquatic biodiversity at the slough-river confluence vs. inland stretches of the slough, and to determine the prevalence of native vs. invasive species within the Katzie Slough. The number of native fish species detected on the Pitt River side of the pump station (9 species) was in stark contrast to the single native fish species (threespine stickleback) detected farther inland within the Katzie Slough. A similar number but slightly different types of invasive/introduced fish species were detected in the two samples analyzed. Introduced species present on both sides of the pump station included pumpkinseed, Oriental weatherfish, and largemouth bass.

# 4.1.1.4.2 Sturgeon Slough

Sturgeon Slough is a short waterway that drains into the Lower Pitt River (Figure 4-5). This waterway has heritage significance and is also an important venue for boating, canoeing, and angling. The main access point to Sturgeon Slough is from Rannie Road, which crosses the lower part of the slough. The rest of the slough is bordered by private lands. Ditches around the agricultural lands drain into this slough, so water can be quite muddy throughout the year. This is one of few spots in the Fraser Valley where carp fishing is available between spring and fall. Trout and salmon also occasionally make their way into this slough from Pitt River. In 2012, a DFO survey concluded that current conditions in Sturgeon Slough do not favour juvenile salmon as the slough is subject to high water temperature, low flows, large amounts of organic debris, and low dissolved oxygen, all of which create negative habitat conditions for salmon. Select field photos of the Sturgeon Slough are shown in Figure 4-13.

Sturgeon Slough is a noted eBird hotspot within the City, with 67 species observed<sup>6</sup>. No bird surveys or habitat assessments were conducted at Sturgeon Slough for the EIMS project. However, incidental wildlife observations made during eDNA sampling included eight bird species, including one SCC (great blue heron, fannini ssp.), black bear scat, American bullfrogs, and dragonflies and mayflies. Invasive reed canarygrass, Himalayan blackberry, and Eurasian watermilfoil were also observed at and around the sampling locations. Water sampling was undertaken in Sturgeon Slough at the Rannie Road and Thompson Road crossings by Zoetica as part of the current project to collect environmental DNA from various waterways across the City of Pitt Meadows (see **Figure 4-4** and Appendix C – 2020 Field Surveys and Desk-based Research). Four native and nine invasive/introduced fish species were detected in the Rannie Road sample, whereas one native (threespine stickleback) and four invasive/introduced species were detected

in the Thompson Road sample. Despite the installation of fish-friendly pumps, the pump station north of Golden Eagle Farms may be restricting fish passage farther inland. More investigation would be needed to understand the cause of limited fish passage.



**Figure 4-13.** Photos of the Sturgeon Slough during field surveys in the summer of 2020. Photos taken from (a) dike trail looking toward private industrial road (Pitt River Quarries) at confluence of Sturgeon Slough and the Pitt River; (b) dike trail looking toward Sturgeon Slough Road with industrial traffic; (c) Rannie Road facing east toward a popular fishing spot; (d) Thompson Road culvert facing south.

#### 4.1.1.5 Riparian Buffer Zones

Riparian buffer zones are defined as the vegetated interface between land and a river or stream. Plant habitats and communities along the river margins and banks are called riparian vegetation. Riparian vegetation is often characterized by plants that are tolerant to high moisture conditions close to the aquatic system, transitioning into more upland plant species near the top of bank and beyond. Riparian zones are important in ecology, environmental resource management, and civil engineering because of their role in hosting and providing travel and migration corridors for a wide range of species, their influence on aquatic ecosystems and the fauna that they host (through their role in cleaning runoff water and controlling surface hydrology and flood risks). Riparian buffer zones are also considered in civil engineering due to the role that their root structures play in protecting against erosion and washouts.

The Riparian Areas Protection Regulation (RAPR), previously known as the Riparian Areas Regulation (RAR), was introduced by the British Columbia government in 2006 and was intended to help protect watercourses by requiring developers to maintain vegetated riparian buffer strips (typically 5 to 15 m).

RAPR only applies to residential, commercial and industrial development on land under local government jurisdiction, while existing infrastructure and farm practices are exempt (BC FLNRO 2016). In an independent review of the RAPR, the Office of the Ombudsperson (2014) found that the regulations are widely misapplied, leading to further losses of riparian vegetation. According to a meta-analysis by Sweeney and Newbold (2014), a minimum of 30 m of riparian vegetation is needed to protect small watercourses from temperature fluctuations associated with climate change. This finding is congruent with numerous other reports that have recommended 30 m riparian buffers or larger (Erman *et al.* 1977, Newbold *et al.* 1980, Wenger 1999, Mayer *et al.* 2007, Rykken *et al.* 2007, Richardson *et al.* 2012). Overall, the existing legislation does not work effectively to protect aquatic habitats from the negative effects that are predicted to be experienced due to climate change, and protection of undeveloped riparian buffer habitat, as well as enhancements to disturbed riparian areas, are greatly needed.

A meta-analysis by Sweeney and Newbold (2014) showed the following benefits of various riparian buffer strip widths; these benefits are summarized in **Table 4-2** below.

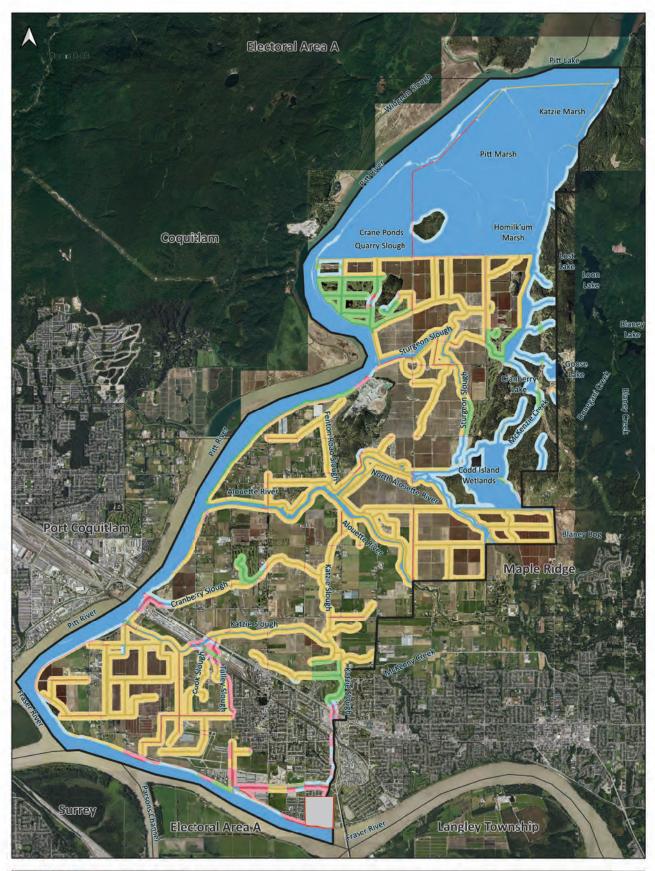
**Table 4-2.** Riparian forest buffers widths needed to provide ecosystem services

Ecosystem	Buffer width		
service and	Partial functionality	Moderate functionality	Full functionality
habitat qualities			
Subsurface	32 m (50% of full forest)*	64 m (75% of full forest)*	212 m (99% of full forest)*
nitrate removal			
Sediment	6 m (50% of full forest) **	17 m (75% of full forest) **	574 m (99% of full forest) **
trapping			
Stream channel	-	-	25 m (significant channel
width			widening) (Sweeney et al.
			2004)
Channel	-	10 m (provides some	-
meandering and		protection) (Burckhardt and	
bank erosion		Todd 1998)	
Shading	-	12 m (provides 80%)	31 m (provides 92%)
		(DeWalle 2010)	(Groom <i>et al.</i> 2011)
Temperature	10 m (hold temp. increases	≥ 20 m (hold temp.	≥ 30 m (full protection)
stability	≤ 3°C) (Sweeney and	increases ≤ 2°C) (Sweeney	(Chen <i>et al.</i> 1998)
	Newbold 2014)	and Newbold 2014)	
Large woody	-	30 m (or average height of	-
debris		streamside trees which are	
		approximately 30 m)	
		(Sweeney and Newbold	
		2014)	
Macro-	15 m (some aspects of	≥ 30 m (supports natural	-
invertebrates	macroinvertebrate ecology	levels of macro-	
	maintained)	invertebrates)	
	(Lorion and Kennedy 2009,	(Newbold <i>et al.</i> 1980, Davies	
	Sweeney and Newbold	and Nelson 1994, Sweeney	
	2014)	et al. 2004)	

Notes: Data summarized from a review by Sweeney and Newbold (2014). \*calculated values based on Equation 6, Sweeney and Newbold (2014) and average water flux of 125 L/m/day and removal rate of 0.022 m-1 to approximate sites where water flux is high. \*\*calculated values based on Equation 8, Sweeney and Newbold (2014).

Using this meta-analysis as a guide, Zoetica constructed a map of the riparian buffer zones within Pitt Meadows to allow for many types of analysis. Areas along the shores of each watercourse or waterbody were divided into "theoretical" distance strips that would accomplish various ecological functions as per Table 4-2. Strips were drawn on maps that represented three main distance buffers: 0-15 m, 15-30 m, and 30-100 m. Once these theoretical distance buffers were placed on maps, human modifications within those distances were recorded (Figure 4-14). Human modifications such as paving and urban infrastructure (e.g., roads) were considered "high" rank and were coloured red, as they are disturbances that are very difficult to "undo", revegetate, or reverse, particularly if they are paved. Human modifications such as agriculture and forestry were considered "moderate" rank and were coloured orange, as these types of modifications do not remove all benefits (e.g., the ground remains pervious to water) and because they can be revegetated, if needed. Human modifications considered "low" rank are coloured green and represent areas that have been modified, but that still have trees and some function, such as manicured parks, golf courses, and low-density rural lots. Finally, riparian habitat that is largely natural within the various buffer widths are coloured blue. Therefore, the healthiest riparian areas are blue and green, while yellow areas possess moderately disturbed (but reversible) riparian zones. Red areas are those that are difficult to restore and have largely been lost to urban and industrial development.

Zoetica notes that, due to the scale, it is difficult to view human modifications within the narrower 0-15 m zone on a static PDF map; however, human modifications within these narrower zones are quite important to understand, as they host the most essential riparian buffer vegetation. Using the supplied spatial files (see end of Section 4.0), the City can investigate in more detail the amounts and locations of human disturbance close to waterways.





Moderate Human

Very Low

Modification

Ranking

# 4.1.1.6 Aquifers

In addition to the surface water aquatic habitats previously described, which are visible and more easily recognizable as natural assets, groundwater and aquifers are also important components of the aquatic ecosystem. Groundwater refers to water that occurs underground, and aquifers are saturated geological units that are permeable and yield water in a usable quantity to a well, spring, or stream. These underground natural assets provide important provisioning services to the community and will require management by the City, especially in the face of a changing climate. As shown in **Figure 4-15**, a single aquifer (number 39) supports almost the entirety of Pitt Meadows, and this aquifer is ranked as being highly vulnerable to human disturbance (i.e., contamination). A separate aquifer (number 38) supplies groundwater to a small area of the City between Neaves Rd and 216 St; this aquifer is ranked as moderately vulnerable to impacts.

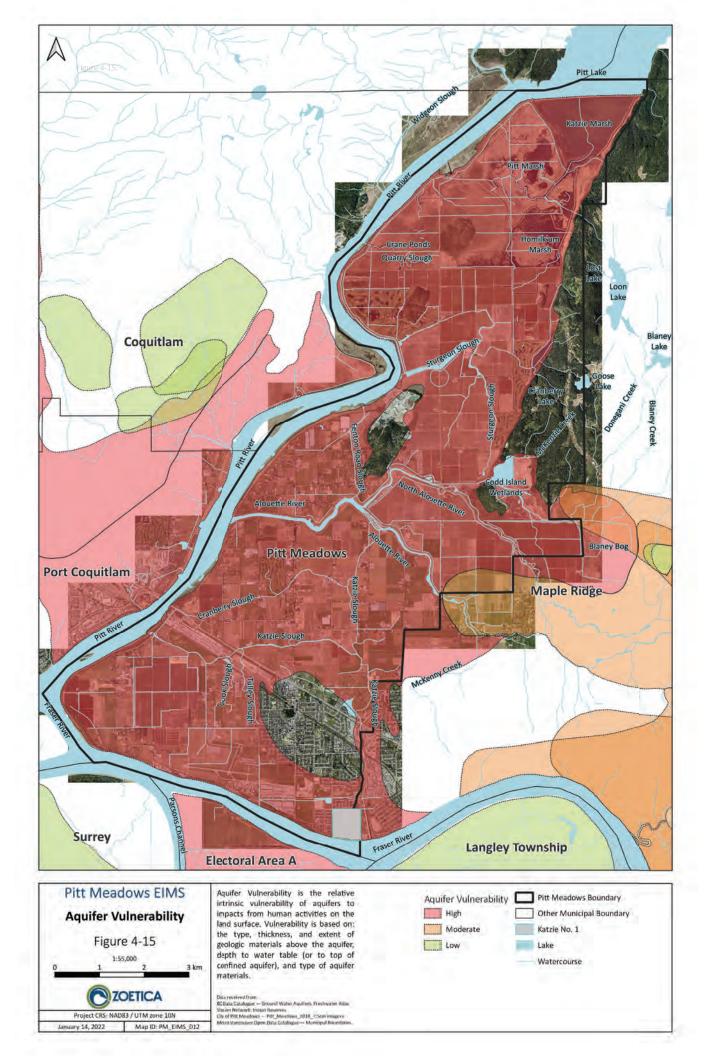
A summary of aquifer information is provided in **Table 4-3**. The two aquifers supplying groundwater to Pitt Meadows are 'unconfined', which allows them to recharge more quickly (e.g., on the order of days/years rather than decades/centuries). However, unconfined aquifers are not protected (or 'confined') by a less permeable layer known as an aquitard; unconfined aquifers may become exposed at the ground surface and are thus highly susceptible to contamination from human activities. The current and potential values of, and risks to, groundwater aquifers are discussed in more detail in Section 4.1.2.4.

Table 4-3. Provincial data for groundwater aquifers in the City of Pitt Meadows.<sup>9</sup>

Aquifer ID (Map Colour)	39 (Red)	38 (Orange)
Location	East Pitt River	Alouette
Material	Sand and Gravel	Sand and Gravel
Subtype	Unconfined sand and gravel – large	Unconfined sand and gravel aquifer
	river system	<ul> <li>medium stream system</li> </ul>
Vulnerability	High	Moderate
Productivity	Moderate	Moderate
Demand	Low	Low
Water Use	Potential Domestic	Multiple
Quality Concerns	-	-
No. Wells Correlated to Aquifer	11 (Low)	41 (Low) – none located in Pitt
(Calculated Well Density)		Meadows
No. Groundwater Licenses	0	0

45

<sup>&</sup>lt;sup>9</sup> Aquifer information was obtained from the 'Ground Water Aquifers' dataset available from the BC Data Catalogue. Summary information is also available from the provincial database: https://apps.nrs.gov.bc.ca/gwells/aquifers



# 4.1.2 Values of Aquatic, Wetland, and Riparian Habitats

Wetlands are important features in the landscape of Pitt Meadows. The services, or functions, that wetlands offer include protecting and improving water quality, providing fish and wildlife habitats, and regulating water volumes, flood risks, and flow. Wetlands also provide flood protection, shoreline erosion control, opportunities for recreation and aesthetic appreciation, and natural products.

#### 4.1.2.1 Relative Values for Flood Risk and Protection

Pitt Meadows is naturally prone to floods due to its low elevation relative to sea level. In addition to this, climate change models predict a probable exacerbation in winter and spring flood risks, and greater and prolonged summer drought conditions (PCIC 2013, Metro Vancouver 2016). There is a growing consensus that the Lower Fraser River and surrounding area will likely experience warmer, drier summers and milder, wetter winters over the near- to medium-term, due to changing climatic conditions. Modeling for the Fraser Basin region shows that, under a moderate climate scenario, the average temperature is likely to warm by 2.5 °C in the summer, and 1.4 °C in the winter, by the mid-century (PCIC 2013). This magnitude of change would result in a 17% increase in winter precipitation and a 15% decrease in summer precipitation compared to current levels (PCIC 2013).

The sea level is also predicted to rise by at least one metre in the next 100 years (Ausenco Sandwell 2011). Some of the most recent regional modeling for Metro Vancouver, based on the "business as usual" scenario (RCP 8.5), suggest even greater changes, with an increase of 3.7 °C in summer and 2.4 °C in the winter by 2050, with an 11% increase in precipitation in the fall and a 19% decline in precipitation in the summer (Metro Vancouver 2016). After 2050, climate change is predicted to cause continued warming and even more extreme temperatures by 2100 and beyond. These scenarios need to be considered alongside the values of wetlands, waterways, lakes, sloughs, and vegetated land for absorbing water in the fall and spring and enabling its use in the summer.

Wetland functions for controlling water volumes is of great value. Wetlands function as 'natural sponges'; they store floodwaters and maintain surface water flow during dry periods. Wetlands act to trap and slowly release surface water, rain, snowmelt, groundwater, and flood waters. Trees, root mats and other wetland vegetation also act collectively to slow the speed of flood waters that pass through them, which leads to the slower distribution of water over the floodplain. This combined water storage and slowed speed of water release lowers flood heights and reduces erosion. Therefore, protecting wetlands can protect against flooding, or to decrease its severity.

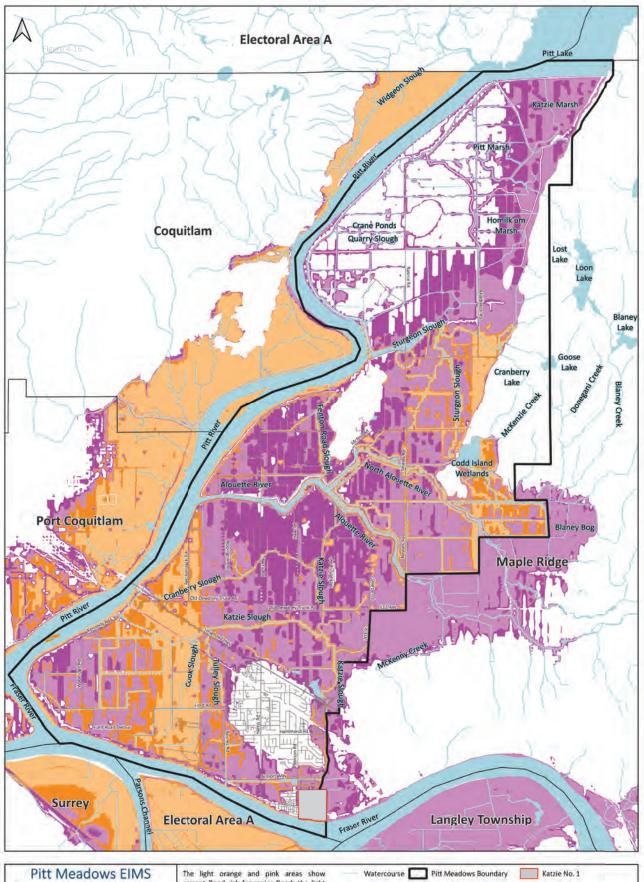
Wetlands within and downstream of urban areas, or areas undergoing increasing urbanization pressures, are particularly valuable. Wetlands in such locations serve to greatly reduce the rate and volume of surface water runoff from pavement and buildings. The holding capacity of wetlands helps control floods and prevents water logging of crops; these are two features of wetlands that are particularly important within the context of Pitt Meadows. Preserving and restoring wetlands together with other natural assets that assist in water retention can often provide the level of flood control otherwise required by expensive dredge operations, stormwater expansion plans, and levees. Retaining vegetation and wetlands along and near the foreshore of the Fraser River will also assist in mitigating against the flood-prone conditions of this area, as trees and vegetation "sop up" water and stabilize banks against fast-flowing flood waters (preventing the loss of land).

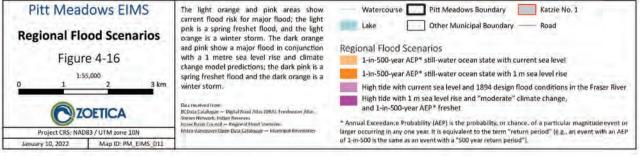
To assist the City in making conservation decisions regarding wetlands that are the most essential in mitigation against flood risks, Zoetica produced maps that show the spatial area of the current 1 in 500 annual exceedance probability (1:500 AEP) flood zones at present, and with climate change assumptions of a 1 m sea level increase and moderate climate change scenario assumptions, along with an assumption of dike breaches and failures. The Fraser Basin Council supplied Zoetica with shapefiles (in 2018) that depict four main flood scenarios that include dike failures: 1. A present day 1:500 AEP winter flood event (Figure 4-16, light purple); 2. The additional extent of a 1:500 AEP winter flood event with a 1 m sea level rise assumed due to climate change and a winter storm surge (Figure 4-16, dark purple); 3. A present day 1:500 AEP flood event due to spring freshet (Figure 4-16, light green), which last occurred in 1894; and 4. The additional extent of a 1:500 AEP spring freshet flood with a 1 m sea level rise due to climate change and "moderate" climate change assumptions (Figure 4-16, dark green). Although the winter and spring flood scenarios (purples and greens) largely occur at different times of the year, they are presented on the same map to show the overall areas of Pitt Meadows that are at risk of a large flood.

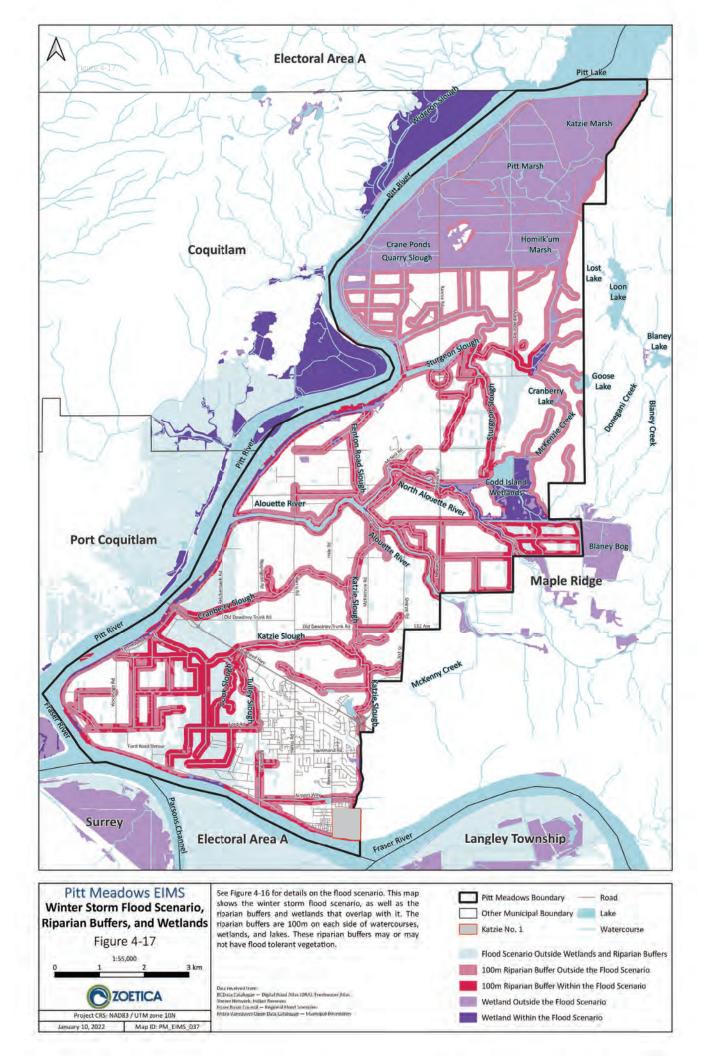
To analyze the relative value of various wetlands and water features for mitigation of the winter flood 1:500 AEP scenario, the winter flood maps with 1 m of sea level rise were superimposed over existing wetlands to show areas with high overlap (i.e., areas where wetlands are already acting as mitigation in terms of their holding capacity). Riparian areas that overlap with this flood scenario were also included on maps to identify the locations where maintaining or restoring riparian vegetation would be most beneficial for flood mitigation. Wetlands that occur within and outside of the winter flood zone are shown in **Figure 4-17**. Riparian areas where conservation or enhancements would be most beneficial in terms of flood mitigation are also shown on **Figure 4-17**. Although it is recognized that these riparian zones are not all vegetated, these maps show areas where habitat enhancements could be most beneficial to flood mitigation, and also provide information about areas where trees selected for planting should be flood resistant (e.g., deep rooting structures, able to "sop up" lots of water).

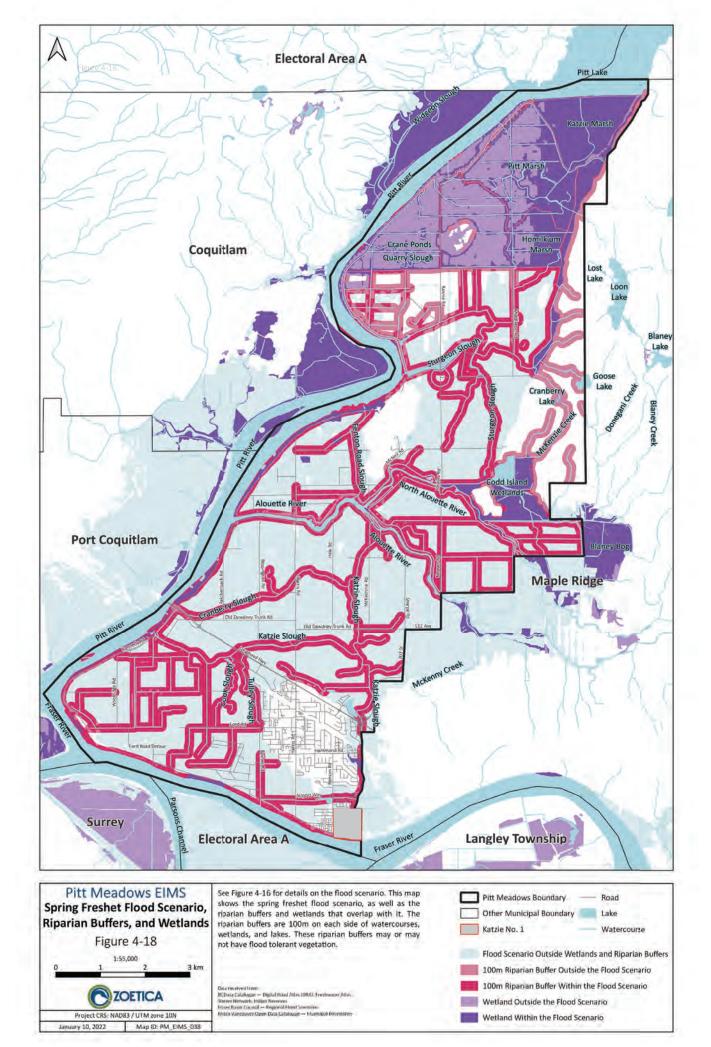
To analyze the relative value of various wetlands and water features for mitigation of spring freshet flood 1:500 AEP scenario, the spring freshet flood maps were superimposed over existing wetlands to show areas with high overlap (i.e., areas where wetlands are already acting as mitigation in terms of their holding capacity). Riparian areas that overlap with this flood scenario were also included on maps to identify the areas where maintaining or restoring riparian vegetation would be most beneficial for flood mitigation. Wetlands that occur within and outside of the spring freshet flood zone are shown in **Figure 4-18**. Riparian areas where conservation or enhancements would be most beneficial in terms of flood mitigation are also shown on **Figure 4-18**.

Finally, when both flood scenarios are considered together, areas where natural water-storing systems (e.g., wetlands) show the greatest overlap with projected high magnitude, low probability flood risks can be better understood. Retaining natural assets within those areas, along with a functioning dike system, may help to provide some natural resilience to flood events. Based on this overlay, the wetlands and riparian zones that show the greatest overlap with the flood scenario analyzed can be pulled out. These systems that do overlap flood scenarios may deserve more focused attention, or investigations, in terms of their overall importance in providing natural resilience against flood events. The key areas generated from this exercise are: 1. Codd Island Wetlands; 2. Katzie Marsh, Pitt Marsh, Homilk'um Marsh; 3. Katzie Slough and connected tributaries and drainage ditches; 4. Sturgeon Slough and connected tributaries and drainage ditches.









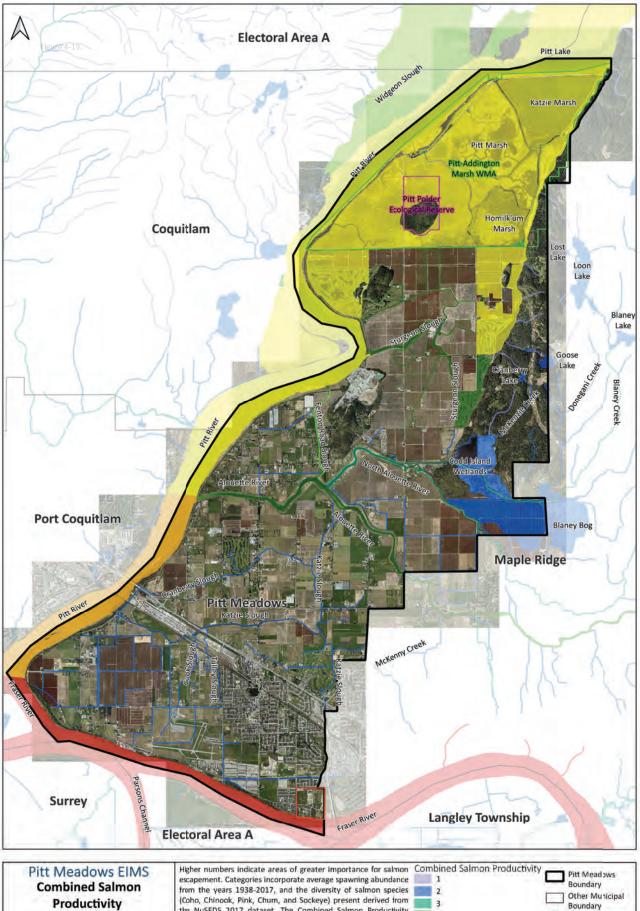
# 4.1.2.2 Relative Values of Aquatic Habitats for Salmon

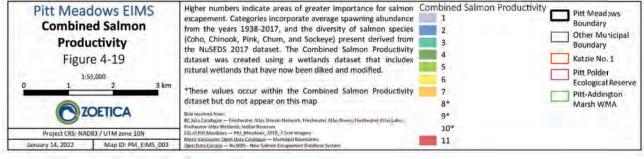
As the engagement feedback received indicated that the community and focus group members place a high importance on salmon, salmon escapement (productivity) was analyzed and mapped across the study area to produce a starting point for prioritization of restoration work focused on salmon. The value of fish travel corridors as migratory necessities was also contemplated and ranked based on the key habitats that they connect. Protecting waterbodies and adjacent riparian vegetation along waterways that contribute the largest numbers of salmon to the study area and regional area will result in benefits to many community members and First Nations. The same exercise could be done for rearing and holding sites, or for habitat of importance to eulachon, sturgeon, and other species of importance to community members and First Nations; however, due to a lack of systematically collected data across the study area, this was not possible at the time of the EIMS. The mapping of such areas in a systematic fashion is identified as an important data gap needing to be addressed by DFO and other agencies; however, the scope of this data gap is large and outside of the responsibility and jurisdiction of Pitt Meadows. Zoetica notes, however, that the relative distribution of high value habitat calculated and mapped for salmon in this section generally coincides with knowledge of the relative importance of many of the same aquatic systems for white sturgeon, although some differences between the species are expected seasonally.

To create relative salmon productivity maps, long-term datasets were first analyzed and converted to a mapped product over the whole of the Lower Fraser region; maps for Pitt Meadows were then created, such that they represent salmon ranks relative to the larger Lower Fraser system. For a more detailed discussion of how Salmon Index values were derived across the study area, refer to Appendix C – 2020 Field Surveys and Desk-based Research in this report and Appendix B of Zoetica and LFFA (2020).

**Figure 4-19** shows the resulting Combined Salmon Productivity Map, which considers information about all salmon species and salmon diversity on a single map for ease of decision-making. Species-specific maps (for chum, pink, chinook, sockeye, coho) are available in Appendix C – 2020 Field Surveys and Desk-based Research. The species-specific maps will allow users to view and select areas that are productive for a given salmon species. For example, looking at sockeye alone would allow users to take into consideration areas important to this species, which is comparatively more diverse (has more Conservation Units in the study area), and may be more critical to protect, particularly under the lens of prioritizing diversity. From another perspective, and depending on how climate change progresses, it may also be preferable to focus on protecting the hardiest species. According to PFRCC (1999), chinook have the highest preferred temperature range (up to 15 °C); therefore, they may be more resistant to higher average water temperatures. Chinook were also noted by Brett (1952) as being more temperature resistant than the other Pacific salmon species. Having species-specific maps will allow map users the flexibility to view detailed information specific to their perspective/objectives. Note that all of these maps were produced prior to any edits made as a result of First Nation feedback.

Based on this exercise, aquatic habitat that precipitates out as the most important for salmon, in order from most to least important, is: 1. Fraser River; 2. Pitt River from confluence of Fraser River north to the Alouette River; 3. Pitt River north of the Alouette River and into Pitt-Addington WMA; 4. Alouette River and tributaries from connection with the Pitt River eastward to the branch point and along the south arm; 5. Sturgeon Slough; 6. North Alouette River; 7. Various other sloughs (Katzie Slough, Tulley Slough, Cook Slough, Cranberry Slough) and associated ditch systems.

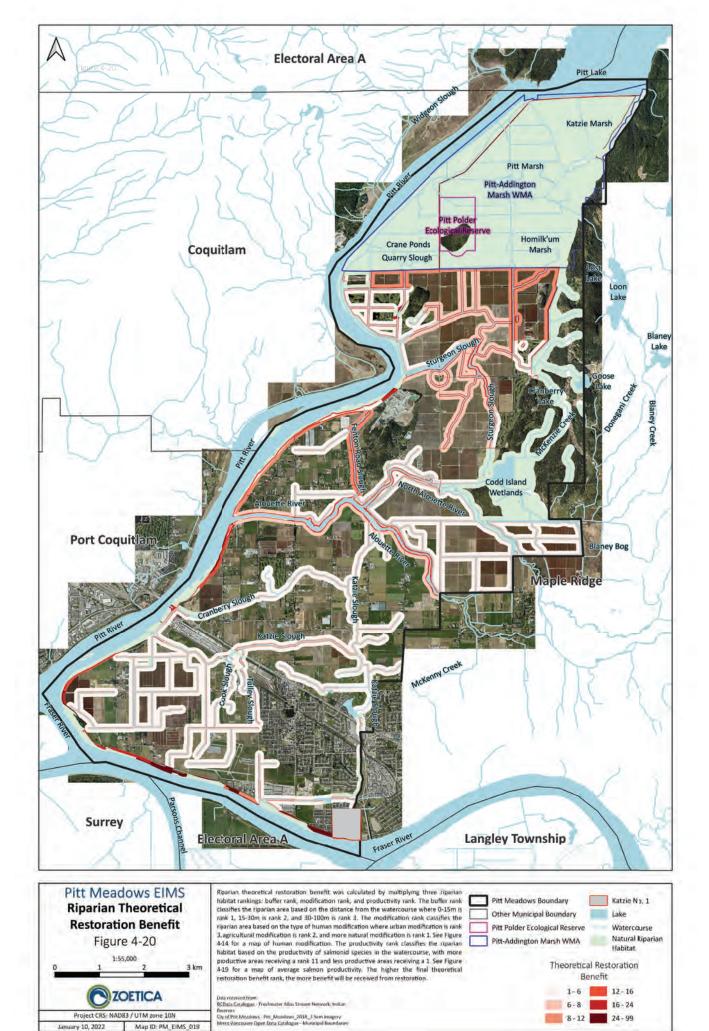




# 4.1.2.3 Relative Values - Riparian Habitat Restoration Potential for Salmon

Retaining or restoring adequate streamside vegetation that includes large shading trees is important. Large shading trees will help reduce impacts of climate change on increasing water temperatures and will give fish cooler stopover sites along their migratory routes. Likewise, streamside vegetation with deep root systems is essential for stabilizing shoreline banks and preventing erosion, bank failures, and a loss of land during raging river conditions, while also helping to clean runoff water entering waterways from urban or agricultural activities, all of which are important for the maintenance of healthy salmon populations.

To map riparian zones relative to their importance to salmon, the Combined Salmon Productivity Map (Figure 4-19) was overlain with the layer showing human modification in riparian areas (Figure 4-14). The riparian rank was then calculated by multiplying the riparian zone rankings, modification rank, and productivity rank. The resulting map highlights areas where restoration potential for preserving salmon would be most beneficial (Figure 4-20), based on the highest value salmon habitat and the severity of human modification in adjacent riparian habitats. However, it is noted that some of the highest value areas may include the most difficult to remedy human modifications. Therefore, before determining the areas for prioritization, the mapped areas should all be visited to determine the areas where habitat restoration is feasible, and where it is not, and ranking decisions should eliminate those areas where restoration is not possible or feasible.



# 4.1.2.4 Value of Aquifers

Aquifers are valuable to both the community and natural ecosystems and biodiversity. Groundwater is used by the community for a variety of purposes, including rural domestic water supplies, municipality/public works (e.g., park operations), agriculture (e.g., irrigation, livestock watering), and industry (e.g., processing plants). Groundwater helps to maintain base flows in rivers and streams and thus are critical for maintaining fish and wildlife habitat, spawning areas, and wetlands. As discussed in Section 4.1.2.1, wetlands, in turn, slow floodwaters and allow absorption and storage of water to recharge aquifers.

There are two main threats to aquifer integrity: human-related impacts to groundwater quality and groundwater supply. Groundwater contamination can result from a variety of sources, including fertilizers, septic systems, gasoline stations, waste disposal, mining, industrial processing, product storage, and transportation activities. As it is very difficult and costly to remove contaminants from groundwater, and a contaminated aquifer may not be usable for many years or even lifetimes, a proactive approach to prevent contamination is needed. Based on provincial data, there are currently no quality concerns (see Table 4-3).

Groundwater supply does not appear to be a concern at present. As shown in **Table 4-3**, the demand for groundwater and calculated well density for both aquifers in Pitt Meadows are considered low, and there are currently no groundwater licenses. However, groundwater usage may be expected to increase if surface water supplies become less accessible. For example, the risk of surface water drying up in late summer is expected to increase due to climate change, and agricultural landowners may need to increase groundwater usage for irrigation. Where groundwater withdrawal exceeds replenishment, this will impact connected aquatic habitats and the fish, wildlife, and community members that depend on them.

It is important that the City continue to monitor and update policies and tools for both surface water and groundwater management to meet the needs of its citizens and for climate change resilience planning.

# 4.2 Terrestrial Habitat

# 4.2.1 Inventory of Terrestrial Habitat

Terrestrial habitats include upland (drier) natural habitat types described in Metro Vancouver's SEI dataset. Forested and vegetated areas of terrestrial habitats were assigned the following six categories, as per the methods in Appendix B – Habitat Quality Assessment and SEI Verification:

- Old Forest Generally conifer-dominated forest with complex vertical structure, where the
  canopy tree ages are mostly 250 years old or older, but may include older mixed coniferous
  stands.
- *Mature Forest* Forests generally >80 years old and <250 years old. Mature forests can be coniferdominated or mixed conifer and deciduous.
- **Young Forest** Forests generally >30-40 years old and <80 years old. Young forests can be coniferdominated, mixed conifer and deciduous, or broadleaf-dominated.
- Woodland Open forests, generally between 10-30% tree cover as a result of site conditions.
   Found on dry sites, mostly on south-facing slopes of rocky knolls and bedrock-dominated areas.
   Stands can be conifer dominated, or mixed conifer and arbutus or deciduous hardwood (e.g., Garry oak).

- Old Field Lands formerly cultivated or grazed but later abandoned. As an intermediate stage in succession, old field sites will eventually become forest if left unmanaged; some may have been wetlands where the drainage has been altered for farming.
- **Sparsely Vegetated** Areas of low vascular vegetation cover, generally 5-10%, but may be greater in some areas. May have high cover of mosses, liverworts, and lichens. Include cliffs, rock outcrops, talus slopes, sand or gravel spits, and sand dunes.

The resulting map of terrestrial habitat polygons is presented in **Figure 4-21**. Semi-natural polygons assigned to the modified subclass are also displayed on this map to indicate areas that could regenerate into more natural habitats (either passively or through active restoration) and potentially improve ecosystem connectivity.

Forested areas include old forest, mature forest, young forest, and woodland habitats. As shown in **Table 4-1**, forested habitats comprise a total of 758.0 ha, which represents 7.8% of Pitt Meadows and 20.8% of all natural vegetated units. Mature forest (528.1 ha, 5.5%) makes up the majority of forested areas, followed by young forest (202.3 ha, 2.1%). Woodland and old forest are rare habitats, making up only 19.7 ha (0.2%) and 7.9 ha (0.1%) of the City, respectively. The distribution and value of urban and rural forests are discussed in more detail in Sections 4.2.1.1 and 4.2.2.1, respectively.

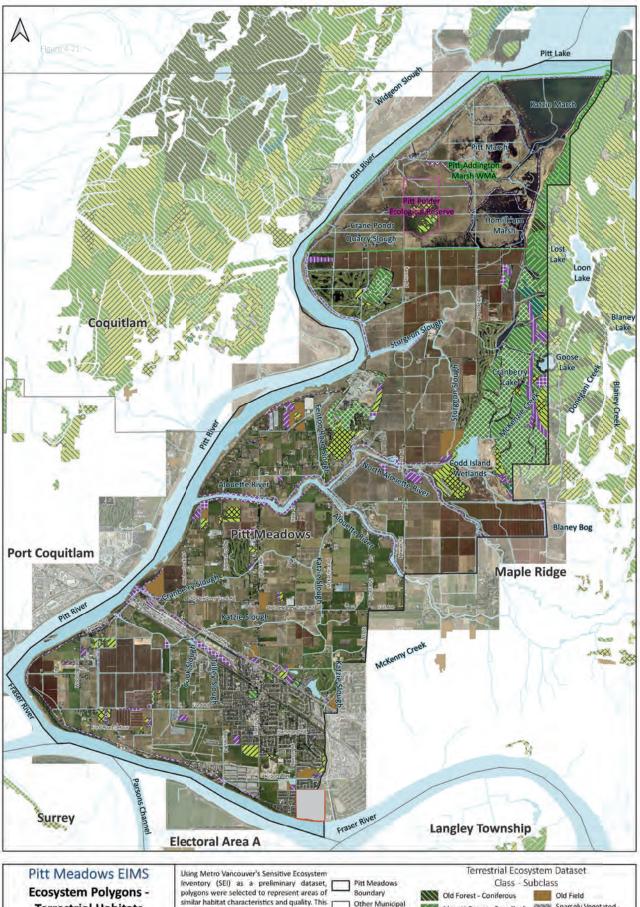
Old field habitats comprise 84.3 ha (0.9%) of the City of Pitt Meadows. This area represents 1.3% of the ALR, indicating that the majority of agricultural lands in Pitt Meadows are either farmed/modified or not in a state of abandonment that would qualify the habitat as old field (i.e., early successional stage), according to the Metro Vancouver's SEI Technical Report (Meidinger *et al.* 2014). The distribution and value of old field habitats are discussed in more detail in Sections 4.2.1.2 and 4.2.2.2, respectively.

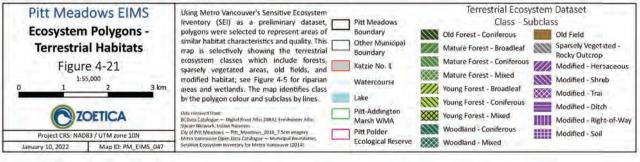
Sparsely vegetated habitats are rare, comprising only 4.4 ha (0.05%) of the City. The only polygons classified as sparsely vegetated are in the Sheridan Hill area (polygon 1021) and the Codd Island Wetlands (polygon 1362; see **Figure 4-21**). Due to the rarity of this habitat class, the inventory and value of sparsely vegetated areas will not be discussed in detail in this report. However, even sparse vegetation provides some erosion control and slope stability; and the landforms upon which sparse vegetation is more likely to occur, such as rock outcrops, may also provide important wildlife habitat.

There are eight performance indicators associated with three management objectives (ENA 8.8.1, ENA 8.8.2, PR 4.1.2) related to terrestrial habitats that are recommended for use in this EIMS (see Section 6.0). Indicators include the proportion of natural areas available, of high quality, and protected; connectivity measures; and carbon storage capacity as related to urban and rural tree cover. Current baseline values within the City range from Optimal to Low (see **Table 6-1**); for example, while there is a large amount of high-quality natural areas (e.g., Pitt-Addington WMA), the amount of tree cover in built areas is low, especially for urban areas – only 4% of the total urban area<sup>10</sup> is treed. Recommended policies and actions that can assist with managing terrestrial habitats, and to help the City improve upon the current baseline values, are found in Section 5.0.

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 $<sup>^{10}</sup>$  Urban area includes the area in the OCP Schedule 3A - Urban Land Use shapefile plus the Katzie First Nation Reserve.





#### 4.2.1.1 Urban and Rural Forests

The term 'urban forest' refers to trees in parks, around buildings, along streets, and in backyards. Urban trees can grow in challenging environments; stressors such as poor soils, confined root space, summer drought, air and water pollution, and greater susceptibility to disease and insects can impact tree health and survival. Urban forests such as remnant forest patches also face development pressures when they are considered to be in 'prime' residential or commercial locations. Rural forests refer to more natural forested habitats outside of urban and suburban areas, such as those in regional or provincial parks.

Within Pitt Meadows, the largest remaining forested habitats are located north of the Alouette River (see **Figure 4-21**) and include the Thompson Mountain (Mt.) range, patches within the Pitt Polder Ecological Reserve, the northeast area of Swaneset Bay Resort and Country Club (hereafter 'Swaneset'), Sheridan Hill south of the Pitt River Quarries, and the Codd Island Wetlands. These areas are mainly composed of mature and young forests. Of note, Thompson Mt. harbours the only patch of old forest (habitat class) in Pitt Meadows (located east of Homilk'um Marsh), as well as relatively large patches of woodlands (located west of Loon Lake; see **Figure 4-21**).

Forested habitats south of the Alouette River are smaller, primarily composed of young forests, and occur on both City- and privately-owned lands (see **Figure 4-21**). Hoffmann Park and the NLSA harbour two of the remaining mature coniferous forest stands within the City's population centre; as noted during community and stakeholder engagement (see Section 3.0 and Appendix A – Engagement Summary), there are concerns that proposed infrastructure and development projects will impact these habitats. Although Harris Landing and Shoreline Park, and other sections of the PRRG, are technically classified as riparian habitats under the SEI habitat classification system used by Metro Vancouver (see **Figure 4-2**), field surveys and community engagement identified patches of mature coniferous and deciduous trees that should be protected. Among young forest habitats, relatively large remnant or planted areas exist surrounding Airport Trail off Harris Road and at polygons 1045 and 967 (private property off Rippington Road just south of the Alouette River).

Select field photos of urban and rural forests are shown in Figure 4-22.







**Figure 4-22.** Photos of urban and rural forests during field surveys in the spring and summer of 2020. (a) Mature conifer forest of Hoffmann Park. (b) Airport Trail through young forest habitat. (c) Mature conifer forest at Swaneset Bay Resort and Country Club.

In December 2020, a search was conducted via the BCSEE for potentially occurring SCC<sup>7</sup> within the City of Pitt Meadows and then vetted to remove species that require habitat conditions or topography/elevation ranges not represented in the City (see Appendix G – Matrix of Habitat Suitability for Species of Conservation Concern). Forested habitats (conifer, mixed, deciduous, riparian) could host up to 35 SCC, including six mammals, 16 birds, one reptile, four amphibians, five insects, two molluscs, and one vascular plant.

During the 2020 field work for the EIMS project, bird surveys were conducted at three locations within *mature forests*: plots 35, 36, and CC03 (see **Figure 4-3** and Appendix C – 2020 Field Surveys and Desk-based Research). A total of 14 bird species were observed during systematic surveys, none of which were SCC. Eleven additional bird species were observed incidentally, including one SCC (barn swallow). Several of the birds observed are indicative of coniferous or mixed forests and were not observed in other surveyed habitats, such as Pacific wren, red-breasted nuthatch, Steller's Jay, western tanager, and red crossbill. An eBird hotspot is located at the eastern end of Thompson Road where the Thompson Mt. range begins; 122 species have been observed at/around this area<sup>6</sup>. Among the target invasive plant species (see Appendix B – Habitat Quality Assessment and SEI Verification), Himalayan blackberry was noted at two out of 10 survey locations, and Japanese knotweed was recorded once at the edge of the NLSA. English ivy, an invasive species of concern identified by the ISCMV and the Invasive Species Council of British Columbia (ISCBC), was also recorded in Hoffmann Park.

Bird surveys were conducted at four locations within *young forests*: plots 11, 15, 29, and 32 (see **Figure 4-3**). A total of 19 bird species were observed during systematic surveys, including one SCC (great blue heron, *fannini* ssp.). However, it should be noted that the heron was flying over plot 29, a remnant patch of young forest surrounded by agricultural lands and ditches that harboured frogs. One additional species was observed incidentally (not a SCC), as well as two bird nests (unidentified species) and honeybees. Among the target invasive plant species, Himalayan blackberry and reed canarygrass were most

commonly observed. Morning glory/field bindweed, Scotch broom, and Japanese knotweed were also observed in disturbed areas (see Appendix C – 2020 Field Surveys and Desk-based Research).

A habitat quality assessment was conducted within one **woodland** polygon: plot 24 located at Harris Road Park (see **Figure 4-3**). A breeding bird survey was not completed at this location due to the time of visit; however, three bird species were observed incidentally (none were SCC). Wildlife habitat may be limited within this woodland polygon due to human modifications and activities: the assessed polygon was adjacent to a very busy section of Lougheed Highway, there is a paved trail (part of the Lougheed Highway multi-use trail) and park benches and picnic tables throughout the polygon, and grassy areas are maintained.

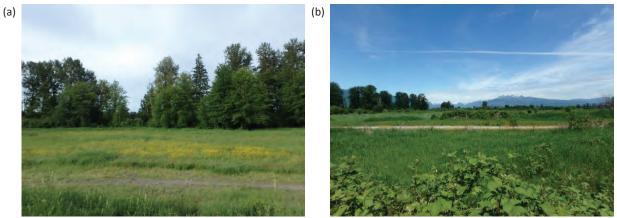
#### 4.2.1.2 Old Field Habitat

According to the Metro Vancouver's 2014 SEI, there are 14 polygons of old field habitat within the City of Pitt Meadows. As many of these polygons are on private agricultural land, it is unclear whether these old field habitats are truly abandoned or will become actively farmed again in the future. Ideally, wildlife surveys would be conducted prior to resuming activities in long-term fallow fields; the presence of SCC may require spatial and/or temporal mitigation to avoid destroying/disturbing these species and their habitat. In December 2020, a search was conducted via the BCSEE for potentially occurring SCC<sup>7</sup> within the City of Pitt Meadows and then vetted to remove species that require habitat conditions or topography/elevation ranges not represented in the City (see Appendix G – Matrix of Habitat Suitability for Species of Conservation Concern). Pasture/old field habitats could host up to 22 SCC, including one mammal, 20 birds, and one insect.

During the 2020 field surveys for the EIMS, an area of (future) old field habitat was found along the PRRG (polygon number 85; see **Figure 4-21**)<sup>11</sup>. This land was used as a hayfield by Metro Vancouver until 2019; however, to align with their Metro 2040 Vision, the area has since been left to grow as old field habitat, with plans for brush cutting along the edges every three years to keep the invasive Himalayan blackberry in check (Tyler Langeloo, Parks Operations Supervisor, Pers. Comm., May 29, 2020). The only bird survey conducted in old field habitat was at this site (plot CC05); a total of 15 bird species were observed during systematic surveys, including one SCC (barn swallow). The only instance of observing the lazuli bunting, a relatively uncommon species in Metro Vancouver that prefers brushy slopes as well as cleared areas and weedy pastures, occurred at this site. Six additional bird species were observed incidentally in old field habitats, including one SCC (great blue heron, *fannini* ssp.). Among the target invasive plant species (see Appendix B – Habitat Quality Assessment and SEI Verification), Himalayan blackberry was noted at all three old field sites surveyed; Canada thistle was also observed at plot CC05 (see Appendix C – 2020 Field Surveys and Desk-based Research). Select field photos of old field habitat are shown in **Figure 4-23**.

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<sup>&</sup>lt;sup>11</sup> Polygon 85 is currently classified as a "Park" in **Figure 4-21** since the habitat has not been left abandoned for long enough to be considered true old field habitat according to SEI data specifications. However, as Metro Vancouver intends for the area to grow as old field habitat, polygon 85 is discussed here rather than in Section 4.4 (Parks, Open Spaces, and Protected Areas).



**Figure 4-23.** Photos of old field habitat (a) off the Pitt River Regional Greenway (land owned by Metro Vancouver), and (b) north of Lougheed Highway after the Pitt River Bridge.

# 4.2.2 Value of Terrestrial Habitat

#### 4.2.2.1 Urban and Rural Forests

Urban and rural forests, especially old and mature forests, provide climate change resiliency and a variety of ecosystem services for the community. The benefits provided by forest ecosystems include:

- Goods such as timber, food, fuel and by-products;
- Ecological functions such as carbon storage, nutrient cycling, water and air purification, and providing food and habitat for wildlife;
- Moderating flood risks by absorbing excess water, and intercepting rainwater to reduce erosion;
- Providing shading to waterways to minimize the impacts of ambient air temperature increases on
  water temperature increases, which protects aquatic life and reduces aquatic habitat quality for
  invasive plant species like parrot's feather; and,
- Social and cultural benefits such as recreation, traditional resource uses, and spirituality.

Mature trees are able to sequester much more carbon than young saplings; therefore, it is important to not only encourage tree planting to expand urban forests within the City, but to preserve the remaining older forests. Old forests are the most structurally complex and considered the most valuable (especially in terms of representing at-risk ecosystems). However, both mature and young forests can function as essential or important habitat areas for many wildlife species and serve as primary connections between ecosystems in a highly fragmented landscape. Larger areas of forest and greater connectivity also support higher biodiversity than smaller, isolated patches.

The benefits provided by urban forests and other natural assets can be maximized by improving ecosystem connectivity, such as increasing and connecting riparian buffers (e.g., along the PRRG), planting hedgerows along the edges of agricultural fields, creating planted boulevards and traffic circles, encouraging citizens to plant native trees in their backyards, and retaining urban forests and green corridors during development (or re-planting if existing trees cannot be retained). The primary challenge for sustainable forest management is finding ways to continue to benefit from ecological services without compromising the forest's ability to provide those services.

#### 4.2.2.2 Old Field Habitat

Old field habitats consist of agricultural lands that were formerly cultivated or grazed but have since been abandoned. Old field habitats are typically dominated by grasses and shrubs and are similar to historic natural prairie or grassland communities, which have been lost or degraded due to urban development and industrial farming. Old field sites can, therefore, provide important habitat for grassland-dependent wildlife species, including SCC such as barn owl, short-eared owl, and great blue heron, *fannini* ssp. (which all prey on Townsend's vole).

# 4.2.2.3 Relative Values of Terrestrial Habitat (Ecosystem Rankings)

Using the methodology outlined in Appendix B – Habitat Quality Assessment and SEI Verification, Zoetica produced a series of maps to depict the relative values of terrestrial habitats in the City. **Figure 4-24** shows the final ecosystem rankings (very low, low, moderate, high, very high) for all natural or semi-natural polygons. Built polygons dominated by buildings or other infrastructure were not included in the rankings. The component/intermediate maps used to derive the final ecosystem rankings can be found in Appendix F – Habitat Quality Assessment: Analytical Maps. The methodology and rationale for rankings are available in Appendix B – Habitat Quality Assessment and SEI Verification.

2,738 ha (32.8%) of the classified polygons were ranked as "very high" quality. The majority of these areas are located in the north and east of Pitt Meadows and include the Pitt-Addington WMA, Thompson Mt. range, and Codd Island Wetlands. The large spatial extent, ecosystem connectivity, and undisturbed condition render these wetland and mature forested areas particularly valuable. Interestingly, partly as a result of adjacency effects and lack of road impacts, the agricultural fields (polygon 151) nestled between the North Alouette River, Codd Island Wetlands, and Thompson Mt. range are also ranked as very high quality. Within the more developed areas of the City, very high quality polygons exist in the riparian areas along the Pitt and Fraser rivers, remnant mature forest patches at Swaneset and Sheridan Hill, and wetland polygon 2264 and young forest polygon 1017 on private agricultural land near Hollandia Greenhouses.

2,624 ha (31.4%) of the classified polygons were ranked as "high" quality. These polygons include areas designated for a variety of land uses, such as agricultural lands, urban parks, golf courses, riparian areas along the Alouette River, other sections of the Fraser and Pitt river foreshores, and buffer habitats between the very high quality polygons previous noted and more disturbed/modified features (e.g., habitat surrounding roads and trails within the Pitt-Addington WMA, forested habitats closer to built areas). Overall, the City of Pitt Meadows has a relatively high proportion of natural and semi-natural areas ranked as high quality. These polygons are distributed throughout the City except for the urban centre (south of Lougheed Highway between Harris Road and Golden Ears Way), the rural area north of the Alouette River between the Pitt River and Sheridan Hill, and agricultural areas on both sides of the South Alouette River.

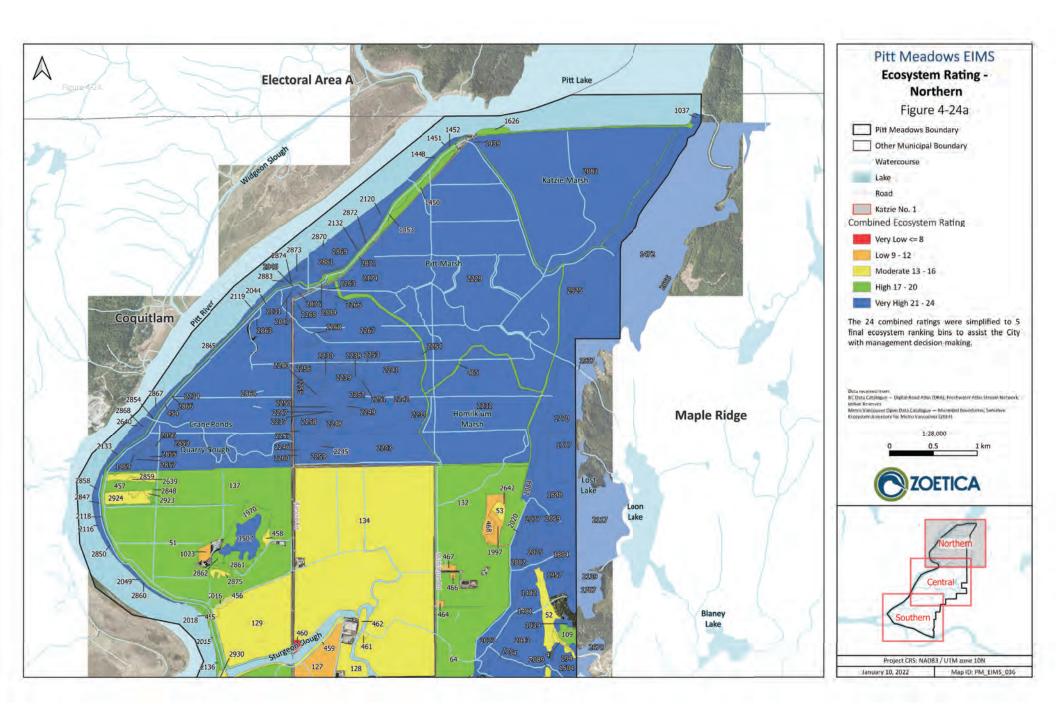
2,252 ha (27.0%) of the classified polygons were ranked as "moderate" quality. The largest areas of moderate quality include agricultural lands in between the North and South Alouette rivers, and those to the north and east of Sturgeon Slough. The 870 ha making up these areas are comprised of only five polygons (117, 159, 129, 134, 138) since these agricultural lands were determined to be fairly uniform. Rural areas along the north of Lougheed Highway, as well as areas in between the Katzie and Cranberry sloughs, are predominantly ranked as moderate quality. South of Lougheed Highway, large areas of

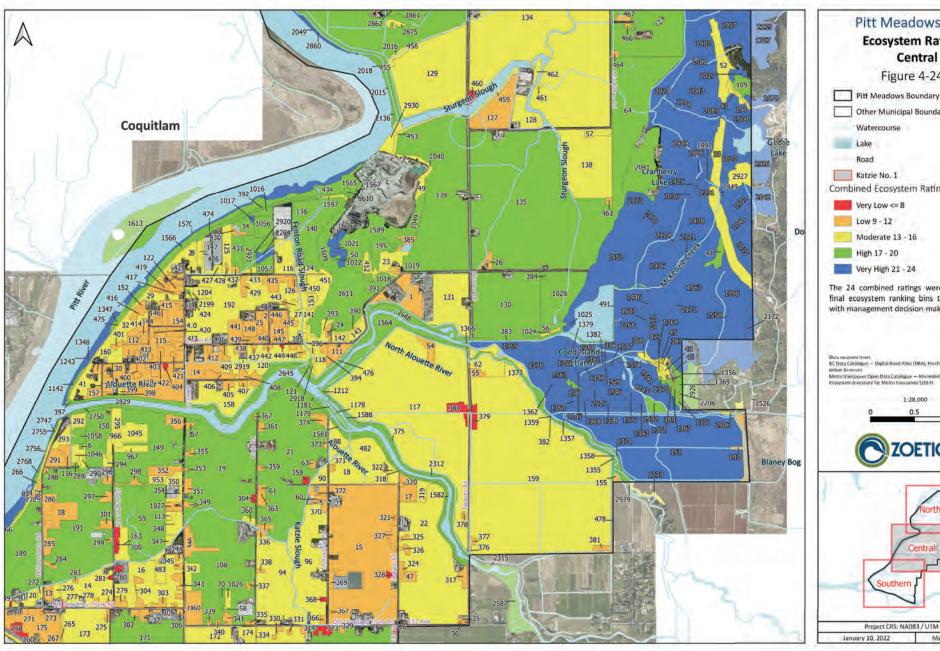
moderate quality include the Pitt Meadows Regional Airport lands and the cranberry fields near the confluence of the Fraser and Pitt Rivers.

706 ha (8.5%) of the classified polygons were ranked as "low" quality. These polygons are distributed throughout the City and include agricultural, industrial, commercial, and residential areas, and some urban parks. The rationale for low quality rankings can be due to several area/size, connectivity, and disturbance factors (see Appendix B – Habitat Quality Assessment and SEI Verification). Therefore, despite the high intrinsic value of certain polygons, such as the mature coniferous forest of Hoffmann Park (see Sections 3.0 and 4.2.1.1), they were ultimately ranked as low ecosystem quality due to the surrounding landscape.

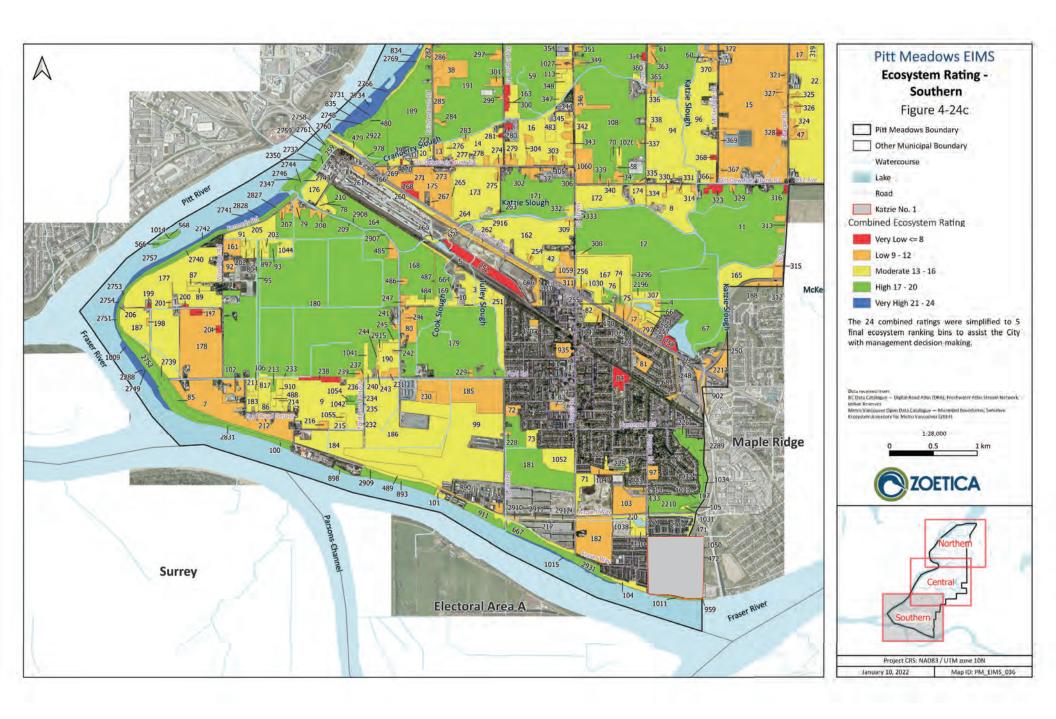
36 ha (0.4%) of the classified polygons were ranked as "very low" quality. These are generally polygons where a small area of semi-natural features exists, different from the surrounding habitat, and associated with some type of disturbance/modification. Examples include cleared but unpaved lots that could naturally revegetate (e.g., polygon 258, the large cleared area southwest of the Loblaws Distribution Centre), and landscaped yards around residential buildings on agricultural land, where there may be a few isolated trees. There are two polygons within the City's urban centre that were ranked as very low quality: polygon 258 is the Fairways townhouse complex between the Meadow Gardens Golf Club and Lougheed Highway; and polygon 84 is North Bonson Park. Similar to the rationale for low-quality urban parks, these two polygons are small and surrounded by highly built areas. Further, as these polygons are predominantly landscaped (North Bonson Park) or built (the Fairways complex) spaces with relatively little tree cover, they do not have the same ecological value as more natural areas.

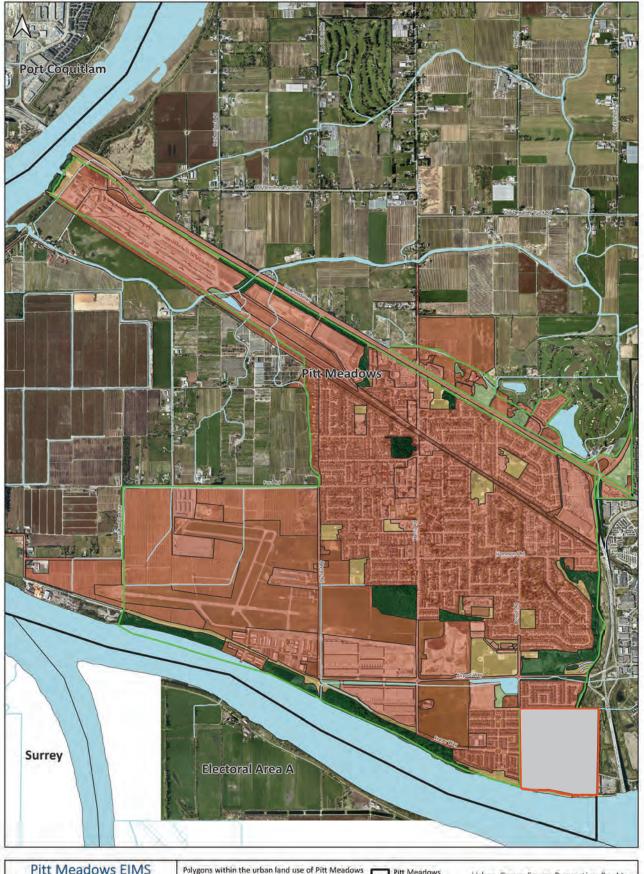
A secondary analysis of "recreation rankings" was completed for the urban area of Pitt Meadows (defined by the 'Urban Land Use' boundaries spatial data provided by the City), presented in **Figure 4-25**. On this map, polygons were ranked according to the habitat type (natural, semi-natural, built) and accessibility for recreation (based on trails within or along the perimeter). Although natural and semi-natural assets in urban areas tend to have lower scores relative to those in rural areas (due to habitat quality assessment components such as area size, area/perimeter ratio, quality of adjacency, and connectivity), the ecological and cultural services provided by accessible, urban green spaces are of high value to the community (see Appendix A – Engagement Summary). Therefore, highly ranked urban assets shown in **Figure 4-25** were considered in Zoetica's EIMS recommendations in Section 5.0.













#### 4.2.2.4 Relative Values for Carbon Storage

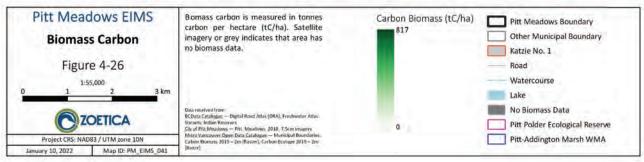
Carbon storage is an important ecosystem service provided by vegetation and soils. Understanding the potential carbon implications of a project is important for municipal planning and environmental management, as the carbon storage provided by natural assets contributes to climate change mitigation and resiliency. For example, wetlands store carbon within their plant communities and soil instead of releasing it to the atmosphere as carbon dioxide, and their presence can help municipalities to reach a carbon neutral status. Metro Vancouver has developed a regional carbon storage dataset (most recently updated in 2019) to provide spatial estimates of carbon stored in vegetation biomass (e.g., trees, shrubs) and soil (Welham and Seely 2019). These data can be used by planners to assess how much carbon could be released by developing an area, how much carbon could be retained by protecting an area, or how much carbon can be additionally stored through restoration of an area.

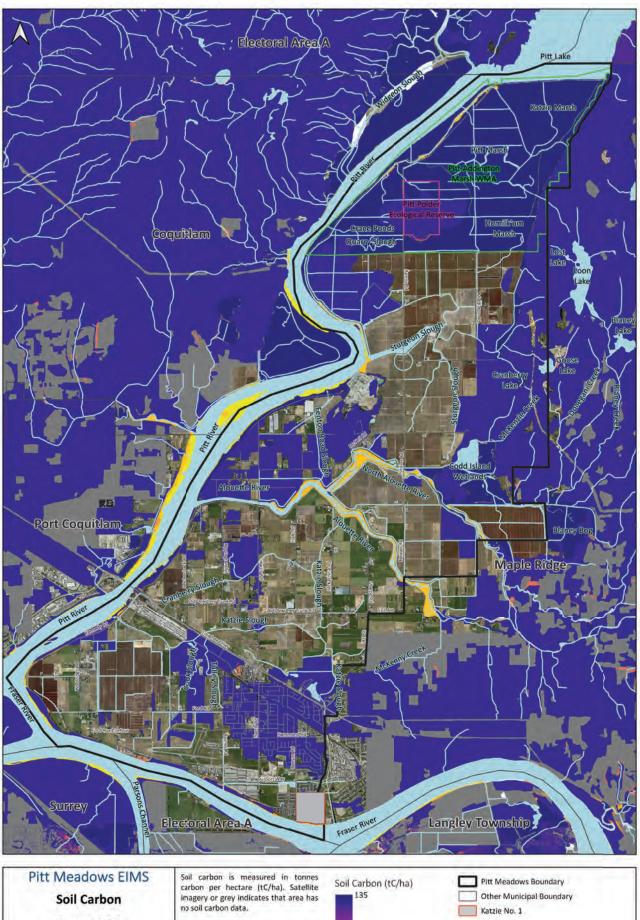
Metro Vancouver's carbon storage dataset for biomass and soils, clipped to the City of Pitt Meadows, are shown in **Figure 4-26** and **Figure 4-27**, respectively. Unfortunately, the dataset is currently restricted to forested, wetland, and riparian ecosystems of Pitt Meadows; therefore, a large portion of the ALR (49% of the City) has not been assessed for carbon storage.

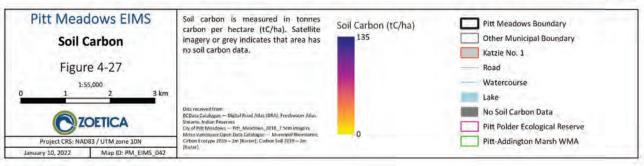
**Figure 4-26** shows that relatively little carbon is stored in biomass within Pitt Meadows, compared to neighbouring jurisdictions with greater forested areas, such as Coquitlam, Electoral Area A, and Maple Ridge. Nevertheless, when compared to SEI data or satellite imagery, darker green areas on the carbon biomass map correspond to mature forested habitats within the City of Pitt Meadows (see Section 4.2.1.1 for a list of specific locations). Development within these forested areas would, therefore, result in larger amounts of carbon being released into the atmosphere and contribute to climate change impacts.

**Figure 4-27** shows that high amounts of carbon are stored in soil, especially within the Pitt-Addington WMA and the Codd Island Wetlands. In fact, when the entire Metro Vancouver region is considered, the largest areas with the highest soil carbon are located at the Pitt-Addington WMA and surrounding marshes west of the Pitt River, and at the Burns Bog Ecological Conservancy Area in Delta (see Figure 15 in Welham and Seely 2019). In general, wetland habitats have the highest soil carbon. Aside from the Pitt-Addington WMA and Codd Island Wetlands, there are wetland habitats along the Pitt River and Fraser River, as well as small polygons within built areas (see **Figure 4-2**).









# 4.3 Agricultural Areas

## 4.3.1 Inventory of Agricultural Areas

Over 70% of the City of Pitt Meadows is located within the ALR. However, not all of the ALR is used for farming; permitted uses of the ALR can be a contentious issue among the community (see Section 3.0 and Appendix A – Engagement Summary). As shown in **Table 4-1**, agriculture habitats make up 3,830 ha (39.6%) of the City. **Figure 4-28** shows the ALR, high-level agricultural subclasses (crops, greenhouses, nurseries), and semi-natural rural habitats (e.g., residential green spaces) present based on Zoetica's interpretation of 2018 satellite imagery.

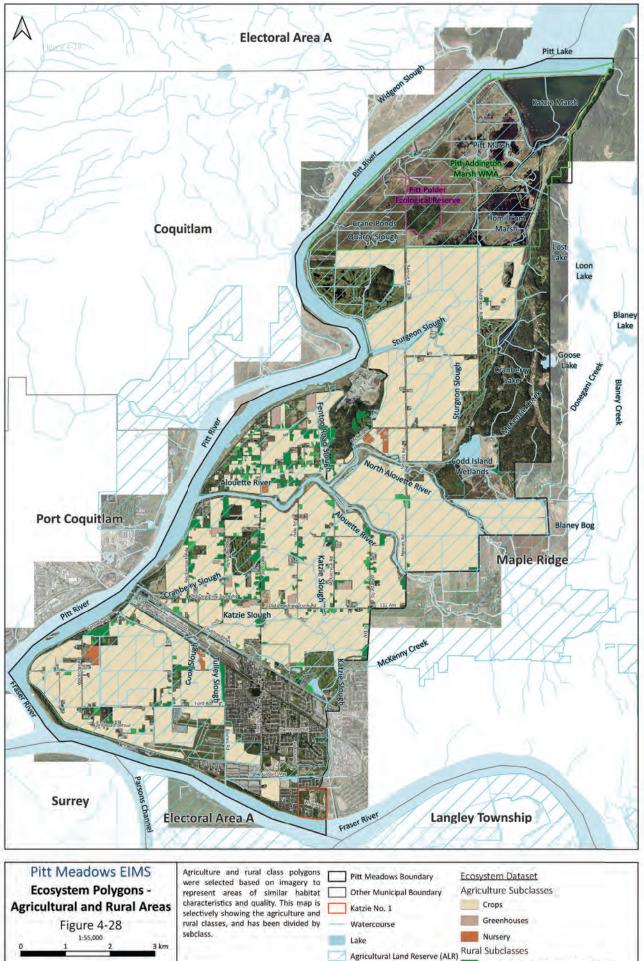
The most recent Agricultural Land Use Inventory (ALUI) for the City of Pitt Meadows was conducted in 2011 by the BC Ministry of Agriculture as part of the "Strengthening Farming Program" (BC AGRI 2014). At that time, Pitt Meadows had 6,868 ha of ALR land and 163 farms. This inventory found that 3,669 ha (53%) was used for farming<sup>12</sup>, 1,280 ha (19%) was anthropogenically modified, and 1,435 ha (21%) was in a natural or semi-natural state. The remaining 484 ha (7%) of the ALR was not surveyed but considered to not be available for farming due to location or size (BC AGRI 2014). Of the areas not actively farmed, 1,876 ha (27%) is unavailable for farming due to existing land uses (e.g., protected areas, parks, golf courses) or unsuitable land cover (e.g., wetlands, waterbodies, non-farm residential use) and 137 ha (2%) had limited potential for agriculture due to physical site limitations (e.g., topography, soils, flooding, small size). Thus, it was concluded that 583 ha (9%) of the ALR had potential for farming but was being used as landscaping and lawns around residential uses (BC AGRI 2014).

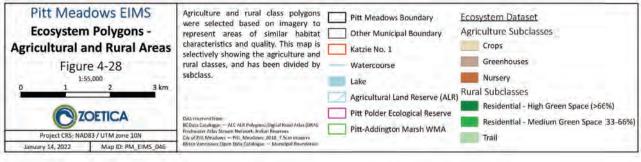
In December 2020, a search was conducted via the BCSEE for potentially occurring SCC<sup>7</sup> within the City of Pitt Meadows and then vetted to remove species that require habitat conditions or topography/elevation ranges not represented in the City (see Appendix G – Matrix of Habitat Suitability for Species of Conservation Concern). Agricultural areas and surrounding habitats, such as cultivated fields, hedgerows, and pasture/old field, could host up to 23 SCC, including one mammal, 21 birds, and one insect.

Bird surveys were not specifically conducted in active agricultural areas as these habitats are not included in the SEI, and bird surveys were typically conducted at the same locations where SEI field verification and habitat quality assessments were performed (see Section 4.2.1 and Appendix B — Habitat Quality Assessment and SEI Verification). However, many survey sites were adjacent to agricultural lands (see **Figure 4-3**). Incidental wildlife observations known to originate from agricultural areas included coyotes and grassland/open habitat bird species such as savannah sparrows and killdeer (see Appendix C — 2020 Field Surveys and Desk-based Research).

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<sup>&</sup>lt;sup>12</sup> 'Used for farming' is defined as parcels where the majority of the parcel area is farmed or parcels that exhibit significant intensity of farming. Specific criteria are detailed in BC AGRI (2014).





From the eBird Canada website, there are three hotspots located within agricultural areas that do not appear to be associated with an obvious natural asset (e.g., watercourse or wetland). These hotspots include Rannie Road between Sturgeon Slough and Swaneset (120 species observed), McNeil Road east of 196c St. (71 species), and Middleton Road north of the Golden Eagle Golf Club (51 species)<sup>6</sup>. However, the locations of eBird hotspots may be imprecise and may cover a larger area than expected, and "newer" hotspots will likely be refined as more observations are made. For example, Middleton Road has since been relocated and updated as "Middleton Rd/Ladner Rd/Koerner Rd Loop". The named loop could encompass a large spatial area that includes Sturgeon Slough and its tributaries. Nevertheless, along with the other two hotspots nearby (Rannie Road and Sturgeon Slough), this general agricultural area of Pitt Meadows is clearly attractive for birds and birdwatchers alike.

## 4.3.2 Value of Agricultural Areas

As noted by the AAC during community and stakeholder engagement meetings, Pitt Meadows has unique soil and soil structure (e.g., Ladner clays) that makes it valuable for crop production. Pitt Meadows boasts some of the richest agricultural land in Canada and ranks sixth among municipalities in BC for agricultural production. Blueberries and cranberries are the dominant crops (see **Figure 4-29** for select field photos); other types of agriculture include dairy production, nursery stock, and greenhouse crops.





Figure 4-29. Photos of (a) cranberry and (b) blueberry agricultural fields adjacent to the Alouette River.

Agricultural areas are not included in Metro Vancouver's SEI data. However, agricultural lands can have some wildlife habitat potential depending on the presence, area, and types of natural or semi-natural vegetation; types of crops; presence of waterbodies or wetlands; and management/maintenance approach (e.g., frequency of cutting or grazing). Therefore, Zoetica interpreted satellite imagery and identified and classified agricultural and rural areas as part of the habitat quality assessments for the EIMS project (see Appendix B – Habitat Quality Assessment and SEI Verification). The relative values (ecosystem rankings) of terrestrial habitats, including agricultural areas, were previously discussed in Section 4.2.2.3 and shown in **Figure 4-24**. Recommended policies and actions that can assist in managing agricultural areas are found in Section 5.0. However, it is emphasized that cooperation with those who own property within the ALR is required, and that these are considered suggestions only; buy-in and cooperation with property owners, along with mutually beneficial outcomes, would likely be needed to include agricultural areas in the overall EIMS.

# 4.4 Parks, Open Spaces, and Protected Areas

This section focuses on areas of Pitt Meadows that have been incorporated into the municipal, regional, or provincial system of parks and open spaces (including greenways and trails)<sup>13</sup>, and their community values. A discussion of ecological values and rankings of the terrestrial habitats found within parks (e.g., mature forest of Hoffmann Park vs. manicured lawn of Somerset Park) can be found in Section 4.2, Appendix B – Habitat Quality Assessment and SEI Verification, and Appendix F – Habitat Quality Assessment: Analytical Maps.

### 4.4.1 Inventory of Parks, Open Spaces, and Protected Areas

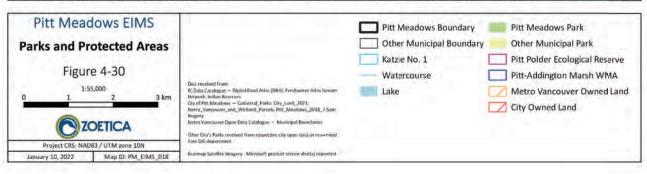
The parks, open spaces, and protected areas under the jurisdiction of the City are shown in **Figure 4-30**. The Grant Wetlands and Codd Island Wetlands are the largest parks in Pitt Meadows and are also protected areas that have been incorporated into provincial and regional planning: the Grant Wetlands include lands within both the Pitt-Addington Marsh WMA (FLNRORD) and Pitt Polder Ecological Reserve (BC Parks), and the Codd Island Wetlands are part of the Codd Wetland Ecological Conservancy Area (Metro Vancouver). Furthermore, Harris Landing and Shoreline Park are part of the PRRG (Metro Vancouver). Aside from Cottonwood Park, the remaining municipal parks are situated within the urban centre. These urban parks vary in size and structure/intended use (e.g., playground, sports field, manicured grass lawn, community garden, urban forests and green spaces with trails or multi-use trails).

There are three performance indicators associated with two management objectives (ENA 8.8.2, PR 4.1) related to parks and protected areas that are recommended for use in this EIMS (see Section 6.0). Current baseline values within the City are Optimal for the two spatial performance indicators regarding accessible green spaces and protected areas. However, the City is currently ranked as Moderate for the management performance indicator, as a formal open space retention and acquisition strategy is being planned but the strategy has yet to be implemented. Recommended policies and actions that can assist in managing parks, open spaces, and protected areas are found in Section 5.0.

or off-road.

<sup>&</sup>lt;sup>13</sup> According to the City of Pitt Meadows' 2020 Draft OCP, a *park* is a traditional outdoor space used by the public for recreation and leisure; an *open space* is publicly owned land that is undeveloped, can be used for passive recreation, and may be accessible to the public; a *greenway* is a linear regional park containing a multi-use trail for walking, running, or cycling (e.g., the PRRG); and a *trail* is a local path for walking, running, or cycling that may be located on-





During the 2020 field work for the EIMS project, bird surveys and/or habitat quality assessments were conducted in several municipal parks, including Harris Landing and Shoreline Park, Hoffmann Park, MacLean Park, Harris Road Park, and semi-natural areas near Mitchell Road Park and Linden Grove Park. Field survey results for Harris Landing and Shoreline Park, Hoffmann Park, and MacLean Park were discussed in Sections 4.1.1.3.1 (Fraser River), 4.2.1.1 (Urban and Rural Forests) and 4.1.1.1.3 (Other Wetland Habitats), respectively. The northeast corner of Harris Road Park includes a woodland SEI polygon, and the area between Airport Trail and Mitchell Road Park was field-verified as herbaceous (nonforested) habitat.

The parks selected for field surveys included known SEI polygons or urban forest patches identified via satellite imagery. However, Zoetica recognizes that several other municipal parks are considered valuable to the community and popular places to visit (see Appendix A – Engagement Summary), such as North Bonson Park, Somerset Park, Waterfront Commons Park, and Bonson Park. These and other parks, open spaces, and protected areas within the City were included in desk-based value assessments, presented in Section 4.4.2 below.

### 4.4.2 Value of Parks, Open Spaces, and Protected Areas

During community engagement for the EIMS project, parks and green spaces were frequently noted as valuable natural and built assets that should prioritized for protection, restoration, and enhancement (see Section 3.0 and Appendix A – Engagement Summary). Based on community feedback, the most highly valued parks within the City are (in order of priority):

- 1. Grant Wetlands (Pitt-Addington WMA)
- 2. Harris Landing and Shoreline Park (PRRG)
- 3. Hoffmann Park
- 4. North Bonson Park
- 5. Somerset Park
- 6. Waterfront Commons Park
- 7. Pitt Meadows Community Garden and adjacent natural area
- 8. Harris Road Park
- 9. Bonson Park

With respect to ecological values, parks were not included in Metro Vancouver's SEI data unless the predominant habitat met the requirements of SEI classes. As such, only a few parks shown in **Figure 4-30** had SEI data available, including the Grant Wetlands, Codd Island Wetlands, Hoffmann Park, old field and wetland areas east of the Pitt Meadows Community Garden, and Harris Landing and Shoreline Park. As part of the habitat quality assessments for the EIMS project, Zoetica interpreted satellite imagery and classified the remaining parks and open spaces (see Appendix B – Habitat Quality Assessment and SEI Verification). Altogether, park polygons make up 557.8 ha (5.8%) of the City (see **Table 4-1**).

The relative values (ecosystem rankings) of terrestrial habitats, including parks, open spaces, and protected areas, were previously discussed in Section 4.2.2.3. Ecosystem rankings for parks and green spaces can be used alongside community values to inform environmental management decisions. Management recommendations for the City of Pitt Meadows are discussed in Section 5.0 below.

## 4.5 Biodiversity

## 4.5.1 Inventory of Biodiversity

Biodiversity inventory results from desk-based research (e.g., BCSEE search for SCC) and field studies (e.g., breeding bird surveys, eDNA surveys, incidental observations) for specific locations and habitat classes were presented in Sections 4.1.1, 4.2.1, 4.3.1, and 4.4.1 of this report. In this current section, overall biodiversity within the City of Pitt Meadows will be discussed, as the total numbers of species, and changes to these numbers, relate to internationally-recognized performance indicators and benchmarks for biodiversity from the City Biodiversity Index (CBI), also known as the Singapore Index on Cities' Biodiversity (Chan *et al.* 2014) (see Section 6.0). In most cases, the current baseline conditions are unknown due to a lack of a wide-scale, ongoing, long-term biodiversity monitoring program.

When determining the biodiversity for the City of Pitt Meadows, multiple indicators were developed. First, the native biodiversity of bird species in urban areas were determined by looking at eBird data. eBird is a citizen science website that allows users to submit bird sightings. Since this is not a systematic survey, various observation biases are likely present in the data. Biases can include more observations in population centres or areas of easy access, less interesting and common birds not being reported, and rare species not being identified. As a group, birds are useful as a performance indicator for environmental management and monitoring because they are abundant, relatively easy to detect by a skilled birder, and sensitive to environmental change (Canterbury *et al.* 2000, Carignan and Villard 2002, Niemi and McDonald 2004). The methodologies for studying birds allow for the collection of data to assess biodiversity and various quantitative community composition metrics, along with information about community assemblages (e.g., numbers and composition of unique communities), which can be linked to various habitat types and can be tracked for change over time (Ralph *et al.* 1995).

Other indicators presented in Section 6.0 relate to changes in the number of both native and invasive vascular plant species, and changes in the number of native butterfly species and other indicator species. As described in Section 6.2.2, Zoetica recommends selecting additional indicator species from the freshwater fish and amphibian groups, as representatives from these groups can be easily detected using eDNA and/or other non-invasive survey techniques (e.g., auditory surveys for calling frogs and toads). Recommended policies and actions that can assist in managing biodiversity are found in Section 5.0. Specific recommendations related to the 2020 field surveys and associated desk-based research (i.e., breeding bird surveys and bird monitoring program, eDNA sampling and monitoring program, invasive species monitoring and management) are presented in Appendix C – 2020 Field Surveys and Desk-based Research.

In total, 69 breeding bird species were observed during 2020 field work for the EIMS project, including five SCC (barn swallow, great blue heron [fannini ssp.], evening grosbeak, double-crested cormorant, and green heron). According to eBird Canada data acquired on September 28, 2020, a total of 149 unique breeding bird species were observed in urban and rural areas of the City within the past three years (2018-2020). Both of these values (69 species observed during 2020 field surveys, 149 species recorded on eBird) place the City within the "Optimal" global category for bird biodiversity (see Section 6.0). Details about the 2020 breeding bird surveys are presented in Appendix C – 2020 Field Surveys and Desk-based Research.

A total of 42 unique species were identified from the eDNA samples collected in Pitt Meadows, including 27 fishes, nine mammals, and six birds, none of which were SCC. However, the number of wildlife species found is likely highly underestimated because the laboratory methods used were optimized for detecting fish species (see Appendix C – 2020 Field Surveys and Desk-based Research for more information). Select field photos of wildlife in Pitt Meadows are shown in **Figure 4-31**.



**Figure 4-31.** Photos of wildlife in Pitt Meadows during the summer of 2020. (a) Black bear on Swan Dike Trail in Pitt-Addington WMA. (b) Osprey perched in riparian tree along South Alouette River. (c) Common mergansers in Alouette River. (d) Black bears on shore of Alouette River.

### 4.5.1.1 Species of Conservation Concern

In December 2020, a search was conducted via the BCSEE for potentially occurring SCC<sup>7</sup> within the City of Pitt Meadows and then vetted to remove species that require habitat conditions or topography/elevation ranges not represented in the City. In total, up to 67 unique SCC could potentially occur in Pitt Meadows. The full species-habitat matrix and details about the BCSEE search criteria are available in Appendix G – Matrix of Habitat Suitability for Species of Conservation Concern. In addition, an investigation of critical habitat mapping in Pitt Meadows was conducted<sup>14</sup>. Critical habitat is defined as the habitat necessary for the survival or recovery of a listed wildlife species (Endangered or Threatened on Schedule 1 of the federal *Species at Risk Act [SARA]*). Critical habitat maps and the value of different habitat types for hosting SCC are presented in Section 4.5.2.1.

#### 4.5.1.2 Native vs. Invasive Species

During SEI field verification and habitat quality assessments, native and invasive plants were noted in terms of dominant tree, shrub, and ground vegetation, as well as invasive species cover for select species (see Appendix B – Habitat Quality Assessment and SEI Verification). However, a comprehensive vegetation and invasive species inventory would be useful to get a better understanding of the number of native species and proportion of invasive alien plant species at proposed monitoring locations, such that the City can evaluate their environmental management efforts against the performance benchmarks shown in Section 6.0. Details about the invasive vegetation species observed during the 2020 EIMS field work, and a brief summary of the provincial Invasive Alien Plant Program (IAPP) data for Pitt Meadows, are presented in Appendix C – 2020 Field Surveys and Desk-based Research.

Based on eDNA metabarcoding analyses, native species comprised the majority of species detected within the Alouette and Pitt rivers, whereas invasive species were detected with greater frequency within the Sturgeon and Katzie sloughs and Pitt-Addington WMA. Further details about the native fish species found during eDNA studies (none of which were SCC) are available in Appendix C – 2020 Field Surveys and Deskbased Research. A brief discussion about invasive fish species is presented in Section 4.5.2.2.2 below.

#### 4.5.2 Value of Biodiversity

Although the previous natural asset inventory sections of this report focused on habitat classes, the ecosystem services that these habitats provide, and the biodiversity supported by these habitats, it is important to recognize that biodiversity itself is a natural asset that provides variety of ecosystem services. For example, wetlands and riparian areas can provide greater flood and erosion control if there is a healthy riparian vegetation community made up of deep-rooted native trees, shrubs, and herbaceous plants. Beneficial insects can assist with pollination and natural pest control, and soil biodiversity promotes nutrient cycling and water infiltration; all of these services may increase crop productivity. Fishing opportunities are dependent on healthy fish populations, which are, in turn, dependent on the biodiversity and abundance of prey such as small-bodied fish species and aquatic invertebrates. Biodiversity also has high cultural value; during community engagement for the EIMS project, nature appreciation and birdwatching were common reasons for visiting the City's parks and open spaces, and

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<sup>&</sup>lt;sup>14</sup> Final and proposed critical habitat polygons in British Columbia are available from the BC Data Catalogue (<a href="https://catalogue.data.gov.bc.ca/dataset/critical-habitat-for-federally-listed-species-at-risk-posted-">https://catalogue.data.gov.bc.ca/dataset/critical-habitat-for-federally-listed-species-at-risk-posted-</a>) and can also be viewed through iMapBC.

wildlife and biodiversity were noted among the City's most valuable natural assets (see Appendix A – Engagement Summary).

With respect to habitat quality factors that are important for biodiversity, many of the same considerations used for terrestrial ecosystem rankings apply (see Section 4.2.2.3 and Appendix B – Habitat Quality Assessment and SEI Verification). For example, large, connected, undisturbed habitats with greater structural diversity and fewer invasive species are more likely to host higher native biodiversity. The ecosystem rankings shown on **Figure 4-24**, therefore, are meant to represent relative values of biodiversity (e.g., number of species and/or individuals) as well as habitats.

## 4.5.2.1 Species of Conservation Concern

A summary of the number of SCC potentially occurring in each habitat subtype<sup>15</sup> present within the City is shown in **Table 4-4**. This table also presents the proportion of SCC that fully or highly depend upon the habitat subtype to meet their life history needs, and the proportion of SCC that have been found using the habitat subtype occasionally or opportunistically (e.g., foraging, migration).

**Table 4-4.** Summary of the number of species of conservation concern that each habitat subtype can potentially support. A full matrix of which habitats can support each species can be found in Appendix G – Matrix of Habitat Suitability for Species of Conservation Concern.

Habitat Subtype	Number of SCC	% Obligate/Frequent Use	% Occasional Use
Marsh	31	81%	13%
Stream/River	30	43%	40%
Lake	28	79%	7%
Pond/Open Water	27	89%	4%
Riparian Forest	27	70%	26%
Pasture/Old Field	22	45%	50%
Conifer Forest	21	71%	14%
Riparian Herbaceous	21	57%	38%
Cultivated Field	21	48%	52%
Hedgerow	21	43%	52%
Swamp	20	90%	10%
Mixed Forest	20	65%	25%
Riparian Shrub	18	67%	33%
Bog	16	94%	6%
Fen	16	94%	6%
Deciduous Forest	15	67%	33%
Gravel Bar	12	50%	50%
Rock/Sparsely Vegetated Rock	6	50%	50%
Mudflat – Intertidal	6	50%	50%

Overall, 12 different habitat subtypes within Pitt Meadows may support 20 or more unique SCC. Marsh habitats could harbour the highest number of SCC (31 species). In terms of preserving biodiversity and SCC, it is beneficial that Pitt Marsh, Katzie Marsh, and Homilk'um Marsh – the largest marsh habitats within Pitt Meadows – are encompassed by the greater protected area of the Pitt-Addington WMA (see **Figure 4-5**). Although fewer SCC inhabit other wetland types (swamp, bog, fen), those that do are highly

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<sup>&</sup>lt;sup>15</sup> Habitat types/subtypes presented in BCSEE data and habitat classes/subclasses described in this report are not fully interchangeable due to different data sources and collection protocols.

dependent upon them (≥90% obligate/frequent use; **Table 4-4**). Watercourses and waterbodies are important for a variety of SCC, including fish and other aquatic or semi-aquatic organisms.

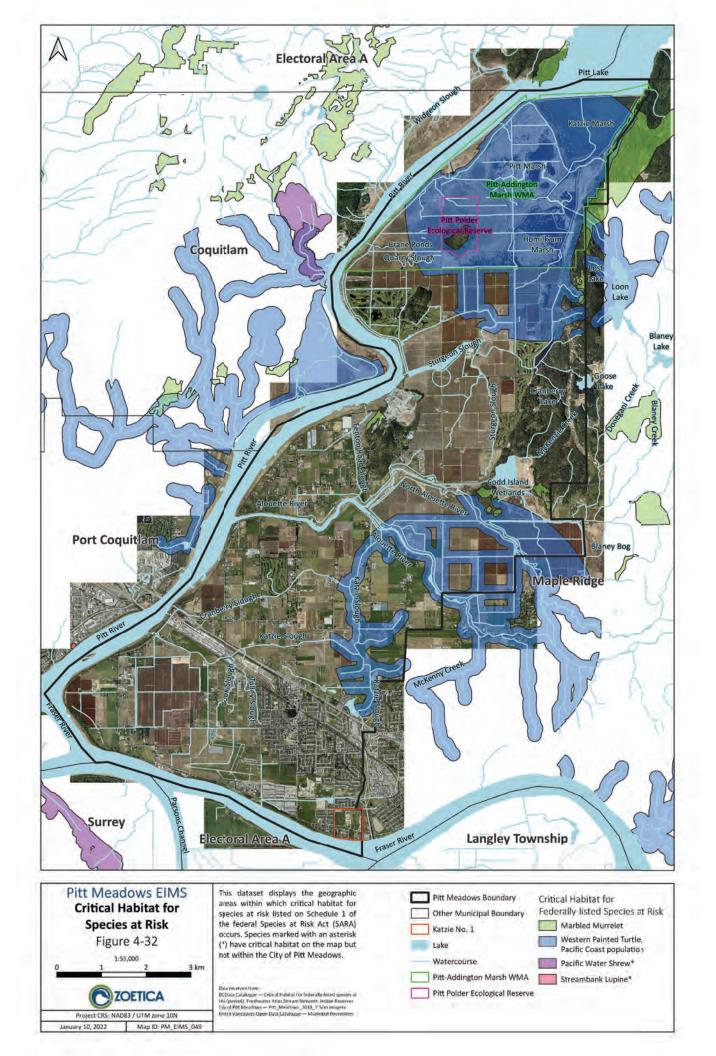
Of the forested habitats, which considered together may support up to 35 unique SCC, riparian forests appear to be the most important for SCC potentially occurring in Pitt Meadows (up to 27 species). Unfortunately, the only riparian forests remaining are in narrow buffers along the PRRG; other waterways within the City, such as the Alouette River, are largely devoid of natural and treed riparian areas (see **Figure 4-5** and **Figure 4-14**). Remnant urban forest patches of all types are among the most at risk and degraded habitats due to development (see Section 4.2.1.1 and Appendix A – Engagement Summary).

Agricultural areas such as cultivated fields, hedgerows, and pastures/old fields could also support a variety of SCC. For example, these areas may provide important foraging habitat for raptors (that prey on rodents and other animals common in agricultural lands) and waterfowl (that feed on waste grains and invertebrates). As shown in **Table 4-4**, agricultural habitats are often only used by SCC occasionally, and their use likely depends on the habitat conditions (e.g., crop type, management schedule, presence of water). However, as long as agricultural practices follow BMPs, such as those developed by the BC Ministry of Agriculture<sup>16</sup>, agricultural areas can also contribute to the biodiversity of Pitt Meadows.

To date, polygons containing critical habitat have been identified (finalized) for marbled murrelet and proposed<sup>17</sup> for western painted turtle, Pacific Coast population (**Figure 4-32**). For marbled murrelet, a total of nine critical habitat polygons have been identified within mature forested habitats, including the west side of Sheridan Hill, the Codd Wetland Ecological Conservancy Area, and the Thompson Mt. range east of Pitt-Addington WMA and west of Loon Lake. For western painted turtle, two large critical habitat polygons have been proposed in Pitt Meadows (and connected to Maple Ridge): 1) Almost the entirety of the Pitt-Addington WMA, along with agricultural lands to the south and streams and riparian areas on the western edge of the Thompson Mt. range; and 2) habitat surrounding and between the North and South Alouette rivers (including parts of the Codd Island Wetlands and agricultural land), and the waterways and riparian areas of the Katzie Slough and connected tributaries extending from the South Alouette River to the Meadow Gardens Golf Club.

<sup>&</sup>lt;sup>16</sup> The BC Ministry of Agriculture has developed a variety of BMPs to help farmers and ranchers protect soil, water, air, and biodiversity. For biodiversity, the *Biodiversity Guide* and *Grazing Management Guide* have been prepared as part of the Canada – BC Environmental Farm Program: <a href="https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/agricultural-land-and-environment/biodiversity">https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/agricultural-land-and-environment/biodiversity</a>

<sup>&</sup>lt;sup>17</sup> Critical habitat is identified by ECCC recovery practitioners or other SAR biologists contracted by ECCC. "Proposed critical habitat" has not been formally identified and is subject to change before it (and the proposed recovery document) is posted as final. "Final critical habitat" is the critical habitat that is included in a final recovery document. However, final recovery documents and critical habitat may still be amended from time to time.



#### 4.5.2.2 Native vs. Invasive Species

Invasive species repeatedly mentioned by stakeholders as management priorities included parrot's feather, Japanese knotweed, Himalayan balsam, purple loosestrife, and Himalayan blackberry, all of which are considered priority species by Metro Vancouver. In addition to knotweed species and parrot's feather, the City of Pitt Meadows currently lists giant hogweed and Eurasian water-milfoil as invasive and noxious plant species of concern on their website (City of Pitt Meadows 2020a). Other invasive species noted by stakeholders include reed canarygrass, Scotch broom, largemouth and smallmouth bass, green frog, and American bullfrog (see Appendix A – Engagement Summary). The following discussion will focus on these invasive species noted by the City and community. A more detailed summary of the invasive species recorded/detected during 2020 field work and in the IAPP database is available in Appendix C – 2020 Field Surveys and Desk-based Research.

### 4.5.2.2.1 Invasive Plants

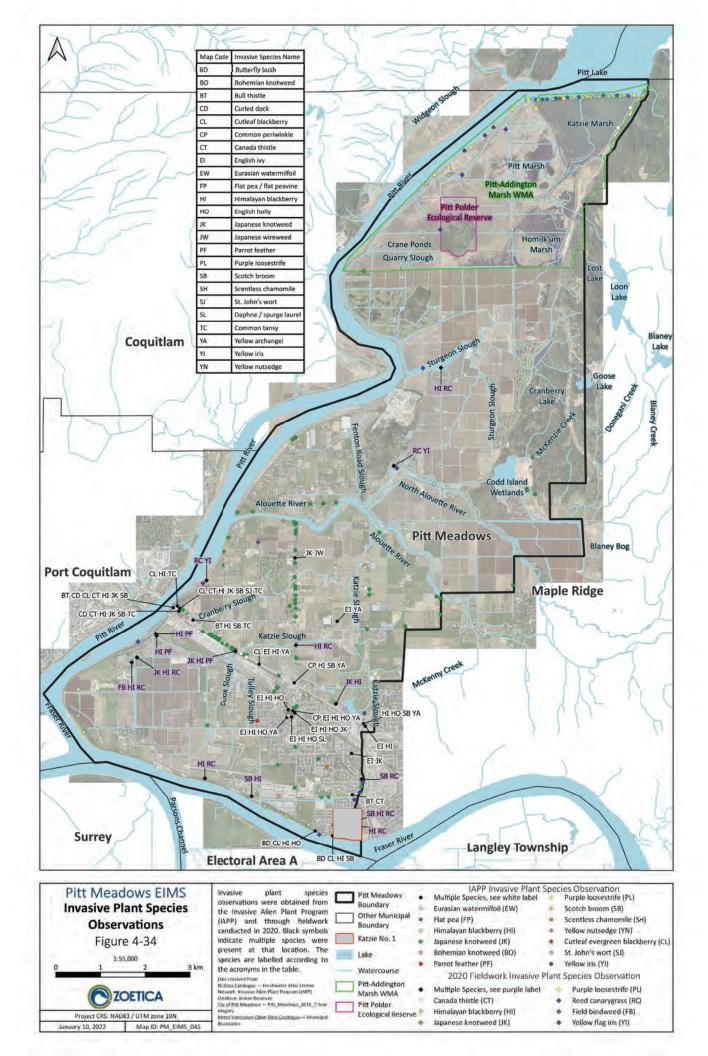
The City of Pitt Meadows has been tracking the spread of parrot's feather since 2004 (**Figure 4-33**). Mechanical removal efforts by the City have occurred, but eradication is very difficult and parrot's feather continues to pose a significant environmental and socio-economic problem. During 2020 field work, parrot's feather was observed at various points along the Katzie Slough, most notably at Kennedy Landing. Eurasian water-milfoil was frequently observed in the North Alouette River and the south arm of the Alouette River, and was also noted in the Sturgeon Slough.

Japanese knotweed grows in disturbed edge habitats and adjacent to linear corridors throughout the City. This invasive species (and provincially noxious weed) appears to be most prevalent along the Lougheed Highway multi-use trail, the Great Trail (previously Trans Canada Trail) near the Pitt River Bridge, and Harris Road (Figure 4-34). Treatment efforts, often multiple applications, have been undertaken by the City of Pitt Meadows at the majority of these sites (see Figure 4-33). To date, Japanese knotweed had not been recorded in the IAPP database north of the Sturgeon Slough; however, Zoetica observed this species on the edge of the wetland habitat between Swaneset and Pitt-Addington WMA (polygon 2859) during habitat quality assessments.

During 2020 field work, Himalayan blackberry was found in a variety of riparian, wetland, forest, and old field habitats throughout the City (Figure 4-34); this species is likely underreported in the IAPP. Scotch broom was observed in more developed/disturbed areas, including the wetland habitats across from the airport (polygon 893), off Wildwood Crescent Trail (polygon 1034), and at MacLean Park; and the young forest habitat at the intersection of Sutton Avenue and Bonson Road (polygon 110). IAPP records for Scotch broom primarily occur along Lougheed Highway from the Pitt River Bridge to the Pitt Meadows—Maple Ridge boundary. Purple loosestrife was most commonly observed along the dike trails around the Pitt-Addington WMA. Reed canarygrass is common in the Pitt-Addington WMA and in riparian/wetland areas of waterways around the City, including the Katzie Slough off Wildwood Crescent Trail. At this location, there is no tree canopy to shade out this invasive species or to moderate water temperatures in the increasingly warm and stagnant Katzie Slough.







Himalayan balsam was not one of the target invasive species during habitat quality assessments (Appendix B – Habitat Quality Assessment and SEI Verification). This invasive species was not observed incidentally by Zoetica, nor has it been documented within Pitt Meadows through the IAPP. Similarly, giant hogweed was not observed during field work and there are no records of it in the IAPP database for Pitt Meadows. However, GIS data from the City indicate that giant hogweed has previously been treated at one location on Kennedy Road southwest of the confluence of the Pitt River and Katzie Slough (see **Figure 4-33**).

According to IAPP data, the highest number/variety of invasive plant species occur at disturbed areas under or near the Pitt River Bridge (eight reported species) and at Hoffmann Park (seven reported species; **Figure 4-34**). However, it is important to keep in mind that invasive species data currently available from the City and the IAPP are not systematic or comprehensive. A detailed invasive species inventory of Pitt Meadows should be completed to identify additional/priority areas of concern to guide invasive species management (see Section 5.0).

### 4.5.2.2.2 <u>Invasive Fishes</u>

During phone engagement for the EIMS project, the Watershed Watch Salmon Society indicated that Mike Pearson (R.P.Bio., Pearson Ecological) has found native sticklebacks alongside invasive pumpkinseed and carp species in the Katzie Slough. Dr. Pearson also reports "substantial populations" of pumpkinseed, largemouth bass, and brown bullhead in the lower Alouette River, as well as black crappie and dojo loach/Oriental weatherfish (Cheater 2020).

A summary of the invasive fish species detected through eDNA metabarcoding analyses for the EIMS project is shown in **Table 4-5**. Consistent with data from traditional fish trapping surveys and stakeholder observations, eDNA results show widespread prevalence of pumpkinseed, largemouth bass, and carp. Smallmouth bass was not identified through metabarcoding analyses. Of note, Oriental weatherfish and bullheads are designated as Prohibited species in the Controlled Alien Species Regulations under the BC *Wildlife Act*. Detection of Oriental weatherfish within the Katzie and Sturgeon sloughs, and of bullheads in the Sturgeon Slough and Katzie Marsh, may be novel findings from this pilot project. The potential spread of these and other invasive species through Pitt Meadows' waterways and wetlands should be monitored and managed (see Section 5.0).

**Table 4-5.** Invasive/introduced fish species detected through eDNA metabarcoding analyses at the watercourses, sloughs, and wetlands sampled in 2020.

Species	South Alouette	Main Alouette	North Alouette	Katzie- Pitt	Katzie Slough	Sturgeon Slough 1 (Rannie)	Sturgeon Slough 2 (Thompson)	Pitt River	(Pitt) Addington Marsh	Katzie Marsh	Katzie Marsh Duplicate	Total
Oriental weatherfish	х	x	x	х	x	x	x	x	x	х	x	11
Pumpkinseed	х	х	х	х	х	х	х		х	х	х	10
Largemouth bass		х	х	х	х	х	х		х	х	х	9
Carassius sp. (goldfish/carp)		х	х		х	х	х		х	х	х	8
Black crappie				х		x			x	х	x	5
Common carp			х			х		х		х	х	5
American shad		х	х					х				3
Brown bullhead						х				х	х	3
Bluegill				х		х						2
Yellow bullhead						х					х	2
Alosa sp. (shad)				х								1
Prussian carp					х							1
Total	2	5	6	6	5	9	4	3	5	7	8	-

### 5.0 EIMS MANAGEMENT FRAMEWORK: POLICY AND ACTION RECOMMENDATIONS

## 5.1 Introduction

This section provides a summary of potential (recommended) policies and actions to help manage natural assets identified within the EIMS. Relevant environmental objectives and policies outlined in the City of Pitt Meadows Official Community Plan 2020 (Draft) are presented in Section 5.2. In Section 5.3, Zoetica has provided recommendations for policies and actions that could be undertaken by the City to meet these draft OCP objectives and policies. Additional information and rationale regarding Zoetica's recommendations are available in Sections 5.3.1 and 5.3.2.

# 5.2 Draft Official Community Plan Objectives and Policies

The following 2020 Draft OCP Objectives and Policies, as they were available at the time of writing, are used to guide the recommended policies and actions in Section 5.3 and performance indicators in Section 6.2.1. The wording and numbering of the Draft OCP objectives and policies may change as the Draft OCP is further developed. Relevant OCP objectives and policies considered for the EIMS are included in **Table 5-1** below. They have been organized based on the chapters of the 2020 Draft OCP (Chapter 4 Parks and Recreation [PR]; Chapter 6 Local Systems [LS]; Chapter 7 Climate and Energy [CE]; Chapter 8 Environment and Natural Areas [ENA]). Note that not all objectives and policies are linked to specific recommendations or performance indicators.

**Table 5-1.** City of Pitt Meadows Draft Official Community Plan 2020 policies and objectives related to EIMS recommendations and monitoring.

## **Draft 2020 OCP Objectives/Policies**

# ENA 8.1: Protect and restore shorelines, wetlands and riparian areas and maintain or improve water quality (Draft OCP Environment and Natural Areas)

ENA 8.1.1: Implement streamside protection measures and require that development conform to regulations and best management practices for protecting fish and aquatic life

ENA 8.1.3: Improve the shoreline habitat

# ENA 8.2: Minimize disturbances to residents and wildlife resulting from light pollution, light trespass and noise (Draft OCP Environment and Natural Areas)

ENA 8.2.1: Incorporate light pollution reduction and light trespass abatement features into municipal facilities, infrastructure and street/park lighting where public safety would not be compromised

ENA 8.2.2: Work with residential, agricultural, industrial and commercial sectors to minimize light pollution and resulting sky glow from homes, buildings and facilities

# ENA 8.4: Show leadership in implementing sustainable environmental practices (Draft OCP Environment and Natural Areas)

ENA 8.4.1: Consider embarking on a study of how the City's natural assets can be used to protect the environment and enhance the community

ENA 8.4.2: Demonstrate corporate stewardship through the preparation and implementation of an environmental management strategy for municipal operations

# ENA 8.5: Carefully consider policies, guidelines and regulations regarding environmental protection and enhancement in harmony with other City goals and objectives (Draft OCP Environment and Natural Areas)

ENA 8.5.1: Consult with the farming community before embarking on policies, standards, guidelines and regulations that may affect agricultural operations

# ENA 8.6: Encourage the community to take a stewardship role regarding the natural environment (Draft OCP Environment and Natural Areas)

ENA 8.6.1: Promote community involvement and increase awareness of environmental issues among residents and business owners

ENA 8.6.2: Work with private landowners to encourage stewardship that protects, preserves and enhances natural systems, and, where appropriate, enter into conservation covenants or provide incentives to protect riparian or environmentally significant areas

ENA 8.6.3: Collaborate with First Nations, regional and senior governments, plus other agencies and community organizations, in the protection, management and stewardship of natural areas, parks, ecological reserves and wildlife management areas

# ENA 8.7: Identify and protect a system of environmentally sensitive areas and environmental assets to the maximum extent possible (Draft OCP Environment and Natural Areas)

ENA 8.7.1: Enhance the City's knowledge of environmental assets through physical and biological resource inventories/Develop a Natural Assets Inventory and Management Strategy

ENA 8.7.2: Minimize habitat loss, fragmentation and disturbances to wildlife through effective land use planning

# ENA 8.8: Maintain and improve the long-term ecological health of the City (Draft OCP Environment and Natural Areas)

ENA 8.8.1: Reduce the density and distribution of invasive species to protect biodiversity and ensure public safety

ENA 8.8.2: Increase the amount of land protected for its ecological values

ENA 8.8.3: Address development growth in balance with environmental protection objectives and agricultural land protection, and encourage development that minimizes environmental impacts.

### ENA 8.9: Protect and enhance the urban forest (Draft OCP Environment and Natural Areas)

ENA 8.9.1: Consider adopting an urban forest strategy to protect, plant and manage trees in Pitt Meadows to create a diverse, resilient and beautiful urban forest on public and private lands

ENA 8.9.2: Support the creation and implementation of a tree preservation bylaw

ENA 8.9.3: Sustain and expand the urban forest through sound management strategies that enhance their potential as carbon sinks

ENA 8.9.4: Promote and encourage the protection and designation of indigenous vegetation, significant trees and wildlife trees

# LS 6.4: Design the City's drainage and irrigation system to meet the public's needs and regional requirements (Draft OCP Local Systems)

LS 6.4.1: The City's drainage and irrigation system is designed and maintained to support agricultural activities

LS 6.4.3: Urban Drainage (to be designed and managed to reduce infrastructure requirements)

### LS 6.5: Maintain and improve flood protection measures throughout Pitt Meadows (OCP Local Systems)

LS 6.6: Meet municipal infrastructure needs efficiently and sustainably while protecting public health, safety and the environment (Draft OCP Local Systems)

LS 6.6.2: Future infrastructure is planned and constructed with the effects of climate change in mind

# LS 6.7: Protect and enhance ground and surface water quality through best practices for integrated rainwater management and green infrastructure (Draft OCP Local Systems)

LS 6.7.1: Maintain or improve the water quality discharged to the natural environment

LS 6.7.2: Increase the amount of natural infiltration of rainwater

LS 6.7.4: The City incorporates green infrastructure into its building projects whenever possible

LS 6.7.5: Incorporate green infrastructure requirements into new and re-developments

## CE 7.1: Prepare to address, mitigate and adapt to the effects of climate change (Draft OCP Climate and Energy)

### CE 7.3: Enhance carbon sequestration within the City's boundaries (Draft OCP Climate and Energy)

CE 7.3.1: Protect and enhance Pitt Meadows' natural environments to support carbon retention as well as other important ecosystem services

# PR 4.1: Design parks and open spaces to connect people to nature and provide peaceful respite (Draft OCP Parks and Recreation)

PR 4.1.1: Find innovative opportunities to create parks and open spaces

PR 4.1.2: Use open space to create connections

### PR 4.4: Maintain and enhance the ecology of parks and open spaces (Draft OCP Parks and Recreation)

PR 4.4.1: Support compatible activities in parks and open spaces to advance environmental stewardship goals (e.g. volunteer stewardship activities, invasive plant management, environmental art)

PR 4.4.2: Collaborate with Metro Vancouver, Katzie, community groups and government agencies to minimize the further introduction and spread of invasive species in the area, and to develop an invasive species management plan to prevent, eradicate, contain and control the spread of invasive species within the municipality

PR 4.4.3: Prioritize the retention of healthy, mature vegetation in the city parks and open spaces wherever possible. Where significant trees cannot be reasonably accommodated in site planning (e.g., conflict with utilities and services or tree hazard), integrate and replace significant vegetation on site

PR 4.4.4: Progressively eliminate the use of cosmetic/non-essential pesticides as well as neonicotinoids (a class of chemical insecticides) on all lands except to treat high-risk invasive plants; and educate the public regarding environmentally friendly alternatives to conventional pesticides

## 5.3 Recommendations

This section includes a summary table of recommendations (**Table 5-2**), followed by subsections discussing the recommendations by theme/area. The recommendations are intended to help manage natural assets identified within the EIMS. Within **Table 5-2**, recommendations are organized by theme and are prioritized (High, Medium, Low) to guide implementation with different time frames (High Priority: <2 years; Medium: 2-5 years; Low: >5 years). Recommendations highlighted in grey are relevant for municipal operations and should be included in a detailed Environmental Management Strategy. Where relevant, links to thematic maps/polygons describing specific natural assets are provided to help guide management actions.

Table 5-2. Recommended policies and actions, links to the City's 2020 Draft OCP objectives and policies, and priorities for implementation.

<b>Table 5-2.</b> Recommended policies and actions, links to the City's 2020 Draft OCP objectives and actions.		ies for imple	l
Recommendations	Draft OCP Objective/Policy	Priority	Map/Polygon #
A. EIMS Implementation and Management (General)			
A.1 Align relevant City bylaws, plans and policies with EIMS to help protect, restore and enhance natural assets.	ENA 8.4; ENA 8.5	Low	N/A
A.2 Pursue funding under the Municipal Natural Assets Initiative (MNAI) to complete an economic evaluation of the City's natural assets to help the City make more informed decisions regarding land use and development by understanding the economic values and trade-offs associated with altering, developing, or converting natural assets and the engineering costs required to restore the equivalent function of a lost natural asset.	ENA 8.4.1	Medium- High	N/A
A.3 Include relevant recommendations of EIMS within a detailed Environmental Management Strategy (EMS) for municipal operations. Relevant recommendations in this table are highlighted in grey.	ENA 8.4.2; ENA 8.5	Medium	N/A
A.4 Ensure internal capacity (staffing, budget, resources) to support follow-up initiatives based on EIMS recommendations.	ENA 8.4	Medium	N/A
A.5 Encourage interdepartmental/interagency cooperation and continued engagement with the private sector, stewardship groups and First Nations to manage the City's natural assets.	ENA 8.4	Low	N/A
A.6 Establish an advisory committee that includes representatives from different stakeholder groups across the City that can work together to come up with solutions that take a holistic look at management of natural assets in a local and regional context.	ENA 8.4	Medium	N/A
A.7 Investigate use of tools such as conservation covenants, easements, community amenity charges and stewardship incentives to protect, enhance and restore priority habitat areas across the City.	ENA 8.5; ENA 8.6.2	Medium- High	N/A
<ul> <li>A.8 Update requirements under Natural Areas Development Permit Area (DPA) Guidelines to support management of natural assets:</li> <li>Prohibit development in all natural assets ranked as high value;</li> <li>Place strict development controls for natural assets ranked moderate value, with focus on maintaining and/or improving connectivity and condition;</li> <li>Require habitat compensation at a minimum of a 2:1 replacement levels, or implement a cash-in-lieu mechanism, for any development affecting low to moderate ranked natural assets. Consider the use of a higher habitat compensation ratio for moderate compared to low ranked habitat;</li> </ul>	ENA 8.5; ENA 8.6.2	High	Refer to Figure 4-24 and Figure 4-25 for ecosystem rankings for the entire City and the urban area only, respectively.

Recommendations	Draft OCP Objective/Policy	Priority	Map/Polygon #
<ul> <li>Require appropriate reports or environmental impact studies by a Qualified Environmental Professional (QEP) with project-specific qualifications and experience for all development within a Natural Areas DPA.</li> </ul>			
A.9 Maintain natural asset mapping within City's GIS, outside of the OCP, to permit greater flexibility, the ability to zoom to different scales without losing resolution, and to review and update as required to inform City planning and development activities.	ENA 8.7.1	High	N/A
A.10 Provide web-based, user-friendly GIS data maps with clear direction about natural assets (e.g., stream setback requirements), which can be accessed by landowners and developers for ease of understanding.	ENA 8.7.1	Low- Medium	N/A
A.11 Identify ecological indicators, develop baseline inventory and conduct regular monitoring to assess changes in ecological health, measure performance and inform future decision-making.	ENA 8.7.1	Medium	Refer to Figure 4-3 and Figure 4-4 for locations of 2020 field surveys and where future monitoring may be conducted.
A.12 Engage and work with the Katzie First Nation and other First Nations to incorporate Indigenous knowledge and support shared identification and management of natural assets, including culturally important plant and animal species.	ENA 8.5; ENA 8.6.3; ENA 8.7.1	High	Information may not be released due to sensitivities
A.13 Integrate Low Impact Development (LID) and green infrastructure practices within the City's DPA guidelines to support management of natural assets.	ENA 8.5; LS 6.4.1; LS 6.4.3; LS 6.7	Medium	N/A
A.14 Develop Biodiversity Design Guidelines to support implementation of site-level management actions that will support biodiversity in the City, including the urban matrix (e.g., residential, commercial, and industrial areas).	ENA 8.5; ENA 8.3	Low	N/A
A.15 Encourage implementation of carbon neutral policies.	ENA 8.5	Medium	N/A
B. Green Infrastructure			
B.1 Streams, Shorelines and Riparian Areas		•	
B.1.1 Prioritize the protection, restoration, and enhancement of streams, shorelines and riparian areas located within Riparian Areas and Natural Areas DPA designations.	ENA 8.111; ENA 8.1.3	High	Draft priority areas are presented in Section 5.3.2.1 and <b>Figure 5-2</b> .
B.1.2 Review minimum setback distances (i.e., riparian buffers) along streams adjacent to residential, commercial and industrial land as permitted under the Local Government Act. Setbacks should be established in consultation with a QEP employing the best available science, considering fish habitat classifications, future	ENA 8.1.1; ENA 8.5	High	Refer to <b>Figure 4-20</b> (Theoretical Restoration Benefit).

Recommendations	Draft OCP Objective/Policy	Priority	Map/Polygon #
climate change mitigation needs (e.g., for water temperature shading and stabilization) and other factors (see Section 5.3.1).			
B.1.3 Consider development incentives (e.g., flexibility in density allowances and non-riparian setback distances) to protect riparian areas within the Riparian Areas DPA.	ENA 8.1.1; ENA 8.5	Medium	N/A
B.1.4 Implement a net gain policy for habitat restoration as a development condition within Riparian Areas DPA.	ENA 8.1.1; ENA 8.5	High	N/A
B.1.5 Engage and work with stakeholders, landowners, First Nations and other agencies to develop restoration and enhancement plans to improve fish habitat (including fish passage) in high priority areas.	ENA 8.1; ENA 8.6	High	Draft priority areas are presented in Section 5.3.2.1 and <b>Figure 5-2</b> .
B.1.6 Develop partnerships with agricultural landowners, industry, stakeholders and other agencies to protect, restore and enhance priority riparian areas on ALR/industrial land to improve water quality by reducing sedimentation and filtering contaminants.	ENA 8.1; ENA 8.5.1; ENA 8.6	Medium	Refer to Section 5.3.2.1 for draft priority riparian areas. Note: the City should have spatial data of ALR and industrial areas to identify relevant stakeholders.
B.1.7 Engage and work with agricultural landowners and producers, stakeholders, First Nations, and other agencies (e.g., MakeWay) to obtain funding through programs such as the BC Salmon Restoration and Innovation Fund (SRIF) to support fisheries management in high priority areas, engineering options to support fish movement, and restore priority riparian habitat.	ENA 8.1; ENA 8.5.1; ENA 8.6	Medium	Draft priority areas are presented in Section 5.3.2.1 and <b>Figure 5-2</b> .
B.1.8 Implement an open drainage/daylighting policy for City streams (i.e., natural watercourses and natural sources of water supply). Such projects may include historical springs in Katzie Slough area, the latter of which the City could engage and work with Katzie First Nation to identify potential management strategies.	ENA 8.1; ENA 8.5	Low	Refer to Figure 4-5 for map of streams, including Katzie Slough and connected tributaries. Selecting priority areas for daylighting 'lost streams' will require a separate study.
B.1.9 Work with agricultural landowners and producers, stakeholders and external agencies to manage dike maintenance and construction such that upgraded flood management structures protect natural assets (e.g., fish, riparian habitat) at the same time as increasing resilience to future flood events that are expected to increase due to climate change.	ENA 8.1; ENA 8.5.1; LS 6.4.1; LS 6.6.2; ENA 8.6; CC 7.1	High	N/A
B.1.10 Encourage agricultural producers to explore the economic and marketing benefits of obtaining <u>Salmon-Safe Certification</u> and implementing best practices (e.g.,	ENA 8.1; ENA 8.5.1; LS 6.7.1; ENA 8.6	Low	N/A

Recommendations	Draft OCP Objective/Policy	Priority	Map/Polygon #
completion of Environmental Farm Plan) to protect water quality, fish and fish habitat next to ALR land.			
B.2 Forests			
B.2.1 Develop Urban Forest Strategy (UFS) that incorporates EIMS (e.g., vegetative cover) and protects natural assets across the City.	ENA 8.9.1	Medium	Refer to <b>Figure 4-21</b> for map of natural and semi-natural treed areas.
B.2.2 Establish City-wide forest cover targets within the UFS to achieve ecological benefits (e.g., carbon sequestration, reduced near-surface air temperature, improved air quality, stormwater capture, decreased run-off and improved human health).	ENA 8.9.1; ENA 8.9.3; CC 7.3; CC 7.3.1	Medium	Refer to <b>Figure 4-21</b> for map of natural and semi-natural treed areas.
B.2.3 Increase structural diversity of plant communities through habitat enhancement and restoration.	ENA 8.9.1	Low	Draft priority areas are presented in Section 5.3.2.2 and <b>Figure 5-3</b> .
B.2.4 Develop strategies to increase resiliency of City's urban forest to climate change, particularly those assets considered to be most at risk (e.g., drought).	ENA 8.9.1; LS 6.6.2; CC 7.3.1	Medium	Refer to <b>Figure 4-21</b> for map of natural and semi-natural treed areas.
B.2.5 Encourage protection and retention of mature tree stands within future tree preservation bylaw. Include single trees and groups of trees (i.e., significant tree stands) in protection and retention measures within the bylaw.	ENA 8.9.2	High	Refer to <b>Figure 4-21</b> for map showing mature urban forests.
B.2.6 Require compensation (e.g., cash-in-lieu to be used for urban forestry projects or replacement trees at specified ratio) for tree removal within Natural Areas DPAs and urban matrix.	ENA 8.9.2	High	N/A
B.2.7 Develop guidelines and requirements for protection of culturally important trees, significant trees and wildlife trees within a tree preservation bylaw.	ENA 8.9.3	High	N/A
B.3 Parks and Open Space	l		
B.3.1 Work with Metro Vancouver, stakeholders, other agencies, and rights-holders to update the City's land acquisition strategy to help identify and protect priority natural assets not currently within the City's or Region's parks and open space system. Opportunities to maintain/enhance ecological functioning, connectivity, biodiversity, and human enjoyment of nature (e.g., bird watching, fishing) within the City and Region should be prioritized.	ENA 8.5; ENA 8.7	High	Draft priority areas are presented in Section 5.3.2.3 and <b>Figure 5-4</b> .
B.3.2 Investigate opportunity for a green city fund or green levy to support acquisition of natural assets that can be brought into parks and open space system.	ENA 8.5; PR 4.1.1	High	N/A

Recommendations	Draft OCP Objective/Policy	Priority	Map/Polygon #
B.3.3 Integrate EIMS into updated Parks, Recreation and Cultural Services Master Plan to raise awareness of natural assets.	ENA 8.5; PR 4.4.1	High	N/A
B.3.4 Promote naturalization of landscaped city parks in low use areas (where possible).	PR 4.4.3	Low	Refer to <b>Figure 4-30</b> for map of City parks. More community engagement likely needed to determine low use areas.
B.4 Agricultural Land			I.
B.4.1 Work with agricultural landowners and producers to identify and protect natural assets in the ALR that provide important benefits.	ENA 8.5.1	Medium	The importance of healthy waterways and soil for agriculture, and flood management upgrades, were noted by the AAC during engagement. Refer to Figure 4-5 for map of watercourses and pump stations. More engagement with farmers and a detailed flood risk study are needed to select priority areas.
B.4.2 Work with agricultural landowners and producers to develop cooperative stewardship models (e.g., Delta Farmland & Wildlife Trust) to preserve farmland and protect natural assets. Focus on win-win solutions and mutual co-benefits of functioning ecosystem services.	ENA 8.5.1	Medium	N/A
B.4.3 Work with farm community to raise awareness of available guidance and supports to implement environmentally-friendly farm management practices (e.g., irrigation, drainage, manure storage, livestock access to water, etc.).		Medium	N/A
B.4.4. Work with other levels of government to create guides and web content to help farmers navigate environmental permitting process and meet local, provincial, and federal regulatory requirements.		High	N/A
B.5 Urban Matrix	ı	1	ı
B.5.1 Develop guidelines and policies specific to managing biodiversity on disturbed/contaminated areas within the urban matrix (residential, commercial and industrial land). Consider implementation of strategies such as phyto-remediation and brownfield conservation.	ENA 8.5	Low	Refer to <b>Figure 4-21</b> for map of modified/disturbed areas. The most up to date information on contaminated sites in Pitt

	Draft OCP		
Recommendations	Objective/Policy	Priority	Map/Polygon #
			Meadows is available from federal and provincial databases. <sup>18</sup>
B.5.2 Encourage implementation of green infrastructure (e.g., engineered or enhanced assets such as bioswales, constructed wetlands, green roofs, planted shading trees) for projects on public and private land.	LS 6.7.41; LS 6.7.5	High	N/A
B.6 Connectivity			
B.6.1 Include important natural assets (designated as hubs, sites and corridors) within a formal Green Infrastructure Network (GIN). This GIN can be supported by Natural Areas and Riparian Areas DPA designations. Designate habitat patches > 50 hectares as hubs and habitat patches > 10 hectares as sites within the City's GIN. Hubs and sites may have specific development conditions for protection, enhancement and/or restoration under the Natural Areas DPA.	ENA 8.5; ENA 8.7; ENA 8.8.2	Medium	Draft priority polygons are presented in Section 5.3.2.4 and <b>Figure 5-5</b> . Potential GIN corridors may be identified through further satellite imagery analysis.
B.6.2 Develop design guidelines specific to key wildlife road crossings to improve connectivity and reduce conflicts with wildlife.	ENA 8.5; ENA 8.7	Low	More information needed about key wildlife road crossings and locations of human-wildlife conflicts.
B.6.3 Improve connectivity by establishing and enhancing corridors between isolated patches to support wildlife movement within a future GIN.	ENA 8.5; ENA 8.7	Low	Draft priority polygons for GIN hubs and sites are presented in Section 5.3.2.4 and <b>Figure 5-5</b> . Potential GIN corridors may be identified through further satellite imagery analysis.
B.6.4 Use EIMS to identify and prioritize a system of greenways and blueways under an updated Parks, Recreation and Cultural Services Master Plan. Work with landowners to facilitate access on private land.	ENA 8.5; PR 4.1.2	High	Draft priority areas are presented in Section 5.3.2.5 and <b>Figure 5-6</b> .
B.6.5 Work with local, regional (Metro Vancouver) and provincial government to establish regional greenways/connectivity between Pitt Meadows, neighbouring municipalities (e.g., Maple Ridge) and adjacent provincial lands.	ENA 8.5; PR 4.1.1; PR 4.1.2	High	Draft priority areas are presented in Section 5.3.2.5 and <b>Figure 5-6</b> .

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<sup>&</sup>lt;sup>18</sup> Information from the Federal Contaminated Sites Inventory (<a href="https://www.tbs-sct.gc.ca/fcsi-rscf/home-accueil-eng.aspx">https://www.tbs-sct.gc.ca/fcsi-rscf/home-accueil-eng.aspx</a>) is available free of charge. Provincial information on contaminated sites can be requested for a fee (<a href="https://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/information-on-sites">https://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/information-on-sites</a>).

Recommendations	Draft OCP Objective/Policy	Priority	Map/Polygon #
C. Plants, Fish and Wildlife			
C.1 Species of Conservation Concern	1	1	
C.1.1 Develop policies for management of priority species of conservation concern that occur within the urban-wildland interface.	ENA 8.5; ENA 8.7.1	Medium	N/A
C.1.2 Work with landowners, stewardship groups and other government agencies to manage species at risk on private and public land.	ENA 8.7.2	Medium	Refer to Figure 4-32 for map of SCC Critical Habitat. The BC Conservation Data Centre (CDC) has more information about species and ecosystems at risk in Pitt Meadows. See Section 5.3.2.6 for rationale.
C.1.3 Protect natural assets of management and legal liability concern (e.g., wildlife trees/eagle nest trees, salmon spawning, migratory bird nesting aggregate areas) by establishing suitable buffers and development controls.	ENA 8.5	High	Critical Habitat may have legal implications (see Section 5.3.2.6). Up to date nest sites and wildlife concentration areas may be available from the CDC, or identified through site investigations for proposed developments.
C. 2 Invasive Species			
C.2.1 Use EIMS map showing distribution and abundance of invasive plants (e.g., parrot's feather, Japanese knotweed) to support management as interim measure prior to development of a more comprehensive Invasive Plant Inventory and Management Plan. Inventory information should be used in conjunction with other tools, such as the Invasive Plant Management Decision Analysis Tool (IPMDAT), to determine response requirement, preferred control strategy and feasibility.	ENA 8.5; ENA 8.8.1; PR 4.4.2	High	Draft priority areas are presented in Section 5.3.2.7 and <b>Figure 5-7</b> .
C.2.2 Expand inventory of invasive plants through formal, systematic surveys and citizen reports throughout Pitt Meadows.	ENA 8.6; ENA 8.8.1; PR 4.4.2	High	N/A
C.2.3 Work with stakeholders and external agencies to manage invasive plant and wildlife species (e.g., parrot's feather, Himalayan blackberry, pumpkinseed, largemouth and smallmouth bass, catfish, carp, American bullfrog) in high value habitats.	ENA 8.6; ENA 8.8.1; PR 4.4.2	Medium	Draft priority areas are presented in Section 5.3.2.7 and <b>Figure 5-7</b> .

Recommendations	Draft OCP Objective/Policy	Priority	Map/Polygon #
C.2.4 Update Pesticide Use Control Bylaw 2502, 2011 to manage non-essential pesticides and promote use of non-chemical methods to manage invasive plants (where practical).	PR 4.4.4	Medium	N/A
C.3 Human – Wildlife Conflicts			
	ΓΝΑ Ο Γ. ΓΝΑ Ο <i>C</i> 1	Madium	NI/A
C.3.1 Implement policies and encourage best practices to mitigate human-wildlife conflicts and disturbances. Action areas to reduce human-wildlife conflicts include: garbage/recycling programs, lighting, pets (dogs and cats), wildlife crossing design to mitigate road mortality, noise, beaver management, responsible motor boat use in sensitive areas, and waste management policies that reduce wildlife attraction to areas where conflicts are likely to occur. General actions can be applicable to whole City and targeted actions may be directed to identified priority areas.	ENA 8.5; ENA 8.6.1	Medium	N/A
C.3.2 Include wildlife-friendly and fish-friendly lighting specifications in the <i>Subdivision and Development Servicing</i> Bylaw, municipal buildings and operations, and in natural areas most prone and/or sensitive to disturbance (e.g., areas where edge effects are most pronounced, known areas with species of conservation concern, breeding habitat).	ENA 8.2.2	Low	Sensitive wildlife habitat may be available from the CDC, or identified through site investigations for proposed developments.
C.3.3 Develop a beaver management strategy to mitigate potential risks (e.g., flood damage) that may affect agricultural landowners and producers, while also supporting beaver populations and healthy functioning ecosystems that can provide benefits to wildlife and people.	ENA 8.5	Medium	Further engagement and field studies likely needed to identify risk areas and prioritize beaver management locations.
D. Climate Change Adaptation			
D.1 Align Climate Change Adaptation Strategy with EIMS to protect and manage priority natural assets that will increase resiliency to future climate change effects.	LS 6.6; LS 6.7	High- Medium	Refer to <b>Figure 4-2</b> for map of wetlands, riparian areas, and forests.
D.2 Develop and align strategies to protect and promote natural assets that sequester carbon and minimize predicted climate change effects (e.g., higher temperatures; increased drought; more severe winter flood events; increased surface runoff, soil erosion, and washouts; warmer water and related impacts to fish and invasive species; and, reduced air quality and implications for human health).	LS 6.6; LS 6.7	Medium	N/A
D.3 Model future sea level rise and flood scenarios (or work with others already doing such modelling); encourage protection and restoration of important natural assets	LS 6.5	High	Refer to <b>Figure 4-16</b> , <b>Figure 4-17</b> , and <b>Figure 4-18</b> for maps associated with flood risk;

Recommendations	Draft OCP Objective/Policy	Priority	Map/Polygon #
such as wetlands and forests to increase resilience to flood events, support irrigation			darker colours indicate more
and to enable the recharge of aquifers.			susceptible areas.
D.4 Review and update development guidelines to manage risk within the 1 and 200	LS 6.5	High	N/A
year floodplain limits for the Fraser River, Pitt River, Alouette River, and tributaries.			
D.5 Develop incentives (e.g., stormwater management levy) to reduce hard surfaces	LS 6.5	High-	N/A
and manage stormwater on site.		Medium	
D.6 Require a flood risk assessment for all development within the 200-year	LS 6.5	High	Refer to Figure 4-16, Figure
floodplain.			<b>4-17</b> , and <b>Figure 4-18</b> for maps associated with flood risk.
D.7 Develop planting and landscaping guidelines to ensure trees and other plants can	ENA 8.1; ENA 8.5;	Medium	N/A
adapt to projected climate change scenarios (e.g., hotter, drier summers).	ENA 8.9; LS6-2		
D.8 Establish shade trees/vegetation in priority riparian areas to mitigate projected	ENA 8.1; ENA 8.5;	High-	Draft priority areas are
warmer water temperatures that could negatively impact streams, fish and aquatic	ENA 8.9; LS 6.6.2	Medium	presented in Section 5.3.2.2
invertebrates.			and Figure 5-3.
E. Stewardship, Education and Awareness	T		
			21/2
E.1 Implement a water quality monitoring program in coordination with stakeholders	ENA 8.1; ENA 8.4;	High	N/A
and external agencies to improve fish and wildlife habitat, and to ensure safety for	ENA 8.8; LS 6.7.1		
human recreation and use.		NA o alivusa	The mest we to date
E.2 Implement a risk-based contaminated sites policy for public and private land which includes directives for identification, assessment, and timely remediation of	ENA 8.4; ENA 8.8	Medium	The most up to date information on contaminated
such sites following a polluter-pays principle. In many cases, contaminated sites may			sites in Pitt Meadows is
fall within Provincial or Federal Lands, which are not the responsibility of the City of			available from federal and
Pitt Meadows. However, the City should consider a policy or protocol, for advocating			provincial databases. 19
for site remediation from appropriate level(s) of government with jurisdiction over			provincial databases.
clean-up, particularly where contaminated sites are putting adjacent private or City-			
owned lands, land owners, and land users at risk and efforts to remediate lands by			
appropriate jurisdictions.			
this the second			

<sup>&</sup>lt;sup>19</sup> Information from the Federal Contaminated Sites Inventory (<a href="https://www.tbs-sct.gc.ca/fcsi-rscf/home-accueil-eng.aspx">https://www.tbs-sct.gc.ca/fcsi-rscf/home-accueil-eng.aspx</a>) is available free of charge. Provincial information on contaminated sites can be requested for a fee (<a href="https://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/information-on-sites">https://www2.gov.bc.ca/gov/content/environment/air-land-water/site-remediation/information-on-sites</a>).

Recommendations	Draft OCP Objective/Policy	Priority	Map/Polygon #
E.3 Prioritize protection, enhancement, and restoration of important natural assets used for recreation and enjoyment, as identified by citizens across the City.	ENA 8.6.1	Medium	Draft priority areas are presented in Section 5.3.2.5 and <b>Figure 5-6</b> .
E.4 Promote awareness and stewardship of the City's natural assets by celebrating locally, nationally, and internationally recognized events and best practices (e.g., World Migratory Bird Day; Canadian Wildlife Federation's "Grow It, Don't Mow It"; salmon festival, etc.).	ENA 8.6.1; ENA 8.6.2	High- Medium	N/A
E.5 Increase opportunities for nature interpretation/wildlife viewing in City parks and community gardens. New technologies including QR-coded signage and augmented reality interpretive apps that can be used on one's phone to provide more information about special places and ecosystems should be encouraged.	ENA 8.6.1	High- Medium	N/A
E.6 Collaborate with local schools to develop educational programs that increase awareness of the City's natural assets.	ENA 8.6.1	Medium	N/A
E.7 Implement citizen science and monitoring programs to improve the City's inventory of natural assets and help monitor environmental trends, changes and health.	ENA 8.6.1	Low- Medium	N/A
E.8 Introduce education programs to raise awareness of dumping and pollution in watercourses, riparian areas and other natural assets.	ENA 8.6.1	Medium	N/A
E.9 Pursue opportunities to engage and work with First Nations in management of fish, fish habitat and other natural assets on traditional territory(ies). Explore opportunities for capacity funding (e.g., grants) to enable the Katzie First Nation to provide feedback on important projects. A City personnel with decision-making authority could be assigned as a liaison with the Katzie First Nation for the advancement of meaningful government-to-government communication.	ENA 8.6.3	High	Need First Nations input
E.10 Prioritize the monitoring and clean-up of chronic illegal dumping-sites along City's watercourses and riparian areas as part of waste clean-up strategy. In some cases where the City does not have the responsibility for clean-up (e.g., in the case of derelict littered boats left in the Alouette River), inform the appropriate authorities of locations needing clean-up (e.g., Transport Canada).	ENA 8.6.3	Medium	Information required from City staff and the community (e.g., illegal dumping reports, observations on the ground; see Figure 5-1 for an example).
E.11 Develop research partnerships with educational institutes (UBC, SFU, University of the Fraser Valley, BCIT Fish and Wildlife Technician Certificate Program) and provincial/federal government agencies (e.g., Canadian Wildlife Services/Environment and Climate Change Canada) to provide expert advice and to help manage fish and wildlife on City land.	ENA 8.7.1	Low- Medium	N/A

Recommendations	Draft OCP Objective/Policy	Priority	Map/Polygon #
E.12 Introduce measures to protect and improve quality of habitat patches adjacent to disturbed landscapes. Patches and adjacent landscapes may have specific development conditions for protection, enhancement and/or restoration under the Natural Areas DPA. Focus on patches that are most compatible first and where it is most feasible to undertake restoration to improve habitat quality overall, particularly in terms of improving connectivity and corridor width.	ENA 8.5; ENA 8.8	High	Refer to Figure F-2 (Patch Type) and Figure F-6 (Quality of Adjacency). Management could focus on Undisturbed or Remnant patches that are Compatible or Somewhat Compatible with the adjacent landscape, where protection and/or restoration would improve connectivity and corridor width.



Figure 5-1. Derelict boat in the Alouette River near its confluence with the Pitt River. Photo by Lesley Sweryda, used with permission.

### 5.3.1 Recommendations for Establishment of Stream Setbacks

Zoetica recommends determining healthy riparian buffer strip widths that will protect streams now, and into the future, based on the best available science and a balance of considerations noted during stakeholder engagement meetings. Considerations of riparian buffer widths around water bodies include:

- i. Existing literature on the width of riparian forest needed to buffer water temperatures against increases in ambient air temperature.
- ii. The need for bank stabilization and erosion control by root systems considering projections for sharp increases in winter rainfall and flash flooding associated with the most probable climate change projections in the region.
- iii. The need for positive recreational (e.g., shaded) walking spaces, which may continue to increase with climate change.
- iv. The long-term role that streamside native vegetation and mature trees play in preventing or limiting the ability of invasive species to enter riparian areas.
- v. The long-term role that riparian trees and shading play in reducing the spread and growth rates of parrot's feather, an aquatic invasive species that costs the City considerable amounts of money in yearly control efforts and in pump blockages.
- vi. Consideration of the importance of healthy riparian vegetation for the filtration of water and natural maintenance of water quality objectives.
- vii. The need to maintain habitat connectivity through the greater Metro Vancouver area; to create movement and migration corridors for the maintenance of biodiversity; and, to promote opportunities to link recreational greenways.
- viii. Consideration of the dual role of riparian vegetation in meeting carbon sequestration objectives and in i-vi listed above.
- ix. Consideration of the dual role that riparian vegetation can play in reducing the risk of floods and road washouts.
- x. Consideration of the dual role that riparian vegetation can plan in reducing the loss of topsoil within the ALR, and in reducing overall dust within the City, due to windy conditions.
- xi. Long term monetary savings from using riparian vegetation for accomplishing ecosystem services listed above, which can be realized by an economic valuation of ecosystem services. The City can seek funding for such an evaluation via the MNAI.
- xii. Practicality and constraints of past developments. For example, planting is not allowed on existing dike structures; this may constrain planting in riparian areas depending on proximity of an existing dikes to a stream. Existing buildings may also already occur within the recommended riparian protection area.

Streamside Protection and Enhancement Areas (SPEAs) can be established under the provincial RAPR. The regulation does not apply to agricultural land. Under RAPR, the SPEA width can be determined by two methods: simple and detailed. The simple method establishes the SPEA width based upon fish presence, current and potential vegetated condition and presence of permanent buildings. SPEAs established under the simple method may be more conservative than SPEAs established using the detailed methods and may be more appropriate for higher value streams (e.g., Alouette River, Pitt River, Fraser River). Designated setbacks should also be included within the Riparian Areas DPA. For less significant streams, Riparian Areas Protection Regulation Detailed Assessment methods may be appropriate. This method does not apply set riparian setbacks, but instead allows a Qualified Environmental Professional (QEP) to

determine them. A QEP may require wider setbacks based on geotechnical, windthrow, flooding, or other environmental concerns. However, it is important to note that QEPs may not be able to consider the long-term implications of planning riparian areas based on considerations outlined in i-xi, which may result in their applying minimum setback widths. For this reason, it may be prudent for the City to consider their desired minimum setbacks in advance, in order to construct a "meet it or beat it" approach to RAPR. For example, Maple Ridge has established watercourse protection setbacks of either 15 m or 30 m depending on quality. In comparison, using the detailed assessment methods under RAPR alone, minimum setbacks may be as narrow as 2 metres for ditches and 5 metres for streams, depending upon their characteristics. These setback distances may not be appropriate for meeting most of the criteria outlined in points i-xi.

#### 5.3.2 Recommended Priority Areas and Polygons

The following recommended priority areas and polygons are based primarily on ecological values and with consideration of engagement feedback from stakeholders and the community. Areas/polygons are listed in decreasing order of recommended priority (i.e., highest priority listed at the top). Recommendations include any area within the boundaries of the City of Pitt Meadows and do not make the distinction between public or privately owned land, or jurisdictional authority over the land. These recommendations are the professional opinions of Zoetica and are presented as decision-making tools for the City; they do not constitute legally binding advice. Final decisions for the prioritization of management efforts are ultimately the responsibility of the City, in collaboration with First Nations, landowners, stewardship groups, and other municipal, regional, provincial, and/or federal agencies, as required. Selection or refinement of priority areas may also depend on the results of more detailed surveys on the ground, and on the funding opportunities and resources available.

#### 5.3.2.1 Watercourses and Riparian Areas

#### Recommendation(s) from Table 5-2:

- B.1.1 Prioritize the protection, restoration, and enhancement of streams, shorelines and riparian areas located within Riparian Areas and Natural Areas DPA designations.
- B.1.5 Engage and work with stakeholders, landowners, First Nations and other agencies to develop restoration and enhancement plans to improve fish habitat (including fish passage) in high priority areas.
- B.1.6 Develop partnerships with agricultural landowners, industry, stakeholders and other agencies to protect, restore and enhance priority riparian areas on ALR/industrial land to improve water quality by reducing sedimentation and filtering contaminants.
- B.1.7 Engage and work with agricultural landowners and producers, stakeholders, First Nations, and other agencies (e.g., MakeWay) to obtain funding through programs such as the BC Salmon Restoration and Innovation Fund (SRIF) to support fisheries management in high priority areas, engineering options to support fish movement, and restore priority riparian habitat.
- D.8 Establish shade trees/vegetation in priority riparian areas to mitigate projected warmer water temperatures that could negatively impact streams, fish and aquatic invertebrates.

# Priority areas/map polygons:

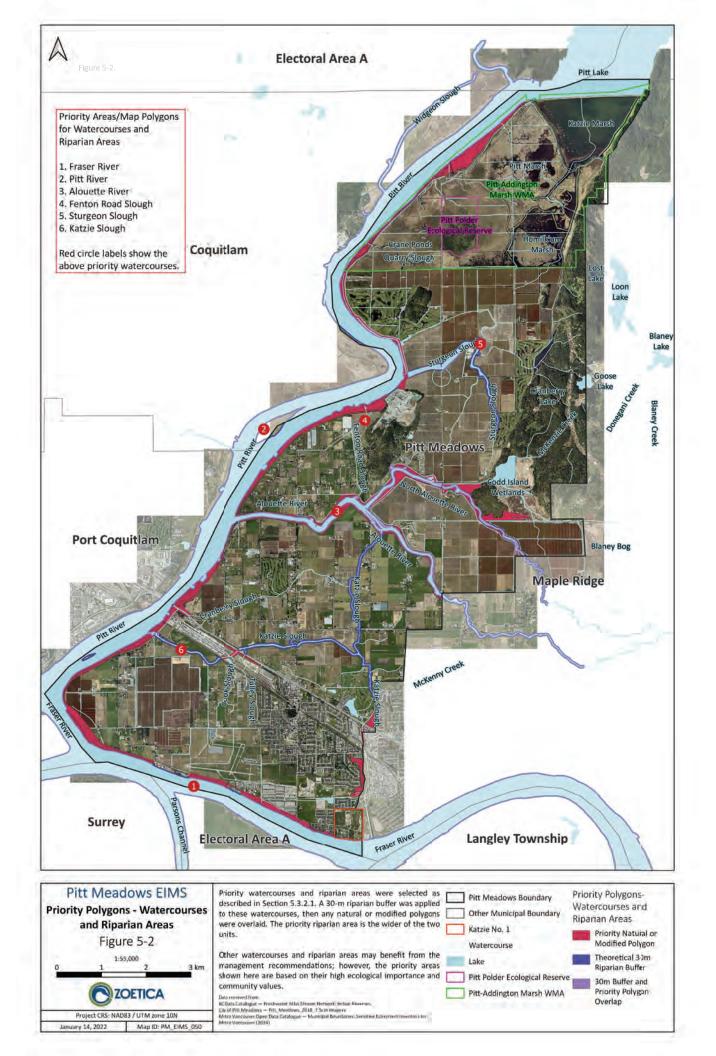
- 1. Fraser River
- 2. Pitt River

- 3. Alouette River
- 4. Sturgeon Slough
- 5. Fenton Road Slough
- 6. Katzie Slough

Prioritized watercourses and riparian areas are shown in **Figure 5-2**. The width of priority riparian areas is defined based on the width of the existing riparian habitat (i.e., natural or modified polygons) or a theoretical 30 m buffer if there are only agricultural or built-up polygons, whichever is the most conservative.

#### Rationale:

Prioritization of watercourses and riparian areas was based on data about ESAs (see Figure 4-1) and theoretical riparian habitat restoration benefits (see Figure 4-20). Areas identified as ESAs, especially natural riparian habitats such as sections of the Fraser and Pitt river foreshores, should be prioritized for protection and enhancement. The map showing restoration potential considers riparian buffer rank (distance bins of 0-15 m, 15-30 m, 30-100 m), human disturbance rank (e.g., urban, agricultural, natural), and salmon productivity rank (see also Figure 4-19, Combined Salmon Productivity map). The higher the final restoration potential rank, the more benefit to salmon will be received from restoration. Based on its lower riparian habitat restoration potential (i.e., feasibility and potential positive impacts for salmon) and its lack of recognition as an ESA, the Katzie Slough was ranked as lower priority than other watercourses. However, Zoetica acknowledges that the Katzie Slough was frequently noted as a management priority by both stakeholders and the community due to its degraded state (see Figure 4-5 and Appendix A – Engagement Summary). If interest from the public and private landowners of the Katzie Slough foreshore can be converted into stewardship actions to assist the City with restoration efforts, then the Katzie Slough may be a viable location to focus management efforts. Note also that there are pump stations and floodgates along the Sturgeon Slough and at drainage channels connected to the Alouette River; restoration efforts at these watercourses may include upgrading the infrastructure to better support fish movement and increasing available salmon habitat.



#### 5.3.2.2 Revegetation and Tree Planting

# Recommendation(s) from Table 5-2:

B.2.3 Increase structural diversity of plant communities through habitat enhancement and restoration.

D.8 Establish shade trees/vegetation in priority riparian areas to mitigate projected warmer water temperatures that could negatively impact streams, fish and aquatic invertebrates.

# Priority areas/map polygons:

- 1. Degraded riparian areas of watercourses noted above
- 2. Previously disturbed areas to mitigate flood risk
  - a. Bonson Road at Fraser River: undeveloped surrounding areas
  - b. Confluence of Alouette River and Pitt River: polygons 292, 293
  - c. North Alouette River at Neaves Road: polygons 54, 62
  - d. Between Pitt River and Fenton Road Slough: polygons 34, 431, 426
  - e. Sturgeon Slough at Rannie Road: polygon 460
- 3. Previously disturbed areas to mitigate slope/soil instability and improve ecosystem connectivity:
  - a. Forested outcrop south of Homilk'um Marsh: polygons 468, 53
  - b. Pitt River Quarries: polygons 385, 49
  - c. Agricultural lands

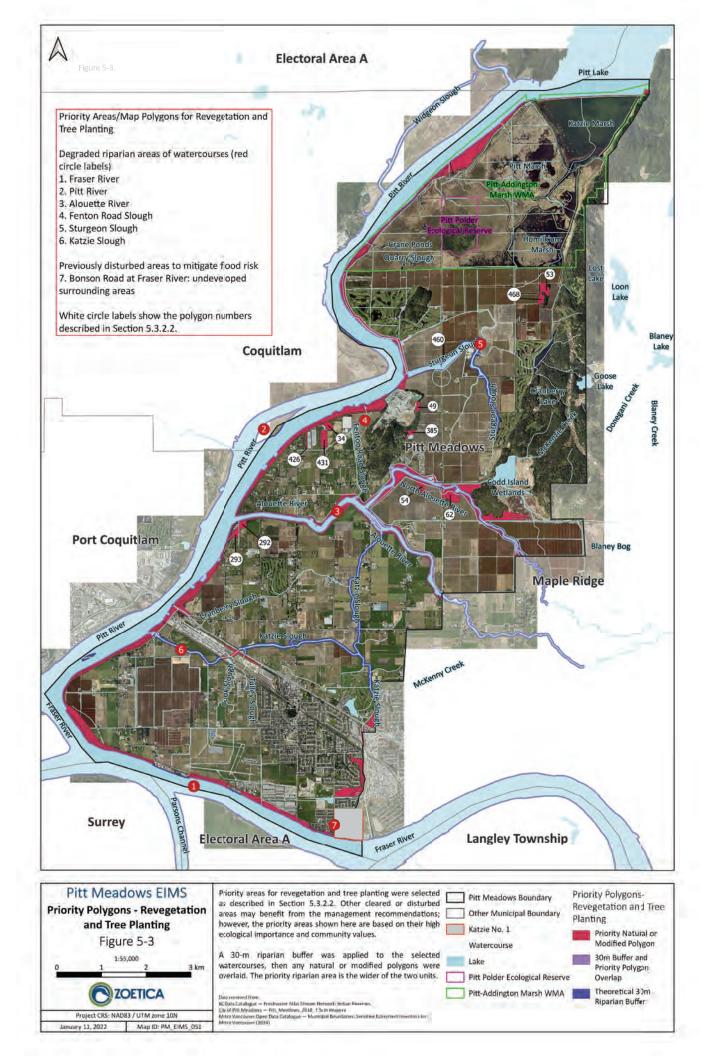
Prioritized areas/polygons for revegetation are shown in **Figure 5-3**. Note: it is not possible for Zoetica to select priority locations for planting hedgerows on agricultural lands; the City will need to work with (and likely incentivize) agricultural landowners to complete this type of habitat enhancement.

# Rationale:

Candidate sites for improving structural diversity through habitat enhancement or restoration include riparian areas where natural vegetation has been cleared and/or outcompeted by invasive species such as reed canarygrass and Himalayan blackberry. In this case, priority locations include the riparian areas associated with the ranked watercourses noted above; revegetation of these areas, especially with native tree species, would provide important ecosystem services to mitigate against climate change impacts, such as providing shading to moderate water temperatures for fish and other aquatic organisms.

Other candidate sites include previously disturbed areas that are currently left unmanaged and are naturally regenerating (see **Figure 4-21** for map of "modified" polygons). In particular, polygons close to shorelines or on slopes could be prioritized, as revegetation of these areas would help provide a buffer against flood risk and improve slope/soil stability, respectively. Habitat enhancement/restoration of some of these modified polygons could also serve to improve ecosystem connectivity as part of a future green infrastructure network.

Finally, planting hedgerows and increasing structural diversity on agricultural lands would benefit both the landowner/producer (e.g., by supporting pollinators and beneficial insects, stabilizing soils from erosion) and the broader community (e.g., providing wildlife habitat, carbon storage, green connectivity).



#### 5.3.2.3 Acquisition of Natural Assets

#### Recommendation(s) from Table 5-2:

B.3.1 Work with Metro Vancouver, stakeholders, other agencies, and rights-holders to update the City's land acquisition strategy to help identify and protect priority natural assets not currently within the City's or Region's parks and open space system. Opportunities to maintain/enhance ecological functioning, connectivity, biodiversity, and human enjoyment of nature (e.g., bird watching, fishing) within the City and Region should be prioritized.

#### Priority areas/polygons:

- 1. Any habitat identified as an ESA that is not currently protected
- 2. Agricultural area between Codd Island Wetlands and Blaney Bog: polygons 151, 193
- 3. Thompson Mountain: all forested polygons
- 4. NLSA: polygon 797 (mature coniferous forest); consider also adjacent polygons 77, 1029, 75 for restoration
- 5. Sheridan Hill: all forested and vegetated polygons
- 6. Swaneset Bay Resort and Country Club: all forested polygons
- 7. Forested outcrop south of Homilk'um Marsh: polygons 53, 468, 1997, 2642
- 8. Young forest around Airport Trail: polygon 1052
- 9. Old field and modified area south of Pitt Meadows Athletic Park: polygons 1038, 110, and wetland/waterbody
- 10. Wetland and modified area north of Linden Grove Park: polygons 226, 2289
- 11. Treed wetlands surrounding transmission line right-of-way (ROW) north of Swaneset: polygons 2859, 2639, 2923, 2924, 2848
- 12. Old field site off Pitt River Bridge: polygon 2922

Priority areas for acquisition and protection are shown in **Figure 5-4**, alongside available data about protected areas owned by the City or Metro Vancouver (provincially protected areas are not indicated on this map, but consist solely of Pitt-Addington WMA). Note that other areas within the City may be protected by covenants or other conservation tools; a definitive database of protected areas would help the City refine priority natural assets to acquire.

#### Rationale:

Prioritization of natural assets for the City to acquire and protect was based on the ESA dataset, the importance of urban and rural forests for a variety of ecosystem services (including human enjoyment), and opportunities to improve area size and/or connectivity of existing natural assets. As shown in **Figure 5-4** below, ESAs in Pitt Meadows include wetlands and major watercourses and their riparian areas. However, only a portion of these habitats are currently protected, and sometimes in disjunct sections (e.g., Fraser and Pitt river foreshores). The Alouette River is a notable gap that should be prioritized for protection. Acquisition of areas noted as gaps would increase ecosystem connectivity from the Fraser River north to Pitt Lake (which is the ultimate plan for the PRRG; City of Pitt Meadows, 2021; Metro Vancouver, 2020), from the Pitt River east to the Codd Island Wetlands and into the Thompson Mt. range, and beyond. Protection of these corridors would also increase regional connectivity to natural assets within neighbouring jurisdictions (e.g., Maple Ridge, Coquitlam, Electoral Area A, Surrey; see also Section 5.3.2.5).

Furthermore, Metro Vancouver recently added 56 ha to the Codd Wetland Ecological Conservancy Area and has a vision to connect this area to the Blaney Bog Regional Park Reserve and the North Alouette Regional Greenway<sup>20</sup>. Acquisition of the agricultural lands between the Codd Island Wetlands and Blaney Bog would provide even greater ecosystem connectivity, especially if the existing dikes were relocated to allow these farms to regenerate into a more natural wetland ecosystem.

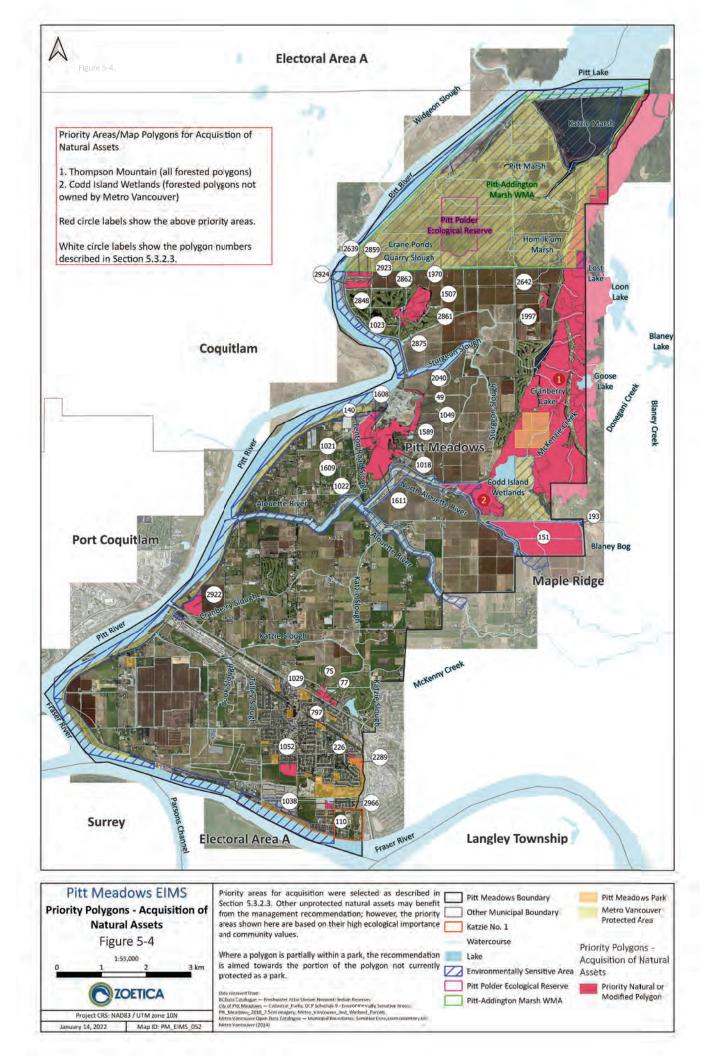
The importance of protecting mature forests, including the conifer stand within the NLSA, was noted repeatedly during stakeholder and community engagement (see Appendix A – Engagement Summary). There are a few natural and semi-natural areas within the City's urban centre that are likely at risk from development pressures, including the relatively large patch of young forest surrounding Airport Trail and the property at Bonson Rd between Airport Way and Sutton Ave. The City could consider acquiring these areas and increase the number, quality, connectivity, and biodiversity of green spaces within the urban centre. According to the City's GIS data for Parks and Protected Areas (**Figure 4-30**), the area north of Linden Grove Park is not currently part of the municipal park system. Extending the Wildwood Crescent Trail "park" up to Hammond Rd would increase the size and ecological function of this urban green space.

There are two SEI wetland polygons north of Swaneset surrounding a power transmission line ROW. During stakeholder engagement, it was noted that western toads (a SCC) breed in the ponds at Swaneset and migrate north through these wetlands. Furthermore, unlike the nearby wetland habitats to the north, these polygons resembled young mixed forest habitat (as noted by Zoetica during 2020 SEI field verification). Zoetica recommends protecting these forested wetland habitats as an extension of the Pitt-Addington WMA and to preserve habitat connectivity for western toads.

Finally, there is a large old field site just off the Pitt River Bridge; the area size and proximity to the Pitt River (and associated wetland and riparian habitats; see **Figure 4-2**) may be attractive to migrating birds and other wildlife.

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http://www.metrovancouver.org/media-room/media-releases/parks/641/record-visitation-validates-regional-parks-land-acquisition-strategy



#### 5.3.2.4 Green Infrastructure Network

# Recommendation(s) from Table 5-2:

B.6.1 Include important natural assets (designated as hubs, sites and corridors) within a formal Green Infrastructure Network (GIN). This GIN can be supported by Natural Areas and Riparian Areas DPA designations. Designate habitat patches > 50 hectares as hubs and habitat patches > 10 hectares as sites within the City's GIN. Hubs and sites may have specific development conditions for protection, enhancement and/or restoration under the Natural Areas DPA.

B.6.3 Improve connectivity by establishing and enhancing corridors between isolated patches to support wildlife movement within a future GIN.

#### Priority areas/polygons:

- 1. GIN hubs undisturbed and remnant polygons >50 ha: Pitt-Addington WMA, Thompson Mt., Codd Island Wetlands, Sheridan Hill
- 2. GIN sites undisturbed and remnant polygons >10-50 ha: riparian areas of the Fraser, Pitt, and Alouette rivers<sup>21</sup>; forested habitats at Swaneset; wetland, forested, and old field habitats around Wildwood Crescent Trail; wetland habitats surrounding transmission line ROW north of Swaneset
- 3. GIN sites regenerating polygons >10-50 ha: old field habitat just off Pitt River Bridge (polygon 2922); wetland, old field, and forested habitats west of Hollandia Greenhouses (polygons 1056, 1057, 2264, 2920, 2921)

Analytical Maps). Undisturbed and remnant patches were prioritized over regenerating ones as the former are more likely to harbour greater tree cover and structural diversity. Landscaped patches were not prioritized here as hubs or sites, but could be considered by the City as sites and corridors to increase green connectivity between more natural habitats. As shown in Figure 4-2, there may be limited opportunities to designate GIN corridors based on SEI classes or existing parks and open spaces within the more built-up areas of the City (i.e., south of the Alouette River), as many of these polygons are surrounded by urban and agricultural areas. The City may wish to further analyze satellite imagery to assess tree cover (e.g., using i-Tree) to incorporate tree-lined streets, planted boulevards and traffic circles, and other types of urban forests into the GIN. The scale of this type of analysis was out of Zoetica's

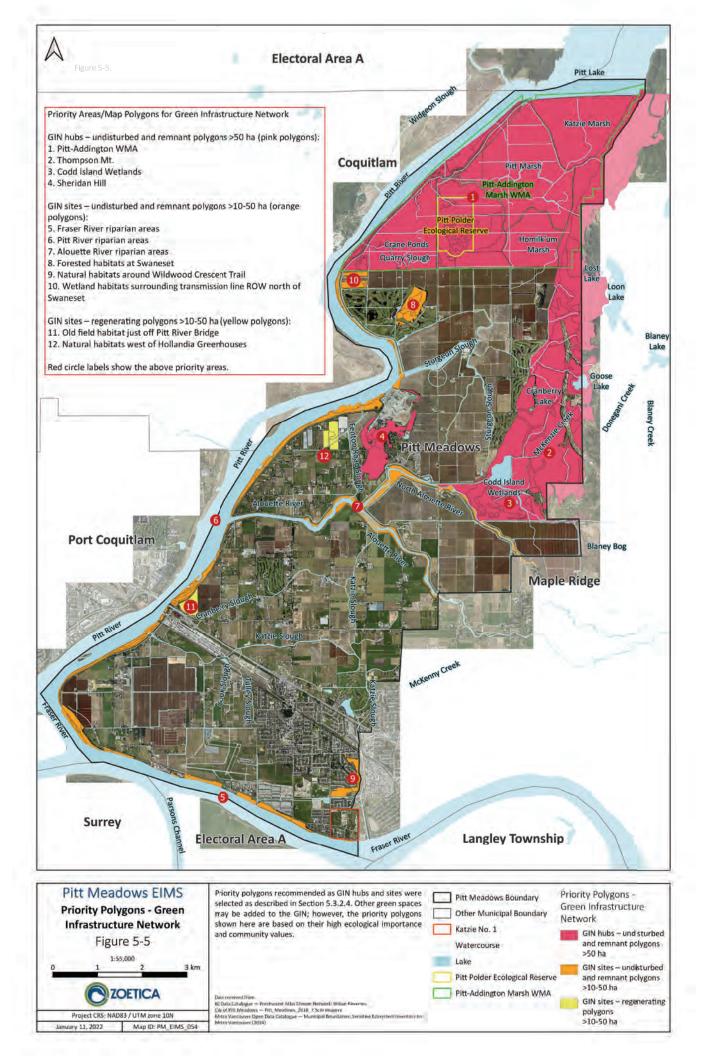
Priority polygons to incorporate into a GIN as hubs and sites are shown in Figure 5-5.

#### Rationale:

As noted in the recommendation, prioritization of hubs and sites for the City's GIN is based on habitat patch type and area size (see Figure F-2 and Figure F-3 in Appendix F - Habitat Quality Assessment:

<sup>21</sup> Some polygons within the Fraser, Pitt, and Alouette riparian areas are less than 10 ha in size; however, the polygons making up these greenways have been considered on a landscape scale, where connectivity is a greater priority than strict area size considerations.

scope for the current EIMS project, which focused on higher-level natural and semi-natural areas.



#### 5.3.2.5 Greenways and Blueways

# Recommendation(s) from Table 5-2:

B.6.4 Use EIMS to identify and prioritize a system of greenways and blueways under an updated Parks, Recreation and Cultural Services Master Plan. Work with landowners to facilitate access on private land.

B.6.5 Work with local, regional (Metro Vancouver) and provincial government to establish regional greenways/connectivity between Pitt Meadows, neighbouring municipalities (e.g., Maple Ridge) and adjacent provincial lands.

E.3 Prioritize protection, enhancement, and restoration of important natural assets used for recreation and enjoyment, as identified by citizens across the City.

# Priority areas/polygons:

- 1. Blueways
  - a. Pitt River and Alouette River<sup>22</sup>
  - b. Sturgeon Slough
  - c. Katzie Slough
- 2. Greenways
  - a. Alouette River, Pitt River, and Fraser River dike trails and surrounding natural habitats
  - b. Codd Island Wetlands
  - c. Thompson Mt.

Priority areas for greenways and blueways are shown in **Figure 5-6**.

### Rationale:

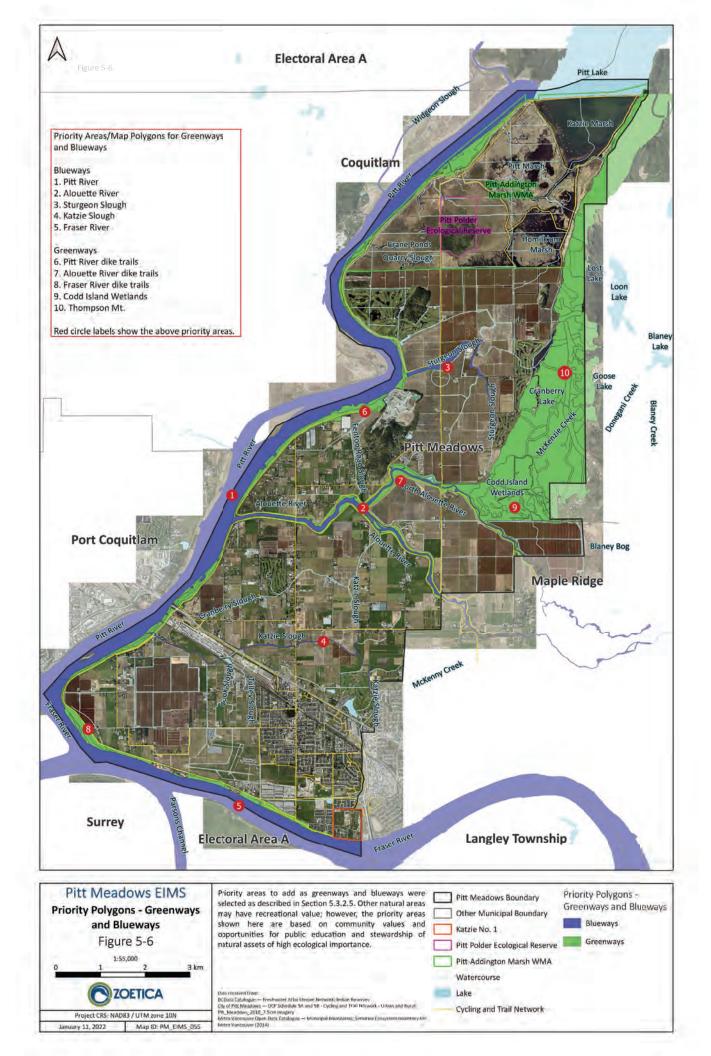
During community engagement, trails and waterways of the Alouette, Pitt, and Fraser rivers were frequently noted as valued natural assets and popular areas for recreation. Various municipal parks were also mentioned as popular areas to visit and important areas to protect, especially Hoffmann Park and Pitt-Addington WMA. Some of these blueways and greenways may already be part of the open space systems managed by the City of Pitt Meadows, Metro Vancouver, or the Province of BC, such as the Fraser River, PRRG, Trans Canada Trail, and the dike trail system within the Pitt-Addington WMA (see **Figure 4-30** for map of existing parks, open spaces, protected areas, and trails). However, as discussed in Section 5.3.2.3, there are some gaps in protection for natural areas adjacent to the trail network. Natural assets that are currently unprotected should be prioritized for inclusion as officially designated greenways and blueways to prevent destructive impacts from future developments.

Prioritization can also focus on less accessible natural assets that could be incorporated into the City's Parks, Recreation and Cultural Services Master Plan. With improvements to habitat quality and access (there are no official launch areas for either watercourse), Sturgeon Slough and Katzie Slough could also be added as blueways for recreation, such as fishing and canoeing/kayaking. The Watershed Watch Salmon Society used to lead canoe trips through the Katzie Slough; however, this activity has become

<sup>&</sup>lt;sup>22</sup> The waterways of the Pitt and Alouette rivers may already be part of an official blueway system; however, they are presented on the map, alongside the City's cycling and trail network dataset, to showcase the existing natural and recreational assets valued by the Pitt Meadows community.

increasingly difficult due to the spread of invasive parrot's feather and other vegetation growing in the stagnant waters.

Allowing public access (even seasonally) to the Codd Island Wetlands and Thompson Mt. may increase the community's affinity and "sense of place" with these valuable natural assets in Pitt Meadows. Although the Codd Island Wetlands (and larger Codd Wetland Ecological Conservancy Area) are intended to be inaccessible to protect the ecosystems and associated wildlife, there is a private driveway belonging to the Bordertown movie studio that enters the wetlands from the east. Similarly, the Thompson Mt. range is valued for its large area of mature forests. While there are numerous trails on the Maple Ridge side of the mountains (e.g., beginning at the Malcolm Knapp Research Forest), existing roads/trails on the Pitt Meadows side appear to be privately owned, including a trail from the eastern end of Thompson Rd that passes through the forest and connects with Bordertown's private driveway. Extension of forest trails from Maple Ridge into Pitt Meadows could also be an option; however, Zoetica's current recommendations are focused on adding to the City's greenway system without further habitat disturbance.



#### 5.3.2.6 Species at Risk and Wildlife Habitat

# Recommendation(s) from Table 5-2:

C.1.2 Work with landowners, stewardship groups and other government agencies to manage species at risk on private and public land.

C.1.3 Protect natural assets of management and legal liability concern (e.g., wildlife trees/eagle nest trees, salmon spawning, migratory bird nesting aggregate areas) by establishing suitable buffers and development controls.

#### Priority areas/polygons:

- 1. Critical habitat for species at risk
  - a. Marbled murrelet (Final, 9 polygons): west side of Sheridan Hill, Codd Wetland Ecological Conservancy Area, Thompson Mt. east of Pitt-Addington WMA and west of Loon Lake
  - b. Western painted turtle, Pacific Coast population (Proposed, 2 polygons): Pitt-Addington WMA plus agricultural lands to the south and Thompson Mt. streams; habitat around and between the North and South Alouette rivers, Katzie Slough and tributaries from the South Alouette River to Meadow Gardens Golf Club
- 2. Areas with known occurrences of species at risk
- 3. Rare habitats of importance for species at risk

Polygons containing critical habitat for species at risk are shown in **Figure 4-32**. Note: critical habitat exists within the defined polygons but does not necessarily extend to the boundaries. To determine precisely what constitutes critical habitat, refer to the species' *SARA* recovery documents for the biological and environmental features ("biophysical attributes") that define critical habitat.

#### Rationale:

Critical habitat is defined as the habitat necessary for the survival or recovery of a listed wildlife species (Endangered or Threatened on Schedule 1 of the federal *Species at Risk Act*). The identification of critical habitat is accompanied by legal requirements under *SARA* – it is illegal to destroy any part of the critical habitat of SCC on federal lands and restrictions may be imposed on development and construction. In BC, critical habitat is legally protected in ecological reserves (under the *Ecological Reserve Act*) and, to some degree, in provincial parks (under the *Park Act*) and WMAs (under the *Wildlife Act*). On non-federal lands outside of these protected areas, local government bylaws (e.g., DPAs) can include habitat protection. If warranted, a protection order under *SARA* can be invoked to prohibit the destruction of critical habitat on non-federal lands.

In Pitt Meadows, polygons containing critical habitat have been identified (finalized by ECCC) for marbled murrelet, and proposed (not finalized) for western painted turtle<sup>17</sup>. Although proposed critical habitat is not yet legally protected, it is an important consideration for the City for land use planning as 1) these polygons may indicate where SCC are more likely to occur, and 2) areas may become finalized critical habitat in the future. Other spatial information about SCC, such as known occurrences and wildlife habitat areas, must be requested through the CDC and/or Wildlife Species Inventory section of the BC Ministry of Environment and Climate Change Strategy. The habitat at known occurrences may not be legally protected, but SARA prohibits killing, harming, harassing, capturing, or taking species listed on Schedule 1. Finally, certain habitat types may be more important for SCC (see Appendix G – Matrix of Habitat

Suitability for Species of Conservation Concern). During engagement, stakeholders and the community noted the importance of urban and rural forests (especially mature forests), watercourses, old field sites, and healthy riparian areas for SCC. Rare habitat types within Pitt Meadows that could potentially support numerous SCC, such as riparian forests, should be prioritized for protection.

#### 5.3.2.7 Invasive Species Management

# Recommendation(s) from Table 5-2:

C.2.1 Use EIMS map showing distribution and abundance of invasive plants (e.g., parrot's feather, Japanese knotweed) to support management as interim measure prior to development of a more comprehensive Invasive Plant Inventory and Management Plan. Inventory information should be used in conjunction with other tools, such as the Invasive Plant Management Decision Analysis Tool (IPMDAT), to determine response requirement, preferred control strategy and feasibility.

C.2.3 Work with stakeholders and external agencies to manage invasive plant and wildlife species (e.g., parrot's feather, Himalayan blackberry, pumpkinseed, largemouth and smallmouth bass, catfish, carp, American bullfrog) in high value habitats.

#### Priority areas/polygons:

- 1. Watercourses and drainage ditches where parrot's feather has been found (including Katzie Slough)
- 2. Natural areas with Japanese knotweed (e.g., Codd Island Wetlands, wetlands around Wildwood Crescent Trail, wetlands north of Swaneset, Pitt and Alouette river foreshores)
- 3. Katzie Marsh
- 4. Sturgeon Slough
- 5. Hoffmann Park

Priority areas for invasive species management are shown in **Figure 5-7**. However, it is important to bear in mind that invasive species data currently available from the City and the IAPP are not systematic or comprehensive. A detailed invasive species inventory of Pitt Meadows should be completed to identify additional priority areas of concern.

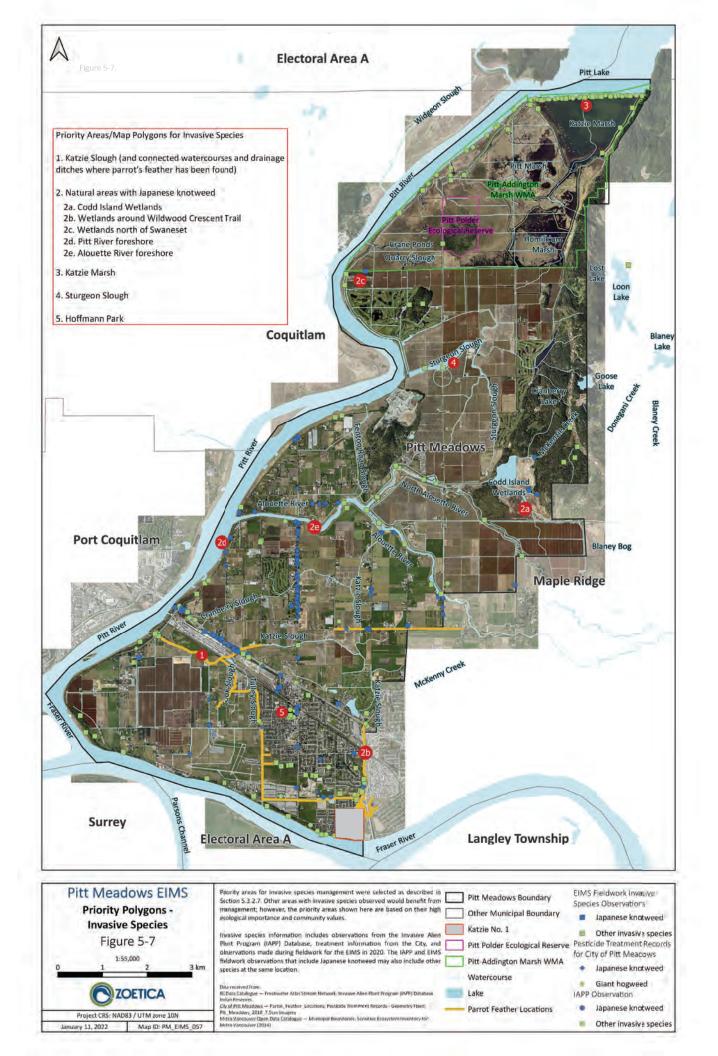
#### Rationale:

Prioritization of invasive species management is based on the ecological and community values of the natural asset and the invasiveness of the species (e.g., how quickly it spreads, its ability to outcompete native species, ease of management and eradication). Parrot's feather and Japanese knotweed are particularly difficult to manage successfully. Management of parrot's feather and improving water flow within the Katzie Slough may have the added benefit of helping to manage invasive fish species – as noted by stakeholders and as shown through eDNA metabarcoding analyses, carp species, pumpkinseed, and Oriental weatherfish are present in the stagnant waters of the slough (see Appendix C – 2020 Field Surveys and Desk-based Research). Although Japanese knotweed appears especially problematic along the Lougheed Highway multi-use trail and Harris Road (see **Figure 4-33** and **Figure 4-34**), these are highly disturbed habitats where the spread of knotweed is more likely to occur. Management efforts may be better allocated to protect remnant natural areas (see point 2 in priority list) and native vegetation from the impacts of knotweed.

Similarly, management efforts could be prioritized at the dike trails around Katzie Marsh to prevent the spread of invasive species to other parts of the marsh and Pitt-Addington WMA. However, the extent of invasive species in this area is so great that the costs for restoring this area may be prohibitive without large monetary contributions from partners or from taxation and use of funds from large developments as part of offset measures. Based on the 2020 eDNA results, Katzie Marsh also harbours a variety of aquatic invasive species (see Appendix C – 2020 Field Surveys and Desk-based Research), which may be outcompeting native fish species (none were detected through metabarcoding analyses). Despite being a protected natural area, historical and/or current disturbances are likely impacting native terrestrial and aquatic biodiversity.

eDNA results also showed that Sturgeon Slough had the highest number of invasive fish species (9) out of all areas sampled (see Appendix C-2020 Field Surveys and Desk-based Research). Since the stretch of Sturgeon Slough between the Pitt River and east of Rannie Road is a popular fishing area, the City could undertake public education/outreach and work with anglers to manage invasive aquatic species.

As shown in **Figure 4-34**, a variety of invasive plants have been found at Hoffmann Park but are relatively limited in spatial extent. Proactive management of invasive species at Hoffmann Park would help maintain the long-term health of this remnant mature forest stand and its understorey of native vegetation.



#### 6.0 MONITORING: PERFORMANCE INDICATORS AND BENCHMARKS

### 6.1 Introduction

This section provides a summary of recommended management objectives, performance indicators and benchmarks to help manage natural assets identified within the EIMS. Performance indicators are adapted from the CBI to more broadly encompass natural assets. Use of these indices provides an international standard for monitoring natural assets within the City of Pitt Meadows.

# 6.2 Adaptive Natural Asset Management

Adaptive management is a framework that incorporates regular monitoring, assessment and adaptation to improve performance over time (**Figure 6-1**). This continuous feedback loop helps to ensure objectives are being met by evaluating the effectiveness of management actions and by implementing best practices and applying new knowledge to respond to changing conditions.

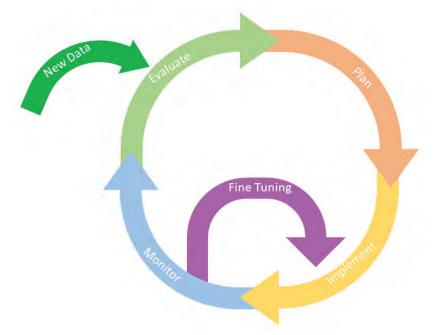


Figure 6-1. Graphical representation of adaptive management.

The EIMS includes a performance matrix (**Table 6-1**) with measures (i.e., performance indicators) to assess and monitor how well the city is managing its natural assets. Some measures are adapted from the CBI, which was initiated in 2008 under the umbrella of the United Nations' Convention on Biological Diversity (CBD) as a self-assessment tool to evaluate and monitor a city's biodiversity conservation efforts using its own baseline information. This international standard has 23 indicators that measure performance in three core areas:

- native biodiversity;
- ecosystem services; and,
- governance and management of biodiversity.

The performance indicators and benchmarks in the EIMS are linked to natural asset management goals and objectives stated in the City of Pitt Meadows' draft OCP (see Section 5.2). Only goals and objectives with measurable performance indicators that could be thematically linked have been included. Performance indicators have been further organized to correspond with the three core areas (see above) described in the CBI, although those core areas have been expanded to include natural assets in general.

Performance indicators derived from the CBI are differentiated from indicators developed specifically for the Pitt Meadows context. The scoring system for the CBI ranks each indicator on a 4-point scale, and this scale (Low, Moderate, Good, and Optimal) is applied to all indicators in the EIMS. All 23 CBI indicators have been included; however, some indicators require baseline information that is not currently available. These indicators have been summarized in Section 6.2.2 with recommendations on how baseline information can be collected. Additional indicators may be added to the performance matrix as the City's capacity to monitor its natural assets grows.

# 6.2.1 EIMS Management Objectives, Performance Indicators and Benchmarks

Management objectives, performance indicators and benchmarks are provided in **Table 6-1** below. Performance benchmarks for CBI indicators (noted with a \*) are based on the Singapore Index on Cities' Biodiversity User's Manual (also known as the City Biodiversity Index; Chan *et al.* 2014). Performance indicators are categorized within one of three core areas: natural assets – green; ecosystem services – blue; and, governance and management of natural assets – yellow. These performance indicators should be reviewed and updated every 1-5 years, as needed, to remain current.

Table 6-1. Management objectives, performance indicators and benchmarks, and current baseline conditions (if known) in the City of Pitt Meadows. An asterisk

(\*) denotes CBI indicators. Green = natural assets, blue = ecosystem services, yellow = governance and management of natural assets.

Management			Recommended Perfe	ormance Benchmarks		
Objectives that PI relates to	Performance Indicators (PI)	Low	Moderate	Good	Optimal	Current Baseline
ENA 8.4 Show	Budget allocated to natural asset	≤2.2%	2.3-2.7%	2.8-3.7%	>3.7%	Low
leadership in	management*					
implementing	Number of natural asset related	<12 Programs/Projects	12-21	22-39	>40 Programs/Projects	Low
sustainable	projects implemented annually by		Programs/Projects	Programs/Projects		
environmental	City*					
practices	Number of City departments <sup>23</sup>	<3 departments	3 departments	4 departments	All applicable	Low
	involved in intra-agency	cooperate on natural	cooperate on natural	cooperate on natural	departments	
	cooperation pertaining to	asset matters	asset matters	asset matters	cooperate on natural	
	management of natural assets*				asset matters	
	Staff capacity to manage natural	City has no dedicated	City has one dedicated	City has two dedicated	City has three or more	Low – Moderate
	assets	staff (e.g.,	staff whose primary	staff whose primary	dedicated staff whose	City currently has one person
		environmental	job is to manage	jobs are to manage	primary jobs are to	who is partially dedicated to this
		coordinator) whose	natural assets	natural assets	manage natural assets	task
		primary job is to				
		manage natural assets				
	Percentage of EIMS	≤10% of	>10-50% of	>50-75% of	>75% of	Low
	recommendations implemented	recommendations	recommendations	recommendations	recommendations	
		have been	have been	have been	have been	
		implemented	implemented	implemented	implemented	
ENA 8.6.1 Promote	Existence of formal or informal	Formal or informal	Formal or informal	Formal or informal	Formal or informal	Moderate
community	public consultation process (e.g.,	process being	process being planned	process in the process	process exists as part	
involvement and	Environmental Advisory	considered as part of	as part of the routine	of being implemented	of the routine process	
increase awareness of	Committee - EAC)*	the routine process	process	as part of the routine		
environmental issues				process		
among residents and	Is awareness of natural assets	Natural assets are not	Natural assets are	Natural assets are in	Natural assets are	Moderate
business owners	(e.g., biodiversity) included in the	included or are being	being planned for	the process of being	included in the school	
	school curriculum <sup>24*</sup>	considered for	inclusion in the school	implemented in the	curriculum	
		inclusion in the school	curriculum	school curriculum		
		curriculum				

<sup>&</sup>lt;sup>23</sup> "Could include departments responsible for biodiversity, planning, water, transport, development, finance, infrastructure, etc." (Chan et al. 2014)

<sup>&</sup>lt;sup>24</sup> "Most cities have no jurisdiction over school curricula. The incorporation of this indicator creates the opportunity for city officials to liaise with education officers so that biodiversity courses are taught at pre-school, primary, secondary and tertiary levels." (Chan et al. 2014).

Management			Recommended Perf	ormance Benchmarks		
Objectives that PI relates to	Performance Indicators (PI)	Low	Moderate	Good	Optimal	Current Baseline
	Number of formal educational visits <sup>24</sup> per child (<16 years old) to natural park areas per year*	0 visits per year	1 visit per year	2 visits per year	≥3 visits per year	TBD
	Number of outreach and public awareness events organized by the City per year*	<6 events per year	6-14 events per year	15-30 events per year	>30 events per year	Moderate 8 Events per year
	Number of biodiversity-related functions from biodiversity focused institutions <sup>25*</sup>	<2 functions	2 functions	3 functions	>3 functions	Low
ENA 8.6.3 Collaborate with First Nations, regional and senior governments, agencies, and community organizations in the	Number of agencies, First Nations, private companies, NGOs, academic institutions, international organizations for which the City is partnering <sup>26</sup> in natural asset activities, projects and programs*	City has <7 partnerships	City has 7-12 partnerships	City has 13-19 partnerships	City has ≥20 partnerships	Low 5 partnerships
protection, management and stewardship of natural areas, local parks, ecological reserves, and wildlife management areas	Number of habitat restoration projects which the City is partnering with other agencies, First Nations, private companies, NGOs, etc.	City partners for <2 restoration projects/year	City partners for 2-5 restoration projects/year	City partners for 6-10 restoration projects/year	City partners for >10 restoration projects/year	Low
ENA 8.7.1 Enhance the City's knowledge of environmental assets through physical and biological resource inventories	Native biodiversity (bird species) in built up areas (not including natural areas)*	≤27 bird species	28-46 bird species	47-68 bird species	>68 bird species	Optimal 149 species Based on eBird data limited to last 3 years (2018-2020), March through August inclusive, Urban locations.
	Change in number of native vascular (non-invasive/non-introduced) plant species*	1 species increase (over last monitoring period)	2 species increase (over last monitoring period)	3 species increase (over last monitoring period)	4 species increase (over last monitoring period)	TBD

<sup>&</sup>lt;sup>25</sup> "Some of the essential institutions include a well managed biodiversity centre, herbarium, zoological garden or museum, botanical garden, insectarium, etc. It is more important to measure whether the functions of these institutions exist rather than the physical existence of these institutions. Hence, if a herbarium is situated in a botanical garden, then two functions exist in the city under one institution." (Chan et al. 2014)

<sup>&</sup>lt;sup>26</sup> Partnerships may be formal or informal but should be substantial and long term. (Chan et al. 2014)

Management			Recommended Perfe	ormance Benchmarks		
Objectives that PI relates to	Performance Indicators (PI)	Low	Moderate	Good	Optimal	Current Baseline
	Change in number of native bird	1 species increase	2 species increase	3 species increase	4 species increase	TBD
	species*	(over last monitoring	(over last monitoring	(over last monitoring	(over last monitoring	
		period)	period)	period)	period)	
	Change in number of native	1 species increase	2 species increase	3 species increase	4 species increase	TBD
	butterfly species*	(over last monitoring	(over last monitoring	(over last monitoring	(over last monitoring	
		period)	period)	period)	period)	
	Change in number of native	1 species increase	2 species increase	3 species increase	4 species increase	TBD
	species for 2 other taxonomic	(over last monitoring	(over last monitoring	(over last monitoring	(over last monitoring	
	groups <sup>27*</sup>	period) for each group	period) for each group	period) for each group	period) for each group	
	Natural Assets Inventory and	No Natural Assets	Natural Assets	Natural Assets	Natural Assets	Good
	Management Strategy	Inventory and	Inventory and	Inventory and	Inventory and	
		Management Strategy	Management Strategy	Management Strategy	Management Strategy	
			being planned	exists	in process of being	
					implemented	
	Proportion of invasive alien plant	Proportion of invasive	Proportion of invasive	Proportion of invasive	Proportion of invasive	TBD
	species*	alien plant species is	alien plant species is	alien plant species is 1-	alien plant species is	
		>20%	11.1-20%	11%	<1%	
ENA 8.8.1 Reduce the	Proportion of natural areas in City*	<7% of land base is	7-13.9% of land base is	14-20% of land base is	>20% of land base is	Optimal
density and		retained as natural	retained as natural	retained as natural	retained as natural	Natural Area: 3643 ha
distribution of		area	area	area	area	Total Area: 9671 ha
invasive species to						% Natural Area: 38%
protect biodiversity						
and ensure public						
safety						
ENA 8.8.2 Increase	Proportion of protected natural	≤7.3% of City's natural	7.4-11.1% of City's	11.2-19.4% of City's	>19.4% of City's	Optimal
the amount of land	areas*	area is protected or	natural area is	natural area is	natural area is	Total Natural Area: 3643 ha
protected for its		secured	protected or secured	protected or secured	protected or secured	Protected Natural Area: 1583 ha
ecological values						% Natural Protected: 43%
						Total Area of Pitt-Addington
						Marsh is 1315 ha, which is all
						protected.

<sup>&</sup>lt;sup>27</sup> "Cities can select any two other taxonomic groups ... (e.g., bryophytes, fungi, amphibians, reptiles, freshwater fish, molluscs, dragonflies, beetles, spiders)" (Chan et al. 2014). The list of taxonomic groups was reduced to those applicable to Pitt Meadows (i.e., no marine species).

Management			Recommended Perf	ormance Benchmarks		
Objectives that PI relates to	Performance Indicators (PI)	Low	Moderate	Good	Optimal	Current Baseline
	Proportion of natural areas	<30% of City's natural	30-60% of City's	>60-90% of City's	>90% of City's natural	Good
	considered moderate, high and	area is considered	natural area is	natural area is	area is considered	Natural Area considered
	very high-quality habitat	moderate, high, very	considered moderate,	considered moderate,	moderate, high, very	Moderate or Higher: 2656 ha
		high quality	high, very high quality	high, very high quality	high quality	Total Natural Area: 3643 ha
						% Natural Area considered
						Moderate or Higher: 73%
						Total Area of Pitt-Addington
						Marsh is 1315 ha, which is all
						moderate or higher.
	Proportion of representative	<30% of representative	30-60% of	60-90% of	>90% of representative	Moderate
	habitat types protected (minimum	habitat types are	representative habitat	representative habitat	habitat types are	50% of habitat types are
	15% of each habitat type area	protected or secured	types are protected or	types are protected or	protected or secured	protected or secured
	should be protected)		secured	secured		Percent area that is protected in
						each class:
						-Fresh Water 15%
						-Riparian 22%
						-Wetland 87%
						-Old Forest 0%
						-Mature Forest 6%
						-Young Forest 15%
						-Woodland 4%
						-Old Field 9%
	Carbon storage and cooling effect	≤19.1% of the City's	19.2-29% of the City's	29.1-59.7% of the	>59.7% of the City's	Low
	of urban vegetation*	urban terrestrial area	urban terrestrial area	City's urban terrestrial	urban terrestrial area	Treed Area: 46 ha
		has tree cover	has tree cover	area has tree cover	has tree cover	Total Urban Area: 1032 ha
						Urban % Treed <sup>28</sup> : 4%
	Carbon storage and cooling effect	≤19.1% of the City's	19.2-29% of the City's	29.1-59.7% of the	>59.7% of the City's	Low
	of rural vegetation*	rural terrestrial area	rural terrestrial area	City's rural terrestrial	rural terrestrial area	Treed Area: 947 ha
		has tree cover	has tree cover	area has tree cover	has tree cover	Total Rural Area: 7552 ha
						Rural % Treed <sup>28</sup> : 13%

<sup>&</sup>lt;sup>28</sup> Treed Area includes classes OF, MF, YF, YS, WD and subclass sp. Urban area includes the area in the OCP Schedule 3A – Urban Land Use shapefile plus the Katzie First Nation Reserve. Rural area includes the area in the OCP Schedule 3B – Rural Land Use shapefile.

Management			Recommended Perfe	ormance Benchmarks		
Objectives that PI relates to	Performance Indicators (PI)	Low	Moderate	Good	Optimal	Current Baseline
ENA 8.9.3 Sustain and expand the urban forest through sound management strategies that	Impervious Area Ratio (IAR) for entire City (urban and rural) (related to regulation of quantity of stormwater runoff)*	≤39.7% of the City's terrestrial area has permeable surface	39.8-64.2% of the City's terrestrial area has permeable surface	64.3-75% of the City's terrestrial area has permeable surface	>75% of the City's terrestrial area has permeable surface	Optimal Pervious Area: 8719 ha Total Area: 9671 ha % Pervious: 90%
enhance their potential as carbon sinks						
PR 4.1 Design parks and open spaces to connect people to nature and provide peaceful respite	Area of urban parks with natural areas (i.e., accessible green spaces)*	≤0.3 ha/1000 persons	0.4-0.6 ha/1000 persons	0.7-0.9 ha/1000 persons	>0.9 ha/1000 persons	Optimal Park Area/1000 persons: 1.9 ha [Analysis limited to urban parks; Area of parks with natural area: 35.6 ha; Population: 18,573]
	EIMS open space retention and acquisition strategy	No retention strategy for natural assets	Formal retention strategy for natural assets planned	Formal retention strategy in process of being implemented	Formal retention developed to support EIMS	Moderate
PR 4.1.1 Find innovative opportunities to create parks and open spaces	Connectivity measures (effective mesh size <sup>29</sup> of connected patches)*	Mesh size ≤500 ha; Little to no connectivity	Mesh size 501-1000 ha; Some connectivity	1001-1500 ha; Significant linkages established	Mesh size >1500 ha; Extensive linkages established	Optimal Mesh size: 2600 ha
PR 4.1.2 Use open space to create connections	Connectivity measures (patch connectivity)	<30% of natural patches are directly connected to adjacent natural patches	30-60% of natural patches are directly connected to adjacent natural patches	>60-90% of natural patches are directly connected to adjacent natural patches	>90% of natural patches are directly connected to adjacent natural patches	Good Natural Patches Directly Connected: 307 Total Natural Patches: 365 % Patches Directly Connected: 84%
	Connectivity measures (patch isolation) (close proximity defined as 100 m	<30% of natural patches are within close proximity (100m) to another natural	30-60% of natural patches are within close proximity (100m) to another natural	>60-90% of natural patches are in close proximity (100m) to another natural patch	>90% of natural patches are in close proximity (100m) to another natural patch	Optimal Natural Patches in Close Proximity: 349 Total Natural Patches: 365
	based on Singapore CBI)	patch	patch			% Natural Patches in Close Proximity: 96%

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<sup>&</sup>lt;sup>29</sup> "The effective mesh size is an expression of the probability that two points randomly chosen within the natural areas of a city are in the same patch or are considered connected (< 100m between the patches with no major barrier between). It can also be interpreted as the ability of two animals of the same species placed randomly in the natural areas to find each other. The more barriers in the landscape, the lower the probability that the two locations will be connected, and the lower the effective mesh size. Therefore, larger values of the effective mesh sizes indicate higher connectivity." (Chan et al. 2014)

Management			Recommended Perfo	ormance Benchmarks		
Objectives that PI relates to	Performance Indicators (PI)	Low	Moderate	Good	Optimal	Current Baseline
LS 6.7.1 Maintain or	Water Quality Monitoring Program	No Water Quality	Water Quality	Water Quality	Water Quality	Low
improve the water	for natural aquatic ecosystems	Monitoring Program	Monitoring Program	Monitoring Program	Monitoring Program	
quality discharged to		exists	measures <50% of	measures ≥50-99% of	measures all required	
the natural			required watercourses	required watercourses	watercourses (see	
environment			(see next three	(see next three	next three indicators	
			indicators for required	indicators for required	for required	
			watercourses)	watercourses)	watercourses)	
	Watercourses meet the recreation	<30% of watercourses	30-60% of	>60-90% of	>90% of watercourses	TBD
	water quality guidelines <sup>30</sup>	used for recreation	watercourses used for	watercourses used for	used for recreation	
		meet the recreation	recreation meet the	recreation meet the	meet the recreation	
		water quality	recreation water	recreation water	water quality	
		guidelines	quality guidelines	quality guidelines	guidelines	
ENA 8.1.1 Implement	Watercourses meet the aquatic life	<30% of fish bearing	30-60% of fish bearing	>60-90% of fish	>90% of fish bearing	TBD
streamside protection	water quality guidelines <sup>30</sup>	watercourses meet the	watercourses meet the	bearing watercourses	watercourses meet the	
measures and require		aquatic life water	aquatic life water	meet the aquatic life	aquatic life water	
that development		quality guidelines	quality guidelines	water quality	quality guidelines	
conform to				guidelines		
regulations and best						
management						
practices for						
protecting fish and						
aquatic life						
LS 6.4.1 The City's	Watercourses meet the	<30% of watercourses	30-60% of	>60-90% of	>90% of watercourses	TBD
drainage and	agricultural use water quality	used as a source for	watercourses used as a	watercourses used as a	used as a source for	
irrigation system is	guidelines <sup>30</sup>	agriculture meet the	source for agriculture	source for agriculture	agriculture meet the	
designed and		agricultural water	meet the agricultural	meet the agricultural	agricultural water	
maintained to support		quality guidelines	water quality	water quality	quality guidelines	
agricultural activities			guidelines	guidelines		

<sup>&</sup>lt;sup>30</sup> Canadian Council of Ministers of the Environment (CCME) Guidelines. (CCME 1993, 1999a, 1999b, 2003)

# 6.2.2 <u>Future Work</u>

A summary of CBI indicators that require baseline information that is not currently available is summarized below. A brief description of what is required to collect this baseline information is also provided. Indicators noted with a \* are based on the Singapore Index on Cities' Biodiversity User's Manual (Chan *et al.* 2014).

Performance Indicators	Description of Baseline Survey Required
Change in number of native vascular (non-invasive/non-introduced) plant species*	Would require a systematic vegetation survey repeated over set period of time (e.g., every 2 to 5 years) to determine the change over time. The City could specifically target areas with planned and completed restoration to ensure restoration efforts are captured and monitored.
Change in number of native bird species*	Would require a bird monitoring program at a consistent time of year, with consistent locations and using consistent effort. Locations could be in areas of planned and completed restoration to determine the effects of restoration on number of species. Repeated analysis of eBird data could also be used to utilize citizen science effort; however, this should be done in conjunction with systematic surveys. Systematic surveys ensure consistent effort across space and knowledge of surveyor. If only eBird is used, the results may be biased towards more easily accessed and frequently visited areas (e.g., Pitt-Addington Marsh, along roads and trails), as well as be biased towards more 'noteworthy' species (i.e., birders may not record species that they frequently see).
Change in number of native butterfly species*	Could utilize a citizen science or community group-led butterfly monitoring program. The City would work with members of the Pitt Meadows Community Garden Society to monitor butterflies and other pollinator species at the community garden.
Change in number of native species for 2 other taxonomic groups*	Cities can select two other taxonomic groups (e.g., bryophytes, fungi, amphibians, reptiles, freshwater fish, molluscs, dragonflies, beetles, spiders). Will require systematic surveys in suitable habitats. Suggested taxonomic groups based on the habitats found in the City, eDNA results, and incidental observations during fieldwork include freshwater fish and amphibians.
Proportion of invasive alien plant species*	Should be based on future, systematic invasive plant surveys. Could be assessed during the native vascular plant species survey. Can also utilize citizen reporting by setting up and advertising a reporting method (e.g., dedicated e-mail address, website form, mobile application). Signage at parks with identification information can educate the public and increase participation in invasive species reporting.
Watercourses meet recreation water quality guidelines <sup>30</sup>	Watercourses that are used for recreation should be included in a Water Quality Monitoring Program that systematically collects water samples for testing against CCME (1999a) water quality guidelines. Watercourses should be tested where the recreation takes place.
Watercourses meet aquatic life water quality guidelines <sup>30</sup>	Watercourses that provide habitat for aquatic life should be included in a Water Quality Monitoring Program that systematically collects water samples for testing against CCME (2003) water quality guidelines. Water sampling efforts can initially target larger watercourses as these tend to be contain the most aquatic species and will also capture upstream effects (e.g., pollution in one tributary can be detected in the mainstem of the watercourse). In subsequent years, more sites may be required in smaller watercourses to determine the sources of some upstream pollutants. Sampling can also target areas of potential and completed restoration to determine if it helped improve the water quality.

Watercourses meet	Watercourses that are used as a source of irrigation for agriculture should be
agricultural use water quality	included in a Water Quality Monitoring Program that systematically collects
guidelines <sup>30</sup>	water samples for testing against CCME (1993, 1999b) water quality guidelines.
	Water sampling should take place near where water is withdrawn; however, if
	there are many withdrawal points along a watercourse then they should be
	systematically spaced.

#### 7.0 REFERENCES

- Ausenco Sandwell. 2011. Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use Sea Dike Guidelines. Prepared by Ausenco Sandwell for the BC Ministry of Environment.
- BC AGRI. 2014. Land Use Inventory Report: City of Pitt Meadows, Summer 2011. Page Growing Knowledge.

  British Columbia Ministry of Agriculture, Strengthening Farming Program.
- BC FLNRO. 2014. Simulating the Effects of Sea Level Rise and Climate Change on Fraser River Flood Scenarios FINAL REPORT. BC Ministry of Forests, Lands and Natural Resource Operations, Flood Safety Section.
- BC FLNRO. 2016. Riparian Areas Regulation Guidebook for Waterfront Home Owners & Property Developers. BC Ministry of Forests, Lands, and Natural Resource Operations.
- BC MOE. 2017. Known BC Fish Observations and BC Fish Distributions (1940-2017) [Dataset]. https://catalogue.data.gov.bc.ca/dataset/known-bc-fish-observations-and-bc-fish-distributions.
- Brett, J. R. 1952. Temperature Tolerance in Young Pacific Salmon, Genus Oncorhynchus. Journal of the Fisheries Board of Canada 9:265–323.
- Burckhardt, J. C., and B. L. Todd. 1998. Riparian forest effect on lateral stream channel migration in the glacial till plains. Journal of the American Water Resources Association 34:179–184.
- Canterbury, G. E., T. E. Martin, D. R. Petit, L. J. Petit, and D. F. Bradford. 2000. Bird communities and habitat as ecological indicators of forest condition in regional monitoring. Conservation Biology 14:544–558.
- Carignan, V., and M. A. Villard. 2002. Selecting indicator species to monitor ecological integrity: A review. Environmental Monitoring and Assessment 78:45–61.
- CCME. 1993. Appendix XV Protocols for Deriving Water Quality Guidelines for the Protection of Agricultural Water Uses (October 1993). Page Canadian Water Quality Guidelines. Prepared by the Task Force on Water Quality Guidelines for the Canadian Council of Resource and Environment Ministers, Winnipeg, MB.
- CCME. 1999a. Recreational Water Quality Guidelines and Aesthetics. Page Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment, Winnipeg, MB.
- CCME. 1999b. Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses: Introduction. Page Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment, Winnipeg, MB.
- CCME. 2003. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Guidance on the Site-Specific Application of Water Quality Guidelines in Canada: Procedures for Deriving Numerical Water Quality Objectives. Page Canadian Environmental Quality Guidelines. Canadian Council of Ministers

- of the Environment, Winnipeg, MB.
- Chan, L., O. Hillel, T. Elmqvist, P. Werner, N. Holman, A. Mader, and E. Calcaterra. 2014. User's Manual on the Singapore Index on Cities' Biodiversity (also known as the City Biodiversity Index). National Parks Board, Singapore, Singapore.
- Cheater, D. 2020. December 3, 2020 Watershed Watch Salmon Society Opinion Letter to Pitt Meadows City Council. Ecojustice on behalf of Watershed Watch Salmon Society.
- Chen, Y. D., S. C. McCutcheon, D. J. Norton, and W. L. Nutter. 1998. Stream Temperature Simulation of Forested Riparian Areas: II. Model Application. Journal of Environmental Engineering 124:316–328.
- City of Pitt Meadows. 2020a. Invasive & Noxious Species Control. https://www.pittmeadows.ca/our-community/environment-sustainability/invasive-noxious-species-control.
- City of Pitt Meadows. 2020b. Katzie Slough and Greenbelts. https://www.pittmeadows.ca/parks-recreation/parks-fields-facilities/parks-list/katzie-slough-and-greenbelts.
- City of Pitt Meadows. 2021. Harris Landing Pitt River Regional Greenway. https://www.pittmeadows.ca/parks-recreation/parks-fields-facilities/parks-list/harris-landing-pitt-river-greenway.
- Cohen, B. I. 2012. The Uncertain Future of Fraser River Sockeye. Page Commission of Inquiry into the Decline of Sockeye Salmon in the Fraser River (Canada).
- Cope, S. 2015. Alouette River Salmonid Smolt Migration Enumeration: 2014 Data Report. Page Alouette Dam Water Use Plan, Alouette River Smolt Enumeration, Implementation Year 7, Study Period: March to June 2014. Prepared by Westslope Fisheries Ltd. for BC Hydro, Cranbrook, BC.
- Davies, P. E., and M. Nelson. 1994. Relationships between riparian buffer widths and the effects of logging on stream habitat, invertebrate community composition and fish abundance. Australian Journal of Marine and Freshwater Research 45:1289–1305.
- DeWalle, D. R. 2010. Modeling Stream Shade: Riparian Buffer Height and Density as Important as Buffer Width. Journal of the American Water Resources Association 46:323–333.
- Erman, D. C., J. D. Newbold, and K. B. Roby. 1977. Evaluation of streamside bufferstrips for protecting aquatic organisms. Page Contribution 165. University of California, Water Resources Center, Davis, California.
- Fraser Basin Council. 2019. Lower Mainland Flood Management Strategy Flood Strategy Briefing.
- Gebauer and Associates Ltd. 2001. Codd Island Wetlands: Summary of Existing Biophysical Information. Prepared by Gebauer & Associates Ltd. for Greater Vancouver Regional District, Surrey, BC.
- Groom, J. D., L. Dent, L. J. Madsen, and J. Fleuret. 2011. Response of western Oregon (USA) stream temperatures to contemporary forest management. Forest Ecology and Management 262:1618–1629.
- Jenness, D. 1955. The Faith of a Coast Salish Indian. Page Anthropology in British Columbia, memoir no. 3. British Columbia Provincial Museum, Victoria, BC.
- Lorion, C. M., and B. P. Kennedy. 2009. Relationships between deforestation, riparian forest buffers and benthic macroinvertebrates in neotropical headwater streams. Freshwater Biology 54:165–180.

- Mayer, P. M., S. K. Reynolds, M. D. McCutchen, and T. J. Canfield. 2007. Meta-Analysis of Nitrogen Removal in Riparian Buffers. Journal of Environmental Quality 36:1172–1180.
- Meidinger, D., J. Clark, and D. Adamoski. 2014. Sensitive Ecosystem Inventory for Metro Vancouver & Abbotsford: 2010-2012 Technical Report. Metro Vancouver.
- Metro Vancouver. 2016. Climate Projections for Metro Vancouver.
- Metro Vancouver. 2019. Climate 2050 Strategic Framework.
- Metro Vancouver. 2020. Regional Greenways 2050.
- MNAI. 2019. What Are Municipal Natural Assets: Defining and Scoping Municipal Natural Assets Decision-Maker Summary. Municipal Natural Assets Initiative.
- Newbold, J. D., D. C. Erman, and K. B. Roby. 1980. Effects of Logging on Macroinvertebrates in Streams With and Without Buffer Strips. Canadian Journal of Fisheries and Aquatic Sciences 37:1076–1085.
- Niemi, G. J., and M. E. McDonald. 2004. Application of ecological indicators. Annual Review of Ecology, Evolution, and Systematics 35:89–111.
- Office of the Ombudsperson. 2014. Striking a Balance: the Challenges of Using a Professional Reliance Model in Environmental Protection -British Columbia's Riparian Areas Regulation. Page Public Report No. 50 to the Legislative Assembly of British Columbia. The Office of the Ombudsperson, B.C.'s Independent Voice for Fairness.
- PCIC. 2013. PCIC Regional Analysis Tool [using HadCM3 B1 1, Fraser River Basin region, 2040-2069 time period]. Pacific Climate Impacts Consortium. http://tools.pacificclimate.org/select.
- PFRCC. 1999. Proceedings Climate Change and Salmon Stocks. Pacific Fisheries Resource Conservation Council, Vancouver, BC.
- Porter, J. 2017. Changes in Water Quality of the Katzie Slough; Historical versus Present Day Conditions.
- Ralph, C. J., J. R. Sauer, and S. Droege, editors. 1995. Monitoring Bird Populations by Point Counts. Page General Technical Report PSW-GTR-14. Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture, Albany, California.
- Richardson, J. S., R. J. Naiman, and P. A. Bisson. 2012. How did fixed-width buffers become standard practice for protecting freshwaters and their riparian areas from forest harvest practices? Freshwater Science 31:232–238.
- Rykken, J. J., S. S. Chan, and A. R. Moldenke. 2007. Headwater riparian microclimate patterns under alternative forest management treatments. Forest Science 53:270–280.
- Sweeney, B. W., T. L. Bott, J. K. Jackson, L. A. Kaplan, J. D. Newbold, L. J. Standley, W. C. Hession, and R. J. Horwitz. 2004. Riparian deforestation, stream narrowing, and loss of stream ecosystem services. Proceedings of the National Academy of Sciences of the United States of America 101:14132–14137.
- Sweeney, B. W., and J. D. Newbold. 2014. Streamside forest buffer width needed to protect stream water quality, habitat, and organisms: A literature review. Journal of the American Water Resources Association 50:560–584.
- Ward, P., K. Moore, and R. Kistritz. 1992. Wetlands of the Fraser Lowland, 1989: An Inventory. Page Technical Report Series No. 146. Canadian Wildlife Service, Pacific and Yukon Region, British

Columbia.

- Welham, C., and S. Seely. 2019. Improving the Metro Vancouver Regional Carbon Storage Dataset Final report. Prepared by 3GreenTree Ecosystem Services Ltd. for Metro Vancouver.
- Wenger, S. 1999. A review of the scientific literature on riparian buffer width, extent and vegetation. Prepared for the Office of Public Service & Outreach, Institute of Ecology, University of Georgia, Athens, Georgia.
- Yanong, R. 2019. Use of Copper in Marine Aquaculture and Aquarium Systems.
- Zoetica, and LFFA. 2020. Lower Fraser Climate Adapt Project: Phase 2 Progress Report. Prepared by Zoetica Environmental Consulting Services and the Lower Fraser Fisheries Alliance.

# APPENDIX A – ENGAGEMENT SUMMARY



# **ENGAGEMENT SUMMARY**

January 14, 2022

PREPARED AND REVIEWED BY

Zoetica Environmental Consulting Services

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# **Revision History**

**Project Title:** Pitt Meadows EIMS **Document Title:** Engagement Summary

Rev. Number	Issue Date	Description	Prepared By	Checked By	Approved By
004	20-Oct-2020	Summary of focus group and public engagement – submitted to the City for review (Word doc)	C. Chui	H. Bears	H. Bears
"004 CO AW EDITS"	19-Nov-2020	Comments from City of Pitt Meadows	C. O'Byrne, A. Wallace		
Арр А	01-Mar-2021	Addressed City comments. Resubmitted as Appendix A of final report.	H. Bears	C. Chui	H. Bears
AppA.R000	14-Jan-2022	Revised for Final EIMS Report	C. Chui	H. Bears	H. Bears

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### 1.0 INTRODUCTION

The Environmental Inventory and Management Strategy (EIMS) is a new plan that will help guide the management of natural assets across the City of Pitt Meadows. The present document is considered a 'living document' that will be used as a basis for future engagement and planning efforts. Some environmental issues can be complex and sensitive; the level of input and engagement must reflect this reality to garner community support of the plan. The City envisioned a public engagement process that aimed to 'inform', 'consult', and 'involve' focus groups (including local First Nations), as described on the public participation spectrum.

The EIMS will provide a formal, high-level, structured framework for environmental planning to align existing and recommended bylaws, policies, and other municipal plans, strategies, and initiatives. Development of the EIMS was informed by focus group engagement findings to ensure citizen concerns and priorities are fully considered.

The EIMS engagement strategy was initially developed using the City of Pitt Meadows' 2017 Civic Engagement Framework Toolkit and in consultation with City staff. This engagement strategy follows a seven step process:

- 1. Clarify the issue and purpose of public participation
- 2. Identify key audiences
- 3. Determine the level of public participation
- 4. Design and scope the process
- 5. Select tools and tactics
- 6. Develop strong messaging and communication methods
- 7. Build in evaluation

Due to the timing of project initiation corresponding with a rapid ramping up of COVID-19 cases shortly after developing the initial engagement strategy, the ways in which steps 1-7 were achieved had to be modified to match the reality that in-person meetings and public engagement events would not be possible and that some of the engagement processes would need to be revised to safer, online forums.

### 2.0 ENGAGEMENT METHODS AND TIMELINE

Focus group engagement for the EIMS was originally planned to include online and phone engagement from the beginning of April to the end of August 2020, and an in-person public engagement event in mid-August 2020. Due to the ongoing COVID-19 situation and physical distancing requirements, the in-person event was postponed and then eventually cancelled.

The City of Pitt Meadows hosted the online engagement through their "Have Your Say!" website from June to October 2020. The City advertised invitations to complete the online engagement through their official website and social media accounts as well as in two "City Talks" newspaper advertisement spreads. Online engagement consisted of separate surveys for the focus group and members of the general public/community. Both surveys included mapping questions and survey questions; dropped pins and comments on the webmaps were visible to the public, but survey responses were private and automatically sent to the City. See Appendix 1 for full list of mapping and survey questions.

Key focus group members were identified while developing the EIMS engagement strategy and were sent a link to complete the focus group survey. These focus group members included Katzie First Nation, various levels of government staff, environmental stewardship and naturalist groups, environmental councils and advisory committees, local scientific experts, and other community groups. Additional informed focus group members were identified through online engagement responses, and Zoetica conducted follow-up phone engagement with these persons/groups and other focus group members between August and October 2020. See Appendix 2 for full list of invited focus group members that were contacted.

Unfortunately, not all identified focus group members had the resources available to participate in the EIMS engagement; of note, the Katzie First Nation were unable to participate during the current project timeline. The EIMS is envisioned to be a living document that will be updated with additional knowledge, when available. While the current findings will be helpful for future planning efforts, additional opportunities to engage the Katzie First Nation and focus groups should be identified prior to considering updates or implementing its recommendations.

### 3.0 ENGAGEMENT RESULTS AND DISCUSSION

Based on the automatic website tracking for the EIMS online engagement, there was a relatively high level of interest in the EIMS for both the community and focus group. Unfortunately, website visitors did not translate into true participation, as only a limited number of participants and unverified users (i.e., anonymous) completed the survey (**Table 3-1**). It was not a requirement to answer all mapping or survey questions; there were no community responses to mapping question 8, and no focus group responses to mapping questions 14 or 17 (see Appendix 1). Mapping results for both community and focus group engagement are shown in Appendix 3.

**Table 3-1.** Summary of EIMS online survey page visits and participation. Actual survey respondents are highlighted in bold.

	Community Survey	Focus Group Survey
Engaged Visitors	121	7
Informed Visitors	241	48
Aware Visitors	379	158
New Registrations	16	9
Participants	13	5
Unverified Users	9	3

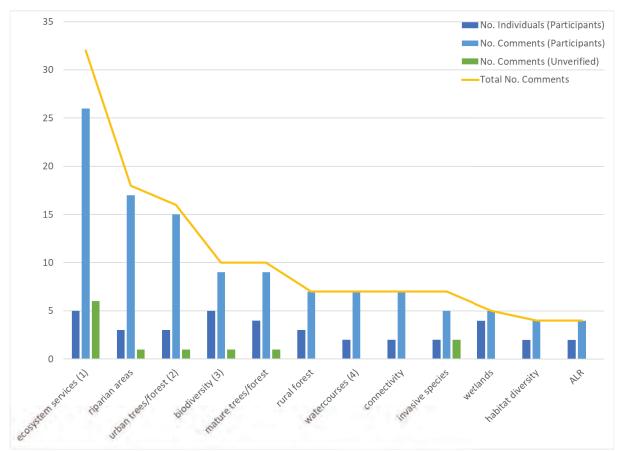
### 3.1 Mapping Questions (Focus Group)

A total of five named participants completed the online mapping questions, along with three unverified/anonymous<sup>1</sup> respondents. The five named participants included representatives from the City

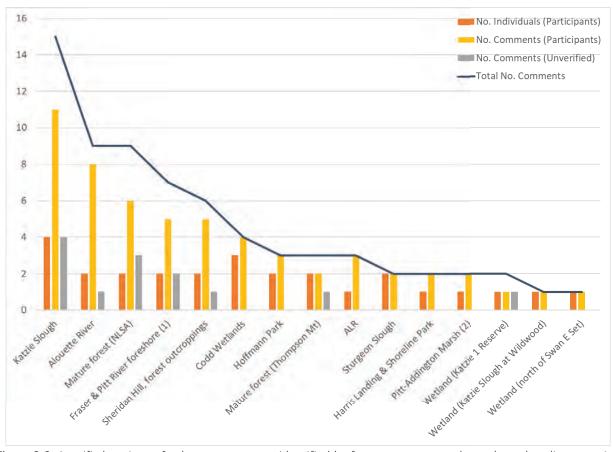
<sup>&</sup>lt;sup>1</sup> Unverified Participation - Choosing this option allows unverified participants to make a contribution. They do not have to register on the site, however, will be asked to provide a username and email address. The email and screen name provided will be recorded against their contribution in the reports. This participation type is available for all tools.

Anonymous - Anyone can participate without having to sign in or register on the site. No details are recorded about the user. This participation type is available only for the **Survey** and the **Quick Poll tool.** 

of Pitt Meadows, Metro Vancouver, and the Pitt Meadows Environmental Network. Key environmental concepts identified by these focus group members are shown in **Figure 3-1**, and specific locations of concern are shown in **Figure 3-2**.



**Figure 3-1.** Summary of key concepts identified by focus group respondents through online mapping questions. Notes: (1) Ecosystem services include regulating, provisioning, supporting, and cultural services. (2) Urban trees/forests include parks and green spaces. (3) Biodiversity includes species and species groups. (4) Watercourses include rivers, sloughs, ditches. Abbreviations: ALR - Agricultural Land Reserve



**Figure 3-2.** Specific locations of value or concern as identified by focus group respondents through online mapping questions. Notes: (1) Foreshore areas include the Pitt River Regional Greenway and the dike trails north of Pitt River Bridge. (2) "Pitt-Addington Marsh" represents Pitt Polder Ecological Reserve and Pitt-Addington Marsh Wildlife Management Area. Abbreviations: NLSA - North Lougheed Study Area; ALR - Agricultural Land Reserve

The most frequently expressed comments among focus group respondents were regarding ecosystem services. Ecosystem services refer to the 'free' values and functions that healthy ecosystems provide and include regulating, provisioning, supporting, and cultural services (**Table 3-2**). Many of these ecosystem services were noted as beneficial to agricultural landowners, including drainage, irrigation, soils, and habitat for pollinators and beneficial insects. The next most frequently expressed concepts were about riparian areas (especially along the Katzie Slough and Alouette River; see **Figure 3-2**) and urban trees/forests. Protection, restoration, and/or enhancement of these natural assets are intricately linked to the regulating and supporting services that they provide to the City's residents and biodiversity.

**Table 3-2.** Ecosystem services provided by natural assets in Pitt Meadows, as identified by focus group through online mapping questions. Number of comments made for each service type is indicated in parentheses; specific services are listed in decreasing order (number of comments).

REGULATING (n=16)	PROVISIONING (n=3)	SUPPORTING (n=18)	CULTURAL (n=14)
Drainage	Irrigation	Habitat for	Recreation
Water and runoff	Fertile soils	• wildlife	<ul> <li>Sense of place/identity</li> </ul>
filtration		• fish	<ul> <li>Natural beauty/scenery</li> </ul>
<ul> <li>Carbon storage and</li> </ul>		<ul> <li>pollinators and</li> </ul>	<ul> <li>Community wellness</li> </ul>
sequestration		beneficial insects	<ul> <li>Scientific interest</li> </ul>

Flood protection/		
attenuation		
<ul> <li>Erosion control and</li> </ul>		
bank/slope stabilization		
Water temperature		
moderation		
Shading		
<ul> <li>Noise buffering</li> </ul>		
Windbreak		

Rationale behind the key concepts and specific locations identified by focus group respondents is shown in **Table 3-3**. The Katzie Slough and Alouette River ranked highest in terms of management priorities. Eight categories/survey questions were applicable for the Katzie Slough, including its values, risks, and current state (degradation, invasive species); and six categories were applicable for the Alouette River, including its values and the presence of species of conservation concern. For these waterways, focus group respondents were referring to both the watercourse (wetted area) and surrounding riparian areas – these habitat types were also noted as high priority for protection, restoration, and/or enhancement in a general sense. Urban forests and green spaces were ranked among the most at risk and degraded habitats (e.g., due to development), and they also have the potential to harbour species of conservation concern. As such, urban forests/green spaces are ranked as high priority for protection and restoration/enhancement.

Species of conservation (or other) concern, as noted by focus group respondents, included sandhill crane (Antigone canadensis), great blue heron (Ardea herodias), bald eagle (Haliaeetus leucocephalus), painted turtle (Chrysemys picta), western toad (Anaxyrus boreas), red-legged frog (Rana aurora), and Pacific water shrew (Sorex bendirii). Focus group members also noted the importance of bears and salmon (as keystone species) and general species groups such as migratory birds, owls and other raptors, and native fish and invertebrate species.

Invasive species repeatedly mentioned as management priorities include parrot's feather (*Myriophyllum aquaticum*), Japanese knotweed (*Reynoutria japonica*), Himalayan balsam/policeman's helmet (*Impatiens glandulifera*), purple loosestrife (*Lythrum salicaria*), and Himalayan blackberry (*Rubus armeniacus*), all of which are considered priority species by Metro Vancouver. Other invasive species noted include reed canarygrass (*Phalaris arundinacea*), which is particularly prevalent along the City's watercourses, and Scotch broom (*Cytisus scoparius*), largemouth (*Micropterus salmoides*) and smallmouth bass (*Micropterus dolomieu*), green frog (*Lithobates clamitans*), and American bullfrog (*Lithobates catesbeianus*).

Two focus group members noted the importance of Blaney Bog. Although this reserve is technically located within the City of Maple Ridge, it is connected to the Codd Wetlands via Blaney Creek. Together, Blaney Bog and the Codd Wetlands make up a larger complex of protected wetlands.

### Appendix A: Pitt Meadows EIMS – Engagement Summary

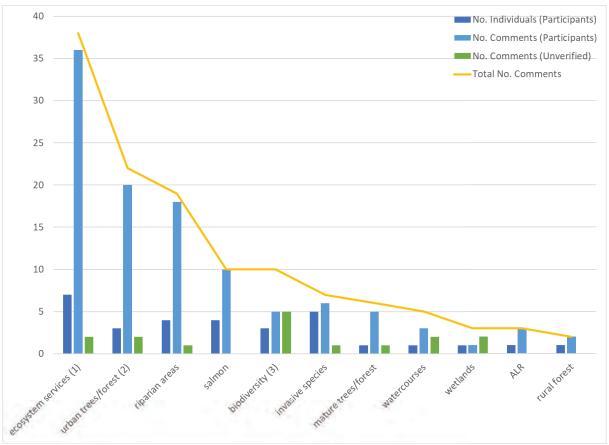
**Table 3-3.** Summary of focus group responses to online mapping questions in relation to specific locations and habitat types noted as important. Abbreviations: SCC - species of conservation concern; NLSA - North Lougheed Study Area; ALR - Agricultural Land Reserve; MUP - multi-use path

Benefits   Walkable   Farmers   at risk   degraded   conflicts	of conservation concern	i, INLSA - IN	iortii Lougile	eu Study	Alea, ALN	- Agriculturai La	nu nese	erve, wior	- muiti-use	раці					
Benefits   Walkable   Farmers   at risk   degraded   conflicts		POSITIVE			NEGATIVE					PRIORITIES	S		No.		
Alouette River										protect			SCC	connectivity	checks
Mature forest (NLSA)         X	Katzie Slough	Х	Х	Х	Х				Х		Х	Х		Х	8
Sheridan Hill, forest outcroppings	Alouette River	Х	Х							Х	Х	Х	Х		6
Praser and Pitt River   Fraser and Pitt River   Fras	Mature forest (NLSA)	Х		Х			Х			Х					4
Foreshore areas		Х		Х				Х		Х					4
Sturgeon Slough		Х				Х				Х				Х	4
Codd Wetlands	Pitt-Addington Marsh	Х				X				Х					3
Hoffmann Park	Sturgeon Slough	Х	Х												2
Harris Landing & Shoreline Park	Codd Wetlands	Х								Х					2
Shoreline Park	Hoffmann Park	Χ								Х					2
Mature forest (Thompson Mt)         X         1<		Х					Х								2
Mt)         X           Wetland (Katzie Slough at Wildwood Trail)         X           Wetland (north of Swan E Set)         X           Set)         X           Wetland (Katzie 1 Reserve)         X           Lougheed Highway MUP         X           General/Various:         X           watercourses*         X         X           urban forests/green spaces         X         X           riparian areas         X         X           old-field habitat         X           soils         X           hedgerows/vegetated buffers         X	ALR									Х	Х				2
Wildwood Trail)         X         1           Wetland (north of Swan E Set)         X         1           Wetland (Katzie 1 Reserve)         X         X         1           Lougheed Highway MUP         X         X         X         1           General/Various:         Watercourses*         X         X         X         X         X         X         Y         9           urban forests/green spaces         X         X         X         X         X         X         X         X         X         8           riparian areas         X         X         X         X         X         X         X         2           soils         X         X         X         X         X         X         X         2           hedgerows/vegetated buffers         X <td< td=""><td>, ,</td><td>Х</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>1</td></td<>	, ,	Х													1
Set	Wildwood Trail)	Х													1
Reserve		Х													1
General/Various:												Х			1
watercourses*         X         <	Lougheed Highway MUP								Χ						1
urban forests/green spaces         X         A </td <td>General/Various:</td> <td></td>	General/Various:														
spaces         X         X         X         X         X         X         X         X         X         X         X         X         X         X         X         X         X         X         Q         A         A         X         X         X         A         A         A         X         X         A <td>watercourses*</td> <td>Х</td> <td>Х</td> <td>Х</td> <td>Х</td> <td>X</td> <td></td> <td></td> <td>Χ</td> <td>Х</td> <td>X</td> <td></td> <td>Х</td> <td></td> <td>9</td>	watercourses*	Х	Х	Х	Х	X			Χ	Х	X		Х		9
old-field habitat         X         X         2           soils         X         X         X         X         1           hedgerows/vegetated buffers         X		Х		Х	Х	Х		Х		Х	Х		Х		8
soils X I I hedgerows/vegetated buffers X I I I I I I I I I I I I I I I I I I	riparian areas		Х		Х					Х	Х				4
hedgerows/vegetated buffers X I I I I I I I I I I I I I I I I I I	old-field habitat		Х										Х		2
buffers X	soils		Х												1
rural forests X 1			х												1
	rural forests												Х		1

<sup>\*</sup> includes rivers (Fraser, Pitt, Alouette, North Alouette), sloughs (e.g., Sturgeon, Katzie, Cranberry), ditches, channelized watercourses.

# 3.2 Mapping Questions (Community)

A total of 13 participants completed the online mapping questions, along with nine unverified/anonymous respondents. Key environmental concepts identified by the community are shown in **Figure 3-3**, and specific locations of concern are shown in **Figure 3-4**.



**Figure 3-3.** Summary of key concepts identified by the community through mapping questions. Notes: (1) Ecosystem services include regulating, provisioning, supporting, and cultural services. (2) Urban trees/forests include parks and green spaces. (3) Biodiversity includes species and species groups. Abbreviations: ALR - Agricultural Land Reserve

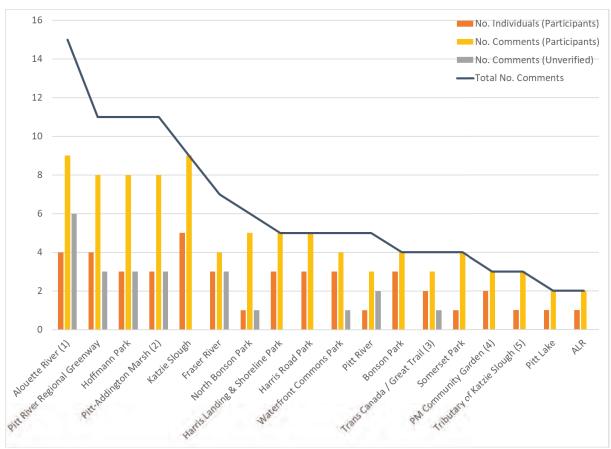


Figure 3-4. Specific locations of value or concern as identified by the community through mapping questions. Notes: (1) "Alouette River" represents both the waterway and adjacent dike trails. (2) "Pitt-Addington Marsh" represents Pitt Polder Ecological Reserve and Pitt-Addington Marsh Wildlife Management Area. (3) "Trans Canada/Great Trail" represents the Pitt River dike trail between Pitt River Bridge and Alouette River. (4) "PM Community Garden" includes the natural area bordered by Bonson Road, Airport Way, and Wildwood Trail. (5) Tributary of Katzie Slough noted is located near Wildwood Trail and Linden Grove Park. Abbreviations: PM - Pitt Meadows; ALR - Agricultural Land Reserve

The most frequently expressed comments among the community were regarding ecosystem services. The community recognized the importance of natural assets for various regulating services, providing water for irrigation, supporting habitat for fish and wildlife, and recreation (**Table 3-4**). Urban trees/forests and riparian areas, which provide a variety of ecosystem services, were commonly mentioned as important natural assets. Of note, the importance of salmon and their habitat (including migration routes) were specifically and repeatedly mentioned by community respondents.

**Table 3-4.** Ecosystem services provided by natural assets in Pitt Meadows, as identified by the community/public through online mapping questions. Number of comments made for each service type is indicated in parentheses; specific services are listed in decreasing order (number of comments).

REGULATING (n=19)	PROVISIONING (n=5)	SUPPORTING (n=20)	CULTURAL (n=7)
Erosion control and bank stabilization	Irrigation	Habitat for • wildlife	Recreation
Drainage		• fish	
Shading			
<ul> <li>Flood protection and</li> </ul>			
water storage			
Water temperature			
moderation			
<ul> <li>Windbreak</li> </ul>			
<ul> <li>Water filtration</li> </ul>			

Rationale behind the key concepts and specific locations identified by the community is shown below in **Table 3-5**. Based on Table 3-5, the Pitt-Addington Marsh area (including Pitt Polder Ecological Reserve) is arguably the most highly regarded natural asset, with the greatest number of positives and no negatives; as such it is recommended for protection and restoration/enhancement by the community. While the Katzie Slough was not as frequently mentioned by the community, the community recognizes its degraded state and potential value. Unlike the focus group responses, the correlation between the locations noted in **Figure 3-4** and the number of categories/survey questions applicable to those locations is not as apparent; however, it is important to note that the information in **Table 3-5** is not a quantitative summary. For example, Hoffmann Park was frequently mentioned by the community as one of the most valuable assets in Pitt Meadows and a popular spot to visit; its recommendation for protection is likely based on its value as a mature, urban forest (as opposed to being in a state of degradation and in need of restoration/enhancement).

Species of conservation (or other) concern, as noted by the community, include Pacific salmon (*Oncorhynchus* spp.), white sturgeon (*Acipenser transmontanus*), eulachon (*Thaleichthys pacificus*), steelhead (*Oncorhynchus mykiss*), barn swallow (*Hirundo rustica*), common nighthawk (*Chordeiles minor*), red-tailed hawk (*Buteo jamaicensis*), sandhill crane, bald eagle, and great blue heron. Only one participant responded to the mapping question about invasive species; this person also noted parrot's feather in the Katzie Slough.

Two community members mentioned natural assets that were technically outside of the City boundaries: Blaney Bog Reserve (City of Maple Ridge), Douglas Island (City of Port Coquitlam), and Widgeon Creek (Electoral Area A). Blaney Bog was noted as providing water storage and flood protection for farmers, and all three locations were identified as important nesting habitat for sandhill cranes.

### Appendix A: Pitt Meadows EIMS – Engagement Summary

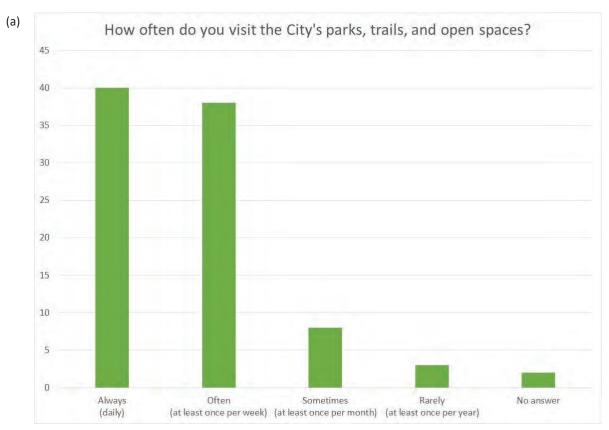
**Table 3-5.** Summary of community/public responses to online mapping questions in relation to specific locations and habitat types noted as important. Abbreviations: SCC - species of conservation concern; ALR - Agricultural Land Reserve

	POS	SITIVE	NEGATIVE			PRIORITIES			No.	
	most valuable	benefits to farmers	most degraded	human-wildlife conflicts	invasive species	protect	restore/enhance	SCC	checks	
Pitt-Addington Marsh	X	X				Х	X	Х	5	
Katzie Slough	Х		Х		Х	Х		Х	5	
Pitt River Regional Greenway*	Х		Х				Х	Х	4	
Pitt River	Х	Х						Х	3	
Fraser River	Х		Х					Х	3	
Hoffmann Park	Х			Х		Х			3	
Tributary of Katzie Slough	Х					Х	Х		3	
Harris Landing & Shoreline Park	Х					Х		Х	3	
Alouette River	X						X	Х	3	
North Bonson Park	Х					Х			2	
Somerset Park	Х					Х			2	
ALR	Х						X		2	
Pitt Lake	Х							Х	2	
Waterfront Commons Park			Х				X		2	
Trans Canada / Great Trail			Х				X		2	
Pitt Meadows Community Garden						Х	Х		2	
Harris Road Park						Х			1	
Bonson Park							X		1	
General/Various:										
watercourses		X	Х	X		Х	X		5	
urban forests/green spaces	Х		X	Х			X		4	
riparian areas		Х	X			Х	X		4	
mature/mixed/rural forests	Х	Х						Х	3	
dikes	Х								1	

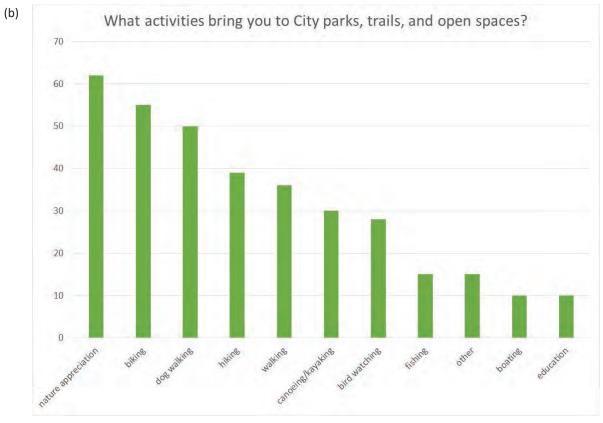
<sup>\*</sup> Specific areas of the Pitt River Regional Greenway to prioritize for protection include mature forest and old-field habitat.

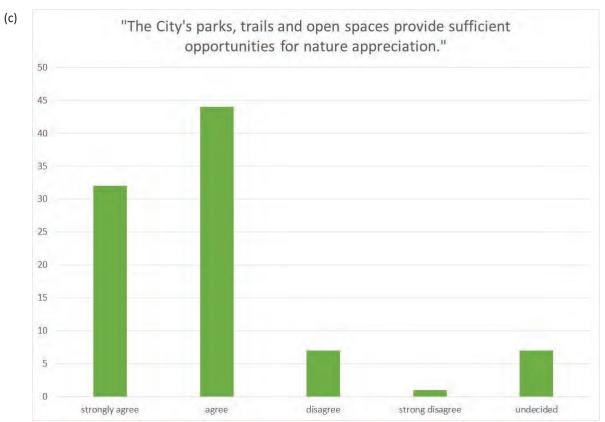
# 3.3 Survey Questions (Community and Focus Group)

There appeared to be more public interest in the survey questions, where 91 unique responses were received between July 7 and August 28, 2020. However, among the selected focus group participants, only three completed the survey questions. Community responses regarding their usage and perception of the City's natural and built assets are shown in **Figure 3-5**.



Appendix A: Pitt Meadows EIMS – Engagement Summary





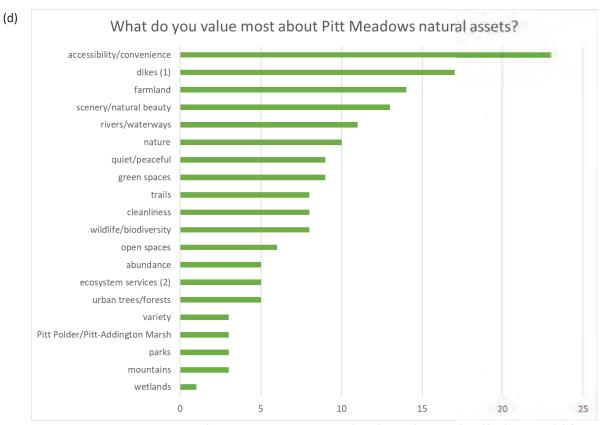
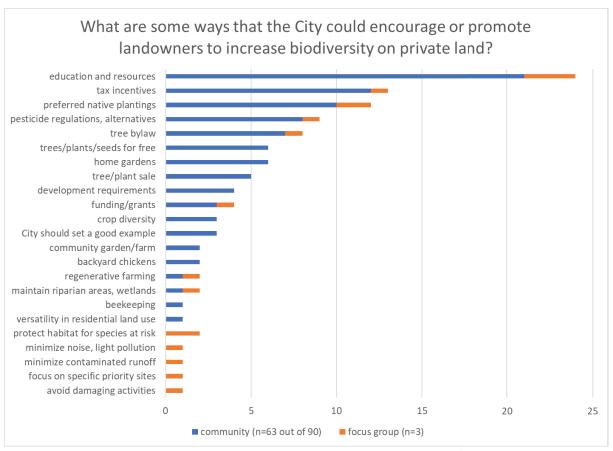


Figure 3-5. Community responses to online survey questions regarding the City's natural and built assets: (a) frequency of visits, (b) purpose of visits, (c) sufficient opportunities, and (d) most valued assets or features. Notes in Figure 3-5d: (1) "dikes" include the Fraser River, Pitt River, and Alouette River waterfronts. (2) Ecosystem services noted include clean air, clean water, food, topsoil retention, nutrient cycles, bees, fish and wildlife (habitat), shade, recreation, aesthetic beauty, and spirituality. Note: while many people mentioned dikes as a natural asset that they value most about Pitt Meadows, the dikes themselves are not natural assets, but manmade structures. We assume that respondents likely meant to refer to the access that the dike trails provide them to recreational opportunities and access to nature.

The majority of community respondents make use of the City's parks, trails, and open spaces at least once a week or daily; and the most common activities are nature appreciation, biking, and dog walking. While most respondents either agreed or strongly agreed to the statement that "the City's parks, trails, and open spaces provide sufficient opportunities for nature appreciation", seven community members disagreed and one person strongly disagreed. From the community's perspective, the most valued feature of the City's natural assets is accessibility in multiple senses (convenience and walkability), especially the dike trails along the various riverfronts. Many respondents mentioned the value of farmland, open spaces, and "rural feel" of Pitt Meadows. Overall, the community responses to what they value most emphasized the various cultural services that the City's natural assets provide.

Both the community and focus group surveys included questions about how the City could encourage/promote biodiversity on private land, actions the City should take regarding climate change mitigation and resilience planning, and any other values or concerns. Summaries of these engagement responses are shown in **Figure 3-6**, **Figure 3-7**, and **Figure 3-8**.



**Figure 3-6.** Ideas and recommendations from the community (blue) and stakeholders/focus group (orange) regarding ways to increase biodiversity on private lands.

The most important way that the City could encourage private landowners to increase biodiversity, as identified by both focus group respondents and the community, is to provide public education and resources (**Figure 3-6**). Tax incentives (or other incentive programs) were recognized as one of the most effective means of encouraging private landowners to take action.

Educational topics include preferred plantings (trees, native species, pollinator- and wildlife-friendly species), invasive species and their negative impacts on ecosystem health and biodiversity, benefits and values of biodiversity, and how to grow a home garden. Two community respondents also suggested demonstration areas to showcase native plants and regenerative farming<sup>2</sup>. In addition to promoting native plantings, some respondents also recommended replacing or discouraging grass lawns, or replanting existing lawns with a diverse mix of other plant species.

Many community respondents had concerns about pesticide and herbicide use, especially on blueberry farms, and their effects on human health and biodiversity. Comments included banning, regulating, restricting, and controlling the use of toxic pesticides, herbicides, and fungicides; and promoting eco-

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<sup>&</sup>lt;sup>2</sup> Regenerative farming/agriculture refers to farming and grazing practices that mitigate against climate change by rebuilding soil organic matter and restoring degraded soil biodiversity. These practices help improve the water cycle and contribute to carbon sequestration.

friendly alternatives such as biological control and companion farming<sup>3</sup>. The City of Pitt Meadows has indicated that any such measures would require consultation with the agricultural sector to assess the feasibility of shifting to alternative measures. Tree retention and protection, which can be promoted/legislated through development of a tree bylaw<sup>4</sup>, was noted by both the community and focus group respondents.

Focus group respondents recommended a few additional ways to increase biodiversity on private lands, including protection of (critical) habitat for species of conservation concern and minimizing excessive noise and light pollution/disturbance. For all of their recommended actions, focus group members consistently discussed working with and supporting landowners, such as through incentives, project funding, and connecting landowners with supportive organizations (e.g., Farmland Advantage).

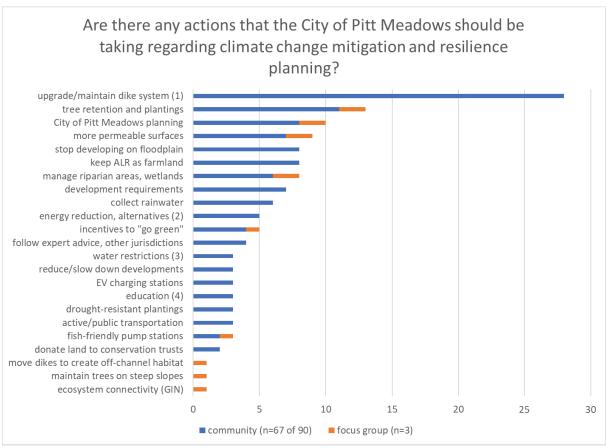


Figure 3-7. Ideas and recommendations from the community (blue) and focus group (orange) regarding climate change mitigation and resilience planning for the City of Pitt Meadows. Notes: (1) "Dike system" represents dikes, pump stations, drainage ditches. (2) Alternative energy options include solar, wind, electric, biofuels. (3) Water restriction recommendations include limiting lawn watering, withdrawal from Alouette River, and metering. (4) Educational topics include native/drought-resistant plants, rainwater collection, waste reduction and recycling, and lowering carbon footprint. Abbreviations: ALR - Agricultural Land Reserve; EV - electric vehicle; GIN - green infrastructure network

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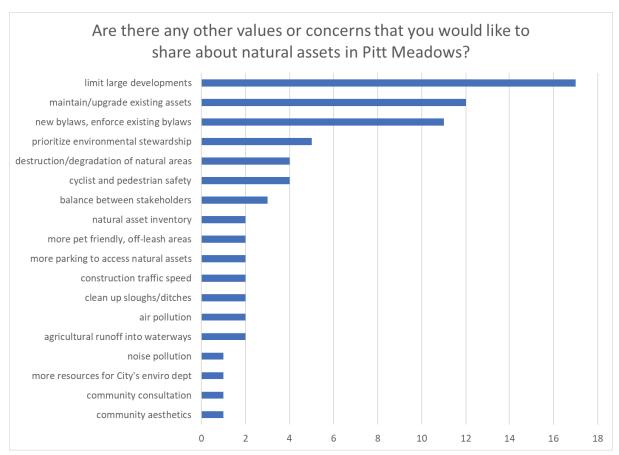
<sup>&</sup>lt;sup>3</sup> Companion farming/planting is a gardening strategy that maximizes growth and crops by planting mutually beneficial plants next to each other. This strategy aids in pest control and pollination, provides habitat for beneficial insects, maximizes the use of space, and increases crop productivity.

<sup>&</sup>lt;sup>4</sup> At the time of writing, the City of Pitt Meadows has planned to develop a tree protection bylaw.

With respect to climate change mitigation and resilience planning, the most frequent community comment was about upgrading and maintaining the dikes, pump stations, and drainage ditches (**Figure 3-7**). A few community and focus group respondents also encouraged installing fish-friendly pump stations. Other methods to reduce flood risk were also commonly noted, including adding more permeable surfaces/green infrastructure for stormwater management (e.g., green roofs, rain gardens, bioswales, and planted boulevards, as well as roof leader disconnection), building codes to stop development on floodplains (and diversion/destruction of sloughs and ditches), and managing/enhancing riparian areas and wetlands.

Urban and rural forests provide a range of ecosystem services and are important for climate resilience (e.g., carbon storage and sequestration); retention and planting of trees was noted by the community and focus group members. Both groups expressed that the City of Pitt Meadows planning for climate change impacts needs to improve. Examples of City planning responsibilities include emergency preparedness, integrated stormwater management, climate action, greenhouse gas (GHG) emissions targets, budgeting/investing in flood infrastructure, setting development requirements, urban forest management, and an agricultural plan. Suggestions from the community for development requirements included tree retention, sustainable long-term plantings, drainage and rainwater infiltration/management, green spaces, grey water reuse, and other eco-friendly options.

Focus group members noted a few additional mitigation options, including moving certain dikes to create new off-channel habitat to increase flood capacity and fish and wildlife habitat, maintaining trees on steep slopes to improve stability during extreme weather events, and the City working together with other municipalities to improve ecosystem connectivity through a regional green infrastructure network (GIN). The benefits of climate change adaptation/mitigation can be maximized by connecting green infrastructure (natural, enhanced, and engineered assets) within and across municipal boundaries.



**Figure 3-8.** Community feedback regarding other values and concerns that may not have been captured by other EIMS engagement questions.

One of the biggest concerns expressed by community respondents is large developments (e.g., warehouses, townhouse complexes, and high-rises) that are being planned for areas that currently support trees and wildlife. Specific locations of concern include the forested area within the North Lougheed Study Area, Airport Way, Pitt Meadows Community Garden and surrounding natural area, and Baynes Road Study Area. One respondent expressed concern that there was not proper community consultation for large development projects that impact the City's remaining natural areas.

Many community responses were about maintaining and improving the City's existing natural and built assets, including green spaces, parks, planted trees, trails, playgrounds, and sports fields. Recommended upgrades include more and bear-proof garbage cans in populated/popular areas, washrooms, seating and lighting, and general improvements. Monitoring and enforcement of existing bylaws, in order to preserve the enjoyment of natural assets, was also a commonly expressed concern. These comments were related to bylaws outlining dog control (no. 2735), traffic (no. 2260), property maintenance (no. 1400), and nuisance abatement (no. 2739), as well as City policies regarding illegal dumping and littering. In addition to controlling industrial/quarry truck speed for cyclist and pedestrian safety, a few participants recommended additional single- or multi-use trails along popularly used roads (e.g., south of Lougheed from Baynes to Kennedy).

Community responses about prioritizing environmental protection and stewardship included preserving wetlands, waterways, and biodiversity. One survey respondent recommended working with Katzie First Nation to rehabilitate wetlands. As discussed in Section 2.0, the City should continue to reach out for meaningful discussions and explore collaborative opportunities with the Katzie First Nation as environmental planning and implementation move forward.

### 3.4 Phone Meetings (Focus Group)

During phone meetings with members of the focus groups, similar concepts and areas of importance as those introduced during online engagement were brought up and reiterated. Representatives from the Pitt Meadows Environmental Network (PMEN) emphasized the importance of the Katzie Slough as (historical) salmon rearing and wintering habitat, and their desire for fish-friendly pumps, clean-up efforts (for invasive species such as parrot's feather) to improve water flow, and restoration plantings to provide shade. The PMEN is particularly concerned about flooding due to development, noting that previous developments in Hammond Hill (near Meadowtown Centre) may have resulted in increased flooding in nearby residential areas. As such, the PMEN recommends protecting wetlands to serve as flood buffers and raising public awareness about the importance of wetlands. The PMEN is also concerned about the proposed development projects in the NLSA and the Harris Road underpass (next to Hoffmann Park) — both of which would impact two of the remaining mature forest stands within the City's population centre.

Phone meetings were conducted with representatives from the City of Pitt Meadows and Metro Vancouver. The City noted the importance of vegetated boulevards, urban and rural forests, riparian areas, and watercourses. Although there is currently no invasive species management strategy, City staff undertake efforts to control invasive species and also complete native planting/replanting projects throughout the City. Metro Vancouver emphasized the importance of ecosystem connectivity and described their proposed vision for the Codd Wetland Ecological Conservancy Area and surrounding wetlands, and extension of the Pitt River Regional Greenway with other connecting greenways. Metro Vancouver also recommends increasing riparian buffer widths, wherever possible.

For an agricultural perspective, phone meetings were conducted with the Pitt Meadows Agricultural Advisory Committee (AAC) and a representative from the BC Ministry of Agriculture. There is a strong opinion – from both members of the AAC and the community (see Figure 3-7) – that the Agricultural Land Reserve (ALR) should only be used for farming. The AAC highlighted the unique soil and soil structure (e.g., Ladner clays) of the region as an environmental asset and its value for crop production. Additional priorities noted by the AAC included protection of waterways (quantity and quality of water for irrigation) and flood management (dike system and pump upgrades). Many AAC members are concerned about invasive aquatic plant species (e.g., parrot's feather) clogging up drainage and water access - the health of Pitt Meadows waterways is a shared concern of all focus group members and should be considered a management priority by the City. Members discussed existing efforts made by agricultural landowners to encourage biodiversity (e.g., promoting birds, which in turn control insect pests) and potential future efforts that the City could undertake, such as planting wildflower and natural meadows on City land (without removing farmland from the ALR). Some members of the AAC thought the promotion of biodiversity as a trade-off, as they lose crops to birds and wildlife; although they recognize the value of biodiversity and were willing to accommodate more if they were subsidized in some way for their crop and productivity losses. Zoetica also heard that farmers generally support environmental measures such

as carbon sinks, wildlife corridors, and pollinator strips, provided that they do not negatively impact the economics of farming.

A major topic of discussion during the AAC meeting was about conflicts between humans and wildlife and between agriculture and other focus group members and the general community. These issues, along with the few online survey responses submitted, are discussed in Section 3.5.

### 3.5 Human-Wildlife and Human-Human Conflicts

Community and focus group respondents commented on general human-wildlife (habitat) conflicts such as water and air pollution, climate change, and urban deforestation. A conflict was identified between the airspace safety requirements for the Pitt Meadows Regional Airport and tree heights along the Pitt River Regional Greenway that are partially blocking airport runway approaches. Also, Metro Vancouver noted that, in the northeast area of Pitt-Addington Marsh, there can be human-wildlife conflicts when bears travel down from the mountains and onto the dikes to forage for berries. Further, coyotes use open fields and may come into conflict with humans and off-leash dogs. Metro Vancouver recommended public education, such as 'Bear Aware' and 'Coexisting with Coyotes' courses, to avoid and/or reduce these conflicts. Focus group members also noted conflicting needs between farmers and wildlife habitat with respect to waterways. From conversations with various focus group members (including the AAC), one of the main conflicts is about salmon habitat and extra regulations (e.g., habitat protection). The presence of salmon restricts agricultural activities within areas adjacent to salmon bearing waterways.

Many AAC members noted conflicts with bears and waterfowl eating their berries and crops. One member commented that grey squirrels are trapped elsewhere and released in Pitt Meadows, where they become a nuisance for tree farms. Beaver management appears to be a controversial topic – the PMEN criticized the current beaver management and trapping practices used by the City and spoke about the value of beavers as ecosystem engineers, creating biodiverse wetland habitat. However, the AAC noted that beavers are detrimental for agriculture as they build dams and decrease water flow in rivers/sloughs, and they forage on trees on tree farms.

The AAC also noted conflicts with other humans, including people trespassing on private agricultural property for recreation or hunting and illegally dumping/littering on farmland (including shotgun shells), which can impact food safety. The AAC and the Ministry of Agriculture recommended more public education to showcase the values and services provided by farms and farmers in the region (including the ways in which farmers promote biodiversity) and to clear up misconceptions about agricultural practices.

### 4.0 APPENDIX 1 – EIMS ONLINE ENGAGEMENT QUESTIONS

### 4.1 Focus Group Survey

https://www.haveyoursaypittmeadows.ca/environmentalinventorystakeholdersurvey

### 4.1.1 Mapping Questions

- 1. What are the City's most valuable natural assets?
- 2. Which of the City's natural assets are most at risk?
- 3. Which of the City's natural assets are most degraded presently?
- 4. What natural assets should the City prioritize for protection?
- 5. What natural assets should the City prioritize for restoration or enhancement?
- 6. What natural assets in the Agricultural Land Reserve (ALR) provide important benefits to farmers?
- 7. Are there areas in the ALR where human-wildlife conflicts occur?
- 8. What natural assets in the ALR should be prioritized for conservation?
- 9. What wetlands and other natural assets should be prioritized for protection or conservation to improve flood protection and to help recharge aquifers?
- 10. What natural assets may be at risk due to increased flood activity?
- 11. What natural assets may be at risk due to drought?
- 12. Please identify important habitats or areas for species of concern you would like to note in the City of Pitt Meadows.
- 13. Please identify if there are any important habitats or areas for species that are important to you (rareness aside) you would like to note in the City of Pitt Meadows.
- 14. Please identify areas where you have witnessed human-wildlife conflicts within the City of Pitt Meadows.
- 15. What natural areas in the City should be prioritized for protection from development and encroachment, or for restoration and/or enhancement?
- 16. Are there any areas where goals around connectivity or re-connection should be prioritized?
- 17. Are there contaminated sites and brownfields in the City that should be prioritized for management?
- 18. Please identify locations where invasive species (plant or animal) should be prioritized for management.

### 4.1.2 Survey Questions

- 1. What are some ways that the City could encourage or promote landowners to increase biodiversity on private land?
- 2. Climate change is increasing the winter rainfall (which can lead to more flooding) and creating generally hotter and drier summers. Are there any actions that the City of Pitt Meadows should be taking regarding Climate Change mitigation and resilience planning?
- 3. Are there any other values or concerns that you would like to share about natural assets in Pitt Meadows?

### **Agricultural Areas (Fields and Soil)**

- 4. What natural assets in ALR provide important benefits to farmers?
  - a. Please provide any notes on why you consider these assets, in the location indicated, so important in the text below.

- 5. Are there areas in the ALR where human-wildlife conflicts occur?
  - a. Please provide more information on the type and nature of these conflicts in the location(s) indicated, including potential causes in the text box below.
  - b. Please provide any ideas on how these conflicts might be prevented or reduced within the text box below.
- 6. If you have any ideas on how these natural assets in the ALR can best be conserved in a way that is respectful to agricultural needs and practices, please provide them in the text box below.

### **Biodiversity and Species of Conservation Concern:**

- 7. What species of conservation concern (fish, birds, mammals, amphibians, reptiles, invertebrates, and/or plants) should be a management priority for the City. Please list in the text box below.
- 8. What other species (rareness aside) that are important to you (fish, birds, mammals, amphibians, reptiles, invertebrates, and /or plants) and should be a management priority for the City. Please list in the text box.
- 9. Please describe any human-wildlife conflicts that you have witnessed within the City of Pitt Meadows in the text below.
- 10. What invasive species (plant or animal) should be prioritized for management? Please list in text box below.

### 4.2 Community Survey

https://www.haveyoursaypittmeadows.ca/environmental-inventory-and-management-strategy1

### 4.2.1 Mapping Questions

- 1. What are the City's most valuable natural assets?
- 2. Which of the City's natural assets are most degraded presently?
- 3. What natural assets should the City prioritize for protection?
- 4. What natural assets should the City prioritize for restoration or enhancement?
- 5. What natural assets in the Agricultural Land Reserve (ALR) provide important benefits to farmers?
- 6. What natural assets in the ALR should be prioritized for conservation?
- 7. Please identify important habitats or areas for species of concern you would like to note in the City of Pitt Meadows.
- 8. Please identify if there are any important habitats or areas for species that are important to you (rareness aside) you would like to note in the City of Pitt Meadows.
- 9. Please identify areas where you have witnessed human-wildlife conflicts within the City of Pitt Meadows.
- 10. Please identify locations where invasive species (plant or animal) should be prioritized for management.
- 11. Which City parks, trails, and open spaces do you visit most often?

### 4.2.2 Survey Questions

- 1. What do you value most about Pitt Meadows natural assets?
- 2. How often do you visit the City's parks, trails, and open spaces?
- 3. What activities bring you to City parks, trails, and open spaces?
- 4. The City's parks, trails and open spaces provide sufficient opportunities for nature appreciation.

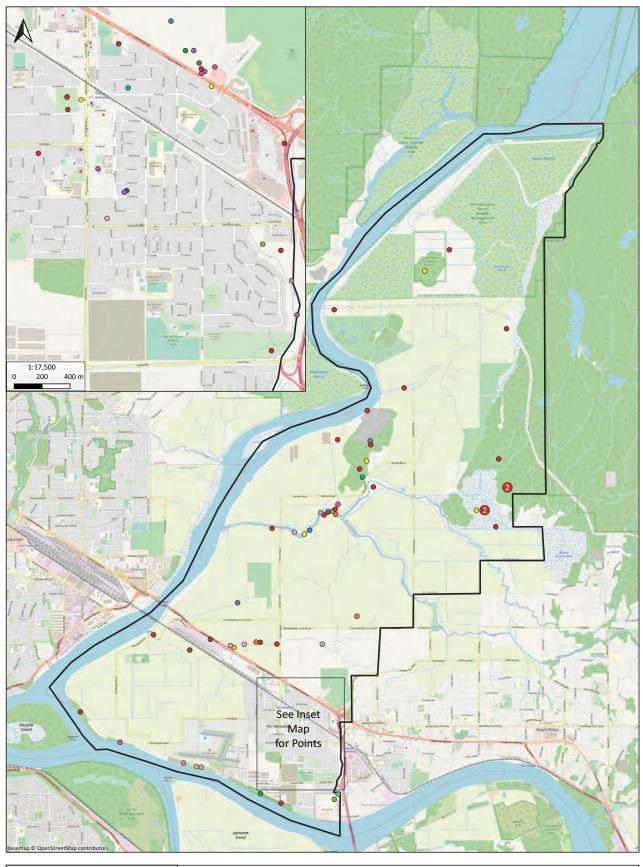
- 5. What are some ways that the City could encourage or promote landowners to increase biodiversity on private land?
- 6. Climate change is increasing the winter rainfall (which can lead to more flooding) and creating generally hotter and drier summers. Are there any actions that the City of Pitt Meadows should be taking regarding Climate Change mitigation and resilience planning?
- 7. Are there any other values or concerns that you would like to share about natural assets in Pitt Meadows?

# 5.0 APPENDIX 2 — LIST OF FOCUS GROUP MEMBERS INVITED TO PARTICIPATE (COLUMN 1) AND WHO PARTICIPATED (COLUMN 2)

Clubs and Societies:	Responded or Participated
Alouette Field Naturalists	
Alouette River Management Society (ARMS)	
Friends of Katzie Slough	x
Maple Ridge Pitt Meadows Environmental Council (MRPMEC)	
Pitt Meadows Environmental Network	x
Watershed Watch Salmon Society	X
Kanaka Education and Environmental Partnership Society	
Ridge Meadows Seniors Society	
First Nations:	
Katzie First Nation	
Kwikwetlem First Nation	
Kwantlen First Nation	
Government – Pitt Meadows:	
Active Transportation Advisory Committee	
Agricultural Advisory Committee	x
Green Leadership Team	
Staff	x
Government – Local/Regional:	
City of Maple Ridge	
Metro Vancouver	X
City of Surrey	
City of Coquitlam	
City of Port Coquitlam	
Township of Langley	
Government – Provincial:	
Ministry of Forests, Lands and Natural Resource Operations and Rural Development (FLNRORD)	
Ministry of Agriculture & Agricultural Land Commission (ALC)	x
Government – Federal:	
Fisheries and Oceans Canada (DFO)	
Environment and Climate Change Canada (ECCC)	
Local Environmental Experts:	
Mike Pearson – Pearson Ecological	
Rob Akester – ISL Engineering and Land Services	
Julie Porter – Katzie Slough biologist	Х
Public:	
Agriculture landowners	X
General	Х
Other Agencies:	
Ducks Unlimited Canada	

# 6.0 APPENDIX 3 – MAPPING RESPONSES

(see next pages)





Focus Group Engagement **Survey Map Results** 1:60,000

Project CRS: NAD83 / UTM zone 10N ZOETICA

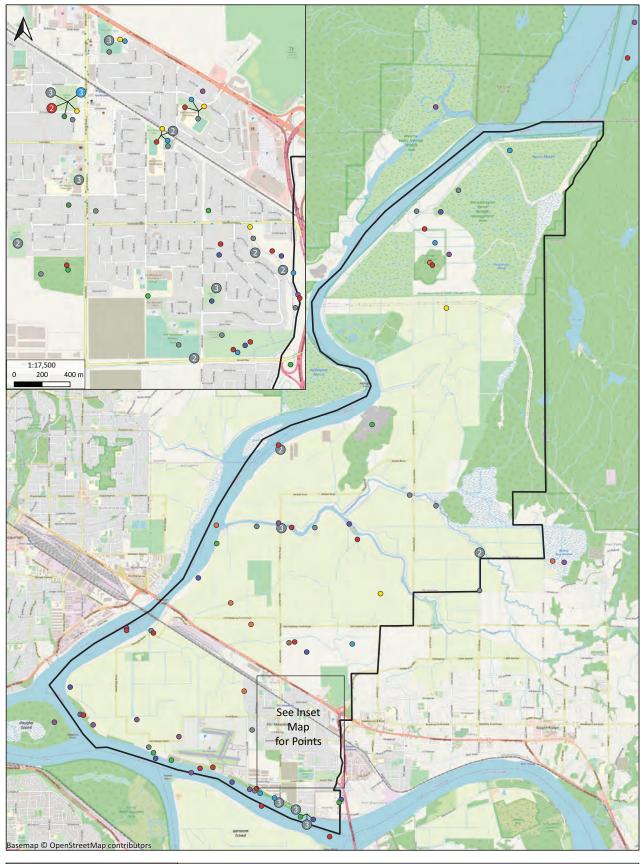
Map ID: PM\_EIMS\_027 October 20, 2020

This map shows the pins dropped by stakeholders while completing the Focus Group and Stakeholder Survey. There were 18 questions with a mapping component. No map pins were placed for Question 14 or 17. Please see section 4.1.1 of Appendix A for a list of the questions asked. Where pins from the same question are close together, these pins have been clustered, and a number inside the symbols indicates the number of pins that have

### Pitt Meadows Boundary

- Question 1 [31] Question 7 [2] Question 13 [1]
- Question 2 [6] Question 8 [6] Question 15 [2]
- Question 3 [2] Question 9 [4] Question 16 [2]
- Question 4 [5] Question 10 [3]
   Question 18 [3]
- Question 5 [3] Question 11 [2]

Question 6 [3] • Question 12 [2] Numbers in square brackets indicate the number of responses per question





0 1:60,000 3 km

Project CRS: NAD83 / UTM zone 10N
ZOETICA

October 20, 2020 Map ID: PM\_EIMS\_026

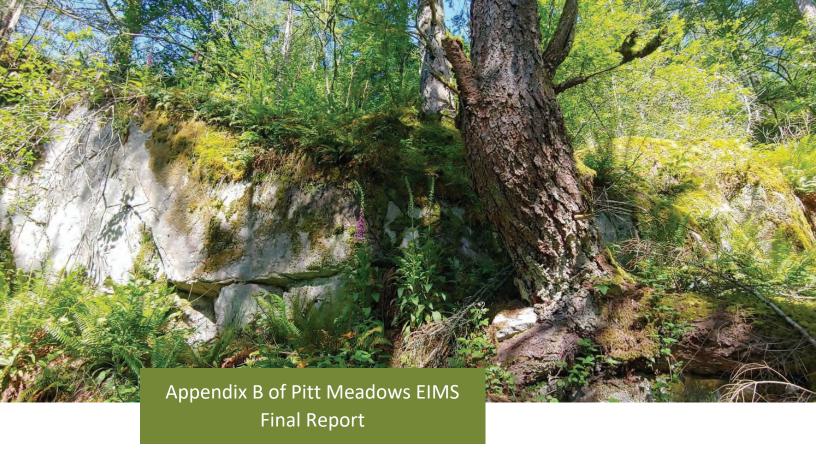
This map shows the pins dropped by community members while completing the Community Survey. There were 11 questions with a mapping component. No map pins were placed for Question 8. Please see section 4.2.1 of Appendix A for a list of the questions asked. Some point symbols were moved, so all pins are visible and to reduce crowding. A black line indicates the original location of the moved symbols. Where pins from the same question are close together, these pins have been clustered, and a number inside the symbols indicates the number of pins that have been clustered.

#### Pitt Meadows Boundary

- Question 1 [25]
   Question 6 [8]
- Question 2 [10]
   Question 7 [15]
- Question 3 [13]
   Question 9 [2]
- Question 3 [13]
   Question 3 [2]
   Question 10 [1]
- Question 5 [6]
   Question 11 [59]

Numbers in square brackets indicate the number of responses per question

# APPENDIX B – HABITAT QUALITY ASSESSMENT AND SEI VERIFICATION



# HABITAT QUALITY ASSESSMENT AND SENSITIVE ECOSYSTEM INVENTORY VERIFICATION

January 14, 2022

**PREPARED AND REVIEWED BY**Zoetica Environmental Consulting Services

**SUBMITTED TO** City of Pitt Meadows

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### **Revision History**

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**Document Title:** Habitat Quality Assessment and Sensitive Ecosystem Inventory Verification

Rev. Number	Issue Date	Description	Prepared By	Checked By	Approved By
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"CO_AWcom ments"	09-Sep-2020	Comments from the City of Pitt Meadows	C. O'Byrne, A. Wallace		
Арр В	02-Mar-2021	Addressed City comments and added content. Re-submitted as Appendix B of final report.	D. MacKinnon	C. Chui	H. Bears
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### 1.0 INTRODUCTION

The current Appendix summarizes the methods used for desk- and field-based habitat quality assessment and Sensitive Ecosystem Inventory (SEI) verification for the City of Pitt Meadows Environmental Inventory and Management Strategy (EIMS) project. The ecosystem dataset developed to describe habitat polygons is described in Section 2.0, the factors used to rank habitat quality are described in Section 3.0 (and a summary is provided in Appendix 1 of this current Appendix), and field forms and supporting documents are available in Appendix 2 and Appendix 3. Refer to Section 4.0 of the *Pitt Meadows EIMS Final Report* for a detailed discussion of the results of habitat quality assessments and ecosystem rankings.

### 2.0 ECOSYSTEM DATASET

To understand the ecosystems and habitats present within the City of Pitt Meadows ('the City'), an ecosystem inventory was created. This dataset, referred to as the ecosystem dataset, can be used to assist the City in planning decisions.

### 2.1 Data Sources Used

The SEI created by Metro Vancouver was used as the initial data for the creation of the ecosystem inventory dataset. The classes and subclasses (see Section 2.2) for natural polygons are based on the classes and subclasses defined within the SEI, which will enable Pitt Meadows to speak a common language used among municipalities within Metro Vancouver. A 5 km SEI buffer was mapped around the municipal boundary to provide the context needed to consider retaining connectivity with other ecosystems outside the City. The SEI only includes sensitive ecosystems (i.e., natural), so additional classes and subclasses were created to cover the rest of the City.

The City provided orthophotos from 2018 that cover the entire city at a resolution of 7.5 cm. Since the SEI data only covers the portion of the city with sensitive ecosystems, the orthophotos were used to select areas not covered by the SEI data. The imagery was also used to edit boundaries of some SEI polygons and complete the habitat quality assessment described in Section 3.0.

### 2.2 Ecosystem Dataset Classes and Subclasses

The dataset is comprised of polygons that have similar ecological characteristics and were classified into classes and subclasses. The classes and subclasses were sorted into three habitat types: Natural, Seminatural, and Built.

**Natural** habitat types are directly based on the SEI developed by Metro Vancouver and include habitats considered natural (i.e., never disturbed) or in advanced recovery from a disturbance, such as forests, wetlands, freshwater, riparian, sparsely vegetated, and old field habitats. The Natural classes and subclasses are summarized in **Table 1**.

**Table 1.** Natural habitat type classes and subclasses. Subclasses marked with an \* are found within the 5 km buffer around the City but not within the City. The classes and subclasses are based on those in the SEI dataset, and the descriptions are based on the descriptions in Table 2 of Meidinger *et al.* (2014).

Class		Subclass	Brief Description
AP: Alpine			Ecosystems above or near the treeline.
	AP	av: avalanche	Avalanche tracks, consisting of shrub and herb ecosystems.
		tracks*	

Class	Subclass	Brief Description
AP	ds: dwarf	Alpine/high subalpine ecosystems dominated by dwarf shrubs.
	shrub*	
AP	pf: parkland	Ecosystems at the transition between alpine and subalpine where
	forest*	trees occur in distinct clumps.
FW: Freshwater		Freshwater bodies of water.
FW	la: lake	Natural or semi-natural open water > 2 m deep; > 8 ha.
FW	pd: pond	Natural or semi-natural open water > 2 m deep, < 8 ha.
MF: Mature		Forests > 80 years and < 250 years.
Forest		
MF	bd: broadleaf	Broadleaf dominated (> 75% of stand composition).
MF	co: coniferous	Conifer dominated (> 75% of stand composition).
MF	mx: mixed	Mixed conifer and broadleaf (< 75% conifer and < 75%
		broadleaf stand composition).
OD: Old Field	od: old field	Large (> 2.5 ha), abandoned-field ecosystems.
OF: Old Forest		Forests > 250 yrs.
OF	co: coniferous	Conifer dominated (> 75% of stand composition).
RI: Riparian		Ecosystems associated with and influenced by freshwater.
RI	ff: fringe	Narrow band near ponds or lake shorelines, or streams with
		no floodplain.
RI	fh: high bench	High bench floodplain terraces.
RI	fl: low bench	Low bench floodplain terraces.
RI	fm: medium	Medium bench floodplain terraces.
	bench	
RI	gu: gully	Watercourse is in a steep V-shaped gully.
RI	mf: mudflat	Freshwater tidal mudflat.
RI	ri: river	River and wider stream watercourses including gravel bars.
SV: Sparsely		Areas with 5 – 10% vascular vegetation (may be greater in
Vegetated		patches); often with mosses, liverwort and lichen cover.
SV	cl: cliff	Steep slopes, often with exposed bedrock.
SV	ro: rocky	Rock outcrops – areas of bedrock exposure, variable vegetation
	outcrop	cover.
SV	ta: talus	Dominated by rubbly blocks of rock, variable vegetation cover.
WN: Wetland		Terrestrial – freshwater transitional areas.
WN	bg: bog	Nutrient-poor wetlands on peat-moss organic soils.
WN	fn: fen	Groundwater-fed sedge-peat wetlands.
WN	ms: marsh	Graminoid or forb-dominated nutrient-rich wetlands.
WN	sp: swamp	Shrub or tree-dominated wetlands.
WN	sw: shallow	Permanently flooded, water < 2 m deep at mid-summer.
	water	
WD: Woodland		Dry site, open stands with 50% or less tree cover.
WD	co: coniferous	Conifer dominated (> 75% of stand composition).
WD	mx: mixed	Mixed conifer and broadleaf (< 75% conifer and < 75% broadleaf
		stand composition).
YF/YS: Young		Patches of forest stands > 30 yrs, < 80 yrs (> 5 ha = YF; < 5 ha = YS).
Forest		

Class	Subclass	Brief Description
YF/YS	bd: broadleaf	Broadleaf dominated (> 75% of stand composition).
YF/YS	co: coniferous	Conifer dominated (> 75% of stand composition).
YF/YS	mx: mixed	Mixed conifer and broadleaf (< 75% conifer and < 75%
		broadleaf stand composition).

**Semi-natural** habitats are continuously modified (e.g., agriculture, parks, trails) or were recently modified (e.g., modified class). Semi-natural habitats provide some habitat value but generally provide lower quality habitat value than natural habitat. The Semi-natural classes and subclasses were developed for this project based on the expected land use in the City and are summarized in **Table 2**.

**Table 2.** Semi-natural habitat type classes and subclasses. Subclasses marked with an \* are found within the 5 km buffer around the City but not within the City.

Class	Subclass	Brief Description
AG: Agriculture		Land used for growing crops, raising livestock, or other agriculture related activities.
AG	cr: crops	Large fields of crops (including hay fields).
AG	nu: nursery	Nursery with mostly impervious surface. Does not include
		greenhouses.
AG	gr:	Greenhouse buildings, which include greenhouses in nurseries.
	greenhouses	
FW: Freshwater		Freshwater bodies of water.
FW	rs: reservoir	Artificial water body of any size.
PA: Park		Area where land has been modified and will continue to be
		maintained for human use.
PA	ma:	Area with maintained lawns, ornamental vegetation, and/or young
	manicured	trees spaced far apart. Can be on public or private land.
	park	
PA	tr: treed park	Area with large, mature trees but no native or natural understory
		(parks with natural understory are classified as a forest ecosystem
		type). Can be on public or private land.
PA	sf: sports	Grass field used for playing sports (includes golf course
	fields	greens/grass areas and horse-riding areas).
PA	ga: garden	Community garden.
MD: Modified		Area where land has been modified in the past, has not been
		maintained, and has begun to grow back.
MD	sh: shrubs	Area where land has been cleared and shrubs have grown.
MD	hb:	Area where land has been cleared, but grass is allowed to grow to
	herbaceous	maturity (i.e., not mowed or maintained).
MD	so: bare soil	Area where land has been cleared and no vegetation has regrown.
MD	rw: right-of-	Repeatedly cleared areas for electrical transmission lines and
	way	access roads.
MD	ri: river	Man-made ditches with green edges.
MD	tr: trail	Gravel or narrow paved walking trails with grass on either side.

Class	Subclass	Brief Description
RU: Rural	rh: residential (high green)	Residential with over 66% green space (green space includes mowed grass). Also includes other land uses more similar to residential than industrial or commercial (e.g., farm buildings).
RU	rm: residential (moderate green)	Residential with 33-66% green space (green space includes mowed grass). Also includes other land uses more similar to residential than industrial or commercial (e.g., farm buildings).
RU	tr: trail	Gravel farming or rural roads. Also includes grassy areas on either side.
XX: Non-SEI	xx: non-SEI*	Non-sensitive or modified ecosystems that were included as part of the original SEI dataset because they provide some habitat value. Only occurs outside Pitt Meadows as all examples within the City were reclassified into other Semi-natural classes.

The **Built** habitat type is heavily modified with buildings, roads, and other structures that will not allow vegetation to regrow easily. Built areas tend to provide very limited habitat potential. Built classes and subclasses were developed for this project based on the expected land use in the City and are summarized in **Table 3**.

**Table 3.** Built habitat type classes and subclasses.

Class	Subclass	Brief Description
UR: Urban		Area where land has been permanently altered for human use.
UR	rl: residential (low green)	Residential with less than 33% green space (green space includes mowed grass). Also includes other land uses more similar to residential than industrial or commercial (e.g., farm buildings).
UR	cm: commercial	Includes most non-residential and non-industry land use with little to no green space (e.g., stadium, schools, parking lots, tennis/basketball courts).
UR	in: industrial	Industrial land use. Includes railway surrounded by impervious material (e.g., pavement, hard packed gravel).
UR	rd: road	Paved local roads, including grass edges. Ramps were included as roads as the surface under the ramp cannot be seen, and likely have limited shade-tolerant vegetation. Includes large, paved areas/parking lots (when not attached to cm subclass; when they are part of a cm development, they were included with the cm subclass).
UR	tu: turf field	Turf field and other large permeable urban land uses.
UR	hi: highway	Multi-lane highway.
UR	ra: railway	Railroad tracks surrounded by green, pervious material. If surrounded by pavement/impervious material, then classified as URin.
UR	qu: quarry	Pitt River Quarry.

### 2.3 Ecosystem Dataset Creation

Zoetica began the ecosystem classification exercise with the SEI dataset. Next, more polygons were created according to the classes and subclasses. As some areas may not have distinct boundaries or were otherwise too complex to define, up to three class/subclass combinations could be assigned to a polygon. The approximate percentage of area covered, rounded to the nearest 10%, was estimated for each class and subclass combination. For example, a polygon might be 40% Wetland swamp, 30% Wetland shallow water, and 30% Freshwater lake.

### 3.0 HABITAT QUALITY ASSESSMENT

Zoetica recommends 11 components for assessing habitat quality, including eight desk-based variables and three field-based ones. The habitat quality ranking is either on a 3-point scale (1, 2, or 3 points) or a 4-point scale (0, 1, 2, 3 points), depending on the variable. Individual variables presented in Sections 3.1 through 3.5 are indicators of habitat quality and include habitat patch type and size, patch vegetative structure and diversity, and patch context and human disruption. The maximum ranking of each variable is 3 points, and the sum of points will determine the final ecosystem ranking of the habitat. Due to the scope and budget of this EIMS project, a field-based assessment could not be completed for the entirety of Pitt Meadows; therefore, only the desk-based variables were included in the final ecosystem rankings presented in Section 4.0 of the *Pitt Meadows EIMS Final Report*. However, if the City chooses to undertake a habitat quality assessment in a smaller area to help inform and prioritize environmental management decisions, Zoetica recommends that the field-based variables be included in the rankings to produce a more comprehensive assessment.

This habitat quality assessment is meant to produce measures that will assist the City in three main areas: 1. making decisions about areas of relatively higher or lower present-day environmental value to consider for conservation or enhancement projects; 2. highlighting areas of low quality that need improvement; 3. providing benchmark ("baseline") measures, against which future measures can be compared to, which will allow the City to demonstrate environmental improvements to meet certain targets (e.g., see Section 6.0 of the *Pitt Meadows EIMS Final Report*, Monitoring: Performance Indicators and Benchmarks). Alternatively, baseline measures can act as a signpost, against which any future degradation in habitat quality can be measured. Providing a starting point for gathering information on certain habitat measures, with detailed instructions such that the same measurements can be repeated at intervals through time, is important for prioritization, decision-making, planning, and monitoring.

All of the variables for habitat quality assessment are summarized in **Appendix 1**, field forms and supporting documents for habitat quality assessment and SEI ground-truthing (e.g., visiting the various SEI units that were categorized by aerial imagery to confirm if the classification was correct, and to make any necessary changes) are available in **Appendix 2**. Examples of common invasive vegetation species are provided in **Appendix 3**. These appendices can be printed for use in the field. Plots to be assessed are randomly chosen within mapped polygons, which are spatial units that comprise relatively similar and continuous habitat. The focus of these surveys will be on publicly accessible and City-owned land and not private land due to access issues. However, GIS-based analyses (identified in the sections below) can include private land.

Patch type, vegetative structure and diversity, and patch context are modified from Cook (2002). The assessment criteria are designed to be simple, transparent, and replicable by City staff, volunteers, not-

for-profit environmental groups, or future consultants as desired or appropriate for the budgeting of the City in the future. In cases where it is deemed helpful, photographic examples, as well as screenshots illustrating decision-making by a GIS specialist, are included to assist in producing replicable measurements in the future for comparison.

The following habitat quality assessments were only performed on the Natural and Semi-natural habitat types, as these are the most ecologically relevant.

# 3.1 Patch Type

**Patch type** provides an initial holistic overview of the likelihood that various habitats in Pitt Meadows could serve as suitable natural areas for various environmental services, and within which other indicators of quality can be assessed. Parts of the patch type assessment can be done via desktop GIS analyses, while other portions warrant an assessment in the field.

When assessing the habitat of a polygon from a subplot or cursory view, the data collector should attempt to identify the overall character of the habitat. There are four classifications for classifying patch type, as defined below:

- **Cleared**: a patch of land where all vegetation has been removed. Includes areas that have bare soil or have been paved.
- Landscaped: a patch of land that has been previously disturbed, and on which the establishment of new vegetation is of human origin. Examples include fields, parks, bioswales, and areas with landscaped shrubs and bushes.
- Regenerated: a patch of land that has been previously and recently cleared, disturbed, or changed, and has since naturally re-established vegetative cover; or engineered habitats (e.g., areas deliberately replanted). Examples include young forest, old uncultivated fields, and regenerating wetlands and riparian areas. Often regenerated areas consist of early seral stage vegetation that establishes early (e.g., aspen, alder) and later matures into mixedwood or coniferous forest as it ages.
- **Remnant**: a patch of land, regardless of age or composition, that is left in its original character following widespread disturbance that changes the surrounding matrix. Examples include: a patch of untouched and unaffected land surrounded by fields, cut blocks, road construction, fire, etc.
- Undisturbed: a patch of land that exists within a predominately natural context and has significant
  natural value. Examples include: mature forest, pristine wetland, and pristine riparian habitat. It
  is recognized that all of Pitt Meadows has been disturbed at some point in the past, and thus
  naturally occurring second and third growth forest is still considered undisturbed for the purposes
  of these definitions.

#### Patch type scoring:

- <u>3 points = Undisturbed</u>
- 2 points = Regenerated or Remnant
- 1 point = Landscaped
- 0 points = Cleared

# 3.2 Area Size and Area/Perimeter Ratio

**Area size** (measured in hectares, ha) and perimeter (measured in metres, m) of a habitat patch is calculated through desk-based GIS methods. The ratio between these two variables (**Area/Perimeter ratio**) gives a measurement of the degree of edge effects<sup>1</sup> on the patch. In the context of habitat fragmentation, edge effects increase the proportion of habitat edges in relation to the total area, rendering any given point within the fragment of land, on average, closer to an edge. Edges create changes in species composition for a given patch because of the following reasons:

- Edges of a forest have microclimatic changes that affect the types of vegetation that can grow there (more direct sunlight, higher soil temperatures, differences in humidity and depth of humus, and increased wind exposure compared with the interior of a forest. This leads to significant differences in the types of vegetation found at a forest edge compared with the forest interior).
- Many wildlife species react negatively to edges in their habitat. As the edges of an area increase, the area needs to be larger to compensate for edge complexity. Highly ranked habitat has a small amount of perimeter to area, i.e., a circle shape. Points will be allocated for area sizes (ha) fit to harbour bird species (Helzer and Jelinski 2016). Some weedy plant species thrive with the extra sunlight, causing a greater spread of noxious species that are undesirable and need to be controlled by the City to keep them from overtaking valuable natural areas (e.g., Scotch broom, Himalayan blackberry) and some bird species will favour perching next to open areas where they can hunt exposed prey. Other species of animals will actively shy away from areas of increased sunlight and exposure, moving further into the interior habitat where the characteristics of land remain unchanged. When we push these species into the now-smaller interior habitat, we are likely to see increased competition for limited resources and some species may be lost.
- Edge-tolerant species are often generalist predators and non-native plant species that
  outcompete native species and habitat specialists. Examples of edge-tolerant species include
  brown-headed cowbirds and crows. These species thrive in an edge habitat and act as nest
  predators and cavity competitors of interior species, which can decrease the populations of forest
  songbirds, ground-nesting birds, reptiles, and amphibians in the remaining habitat fragments.
- Edges become areas with increased noise, light, pollution, human recreation, and roadkill. The increased noise, light, and human activity may cause some species to move further inland, away from habitat edges.

#### Area size scoring:

- 3 points = > 50 ha
- 2 points = 10 50 ha
- <u>1 point = < 10 ha</u>

#### Area/Perimeter ratio scoring:

- 3 points = > 200
- 2 points = 50 200
- 1 point = < 50

<sup>&</sup>lt;sup>1</sup> The effect of an abrupt transition between two quite different adjacent ecological communities on the numbers and kinds of organisms in the marginal habitat.

# 3.3 Vegetative Structure and Diversity

The presence or absence of vegetation, along with the type (species), plant diversity, and complexity of vegetation can provide a great deal of additional information about the various natural services that a vegetated area can provide. The following attributes of vegetated surfaces are assessed in Pitt Meadows.

**Vegetative cover**: This is measured via desk-based GIS analysis as the percentage of ground covered with any type of vegetation. Vegetation cover can include all forms of mosses, grasses, shrubs, bushes, and trees, including crops on agricultural land. This variable is meant to differentiate areas of natural or planted vegetation from cleared or built-up areas. Areas of water cover or natural methods of vegetation removal (e.g., wave action or frequent flooding) are not included in this calculation.

For the purposes of the measurements of natural cover vs. non-natural cover, classes are ascribed (ranked) using the following point system identified below:

- 3 points = > 66% vegetative cover
- 2 points = 33 66% vegetative cover
- 1 point = 5 33% vegetative cover
- 0 points = < 5% vegetative cover</li>

Examples of vegetative cover percentage bins are shown in the figures below.



Figure 1. Example of > 66% vegetation cover.



Figure 2. Example of 33-66% vegetation cover (within the center polygon).



Figure 3. Red tinted area shows examples of < 33% vegetation cover.

**Invasive species cover**: Invasive species are attributed to negatively affect the presence of native species, and certain invasive species that are common in Pitt Meadows can greatly reduce the usability of land (e.g., Himalayan blackberry). Based on the investigation of the sample plot in the field, the percentage of vegetation that is comprised of invasive species (see Appendix 3 for common invasive species) will be estimated and points will be ascribed using the following general point system:

- 3 points = < 1% invasive species
- 2 points = 1 10% invasive species
- 1 point = > 10% invasive species

A detailed invasive species management plan is outside of the scope of the EIMS study, but this cursory exercise will serve to indicate areas that are currently more, or less, affected by the spread of invasive plant species and will guide future recommendations.

**Structural diversity**: Structural diversity is measured as the vertical stratification of vegetation structure, as divided into the categories: 1) tree canopy, 2) shrub cover, and 3) ground cover (Moeur 1985). Tree canopy consists of canopy cover from hard woody vegetation > 5 metres in height, shrub cover consists of vegetation between 1 and 5 metre in height, and ground cover vegetation (mosses, grasses, ferns, mushrooms) consists of vegetation < 1 metre in height. To ascribe points for structural diversity, the presence of each structural diversity category will be noted, and the percent cover estimated. Each structural diversity category with minimum of 25% presence will be ascribed one point, for a maximum of 3 points, as noted below:

- 3 points = ≥ 25% presence of all 3 cover classes (ground, shrub, and tree)
- 2 points = ≥ 25% presence of 2 cover classes (two of ground, shrub, or tree)
- 1 point =  $\geq$  25% presence of 1 cover class only (one of ground, shrub, or tree)
- 0 points = No vegetation

#### 3.4 Patch Context

In a landscape consisting of a mosaic of natural areas, fields, and human development, patch context can be an important defining feature of how a patch functions, particularly in promoting biodiversity. An area of seemingly prime habitat may not function as habitat for many species if it is in a non-ideal context; inversely, an area of sub-par habitat may be unexpectedly teeming with life and providing vital ecological services if in another context. Patch context needs to be viewed in terms of degree of connectivity to other patches of natural habitat, the quality of adjacent habitat, or the degree of isolation from other habitats when dealing with mosaic landscapes consisting of many dispersed patches. All measures of patch context can be assessed using desk-based GIS methods.

**Quality of adjacency**: Adjacency is the extent that species may utilize the landscape adjacent to and immediately surrounding patch boundaries, or that habitat patches are connected in a network to form a larger functional unit. Adjacency is ascribed points as follows:

- <u>3 points = habitat patch is adjacent to a wholly compatible natural unit (example: forested area next to a pristine riparian area)</u>
- <u>2 points = habitat patch is adjacent to a somewhat compatible unit (example: forested area next to a man-made park area or agriculture field)</u>

- <u>1 point = habitat patch is adjacent to a minimally compatible unit (example: field or forest next to a sports field with some trees around the edge)</u>
- <u>O points = habitat patch is surrounded by wholly incompatible units (example: forested area surrounded by parking lot)</u>

A matrix of relative compatibility is provided below in **Table 4** and a summary of which ecosystem classes and subclasses fall into each polygon type are provided in **Table 5**. In **Table 4**, the first column indicates the type of polygon being assessed, and the top row indicates the polygon that is adjacent to the assessed polygon. If a polygon is next to multiple polygon types, then the highest quality of adjacency value is used. For example, if a forest polygon is being assessed, and is next to both a parking lot (0) and an agriculture field (2), then the forest polygon will be assigned a 2 for quality of adjacency.

# Appendix B: Pitt Meadows EIMS – Habitat Quality Assessment and SEI Verification

 Table 4. Matrix of compatibility definitions used in GIS decision-making: 3 = Wholly Compatible (green); 2 = Somewhat Compatible (yellow); 1 = Minimally

Compatible (orange); 0 = Incompatible (red). See Table 5 for a summary of which ecosystem classes/subclasses make up each polygon type.

Adjacent Polygon								Semi-natural Habitat Type						Built Habitat Type			
Туре			- Tacar									.,,,,					7,60
Assessed Polygon Type			Wetland	Freshwater	Riparian	Sparsely Vegetated	Old Field/Early Regrowth	Treed Parks	Agriculture	Residential with Over 66% Green Space	Manicured Parks/Trails	Recreational Sports Fields	Residential with 33-66% Green Space	Residential with Less than 33% Green Space	Urban Centre	Industrial	Parking Lots/Paved (other)
) e	Forested	3	3	3	3	3	2	2	2	1	1	1	1	0	0	0	0
Natural Habitat Type	Wetland	3	3	3	3	3	2	2	2	1	1	1	1	0	0	0	0
atul	Freshwater	3	3	3	3	3	2	2	2	1	1	1	1	0	0	0	0
ab i	Riparian	3	3	3	3	3	2	2	2	1	1	1	1	0	0	0	0
工	Sparsely Vegetated	3	3	3	3	3	2	2	2	1	1	1	1	0	0	0	0
	Old Field/Early Regrowth	3	3	3	3	3	3	2	2	1	1	1	1	0	0	0	0
(D)	Treed Parks	3	3	3	3	3	3	2	2	1	1	1	1	0	0	0	0
, d	Agriculture	3	3	3	3	3	3	3	2	1	1	1	1	0	0	0	0
Built Habitat Type	Residential with Over 66% Green Space	3	3	3	3	3	3	3	2	2	1	1	1	0	0	0	0
H	Manicured Parks/Trails	3	3	3	3	3	3	3	2	2	2	2	1	0	0	0	0
uilt	Recreational Sports Fields	3	3	3	3	3	3	3	2	2	2	2	1	0	0	0	0
Δ	Residential with 33-66% Green Space	3	3	3	3	3	3	3	2	2	2	2	1	0	0	0	0

**Table 5.** Summary of categories used in Table 4.

Categories in Table 4	Ecosystem Class and Subclass
Forested	YF, YS, MF, OF, WD (all subclasses)
Wetland	WN (all subclasses)
Freshwater	FW (all subclasses)
Riparian	RI (all subclasses)
Sparsely Vegetated	SV (all subclasses)
Old Field/Early Regrowth	OD, MDhb, MDsh, MDrw
Treed Parks	PAtr
Agriculture	AG (all subclasses)
Manicured Parks	PAma, PAga
Recreational Sports Fields	PAsp

**Isolation index**: This index is a function of proximity of other vegetated patches or corridors within a landscape mosaic, (i.e., an index of the distance between patches and the number of neighbouring patches). This variable can be assessed through desk-based methods.

The isolation index can be calculated as the distance between a patch and the nearest natural polygon.

- 3 points = distance of < 10
- $\underline{2 \text{ points}} = \text{distance of } 10 100$
- <u>1 point = distance of 100 500</u>
- <u>0 points = distance of > 500</u>

**Connectivity**: A simple measure of number of physical connections of corridors and/or vegetated patches (if any natural or semi-natural) included within the ecological network. No points are awarded if there are zero connections.

- 3 points = ≥ 50% physical connections to adjacent patches
- 2 points = 25 50% physical connections
- 1 point = < 25% physical connections
- 0 points = 0% physical connections

# 3.5 Human Impact

The extent of human impact on area is difficult to summarize and quantify into one umbrella variable for data collection. The following variables are modified from Natale *et al.* (2015) and are meant to give an indication of the extent of human impact in an area that translates into reduction in of habitat quality.

Road presence: Measurement of the number of roads within or adjacent to the polygon. This can be conducted as a desk-based task. The different types of roads and a map of their distribution can be found in the City's Transportation Master Plan (City of Pitt Meadows 2014). For the GIS analysis, the Digital Road Atlas (DRA) dataset freely available from BC Data Catalogue was used to determine the road type and location (FLNRORD 2019). When counting the roads present in or surrounding the polygon, the sum of their impact as defined in **Table 6** will translate to the points allocated to them.

**Table 6.** Table of road types and road impact scores.

Road type	Impact scores
Provincial highway	4
Major road network	3
Arterial	2
Collector	2
Local	1

- 3 points = Impact score of 0
- 2 points = Impact score of 1 3
- 0 points = Impact score of ≥ 4

Bare ground/disturbed areas: In patches where there is no vegetation or there is obvious disruption of natural state, assess the amount of area (in percentage of the plot being sampled) with evidence of: compacted soil, visible areas of erosion, bare/unproductive areas, pavement, gravel patches, garbage cover, dust cover on vegetation.

- 3 points = < 1% disruption
- 2 points = 1 25% disruption
- 1 point = > 25% disruption

## 3.6 Combined Habitat Quality Assessment

For this EIMS project, each polygon within Natural and Semi-natural classes had all the assigned points from desk-based variables totaled, for a maximum possible score of 24 (8 variables x max. 3 pts each). The combined ranking was then simplified into five ecosystem rating bins:

- Very Low ≤ 8
- Low 9-12
- Moderate 13-16
- High 17-20
- Very High 21-24

See Appendix F of the *Pitt Meadows Environmental Inventory and Management Strategy – Final Report* for all the mapped results for Sections 3.1 through 3.5, the final combined ranking, and the simplified ecosystem rating bins. We note that a "very low" habitat ranking is only based on the variables considered. Habitats and areas may have other benefits and values that are not captured here, and the rankings should not be considered to exclude habitats and areas for other lesser-known ecological function or value they provide. For instance, if a very low ranked area hosts an extremely rare species that is discovered in the future, the City should use its discretion to add those considerations into this assessment.

#### 4.0 REFERENCES

City of Pitt Meadows. 2014. Transportation Master Plan: Summary Report.

Cook, E. A. 2002. Landscape structure indices for assessing urban ecological networks. Landscape and Urban Planning 58:269–280.

FLNRORD. 2019. Digital Road Atlas (DRA) - Demographic Partially-Attributed Roads. Ministry of Forests

- Lands Natural Resource Operations and Rural Development; available from the BC Data Catalogue.
- Helzer, C. J., and D. E. Jelinski. 2016. The Relative Importance of Patch Area and Perimeter-Area Ratio to Grassland Breeding Birds Author 9:1448–1458.
- Meidinger, D., J. Clark, and D. Adamoski. 2014. Sensitive Ecosystem Inventory for Metro Vancouver & Abbotsford: 2010-2012 Technical Report. Metro Vancouver.
- Moeur, M. 1985. COVER: A User's Guide to the CANOPY and SHRUBS Extension of the Stand Prognosis Model. Page General Technical Report INT-190. United States Department of Agriculture, Forest Service, Intermountain Research Station.
- Natale, E., G. Villalba, J. E. Junquera, and S. M. Zalba. 2015. Assessment of the conservation status of natural and semi-natural patches associated with urban areas through habitat suitability indices. International Journal of Environmental Research 9:495–504.
- RIC. 1998. Standard for Terrestrial Ecosystem Mapping in British Columbia. Prepared by Ecosystem Working Group, Terrestrial Ecosystems Task Force, Resources Inventory Committee.

# APPENDIX 1. SUMMARY OF HABITAT QUALITY COMPONENTS, SCORING AND CONDITIONS

	<b>Indicator Categories</b>	Habitat Quality Metrics	Points	Condition
1	<b>Patch Type</b> - The overarching character of the environment is an easy initial	<b>Cleared</b> : a patch of land where all vegetation has been removed. Includes areas that have bare soil or have been paved.	0	
	indication, giving expectations as to whether or not an area could be considered good natural habitat.	<b>Landscaped</b> : a patch of land that has been previously disturbed, and on which the establishment of new vegetation is of human origin. Examples include fields, parks, bioswales, and areas with landscaped shrubs and bushes.	1	
		Regenerated: a patch of land that has been previously and recently cleared, disturbed, or changed, and has since naturally re-established vegetative cover; or engineered habitats. Examples include young forest, old uncultivated fields, and regenerating wetlands and riparian areas. Often regenerated areas consist of early seral stage vegetation that establishes early (e.g., aspen, alder) and later matures into mixedwood or coniferous forest as it ages.	2	
		<b>Remnant:</b> a patch of land, regardless of age or composition, that is left in its original character following widespread disturbance that changes the surrounding matrix. Examples include: a patch of untouched and unaffected land surrounded by fields, cut blocks, road construction, fire, etc.	2	
		<b>Undisturbed</b> : a patch of land that exists within a predominately natural context and has significant natural value. Examples include: mature forest, pristine wetland, and pristine riparian habitat. It is recognized that all of Pitt Meadows has been disturbed at some point in the past, and thus naturally occurring second and third growth forest is still considered undisturbed for the purposes of these definitions.	3	
2	Area Size and Area/Perimeter - Larger areas allow more natural processes to occur, allow wildlife to meet basic needs (food, shelter) and disperse genetic diversity, and minimize disturbance effects. Many wildlife	Area size: points will be allocated for area sizes (ha) fit to harbour bird species (Helzer and Jelinski 2016).	3 2 1	> 50 ha 10 – 50 ha < 10 ha
	species react negatively to edges in their habitat, and edge effects are more pronounced as habitat area becomes smaller and narrower. As the edges of an area increase, the area needs to be larger to compensate for edge complexity.	Area/Perimeter ratio: highly ranked habitat has a small amount of perimeter to area, i.e., a circle shape. Calculate the area/perimeter index as area ( $m^2$ ) / perimeter ( $m$ ). As an example, a 50 ha circle has a perimeter of 2506.99 m and would be calculated as: 500 000 $m^2$ / 2506.99 m = 200	3 2 1	> 200 50 – 200 < 50

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3	Vegetative Structure and Diversity - When determining if a patch can function as a good basis for natural habitat, vegetation presence and type is a prerequisite and telltale for other forms of life. The quality of the ground can be assessed through the presence or absence of vegetation, and further the type, diversity, and complexity of present vegetation.	Vegetative cover: measured as percentage of ground covered with any type of vegetation. This includes all forms of mosses, grasses, shrubs, bushes, and trees, including agricultural crops. This variable is meant to differentiate areas of vegetation from cleared or built-up areas.  Invasive species: invasive species are attributed to negatively affect the presence of native species, therefore yielding an area basis for quality habitat. Scoring is based on an estimate of percentage cover by target invasive plants.  Structural diversity: measured as vertical stratification of vegetation structure, divided into the categories as 1) tree canopy, 2) shrub cover, and 3) ground cover (Moeur 1985). Tree canopy is considered as hard woody vegetation > 5 metres in height, shrub cover is considered vegetation between 1 and 5 metres in height, and ground cover vegetation (mosses, grasses, ferns, mushrooms) < 1 metre in height. A minimum of 25% presence of the existing vegetation structure is needed for a given layer to count as present.	3 2 1 0 3 2 1 3 2 1	> 66% 33 - 66% 5 - 33% < 5% < 1% 1 - 10% > 10%  3 layers 2 layers 1 layer No vegetation
4	Patch Context - In a landscape consisting of a mosaic of natural areas, fields, and human development, it can become difficult to predict where pockets of natural areas can or cannot function as quality habitat. An area of seemingly prime habitat may	Quality of adjacency: the extent species may use the landscape adjacent to and immediately surrounding patch boundaries based on a measure of naturalness. Adjacent landscapes may be considered wholly compatible (example: forested area next to a pristine riparian area), somewhat compatible (example: forested area next to an agriculture field), minimally compatible (example: forested area next to a sports field), or wholly incompatible (example: forested area next to a parking lot).	3 2 1 0	wholly compatible somewhat compatible minimally compatible wholly incompatible
	unexpectedly not function as quality habitat for many species, and inversely an area of sub-par habitat may unexpectedly be teeming with life. The factors of connectivity to other patches of habitat and the quality of adjacent	<b>Isolation index</b> : function of proximity of other vegetated patches or corridors within a landscape mosaic, (i.e., an index of the distance between patches and the number of neighbouring patches). This variable can be assessed through desk-based methods. The isolation index can be calculated as the distance between a patch and the nearest natural polygon.	3 2 1 0	Distance of > 10 Distance of 10 – 100 Distance of 100 – 500 Distance of < 500
	habitat account for these scenarios when dealing with mosaic landscapes consisting of many dispersed patches.	<b>Connectivity</b> : a simple measure of number of physical connections of corridors and/or patches included within the ecological network.	3 2 1 0	≥ 50% connections 25 – 50% connections < 25% connections 0% connections
5	Human Impact - The extent of human impact on area is difficult to summarize and quantify into one umbrella variable for data collection. The following variables are meant to give an indication of the extent of human impact in an area that translates into reduction in of habitat quality.	Road presence: measurement of the number of roads within the polygon. This can be conducted as a desk-based task. The different types of roads and a map over their distribution can be found in the City's Transportation Master Plan (City of Pitt Meadows 2014). When counting the roads present in the polygon, the sum of their impact as defined below will translate to the points allocated to them.  Road type Impact  Provincial highway 4  Major road network 3  Arterial 2  Collector 2  Local 1	3 2 0	Impact score of 0 Impact score of 1 − 3 Impact score of ≥ 4

Appendix B: Pitt Meadows EIMS – Habitat Q	uality Assessment and SEI Verification
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Bare ground/disturbed areas: in patches where there is no vegetation or there is obvious disruption of natural state, assess the amount of area (in percentage of the plot being sampled) where soil is compacted or with visible areas of erosion, bare/unproductive areas, pavement, gravel patches, garbage cover, dust cover on vegetation.	3 2 1	< 1% disruption 1 – 25% disruption > 25% disruption
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#### APPENDIX 2. FIELD FORMS AND SUPPORTING DOCUMENTS

# 1.0 REQUIRED EQUIPMENT

- Clipboard
- Pen/pencil
- Field maps (digital and print)
- List of pre-conceived points with IDs
- GPS
- Camera
- Binoculars
- Plant ID book, mobile app, etc.

## 2.0 FIELD PROCEDURE

# 2.1 Survey Effort

The Standard for Terrestrial Ecosystem Mapping in BC (RIC 1998) provides guidance for percentage of polygons to be visited based on the size of the area. These standards suggest visiting 26-50% of polygons based on the fact that Pitt Meadows is approximately 8,825 ha in size.

#### 2.2 SEI Field Form

- 1. Indicate if you were able to access the site or if it was observed from a distance.
- 2. If possible, walk around the plot/through the polygon to get an overview of the habitat, up to 100 m in each direction or until a transition is found.
  - a. If the polygon appears relatively uniform, the survey can be done as a stationary point.
  - b. If habitat changes are observed, a *transect survey* should be used where the start, end, and transition locations will be noted.
- 3. Record the date (in DD-MMM-YY format).
- 4. Record the mapsheet letter of the field map used.
- 5. Using the list of points, record the polygon ID.
- 6. Record the Plot ID and surveyor(s) for this plot.
  - a. If habitat differences/changes indicate that a new polygon should be defined, mark as a new waypoint on the GPS and label the Plot ID with your initials as a prefix, e.g., "DM001".
- 7. Describe the location of the plot. Use nearest street names, landmarks, park names, etc.
- 8. Take photographs of the site, including representative conditions and special features. Record the number of photos taken to help organize later.
- 9. Record the UTM Easting, Northing, elevation, and GPS accuracy.
  - a. Start and end coordinates should be recorded for transect surveys.
- 10. Using the field map and/or list of points, record the original SEI label. (Note: this should match the plot ID prefix.)
- 11. Using **Table 1**, record the condition rank.
- 12. Using **Table 2**, record the disturbance code(s).
- 13. If there is only one SEI class within the polygon, only complete the Decile 1 column. If there are two or three SEI classes within the polygon, complete Decile 1 column with the largest SEI class followed by Decile 2 for the next largest SEI class, and if needed, Decile 3 column with the smallest SEI class.
- 14. Record the percentage of the polygon the SEI class covers to the nearest 10%. Row should sum to 100%.

- 15. Record the SEI class according to Table 3.
- 16. Record the SEI subclass (if applicable) according to **Table 3**.
- 17. Using **Table 4**, record the structural stage. Only applicable for forested habitats.
- 18. Record the % Coniferous and % Deciduous stand composition. Total for each decile should sum to 100%. Only applicable for forested habitats.
- 19. Record the dominant vegetation species for tree canopy, shrub cover, and ground cover.
- 20. Use the comments section to record any clarifications and to note any important features not otherwise recorded. Habitat changes (that warrant identification of new SEI polygons) and important features such as wildlife trees and small ponds/wetlands should be marked as waypoints; record the GPS coordinates in this field.

# 2.3 Habitat Quality Assessment Form

- 1. Desk-based assessments that can be done through GIS are shaded grey on the survey form.
- 2. Field-based assessments should be completed at the same sites as SEI verification.
- 3. Complete the form according to **Table 5**. Evaluate each variable/indicator and mark the check box containing the observed conditions.
  - a. Mark the percent cover of invasive species. If invasive species other than the 10 common ones shown in 0 are identified, include their presence in the percent cover estimate and record the species name in the notes section.
  - b. Mark the number of structural stages present (tree canopy, shrub cover, ground cover).
     Each vegetation layer must have ≥ 25% presence to be counted.
  - c. Mark the percentage of bare ground or disturbed areas.
- 4. Use the notes section to record additional information, such as the species of invasive plants present, etc.
- 5. Record any incidental observations such as wildlife, wildlife sign (e.g., tracks, scat), wildlife trees/snags, human activity, etc.
- 6. After the form is completed (both desk- and field-based work), tally up the total amount of points.

# SENSITIVE ECOSYSTEMS INVENTORY (SEI) FIELD FORM

					• ,									
Site accesse						Poly	go	n ID:			Surve	eyor(s):		
From distan	rom distance 🗌   Mapsheet:					Plot	ID	:						
Location:												Photo	os? 🗆	# photos:
UTM (start)	E	:			N:				Elev	atio	on:		Accu	racy:
UTM (end) E:					N: Eleva				atio	ation: Accur			racy:	
SEI Label: Condition				Rank:			Disturbance	e Code	e(s)	):				
			Dec	ile 1				Decile 2				Decile	e 3	
% of polygor	า													
SEI Class														
SEI Subclass														
Structural St	age													
% Stand con	npos	ition	С	9	6 D	%		C %	D		%	С	%	D %
Dominant	Tre	e												
Vegetation	Shr													
	Gro	ound												
Notes:														
HABITAT QUA	ידו וע	ν Δ <b>SS</b> I	SSMF	NT FIF	I D FOR	М					Tota	al amoi	unt of	points: (
Variable (Habit		0 po			1 point			2 points				ints	unic 01	Survey Type
Quality Indicat		Оро	11103		I point	•		2 points			3	,,,,,		Survey Type
Patch type		Clea	-ed		Landsc	aned [		Regenerate	h-d		Und	isturbed	d 🗆	Desk-based
r aton type		Cicai		_	Larrase	арса -	_	Remnant			Ona	istar set	<b>.</b> _	Desk Basea
Area size		N/A			< 10 ha	a [		10 – 50 ha	[		> 50	ha		Desk-based
Area/Perimet	er	N/A			< 50	[		50 – 200	[		> 20	0		Desk-based
ratio														
Vegetative co	ver	< 5%			5 - 33%	6 [		33 – 66%	[		> 66	%		Desk-based
Invasive speci	ies	N/A			> 10%			1 – 10%	[		< 1%	, 0		Field-based
cover														
Structural	-01	No			1 layer			2 layers	[		3 lay	ers/		Field-based
diversity (≥ 25 presence)	<b>o</b> %	vege	tation											
		<u> </u>		-		<u>-</u>		<u> </u>	<u> </u>	!			-	
Quality of		Who			Minima	•		Somewhat	[		Who	•		Desk-based
adjacency			npatible		compat		_	compatible		_		patible		5 1 1 1
Isolation inde Connectivity	Х	> 500	Jm		100 - 5			10 - 100 25 - 50%			< 10 ≥ 50			Desk-based Desk-based
Connectivity		0%			< 25%	L	_	25 – 30%	Į.		≥ 50	J%		Desk-based
Road presenc		≥ 4			N/A			1-3	[		0			Desk-based
(impact score														
Bare ground/		N/A			> 25%			1 – 25%	l		< 1%	ó		Field-based
disturbed														
Notes:														
Incidental Ob	serva	ations:												

# **Table 1. SEI Condition Ranking**

# 3.0 REFERENCE MATERIALS FOR SEI VERIFICATION

Adapted from: Meidinger, D., J. Clark, and D. Adamoski. 2014. Sensitive Ecosystem Inventory for Metro Vancouver & Abbotsford: 2010-2012 - Technical Report. Metro Vancouver.

SEI Class	Α	В	С	D	E
Riparian	<ul> <li>no unnatural edge</li> <li>no anthro disturbance evident</li> <li>natural hydrology</li> </ul>	<ul> <li>&lt; 25% unnatural edge</li> <li>possibly some anthro disturbance</li> <li>possibly slightly altered drainage or water level control</li> </ul>	<ul> <li>25 – 50% unnatural edge</li> <li>substantial anthro disturbance</li> <li>substantial drainage or water level control</li> </ul>	<ul> <li>50 – 75% unnatural edge</li> <li>substantial anthro disturbance</li> <li>sign't drainage or water level control</li> </ul>	<ul> <li>&gt; 75% unnatural edge</li> <li>sign't anthro disturbance</li> <li>severely disrupted hydrology</li> </ul>
Wetland – swamp (forested)	<ul> <li>old or mature forest</li> <li>no unnatural edge</li> <li>no disturbance</li> </ul>	<ul><li>old or mature forest</li><li>&lt; 35% unnatural edge</li><li>no disturbance</li></ul>	<ul> <li>old or mature forest and &gt; 35% unnatural edge; or young forest and &lt; 20% unnatural edge</li> <li>some disturbance</li> </ul>	<ul> <li>old or mature forest and &gt; 60% unnatural edge; or young forest and &lt; 50% unnatural edge</li> <li>moderate disturbance</li> </ul>	<ul> <li>young forest and &gt; 50% unnatural edge</li> <li>sign't disturbance</li> </ul>
Wetland – all others	<ul> <li>no unnatural edge</li> <li>no anthro disturbance evident</li> <li>natural hydrology</li> </ul>	<ul> <li>&lt; 25% unnatural edge</li> <li>possibly some anthro disturbance</li> <li>possibly slightly altered drainage or water diversion</li> </ul>	<ul> <li>25 – 50% unnatural edge</li> <li>moderate anthro disturbance</li> <li>substantial drainage or water diversion</li> </ul>	<ul> <li>50 – 75% unnatural edge</li> <li>substantial anthro disturbance</li> <li>substantial drainage or water diversion</li> </ul>	<ul> <li>&gt; 75% unnatural edge</li> <li>sign't anthro disturbance</li> <li>severely disrupted hydrology</li> </ul>
Lakes & Ponds Reservoirs	• n/a	• n/a	• n/a	• n/a	• n/a
Old Forest	<ul> <li>vo or co subclass</li> <li>no unnatural edge</li> <li>no disturbance</li> </ul>	vo or co subclass and < 20% unnatural edge, or     mx subclass and no     unnatural edge     no disturbance	<ul> <li>vo or co subclass and &lt; 50% unnatural edge, or mx subclass and &lt;20% unnatural edge</li> <li>some disturbance</li> </ul>	<ul><li>any subclass</li><li>&lt;75% unnatural edge</li><li>moderate disturbance</li></ul>	<ul><li>any subclass</li><li>&gt; 75% unnatural edge</li><li>sign't disturbance</li></ul>
Mature Forest SEI	<ul><li>co subclass</li><li>no unnatural edge</li><li>no disturbance</li></ul>	co subclass and < 20% unnatural edge, or mx subclass and no unnatural edge     no disturbance	<ul> <li>co subclass and &lt; 50% unnatural edge; or mx subclass and &lt;20% unnatural edge</li> <li>possibly some disturbance</li> </ul>	<ul><li>any subclass</li><li>&lt;75% unnatural edge</li><li>moderate disturbance</li></ul>	<ul><li>any subclass</li><li>&gt; 75% unnatural edge</li><li>sign't disturbance</li></ul>
Young Forest	<ul><li>co subclass</li><li>no unnatural edge</li></ul>	• co subclass and < 20% unnatural edge, or mx	• co or mx subclass and < 50% unnatural edge; or	• co or mx subclass and < 75% unnatural edge; or	<ul><li>any subclass</li><li>&gt; 75% unnatural edge</li></ul>

# **Table 1. SEI Condition Ranking**

SEI Class	Α	В	С	D	E
	no disturbance	subclass and no unnatural edge • no disturbance	<ul><li>bd subclass and &lt;20%</li><li>edge</li><li>possibly some</li><li>disturbance</li></ul>	<ul><li>bd subclass and &lt;50%</li><li>edge</li><li>moderate disturbance</li></ul>	sign't disturbance
Woodland	<ul><li>trees old</li><li>no unnatural edge</li><li>no disturbance</li></ul>	<ul> <li>trees mature and no unnatural edge; or trees old and &lt; 20% unnatural edge</li> <li>no or some disturbance</li> </ul>	<ul> <li>trees old or mature and</li> <li>50% unnatural edge;</li> <li>or trees young and </li> <li>20% unnatural edge</li> <li>some disturbance</li> </ul>	<ul> <li>trees old or mature and</li> <li>75% unnatural edge;</li> <li>or trees young and </li> <li>50% unnatural edge</li> <li>mod. disturbance</li> </ul>	<ul> <li>trees old or mature and</li> <li>75% unnatural edge;</li> <li>or trees young and &gt;</li> <li>50% unnatural edge</li> <li>sign't disturbance</li> </ul>
Herbaceous	<ul><li>no unnatural edge</li><li>no anthro disturbance evident</li></ul>	<ul><li>&lt; 25% unnatural edge</li><li>possibly some anthro disturbance</li></ul>	<ul> <li>25 – 50% unnatural edge</li> <li>moderate anthro disturbance</li> </ul>	<ul> <li>50 – 75% unnatural edge</li> <li>substantial anthro disturbance</li> </ul>	<ul><li>&gt; 75% unnatural edge</li><li>sign't anthro disturbance</li></ul>
Alpine	<ul><li>no unnatural edge</li><li>no anthro disturbance evident</li></ul>	<ul><li>&lt; 25% unnatural edge</li><li>possibly some anthro disturbance</li></ul>	<ul> <li>25 – 50% unnatural edge</li> <li>moderate anthro disturbance</li> </ul>	<ul> <li>50 – 75% unnatural edge</li> <li>substantial anthro disturbance</li> </ul>	<ul><li>&gt; 75% unnatural edge</li><li>sign't anthro disturbance</li></ul>
Sparsely vegetated	<ul><li>no unnatural edge</li><li>no anthro disturbance evident</li></ul>	<ul><li>&lt; 25% unnatural edge</li><li>possibly some anthro disturbance</li></ul>	<ul> <li>25 – 50% unnatural edge</li> <li>moderate anthro disturbance</li> </ul>	<ul> <li>50 – 75% unnatural edge</li> <li>substantial anthro disturbance</li> </ul>	<ul><li>&gt; 75% unnatural edge</li><li>sign't anthro disturbance</li></ul>
Karst	<ul><li>no unnatural edge</li><li>no anthro disturbance evident</li></ul>	<ul><li>&lt; 25% unnatural edge</li><li>possibly some anthro disturbance</li></ul>	<ul> <li>25 – 50% unnatural edge</li> <li>moderate anthro disturbance</li> </ul>	<ul> <li>50 – 75% unnatural edge</li> <li>substantial anthro disturbance</li> </ul>	<ul><li>&gt; 75% unnatural edge</li><li>sign't anthro disturbance</li></ul>
Estuarine	<ul><li>no unnatural edge</li><li>no anthro disturbance evident</li></ul>	<ul><li>&lt; 25% unnatural edge</li><li>possibly some anthro disturbance</li></ul>	<ul> <li>25 – 50% unnatural edge</li> <li>moderate anthro disturbance</li> </ul>	<ul> <li>50 – 75% unnatural edge</li> <li>substantial anthro disturbance</li> </ul>	<ul><li>&gt; 75% unnatural edge</li><li>sign't anthro disturbance</li></ul>
Intertidal & shallow sub-tidal	<ul><li>no unnatural edge</li><li>no anthro disturbance evident</li></ul>	<ul><li>&lt; 25% unnatural edge</li><li>possibly some anthro disturbance</li></ul>	<ul> <li>25 – 50% unnatural edge</li> <li>moderate anthro disturbance</li> </ul>	<ul> <li>50 – 75% unnatural edge</li> <li>substantial anthro disturbance</li> </ul>	<ul><li>&gt; 75% unnatural edge</li><li>sign't anthro disturbance</li></ul>
Seasonally flooded agriculture fields	• n/a	• n/a	• n/a	• n/a	• n/a
Old field	• n/a	• n/a	• n/a	• n/a	• n/a

**Table 1. SEI Condition Ranking** 

SEI Class	Α	В	С	D	E
					•
Manicured Parks (Optional)	Sports, recreational field, park, or child's playground that is well-integrated with trees and/or shrubs (>25%), with vertical stratification, including many mature trees	Sports, recreational field, park, or child playground well integrated with trees and/or shrubs (>25%)	Sports, recreational field, park, or child playground with trees and shrubs around outside (10-25%)	Sports, recreational field, park, or child playground with minimal trees and shrubs around outside (<10%)	Sports, recreational field, park, or child playground with no trees or shrubs. May have some cement or impervious surfaces along with grass.

Abbreviated terms: anthro = anthropogenic, sign't = significant

# **Table 2. Disturbance Codes**

#### A. Atmosphere-related effects

Use these codes if causative factors are no longer in effect or are isolated incidents.

e. climatic extremes

co extreme cold

ht extreme heat

**gl** glaze ice

**ha** severe hail

sn heavy snow

**p.** atmospheric pollution

ac acid rain

to toxic gases

w. windthrow

#### **B.** Biotic effects

- b. beaver tree cutting
- d. domestic grazing/browsing
- w. wildlife grazing/browsing
- **e.** excrement accumulation (other than that normally

associated with grazing/browsing)

i. insects

- **p.** disease
- t. turbation (soil)
- v. aggressive vegetation

#### D. Disposals

- c. chemical spill or disposal
- e. effluent disposal
- **g.** domestic garbage disposal
- o. oil spill or disposal
- r. radioactive waste disposal or exposure

#### F. Fires

- c. overstorey crown fire
- g. light surface (ground) fire
- r. repeated light surface fires
- s. severe surface fire
- i. repeated severe surface fires

#### I. burning of logging slash

# H. Human developments and

ag. agriculture

com. commercial

con. construction, unknown

type

infrastructure

fld. sports field

glf. golf course

grd. manicured gardens

ind. industry

rail. railway, active

rds. roads

rec. recreation (including trails)

res. residential

row. right-of-way

#### L. Forest harvesting

- I. land clearing (including abandoned agriculture)
- a. patch cut system
- c. clearcut system (if slashburned, see also "Fires")
- **d.** seed tree system

**un** uniform

gr grouped

**e.** selection system

gr group selection

si single tree

st strip

s. shelterwood system

**un** uniform

gr group

st strip

ir irregular

na natural

**nu** nurse tree

o. coppice

#### M. Plant or site modification effects

- c. herbicide use (chemical)
- f. fertilization (specify type under "Notes")
- i. irrigation
- g. seeded or planted to grasses
- h. seeded or planted to herbs
- s. planted or seeded to shrubs
- t. planted or seeded to trees

# P. Gathering or removal of plant products

- f. firewood gathering
- m. mushrooms
- o. moss
- s. shrubs (e.g., salal, falsebox)
- x. other (specify under "Notes")

#### S. Soil disturbance

- a. cultivation (agricultural)
- **c.** compaction
- **g.** gouging (> 5 cm into mineral soil)
- s. scalping (forest floor removed)
- f. sidecast/fill
- r. road bed, abandoned
- t. railway, abandoned
- e. excavation
- m. mining effects

**pt** placer tailings

rq rock quarrying (including open pit

mines)

ta tailings

**p.** mechanical site preparation

**bb** brush blading

**ds** drag scarification

(anchor chain or shark fin)

dt disc trenching

md mounding
ps patch scarification
vp V-plowing
xx other (specify under
"Notes")

#### T. Terrain-related effects

- a. avalanche
- d. recent deglaciation
- **e.** eolian (active deflation or deposition)
- s. terrain failures (active/recent slumps, slides, solifluction, etc.)

#### W. Water-related effects

- i. inundation (including temporary inundation resulting from beaver activity)
- s. temporary seepage (usually artificially induced; excludes intermittent seepage resulting from climatic conditions)
- **d.** water table control (diking, damming)
- e. water table depression
  (associated with extensive
  water extraction from wells)

#### X. Miscellaneous

(For other disturbance types, enter "X" and describe under "Notes")

#### Riparian (RI)

Ecosystems associated with and influenced by freshwater, generally along rivers, streams, and creeks, but for SEI, also includes fringes around lakes. Ecosystems are influenced by factors such as erosion, sedimentation, flooding and/or subterranean irrigation due to proximity to the water body. This Class includes all vegetation developmental stages, i.e., structural stages 1 through 7, but only in a natural or semi-natural state.

#### **Subclasses:**

**fl** – low bench floodplain: flooded at least every other year for moderate periods of growing season; plant species adapted to extended flooding and abrasion, low or tall shrubs most common.

**fm** – medium bench floodplain: flooded every 1-6 years for short periods (10-25 days); deciduous or mixed forest dominated by species tolerant of flooding and periodic sedimentation.

**fh** – high bench floodplain: only periodically and briefly inundated by high waters, but lengthy subsurface flow in the rooting zone; typically conifer-dominated floodplains of larger coastal rivers.

**ff** – fringe: narrow linear communities along open water bodies (rivers, lakes and ponds) where there is no floodplain – see Appendix 1 for mapping guidelines.

**gu** – gully riparian: watercourse is within a steep sided V-shaped gully or ravine; generally only minimal area of flooding but gully is important due to proximity to water and sensitive due to steeper slopes.

**ca** – canyon: watercourse is within a steep sided U-shaped canyon; generally only minimal area of flooding but canyon is important due to proximity to water, steep valley walls, and somewhat unique microclimate of canyon.

**ri** – river: river and associated gravel bars, if wide enough to be mapped.

#### Wetland (WN)

Wetland ecosystems are found where soils are saturated by water for enough time that the excess water and resulting low oxygen levels influence the vegetation and soil. The water influence is generally seasonal or year-round and occurs either at or above the soil surface or within the root zone of plants. Wetlands are usually found in areas of flat or undulating terrain. They encompass a range of plant communities that includes western redcedar/skunk cabbage swamps, cattail marshes, and peat-moss dominated bogs. Estuarine vegetation is in a separate Class for this SEI to emphasize the different flooding frequency (mostly diurnal) and water chemistry (brackish). Therefore, the wetland class is for freshwater wetlands.

#### **Subclasses:**

**bg** — bog: acidic, nutrient-poor wetlands that characteristically support peat-mosses and ericaceous shrubs such as Labrador tea and bog-rosemary. Being generally isolated from mineral rich groundwater or surface water, their primary source of water and nutrients is from rainfall.

fn – fen: underlain by sedge or brown moss peat, fens are closely related to bogs. In addition to rainfall, fens receive mineral and nutrient-enriched water from upslope drainage or groundwater. Thus a broader range of plants, including shrubs and small trees, is able to grow.

ms – marsh: characterized by permanent or seasonal flooding by nutrient-rich waters. May include some areas of diurnal flooding of fresh water above the normal high high-tide, due to high river water levels. Examples include freshwater marshes that are dominated by rushes, sedges or grasses.

**sp** – swamp: wooded wetlands dominated by 25% or more cover of flood-tolerant trees or shrubs. Characterized by periodic flooding and nearly permanent sub-surface waterflow through mixtures of

mineral and organic materials, swamps are high in nutrient, mineral and oxygen content.

**sw** – shallow water: wetlands characterized by water less than 2 m in depth in mid-summer; transition between deep water bodies and other wetland ecosystems (i.e. bogs, swamps, fens, etc.); often with vegetation rooted below the water surface.

**wm** – wet meadow: wetlands that receive water from run-off or seepage – periodically saturated but not inundated with water; vegetation a grassy overall mixture of moisture-tolerant grasses, low sedges, rushes and forbs.

#### **Lakes & Ponds (FW)**

Freshwater ecosystems include bodies of water such as lakes and ponds that usually lack floating vegetation.

#### Subclasses:

 ${f la}$  — lake: naturally occurring, static body of open water greater than 2 m deep and generally greater than 50 ha, with little to no floating vegetation

**pd** – pond: naturally occurring, small body of open water, greater than 2 m deep and generally less than 50 ha, with little to no floating vegetation.

# **Old Forest (OF)**

Generally conifer-dominated forest with complex vertical structure, where the canopy tree ages are mostly 250 years old or older, but may include older mixed coniferous stands. Old broadleaf stands are unlikely to occur in Metro Vancouver.

#### Subclasses:

**co** – conifer-dominated forest stands (>75% conifer composition) where canopy tree ages mostly 250 – 400 years old.

mx – mixture of coniferous and broadleaf trees (<75% coniferous and < 75% broadleaf composition) where canopy tree ages mostly 250 – 400 years old.

vo – very old: canopy trees are mostly 400 years old or older.

#### **Mature Forest (MF)**

Forests generally >80 yrs old and < 250 yrs old. Mature forests are not as structurally complex as old forests, but can function as essential habitat areas for many wildlife species and as primary connections between ecosystems in a highly fragmented landscape. A minimum polygon size of 5 ha is proposed for inclusion in the MF sensitive ecosystem class. MF polygons of <5ha would be considered Other Important ecosystems.

#### **Subclasses:**

co – conifer dominated (> 75% coniferous species).

**mx** – mixed conifer and deciduous (<75% coniferous and < 75% broadleaf composition).

# Woodland (WD)

Woodlands are open forests, generally between 10 and 30% tree cover, as a result of site conditions, i.e., they are ecological woodlands. They are found on dry sites, mostly on south facing slopes of rocky knolls and bedrock-dominated areas. The stands can be conifer dominated or mixed conifer and arbutus (or deciduous hardwoods, e.g., Garry oak) stands and because of the open canopy, will often include non-forested openings, generally on shallow soils and bedrock outcroppings.

#### Subclasses:

**co** – conifer dominated ecological woodlands (greater than 75% coniferous composition).

mx – mixed conifer and broadleaf ecological woodlands (minimum of 25% composition of each group comprises the total tree cover)

#### Herbaceous (HB)

This class comprises non-forested ecosystems (i.e., less than 10% tree cover), generally associated with shallow soils, often with bedrock outcroppings, coarse-textured soils, or natural disturbances (wind or wave action); includes a variety of natural ecosystems such as large, bedrock-controlled openings within forested areas, coastal headlands, shorelines vegetated with grasses and herbs, sometimes low shrubs, and moss and lichen communities on rock outcrops.

#### Subclasses:

**hb** – herbaceous: central concept of the category; non-forested, less than 10% tree cover, generally shallow soils, often with exposed bedrock; predominantly a mix of grasses and forbs, but also lichens and mosses.

cs – coastal herbaceous: criteria as for 'hb' but influenced by proximity to ocean; windswept shoreline and slopes; > 20% vegetation of grasses, herbs, mosses and lichens.

vs – vegetated shoreline: low-lying rocky shoreline, soil pockets in rock cracks and crevices; salt-tolerant vegetation, generally with < 20% vegetation cover.

**sh** – shrub component: > 20 % of total vegetation cover is shrub cover, with grasses and herbs.

# **Sparsely Vegetated (SV)**

Areas of low vascular vegetation cover, generally 5 - 10 percent, but may be greater in some areas; may have high cover of mosses, liverworts and lichens.

#### Subclasses:

**cl** – cliff: steep to very steep slopes, often with exposed bedrock; may include steep-sided sand bluffs.

**ro** – rock outcrop: exposed bedrock, usually at the top of knolls or on portions of steeper slopes.

ta – talus: generally steep slopes comprised of rubbly blocks of rock.

**st** – spit: finger-like extension of beach, comprised of sand or gravel deposited by longshore drifting; low to moderate cover of salt-tolerant grasses and herbs.

**sd** – sand dunes: ridge or hill, or beach area created by windblown sand; may be more or less vegetated depending on depositional activity; beach dunes will have low cover of salt-tolerant grasses and herbs.

#### Estuarine (ES)

Estuarine ecosystems are found at the confluence of rivers with the sea where they are influenced by occasional or diurnal tidal inundation and brackish water. The vegetation reflects the brackish water conditions to varying degrees, depending on the position in the estuary and the magnitude of freshwater outflow. Estuarine ecosystems are distinguished from intertidal ecosystems by the degree of freshwater input – intertidal ecosystems are influenced by saltwater tidal inundation with little to no freshwater input, except by rainfall runoff.

#### **Subclasses:**

**sp** — estuary swamp: treed or shrubby ecosystems in brackish lagoons, on channel and estuary edges with occasional tidal flooding and waterlogged, slightly saline soils

**md** – estuary meadow: found in the high intertidal zone of estuaries where tidal flooding occurs less frequently than daily and is tempered by freshwater mixing. Species composition is relatively diverse, typically with a mix of graminoids and forbs.

**ms** – estuary marsh: intertidal ecosystem that is flooded and exposed during most tidal cycles; usually simple communities dominated by salt-tolerant emergent graminoids and succulents.

**tf** – estuary tidal flat: large flats of silts, sands or pebbles, flooded and exposed in most tidal cycles; macroalgae common.

#### Intertidal & Shallow sub-tidal (IT)

Mudflats, beaches and rocky shorelines influenced by diurnal tidal cycles with little to no freshwater input (primarily through rainfall runoff). The intertidal ecosystems link the marine and terrestrial environments.

#### Subclasses:

mf – mudflats, non-vegetated or varying amounts of algae

**bs** – beaches and shorelines, well- to sparsely-vegetated or non-vegetated

el - intertidal & shallow subtidal eelgrass beds

## Alpine (AP)

Ecosystems above or near tree-line – mostly non-forested but includes treed islands and windblown, shrubby treed patches termed krummholz.

#### **Subclasses:**

**hb** – herbaceous: alpine or high subalpine ecosystems dominated by forb or graminoid vegetation.

**kr** – krummholz: alpine ecosystems dominated by trees with shrubby, 'windblown' form

**pf** – parkland forest: ecosystems in the high subalpine, near treeline, where trees are mostly erect and occur in distinct patches or clumps

**sh** – shrub: alpine ecosystems dominated by dwarf shrubs

**av** – avalanche tracks: subalpine ecosystems influenced by repeated snow avalanches; shrub or herb dominated.

#### Karst (KA)

Karst topography is a landscape shaped by the dissolution of soluble bedrock, usually carbonate rock such as limestone, dolomite or marble. Although karst may include considerable areas of caves and underground rivers/streams, karst as a sensitive ecosystem is intended to delineate areas of distinctive surface features, e.g., sinkholes, cave openings, and other distinctive erosion features. These areas may contain rare species and are sensitive to disturbance.

#### **Other Important Ecosystems**

Other Important Ecosystems are mapped to identify important elements of biodiversity or recruitment sites for ecosystems at risk or important wildlife habitat requiring recovery or restoration.

#### Seasonally Flooded Agricultural Fields (FS)

Seasonally Flooded Agricultural Fields are lands that have been modified for agricultural use, but have important wildlife habitat value during specific times of the year. These fields are located primarily in low-lying areas such as valley bottoms and deltas of large alluvial rivers and creeks. In some cases they are found on moisture-receiving sites, usually in association with lake shores, or lowlands adjacent to coastal bays. They are usually former wetlands, and in many cases, are located adjacent to surviving wetlands such as marshes, swamps, and wet meadows. In such cases, other environmental factors such as poor drainage or a high water table contribute to flooding during the winter, fall and rainy season. Mapping of this class will require the further development of criteria in order to consistently identify areas.

# **Mature Forest (MF)**

Forests generally >80 yrs old and < 250 yrs old. For **co** or **mx** stands, a polygon size of <5ha is proposed for inclusion as an Other Important ecosystem – polygons of greater size would be classified as a sensitive ecosystem.

Broadleaf-dominated (**bd**) polygons of any size are considered Other Important ecosystems. These mature forests are not as valuable as old forests as far as representing the at-risk ecosystems, but can be important habitat areas for many wildlife species and serve as primary connections between ecosystems in a highly fragmented landscape.

#### Subclasses:

co – conifer dominated (> 75% coniferous species).

**mx** – mixed conifer and deciduous (<75% coniferous and < 75% broadleaf composition).

**bd** – broadleaf dominated (>75% broad-leaved species).

#### **Young Forest (YF)**

Forests generally >30-40 yrs old and <80 yrs old. Young forests can be important habitat areas for many wildlife species and serve as primary connections between ecosystems in a highly fragmented landscape.

#### Subclasses:

co – conifer dominated (> 75% coniferous species).

**mx** – mixed conifer and deciduous (<75% coniferous and < 75% broadleaf composition).

**bd** – broadleaf dominated (>75% broad-leaved species).

# Old Field (OD)

Lands formerly cultivated or grazed but later abandoned. Old-field sites can provide important habitat for wildlife species in human-influenced landscapes. As an intermediate stage in succession, without management they will eventually become forest — some may have been wetlands where the drainage has been altered in order to farm. Further criteria need to be developed to guide mapping of this class.

## Reservoirs (FW)

Freshwater ecosystems include bodies of water such as lakes and ponds – reservoirs are included in the Freshwater Class but as an 'other important ecosystem'. Even though the natural hydrology of reservoirs is modified, they are still important freshwater habitat.

#### **Subclasses:**

**rs** – reservoir: artificial body of water behind a dam.

# **Table 4. Structural Stage**

**1 Sparse/cryptogam** Either the initial stages of primary succession, or a very early stage of cohort establishment following a stand-destroying disturbance, or a cryptogam community maintained by environmental conditions (e.g., bedrock, boulder fields, talus);

1a Sparse – less than 10% vegetation cover.

**1b Bryoid** – bryophyte-dominated.

1c Lichen – lichen-dominated.

**2 Herb** Early successional stage or a herb community maintained by environmental conditions (e.g., very wet, warm & dry, or late snow site) or disturbance (e.g., avalanche track, flooding, intensive grazing, animal burrowing); generally dominated by herbs (forbs, graminoids, ferns).

2a Forb-dominated – includes non-graminoid herbs and ferns.

**2b Graminoid-dominated** — includes grasses, sedges, reeds, and rushes.

**2c Aquatic** – floating or submerged plants dominate; (sedge communities

growing in marshes with standing water are classed as 2b).

**2d Dwarf shrub-dominated** — dominated by dwarf woody species such as kinnikinnick, dwarf willows, or mountain-heathers

**3 Shrub/Herb** Early successional stage or a shrub community maintained by environmental conditions (e.g., wet soils, cold air accumulation) or disturbance (e.g., avalanche track); tree cover sparse but tree seedlings and advance regeneration may be abundant; either dominated by shrubby vegetation, or if sparsely vegetated overall, shrub cover and stature characterizes the community as a shrubland.

**3a Low shrub** – dominated or characterized by shrubby vegetation < 2 m tall; time since disturbance < 20 years for normal forest succession; may be perpetuated indefinitely by environmental conditions (e.g., cold air basins) or disturbance.

**3b Tall shrub** – dominated or characterized by shrubby vegetation that is 2–10 m tall; time since disturbance < 40 years for normal forest succession; may be perpetuated indefinitely.

**4 Pole/Sapling** Trees > 10 m tall, typically densely stocked, and have overtopped shrub and herb layers; younger stands are vigorous (usually > 15—

20 years old); self-thinning and vertical structure are not yet evident in the canopy.

**5 Young Forest** Self-thinning has become evident and the forest canopy has begun to differentiate into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the Pole/Sapling stage; begins as early as age 30 (e.g., broadleaf or vigorous conifer stands) and extends to 50–80 years, depending on tree species and ecological conditions.

**6 Mature Forest** Trees established after the last stand-replacing disturbance have matured; a second cycle of shade-tolerant trees may have become established; shrub and herb understories become well developed as the canopy opens up.

**7 Old Forest** Stands of old age with complex structure; patchy shrub and herb understories are typical; regeneration is usually of shade-tolerant species with composition similar to the overstorey; long-lived seral species may be present in some ecosystem types or on edaphic sites. Old growth structural attributes will differ across biogeoclimatic units and ecosystems.

**7a Old Forest** Stands with moderately to well developed structural complexity; stands comprised mainly of shade-tolerant tree species in canopy and regeneration layers, although older seral trees from a disturbance such as fire may still dominate the upper canopy; fire-maintained stands may have a 'single-storied' appearance (see modifiers); time since stand replacing disturbance is generally 140 – 250 years.

**7b Very Old Forest** Very old stands having complex structure with abundant large-sized trees, snags and coarse woody debris (size is relative to the specific ecosystem); snags and CWD occur in all stages of decomposition; stands are comprised entirely of shade-tolerant overstorey species with well-established canopy gaps; time since stand-replacing disturbance generally > 250 years.

# APPENDIX 3. PHOTOGRAPHS OF COMMON INVASIVE SPECIES

Canada Thistle (Cirsium arvense)



"Canada Thistle Noxious Weed" by nature80020 at <a href="http://flic.kr/p/opNm7">http://flic.kr/p/opNm7</a>j. Licensed under CC BY 2.0.

# Giant Hogweed (Heracleum mantegazzianum)



"dsc\_078446-2017.06.24" by ChristianWernerZH at http://flic.kr/p/XWXRHo. Licensed under CC BY-SA 2.0.

# Scotch Broom (Cytisus scoparius)



Main photo: "Cytisus scoparius" by Björn S... at <a href="http://flic.kr/p/VutfG4">http://flic.kr/p/VutfG4</a>. Licensed under CC BY-SA 2.0. Inset photo: "Cytisus scoparius" by Andreas Rockstein at <a href="http://flic.kr/p/UAyih2">http://flic.kr/p/UAyih2</a>. Licensed under CC BY-SA 2.0.

# Bindweed or Morning Glory (Convolvulus arvensis)



"Convulvulus arvensis" by Matt Lavin at <a href="http://flic.kr/p/91AAAk">http://flic.kr/p/91AAAk</a>. Licensed under CC BY-SA 2.0.

# Purple Loosestrife (Lythrum salicaria)



"Purple Loosestrife Lythrum salicaria" by gailhampshire at <a href="http://flic.kr/p/gXUteG">http://flic.kr/p/gXUteG</a>. Licensed under CC BY 2.0.

# Japanese Knotweed (Reynoutria japonica)



Main photo: Reynoutria japonica (Public Domain). Inset photo: "Japanese knotweed young stems" by Scottish Invasive Species Initiative at <a href="http://flic.kr/p/2g6ak47">http://flic.kr/p/2g6ak47</a>. Licensed under CC BY 2.0.

# Himalayan Blackberry (Rubus armeniacus)



"starr-190930-6989-Rubus\_discolor-fruit\_leaves-Puu\_Nianiau-Maui" by Forest and Kim Starr at <a href="http://flic.kr/p/2i3qghb">http://flic.kr/p/2i3qghb</a>. Licensed under CC BY 2.0.

# Parrot's Feather (Myriophyllum aquaticum) (Aquatic)



"Myriophyllum aquaticum habit1" by Harry Rose at <a href="http://flic.kr/p/ojqWFW">http://flic.kr/p/ojqWFW</a>. Licensed under CC BY 2.0.

Reed Canarygrass (Phalaris arundinacea)



"Reed Canary Grass (Phalaris arundinacea) by Ryan Hodnett at http://flic.kr/p/Jpq7DX. Licensed under CC BY-SA 2.0.

# Yellow Flag Iris (Iris pseudacorus)



Main photo: "Thorpe Marshes Nature Reserve" by Jeremy Halls at <a href="http://flic.kr/p/toUe1a">http://flic.kr/p/toUe1a</a>. Licensed under CC BY-SA 2.0. Inset photo: "Iris pseudacorus" by Andreas Rockstein at <a href="http://flic.kr/p/UaXBVm">http://flic.kr/p/UaXBVm</a>. Licensed under CC BY-SA 2.0.

# APPENDIX C – 2020 FIELD SURVEYS AND DESK-BASED RESEARCH



# 2020 FIELD SURVEYS AND DESK-BASED RESEARCH

January 14, 2022

**PREPARED AND REVIEWED BY**Zoetica Environmental Consulting Services

**SUBMITTED TO**City of Pitt Meadows

c/o Colin O'Byrne 12007 Harris Rd Pitt Meadows, BC

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# **Revision History**

**Project Title:** Pitt Meadows EIMS

**Document Title:** 2020 Field Surveys and Desk-based Research

Rev. Number	Issue Date	Description	Prepared By	Checked By	Approved By
A000	26-Feb-2021	Summary of 2020 field surveys and desk-based research	C. Chui	D. MacKinnon	H. Bears
R000	14-Jan-2022	Revised for Final EIMS Report	C. Chui	D. MacKinnon	H. Bears

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# 1.0 INTRODUCTION

The current Appendix summarizes the desk- and field-based research conducted by Zoetica to fill gaps identified as important and feasible within the budget and timeline of the City of Pitt Meadows Environmental Inventory and Management Strategy (EIMS) project. Investigations included relative salmon productivity mapping (Section 2.0), breeding bird surveys (Section 3.0), aquatic eDNA metabarcoding analyses (Section 4.0), and invasive vegetation (Section 5.0). Recommendations for additional baseline data collection and/or monitoring for each program are also described in this Appendix. Refer to Section 5.0 of the *Pitt Meadows EIMS Final Report* for a detailed discussion of management and monitoring recommendations.

# 2.0 RELATIVE SALMON PRODUCTIVITY MAPPING

# 2.1 Introduction

As the engagement feedback received indicated that the community and focus group members place a high importance on salmon, salmon escapement (productivity) was analyzed and mapped across the study area to produce a starting point for prioritization of conservation and restoration work focused on salmon. The value of fish travel corridors as migratory necessities was also contemplated and ranked based on the key habitats that they connect. Protecting waterbodies and adjacent riparian vegetation along waterways that contribute the largest numbers of salmon to the study area and regional area will result in benefits to many community members and First Nations. The same exercise could be done for rearing and holding sites, or for habitat of importance to eulachon, sturgeon, and other species of importance to community members and First Nations; however, due to a lack of systematically collected data across the study area, this was not possible at the time of the EIMS. The mapping of such areas in a systematic fashion is identified as an important data gap that should be undertaken by Fisheries and Oceans Canada (DFO) in the larger Lower Fraser region. Zoetica notes, however, that the relative distribution of high value habitat calculated and mapped for salmon in this section generally coincides with knowledge of the relative importance of many of the same aquatic systems for white sturgeon, although some differences between the species are expected seasonally. Therefore, salmon-focused conservation and restoration efforts are likely to benefit many of these other species.

# 2.2 Methods

To create relative salmon productivity maps, long-term datasets were first analyzed and converted to a mapped product over the whole of the Lower Fraser region; maps for Pitt Meadows were then created, such that they represent salmon ranks relative to the larger Lower Fraser system. For a more detailed discussion of how Salmon Index values were derived across the study area, refer to Appendix B of Zoetica and LFFA (2020). Briefly, the 2017 New Salmon Escapement Database System (NuSEDS) data were used and assigned values for average salmon productivity over time, according to the current and previous capacities of each watercourse. Prior to mapping these data, raw NuSEDS data were first refined by removing statistical outliers (erroneous years), which DFO confirmed were likely human error in the dataset. Reach estimates were also combined in certain years, where appropriate, based on detailed consultations with DFO during the technical review process (Tracy Cone, Pers. Comms., throughout March 2019). Once outliers were removed, averages per watercourse per species were calculated from 1938-2017 for sockeye, chum, coho, pink, and chinook salmon. A longer time period was utilized to account for

fluctuations in numbers known to occur over time, and because the use of a longer time series means that habitats that were previously important to very large numbers of salmon, and that can perhaps be restored to functional spawning habitats, will still be recognized as having some value on final maps where reaches are averaged over time.

The use of the NuSEDS dataset for creating the salmon productivity maps comes with important caveats. First and foremost, the practices and methods for conducting salmon spawner counts have changed substantially over the past 80 years. Visual surveys (walk, snorkel, boat), including aerial counts (helicopter, fixed-wing), are commonly used to provide general estimates, while mark recapture studies and fixed weir and fence counts provide more precise estimates (Tompkins and Baxter 2015). From the 1950s to 1990s, spawner escapement values were recorded on a single form that included the annual estimate, enumeration methods used, estimate reliability, and stream conditions. However, the nowantiquated Fortran database could not store the information on methods used, and so these details were lost (Baxter 2016). In 1995, the database was recreated to allow descriptive information; however, for most estimates from the 1950s to 2000, the methods were still unspecified and there can be variation in the methods used and reliability of estimate (Baxter 2016).

Sampling frequency was also generally selective. Some areas known to be more productive were focused on, while others were never measured. Smaller and less accessible streams tended to be given a lower priority for surveillance (McDougall 1987), while streams containing commercially valuable species were prioritized and received more survey effort historically. At present, not all salmon populations are assessed, and the scale of assessment can vary depending on the species. For example, Fraser pink salmon were historically determined for broad watersheds, but since 2003 there is only a single value for the entire Fraser River. Chum data are also considered patchy with many years devoid of surveys for certain watercourses. Sockeye data are more reliable, although pre-1950s data are more uncertain. Chinook data are somewhat reliable with some gaps. Overall, a comparison of mean abundance values over decades is more reliable than single years (Baxter 2016). Because of these limitations, outliers were removed to refine the data, while still retaining as much information as possible. The collection of high quality systematic or randomized spawner abundance data for salmon was also identified as a key data gap for the DFO to undertake, particularly for pink and chum salmon. However, data that are currently available can be used to paint a preliminary picture of spawning abundance and relative habitat rankings across space, with these caveats in mind. As the NuSEDS data are the only Pacific salmon data available for this type of freshwater analysis of relative fisheries productivity at the regional scale, its use is a necessary starting point.

Next, six Spawner Abundance Categories (Very Low, Low, Moderate-Low, Moderate, High, and Very High), were created based on the average and range of NuSEDS data (Max Estimate) for each species of salmon. The resulting categories for each species are shown in **Table 2-1**. Categories were scaled based on average abundances for each species to account for differences between species. For example, a large average escapement size for coho is 1,800 spawners, while a large average escapement size for pink salmon is 26,600 spawners. Note that numbers are based on average values for a given location, whereas salmon spawning can be much greater in a single peak year (on the order of several million), depending on population cycles (Henderson and Graham 1998). This spawner abundance classification system is similar to classification systems used by Bell-Irving (1978) and McDougall (1987), who also designed categories for each species ranging from low to high; however, ranked values are specific to data within the study area, and included the most up-to-date spawning data at the time.

**Table 2-1.** Salmon Spawner Abundance Categories for each species of salmon.

	Very Low (1)	<b>Low</b> (2)	Moderate-Low (3)	Moderate (4)		
Sockeye	<200	200-1,800	1,800-3,400	3,400-5,000 5,000-6,600		>6,600
Chum	<200	200-2,000	2,000-3,800	3,800-5,600 5,600-7,400		>7,400
Coho	<100	100-525	525-950	950-1,375 1,375-1,800		>1,800
Pink	<300	300-6,875	6,875-13,450	13,450-20,025 20,025-26,600		>26,600
Chinook	<100	100-375	375-650	650-925	925-1,200	>1,200

An analysis of standard deviations and a statistical cluster analysis conducted in SPSS (see Appendix B, Section 2 in Zoetica and LFFA, 2020) revealed several waterbodies with extremely high spawner counts for each salmon species (e.g., Fraser River), which are considered "outlier systems". If a single linear scale system was utilized to map all waterbodies, most would fall at the extreme low end or the extreme high end of a very wide numerical scale that would render data unmappable; many categories (resulting in a lengthy map legend), would fall between low and high values and would have no representative waterbodies. Furthermore, the use of a single linear scale could create a situation where only one or two areas (with extremely productive watercourses) end up designated as priorities for fisheries conservation and restoration work, with none in other areas. Therefore, a second ranked scale system for each species within areas considered to be outliers was produced (i.e., for areas that were extremely more productive than other areas; e.g., Fraser River) (Table 2-2). Both scales were then consolidated into one scale system, skipping unrepresented values in between, and with some additional considerations. More information on analyses to convert salmon numbers to categories is provided in Appendix B of Zoetica and LFFA (2020).

Table 2-2. Salmon Spawner Abundance Categories for outlier data.

	Very Low (1)	<b>Low</b> (2)	Moderate-Low (3)	Moderate (4)	<b>High</b> (5)	Very High (6)
Sockeye	14,945- 16,526	16,526- 18,107	18,107-19,689	19,689-21,270	21,270-22,851	22,851-24,432
Chum	31,721- 43,350	43,350- 54,979	54,979-66,608	66,608-78,236	78,236-89,865	89,865- 101,494
Coho	4,284-5,795	5,795-7,306	7,306-8,817	8,817-10,328	10,328-11,839	11,839-13,351
Pink	308,046- 434,289	434,289- 560,532	560,532- 686,774	686,774- 813,017	813,017- 939,260	939,260- 1,065,502
Chinook	35,372- 44,534	44,534- 53,696	53,696-62,858	62,858-72,020	72,020-81,182	81,182-90,344

Within the recommended framework, other ranking categories for streams were also incorporated that did not have salmon spawning data available from NuSEDS, yet may be fish-bearing, as well as streams

that feed into fish-bearing waters. The 'Known BC Fish Observations and BC Fish Distributions' dataset from DataBC (accessed in 2017) were used to identify additional salmon-bearing watercourses, where at least one type of salmon (chum, pink, sockeye, chinook, or coho) had been observed; these watercourses were given a rank of 3. Watercourses with slopes of <20%, but with no available records of salmon, were given a ranked value of 2, as these areas are considered capable of supporting salmon or salmon movements, as their slope renders them accessible to fish (BC MOF 1998). Watercourses upstream of important fish habitat that do not contain fish were given a value of 1 rather than 0, as they provide indirect value in providing cool water and nutrients downstream. The resulting Overall Salmon Productivity Ranking Framework has 11 major rankings (**Table 2-3**), which were mapped across the study area. Maps can be modified in the future with input from First Nations groups that may have more reliable species-specific information for certain locations (e.g., salmon in areas traditionally fished by the Katzie First Nation).

After mapping these categories (**Table 2-3**), ranks were adjusted to incorporate salmon migration (spawning access). All watercourses leading up to a very high-ranking stream were also ranked equivalently high, up to the point where the tributary branches. This adjustment is needed to account for the migration process, where passage through larger rivers and streams on the way to spawning grounds must be maintained. In addition, the Fraser River was upgraded to 11, due to its critically important connection to the Harrison River, which also has a rank of 11. This adjustment is recommended for the Fraser River due to its importance as a migration route, even though spawner abundance records in the Fraser itself were not as high. Extending the ranking of 11 along the entire length of the Fraser River is also recommended due to the exceptional ecological importance of this corridor for access to numerous spawning tributaries, including the upper Fraser River tributaries beyond the study area boundary.

**Table 2-3.** Species-Specific Salmon Productivity Ranking (NOTE: use Table 2-1 and Table 2-2 to convert category numbers in those tables to salmon abundance values on a species-specific basis).

Species-Specific Productivity Ranking	Description and rationale
11	Watercourses with <i>Outlier</i> Spawner Abundance Category 5-6
10	Watercourses with <i>Outlier</i> Spawner Abundance Category 3-4
9	Watercourses with <i>Outlier</i> Spawner Abundance Category 1-2
8	Watercourses with Spawner Abundance Category 6
7	Watercourses with Spawner Abundance Category 5
6	Watercourses with Spawner Abundance Category 4
5	Watercourses with Spawner Abundance Category 3
4	Watercourses with Spawner Abundance Category 2
3	Watercourses with Spawner Abundance Category 1 or other watercourses where at least spawner presence of the salmon species of interest has been observed
2	Watercourses with gradients <20% (considered accessible to fish) or streams that have other species of salmon besides the species of interest

1	Small streams and tributaries upstream of fish-bearing watercourses (with gradients
	>20%)

Once species-specific ranked values were created for typical streams (**Table 2-1**), as well as for outlier systems (**Table 2-2**), the framework shown in **Table 2-3** was used to create a series of species-specific salmon productivity maps. To create **Table 2-3**, the outlier watercourses were separated out. Streams without NuSEDS data were considered to be salmon-bearing where at least one type of salmon had been observed. Some rankings were also further adjusted to incorporate spawning access considerations (migration). Streams where none of the species of interest were found, but where other salmon species are present, were given a value of 2, which was the same as watercourses with gradients less than 20% that are accessible to fish. A value of 1 was assigned to upstream watercourses with slopes that are generally too steep for fish to access (>20%) but that feed into downstream fish-bearing habitat. The resulting species-specific Salmon Productivity ranking has 11 categories (**Table 2-3**), which were mapped across the study area.

The species-specific maps will allow users to view and select areas that are productive for a given salmon species (chum, coho, sockeye, chinook, pink). For example, looking at sockeye alone would allow users to take into consideration areas important to this species, which is comparatively more diverse (has more Conservation Units in the study area), and may be more critical to protect, particularly under the lens of prioritizing diversity. From another perspective, and depending on how climate change progresses, it may also be preferable to focus on protecting the hardiest species. According to PFRCC (1999), chinook have the highest preferred temperature range (up to 15 °C); therefore, they may be more resistant to higher average water temperatures. Chinook were also noted by Brett (1952) as being more temperature resistant than the other Pacific salmon species. Having species-specific maps will allow map users the flexibility to view detailed information specific to their perspective/objectives.

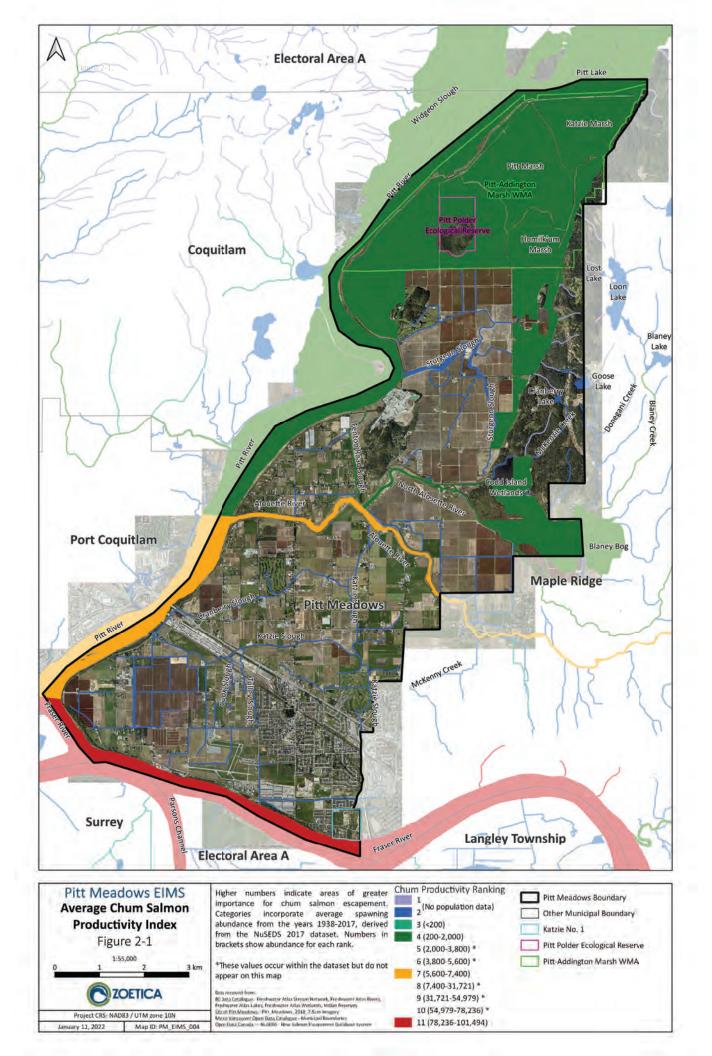
# 2.3 Results and Discussion

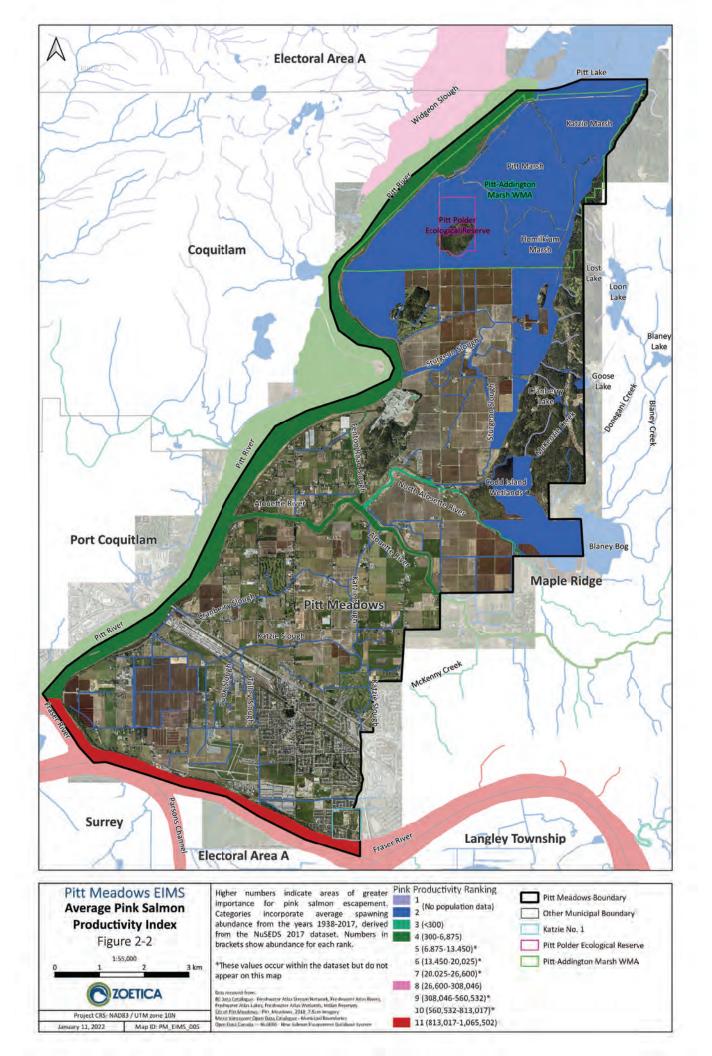
**Figure 2-1** through **Figure 2-5** show the resulting species-specific maps produced, prior to any edits made as a result of First Nation feedback. Note that the maps include spawning abundance data from NuSEDS spanning 1938-2017, and changes in the landscape during this time are not accounted for. As such, some areas that have since been modified (e.g., via installation of flood infrastructure, conversion of wetlands for other land uses) are still presented with their historically high salmon productivity rankings.

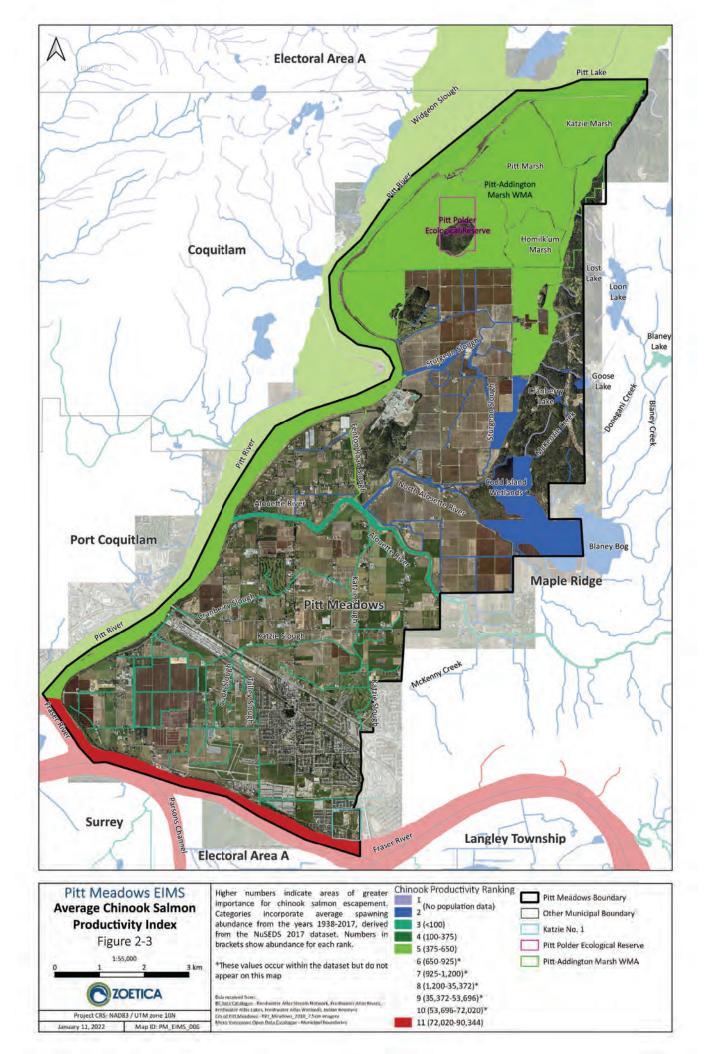
The Combined Salmon Productivity map, which considers information about all salmon species and salmon diversity on a single map for ease of decision-making, was also created and is shown in Figure 4-19 in the *Pitt Meadows EIMS Final Report*.

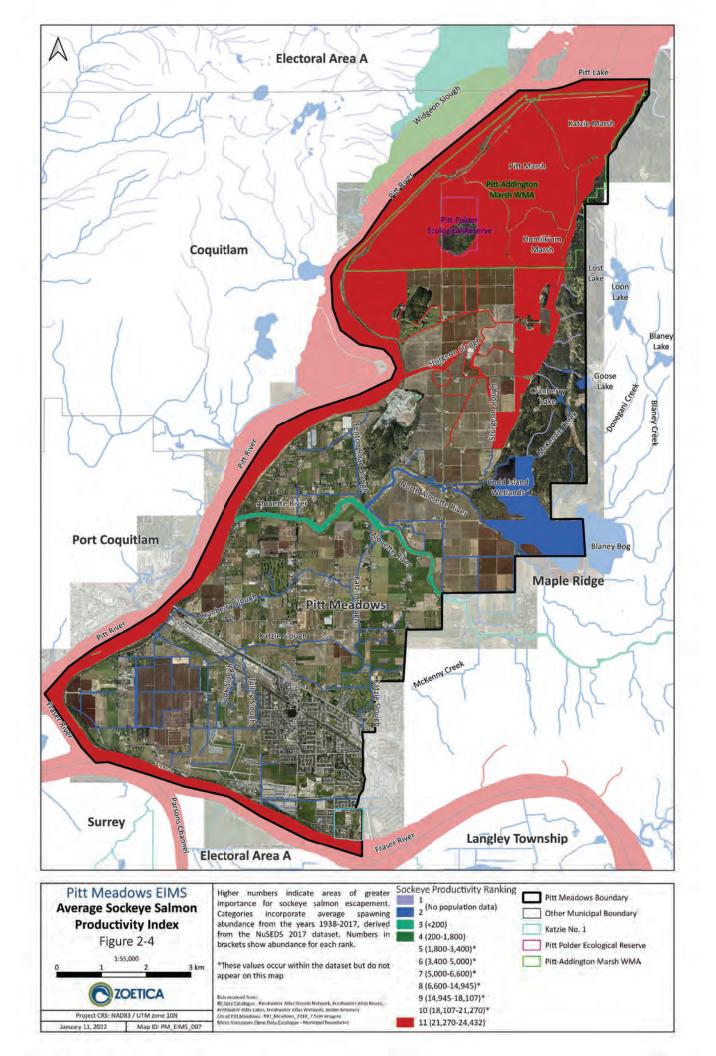
# 2.4 Recommendations

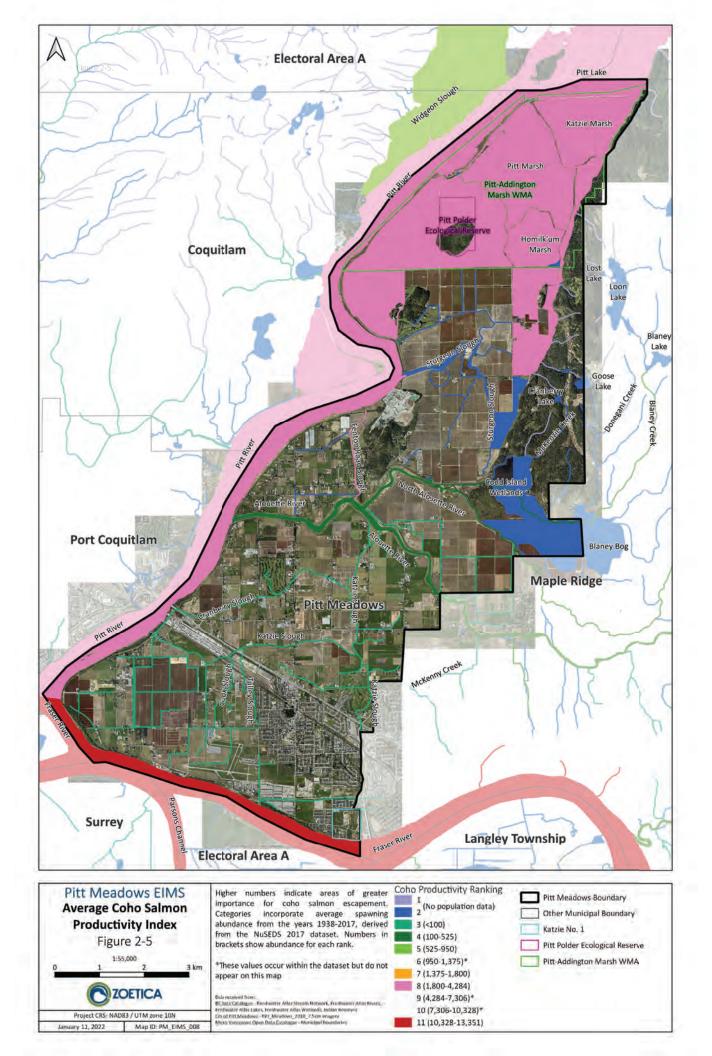
Refer to Section 5.0 of the *Pitt Meadows EIMS Final Report* for policy and action recommendations. The results of relative salmon productivity mapping were used to help prioritize areas for management actions related to streams and riparian areas.











# 3.0 BREEDING BIRD SURVEYS

# 3.1 Introduction

Breeding birds are recognized as important by various levels of government Acts and regulations. The *Migratory Birds Convention Act, 1994* and the attendant Migratory Birds Regulations protect migratory birds, their eggs, and nests from disturbance or destruction. The federal *Species at Risk Act (SARA)* protects critical habitat of species at risk (SAR) on federally owned lands, seeks to bind management of endangered or threatened wildlife from becoming extinct or lost from the wild, and provides management plans to promote the recovery of these species. The *SARA* is also intended to manage species of special concern and to prevent them from becoming endangered or threatened. In British Columbia, the provincial *Wildlife Act* prohibits the taking of birds, eggs, and nests; further, nests of some species such as eagle, peregrine falcon, gyrfalcon, osprey, and heron are protected whether or not they are active. The nesting season in Metro Vancouver occurs between March 1 and August 30 for most birds, as established by the BC Ministry of Environment in the *Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (MOE 2014). Birds are also recognized as culturally important species that were both historically and currently hunted (e.g., waterfowl), culturally significant to First Nations, and enjoyed by many birdwatchers and recreational nature lovers.

Breeding bird surveys were conducted throughout the City of Pitt Meadows during the spring/summer of 2020 to document the presence and distribution of breeding bird species, including rare and at-risk species. Along with the results of habitat quality assessments (see Section 4.0 and Appendix B of the *Pitt Meadows EIMS Final Report*), breeding bird survey data can help inform environmental management decisions, such as prioritizing important habitats to protect, enhance, or restore. The City Biodiversity Index (also known as the Singapore Index on Cities' Biodiversity; Chan *et al.* 2014), which Zoetica has recommended that the City of Pitt Meadows track in a systematic fashion going forward, uses the number of bird species present in cities as a global indicator of biodiversity (see Section 6.0 in the *Pitt Meadows EIMS Final Report*). Under the auspices of the City Biodiversity Index, the presence of >68 bird species is considered optimal, 47-68 is considered good, 28-46 is considered moderate, and ≤27 is considered poor.

# 3.2 Methods

# 3.2.1 Site Selection

Breeding bird surveys were conducted alongside habitat quality assessments and SEI verification. Sixty-five (65) survey sites were selected based on SEI polygons mapped by Metro Vancouver (Figure 4-3 in the *Pitt Meadows EIMS Final Report*). However, accessibility was a major obstacle during May, 2020, when Zoetica began the field surveys. In addition to the prevalence of private lands (e.g., agricultural, industry) and roads throughout Pitt Meadows, areas such as Pitt-Addington Marsh Wildlife Management Area (WMA), Thompson Mountain, and the Katzie 1 Reserve lands were closed due to COVID-19 risks. Further, trails in Pitt Polder Ecological Reserve were closed between March 15 and August 15 to protect the sandhill crane nesting area. Temporary COVID-19 closures eased in July; however, summertime is not ideal for conducting breeding bird surveys, which rely predominantly on audio identification. In the summer, breeding activities have shifted from males singing to pairs incubating eggs and rearing chicks; during this time, birds reduce vocalizations to avoid attracting predators.

Although survey sites were selected prior to publication of the online EIMS survey and mapping questions, a retrospective comparison of these datasets showed that breeding bird surveys and habitat assessments coincided with several of the areas noted by the community as important (e.g., Alouette River, Katzie Slough, Pitt River Regional Greenway [PRRG], Hoffmann Park, Pitt Polder Ecological Reserve/Pitt-Addington Marsh WMA; see *Engagement Summary* memo in Appendix A in the *Pitt Meadows EIMS Final Report*).

To compensate for the lack of 2020 breeding bird surveys in the Pitt-Addington Marsh area (hereafter 'Pitt-Addington WMA' to denote the area north of Koerner Rd), and to make use of existing citizen science data available throughout the City, Zoetica also collated bird observations from eBird Canada. The Pitt-Addington WMA is a popular destination for recreation and birdwatching, and several eBird "hotspots" exist, including the Pitt Marsh WMA, Catbird Slough, Grant Narrows (and Grant Narrows Nature Trail), and Katzie Marsh. More information about eBird Canada data is presented in Section 3.3.2.

### 3.2.2 Timing and Weather Conditions

In Metro Vancouver, the peak songbird breeding period (singing window) is anticipated to occur between April and May (Rousseu and Drolet 2015). Surveys were conducted over three days on May 27-29, 2020. The weather on these days was warm and sunny, with zero cloud cover; average daytime temperatures ranged from 23.9-28.0° C. Surveys began between 05:00-06:00 until approximately 10:30. At the stoppage time, weather conditions on all days had become very warm and bird singing activity had dropped notably.

### 3.2.3 Point Count Survey Protocol

Variable radius point count surveys followed a standard methodology (Ralph *et al.* 1995, RIC 1999). The survey utilized a 10-minute detection period per point count. At each point count station, observers recorded all birds detected (by ear and visually) during the 10-minute detection period within an area 100 m around them; all birds were plotted by location on a point count form with care to not double count. Each observation included the species identified, number of birds, distance away, and behaviour (such as a male singing, or parental nesting behaviour). Birds flying over, occurring outside the point count range, or occurring outside the 10-minute detection period, were recorded as incidentals. The City possesses mostly open habitat and a few remnant forest stands; 100-m radius point counts are appropriate for these habitats where bird calls are not intercepted by trees (RIC 1999). As stated in Section 3.2.1, the dense forest of the Thompson Mountain could not be surveyed in May 2020; however, if breeding bird surveys are conducted in this area during future monitoring efforts, 50-m radius point counts are preferred due to the higher density of trees and complex vegetation structure (Ralph *et al.* 1995).

At each point count site, notes on habitat characteristics were collected as part of the habitat quality assessment and SEI verification (see Appendix B in the *Pitt Meadows EIMS Final Report*). Photographs were taken in each cardinal direction at the plot centre, as well as upward to assess canopy cover. Surveyors also recorded information about weather and other conditions that could have affected the detection or song rate of breeding birds, such as noise from human activities.

In addition to the point counts, incidental wildlife observations were collected while conducting the habitat quality assessments (outside of the 10-min point count period) and while travelling to/between survey locations. Observations of both breeding bird species and non-target species (e.g., mammals, amphibians) were recorded.

# 3.3 Results and Discussion

# 3.3.1 2020 Field Data

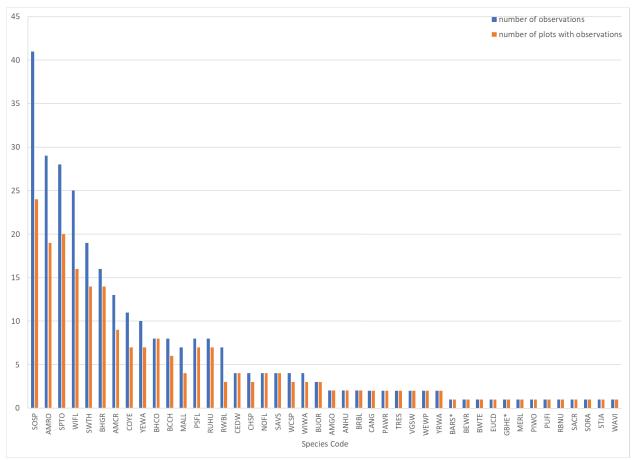
Point count surveys were completed at 36 locations around the City. Only 29 of the original 65 sites selected (44.6%) were surveyed for breeding birds in May 2020 due to accessibility or the time of day (habitat quality assessments continued into the afternoon. All point count surveys had to end by 10:30, as birds sing unreliably and less frequently after this time; see methods in Section 3.2.2). Two sites within the Pitt-Addington WMA were replaced with accessible locations nearby, and five additional sites were created on the ground by Zoetica biologists at locations where the habitat either did not fully correspond with Metro Vancouver's SEI designation, or appeared to be unique and biodiversity-rich, and warranted a habitat assessment and breeding bird survey for the EIMS project.

Forty-four breeding bird species were observed during point count surveys, which included 37 upland breeding birds, one raptor, three waterfowl, and three "other waterbirds" (e.g., gulls, herons). Seventeen additional species were observed incidentally during the May 2020 field work, equalling 61 species in total (see Appendix 1, **Table A-1** for the full list of species observed). Incidental observations included eight upland breeding birds, five raptors, and four "other waterbird" species. Four species of conservation concern were observed during the May 2020 field work: barn swallow (Blue-listed in BC, Threatened under *SARA*), great blue heron *fannini* subspecies (Blue-listed in BC, Special Concern under *SARA*), evening grosbeak (Yellow-listed in BC but Special Concern under *SARA*), and double-crested cormorant (Blue-listed in BC, not listed under *SARA*). Barn swallows were detected at three survey sites (Plots 19, 40, and CCO5) and noted as incidental observations near Plots 3 and 27. Great blue herons were detected at four survey sites (Plots 17, 29, D1, CCO2) and noted as incidental observations at Plots 61 and CCO4. Evening grosbeak and double-crested cormorant were only recorded at Plots CCO1 and CCO2, respectively.

The number of observations of each breeding bird species, along with the number of survey plots where the species was observed, is presented in Figure 3-1. Song sparrow (a species associated with riparian habitat and proximate to water) was the most frequently observed species and was detected at 24 out of 36 plots (66.7%), followed by American robin, spotted towhee, and willow flycatcher. Thirteen species were only observed once during point count surveys and had no additional incidental observations; these species include: blue-winged teal, sora, and merlin (Plot 19/D10); Eurasian collared-dove and Steller's jay (Plot CC03); pileated woodpecker (Plot 1); purple finch (Plot 35); and red-breasted nuthatch (Plot 36). Plot 19/D10 is located at the southwest corner of Airport Way and Bonson Road and includes a small wetland where the merlin was observed hunting ducks. Plot CC03 is located in Hoffmann Park, which comprises one of the few remnant mature forest stands within the City south of Lougheed Highway; during the habitat quality assessment conducted on the previous day, a red-tailed hawk was being harassed by a flock of crows. Plot 1 is located at Harris Landing and Shoreline Park (along the PRRG); near this location, where the mature mixedwood forest transitions into young deciduous forest, American robins and other songbirds were observed alarm calling at a barred owl. Other single incidental observations included a marsh wren at Plot 26 (swamp habitat between the Pitt River and the Trans Canada/Great Trail north of the Pitt River Bridge), a killdeer in the agricultural lands (cranberry farms) near Plot 8, and a lazuli bunting at Plot CC05 (meadow along the PRRG in the southwest 'corner' of the City that Metro Vancouver is leaving to become old field habitat).

Including the incidental species observed during the point count surveys (i.e., fly-overs and birds observed >100 m away), the number of species observed at each plot ranged from two (Plot 25) to 16 (Plot 47),

with an average of 8.9 different species across the surveys. Differences in the number of species observed among survey locations could be due to various factors, including the time of day and levels of human disturbance. Plot 47 is located in the more natural habitats of Pitt-Addington WMA, whereas Plot 25 was located at the south end of MacLean Park, just south of Lougheed Highway between a townhouse complex and the Loblaws Distribution Centre. During the survey, there was a large amount of noise disturbance from human activities, including gardening equipment, a train passing by, and humans in the park. MacLean Park also contains a small pond/wetland north of the breeding bird survey location. Incidental observations within the park included black-capped chickadee, yellow-rumped warbler, cedar waxwing, and a flock of mallards within the pond. There was also evidence of beaver activity (e.g., felled trees, lodge) in the pond; both community members and City staff (Polly Coad, Parks Operations Supervisor) explained that beaver and drainage management was/is needed at MacLean Park (e.g., protective wrapping on young alder trees, cleaning out the slough, installing piping to improve water flow).



**Figure 3-1.** Number of observations of each species (not individuals) and the number of plots within which the species was observed (out of 36 total) during breeding bird surveys conducted within the City of Pitt Meadows in May 2020. Species with an asterisk (\*) are of conservation concern. Species code explanations can be found in Appendix 1, **Table A-1**.

As described in Section 3.2.1, areas in and around the Pitt-Addington WMA and Thompson Mountain, which were temporarily closed due to COVID-19, were visited on July 21, 2020 to complete habitat quality assessments. Incidental wildlife observations made during this field day included eight bird species that

had not been detected during the May 2020 breeding bird surveys, including one species of conservation concern (**Table 3-1**); a pair of green herons was observed in the ditch along the northern edge of Plot 64.

**Table 3-1.** Bird species observed incidentally during habitat quality assessments on July 21, 2020. Species highlighted bold are of conservation concern.

Common Name	Scientific Name	BC List	SARA
Wood Duck	Aix sponsa	Yellow	-
Green Heron	Butorides virescens	Blue	-
Orange-crowned Warbler	Leiothlypis celata	Yellow	-
Red Crossbill	Loxia curvirostra	Yellow	-
American Wigeon	Mareca americana	Yellow	-
Belted Kingfisher	Megaceryle alcyon	Yellow	-
Western Tanager	Piranga ludoviciana	Yellow	-
Pine Siskin	Spinus pinus	Yellow	-

Thus, with the inclusion of point counts and incidentally observed bird species, a total of 69 species were observed within the City during the 2020 field surveys, when both breeding bird surveys (in May) and late-season (in July) habitat quality assessments were considered. A full list of the species observed during 2020 field work is presented in Appendix 1, **Table A-1**.

### 3.3.2 eBird Canada Data

Complete eBird Canada data for the City of Pitt Meadows were acquired on September 28, 2020. Zoetica analyzed these data in various ways: 1) assessing the number of unique species (including hybrids) over all years of data available (1962-2020), over the past 10 years (2010-2020), and over the past three years (2018-2020); 2) assessing the number of unique breeding bird species (observations made in March through August) rather than counting migrants that only stop in the City briefly prior to moving farther north (to breed) or south (to overwinter); and 3) assessing the number of unique species observed within natural vs. built-up/urban areas. Built-up/urban was defined as any area not assigned into an SEI class (see Appendix B in the *Pitt Meadows EIMS Final Report*). The total number of species within each criterion is presented in **Table 3-2**.

Table 3-2. Summary of eBird Canada data for the City of Pitt Meadows. Data downloaded on September 28, 2020.

	All Years	Past 10 Years	Past 3 Years
Number of Species	(1962-2020)	(2010-2020)	(2018-2020)
Year-round	234	216	194
Breeding (Mar-Aug)	219	198	179
Urban	189	169	149

eBird data show that the City of Pitt Meadows has a very high bird biodiversity, even when only breeding bird species in built-up areas within the past three years are considered (149 unique species). According the City Biodiversity Index, this number of species within urban areas places Pitt Meadows within the "optimal" category worldwide (see Section 3.3.3 in this Appendix and Section 6.0 of the *Pitt Meadows EIMS Final Report*). The following discussion will be based on these spatial (i.e., built-up areas only) and temporal criteria (i.e., breeding season only) to comply with the relevant EIMS Performance Indicators (PIs) (see Section 3.3.3); however, it is valuable to recognize that 30 additional breeding bird species have been observed in natural areas, and that another 15 species are supported by available habitats within

the City during the non-breeding seasons (**Table 3-2**). The overall decline in the number of species among all years, the past 10 years, and past three years of eBird data could be due to various factors; a more rigorous analysis of historical trends – as well as future monitoring data – would aid in data interpretation.

The 149 breeding bird species reported within built-up areas of the City between 2018-2020 include 90 upland breeding birds, 14 raptors, 24 waterfowl, and 21 other waterbirds. Of these, 17 species of conservation concern were reported (**Table 3-3**), including four Red-listed species and 11 Blue-listed species in BC. Federally, there are two species listed as Endangered, four listed as Threatened, and six listed as Special Concern under Schedule 1 of *SARA*. A full list of the breeding bird species reported on eBird Canada within built-up areas of the City from 2018 to 2020 is presented in Appendix 1, **Table A-2**.

**Table 3-3.** Species of conservation concern within the City of Pitt Meadows as reported through eBird. Data are restricted to observations made in urban areas between March and August and from 2018-2020.

Common Name	Scientific Name	BC List	SARA				
UPLAND BIRDS							
Common Nighthawk	Chordeiles minor	Yellow	Threatened				
Evening Grosbeak	Coccothraustes vespertinus	Yellow	Special Concern				
Olive-sided Flycatcher	Contopus cooperi	Blue	Threatened				
Black Swift	Cypseloides niger	Blue	Endangered				
Barn Swallow	Hirundo rustica	Blue	Threatened				
Sage Thrasher	Oreoscoptes montanus	Red	Endangered				
Band-tailed Pigeon	Patagioenas fasciata	Blue	Special Concern				
Purple Martin	Blue	-					
	RAPTORS						
Short-eared Owl	Asio flammeus	Blue	Special Concern				
Peregrine Falcon	Falco peregrinus	Red	Special Concern				
	WATERFOWL						
Tundra Swan	Cygnus columbianus	bianus Blue					
	OTHER WATERBIRDS						
Great Blue Heron	Ardea herodias	Blue	Special Concern				
American Bittern	Botaurus lentiginosus	Blue	Threatened				
Long-billed Curlew	Numenius americanus	Blue	Special Concern				
Whimbrel	Numenius phaeopus	Red	-				
American White Pelican	Pelecanus erythrorhynchos	Red	-				
Double-crested Cormorant	Phalacrocorax auritus	Blue	-				

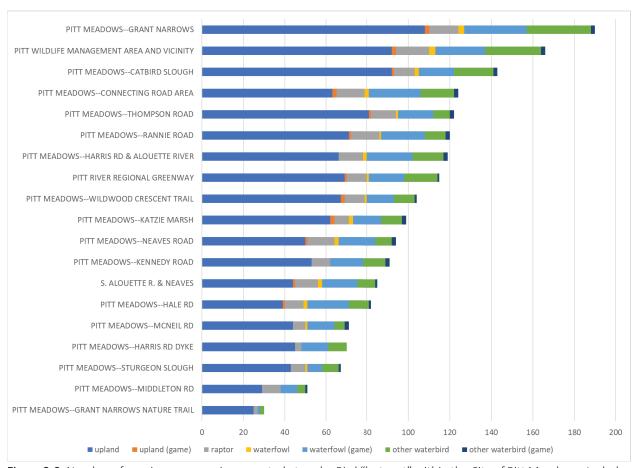
Note that eBird obscures records for sensitive species<sup>1</sup> and these data were not provided in Zoetica's data request for the EIMS project. For future analyses, sensitive records may be requested through Birds Canada/NatureCounts with appropriate justification (a 1-2 page written proposal outlining the nature and topic of the research). Based on publicly available information on the eBird Canada website, the following three species (including one SAR) have been reported in Metro Vancouver and may have been found within the City of Pitt Meadows:

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<sup>&</sup>lt;sup>1</sup> https://ebird.freshdesk.com/en/support/solutions/articles/48000803210-sensitive-species-in-ebird

- Northern Hawk Owl (Surnia ulula), Yellow-listed in BC, not listed under SARA
- Great Gray Owl (Strix nebulosa), Yellow-listed in BC, not listed under SARA
- Barn Owl (Tyto alba), Red-listed in BC, Threatened under Schedule 1 of SARA

eBird data are also organized into "hotspots" and there are currently 19 eBird hotspots within the City (data downloaded on July 17, 2020). Considering year-round data from the past 10 years (2010-2020), the "Pitt Meadows—Grant Narrows" hotspot has the highest number of reported observations (190 species), followed by the "Pitt Wildlife Management Area and Vicinity" with 166 species reported, and "Pitt Meadows—Catbird Slough" with 143 species reported. All three of these hotspots are located within the Pitt-Addington WMA (Figure 3-2). Pitt Meadows—Grant Narrows is consistently within the top 20 out of 493 hotspots within Metro Vancouver with respect to the number of species observed.



**Figure 3-2.** Number of species per grouping reported at each eBird "hotspot" within the City of Pitt Meadows. Includes year-round data between 2010-2020; downloaded on July 17, 2020. Upland game birds include band-tailed pigeon, ring-necked pheasant, and sooty grouse. All waterfowl are game birds except for the three swan species (mute, trumpeter, tundra). "Other waterbird" game species include American coot and Wilson's snipe.

#### 3.3.3 EIMS Performance Indicators

In Section 6.0 of the *Pitt Meadows EIMS Final Report*, Monitoring: Performance Indicators and Benchmarks, there are two PIs within Management Objective ENA7-1 related to native bird biodiversity:

Native biodiversity (bird species) in built-up areas (not including natural areas)

### 2. Change in number of native bird species

As discussed in Section 3.3.1, 61 breeding bird species were recorded in total during point count surveys (including incidentals). Excluding the five survey sites that Zoetica was able to set up in May 2020 within the Pitt-Addington WMA (i.e., north of Koerner Road), which are natural areas, a total of 51 breeding bird species were observed (84% of all species observed). This value would place the City within the "good" performance benchmark of 47-68 bird species for PI (1), even though bird surveys only provided a brief "snapshot" of avian species diversity over time and space. It is important to note that not all built-up areas within the City that could potentially support breeding birds were surveyed. For example, additional surveys within agricultural lands, golf courses, and other urban parks would likely have increased the number of species detected. Zoetica feels that it is likely that with additional bird survey efforts, the City could easily rest at an "optimal" performance benchmark of >68 species, which is more in line with what eBird data, collected over a longer period of time (though non-systematically) suggest.

Using eBird data to measure performance may provide a more accurate representation of bird biodiversity within the City. As discussed in Section 3.3.2, 149 unique breeding bird species were reported within built-up (non-SEI) areas within the past three years. This value places the City within the "optimal" performance benchmark of >68 bird species for PI (1); hence, this value suggests that the City should be placed within the "optimal" category for bird biodiversity on a global, urban relative scale. Avian biodiversity can certainly be advertised as a "strength" of Pitt Meadows that can be appreciated by outdoor naturalists and both local and international visitors.

Regarding PI (2), the City's performance cannot be ascertained until results are available from a monitoring program (see Section 3.4 below). Data from breeding bird monitoring surveys and/or eBird analyses, conducted every three years, can identify whether the number of native bird species is likely increasing, decreasing, or relatively stable in the City. As discussed in Section 3.3.1, a total of 69 unique breeding bird species were observed (via point count surveys or incidentally during habitat quality assessments) during the May and July 2020 field work conducted for the EIMS project. If the City implements an on-the-ground bird monitoring program, they may use 69 species as the baseline value against which monitoring data can be compared.

### 3.3.4 Other Incidental Wildlife

Six mammalian species were incidentally observed during the May and July 2020 field work for breeding bird surveys and habitat quality assessments (**Table 3-4** and **Figure 3-3**). The most common sightings were of American beaver and beaver sign. While many observations were unsurprisingly made within the Pitt-Addington WMA, and within the riparian and wetland habitats along the various shoreline dike trails along the Fraser and Pitt rivers, there were a few wildlife sightings in agricultural and urban areas, especially near watercourses, waterbodies, and wetlands.

**Table 3-4.** Incidental mammal observations during 2020 breeding bird surveys and habitat quality assessments for the City of Pitt Meadows EIMS project.

Common Name	Scientific Name	Observation	Plot ID(s)	Location Description
Black Bear	Ursus americanus	Animal	47	Pitt-Addington WMA (Rannie
				Road dike access)

Appendix C: Pitt Meadows EIMS – 2020 Field Surveys and Desk-based Research

		Animal	N/A	South end of Katzie Marsh; could not access 2 plots due to bear on dike trail
Coyote	Canis latrans	Animal	26	Berry farm across Trans Canada/Great Trail
		Animals (2)	Near 29	Travelling on Rippington Road
		Animal	31	Alouette River (west of confluence of north and south arms)
River Otter	Lontra canadensis	Sign (trails)	Near 26 and 27	Marsh habitat along Pitt River north of Pitt River Bridge
Coastal Black-tailed Deer	Odocoileus hemionus columbianus	Animal	33	Pitt River Dike Trail (west of Pitt River Quarries)
American	Castor canadensis	Felled tree	22	Wildwood Trail / Katzie Slough
Beaver		Felled trees, lodge	25	MacLean Park
		Animal	40	North Alouette River at City boundary
		Animal	47	Pitt-Addington WMA (Rannie Road dike access)
		Lodge	CC06	Southeast corner of Katzie Marsh
		Lodge	CC09	Pitt-Addington WMA (west dike trail)
Grey Squirrel	Sciurus carolinensis	Animal	1	Harris Landing & Shoreline Park

In addition to mammals, field surveyors recorded incidental observations of frog activity (e.g., calling) and various invertebrates, including dragonflies, butterflies, honeybees, and wasps. Field surveyors noted the presence of calling green frogs and American bullfrogs in many areas adjacent to dike trails. The American bullfrog is an invasive frog species accidentally released by the frog-leg industry, and which can cause significant losses in the diversity of other amphibians (Pearl *et al.* 2004, Garner *et al.* 2006).



Figure 3-3. Black bear on Swan Dike Trail blocking access to planned survey plots 53 and 54 within Pitt-Addington WMA.

### 3.4 Recommendations

### 3.4.1 Current Baseline Data

As a result of access restrictions due to COVID-19 in the spring of 2020, certain areas within the City could not be surveyed for breeding birds, including the biodiversity-rich areas of Pitt-Addington WMA and Thompson Mountain. Although the eBird data are useful to get a general idea of the bird species present, and these data can be further analyzed to investigate seasonal occurrences of species (e.g., breeding birds), a more systematic approach to data collection will allow for statistically valid comparisons between locations and will reduce uncertainty regarding species identification and observer bias. Therefore, Zoetica recommends that point count surveys, following the procedures used in 2020 (see Section 3.2.3), be conducted at the previously inaccessible locations. It would also be valuable if the City could request permission to access private lands that were identified as polygons in Metro Vancouver's SEI, such that breeding bird surveys and habitat quality assessments can be conducted to help inform environmental management decision-making.

### 3.4.2 Bird Monitoring Program

Zoetica recommends that a bird monitoring program be implemented to measure the City's performance in meeting the Draft 2020 OCP Objective ENA 8.7.1 and associated performance indicators and recommended performance benchmarks (see Section 6.0 in the *Pitt Meadows EIMS Final Report*). There are two main options: 1) a monitoring program designed specifically for the City of Pitt Meadows EIMS, and 2) citizen science project(s) organized by Birds Canada (previously Bird Studies Canada).

### 3.4.2.1 Breeding Bird Point Count Surveys

This option involves a monitoring program following the point count survey protocol used by Zoetica for the EIMS project. The following recommendations are based on our 2020 breeding bird survey results, input from the community and other stakeholders, and practical considerations:

- Survey locations survey sites should be consistent between years; therefore, publicly accessible
  locations are preferred. To collect data that can address the recommended EIMS PIs, survey sites
  should be selected on City-owned land in built-up areas, stratified by habitat type.
- **Survey timing** breeding bird surveys are conducted in the spring (April to May). The timing of surveys should be consistent between years.
- **Survey frequency** breeding bird surveys should be conducted every three (3) years to help assess natural variability such that comparisons with the performance benchmarks can be interpreted with greater certainty (e.g., change in number of native bird species).
- Roles and responsibilities point count surveys should be conducted by experienced biologists, or by field naturalists/birdwatchers with appropriate training and an ability to identify birds by sight and sound. See the Roles and Responsibilities for Implementation Framework memo in Appendix E of the Pitt Meadows EIMS Final Report for more information on how a bird monitoring program can be implemented by the City, in collaboration with external parties, and integrated into future environmental management plans.

One of the benefits of a monitoring program specifically designed for the EIMS is that specific areas of interest can be targeted, and the data collected by known and experienced field personnel may be deemed more reliable.

#### 3.4.2.2 Citizen Science Projects

Birds Canada manages or promotes a variety of citizen science projects<sup>2</sup> that could be valuable for the EIMS and cost-effective for the City. Depending on the level of participation and area of coverage, results could be in-depth and wide-ranging across the City. Encouraging community involvement has the benefit of increasing public education and awareness about the natural assets and biodiversity present within the City, and may also enable the collection of bird inventory data on private lands.

- Breeding Bird Survey the North American Breeding Bird Survey (BBS) is jointly managed by ECCC/CWS and the USGS. Each route is approximately 39.4 km (24.5 mi) long and a 3-min point count is conducted at stops located approximately 0.8 km (0.5 mi) apart. The "Maple Ridge (11411)" BBS route should overlap with the City of Pitt Meadows; these data may be publicly available through NatureCounts<sup>3</sup>.
- Christmas Bird Count conducted on a single day between December 14 and January 5 within a pre-determined and consistent 24-km diameter circle. The Pitt Meadows count is coordinated by Jennifer Tayes, a resident of the City and a member of the Alouette Field Naturalists.
- **Great Backyard Bird Count** a joint program between the Cornell Lab of Ornithology, Audubon, and Birds Canada, this is a four-day event each February intended to create an annual snapshot of the distribution and abundance of birds. Data are stored/shared in real-time in the Great Backyard Bird Count subset of data on eBird.

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<sup>&</sup>lt;sup>2</sup> https://www.birdscanada.org/bird-science/where-we-work/

<sup>&</sup>lt;sup>3</sup> https://www.birdscanada.org/birdmon/default/main.jsp

- Schoolyard Bird Blitz this event is performed in May and could provide valuable breeding bird species information. However, publicly available data have been summarized into provinces, so the City would need to contact Birds Canada for raw data specific to Pitt Meadows.
- **Nocturnal Owl Survey** conducted at least once a year in February for the south coast of BC. Routes consist of 10-30 stops spaced 1.6 km apart along secondary roads; at each stop, a 5-min call playback survey (using western screech-owl vocalizations) is conducted. Data are not publicly available and would need to be requested through NatureCounts.

# 4.0 ENVIRONMENTAL DNA METABARCODING STUDY

# 4.1 Introduction

Environmental DNA (eDNA) refers to genetic material collected in the environment (e.g., water or sediment samples) rather than directly from organisms (e.g., tissue samples). Metabarcoding refers to the use of 'universal' primers and high-throughput sequencing technology to identify an entire suite of species whose eDNA was detected in the sample. The metabarcoding approach differs from targeted assays, which use species-specific primers and quantitative PCR (qPCR) methods and are designed to detect a single species (or a few related species). While targeted qPCR is a useful tool when looking for specific species of interest (e.g., a certain SAR or invasive species), metabarcoding is a cost-effective way of conducting an initial screening of the biodiversity present at a sampling site.

The use of environmental DNA (eDNA) metabarcoding for assessing biodiversity is an emerging technology that has recently been applied to biodiversity monitoring studies around the world (reviewed in Ruppert *et al.* 2019). DNA barcoding is becoming recognized as an important tool for biodiversity baseline data collection (Gullison *et al.* 2015) and ecological assessment (Hering *et al.* 2018). Compared to traditional/conventional survey methods, eDNA methods are non-invasive, have low risk of pathogen transfer between sites (e.g., amphibian chytrid fungus), are highly sensitive and accurate, generally more cost-effective for taxa that are otherwise difficult to detect, and have little to no permitting requirements. Furthermore, eDNA metabarcoding along with high-throughput sequencing can enable the rapid screening for multiple species (which can be measured in water and soil) simultaneously and retroactive analysis of previously collected data.

Some research has shown that eDNA metabarcoding performs equal to, or better than, traditional capture-based surveys for species detection, relative abundance estimates, or characterization of ecological fish communities (Civade *et al.* 2016, Hänfling *et al.* 2016, Li *et al.* 2019) and/or herpetofauna (Lacoursière-Roussel *et al.* 2016, Valentini *et al.* 2016, Lopes *et al.* 2017). In addition, terrestrial animals frequently travel to and from water sources and eDNA metabarcoding methods have been developed to identify mammals (Ushio *et al.* 2017, Harper *et al.* 2019b) and birds from water samples (Ushio *et al.* 2018). The use of eDNA metabarcoding has also been used for detection of rare and/or invasive aquatic species in the Great Lakes (Klymus *et al.* 2017, Balasingham *et al.* 2018).

In Metro Vancouver and South Coast BC region, the application of eDNA methods for biodiversity-related projects is continuing to grow. Recent projects include:

 Metro Vancouver – collecting eDNA samples in Lynn Headwaters Regional Park and Grouse Mountain Regional Park to detect rare species such as coastal cutthroat trout, northern redlegged frog, coastal tailed frog, and Pacific water shrew. This project uses a targeted qPCR

- approach (not metabarcoding) in collaboration with Dr. Caren Helbing's laboratory at the University of Victoria. <a href="https://vimeo.com/348722953">https://vimeo.com/348722953</a>
- BC Ministry of Transportation for the Pattullo Bridge Replacement Project, a targeted eDNA survey (i.e., using qPCR assay developed for one target species, but not using metabarcoding to look for all species) is proposed to monitor for Pacific water shrew and to determine if small mammal salvage is needed prior to construction.
- Fisheries and Oceans Canada (DFO) using eDNA metabarcoding to detect invasive species, such as yellow perch, northern pike, smallmouth bass, largemouth bass, and zebra/quagga mussel, in BC lakes. Analyses are completed at the DFO's Pacific Biological Station in Nanaimo.

To our knowledge, the present study is the first use of eDNA combined with metabarcoding to assess baseline aquatic biodiversity in any municipality in the South Coast of BC.

Since eDNA survey methods, particularly when paired with metabarcoding analysis, are relatively new and continue to be optimized, there are currently no formally accepted, standard methods; however, cohesive international guidelines are emerging, such as the Environmental DNA Sampling and Experiment Manual Version 2.1 produced by the eDNA Methods Standardization Committee (The eDNA Society 2019). Within Canada, efforts are also being made through collaboration among academic researchers, government regulators, and industry experts to develop standards and guidelines for eDNA sample collection, analysis, and interpretation. For example, Environmental DNA Protocol for Freshwater Aquatic Ecosystems Version 2.2 has been submitted to the BC Ministry of Environment (BC MOE) for consideration as a new RISC Inventory Standard (Hobbs et al. 2017). Critical considerations for study design and results inference, incorporating appropriate quality assurance and quality control (QA/QC) protocols, have been published as recommended guidelines (Goldberg et al. 2016). A recent paper presents recommendations for sampling protocols in lentic (waterbodies and wetlands) and lotic (watercourses) systems, including sample volumes and spatial intervals (Bedwell and Goldberg 2020). There are also recommendations specific to the eDNA metabarcoding workflow and increasing the transparency of bioinformatic data processing (Deiner et al. 2017, Zinger et al. 2019). The Canadian Standards Association (CSA Group) recently published a Standards Research report on eDNA standardization needs for fish and wildlife population assessments and monitoring, including minimum reporting requirements (Helbing and Hobbs 2019).

Best practices and guidelines are continuing to be informed by ongoing research aimed at overcoming uncertainties in data interpretation, such as eDNA persistence and fate within the environment (Harrison et al. 2019), accounting for potential biases introduced by the laboratory processes used to sequence DNA<sup>4</sup> (Kelly et al. 2019), and habitat-specific recommendations (Harper et al. 2019a). However, it is important to recognize that uncertainties in eDNA metabarcoding continue to exist, and misuses of the technology may be detrimental for biodiversity science and conservation (Cristescu and Hebert 2018). It is crucial that sources of uncertainty – most notably, the rates of false positives and false negatives – be understood, identified, and addressed. Table 1 in Cristescu & Hebert (2018) summarizes the problems

is partially incorrect, which could lead to potential misidentification of the species.

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<sup>&</sup>lt;sup>4</sup> An example of how errors can arise is via polymerase chain reaction (PCR). PCR is a method used to make many copies (i.e., amplification) of the small amounts of eDNA collected in a sample, such that the amplified DNA sequences can be detected and analyzed (e.g., to assess biodiversity). Sometimes the amplification process, which involves repeated heating and cooling to split the double-stranded DNA and add nucleotides to form new matching strands, results in errors, whereby the wrong nucleotide ends up in the wrong place. This error then gets carried through the DNA amplification process, resulting in a DNA sequence that

associated with species detection using eDNA and presents possible solutions, which include optimization, calibration, and validation of eDNA field and laboratory methods; and comparison of results derived from eDNA methods with traditional assessments of community composition.

For the Pitt Meadows EIMS, Zoetica attempted to address these uncertainties through field and laboratory quality controls, detailed data recording, and collaboration with eDNA metabarcoding experts (Dr. Hanner's Laboratory at the University of Guelph) who assisted with study design and laboratory eDNA analyses.

### 4.2 Methods

### 4.2.1 Site Selection

For this 2020 pilot project, sampling locations were restricted to larger watercourses, waterbodies, and wetlands identified as high priority (for protection, restoration, or enhancement) based on known or suspected biodiversity and presence of SAR and/or invasive species, community input from the online EIMS survey and mapping questions, and accessibility. Four main areas and 10 sampling sites (i.e., 10 individual samples for analysis) were thus identified (Figure 4-4 in the *Pitt Meadows EIMS Final Report*):

#### 1) Alouette River

- a. North Alouette River from Neaves Road to confluence with Alouette River
- b. "South Alouette" from Neaves Road to confluence with North Alouette
- c. "Main Alouette" from the confluence of North and South arms to the Pitt River

### 2) Katzie Slough

- a. "Katzie-Pitt" on the Pitt River side of the pump station at Kennedy Road
- b. "Katzie Slough" between the Kennedy pump station and the foot bridge, after the berm by Kennedy Road, at the multi-use path (MUP) near Lougheed Highway, at Harris Road, at Meadow Gardens Golf Club, and off Wildwood Trail.

#### 3) Sturgeon Slough

- a. "Sturgeon Slough #1" west and east of Rannie Road
- b. "Sturgeon Slough #2" north and south of Thompson Road (beside Golden Eagle Golf Club)
- 4) Pitt River from the Pitt Lake Boat Launch to the dike access point at Rannie Road
- 5) Pitt-Addington WMA
  - a. "Addington Marsh" western segment of Katzie Marsh Loop
  - b. "North Katzie Marsh" northern segment of Katzie Marsh Loop

The Alouette River and Pitt River were sampled from a kayak, while the other sites were accessed from the shore. Whenever possible, field staff avoided entering the water to minimize the risk of contamination.

#### 4.2.2 Decontamination and Quality Control

Since only small amounts of eDNA are needed for analysis (especially when using metabarcoding combined with high-throughput sequencing), strict decontamination protocols to avoid cross-contamination between samples are needed. All reusable eDNA equipment and gear was decontaminated with bleach solution: 50% for items that come into contact with samples (e.g., sample bottles, tweezers) and 10% for other field and laboratory gear (e.g., extendable pole, filtration equipment). Equipment was

thoroughly rinsed of bleach with distilled or tap water and air dried before use. Bleach decontamination is also advised for wetland work that could spread disease to sensitive amphibians (BC MOE 2008).

It should be noted that while field staff for this project were diligent about decontamination, the watercourses sampled in the summer of 2020 are known or likely to be influenced by recreation, agriculture, and possibly industry. For example, at the time of sampling the Alouette River, we observed kayakers, swimmers, and dogs in the water. While positive detections for "suspicious" species can be censored out, it is also possible that human activities can lead to false positives. To use another example, people were fishing at the Sturgeon Slough at the time of sampling. Although we collected water away from where others were located, eDNA from their bait fish or other "contaminants" could be picked up during metabarcoding analyses and may confound the results of what is naturally found in the Sturgeon Slough.

Two quality control checks were included in sample collection:

- 1) A duplicate sample was collected at the North Katzie Marsh at the same time, at the same location, and following the same protocol as the "real" sample. Duplicate samples are collected as a check for reproducibility (i.e., how reliable the results are) and also increases the probability of eDNA detection by increasing the volume of water sampled.
- 2) A field negative is a sample collected at a location where the target species is/are known to be absent. However, there can be no true field negatives as we cannot be sure that a species is not present at the sampling site. Instead, the field negative consisted of "collection" of distilled water to ensure that the eDNA equipment has been properly decontaminated.

### 4.2.3 Sample Collection

Sample collection occurred over five days between July 27 and August 5, 2020. As a result of access restrictions due to COVID-19 in the spring of 2020, the timing of eDNA surveys was suboptimal. Implications of eDNA sample collection in the heat of summer are discussed in Section 4.3.1.

A grab sample method, based on the protocol developed by Dr. Caren Goldberg's team at Washington State University (Goldberg and Strickler 2017) and consistent with the proposed RISC standard (Hobbs *et al.* 2017), was used to collect water samples for eDNA analysis. Zoetica has also developed a Standard Operating Procedure that can be shared with the City of Pitt Meadows and other interested parties. Briefly, water was collected at or just under the surface into 1 L labelled Nalgene bottles. An extendable pole was invariably used so that water samples were collected away from any gear that was touching the water (e.g., boots, kayak) (Figure 4-1). Areas with visible sediment or detritus was avoided wherever possible, as sediments will quickly clog the filter membrane. For the Alouette and Pitt rivers, samples were collected from the centre of the watercourse. For the sites accessed from land, samples were collected close to shore. Sample bottles were placed on ice in a cooler immediately after collection.



Figure 4-1. eDNA sample collection in the North Katzie Marsh on August 7, 2020.

Two litres of water were collected in total for each site. The volume of water collected at each sampling location depended on the number of predetermined points per site; however, subsample volumes that would be pooled together for a site were kept equal. For example, four subsamples of 250 mL were collected while paddling along the Alouette River and combined into a 1 L bottle for analysis. Other sites with difficult access necessitated collecting the full 1 L bottle of water at a single location. There are advantages and disadvantages to both methods. Subsampling allows greater spatial coverage of "search effort", but spatial resolution of the results will be less precise and additional studies will be needed to determine where (e.g., how far upstream) the species is found, if desired. Sampling a greater volume at a single location will increase the probability of detection (i.e., more water should have more eDNA) and positive results are easily interpreted; however, a false negative could occur if the species was present elsewhere in the system that was not sampled, or where water mixing is minimal or stagnant.

Each (sub)sample collected was accompanied by field data recording, which included:

- Sample information watercourse name, unique site code, replicate/subsample number, date, time collected, volume collected, method
- Survey crew initials of eDNA sample collector, environmental data collector, record keeper
- Sampling location UTM easting and northing (NAD 83) recorded with GPS unit
- Environmental conditions cloud cover, precipitation, canopy cover (assessed visually); water temperature, pH (collected using a portable pH meter)

• Site information – photos, site characteristics (e.g., human activities and infrastructure, aquatic and riparian vegetation), incidental wildlife/fish observations. Incidental observations (especially of aquatic or semi-aquatic species) can be useful to corroborate the eDNA results and/or as a positive quality control check.

### 4.2.4 Sample Filtration

Although the proposed RISC standard recommends that samples be filtered within 24 hours (Hobbs *et al.* 2017), Dr. Hanner advised that samples be filtered within 8 hours of collection to reduce the likelihood of eDNA degradation (pers. comm.). The 8-hour timing threshold was achieved for all samples except one collected for the "Main Alouette", which was stored on ice for 9 hours prior to filtering.

Sample filtration was performed at the office/lab following the procedure outlined in the proposed RISC standard (Hobbs *et al.* 2017). Briefly, a Masterflex L/S peristaltic pump was connected to a vacuum flask with silicone tubing. A sterile funnel filter is installed on top of the vacuum flask and the water sample is poured into the funnel. The pump was allowed to run for 1 hour for each 1 L sample bottle. For this project, we used cellulose nitrate filters with a pore size of 0.45  $\mu$ m (also recommended by the proposed RISC standard). Unfortunately, the relatively high turbidity of the watercourses, waterbodies, and wetlands sampled resulted in clogged filters fairly quickly. The volume of water filtered ranged from 100 mL (from "Addington Marsh") to 750 mL (from the Pitt River) out of 1 L. Typically, if filters do not become clogged, the full 2 L of water collected at each site would be filtered through a single membrane. Given the filtration challenges from the 2020 field samples, we used one filter membrane for each 1 L sample bottle – i.e., each site resulted in two sample filters. The sampling protocol can be adapted to mitigate turbidity issues; these measures will be discussed in Section 4.4.1.

Dried filters were handled with decontaminated tweezers while wearing a sterile glove. Each filter was placed into a labelled paper coin envelope, which was, in turn, placed into a Ziploc bag with silica gel desiccant packets. The Ziploc bags were then stored in the dark at room temperature until they were shipped to the Dr. Hanner's Laboratory at the University of Guelph. A desiccant-based preservation method is preferred by both the proposed RISC standard (Hobbs *et al.* 2017) and Dr. Hanner's Laboratory because, unlike ethanol preservation, dried filters do not require a Transportation of Dangerous Goods permit.

### 4.2.5 Laboratory and Bioinformatic Analyses

Sample filters were received at the Hanner Lab and stored in the freezer until extraction. DNA extraction was performed for each sample filter following a modified QIAGEN kit for DNA extractions (DNeasy Blood and Tissue kit). Extracts from the two sample filters for each site were combined for subsequent analyses.

A combination of universal PCR primers targeting 12S rRNA and COI genes were used to capture vertebrates (especially fish species; Miya et al. 2015, Sato et al. 2018) and freshwater invertebrates (Elbrecht and Leese 2017), respectively. Library preparation consisted of two rounds of PCR and clean-up steps (using magnetic beads). The first PCR amplifies the specific molecular marker to be used for molecular identification, while the second PCR complements the first to add specific adaptors/indexes to the amplicons in preparation for high-throughput sequencing using the Illumina MiSeq System with MiSeq reagent kit v3 (600 cycles).

For the bioinformatics analyses, the MiFish pipeline for metabarcoding analysis of fish/vertebrate mitochondrial eDNA was used, which compares the 12S rRNA gene sequences against the MitoFish

database (Sato *et al.* 2018). For freshwater invertebrates, the COI gene sequences were further analyzed using the Geneious software v10.2.4 (Geneious Biologics) against sequences in the Barcode of Life Database (BOLD).

Based on a cutoff value of 97% sequence similarity, a list of the species identified (or genus, if species-level identification was not possible) and their relative abundance in each sample was created. The results generated through the MiFish pipeline were manually vetted. Where results seemed implausible based on global species ranges and known occurrences of closely related native or introduced species in the area, additional Basic Local Alignment Search Tool (BLAST) analyses were run against the National Center for Biotechnology Information (NCBI) reference sequence database. The implausible results were then adjusted to reflect more likely species that were ranked as the top matches (typically 100% sequence similarity; no lower than 99.42%). Where more likely species were not the top matches, the implausible results are presented in Section 4.3.2 at the genus level to reflect this uncertainty. eDNA sequences from selected known species in the area were also re-analyzed using BLAST against the NCBI database as a data verification step; these results were consistent with the previous MiFish outputs.

A summary of the eDNA metabarcoding results is presented in Section 4.3.2. Further details about laboratory and bioinformatics methods and the full eDNA results are available in Appendix 2.

# 4.3 Results and Discussion

# 4.3.1 Environmental Conditions

Air temperature on the field days ranged from 19.6-33.0°C, and water temperature at the collection locations ranged from 17.3-27.5°C. The highest water temperature recorded was at 3:00 pm on July 27, 2020 (also the hottest day); this was a particularly long field day, whereas sample collection was generally completed by noon on other days. There was 0-5% cloud cover and no precipitation on the four sampling days between July 27 and August 5, 2020. On August 7, there was 100% cloud cover with intermittent light precipitation (also the coolest day). There was no canopy cover at any sampling location except the Katzie Slough at Harris Road, where two deciduous trees growing in the riparian area were providing shade over the watercourse. These conditions may not have been ideal for field sampling as eDNA degrades more quickly at higher temperatures and UV (Strickler *et al.* 2015). We attempted to mitigate these issues by keeping all sample bottles (empty, full, or partially full) on ice in a cooler (in the dark).

Measurements of pH ranged from a low of 6.6 (North Alouette River) to a high of 8.33 (Sturgeon Slough). The North Alouette may be more acidic due to water flow from the Codd Wetlands (mostly fen habitats; Ward *et al.* 1992) via Blaney Creek. These pH values are circumneutral or slightly basic and are unlikely to increase degradation of eDNA. The values are also within pH 6.5-9.0, the preferred/acceptable range for fish and other freshwater aquatic life, which have been adopted as approved water quality guidelines for aquatic life in BC (BC MOE 2019) and in the United States (US EPA 2020). Due to equipment malfunctions, water temperature and pH readings were not taken at the Wildwood Trail location of the Katzie Slough or at any location within the Pitt-Addington Marsh Wildlife Management Area.

#### 4.3.2 eDNA Metabarcoding

A total of 42 unique species were identified from the eDNA samples collected in Pitt Meadows, including 27 fishes, nine mammals, and six birds. Unfortunately, the PCR primers for freshwater invertebrates were not successful in recovering sequences of species in Pitt Meadows. Due to the use of PCR primers optimized for fish species (see Section 4.2.5 and Appendix 2), the results for non-fish vertebrates are likely

incomplete. All vertebrates identified are included in the summary tables presented in this section, and those that follow; however, the discussion will focus on native and introduced fish species. It is emphasized that the samples were collected in late summer, and thus may only represent species present within this season. Repeated sampling during the spring, early summer, fall, and winter with primers that are optimized to the group(s) of organisms of greatest interest to the City would provide a more complete set of species in Pitt Meadows. Repeating seasonal sampling among several years (e.g., every 3 years) would increase confidence in the patterning observed in results.

Some detections could not be identified to the species level; these results are presented at the genus level. The *Cottus* sp. detected are likely native species known to occur within Pitt Meadows waterways, such as coastrange sculpin (*C. aleuticus*) or prickly sculpin (*C. asper*). Similarly, *Salvelinus* sp. and *Ardea* sp. are suspected to be the native Dolly varden (*S. malma*) and great blue heron (*A. herodias*), respectively, and were included in the counts for native species. Among the exotic species, *Carassius* sp. and *Alosa* sp. are suspected to be goldfish (*C. auratus*) and American shad (*A. sapidissima*), both of which are known invasive fish species in BC and Pitt Meadows.

A few species detected are assumed to be domestic animals (e.g., farm animals, pets) as the presence of their wild ancestral species are unlikely or very unlikely to occur in Pitt Meadows. These species include Bos sp. (cow), Sus scrofa (wild boar; pig), Gallus gallus (red junglefowl; chicken), Meleagris gallopavo (wild turkey; turkey), and Canis lupus (wolf; dog). Other "domestic" species detected include Ovis aries (sheep) and Homo sapiens (humans).

A summary of the number of native species, invasive/introduced species, and domestic species detected at each sampling site is presented in **Table 4-1**, and a summary list of native and introduced <u>fish</u> species detected is shown in **Table 4-2**. Native species comprised the majority of species detected within the Alouette and Pitt rivers, whereas invasive species were detected with greater frequency within the Sturgeon and Katzie sloughs and Pitt-Addington WMA. A discussion about each general sampling area and the species detected is provided in the following Sections 4.3.2.1 through 4.3.2.4. The original results provided by the Hanner Laboratory are available in Appendix 2.

**Table 4-1.** Number of species by 'provincial status' detected at each sampling site through eDNA metabarcoding analysis, sorted by native species in descending order. Percentages are calculated out of the total number of species detected at that sampling site.

Sampling Site	Nat	tive	Intro	duced	Domestic		Total
South Alouette	12	75%	3	19%	1	6%	16
Main Alouette	12	63%	5	26%	2	11%	19
North Alouette	11	55%	6	30%	3	15%	20
Pitt River	9	64%	3	21%	2	14%	14
Katzie-Pitt	9	56%	6	38%	1	6%	16
Sturgeon Slough (Rannie Rd)	4	29%	9	64%	1	7%	14
Katzie Slough	3	27%	5	45%	3	27%	11
Katzie Marsh Duplicate	3	17%	10	56%	5	28%	18
Sturgeon Slough (Thompson Rd)	2	33%	4	67%	0	0%	6
Addington Marsh	1	14%	5	71%	1	14%	7
Katzie Marsh	0	0%	7	58%	5	42%	12

**Table 4-2.** Native and invasive/introduced fish species detected through eDNA studies. Eleven samples were collected throughout Pitt Meadows for the 2020 pilot project.

<b>Native Species</b>	No.	%	Introduced Species	No.	%
	Samples	Samples		Samples	Samples
Threespine stickleback	7	64%	Oriental weatherfish	11	100%
Cottus sp. (sculpin)	6	55%	Pumpkinseed	10	91%
Largescale sucker	6	55%	Largemouth bass	9	82%
Northern pikeminnow	6	55%	Carassius sp. (goldfish/carp)	8	73%
Peamouth	6	55%	Black crappie	5	45%
Redside shiner	4	36%	Common carp	5	45%
Sockeye salmon	4	36%	American shad	3	27%
Longnose dace	3	27%	Brown bullhead	3	27%
Rainbow trout	3	27%	Bluegill	2	18%
Chinook salmon	2	18%	Yellow bullhead	2	18%
Cutthroat trout	2	18%	Alosa sp. (shad)	1	9%
Mountain whitefish	2	18%	Prussian carp	1	9%
Coho salmon	1	9%			
Salvelinus sp. (char)	1	9%			
Starry flounder	1	9%			

#### 4.3.2.1 Alouette River

A total of 24 unique species were detected in the Alouette River samples, including 12 native fish species and six invasive/introduced fish species. **Table 4-3** presents the species that were detected in one, two, or all three sections of the Alouette River sampled. Overall, among native fish species detected in all three sampled areas, northern pikeminnow (*Ptychocheilus oregonensis*) produced the most eDNA reads, followed by threespine stickleback (*Gasterosteus aculeatus*), sculpins (*Cottus* sp.), and largescale sucker (*Catostomus macrocheilus*). In addition, low numbers of reads were attributed to various salmonid species. However, relatively high numbers of reads were also produced by the invasive American shad (*A. sapidissima*) and goldfish/carp (*Carassius* sp.) in the Main and North Alouette samples. Other known invasive fish species include pumpkinseed (*Lepomis gibbosus*), Oriental weatherfish (*Misgurnus anguillicaudatus*), largemouth bass (*Micropterus salmoides*), and common carp (*Cyprinus carpio*).

**Table 4-3.** Species detected in the Alouette River through eDNA metabarcoding analysis. Green = native species, red = known invasive/introduced species, yellow = "domestic" species. % RA = relative abundance of the reported species' sequence reads within a sample.

Species	MAIN	NORTH	SOUTH	Average of % RA of reads in eDNA sample
Northern pikeminnow	х	х	х	42.30
Threespine stickleback	х	х	х	17.92
Cottus sp.	х	х	х	9.47
Largescale sucker	х	х	х	7.74
Peamouth	х	х	х	3.21
Redside shiner	х	х	х	1.77
Longnose dace	Х	х	х	0.54

Rainbow trout	x	х	x	0.53
Coho salmon	х			0.39
Sockeye salmon	х	х	х	0.20
Cutthroat trout	х		х	0.18
American beaver		х	х	0.16
Mountain whitefish		х	х	0.08
Canada goose	х			0.07
American shad	Х	Х		12.94
Carassius sp.	Х	Х		5.59
Pumpkinseed	Х	Х	Х	1.69
Oriental weatherfish	X	Х	Х	0.80
Largemouth bass	X	Х		0.35
Common carp		Х		0.18
European rabbit			X	0.04
Human	х	х		0.62
Pig	х	Х		0.44
Cow		Х	х	0.06

#### 4.3.2.2 Katzie Slough

A total of 22 unique species were detected in samples collected from the Katzie Slough and at the confluence of the Katzie Slough and Pitt River, including nine native and eight invasive/introduced fish species. **Table 4-4** presents the species that were detected at one or both sampling areas.

Only one native fish species, the threespine stickleback, was found in the Katzie Slough. However, five invasive fish species were detected in the Katzie Slough, with goldfish/carp (*Carassius* sp.) producing the most eDNA reads. In contrast, nine native species occurred on the Pitt River side of the Kennedy pump station, which separates the Pitt River from Katzie Slough. Of these, four native species produced high eDNA reads (threespine stickleback, sculpins, peamouth, and northern pikeminnow). Invasive pumpkinseed, Oriental weatherfish, and largemouth bass were found on both sides of the pump station within both the Pitt River and Katzie Slough systems.

**Table 4-4.** Species detected in the Katzie Slough and at the confluence of the Katzie Slough and Pitt River through eDNA metabarcoding analysis. Green = native species, red = known invasive/introduced species, yellow = "domestic" species. % RA = relative abundance of the reported species' sequence reads within a sample.

Species	KATZIE-PITT	KATZIE SLOUGH	Average of % RA of reads in eDNA sample
Threespine stickleback	Х	х	43.77
Cottus sp.	Х		18.90
Peamouth	Х		18.68
Northern pikeminnow	Х		12.62
Largescale sucker	Х		2.82
Redside shiner	Х		1.55
Salvelinus sp.	Х		1.16
Chinook salmon	Х		0.56

Sockeye salmon	Х		0.55
· · · · · · · · · · · · · · · · · · ·	X		
American beaver		X	0.13
Ardea sp.		X	0.05
Carassius sp.		Х	21.62
Pumpkinseed	Х	Х	7.06
Oriental weatherfish	Х	Х	5.29
Black crappie	Х		2.78
Largemouth bass	Х	Х	1.69
Bluegill	Х		0.62
Alosa sp.	Х		0.42
Prussian carp		Х	0.19
Pig	Х	х	0.73
Cow		Х	0.13
Sheep		Х	0.11

### 4.3.2.3 Sturgeon Slough

A total of 16 unique species were detected in samples collected from the Sturgeon Slough at the Rannie Road and Thompson Road crossings, including five native fish species and nine invasive/introduced fish species. **Table 4-5** presents the species that were detected at one or both sampling areas. Only one native species, the threespine stickleback, was found at the upstream sampling location. There was no overlap in native species detection; however, five invasive species were detected at both locations. Of note, the top four species producing the most eDNA reads from the Rannie Rd sample are known invasive species: pumpkinseed, common carp, largemouth bass, and black crappie (*Pomoxis nigromaculatus*; see Appendix 2).

**Table 4-5.** Species detected in the Sturgeon Slough through eDNA metabarcoding analysis. Notes: Green = native species, red = known invasive/introduced species, yellow = "domestic" species. % RA = relative abundance of the reported species' sequence reads within a sample.

Smaring	DANNIE (1)	THOMPSON (2)	Average of % RA of
Species	RANNIE (1)	THOMPSON (2)	reads in eDNA sample
Threespine stickleback		X	44.49
Largescale sucker	Х		7.39
Northern pikeminnow	Х		2.43
Peamouth	Х		2.04
Cottus sp.	х		0.90
American beaver		х	0.61
Carassius sp.	Х	Х	22.56
Common carp	Х		16.99
Pumpkinseed	Х	Х	16.43
Black crappie	Х		13.91
Largemouth bass	Х	х	8.60
Oriental weatherfish	Х	Х	6.69
Bluegill	Х		2.24

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Brown bullhead	Х	0.15
Yellow bullhead	X	0.13
Human	х	0.17

#### 4.3.2.4 Pitt River and Pitt-Addington WMA

As eDNA sampling of the Pitt River occurred off the shoreline of the Pitt-Addington WMA, these results will be discussed together. A total of 29 unique species were detected from the four samples collected, including seven native fish species and nine invasive/introduced fish species. **Table 4-6** presents the species that were detected in each area sampled. Native threespine stickleback, sculpins, and peamouth produced the most eDNA reads in the Pitt River sample, and three known invasive species (Oriental weatherfish, common carp, American shad) were also detected. No native fish species were detected within the marsh samples; however, invasive species such as pumpkinseed, Oriental weatherfish, largemouth bass, and common carp were found with relatively high eDNA reads (see Appendix 2). Surprisingly, the Katzie Marsh samples contained eDNA from the greatest variety of domestic species despite not being in proximity to agricultural operations.

**Table 4-6.** Species detected in the Pitt River and in the Pitt-Addington WMA through eDNA metabarcoding analysis. Notes: Green = native species, red = known invasive/introduced species, yellow = "domestic" species. % RA = relative abundance of the reported species' sequence reads within a sample.

	DITT	ADDINGTON	WATTIE	KATZIE	Average of %
Species	PITT RIVER	ADDINGTON MARSH	KATZIE MARSH	MARSH DUPLICATE	RA of reads in eDNA sample
Threespine stickleback	Х				43.86
Cottus sp.	Х				22.36
Peamouth	Х				13.63
Northern pikeminnow	Х				5.79
Largescale sucker	Х				3.31
Chinook salmon	Х				1.22
Starry flounder	Х				0.60
American beaver	Х			х	0.19
American black bear		х			0.09
Mallard				х	0.06
Canada goose	Х				0.04
Red-winged blackbird				Х	0.04
Pumpkinseed		Х	Х	Х	38.39
Oriental weatherfish	Х	Х	Х	Х	29.24
Largemouth bass		Х	Х	Х	11.03
Common carp	Х		Х	Х	5.34
Black crappie		Х	Х	Х	2.00
American shad	Х				1.36
Carassius sp.		Х	Χ	Х	0.38
Brown bullhead			Х	Х	0.28
European rabbit				Х	0.26

House mouse				Х	0.06
Yellow bullhead				Х	0.05
Cow		х	Х	х	3.03
Pig	Х		Х		2.38
Human	Х		Х	х	0.75
Chicken			Х	х	0.65
Turkey				X	0.19
Dog			Х	Х	0.19

As shown in **Table 4-6**, the results for Katzie Marsh and its duplicate sample are not 100% concordant. However, as these samples were not true technical duplicates – i.e., the two samples were collected independently from the same location, rather than one sample collected in the field and subsequently aliquoted into two samples at the filtration step – minor differences may be expected due to water mixing or sediment disturbance, as well as laboratory 'errors' (see Section 4.3.5). Overall, the Katzie Marsh sample and duplicate were highly concordant for the species detected with higher numbers of reads (see Appendix 2).

#### 4.3.2.5 Prohibited Aquatic Invasive Species

Under the BC Wildlife Act, Schedule 3 of the Controlled Alien Species Regulations lists the invasive fish species that are **prohibited** from possession, breeding, release, sale, or transport in BC. Several invasive species detected in Pitt Meadows waterways through eDNA metabarcoding analyses are designated as prohibited, including Oriental weatherfish, brown bullhead (*Ameiurus nebulosus*), and yellow bullhead (*A. natalis*).

Oriental weatherfish was previously only documented in the Alouette River system<sup>5</sup>; however, since 2015 this invasive species has been found in other Pitt River tributaries and Pitt-Addington Marsh, as well as the Coquitlam River at Colony Farm (Cheater 2020, Pearson Ecological 2021). Based on eDNA data for the EIMS project, Oriental weatherfish was detected at all 11 areas sampled, with the most reads found within the Pitt-Addington WMA samples; its detection within the Katzie and Sturgeon sloughs may be a novel finding from this pilot project. Overall, the eDNA results for Oriental weatherfish suggest that this invasive species has spread into waterways throughout Pitt Meadows and should be reported to the BC Inter-Ministry Invasive Species Working Group (IMISWG).<sup>6</sup>

Brown bullhead and yellow bullhead are known to be present in the Lower Mainland<sup>7</sup>, including Fraser River tributaries and the lower Alouette River (Cheater 2020). Based on eDNA data, these two invasive species were only detected with very low eDNA reads in the Sturgeon Slough and Katzie Marsh (see Appendix 2). These results may also be novel findings from the eDNA pilot project and observations should be reported to the BC IMISWG.

<sup>&</sup>lt;sup>5</sup> https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/invasive-species/alerts/oriental weatherfish alert.pdf

<sup>&</sup>lt;sup>6</sup> https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/invasive-species/reporting-invasive-species

<sup>&</sup>lt;sup>7</sup> https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/invasive-species/alerts/bullhead\_alert.pdf

## 4.3.3 Riparian and Aquatic Vegetation

Riparian and aquatic vegetation at and around the sampling locations were recorded; however, these observations are not intended be a comprehensive vegetation inventory. Riparian vegetation was not noted for the Alouette nor Pitt rivers as sampling occurred away from the shoreline. However, knotweed (*Reynoutria* sp.) was observed along the north shore of the Alouette River during a separate site visit. Aquatic vegetation in the North and South Alouette rivers included the invasive Eurasian water-milfoil (*Myriophyllum spicatum*).

Riparian areas along the Katzie Slough were dominated by invasive species such as Himalayan blackberry (*Rubus armeniacus*) and reed canarygrass (*Phalaris arundinacea*); the latter was especially prevalent along Wildwood Trail. Furthermore, invasive parrot's-feather (*M. aquaticum*) was present in the Katzie Slough at Kennedy Road, and knotweed was found at the Lougheed Highway/MUP crossing of the Katzie Slough. Native riparian vegetation such as red-osier dogwood (*Cornus stolonifera*), salmonberry (*Rubus spectabilis*), and hardhack (*Spirea douglasii*) were found at the confluence of the Katzie Slough and Pitt River; and willows (*Salix* spp.), black cottonwood (*Populus trichocarpa*), hardhack, and ferns were present at the Meadow Gardens Golf Club – the presence of these native species may be the result of successful invasive species management and restorative plantings.

Similarly, vegetation in and around the Sturgeon Slough consisted of both native (e.g., cattails, duckweed) and invasive species (e.g., reed canarygrass, Himalayan blackberry, Eurasian water-milfoil). As the Pitt-Addington WMA is more natural and less disturbed, a greater variety of native plants were observed, including vine maple (*Acer circinatum*), black cottonwood, red-osier dogwood, hardhack, willows, cattails, bulrushes, bracken fern, horsetails, and lily pads and other aquatic vegetation. However, Himalayan blackberry and reed canarygrass were also present along the Katzie Marsh dike trail.

More information about invasive plant species observed during 2020 field work is presented in Section 5.0 of this Appendix.

## 4.3.4 Incidental Wildlife and Fish Observations

A variety of bird species were observed in and around the watercourses and wetlands sampled for eDNA (**Table 4-7**). Although wildlife observations made during breeding bird surveys and habitat quality assessments were presented in Section 3.3, it is useful to note species that were specifically observed near the eDNA sampling locations to aid with interpreting and corroborating laboratory results.

Mammals or mammal sign observed include a river otter (*Lontra canadensis*) swimming across the North Alouette River, a harbour seal (*Phoca vitulina*) in the Pitt River, and American black bear (*Ursus americanus*) scat on the dike trails in "Addington Marsh" and along the Sturgeon Slough. American bullfrogs (*Lithobates catesbeianus*) were heard calling along the North Alouette River, and there was high frog activity in Sturgeon Slough at the Thompson Road crossing. Dragonflies and mayflies were also observed along the Alouette River and Sturgeon Slough. Small fish were observed in "Alouette South" and in the Katzie Slough at the Meadow Gardens Golf Club; however, species identification could not be ascertained as no netting/trapping was conducted. A dead stickleback was observed in Sturgeon Slough at Thompson Road.

**Table 4-7.** Bird species observed during eDNA field work in July and August 2020. All species noted were also observed during breeding bird surveys and/or habitat quality assessments conducted in May and July 2021.

Common Name	Scientific Name
Mallard	Anas platyrhynchos
Great blue heron	Ardea herodias
Cedar waxwing	Bombycilla cedrorum
Canada goose	Branta canadensis
Red-tailed hawk	Buteo jamaicensis
Northern flicker	Colaptes auratus
American crow	Corvus brachyrhynchos
Common raven	Corvus corax
Pacific-slope flycatcher	Empidonax difficilis
Willow flycatcher	Empidonax traillii
Common loon	Gavia immer
Common yellowthroat	Geothlypis trichas
Bald eagle	Haliaeetus leucocephalus
Barn swallow	Hirundo rustica
Song sparrow	Melospiza melodia
Osprey	Pandion haliaetus
Spotted towhee	Pipilo maculatus
Black-capped chickadee	Poecile atricapillus
American goldfinch	Spinus tristis
Eurasian collared-dove	Streptopelia decaocto
European starling	Sturnus vulgaris
Tree swallow	Tachycineta bicolor
American robin	Turdus migratorius
Eastern kingbird	Tyrannus tyrannus
White-crowned sparrow	Zonotrichia leucophrys

## 4.3.5 Limitations of eDNA Pilot Project

Lack of amphibian data: Although the MiFish primer set targets a hypervariable region of the 12S rRNA gene and was expected to capture other vertebrate species (as evidenced by the detection of some mammals and birds), these primers are optimized for fish species (Miya et al. 2015, Sato et al. 2018). If detection of amphibians is a priority for the City (e.g., for SAR such as northern red-legged frog and western toad), universal PCR primers optimized for detection of amphibians or targeted qPCR surveys for specific SAR could be undertaken. Despite direct observations in the field (see Section 4.3.4), it is also possible that amphibian eDNA was not present in detectable amounts at the sampling locations due to factors such as eDNA shedding rate, transport, and degradation.

**Non-detection of known fish species**: A few species known to be present within Pitt Meadows waterways were notably absent from the eDNA metabarcoding results, including white sturgeon (*Acipenser transmontanus*) and salmonid species such as bull trout (*Salvelinus confluentus*), and pink salmon (*Oncorhynchus gorbuscha*). The absence of eDNA from these species may be due to temporal misalignment (i.e., sampling in July and August did not coincide with when the species are present), spatial misalignment in the water column (i.e., surface water sampling may not capture eDNA from a benthic-

feeding species such as white sturgeon), or other factors such as eDNA transport and degradation. If certain species are of particular interest to the City, such as white sturgeon or other fish SAR (see *Matrix of Habitat Suitability for SCC* in Appendix G of the *Pitt Meadows EIMS Final Report*), eDNA studies should be designed to maximize the likelihood of detecting these species through appropriate microhabitat selection, optimal timing windows, and repeated sampling.

# 4.4 Recommendations

The 2020 eDNA field sampling was a pilot project conducted by Zoetica staff at a select number of locations. Zoetica recommends that eDNA metabarcoding continue as a long-term monitoring program in the City to monitor for changes in native and invasive species presence and changes in aquatic community composition (i.e., biodiversity). Lessons learned from 2020 were incorporated into our recommendations in Section 4.4.1.

# 4.4.1 eDNA Sampling and Filtration

Although grab sampling using Nalgene bottles is a simple and cost-effective approach, without an additional pre-filtering step (which was not used for 2020 field work), collecting sediment and particulates is unavoidable and leads to filter clogging and smaller volumes of water being pumped through. As a result of filter clogging, less eDNA is captured and the amount of PCR inhibitors (e.g., organic material) that is trapped along with the eDNA increases; both of these factors can impact eDNA detection in the laboratory. As the watercourses, waterbodies, and wetlands in Pitt Meadows have relatively high turbidity, it is important to adapt the sampling and filtration methods to improve eDNA detection. There are a few options to mitigate these issues:

- Increasing the filter pore size filter pore sizes ranging from 0.2-5 μm have been used in eDNA studies. While some eDNA may pass through larger pore sizes, this drawback is balanced by increasing the amount of water that can flow through the filter, thus increasing the total amount of eDNA captured.
- Adding a pre-filter stage pre-filtering water samples through filters with larger pore sizes (e.g., 10-20 µm) will reduce the amount of sediment and particulates that end up on the final sample filter. An added benefit is that pre-filtering will likely reduce the amount of filtering time needed. However, as with increasing the pore size of the final filters, some eDNA loss may occur.
- Investing in an eDNA sampling backpack eDNA sampling backpacks combine sample collection and filtration in the field, and either have a pre-filter stage (Halltech OSMOS<sup>8</sup>) or have eDNA filter packs designed to reduce the capture of unwanted materials (Smith-Root eDNA Sampler<sup>9</sup>). These backpacks can also pump 1-2 L of water in a few minutes and would increase efficiency in the field/lab. eDNA sampling backpacks have a high capital cost (\$8,000-10,000) but could be cost-effective for a long-term monitoring program.

## 4.4.2 Sampling Locations

Establishing 'permanent' sampling stations will allow for collection and analysis of long-term eDNA data. The number and locations of sampling stations will ultimately depend on the City's objectives. Given what we understand about the City and its citizens' environmental priorities, we recommend continuing to

<sup>8</sup> http://halltech.ca/dir/products/osmos-edna-sampler/

<sup>&</sup>lt;sup>9</sup> https://www.smith-root.com/edna

monitor the Alouette River and Katzie Slough, and adding sampling locations along other sloughs where parrot's feather and/or Eurasian water-milfoil are known to be present (e.g., Cook Slough, Tulley Slough) and along connected watercourses where these invasive species have not yet spread. Parrot's feather and Eurasian water-milfoil continue to have severe and negative environmental, agricultural, and economic impacts in the City; they form dense layers that create stagnant waters, impacting native aquatic vegetation, insect, and fish populations, and favouring other invasive species (e.g., pumpkinseed). Monitoring these locations using eDNA metabarcoding could accomplish several objectives:

- 1) Creating a baseline of aquatic biodiversity to help prioritize management actions;
- 2) Comparing the current aquatic biodiversity in watercourses with and without *Myriophyllum* to understand how these invasive species are impacting native species;
- 3) Monitoring the effects of climate change (e.g., increasing water temperatures) on aquatic biodiversity; and,
- 4) Assessing the effectiveness of invasive species management, enhancement/restoration planting, or other stewardship actions by comparing monitoring results to baseline.

One logistical difficulty that Zoetica encountered during the summer of 2020 was a lack of access to waterbodies through private lands, and to certain areas of the City during optimal sampling periods due to COVID-19 trail closures. Depending on accessibility, conducting subsampling by paddling along the Katzie Slough (similar to how Zoetica sampled the Alouette River) would be valuable. However, Lina Azeez (Connected Waters Campaign Manager, Watershed Watch Salmon Society) commented on the difficulties of paddling through the mats of invasive aquatic vegetation in the Katzie Slough in recent years.

## 4.4.3 Sampling Timing and Frequency

Although eDNA methods for biodiversity are not as limited in their survey window as traditional methods that rely on live-capture or visual or audio observations, there are still optimal sampling times and conditions that should be employed for eDNA studies. It is best to collect samples during a time when biodiversity values are more likely to be present such as during the breeding season. Ideally, eDNA monitoring would occur seasonally and annually to capture eDNA from species that may only be present in the City's watercourses at certain times of year and to assess natural variation between years, respectively. However, given that there is a limited budget for eDNA studies, we recommend the following monitoring timing and frequency:

- Collect samples in spring/early summer (March-June)\* sampling during this time should enable capture of eDNA from fish (e.g., juvenile Pacific salmon), amphibians, and other species that breed in the area.
- **Collect samples every 2-3 years** this sampling frequency should be sufficient to detect short- or medium-term changes to biodiversity and to help inform environmental management decisions.
- \* As a result of access restrictions due to COVID-19 in the spring of 2020, Zoetica completed eDNA sampling in July and August for the EIMS project. Sampling earlier in the breeding season is recommended.

It is optimal to sample around the same date between years to allow for scientifically valid comparisons; however, the schedule will likely need to remain flexible to accommodate inclement weather conditions. It is recommended that sample collection be avoided during or immediately after heavy rains, as the resulting high-flow conditions are more likely to dilute or transport eDNA away from the course, or inhibit laboratory analyses by increasing suspended particulates, both of which may lead to false negative results

(Hobbs *et al.* 2017). Conversely, these conditions may also stir up sediments that have trapped historic eDNA, leading to false positive results about current species presence (Turner *et al.* 2015).

## 4.4.4 Roles and Responsibilities

Refer to the *Roles and Responsibilities for Implementation Framework* memo in Appendix E of the *Pitt Meadows EIMS Final Report* for more information on how an eDNA monitoring program can be implemented by the City, in collaboration with external parties, and integrated into future environmental management plans.

With respect to field work, as eDNA sample collection and filtration methods are relatively simple and can be undertaken by trained persons, there are several options for implementation, depending on available resources.

- City of Pitt Meadows staff field staff such as members of the Parks, Recreation & Culture or Engineering & Operations departments could undertake eDNA sampling during maintenance activities along selected waterways.
- Katzie First Nation as Pitt Meadows is part of the Katzie First Nation's traditional territory, they
  may want to undertake the eDNA monitoring. Katzie First Nation is a member Nation of the Lower
  Fraser Fisheries Alliance, which is also conducting an eDNA study. We recommend that the City
  discuss potential partnerships with Katzie First Nation.
- Stewardship groups staff or volunteers from the Friends of Katzie Slough, Alouette River Management Society, or Watershed Watch Salmon Society could conduct eDNA sampling in conjunction with riparian replanting projects or other activities.
- **Local students** as the use of eDNA metabarcoding is a new and exciting tool in biodiversity studies, there is potential for research project(s) to be undertaken at the same time as monitoring as part of the EIMS. Post-secondary students from local universities/colleges interested in directed studies or other independent research could assist the City with eDNA monitoring.

## 5.0 INVASIVE VEGETATION

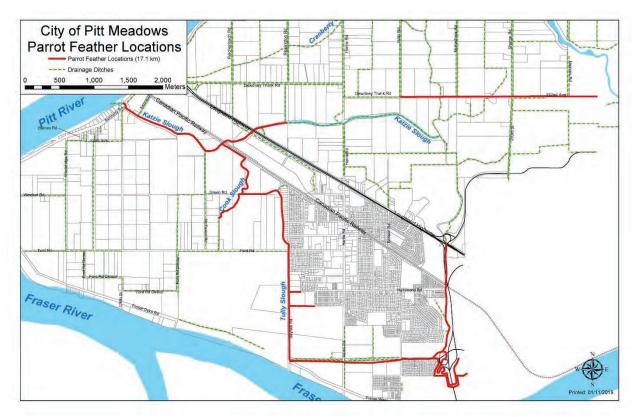
## 5.1 Introduction

The City of Pitt Meadows currently lists knotweed species (*Reynoutria* spp.), giant hogweed (*Heracleum mantegazzianum*), parrot's feather (*Myriophyllum aquaticum*), and Eurasian water-milfoil (*M. spicatum*) as invasive and noxious plant species of concern on their website (City of Pitt Meadows 2020). The City has been tracking the spread of parrot's feather since 2004. From its original discovery in the Tulley Slough at Ford Road and Baynes Road, this invasive species has spread into Cook Slough, Katzie Slough, and other waterways and drainage ditches throughout the City (**Figure 5-1**). Mechanical removal efforts by the City have occurred, but eradication is very difficult; parrot's feather continues to pose a significant environmental and socio-economic problem.

The BC Ministry of Environment manages the Invasive Alien Plant Program (IAPP)<sup>10</sup>, an invasive plant map and database that provides information about invasive plant surveys, treatments, and activity plans. The IAPP can assist the City with planning and implementing an effective invasive plant management program.

<sup>&</sup>lt;sup>10</sup> https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/invasive-species/iapp

The IAPP web map shows the known locations of invasive plant species within Pitt Meadows; current information from the IAPP database is presented in Section 5.3.2.



**Figure 5-1.** Identified parrot's feather locations in the City of Pitt Meadows as of November 1, 2019. Map figure provided by the City of Pitt Meadows.

# 5.2 Methods

Ten common invasive plant species were highlighted for field assessments of habitat quality (see *Habitat Quality Assessment and SEI Verification* memo in Appendix B of the *Pitt Meadows EIMS Final Report*):

- Provincially noxious weeds regulated under the Weed Control Act Canada thistle (Cirsium arvense), giant hogweed, Japanese knotweed (Reynoutria japonica), purple loosestrife (Lythrum salicaria), and yellow flag iris (Iris pseudacorus);
- Unregulated invasive plants of concern in BC (ISCBC 2020) Scotch broom (*Cytisus scoparius*), field bindweed/morning glory (*Convolvulus arvensis*), and Himalayan blackberry (*Rubus armeniacus*); and,
- Unregulated invasive species of concern in Metro Vancouver (ISCMV 2020) parrot's feather and reed canarygrass (*Phalaris arundinacea*).

For invasive species of particular concern (e.g., due to their significant environmental and/or socioeconomic impacts and management challenges), such as Japanese knotweed and parrot's feather, any incidental observations were recorded along with GPS coordinates.

## 5.3 Results and Discussion

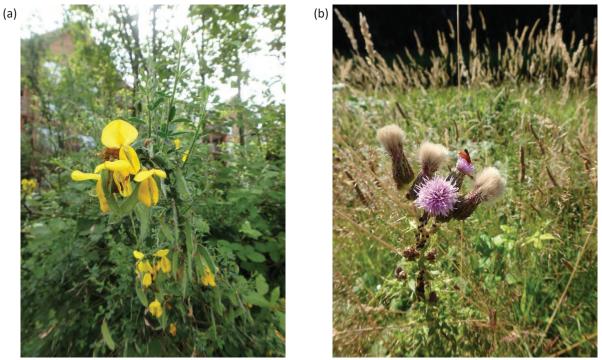
## 5.3.1 2020 Field Data

During habitat quality assessments, eight of the 10 highlighted invasive plant species were detected (see Figure 4-34 in the Pitt Meadows EIMS Final Report). Himalayan blackberry was the most frequently observed invasive species and was found throughout the City (Figure 5-2a). Reed canarygrass was the second most observed species and was common in the Pitt-Addington Marsh area (hereafter 'Pitt-Addington WMA' to denote the area north of Koerner Rd) and in riparian/wetland areas of waterways around the City (Figure 5-2b). Yellow flag iris was observed along the Pitt and Alouette rivers, in the Pitt-Addington WMA, and at MacLean Park within the urban City area. Scotch broom was observed in more developed areas of the City, including the wetland habitats across from the airport, off Wildwood Trail, and at MacLean Park (Figure 5-3a); and the young forest habitat at the intersection of Sutton Ave and Bonson Rd. Morning glory (field or hedge bindweed) was recorded twice within young forest habitats with human disturbance. Japanese knotweed was observed in disturbed edge habitats and adjacent to greenway paths/trails throughout the City, including the northern edge of the wetland habitat between Pitt-Addington WMA and the transmission line ROW north of Swaneset. Canada thistle was observed along the Swan Dike Trail at Katzie Marsh (Figure 5-3b) and adjacent to the old field habitat along the Pitt River Regional Greenway. Purple loosestrife was only observed at the dike trails around Katzie Marsh. Parrot's feather was not observed during habitat quality assessments, which were focused on terrestrial habitats; however, this invasive species was found during eDNA sampling (see below). Giant hogweed was not observed during 2020 field work for the EIMS project.





**Figure 5-2.** (a) Himalayan blackberry (shown at bottom left) east of the Rannie Road crossing at Sturgeon Slough. (b) Reed canarygrass dominating the riparian area of Katzie Slough off Wildwood Trail. Photos were taken on July 28-29, 2020 during eDNA sampling.



**Figure 5-3.** (a) Invasive Scotch broom found at MacLean Park on May 28, 2020. (b) Invasive Canada thistle (among larger patches) found along the Swan Dyke Trail at Katzie Marsh on July 21, 2020.

Japanese knotweed and Canada thistle were infrequently observed during formal assessments/surveys; however, several incidental observations of these two provincially noxious weeds were made during the spring/summer of 2020 (see Figure 4-34 in the *Pitt Meadows EIMS Final Report*). Japanese knotweed was most prevalent along the Lougheed Highway MUP and the Great Trail (previously Trans Canada Trail); it was also observed along the north shore of the Alouette River during a separate site visit. Canada thistle was found along the Lougheed Highway MUP east of Katzie Slough, off Wildwood Trail near the "Do not enter; fish habitat" sign, and along the Swan Dike Trail east of Katzie Marsh.

In addition to the 10 highlighted species, several other invasive or weedy species were noted during habitat quality assessments, including creeping buttercup (*Ranunculus repens*) and other buttercup species, cutleaf evergreen blackberry (*Rubus laciniatus*), English ivy (*Hedera helix*), yellow archangel (*Lamium galeobdolon*), common foxglove (*Digitalis purpurea*), butterfly-bush (*Buddleja davidii*), herb-Robert (*Geranium robertianum*), and common weeds such as horsetails, dandelions, clovers, and cinquefoils.

During eDNA sampling, both invasive aquatic and terrestrial vegetation were documented. Five of the 10 highlighted invasive species were observed in and around the watercourses and wetlands sampled (see Figure 4-34 in the *Pitt Meadows EIMS Final Report*). Himalayan blackberry and reed canarygrass were common in riparian areas. Purple loosestrife was observed along the dike trails around the Pitt-Addington WMA. Japanese knotweed was observed once at the Lougheed Highway MUP crossing of the Katzie Slough. Parrot's feather was observed at various points along the Katzie Slough, most notably at Kennedy Landing (Figure 5-4a-b), but one emergent stem was observed at the Lougheed Highway MUP crossing (Figure 5-5).

Based on observations at the Kennedy pump station and results from community engagement (see Appendix A in the *Pitt Meadows EIMS Final Report*), parrot's feather continues to be a major problem in the Katzie Slough. It was apparent that invasive species management actions had been attempted, as the results of these efforts were piled upland from the slough; however, despite not being in the water, the parrot's feather was alive and appeared to be thriving (**Figure 5-4c-d**).

Eurasian watermilfoil, another invasive aquatic plant species of concern, was frequently observed in the North Alouette River and the south arm of the Alouette River (Figure 5-6). Eurasian watermilfoil was also observed at the eDNA sampling location at Sturgeon Slough, west of Rannie Road.



**Figure 5-4.** (a-b) Parrot's feather in the Katzie Slough at Kennedy Road on July 28, 2020 and September 12, 2020. This species spread quickly within 1.5 months and emergent plants have formed a mat along the far shore. (c-d) The results of previous management efforts piled upland observed on July 28, 2020 and September 12, 2020, showing that these invasive plants are still alive.



**Figure 5-5.** Emergent stem of parrot's feather amongst lily pads in the Katzie Slough under the multi-use path between Lougheed Highway and the railroad. Other invasive species at this site include Japanese knotweed and Himalayan blackberry.





**Figure 5-6.** Dense mats of Eurasian watermilfoil observed in the (a) North Alouette River and (b) south arm of the Alouette River on July 27, 2020.

# 5.3.2 Invasive Alien Plant Program Data

Access to the IAPP web map is free and unrestricted. However, access to the database for more in-depth analyses requires a business BCeID. Zoetica was granted access to the database in October 2020; a brief summary of notable invasive species observations from the 'Invasive Alien Plant Site' dataset, available from the BC Data Catalogue<sup>11</sup>, is provided here.

A total of 24 invasive plant species have been recorded within the City of Pitt Meadows in the IAPP database (**Table 5-1**). Of these, seven species are Provincially Noxious Weeds and regulated under the *Weed Control Act*, 11 species are considered provincial priority invasive species by the BC Inter-Ministry Invasive Species Working Group (seven in the medium-high risk "Regional Containment/Control" category, and four in the lower risk "Management" category), and 12 species are considered additional unregulated invasive plants of concern in BC according to the Invasive Species Council of BC (ISCBC). At a regional scale, the Invasive Species Council of Metro Vancouver's (ISCMV) priority plant list includes all of the IAPP-documented species within the City except for curled dock and Japanese wireweed. **Table 5-1** also presents regional priority and other invasive species of concern that are not currently documented in the IAPP database but were noted during 2020 field work; these species include reed canarygrass, morning glory, foxglove, herb-Robert, and creeping buttercup.

IAPP data for the City currently include 200 records of the 24 invasive plant species (**Table 5-2** and Figure 4-34 in the *Pitt Meadows EIMS Final Report*). Most observations have been made on City- or provincially-owned land, and records appear to be concentrated in more highly trafficked areas (e.g., Lougheed Highway, Harris Road, Pitt Marsh and Katzie Marsh dikes, Hoffmann Park). Japanese knotweed is by far the most frequently documented species (78 records), which likely reflects the management priorities of Metro Vancouver. Japanese knotweed has been recorded throughout the City – mostly along Lougheed Highway and Harris Road, but also at various locations within urban centre and areas close to the Pitt and Alouette rivers. Himalayan blackberry, yellow flag iris, and flat pea (*Lathyrus sylvestris*) have been recorded most frequently along the Pitt and Katzie marsh dikes; however, it is likely that the invasive blackberry species is underreported as it is abundant throughout the City (see Section 5.3.1).

Two disturbed locations near the Pitt River Bridge and Trans Canada/Great Trail harboured six different invasive plant species (together comprising eight unique species): Canada thistle, Himalayan blackberry, Japanese knotweed, Scotch broom, St. John's wort (*Hypericum perforatum*), common tansy (*Tanacetum vulgare*), curled dock (*Rumex crispus*), and cutleaf blackberry. Seven different invasive plants have been reported at Hoffmann Park: English ivy, Himalayan blackberry, English holly (*Ilex aquifolium*), yellow archangel, Japanese knotweed, daphne/spurge laurel (*Daphne laureola*), and common periwinkle (*Vinca minor*).

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<sup>&</sup>lt;sup>11</sup> https://catalogue.data.gov.bc.ca/dataset/invasive-alien-plant-site

**Table 5-1.** Invasive plant species documented in the City of Pitt Meadows in the IAPP database and during 2020 EIMS field work, and their current provincial and regional priority rankings

IAPP Map	Count	Common Name	Scientific Name	BC Noxious	EDRR (1)	ISCBC Additional	ISCMV	2020 EIMS
Label				Weeds	Priority (1)	Plants of Concern	Rank (2)	Field Work (3)
HI	29	Himalayan blackberry	Rubus armeniacus		R	X	82%*	X
ВО	2	Bohemian knotweed	Reynoutria x bohemica	X	R		80%*	
JK	78	Japanese knotweed	Reynoutria japonica	X	R		80%*	X
EW	2	Eurasian watermilfoil	Myriophyllum spicatum		M	X	80%	X
EI	9	English ivy	Hedera helix			X	78%*	X
YI	3	Yellow iris	Iris pseudacorus	X	R		78%*	X
PL	12	Purple loosestrife	Lythrum salicaria	X	M		76%*	X
CL	7	Cutleaf blackberry	Rubus laciniatus				72%	X
PF	1	Parrot feather	Myriophyllum aquaticum				72%*	X
SB	8	Scotch broom	Cytisus scoparius		R	X	72%*	X
		Reed canarygrass	Phalaris arundinacea				70%*	X
BD	2	Butterfly bush	Buddleja davidii			X	66%	X
SL	1	Daphne / spurge laurel	Daphne laureola		M	X	64%	
СТ	4	Canada thistle	Cirsium arvense	X			64%	Χ
но	7	English holly	Ilex aquifolium			X	62%*	
YN	2	Yellow nutsedge	Cyperus esculentus	X			62%	
SJ	4	St. John's wort	Hypericum perforatum			X	58%	
		Hedge bindweed	Calystegia sepium				56%	(X)
TC	4	Common tansy	Tanacetum vulgare		R		56%	
YA	6	Yellow archangel	Lamium galeobdolon		R	X	56%*	X
		Foxglove	Digitalis purpurea				46%	X
CP	2	Common periwinkle	Vinca minor			X	42%	
ВТ	3	Bull thistle	Cirsium vulgare			X	40%	
SH	1	Scentless chamomile	Tripleurospermum inodorum	X	M		40%	
FP	10	Flat pea / flat peavine	Lathyrus sylvestris				36%	
		Herb-Robert	Geranium robertianum				32%	X
CD	2	Curled dock	Rumex crispus			X		
		Creeping buttercup	Ranunculus repens			X		X
		Field bindweed	Convolvulus arvensis			X		(X)
JW	1	Japanese wireweed	Sargassum muticum					

Notes: (1) EDRR – BC Invasive Species Early Detection and Rapid Response Plan. Priorities developed by the BC Inter-Ministry Invasive Species Working Group and the Provincial Government's Invasive Species Specialists, current to February 2020. Management categories: R – Regional Containment/Control; M – Management. (2) Metro Vancouver Invasive Plant Prioritization Rankings from the ISCMV's list of 94 plant species evaluated to August 2020, where rankings ranged from 30-84%. An asterisk (\*) indicates that Metro Vancouver has developed a BMP to manage the invasive species. (3) Field bindweed and hedge bindweed (both commonly called "morning glory") were not distinguished during 2020 field work for the EIMS project.

**Table 5-2.** Number of IAPP records for each invasive species found within the City of Pitt Meadows and the jurisdiction/land ownership where the plant was found. See Table 3-1 for map label codes and species names.

Jurisdiction	BD	ВО	ВТ	CD	CL	CP	CT	EI	EW	FP	Н	НО	JK	JW	PF	PL	SB	SH	SJ	SL	TC	YA	ΥI	YN	Total
BC Rail													1												1
CP Rail													1												1
Ministry of Forests, Lands and Natural Resource Operations					1				2	10	11					12			3				3		42
Ministry of Transportation and Infrastructure		1	3	2	4	1	4	3			9	1	16				6	1	1		4	4			60
Municipality owned land	2				2	1		6			7	6	49	1	1		2			1		2			80
Private Land		1											2											2	5
Regional District owned land											2		9												11
Total	2	2	3	2	7	2	4	9	2	10	29	7	78	1	1	12	8	1	4	1	4	6	3	2	200

## 5.4 Recommendations

As noted in Section 5.3.2, access to the IAPP database requires a business BCeID. The City would benefit from obtaining access to the raw IAPP data such that spatial and temporal analyses can be made to inform management decisions. For example, the City can use these IAPP data to:

- Identify areas where the number and/or abundance of invasive species is highest;
- Identify areas where invasive species threaten rare or at-risk native species or ecological communities (when combined with at-risk species occurrences available from the BC Conservation Data Centre<sup>12</sup>);
- Identify areas where particularly problematic invasive species (e.g., parrot's feather, Japanese knotweed) have been found; and,
- Identify where invasive plant surveys and treatments have already occurred to help direct future management actions and monitoring efforts.

It is also recommended that the City and local environmental groups contribute data to the IAPP to help inform regional or provincial invasive species management plans/programs. Documentation and tracking of invasive species would support the City's continuing work with the ISCMV and neighbouring municipalities toward implementation of a long-term regional plan (City of Pitt Meadows 2020).

Zoetica recommends that the City develop and implement an invasive species management program that expands upon their current focus on City-owned lands and road rights of way (City of Pitt Meadows 2020) to include waterways. Refer to Section 5.0, EIMS Management Framework: Policy and Action Recommendations, of the *Pitt Meadows EIMS Final Report* for more information on how the City can develop an invasive species management plan, in collaboration with Metro Vancouver, Katzie First Nation, community groups, and other government agencies.

During community engagement conducted in August and September 2020 for the EIMS project, parrot's feather and its impact on water flow (especially within the Katzie Slough) was brought up as a major concern by multiple stakeholders (see Appendix A in the *Pitt Meadows EIMS Final Report*). The following recommendations are based on best management practices (BMPs), input from the community and other stakeholders, existing invasive species data and 2020 field data, and practical considerations:

- Priority invasive plant species continue focusing on parrot's feather and Eurasian watermilfoil, knotweed species, and giant hogweed (if found). Effective management (complete eradication) of these species will require sustained, long-term efforts.
- Priority areas for management If additional resources are available, management of other invasive species in priority areas can be undertaken. For example, water in the Katzie Slough near Wildwood Trail is stagnant and becoming increasingly warmer, and the slough is currently surrounded by invasive reed canarygrass. Increasing canopy cover through habitat enhancement tree plantings would provide multiple benefits shading out reed canarygrass to allow native riparian vegetation to grow, and cooling water temperatures, making the Katzie Slough more favourable to native fish species. Feedback from the community included concerns about the presence of pumpkinseed and other invasive fish species, and lack of salmonids, in this and other sections of the Katzie Slough. Another example is to undertake proactive and dedicated invasive

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<sup>&</sup>lt;sup>12</sup> https://www2.gov.bc.ca/gov/content/<u>environment/plants-animals-ecosystems/conservation-data-centre</u>

- species management at Hoffmann Park. A variety of invasive plants have been observed at the park but are relatively limited in spatial extent, making this option potentially more feasible for the City. Proactive management of invasive species would help maintain the long-term health of this remnant mature forest stand and its understorey of native vegetation.
- Management methods follow the invasive species BMPs developed by Metro Vancouver and the ISCMV<sup>13</sup>, which include recommendations for treatment type(s), timing, and monitoring. Of the 10 common invasive plant species highlighted for habitat quality assessments for the EIMS project, BMPs are currently available for all except Canada thistle and field bindweed/morning glory. Additional BMPs have been developed for English and Irish ivies, English holly, Himalayan balsam (policeman's helmet), wild chervil, and yellow archangel, as well as for European chafer beetle and European fire ant.
- Roles and responsibilities depending on the recommended methods outlined in the invasive species BMPs, management actions may need to be undertaken by hired contractors or City staff (e.g., chemical stem injections, excavation or dredging using heavy machinery), or they can be done with assistance from environmental stewardship groups and the community (e.g., hand pulling). As described in the Roles and Responsibilities for Implementation Framework memo in Appendix E of the Pitt Meadows EIMS Final Report, the City's Engineering and Operations department currently coordinates management of invasive species, and the Parks, Recreation, and Culture department manages invasive species in the City's parks and recreation areas. Zoetica recommends that the City works with Friends of the Katzie Slough to help manage invasive plants.

# 6.0 REFERENCES

Balasingham, K. D., R. P. Walter, N. E. Mandrak, and D. D. Heath. 2018. Environmental DNA detection of rare and invasive fish species in two Great Lakes tributaries. Molecular Ecology 27:112–127.

Baxter, B. 2016. NuSEDS Background Information. Fisheries and Oceans Canada.

BC MOE. 2008. Interim Hygiene Protocols for Amphibian field staff and researchers.

- BC MOE. 2019. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture: Summary Report. Ministry of Environment & Climate Change Strategy, Water Protection & Sustainability Branch.
- BC MOF. 1998. Fish-stream Identification Guidebook, Version 2.1. 2nd edition. Forest Practices Code of British Columbia Act, Operational Planning Regulation.
- Bedwell, M. E., and C. S. Goldberg. 2020. Spatial and temporal patterns of environmental DNA detection to inform sampling protocols in lentic and lotic systems. Ecology and Evolution 10:1602–1612.
- Bell-Irving, R. 1978. Salmon Escapements. Potential Pacific Coast Oil Ports: A Comparative Environmental Risk Analysis. Volume II Supplementary Appendices. Fisheries and Environment Canada, Working Group on West Coast, Deepwater Oil Ports, Vancouver, BC.
- Brett, J. R. 1952. Temperature Tolerance in Young Pacific Salmon, Genus Oncorhynchus. Journal of the Fisheries Board of Canada 9:265–323.

 $<sup>\</sup>frac{\text{13 http://www.metrovancouver.org/services/regional-planning/conserving-connecting/invasive-species/Pages/default.aspx}{}$ 

- Chan, L., O. Hillel, T. Elmqvist, P. Werner, N. Holman, A. Mader, and E. Calcaterra. 2014. User's Manual on the Singapore Index on Cities' Biodiversity (also known as the City Biodiversity Index). National Parks Board, Singapore, Singapore.
- Cheater, D. 2020. December 3, 2020 Watershed Watch Salmon Society Opinion Letter to Pitt Meadows City Council. Ecojustice on behalf of Watershed Watch Salmon Society.
- City of Pitt Meadows. 2020. Invasive & Noxious Species Control. https://www.pittmeadows.ca/our-community/environment-sustainability/invasive-noxious-species-control.
- Civade, R., T. Dejean, A. Valentini, N. Roset, J. C. Raymond, A. Bonin, P. Taberlet, and D. Pont. 2016. Spatial Representativeness of Environmental DNA Metabarcoding Signal for Fish Biodiversity Assessment in a Natural Freshwater System. PLoS ONE 11:1–19.
- Cristescu, M. E., and P. D. N. Hebert. 2018. Uses and Misuses of Environmental DNA in Biodiversity Science and Conservation. Annual Review of Ecology, Evolution, and Systematics 49:209–230.
- Deiner, K., H. M. Bik, E. Mächler, M. Seymour, A. Lacoursière-Roussel, F. Altermatt, S. Creer, I. Bista, D. M. Lodge, N. de Vere, M. E. Pfrender, and L. Bernatchez. 2017. Environmental DNA metabarcoding: Transforming how we survey animal and plant communities. Molecular Ecology 26:5872–5895.
- Elbrecht, V., and F. Leese. 2017. Validation and development of COI metabarcoding primers for freshwater macroinvertebrate bioassessment. Frontiers in Environmental Science 5:1–11.
- Garner, T. W. J., M. W. Perkins, P. Govindarajulu, D. Seglie, S. Walker, A. A. Cunningham, and M. C. Fisher. 2006. The emerging amphibian pathogen Batrachochytrium dendrobatidis globally infects introduced populations of the North American bullfrog, Rana catesbeiana. Biology Letters 2:455–459.
- Goldberg, C. S., C. R. Turner, K. Deiner, K. E. Klymus, P. F. Thomsen, M. A. Murphy, S. F. Spear, A. McKee, S. J. Oyler-McCance, R. S. Cornman, M. B. Laramie, A. R. Mahon, R. F. Lance, D. S. Pilliod, K. M. Strickler, L. P. Waits, A. K. Fremier, T. Takahara, J. E. Herder, and P. Taberlet. 2016. Critical considerations for the application of environmental DNA methods to detect aquatic species. Methods in Ecology and Evolution 7:1299–1307.
- Goldberg, C., and K. Strickler. 2017. eDNA Protocol: Sample Collection. Washington State University.
- Gullison, T., J. Hardner, S. Anstee, and M. Meyer. 2015. Good Practices for the Collection of Biodiversity Baseline Data. Prepared for the Multilateral Financing Institutions Biodiversity Working Group & Cross Sector Biodiversity Initiative.
- Hänfling, B., L. L. Handley, D. S. Read, C. Hahn, J. Li, P. Nichols, R. C. Blackman, A. Oliver, and I. J. Winfield. 2016. Environmental DNA metabarcoding of lake fish communities reflects long-term data from established survey methods. Molecular Ecology 25:3101–3119.
- Harper, L. R., A. S. Buxton, H. C. Rees, K. Bruce, R. Brys, D. Halfmaerten, D. S. Read, H. V. Watson, C. D. Sayer, E. P. Jones, V. Priestley, E. Mächler, C. Múrria, S. Garcés-Pastor, C. Medupin, K. Burgess, G. Benson, N. Boonham, R. A. Griffiths, L. Lawson Handley, and B. Hänfling. 2019a. Prospects and challenges of environmental DNA (eDNA) monitoring in freshwater ponds. Hydrobiologia 826:25–41.
- Harper, L. R., L. Lawson Handley, A. I. Carpenter, M. Ghazali, C. Di Muri, C. J. Macgregor, T. W. Logan, A. Law, T. Breithaupt, D. S. Read, A. D. McDevitt, and B. Hänfling. 2019b. Environmental DNA (eDNA)

- metabarcoding of pond water as a tool to survey conservation and management priority mammals. Biological Conservation 238:108225.
- Harrison, J. B., J. M. Sunday, and S. M. Rogers. 2019. Predicting the fate of eDNA in the environment and implications for studying biodiversity. Proceedings of the Royal Society B: Biological Sciences 286:20191409.
- Helbing, C. C., and J. Hobbs. 2019. Environmental DNA Standardization Needs for Fish and Wildlife Population Assessments and Monitoring. Standards Research. Canadian Standards Association (CSA Group).
- Henderson, M. A., and C. C. Graham. 1998. History and Status of Pacific Salmon in British Columbia. North Pacific Anadromous Fish Commission:13–22.
- Hering, D., A. Borja, J. I. Jones, D. Pont, P. Boets, A. Bouchez, K. Bruce, S. Drakare, B. Hänfling, M. Kahlert,
  F. Leese, K. Meissner, P. Mergen, Y. Reyjol, P. Segurado, A. Vogler, and M. Kelly. 2018.
  Implementation options for DNA-based identification into ecological status assessment under the
  European Water Framework Directive. Water Research 138:192–205.
- Hobbs, J., C. S. Goldberg, C. C. Helbing, and N. Veldhoen. 2017. Environmental DNA Protocol for Freshwater Aquatic Ecosystems, Version 2.2. Prepared for BC Ministry of Environment, Ecosystems Branch.
- ISCBC. 2020. List of Regulated Invasive Plants in BC. Invasive Species Council of British Columbia. https://bcinvasives.ca/invasive-species/about/regulated-invasive-species-in-bc/list-of-regulated-invasive-plants-in-bc.
- ISCMV. 2020. Priority Plants. Invasive Species Council of Metro Vancouver. https://iscmv.ca/invasive-species/priority-plants/.
- Kelly, R. P., A. O. Shelton, and R. Gallego. 2019. Understanding PCR Processes to Draw Meaningful Conclusions from Environmental DNA Studies. Scientific Reports 9:1–14.
- Klymus, K. E., N. T. Marshall, and C. A. Stepien. 2017. Environmental DNA (eDNA) metabarcoding assays to detect invasive invertebrate species in the Great Lakes. PLoS ONE 12:1–24.
- Lacoursière-Roussel, A., Y. Dubois, E. Normandeau, and L. Bernatchez. 2016. Improving herpetological surveys in eastern North America using the environmental DNA method. Genome 59:991–1007.
- Li, J., T. W. Hatton-Ellis, L. J. Lawson Handley, H. S. Kimbell, M. Benucci, G. Peirson, and B. Hänfling. 2019. Ground-truthing of a fish-based environmental DNA metabarcoding method for assessing the quality of lakes. Journal of Applied Ecology 56:1232–1244.
- Lopes, C. M., T. Sasso, A. Valentini, T. Dejean, M. Martins, K. R. Zamudio, and C. F. B. Haddad. 2017. eDNA metabarcoding: a promising method for anuran surveys in highly diverse tropical forests. Molecular Ecology Resources 17:904–914.
- McDougall, R. D. 1987. Classification of British Columbia Salmon Stream Escapements by Species and Subdistrict. Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 1870. Planning and Economics Branch, Fisheries and Oceans Canada, Vancouver, BC.
- Miya, M., Y. Sato, T. Fukunaga, T. Sado, J. Y. Poulsen, K. Sato, T. Minamoto, S. Yamamoto, H. Yamanaka, H. Araki, M. Kondoh, and W. Iwasaki. 2015. MiFish, a set of universal PCR primers for metabarcoding

- environmental DNA from fishes: Detection of more than 230 subtropical marine species. Royal Society Open Science 2.
- MOE. 2014. Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia. Section 5.6 South Coast Region. British Columbia Ministry of Environment.
- Pearl, C. A., M. J. Adams, R. B. Bury, and B. McCreary. 2004. Asymmetrical Effects of Introduced Bullfrogs (Rana catesbeiana) on Native Ranid Frogs in Oregon. Copeia:11–20.
- Pearson Ecological. 2021. Dojo Loach. https://pearsonecological.com/fish-l2-single/dojo-loach/.
- PFRCC. 1999. Proceedings Climate Change and Salmon Stocks. Pacific Fisheries Resource Conservation Council, Vancouver, BC.
- Ralph, C. J., J. R. Sauer, and S. Droege, editors. 1995. Monitoring Bird Populations by Point Counts. General Technical Report PSW-GTR-14. Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture, Albany, California.
- RIC. 1999. Inventory Methods for Forest and Grassland Songbirds. Standards for Components of British Columbia's Biodiversity No. 15. Prepared by Ministry of Environment, Lands and Parks, Resources Inventory Branch for the Terrestrial Ecosystems Task Force, Resources Inventory Committee.
- Rousseu, F., and B. Drolet. 2015. Prediction of the nesting phenology of birds in Canada. Project NestWatch. Bird Studies Canada / Études d'Oiseaux Canada. https://www.birdscanada.org/apps/rnest/warning.jsp.
- Ruppert, K. M., R. J. Kline, and M. S. Rahman. 2019. Past, present, and future perspectives of environmental DNA (eDNA) metabarcoding: A systematic review in methods, monitoring, and applications of global eDNA. Global Ecology and Conservation 17:e00547.
- Sato, Y., M. Miya, T. Fukunaga, T. Sado, and W. Iwasaki. 2018. MitoFish and MiFish pipeline: A mitochondrial genome database of fish with an analysis pipeline for environmental DNA metabarcoding. Molecular Biology and Evolution 35:1553–1555.
- Strickler, K. M., A. K. Fremier, and C. S. Goldberg. 2015. Quantifying effects of UV-B, temperature, and pH on eDNA degradation in aquatic microcosms. Biological Conservation 183:85–92.
- The eDNA Society. 2019. Environmental DNA Sampling and Experiment Manual Version 2.1. eDNA Methods Standardization Committee, Otsu, Japan.
- Tompkins, A., and B. Baxter. 2015. Pacific Salmon Escapement Estimation Methods and Data for Canada. NPAFC Doc. 1604. Fisheries and Oceans Canada.
- Turner, C. R., K. L. Uy, and R. C. Everhart. 2015. Fish environmental DNA is more concentrated in aquatic sediments than surface water. Biological Conservation 183:93–102.
- US EPA. 2020. National Recommended Water Quality Critiera Aquatic Life Criteria Table. United States Environmental Protection Agency. https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table.
- Ushio, M., H. Fukuda, T. Inoue, K. Makoto, O. Kishida, K. Sato, K. Murata, M. Nikaido, T. Sado, Y. Sato, M. Takeshita, W. Iwasaki, H. Yamanaka, M. Kondoh, and M. Miya. 2017. Environmental DNA enables detection of terrestrial mammals from forest pond water. Molecular Ecology Resources 17:e63–e75.

- Ushio, M., K. Murata, T. Sado, I. Nishiumi, M. Takeshita, W. Iwasaki, and M. Miya. 2018. Demonstration of the potential of environmental DNA as a tool for the detection of avian species. Scientific Reports 8:1–10.
- Valentini, A., P. Taberlet, C. Miaud, R. Civade, J. Herder, P. F. Thomsen, E. Bellemain, A. Besnard, E. Coissac, F. Boyer, C. Gaboriaud, P. Jean, N. Poulet, N. Roset, G. H. Copp, P. Geniez, D. Pont, C. Argillier, J. M. Baudoin, T. Peroux, A. J. Crivelli, A. Olivier, M. Acqueberge, M. Le Brun, P. R. Møller, E. Willerslev, and T. Dejean. 2016. Next-generation monitoring of aquatic biodiversity using environmental DNA metabarcoding. Molecular Ecology 25:929–942.
- Ward, P., K. Moore, and R. Kistritz. 1992. Wetlands of the Fraser Lowland, 1989: An Inventory. Technical Report Series No. 146. Canadian Wildlife Service, Pacific and Yukon Region, British Columbia.
- Zinger, L., A. Bonin, I. G. Alsos, M. Bálint, H. Bik, F. Boyer, A. A. Chariton, S. Creer, E. Coissac, B. E. Deagle, M. De Barba, I. A. Dickie, A. J. Dumbrell, G. F. Ficetola, N. Fierer, L. Fumagalli, M. T. P. Gilbert, S. Jarman, A. Jumpponen, H. Kauserud, L. Orlando, J. Pansu, J. Pawlowski, L. Tedersoo, P. F. Thomsen, E. Willerslev, and P. Taberlet. 2019. DNA metabarcoding—Need for robust experimental designs to draw sound ecological conclusions. Molecular Ecology 28:1857–1862.
- Zoetica, and LFFA. 2020. Lower Fraser Climate Adapt Project: Phase 2 Progress Report. Prepared by Zoetica Environmental Consulting Services and the Lower Fraser Fisheries Alliance.

# APPENDIX 1 - BREEDING BIRD LISTS

**Table A-1.** Full list of species observed during breeding bird surveys conducted in the City of Pitt Meadows in May 2020 and observed incidentally during summer 2020 field work (n=69). Species shaded grey = incidental observations (not detected during systematic point count surveys). Species at risk are highlighted in bold.

Species	ed during systematic point count sui			64.04
Code	Common Name	Scientific Name	BC List	SARA
	UPI	LAND BREEDING BIRDS		
RWBL	Red-winged Blackbird	Agelaius phoeniceus	Yellow	-
CEDW	Cedar Waxwing	Bombycilla cedrorum	Yellow	-
ANHU	Anna's Hummingbird	Calypte anna	Yellow	-
WIWA	Wilson's Warbler	Cardellina pusilla	Yellow	-
SWTH	Swainson's Thrush	Catharus ustulatus	Yellow	-
BRCR	Brown Creeper	Certhia americana	Yellow	-
MAWR	Marsh Wren	Cistothorus palustris	Yellow	-
EVGR	Evening Grosbeak	Coccothraustes vespertinus	Yellow	Special Concern
NOFL	Northern Flicker	Colaptes auratus	Yellow	-
WEWP	Western Wood-Pewee	Contopus sordidulus	Yellow	-
AMCR	American Crow	Corvus brachyrhynchos	Yellow	-
CORA	Common Raven	Corvus corax	Yellow	-
STJA	Steller's Jay	Cyanocitta stelleri	Yellow	-
PIWO	Pileated Woodpecker	Dryocopus pileatus	Yellow	-
PSFL	Pacific-slope Flycatcher	Empidonax difficilis	Yellow	-
WIFL	Willow Flycatcher	Empidonax traillii	Yellow	-
BRBL	Brewer's Blackbird	Euphagus cyanocephalus	Yellow	-
COYE	Common Yellowthroat	Geothlypis trichas	Yellow	-
HOFI	House Finch	Haemorhous mexicanus	Yellow	-
PUFI	Purple Finch	Haemorhous purpureus	Yellow	-
BARS	Barn Swallow	Hirundo rustica	Blue	Threatened
BUOR	Bullock's Oriole	Icterus bullockii	Yellow	-
OCWA	Orange-crowned Warbler	Leiothlypis celata	Yellow	-
RECR	Red Crossbill	Loxia curvirostra	Yellow	-
BEKI	Belted Kingfisher	Megaceryle alcyon	Yellow	-
SOSP	Song Sparrow	Melospiza melodia	Yellow	-
ВНСО	Brown-headed Cowbird	Molothrus ater	Yellow	-
SAVS	Savannah Sparrow	Passerculus sandwichensis	Yellow	-
LAZB	Lazuli Bunting	Passerina amoena	Yellow	-
BHGR	Black-headed Grosbeak	Pheucticus melanocephalus	Yellow	-
SPTO	Spotted Towhee	Pipilo maculatus	Yellow	-
WETA	Western Tanager	Piranga ludoviciana	Yellow	-
ВССН	Black-capped Chickadee	Poecile atricapilla	Yellow	-
RUHU	Rufous Hummingbird	Selasphorus rufus	Yellow	-
YRWA	Yellow-rumped Warbler	Setophaga coronata	Yellow	-
YEWA	Yellow Warbler	Setophaga petechia	Yellow	-

Appendix C: Pitt Meadows EIMS – 2020 Field Surveys and Desk-based Research

RBNU	Red-breasted Nuthatch	Sitta canadensis	Yellow	-					
PISI	Pine Siskin	Spinus pinus	Yellow	-					
AMGO	American Goldfinch	Spinus tristis	Yellow	-					
CHSP	Chipping Sparrow	Spizella passerina	Yellow	-					
EUCD	Eurasian Collared-Dove	Streptopelia decaocto	Exotic	-					
EUST	European Starling	Sturnus vulgaris	Exotic	-					
TRES	Tree Swallow	Tachycineta bicolor	Yellow	-					
VGSW	Violet-green Swallow	Tachycineta thalassina	Yellow	-					
BEWR	Bewick's Wren	Thryomanes bewickii	Yellow	-					
PAWR	Pacific Wren	Troglodytes pacificus	Yellow	-					
AMRO	American Robin	Turdus migratorius	Yellow	-					
EAKI	Eastern Kingbird	Tyrannus tyrannus	Yellow	-					
WAVI	Warbling Vireo	Vireo gilvus	Yellow	-					
WCSP	White-crowned Sparrow	Zonotrichia leucophrys	Yellow	-					
RAPTORS									
RTHA	Red-tailed Hawk	Buteo jamaicensis	Yellow	-					
TUVU	Turkey Vulture	Cathartes aura	Yellow	-					
MERL	Merlin	Falco columbarius	Yellow	-					
BAEA	Bald Eagle	Haliaeetus leucocephalus	Yellow	-					
OSPR	Osprey	Pandion haliaetus	Yellow	-					
BADO	Barred Owl	Strix varia	Yellow	-					
		WATERFOWL							
WODU	Wood Duck	Aix sponsa	Yellow	-					
MALL	Mallard	Anas platyrhynchos	Yellow	-					
CANG	Canada Goose	Branta canadensis	Yellow	-					
AMWI	American Wigeon	Mareca americana	Yellow	-					
BWTE	Blue-winged Teal	Spatula discors	Yellow	-					
		OTHER WATERBIRDS							
SACR	Sandhill Crane	Antigone canadensis	Yellow	-					
GBHE	Great Blue Heron	Ardea Herodias fannini	Blue	Special Concern					
GRHE	Green Heron	Butorides virescens	Blue	-					
KILL	Killdeer	Charadrius vociferus	Yellow	-					
COLO	Common Loon	Gavia immer	Yellow	-					
GWGU	Glaucous-winged Gull	Larus glaucescens	Yellow	-					
DCCO	<b>Double-crested Cormorant</b>	Phalacrocorax auritus	Blue	-					
SORA	Sora	Porzana carolina	Yellow	-					

**Table A-2.** Full list of breeding bird species (observed between May through August) reported on eBird Canada within built-up areas of City of Pitt Meadows from 2018-2020 (n=149). Species at risk are highlighted in bold.

Common Name	Scientific Name	BC List	SARA
	UPLAND BIRDS	- 1	
Red-winged Blackbird	Agelaius phoeniceus	Yellow	-
American Pipit	Anthus rubescens	Yellow	-
Cedar Waxwing	Bombycilla cedrorum	Yellow	-
Anna's Hummingbird	Calypte anna	Yellow	-
Wilson's Warbler	Cardellina pusilla	Yellow	-
Swainson's Thrush	Catharus ustulatus	Yellow	-
Brown Creeper	Certhia americana	Yellow	-
Vaux's Swift	Chaetura vauxi	Yellow	-
Common Nighthawk	Chordeiles minor	Yellow	Threatened
Marsh Wren	Cistothorus palustris	Yellow	-
Evening Grosbeak	Coccothraustes vespertinus	Yellow	Special Concern
Northern Flicker	Colaptes auratus	Yellow	-
Rock Pigeon	Columba livia	Exotic	-
Olive-sided Flycatcher	Contopus cooperi	Blue	Threatened
Western Wood-Pewee	Contopus sordidulus	Yellow	-
American Crow	Corvus brachyrhynchos	Yellow	-
Northwestern Crow	Corvus caurinus	Yellow	-
Common Raven	Corvus corax	Yellow	-
Steller's Jay	Cyanocitta stelleri	Yellow	-
Black Swift	Cypseloides niger	Blue	Endangered
Downy Woodpecker	Dryobates pubescens	Yellow	-
Hairy Woodpecker	Dryobates villosus	Yellow	-
Pileated Woodpecker	Dryocopus pileatus	Yellow	-
Gray Catbird	Dumetella carolinensis	Yellow	-
Pacific-slope Flycatcher	Empidonax difficilis	Yellow	-
Hammond's Flycatcher	Empidonax hammondii	Yellow	-
Willow Flycatcher	Empidonax traillii	Yellow	-
Brewer's Blackbird	Euphagus cyanocephalus	Yellow	-
MacGillivray's Warbler	Geothlypis tolmiei	Yellow	-
Common Yellowthroat	Geothlypis trichas	Yellow	-
House Finch	Haemorhous mexicanus	Yellow	-
Purple Finch	Haemorhous purpureus	Yellow	-
Barn Swallow	Hirundo rustica	Blue	Threatened
Bullock's Oriole	Icterus bullockii	Yellow	-
Varied Thrush	Ixoreus naevius	Yellow	-
Dark-eyed Junco	Junco hyemalis	Yellow	-
Northern Shrike	Lanius borealis	Yellow	-
Orange-crowned Warbler	Leiothlypis celata	Yellow	-
Gray-crowned Rosy-Finch	Leucosticte tephrocotis	Yellow	-

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Belted Kingfisher	Megaceryle alcyon	Yellow	-
Lincoln's Sparrow	Melospiza lincolnii	Yellow	-
Song Sparrow	Melospiza melodia	Yellow	-
Brown-headed Cowbird	Molothrus ater	Yellow	-
Townsend's Solitaire	Myadestes townsendi	Yellow	-
Sage Thrasher	Oreoscoptes montanus	Red	Endangered
House Sparrow	Passer domesticus	Exotic	-
Savannah Sparrow	Passerculus sandwichensis	Yellow	-
Fox Sparrow	Passerella iliaca	Yellow	-
Lazuli Bunting	Passerina amoena	Yellow	-
Band-tailed Pigeon	Patagioenas fasciata	Blue	Special Concern
Cliff Swallow	Petrochelidon pyrrhonota	Yellow	-
Ring-necked Pheasant	Phasianus colchicus	Exotic	-
Black-headed Grosbeak	Pheucticus melanocephalus	Yellow	-
Spotted Towhee	Pipilo maculatus	Yellow	-
Western Tanager	Piranga ludoviciana	Yellow	-
Black-capped Chickadee	Poecile atricapillus	Yellow	-
Chestnut-backed Chickadee	Poecile rufescens	Yellow	-
Purple Martin	Progne subis	Blue	-
Bushtit	Psaltriparus minimus	Yellow	-
Ruby-crowned Kinglet	Regulus calendula	Yellow	-
Golden-crowned Kinglet	Regulus satrapa	Yellow	-
Rufous Hummingbird	Selasphorus rufus	Yellow	-
Yellow-rumped Warbler	Setophaga coronata	Yellow	-
Black-throated Gray Warbler	Setophaga nigrescens	Yellow	-
Yellow Warbler	Setophaga petechia	Yellow	-
American Redstart	Setophaga ruticilla	Yellow	-
Townsend's Warbler	Setophaga townsendi	Yellow	-
Mountain Bluebird	Sialia currucoides	Yellow	-
Red-breasted Nuthatch	Sitta canadensis	Yellow	-
Red-breasted Sapsucker	Sphyrapicus ruber	Yellow	-
Pine Siskin	Spinus pinus	Yellow	-
American Goldfinch	Spinus tristis	Yellow	-
Chipping Sparrow	Spizella passerina	Yellow	-
Northern Rough-winged			
Swallow	Stelgidopteryx serripennis	Yellow	-
Eurasian Collared-Dove	Streptopelia decaocto	Exotic	-
Western Meadowlark	Sturnella neglecta	Yellow	-
European Starling	Sturnus vulgaris	Exotic	-
Tree Swallow	Tachycineta bicolor	Yellow	-
Violet-green Swallow	Tachycineta thalassina	Yellow	-
Bewick's Wren	Thryomanes bewickii	Yellow	-
Pacific Wren	Troglodytes pacificus	Yellow	-

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Snow Goose	Anser caerulescens	Yellow	-
Greater White-fronted Goose	Anser albifrons	Yellow	-
Mallard	Anas platyrhynchos	Yellow	-
Green-winged Teal	Anas crecca	Yellow	-
Northern Pintail	Anas acuta	Yellow	-
Wood Duck	Aix sponsa	Yellow	-
	WATERFOWL	•	
Osprey	Pandion haliaetus	Yellow	-
Bald Eagle	Haliaeetus leucocephalus	Yellow	-
American Kestrel	Falco sparverius	Yellow	-
Peregrine Falcon	Falco peregrinus	Red	Special Concern
Merlin	Falco columbarius	Yellow	-
Northern Harrier	Circus hudsonius	Yellow	-
Turkey Vulture	Cathartes aura	Yellow	-
Red-tailed Hawk	Buteo jamaicensis	Yellow	-
Great Horned Owl	Bubo virginianus	Yellow	-
Short-eared Owl	Asio flammeus	Blue	Special Concern
Golden Eagle	Aquila chrysaetos	Yellow	-
Northern Saw-whet Owl	Aegolius acadicus	Yellow	-
Sharp-shinned Hawk	Accipiter striatus	Yellow	-
Cooper's Hawk	Accipiter cooperii	Yellow	-
Time Gownea Spanow	RAPTORS	1011044	1
White-crowned Sparrow	Zonotrichia leucophrys	Yellow	-
Golden-crowned Sparrow	Zonotrichia atricapilla	Yellow	_
Mourning Dove	Zenaida macroura	Yellow	_
Yellow-headed Blackbird	Xanthocephalus xanthocephalus	Yellow	_
Hutton's Vireo	Vireo huttoni	Yellow	-
Warbling Vireo	Vireo gilvus	Yellow	-
Western Kingbird	Tyrannus verticalis	Yellow	-
Eastern Kingbird	· '		-
Eastern Kingpird	Turdus migratorius Tyrannus tyrannus	Yellow	-

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American Wiggen	Maraga amariaana	Yellow	
American Wigeon	Mareca americana	_	-
Eurasian Wigeon	Mareca penelope	No Status	-
Gadwall	Mareca strepera	Yellow	-
Common Merganser	Mergus merganser	Yellow	-
Northern Shoveler	Spatula clypeata	Yellow	-
Cinnamon Teal	Spatula cyanoptera	Yellow	-
Blue-winged Teal	Spatula discors	Yellow	-
	OTHER WATERBIRDS		
Spotted Sandpiper	Actitis macularius	Yellow	-
Sandhill Crane	Antigone canadensis	Yellow	-
Great Blue Heron	Ardea herodias	Blue	Special Concern
American Bittern	Botaurus lentiginosus	Blue	Threatened
Killdeer	Charadrius vociferus	Yellow	-
American Coot	Fulica americana	Yellow	-
Wilson's Snipe	Gallinago delicata	Yellow	-
Common Loon	Gavia immer	Yellow	-
Mew Gull	Larus canus	Yellow	-
Ring-billed Gull	Larus delawarensis	Yellow	-
Glaucous-winged Gull	Larus glaucescens	Yellow	-
Long-billed Curlew	Numenius americanus	Blue	Special Concern
Whimbrel	Numenius phaeopus	Red	-
American White Pelican	Pelecanus erythrorhynchos	Red	-
<b>Double-crested Cormorant</b>	Phalacrocorax auritus	Blue	-
Pied-billed Grebe	Podilymbus podiceps	Yellow	-
Sora	Porzana carolina	Yellow	-
Virginia Rail	Rallus limicola	Yellow	-
Lesser Yellowlegs	Tringa flavipes	Yellow	-
Greater Yellowlegs	Tringa melanoleuca	Yellow	-
Solitary Sandpiper	Tringa solitaria	Yellow	-

# APPENDIX 2 – eDNA METABARCODING METHODS AND RESULTS

#### **Laboratory Methods**

Amplicon sequencing libraries were prepared from the extracted eDNA following the procedures described in the 16S Metagenomic Sequencing Library Preparation Guide (Illumina) (1) and by Miya *et al.* (2) and Elbrecht & Leese (3). The universal MiFish primers (2) and the BF2+BR2 primers (3) were used as the locus-specific sequences to target the hypervariable region of fish mitochondria 12S rRNA gene and COI gene, respectively. The library quality and quantity were assessed by a Fragment Analyzer Automated CE System with the dsDNA 935 reagent kit (Agilent Technologies) and Qubit® Fluorometer with the Qubit® dsDNA BR Assay kit (Thermo Fisher Scientific). The purified libraries were then normalized and combined in an equal molar ratio for sequencing. PhiX (Illumina) was included to serve as an internal control for sequencing, and a fish control containing ten different species was included to monitor the entire process. Sequencing was conducted using a MiSeq sequencer with a MiSeq Reagent Kit v2 (Illumina) and 2x250 paired-end cycles according to the manufacturer's protocol.

## **Bioinformatics**

Raw sequence reads were filtered using the MiSeq Sequencer System Software (Illumina) to remove low-quality sequences and trimmed to remove adaptor sequences. The 12S rRNA gene sequences were further analyzed using the MiFish pipeline described by Sato *et al.* (4). The sequence database for the fish mitochondria 12S rRNA gene target was MitoFish (4).

The COI gene sequences were further analyzed using the Geneious software v10.2.4 (Geneious Biologics) against sequences in the Barcode of Life Database (BOLD) (<a href="http://www.boldsystems.org">http://www.boldsystems.org</a>). FastQ raw data files were analyzed sequentially as follows: 1) paired reads were set; 2) sequences were trimmed with BBDuk version 38.84, keeping a minimum sequence quality of 20 Phred (i.e., 99% base call accuracy), and a minimum length of 200 bp; 3) paired-end reads were merged with BBMerge version 38.84; 4) duplicates were removed with Dedupe version 38.84; 5) clustering was completed by *de novo* assembly using Geneious assembler, as well as minimum overlap identity of 98%; and, 6) the Basic Local Alignment Search Tool (BLAST) was used to compare the sequence library against curated databases for species identification.

The analysis programs align the sequences with the database sequences, identifies a target to taxonomic genus or species and generates data summaries of taxa present. A list of species composition per sample and for each molecular marker has been created, including genus/species identified in each sample and their relative abundance based on a cutoff value of 97% sequence similarity. The list of species ID is based on successful matches when comparing against the DNA reference database. Successful hits are considered based on the percentages of pairwise genetic identity/identical sites and query coverage, where each match receives a score (e.g., bit-score). The summary list of species shows the best-positioned match per sequence.

#### Data Checks and Verification

The results generated through the MiFish pipeline were manually vetted. Where results seemed implausible based on global species ranges and known occurrences of closely related native or introduced species in the area, additional BLAST analyses were run against the National Center for Biotechnology Information (NCBI) reference sequence database. The implausible results were then adjusted to reflect

more likely species that were ranked as the top matches (typically 100% sequence similarity; no lower than 99.42%). Where more likely species were not the top matches, the implausible results are presented in Section 4.3.2 at the genus level to reflect this uncertainty. In the case of *Ardea cinerea*, where the likely species (*A. herodias*) was not listed in the BLAST results, further investigation revealed that 12S rRNA gene sequences for *A. herodias* (or the *fannini* subspecies) do not currently exist in the NCBI nucleotide database. eDNA sequences from selected known species in the area were also re-analyzed using BLAST against the NCBI database as a data verification step; these results were consistent/as expected.

The results tables shown below present the original and vetted results with notes of explanation. Where species identification was corrected for implausible species, the number of reads and relative read abundance values were combined as appropriate.

#### Limitations

eDNA metabarcoding results need to be interpreted carefully. There are several reasons why implausible species appeared in the original results: 1) The list of species identified is based on the best match when compared against the DNA reference database. However, the best match may not be the correct assignment, depending on the marker's ability to discriminate against closely related species, and the comprehensiveness of the reference libraries (and accounting for geographic/subspecies variation). 2) The presence of implausible species could potentially be associated with human activities, such as fishing, runoff, and wastewater processing. That is, the source of eDNA from non-native, non-invasive species could be from baitfish, aguaculture, domestic animals, or food products (for humans and animals). 3) It is also important to consider the <u>number of reads</u> and relative read abundance of the unlikely species. Results with very low relative read abundance may be associated with amplification bias and general stochasticity, and carryover or 'tag jumping' on the MiSeq sequencer is also a possibility. 4) The sample may have been contaminated with DNA from other samples or other sources. 5) Finally, if there are no plausible alternatives as determined through rigorous bioinformatic analyses, the unlikely species could be real. Native species could be undergoing shifts in their range, or invasive species may have recently arrived. Depending on the City's budget and priorities, additional eDNA studies and/or traditional surveys (e.g., minnow trapping) can be conducted in the field to verify the results of this pilot project.

#### References

- 1. 16S Metagenomic Sequencing Library Preparation Guide Preparing 16S Ribosomal RNA Gene Amplicons for the Illumina MiSeq System (Part 15044223 Rev. B).
- 2. Miya M *et al.* 2015. MiFish, a set of universal PCR primers for metabarcoding environmental DNA from fishes: detection of more than 230 subtropical marine species. R. Soc. open sci. 2: 150088.
- 3. Elbrecht V and Leese F. 2017. Validation and Development of COI Metabarcoding Primers for Freshwater Macroinvertebrate Bioassessment. Front. Environ. Sci. 5:11. doi: 10.3389/fenvs. 2017.00011.
- 4. Sato Y *et al.* 2018. MitoFish and MiFish Pipeline: A Mitochondrial Genome Database of Fish with an Analysis Pipeline for Environmental DNA Metabarcoding. Mol. Biol. Evol. 35(6):1553–1555.

# Metabarcoding Analysis of eDNA - MiFish Target

For the following tables, **bold** and strikethrough text indicate changes to the original results (generated by the MiFish pipeline) based on additional NCBI BLAST analyses and ecological interpretation and consideration of known native species ranges or introduced species for the area. Number of reads and relative read abundance were combined where appropriate. See notes below each table for details.

\*%RA: Relative abundance of the reported species within a sample

Sample ID	20-075884-0001	(C-ALOUETTE_SOUTH)			
	Genus	Species (scientific name)	Species (common name)	# of Reads	% RA*
	Ptychocheilus	Ptychocheilus oregonensis	Northern pikeminnow	49,382	73.81
	Cottus <sup>1</sup>	/	/	6,277	9.38
	Gasterosteus	Gasterosteus aculeatus	Threespine stickleback	5,087	7.60
	Catostomus	Catostomus macrocheilus	Largescale sucker	2,411	3.60
	Richardsonius	Richardsonius balteatus	Redside shiner	1,526	2.28
	Oncorhynchus	Oncorhynchus mykiss	Rainbow trout	796	1.19
	Rhinichthys	Rhinichthys cataractae	Longnose dace	537	0.80
	Cottus	Cottus perplexus	Reticulate sculpin	288	0.43
	Oncorhynchus	Oncorhynchus nerka	Sockeye salmon	266	0.40
	Comephorus	<i>f</i>	+	234	0.35
	Lepomis	Lepomis gibbosus	Pumpkinseed	195	0.29
	Mylocheilus	Mylocheilus caurinus	Peamouth	127	0.19
	Misgurnus <sup>2</sup>	Misgurnus anguillicaudatus	Oriental weatherfish	97	0.14
	Misgurnus	Misgurnus mizolepis	Mud loach	74	0.11
	Prosopium	Prosopium williamsoni	Mountain whitefish	57	0.09
	Castor	Castor canadensis	American beaver	52	0.08
	Bos	/	/	48	0.07
	Oryctolagus	Oryctolagus cuniculus	European rabbit	24	0.04
	<del>Paramisgurnus</del>	<del>Paramisgurnus dabryanus</del>	Large-scale loach	23	0.03
	Oncorhynchus	Oncorhynchus clarkii	Cutthroat trout	22	0.03
Total numb	er of reported rea	ads		66,904	
Total perce	nt of reads occupi	ied by the reported species			100.00
Total numb	er of raw reads (R	R1+R2)		162,985	
Total numb	er of assembled r	eads		75,415	

#### <u>Notes</u>

- 1. Cottus perplexus and Comephorus were re-classified as Cottus sp. (already detected in this sample with 5,755 reads).
- 2. *Misgurnus mizolepis* and *Paramisgurnus dabryanus* (considered by some to be the same species) were re-classified as *Misgurnus anguillicaudatus* (new row added to this table).

Appendix C: Pitt Meadows EIMS – 2020 Field Surveys and Desk-based Research

Sample ID	20-075884-0002	(B-ALOUETTE_MAIN)			
	Genus	Species (scientific name)	Species (common name)	# of Reads	% RA*
	Ptychocheilus	Ptychocheilus oregonensis	Northern pikeminnow	13,384	31.72
	Gasterosteus	Gasterosteus aculeatus	Threespine stickleback	9,285	22.00
	Alosa	Alosa sapidissima	American shad	5,296	12.55
	Cottus <sup>1</sup>	/	/	5,191	12.30
	Catostomus	Catostomus macrocheilus	Largescale sucker	5,011	11.88
	Mylocheilus	Mylocheilus caurinus	Peamouth	1,298	3.08
	Richardsonius	Richardsonius balteatus	Redside shiner	791	1.87
	Lepomis	Lepomis gibbosus	Pumpkinseed	612	1.45
	Rhinichthys	Rhinichthys cataractae	Longnose dace	288	0.68
	Misgurnus <sup>2</sup>	Misgurnus anguillicaudatus	Oriental weatherfish	266	0.63
	<del>Misgurnus</del>	Misgurnus mizolepis	Mud loach	<del>194</del>	0.46
	Oncorhynchus	Oncorhynchus kisutch	Coho salmon	165	0.39
	Oncorhynchus	Oncorhynchus clarkii	Cutthroat trout	139	0.33
	Sus	Sus scrofa	Wild boar	124	0.29
	Oncorhynchus	Oncorhynchus mykiss	Rainbow trout	108	0.26
	<del>Paramisgurnus</del>	<del>Paramisgurnus dabryanus</del>	Large-scale loach	<del>72</del>	0.17
	Carassius	/	/	66	0.16
	Comephorus	<i>f</i>	<del>/</del>	<del>61</del>	0.14
	Oncorhynchus	Oncorhynchus nerka	Sockeye salmon	55	0.13
	Homo	Homo sapiens	Human	50	0.12
	Micropterus	Micropterus salmoides	Largemouth bass	35	0.08
	Branta	Branta canadensis	Canada goose	31	0.07
Total numb	er of reported rea	ads		42,195	
Total perce	nt of reads occup	ied by the reported species			100.00
Total numb	er of raw reads (F	R1+R2)		133,090	
Total numb	er of assembled r	eads		62,048	

- 1. Comephorus was re-classified as Cottus sp. (already detected in this sample with 5,130 reads).
- 2. *Misgurnus mizolepis* and *Paramisgurnus dabryanus* (considered by some to be the same species) were re-classified as *Misgurnus anguillicaudatus* (new row added to this table).

Sample ID	20-075884-0003	(D-ALOUETTE_NORTH)			
	Genus	Species (scientific name)	Species (common name)	# of Reads	% RA*
	Gasterosteus	Gasterosteus aculeatus	Threespine stickleback	9,029	24.14
	Ptychocheilus	Ptychocheilus oregonensis	Northern pikeminnow	7,993	21.37
	Alosa	Alosa sapidissima	American shad	4,984	13.32
	Carassius	/	/	4,120	11.01
	Catostomus <sup>1</sup>	Catostomus macrocheilus	Largescale sucker	2,895	7.74
	Cottus	/	/	2,519	6.73
	Mylocheilus	Mylocheilus caurinus	Peamouth	2,375	6.35
	Lepomis	Lepomis gibbosus	Pumpkinseed	1,240	3.32
	Misgurnus <sup>2</sup>	Misgurnus anguillicaudatus	Oriental weatherfish	612	1.64
	<del>Misgurnus</del>	Misgurnus mizolepis	Mud loach	<del>591</del>	<del>1.58</del>
	Richardsonius	Richardsonius balteatus	Redside shiner	436	1.17
	Ното	Homo sapiens	Human	423	1.13
	Micropterus	Micropterus salmoides	Largemouth bass	231	0.62
	Sus	Sus scrofa	Wild boar	217	0.58
	Castor	Castor canadensis	American beaver	92	0.25
	Cyprinus <sup>3</sup>	Cyprinus carpio	Common carp	68	0.18
	<del>Pseudorasbora</del>	<del>Pseudorasbora parva</del>	Stone moroko	68	0.18
	Rhinichthys	Rhinichthys cataractae	Longnose dace	53	0.14
	Oncorhynchus	Oncorhynchus mykiss	Rainbow trout	49	0.13
	Prosopium	Prosopium williamsoni	Mountain whitefish	25	0.07
	Oncorhynchus	Oncorhynchus nerka	Sockeye salmon	22	0.06
	<del>Paramisgurnus</del>	Paramisgurnus dabryanus	Large-scale loach	21	0.06
	Bos	/	/	21	0.06
	<del>Xyrauchen</del>	<del>Xyrauchen texanus</del>	Razorback sucker	<del>17</del>	0.05
Total numb	er of reported rea	nds		37,404	
Total percei	nt of reads occupi	ed by the reported species			100.00
Total numb	er of raw reads (R	1+R2)		113,373	
Total numb	er of assembled r	eads		52,640	

- 1. Xyrauchen texanus was re-classified as Catostomus macrocheilus (already detected in this sample with 2,878 reads).
- 2. *Misgurnus mizolepis* and *Paramisgurnus dabryanus* (considered by some to be the same species) were re-classified as *Misgurnus anguillicaudatus* (new row added to this table).
- 3. Pseudorasbora parva was re-classified as Cyprinus carpio (new row added to this table).

Sample ID	20-075884-0004 (KATZIE-PITT)					
	Genus	Species (scientific name)	Species (common name)	# of Reads	% RA*	
	Gasterosteus <sup>1</sup>	Gasterosteus aculeatus	Threespine stickleback	6,633	22.71	
	Cottus <sup>2</sup>	/	/	5,522	18.90	
	Mylocheilus	Mylocheilus caurinus	Peamouth	5,457	18.68	
	Ptychocheilus	Ptychocheilus oregonensis	Northern pikeminnow	3,687	12.62	
	Lepomis	Lepomis gibbosus	Pumpkinseed	3,069	10.51	
	Micropterus	Micropterus salmoides	Largemouth bass	971	3.32	
	Catostomus	Catostomus macrocheilus	Largescale sucker	825	2.82	
	Pomoxis	Pomoxis nigromaculatus	Black crappie	811	2.78	
	Richardsonius	Richardsonius balteatus	Redside shiner	454	1.55	
	Misgurnus	Misgurnus mizolepis	Mud loach	441	1.51	
	Sus	Sus scrofa	Wild boar	370	1.27	
	Salvelinus³	Salvelinus <del>alpinus</del>	Arctic char	339	1.16	
	<del>Comephorus</del>	<i>f</i>	<i>†</i>	228	0.78	
	Lepomis	Lepomis macrochirus	Bluegill	180	0.62	
	Oncorhynchus	Oncorhynchus tshawytscha	Chinook salmon	165	0.56	
	Oncorhynchus	Oncorhynchus nerka	Sockeye salmon	162	0.55	
	Alosa <sup>4</sup>	Alosa <del>pseudoharengus</del>	River herring	124	0.42	
	<del>Gasterosteus</del>	Gasterosteus microcephalus	Smallhead stickleback	<del>69</del>	0.24	
Total number of reported reads				29,210		
Total percent of reads occupied by the reported species					100.00	
Total number of raw reads (R1+R2)				95,794		
Total number of assembled reads				44,527		

- 1. *Gasterosteus microcephalus* was re-classified as *Gasterosteus aculeatus* (already detected in this sample with 6,564 reads; considered by some to be the same species).
- 2. Comephorus was re-classified as Cottus sp. (already detected in this sample with 5,294 reads).
- 3. Salvelinus was reported at the genus level. It is likely (but unconfirmed) that the eDNA came from Salvelinus malma (Dolly varden).
- 4. *Alosa* was reported at the genus level. It is likely (but unconfirmed) that the eDNA came from *Alosa sapidissima* (American shad).

Sample ID	20-075884-0005 (KATZIE-SLOUGH)					
	Genus	Species (scientific name)	Species (common name)	# of Reads	% RA*	
	Gasterosteus	Gasterosteus aculeatus	Threespine stickleback	35,201	64.83	
	Carassius	/	/	11,738	21.62	
	Misgurnus <sup>1</sup>	Misgurnus anguillicaudatus	Oriental weatherfish	4,928	9.08	
	<del>Misgurnus</del>	Misgurnus mizolepis	Mud loach	4,043	<del>7.45</del>	
	Lepomis	Lepomis gibbosus	Pumpkinseed	1,962	3.61	
	<del>Paramisgurnus</del>	Paramisgurnus dabryanus	Large-scale loach	<del>885</del>	<del>1.63</del>	
	Sus	Sus scrofa	Wild boar	110	0.20	
	Carassius	Carassius gibelio	Prussian carp	103	0.19	
	Castor	Castor canadensis	American beaver	70	0.13	
	Bos	/	/	69	0.13	
	Ovis	Ovis aries	Sheep	61	0.11	
	Micropterus	Micropterus salmoides	Largemouth bass	34	0.06	
	Ardea <sup>2</sup>	Ardea <del>cinerea</del>	Grey heron	25	0.05	
Total number of reported reads				54,301		
Total percent of reads occupied by the reported species					100.00	
Total number of raw reads (R1+R2)				148,215		
Total number of assembled reads				69,290		

- 1. *Misgurnus mizolepis* and *Paramisgurnus dabryanus* (considered by some to be the same species) were re-classified as *Misgurnus anguillicaudatus* (new row added to this table).
- 2. Ardea was reported at the genus level. It is likely (but unconfirmed) that the eDNA came from Ardea herodias (great blue heron).

Sample ID	20-075884-0006 (STURGEON_SLOUGH_1)					
	Genus	Species (scientific name)	Species (common name)	# of Reads	% RA*	
	Lepomis	Lepomis gibbosus	Pumpkinseed	14,677	29.96	
	Cyprinus <sup>1</sup>	Cyprinus carpio	Common carp	8,323	16.99	
	<del>Pseudorasbora</del>	<del>Pseudorasbora parva</del>	Stone moroko	<del>8,323</del>	<del>16.99</del>	
	Micropterus	Micropterus salmoides	Largemouth bass	7,961	16.25	
	Pomoxis	Pomoxis nigromaculatus	Black crappie	6,813	13.91	
	Catostomus	Catostomus macrocheilus	Largescale sucker	3,623	7.39	
	Misgurnus <sup>2</sup>	Misgurnus anguillicaudatus	Oriental weatherfish	2,181	4.45	
	<del>Misgurnus</del>	Misgurnus mizolepis	Mud loach	<del>1,496</del>	<del>3.05</del>	
	Carassius	/	/	1,466	2.99	
	Ptychocheilus	Ptychocheilus oregonensis	Northern pikeminnow	1,190	2.43	
	Lepomis	Lepomis macrochirus	Bluegill	1,097	2.24	
	Mylocheilus	Mylocheilus caurinus	Peamouth	1,000	2.04	
	<del>Paramisgurnus</del>	<del>Paramisgurnus dabryanus</del>	Large-scale loach	<del>685</del>	1.40	
	Cottus	/	/	443	0.90	
	Ното	Homo sapiens	Human	82	0.17	
	Ameiurus	Ameiurus nebulosus	Brown bullhead	73	0.15	
	Ameiurus	Ameiurus natalis	Yellow bullhead	66	0.13	
Total number of reported reads				48,995		
Total percent of reads occupied by the reported species					100.00	
Total number of raw reads (R1+R2)				148,728		
Total number of assembled reads				69,891		

- 1. Pseudorasbora parva was re-classified as Cyprinus carpio (new row added to this table).
- 2. *Misgurnus mizolepis* and *Paramisgurnus dabryanus* (considered by some to be the same species) were re-classified as *Misgurnus anguillicaudatus* (new row added to this table).

Sample ID	20-075884-0007 (STURGEON_SLOUGH_2)					
	Genus	Species (scientific name)	Species (common name)	# of Reads	% RA*	
	Gasterosteus	Gasterosteus aculeatus	Threespine stickleback	22,857	44.49	
	Carassius	/	/	21,641	42.12	
	Misgurnus <sup>1</sup>	Misgurnus anguillicaudatus	Oriental weatherfish	4,591	8.94	
	<del>Misgurnus</del>	Misgurnus mizolepis	Mud loach	<del>3,122</del>	6.08	
	Lepomis	Lepomis gibbosus	Pumpkinseed	1,493	2.91	
	<del>Paramisgurnus</del>	Paramisgurnus dabryanus	Large-scale loach	<del>1,469</del>	<del>2.86</del>	
	Micropterus	Micropterus salmoides	Largemouth bass	484	0.94	
	Castor	Castor canadensis	American beaver	314	0.61	
Total number of reported reads				51,380		
Total percent of reads occupied by the reported species					100.00	
Total number of raw reads (R1+R2)				141,406		
Total number of assembled reads				66,016		

<sup>1.</sup> *Misgurnus mizolepis* and *Paramisgurnus dabryanus* (considered by some to be the same species) were re-classified as *Misgurnus anguillicaudatus* (new row added to this table).

Sample	20.075004.0000	(DITT DIVED)			
ID	20-075884-0008	(PITI_RIVER)		# of	
	Genus	Species (scientific name)	Species (common name)	Reads	% RA*
	Gasterosteus	Gasterosteus aculeatus	Threespine stickleback	29,067	43.86
	Cottus	/	/	14,816	22.36
	Mylocheilus	Mylocheilus caurinus	Peamouth	9,030	13.63
	Ptychocheilus	Ptychocheilus oregonensis	Northern pikeminnow	3,839	5.79
	Sus	Sus scrofa	Wild boar	2,658	4.01
	Misgurnus <sup>1</sup>	Misgurnus anguillicaudatus	Oriental weatherfish	2,218	3.35
	Catostomus	Catostomus macrocheilus	Largescale sucker	2,192	3.31
	<del>Misgurnus</del>	Misgurnus mizolepis	Mud loach	<del>1,361</del>	2.05
	Alosa	Alosa sapidissima	American shad	900	1.36
	<del>Paramisgurnus</del>	<del>Paramisgurnus dabryanus</del>	Large-scale loach	<del>857</del>	<del>1.29</del>
	Oncorhynchus	Oncorhynchus tshawytscha	Chinook salmon	809	1.22
	Platichthys <sup>2</sup>	Platichthys stellatus	Starry flounder	397	0.60
	Pleuronectes	Pleuronectes pinnifasciatus	Far Eastern smooth flounder	<del>397</del>	0.60
	Ното	Homo sapiens	Human	212	0.32
	Cyprinus <sup>3</sup>	Cyprinus carpio	Common carp	85	0.13
	<del>Pseudorasbora</del>	<del>Pseudorasbora parva</del>	Stone moroko	<del>85</del>	0.13
	Branta	Branta canadensis	Canada goose	25	0.04
	Castor	Castor canadensis	American beaver	22	0.03
Total number of reported reads				66,270	
Total percent of reads occupied by the reported species					100.0
Total number of raw reads (R1+R2)				151,48 5	
Total number of assembled reads				69,137	

- 1. *Misgurnus mizolepis* and *Paramisgurnus dabryanus* (considered by some to be the same species) were re-classified as *Misgurnus anguillicaudatus* (new row added to this table).
- 2. Pleuronectes pinnifasciatus was re-classified as Platichthys stellatus (new row added to this table).
- 3. Pseudorasbora parva was re-classified as Cyprinus carpio (new row added to this table).

Sample ID	20-075884-0009 (ADDINGTON_MARSH)					
	Genus	Species (scientific name)	Species (common name)	# of Reads	% RA*	
	Misgurnus <sup>1</sup>	Misgurnus anguillicaudatus	Oriental weatherfish	44,739	53.68	
	<del>Misgurnus</del>	Misgurnus mizolepis	Mud loach	<del>32,469</del>	<del>38.96</del>	
	Lepomis	Lepomis gibbosus	Pumpkinseed	25,832	30.99	
	<del>Paramisgurnus</del>	<del>Paramisgurnus dabryanus</del>	Large-scale loach	12,255	14.70	
	Micropterus	Micropterus salmoides	Largemouth bass	10,982	13.18	
	Bos	/	/	1,151	1.38	
	Pomoxis	Pomoxis nigromaculatus	Black crappie	357	0.43	
	Carassius	/	/	211	0.25	
	Ursus	Ursus americanus	American black bear	77	0.09	
Total number of reported reads						
Total percent of reads occupied by the reported species				83,349	100.00	
Total number of raw reads (R1+R2)				184,563		
Total number of assembled reads				85,790		

<sup>1.</sup> *Misgurnus mizolepis* and *Paramisgurnus dabryanus* (considered by some to be the same species) were re-classified as *Misgurnus anguillicaudatus* (already detected in this sample with 15 reads).

Sample ID	20-075884-0010 (NORTH_KATZIE_MARSH)				
	Genus	Species (scientific name)	Species (common name)	# of Reads	% RA*
	Lepomis	Lepomis gibbosus	Pumpkinseed	24,954	45.30
	Misgurnus <sup>1</sup>	Misgurnus anguillicaudatus	Oriental weatherfish	16,025	29.09
	<del>Misgurnus</del>	Misgurnus mizolepis	Mud loach	9,184	<del>16.67</del>
	<del>Paramisgurnus</del>	Paramisgurnus dabryanus	Large-scale loach	6,841	12.42
	Cyprinus <sup>2</sup>	Cyprinus carpio	Common carp	5,294	9.61
	<del>Pseudorasbora</del>	Pseudorasbora parva	Stone moroko	5,294	9.61
	Micropterus	Micropterus salmoides	Largemouth bass	4,628	8.40
	Bos	/	/	1,472	2.67
	Pomoxis	Pomoxis nigromaculatus	Black crappie	997	1.81
	Ното	Homo sapiens	Human	583	1.06
	Sus	Sus scrofa	Wild boar	418	0.76
	Carassius	/	/	369	0.67
	Canis	Canis lupus	Wolf	129	0.23
	Ameiurus	Ameiurus nebulosus	Brown bullhead	124	0.23
	Gallus gallus	Gallus gallus	Red junglefowl	97	0.18
Total number	er of reported read	ls		55,090	
Total percen	t of reads occupie	d by the reported species			100.00
Total number of raw reads (R1+R2)				128,016	
Total number	er of assembled re	ads		58,854	

#### Notes:

- 1. *Misgurnus mizolepis* and *Paramisgurnus dabryanus* (considered by some to be the same species) were re-classified as *Misgurnus anguillicaudatus* (new row added to this table).
- 2. Pseudorasbora parva was re-classified as Cyprinus carpio (new row added to this table).

Sample ID	20-075884-0011 (NORTH_KATZIE_MARSH_DUPLICATE)				
	Genus	Species (scientific name)	Species (common name)	# of Reads	% RA*
	Lepomis	Lepomis gibbosus	Pumpkinseed	29,317	38.89
	Misgurnus <sup>1</sup>	Misgurnus anguillicaudatus	Oriental weatherfish	23,252	30.84
	<del>Misgurnus</del>	Misgurnus mizolepis	Mud loach	<del>13,121</del>	<del>17.40</del>
	<del>Paramisgurnus</del>	<del>Paramisgurnus dabryanus</del>	Large-scale loach	10,131	13.44
	Micropterus	Micropterus salmoides	Largemouth bass	8,689	11.53
	Cyprinus <sup>2</sup>	Cyprinus carpio	Common carp	4,728	6.27
	<del>Pseudorasbora</del>	Pseudorasbora parva	Stone moroko	4,728	6.27
	Bos	/	/	3,793	5.03
	Pomoxis	Pomoxis nigromaculatus	Black crappie	2,836	3.76
	Gallus	Gallus gallus	Red junglefowl	840	1.11
	Ното	Homo sapiens	Human	666	0.88
	Castor	Castor canadensis	American beaver	256	0.34
	Ameiurus	Ameiurus nebulosus	Brown bullhead	251	0.33
	Oryctolagus	Oryctolagus cuniculus	European rabbit	198	0.26
	Carassius	/	/	159	0.21
	Meleagris	Meleagris gallopavo	Wild turkey	147	0.19
	Canis lupus	Canis lupus	Wolf	109	0.14
	Mus	Mus musculus	House mouse	47	0.06
	Anas <sup>3</sup>	Anas platyrhynchos	Mallard	42	0.06
	<del>Tadorna</del>	<del>Tadorna tadorna</del>	Common shelduck	4 <u>2</u>	0.06
	Ameiurus	Ameiurus natalis	Yellow bullhead	34	0.05
	Agelaius	Agelaius phoeniceus	Red-winged blackbird	27	0.04
Total number	er of reported read	ls		75,391	
Total percen	nt of reads occupie	d by the reported species			100.00
Total number of raw reads (R1+R2)					
Total number	er of assembled re	ads		78,527	

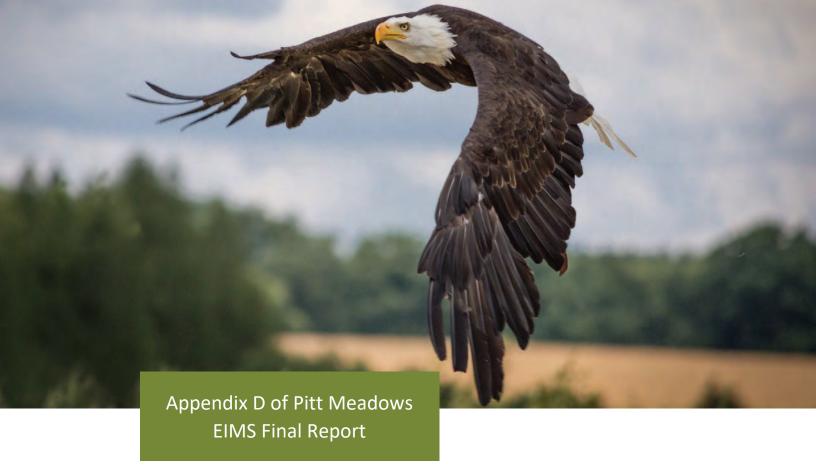
#### Notes:

- 1. *Misgurnus mizolepis* and *Paramisgurnus dabryanus* (considered by some to be the same species) were re-classified as *Misgurnus anguillicaudatus* (new row added to this table).
- 2. Pseudorasbora parva was re-classified as Cyprinus carpio (new row added to this table).
- 3. Tadorna tadorna was re-classified as Anas platyrhynchos (new row added to this table).

Appendix C: Pitt Meadows EIMS – 2020 Field Surveys and Desk-based Research

Sample ID	20-075884-0012 (FIELD_NEGATIVE)			
	Species (scientific name)	Species (common name)	# of Reads	% RA*
	Mus musculus	House mouse	142	100.00
Total number	r of reported reads		142	
	of reads occupied by the reporte	d species		100.00
	r of raw reads (R1+R2)		49,664	
Total number	r of assembled reads		16,044	

# APPENDIX D – POLICY SUMMARY AND GAP ASSESSMENT



# **POLICY SUMMARY AND GAP ASSESSMENT**

January 14, 2022

PREPARED BY Jimmy Allen
SENIOR REVIEW Heather Bears

**SUBMITTED TO** City of Pitt Meadows

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#### **Revision History**

**Project Title:** Pitt Meadows EIMS

**Document Title:** Policy Summary and Gap Assessment

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B000	09-Mar-2020	Comments from Client	C. O'Byrne		
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AppD.R000	14-Jan-2022	Revised for Final EIMS Report	C. Chui	H. Bears	H. Bears

# Appendix D: Pitt Meadows EIMS – Policy Summary and Gap Assessment

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#### 1.0 INTRODUCTION

The City of Pitt Meadows is undertaking an Environmental Inventory and Management Strategy (EIMS) to help support its efforts towards greater sustainability and environmental responsibility. The EIMS formally assesses the current state of the environment and include a baseline inventory of the City's natural assets (i.e., natural capital) which produce a multitude of ecosystem goods and services that benefit the community. The EIMS provides a formal framework, with actions, roles, and timelines, for all areas of environmental planning, including natural area protection, invasive species, and water conservation. It also considers the important goods and services provided by agriculture in the City, and the benefits of well-managed agricultural land that can protect land from over development and preserve certain environmental services.

The City has enacted (and is planning to enact) specific bylaws and policies that can support and guide the EIMS. This work includes an update to the City's Official Community Plan (OCP) and enactment of new environmental Development Permit Areas (DPAs) that will support environmental planning and management. This report provides a brief summary of these relevant bylaws and policies, and their specific relevance to the EIMS (see Section 2.0 Bylaws, Policies and Plans).

This report also identifies gaps and best practices that should be considered to meet specific goals and objectives contained in the draft OCP (see Section 3.0 Gap Analysis and Best Practices). The goals and objectives in the draft OCP were developed based on community engagement and supports a future vision for the City's environmental values. A gap analysis was completed to assess the stated environmental goals and objectives in the draft OCP (i.e., where do we want to be?) and the City's current performance towards meeting those targets (i.e., where are we now?).

A preliminary determination of how the city can achieve its environmental goals and objectives was based in terms of implementation of policy and best practices. This part of the gap analysis answers, at a high level, the question 'how do we get there?' The EIMS and other city policies, bylaws, and regulations can address many of the environmental and sustainability challenges that exist; however, additional best practices and policy options not within the scope of the EIMS may also be required to meet certain objectives and close existing gaps in environmental management in the City.

Actions taken at the local level to better manage natural assets contribute to regional, national and even international objectives. For example, Canada is a signatory (1992) to the Convention on Biological Diversity (CBD). This agreement recognizes that the diversity of nature is a global asset of tremendous value to present and future generations. The EIMS, on a local level, will support many of the objectives in the Canadian Biodiversity Strategy (Canada's response to the CBD) in addition to biodiversity conservation programs enacted by the province of British Columbia.

#### 2.0 BYLAWS, POLICIES AND PLANS

#### 2.1 Official Community Plan

I See Pitt Meadows 2040 Official Community Plan (Draft) Bylaw - The current City of Pitt Meadows Official Community Plan (2008) is in the final stage of an update and review process that has been under way since 2017. This OCP update, underpinned by significant community engagement, will provide a long-

term vision to 2040 while addressing emerging issues related to transportation, climate change, and the environment. Several chapters in the draft 2020 OCP are particularly relevant to the EIMS; these chapters cover the Environment and Natural Areas; Parks and Recreation; and Local Systems. A more detailed evaluation of the specific goals and objectives described in these chapters is provided in Section 3.0 – Gap Analysis and Best Practices.

#### 2.2 Strategic Plan

City of Pitt Meadows Strategic Plan 2019 – 2022 – The Strategic Plan provides a community vision and describes goals for five community pillars. Under the Community and Wellbeing pillar, and perhaps most relevant to the EIMS, there is a stated goal to promote the conservation and enhancement of [the City's] natural environment for the benefit of current and future generations.

#### 2.3 Zoning Bylaw

**Zoning Bylaw No. 2505, 2011** - This bylaw provides land use regulations for the orderly, economic, beneficial, equitable, and environmentally sensitive use, development, and redevelopment of the City of Pitt Meadows, having regard for the provisions of the OCP. The zoning bylaw designates different zones that have specific permitted uses and conditions. Some of these zones include conditions that may support recommendations in the EIMS. For example, the A-5 Agriculture and Wildlife Management zone is intended to protect farming areas of the municipality and support and acknowledge efforts to accommodate and foster wildlife with regulations consistent with the provisions of the Agriculture Land Commission Act and regulations. The bylaw also includes specifications for landscaping and screening (including landscape buffers). Opportunities to enhance these specifications to ensure they support EIMS objectives could be explored at a later date.

Zoning bylaws can be used to help protect natural assets by regulating development. For example, limiting density or increasing setbacks (i.e., buffers) in environmentally sensitive areas. Opportunities to amend the existing Zoning bylaw to support the EIMS should be investigated.

## 2.4 Subdivision and Development Servicing Bylaw

Subdivision and Development Servicing Bylaw No. 2589, 2013 – This bylaw regulates the subdivision, servicing and development of land in an orderly and economical way to produce a safe, efficient, convenient and healthful environment and to preserve and enhance its natural amenities. Developer Responsibilities for works defined under the bylaw, including their design, location, construction, and installation are described. The bylaw encourages innovative approaches (e.g., rain gardens and vegetated swales) to control post development runoff and provide environmental benefits such as groundwater recharge. These types of approaches (e.g., bioswales) can complement the EIMS at the site level to support ecological connectivity in more urbanized areas and further enhance biodiversity.

The bylaw also provides recommendations for protection of natural assets on a larger scale through provision of parkland (including open space), or payment in lieu of providing parkland. The EIMS can be used to help guide parkland designation and/or allocation of payments in lieu of park land, particularly in the context of ecological connectivity.

The subdivision bylaw could also support EIMS objectives by considering natural assets and connectivity during the subdivision and development, including location and alignment of streets, lanes and walkways, and other associated works.

Engineering specifications at the site level could be amended to support EIMS objectives where relevant. These amendments could include the implementation of wildlife-friendly lighting specifications and fish-friendly drainage structures (e.g., open bottom culverts).

#### 2.5 Drainage System Protection Bylaw

Drainage System Protection Bylaw No. 2266, 2007 - This bylaw regulates the obstruction, discharge and operation of the municipal drainage system and imposes a charge for its use. The municipal drainage system conveys surface and ground water to receiving watercourses, and includes natural watercourses, key ditches, channels, swales, drains or sewers, drainage works, pump stations, flood boxes, dike gates or valves, mains, pipes, culverts, catch basins, leads, and curbs and gutters, on public and private property in the City. The bylaw prohibits the obstruction or alteration of a watercourse and regulates work in and about key ditches and watercourses. Discharge of deleterious substances (e.g., waste, contaminants; nutrient-laden water) is also prohibited. Requirements for watercourse maintenance, subject to provincial and federal Acts, are included. Requirements for culvert installation are also covered by the bylaw; however, there are no requirements specific to fish (other than what is contained in the Pitt Meadows Subdivision and Development Servicing Bylaw No. 2589, 2013).

#### 2.6 Floodplain Designation and Construction Control Bylaw

**Floodplain Designation and Construction Control Bylaw No. 2384, 2008** - This bylaw regulates construction in the floodplain (designated floodplain boundaries are defined and mapped). Specifically, the bylaw defines flood plain elevations, provides elevation requirements for buildings and structures located within the floodplain, and describes exemptions. Floodplain mapping can be incorporated as a data layer in the EIMS.

## 2.7 Pesticide Use Control Bylaw

**Pesticide Use Control Bylaw 2502, 2011** - This bylaw regulates the use of pesticides within the city. Specifically, the bylaw describes the type of pesticides allowed, permitted uses of pesticides, where pesticides can be applied, and exemptions. This bylaw will act as supporting policy for relevant management recommendations within the EIMS.

# 2.8 Soil Removal and Fill Deposit Regulation Bylaw

**Soil Removal and Fill Deposit Regulation Bylaw No. 2593, 2013** - This bylaw regulates the removal or placement of soil or other material on land in the city. Provisions for the deposit of fill or removal of soil within the ALR and other land in the city are described, including exemptions. This bylaw may support recommendations within the EIMS concerning natural areas restoration and reclamation.

#### 2.9 Development Permit Areas

**Pitt Meadows Development Permit Area (Draft)** - Four new Development Permit Areas (DPA) are proposed for the City of Pitt Meadows. These DPAs are specific to Farmland Protection, Natural Environment, Riparian Areas, and Steep Slopes. Specific regulations in these DPAs may support recommendations in the EIMS.

#### 2.9.1 Farmland Protection DPA (Draft)

This DPA establishes objectives for the protection of farming pursuant to the Local Government Act (LGA). The DPA applies to the development of all land within 30 metres of the ALR. Guidelines for siting, construction, and landscaping on land adjacent to the ALR are provided, with the intention of minimizing land use conflicts. Guidelines to maintain and establish buffers (natural or landscaped) may support recommendations in the EIMS, particularly with respect to natural corridors and the movement of people and wildlife.

The Farmland Protection DPA focuses on management of land adjacent to agricultural areas. Measures to preserve farmland and associated wildlife habitat for migratory waterfowl and other species in addition to potential mitigation measures to reduce conflicts between wildlife and agriculture, are not considered. The EIMS provides recommendations promoting stewardship and best practices to address these issues.

#### 2.9.2 Natural Environment DPA (Draft)

This environmental DPA establishes objectives for the protection of the natural environment, its ecosystems and biological diversity pursuant to the LGA. This DPA is intended to minimize potential development impacts on natural features, areas, and systems. The DPA may require an environmental impact assessment and require certain actions (including mitigation) associated with a proposed development to protect, maintain, or enhance the natural environment and associated environmental values. Specific environmental values mentioned in the bylaw include habitat for species at risk, mature tree stands, raptor nest sites, wetlands, and wildlife corridors.

No defined areas in the city have been described for implementation of the DPA; however, the EIMS can provide guidance for its application based on natural assets that are either present and/or are being managed for. The EIMS can also provide guidance for allocation of green infrastructure networks (i.e., connected system of natural areas and corridors) that could provide a basis for DPA designation. Alternatively, a Natural Environment DPA applying to the entire city may provide more flexibility by permitting guidance at the site-level and within the urban matrix (i.e., areas outside of a green infrastructure network).

#### 2.9.3 Riparian Areas DPA (Draft)

This environmental DPA establishes objectives for the protection of the natural environment, its ecosystems and biological diversity pursuant to the LGA. More specifically, the *Riparian Areas* DPA is designated to protect riparian areas from development where the areas provide natural features, functions and conditions that support fish life processes. This protection will indirectly extend to other species (i.e., wildlife) that inhabit riparian and aquatic habitats. The DPA only applies to ditches and

watercourses that support fish or fish habitat. A development permit may contain terms and conditions related to siting; land use; construction; timing; maintenance, protection, restoration and enhancement of watercourses and natural features; and post-development certification and inspection. The DPA may support recommendations in the EIMS, specifically those associated with fish habitat and natural riparian corridors (protection, restoration and enhancement).

Please note that this draft DPA references the provincial *Riparian Areas Regulation*. This regulation has been updated with new amendments by the provincial *Riparian Areas Protection Regulation*, which was enacted in November, 2019.

#### 2.9.4 Steep Slopes DPA (Draft)

This DPA establishes objectives for the protection of development from hazardous conditions pursuant to the LGA. More specifically, the DPA is designated to minimize risk to people and property from slope hazards. Development guidelines consider siting, building construction, and landscaping. The DPA may support recommendations in the EIMS, specifically in relation to risk management (steep/unstable slopes), implementation of natural buffers; planting of native trees, shrubs, and other plants (improve slope stability); and maintenance of permeable surfaces.

#### 2.10 Parks, Recreation and Culture Master Plan

Maple Ridge and Pitt Meadows Parks, Recreation and Culture Master Plan, 2010 – This joint master plan was developed to provide a sustainable road map for parks planning and management over a 5 to 10 year period. Of most relevance to the EIMS, the plan provides high-level recommendations related to the environment, parkland supply, trails, and greenways. Key environmental recommendations in this plan include:

- Acquire areas with significant environmental value that are appropriate as parkland at the municipal level, preferably through the development process;
- Acquire environmentally sensitive areas appropriate as parkland at the municipal level, preferably through the development process;
- Use environmental mapping to assist in the identification of potential parkland;
- Work with the Planning Department to acquire natural open space for parkland from developers as part of the negotiation process;
- Continue to research and improve management of invasive species, wildlife interfaces, and other issues; and,
- Encourage Maple Ridge and Pitt Meadows planning departments to complete their strategies for managing areas with significant environmental values.

Note that Pitt Meadows and Maple Ridge no longer jointly manage parks, recreation, and cultural services. The EIMS can be used to inform the new parks and a recreation and culture plan, in terms of directing parkland acquisition, designation of natural area parks and trails, and greenway/blueway planning.

#### 2.11 Pitt River Regional Greenway Concept Plan

Pitt River Regional Greenway (PRG) Concept Plan - The PRG was first proposed in 1996 as a joint partnership of Metro Vancouver, Pitt Meadows and Maple Ridge. This 31 km corridor was promoted as an integral component of the Regional Parks and Greenways System. The PRG provides an opportunity to integrate provincial, regional and municipal sites and management regimes into a comprehensive waterfront recreation and conservation greenway strategy that meets objectives for recreation, nature appreciation, economic development, environmental protection, and biodiversity conservation. A full greenway management plan was proposed to be developed at later stages of the project. The Greenway Concept Plan and EIMS can support each other to enhance ecological connectivity while also meeting recreation and active transportation objectives.

#### 3.0 GAP ANALYSIS AND BEST PRACTICES

This section of the report provides a high level review of the City in terms of its environment policy. The review is framed by asking three questions:

Where do we want to be? Specific goals and objectives related to environmental management as outlined in the OCP (draft) are summarized. These goals and objectives are considered to be aspirational and support a future vision for the City;

Where are we now? Existing plans, bylaws and management actions being taken by the City, in addition to any identified gaps in environmental policy, represent (on a general level) the City's current performance. While the EIMS includes recommendations for future action, it is indicative of the City's current policy direction for environmental management and provides a benchmark with which to measure progress.

How do we get there? Local actions and best practices from other jurisdictions (e.g., regional, national, international) are briefly summarized to provide context, awareness and direction to help the City achieve its environmental goals and objectives. Please note that not all actions and best practices identified fall under the scope of the EIMS; rather, some of these actions and best practices would be implemented under separate strategies that may be considered as stand alone or complementary to the EIMS. Linkages between different supporting bylaws and policies and ways the EIMS can address existing environmental management gaps are described. The actions and best practices included in this section are meant to be achievable within a reasonable time frame while considering the City's current and future capacity.

Table 1 summarizes considerations of these three questions for multiple environmental goals that are noted as part of the draft OCP.

**Table 1**. Summary of considerations regarding *draft* OCP goals and objectives; existing policies, bylaws, and gaps; and best practices and implementation

Where do we want to be?  OCP goals and objectives	Where are we now? Existing policies, bylaws, actions and gaps	How do we get there?  Best practices and implementation		
Category: Environment and Natural Areas				
Goal 1: Shorelines, wetlands, and riparian areas are prote	ected and restored and water quality is maintained or impr	roved		
Objective 1.1: Implement streamside protection measures and require that development conform to regulations and best management practices for protecting fish and aquatic life.	EIMS: Includes environmental inventory with updated salmon escapement classifications.  Policy: Draft Riparian Areas DPA (not enacted) to protect riparian areas from development where the areas provide natural features, functions and conditions that support fish life processes.  Gap: n/a	Policy Alignment and Implementation: EIMS can support Riparian Areas DPA designations		
Objective 1.3: Improve the shoreline habitat.	EIMS: Includes environmental inventory and assessment of natural assets, including shoreline habitat.  Policy: Riparian Areas DPA (Draft) and Natural Areas DPA (Draft) include measures to reduce impacts or restore habitat.  Gap: Areas where Natural Areas DPA will apply not designated.	Policy Alignment and Implementation: EIMS can support Natural Areas DPA and Riparian Areas DPA designations		
Goal 2: Disturbances to residents and wildlife resulting fr	om light pollution, light trespass and noise are minimized			
Objective 2.1: Incorporate light pollution reduction and light trespass abatement features into municipal facilities, infrastructure and street /park lighting where public safety is not compromised.	EIMS: Includes general recommendations for areas with high biodiversity value to incorporate wildlife-friendly designs in the future.  Policy: Subdivision and Development Servicing Bylaw Part F describes standards for street lighting.  Gap: Wildlife/bird-friendly lighting specifications not considered in current bylaw.	Policy Alignment and Implementation: n/a International Strategies: Design standards to minimize night time lighting and light pollution: Bird-friendly Building Design 2019 standards (American Bird Conservancy, 2019)		
Objective 2.2: Work with residential, agricultural, industrial and commercial sectors to minimize light pollution and resulting sky glow from homes, buildings and facilities.	EIMS: Includes general recommendations for areas with high biodiversity value to incorporate wildlife-friendly designs in the future.  Policy: Subdivision and Development Servicing Bylaw Part F describes standards for street lighting.  Gap: Wildlife/bird-friendly lighting specifications not considered in current bylaw.	Policy Alignment and Implementation: n/a International Strategies: Design standards to minimize night time lighting and light pollution: Bird-friendly Building Design 2019 standards (American Bird Conservancy, 2019)		
Goal 4: The municipality demonstrates leadership in implementing sustainable environmental practices				
General	EIMS: Integrates best practices for management of biodiversity and ecosystem services.  Policy: OCP describes environmental challenges associated with climate change  Gap: No climate adaptation goals/objectives specific to fish, wildlife and ecosystems	Policy Alignment and Implementation: n/a International Strategies: EU 2020 Biodiversity Strategy; National Fish, Wildlife, and Plants Climate Adaptation Strategy (NFWPCAP, 2012). Describes adaptation actions to help fish, wildlife, plants, and ecosystems adapt to changing conditions. These actions will help sustain ecosystems, natural resources and ecosystem services that benefit people.		

Where do we want to be?	Where are we now?	How do we get there?
OCP goals and objectives	Existing policies, bylaws, actions and gaps	Best practices and implementation
Objective 4.1: Consider embarking on a study of how the City's natural assets can be used to protect the environment and enhance the community.	EIMS: One of the main goals of this project is to protect, enhance, and/or restore the City's ecological values and natural capital. The EIMS includes an inventory of natural assets and prioritizes values (e.g., important habitats, wildlife corridors) and risks.  Policy: n/a  Gap: Updated environmental inventory and assessment of natural assets.	Policy Alignment and implementation: Implement EIMS recommendations and align with other relevant bylaws and policies  Local Strategies: Municipal National Asset Initiative
Objective 4.2: Demonstrate corporate stewardship through the preparation and implementation of an environmental management strategy for municipal operations.	EIMS: Includes an inventory of natural assets and a performance matrix with both management planning and ecological indicators to evaluate and monitor progress towards meeting specific environmental goals and objectives.  Policy: n/a  Gap: Environmental Management Strategy for municipal operations and service delivery to protect natural assets by reducing pollution (air, water, groundwater), contaminants, hazardous waste/materials/spills; Environmental targets/requirements for municipal operations	Policy Alignment and Implementation: EIMS natural assets inventory can inform a more detailed Environmental Management Strategy for municipal operations
Goal 5: The City carefully considers policies, standards, guidelines and regulations regarding environmental protection and enhancement in harmony with other City goals and objectives.	EIMS: Aims to provide a formal, high-level, structured framework for environmental planning that aligns with existing bylaws, policies, and other municipal plans, strategies, and initiatives. One of the main goals of this project is to protect, enhance, and/or restore the City's ecological values and natural capital.  Policy: OCP, Environmental DPAs  Gap: Overarching City policy that links interrelated sectors and issues; Updated Parks, Recreation and Culture Master Plan required (Pitt Meadows and Maple Ridge no longer jointly manage this service)	Policy Alignment and Implementation: Support relevant goals and objectives of OCP and updated Parks, Recreation and Culture Master Plan Local Strategies: City of Surrey Sustainability Charter 2.0, 2016
Objective 5.1: Consult with the farming community before embarking on policies, standards, guidelines and regulations that may affect agricultural operations.	EIMS: Includes agriculture-specific recommendations based on stakeholder consultation.  Policy: City of Pitt Meadows Agricultural Plan; Farmland Protection DPA (Draft); Zoning Bylaw 2505, 2011 Agriculture and Wildlife Management zone; Pitt Meadows Agriculture Advisory Committee Gap: Guidelines recognizing impacts, dependency and benefits between the agricultural sector and biodiversity	Policy Alignment and Implementation: n/a International Strategies: European Union Business and Biodiversity Platform - Agriculture Sector and Biodiversity Conservation Best Practice Benchmarking; Stewardship: Delta Farmland and Wildlife Trust
Goal 6: The community takes a role in looking after the n	atural environment	
Objective 6.1: Promote community involvement and increase awareness of environmental issues among residents and businesses.	EIMS: Community engagement to help identify and raise awareness of important environmental values (i.e., natural assets) across the City.  Policy: n/a  Gap: Environmental Planner	Policy Alignment and Implementation: n/a Local Strategies: The City of Langley Environmentally Sensitive Areas Mapping Study (2016) included Langley Environmental Partners Society (LEPS), Langley Field Naturalists (LFN); and Nicomekl Enhancement Society (NES);

Where do we want to be?	Where are we now?	How do we get there?
OCP goals and objectives	Existing policies, bylaws, actions and gaps	Best practices and implementation
		Provincial Strategies: WildSafeBC and Bear Smart Community Programs (British Columbia Conservation Foundation) to reduce human-wildlife conflicts; British Columbia Lake Stewardship and Monitoring Program;
Objective 6.2: Work with private landowners to encourage stewardship that protects, preserves, and enhances natural systems and, where appropriate, enter into conservation covenants or provide incentives to protect riparian or environmentally significant areas.	EIMS: Community engagement to help identify and raise awareness of important environmental values (i.e., natural assets) across the City Policy: n/a Gap: Natural areas conservation strategy (includes tools such as conservation covenants, easements and stewardship incentives)	Policy Alignment and Implementation: n/a Stewardship Groups: Delta Farmland and Wildlife Trust; Private Landowners: Pitt Meadows Gun Club Environmental Stewardship Plan. International Strategies: Portland Natural Areas Acquisition Strategy
Objective 6.3: Collaborate with First Nations, regional and senior governments, agencies, and community organizations in the protection, management and stewardship of natural areas, local parks, ecological reserves, and wildlife management areas.	EIMS: The engagement process aims to raise public awareness on the importance of biodiversity and natural capital, and to encourage citizen input into the EIMS planning process;  Policy: n/a  Gap: Develop a natural areas conservation strategy; Environmental Planner; liaison with stewardship groups	Policy Alignment and Implementation: n/a First Nations Engagement: Katzie First Nation Stewardship: Pitt Meadows Environmental Network; Maple Ridge Pitt Meadows Environmental Council (MRPMEC); Alouette Field Naturalists; Alouette River Management Society (ARMS); Pitt Polder Preservation Society; Watershed Watch Salmon Society
Goal 7: A system of Environmentally Sensitive Areas is ide	entified and protected to the maximum extent possible	
General	EIMS: Identifies important natural assets (e.g., forest or wetland habitats) that can potentially be connected as part of a green infrastructure network  Policy: n/a  Gap: Updated environmental inventory and assessment of natural assets	Policy Alignment and Implementation: n/a International Strategies: EU Strategy on Green Infrastructure – Objective to restore ecosystem health, connect natural areas, and support biodiversity to enable ecosystems to deliver their many services to people and nature Local Strategies: City of Surrey Biodiversity Conservation Strategy performance indicators
Objective 7.1: Enhance the City's knowledge of environmental assets through physical and biological resource inventories/Develop a Natural Assets Inventory and Management Strategy.	EIMS: Includes baseline inventory of natural assets/capital and assesses its current state; Policy: n/a Gap: Targeted field work of priority habitats or important areas; development of ecological indicators; ecological health monitoring;	Policy Alignment and Implementation: Integrate biodiversity indicators into monitoring plan to measure performance and inform future decision-making International Strategies: EU Biodiversity Strategy/Streamlined European Biodiversity Indicators (SEBI) - Establish a set of biodiversity indicators to assess and provide information about progress towards the targets and commitments.  Local Strategies: City of Langley Environmentally Sensitive Areas Mapping Study
Objective 7.2: Minimize habitat loss, fragmentation and disturbances to wildlife through effective land use planning.	EIMS: Identifies opportunities to protect, enhance, and/or restore the City's natural assets and improve connectivity.  Policy: Natural Environment DPA (Draft); Riparian Areas DPA Gap: Green Infrastructure Network Plan; specific policies for wildlife (e.g., bear, cougar, coyote) management in urban-wildland interface; brownfield conservation	Policy Alignment and Implementation: EIMS can provide framework to include natural assets within formalized green infrastructure plan.  International Strategies: Brownfield site planning for conservation (Hunter, 2014)  Local Strategies: City of Surrey Natural Areas Management Plan. This multi-pronged plan has strategies for fauna management; vegetation management; coarse woody debris;

Where do we want to be?	Where are we now?	How do we get there?
OCP goals and objectives	Existing policies, bylaws, actions and gaps	Best practices and implementation
		yard waste and refuse; tree hazards; fire management; access
		and recreation management
Goal 8: The long-term ecological health of the city is main	ntained and improved	
Objective 8.1: Reduce the density and distribution of invasive species to protect biodiversity and ensure public safety.	EIMS: Provides general recommendations specific to invasive species in natural areas  Policy: Natural Environment DPA (Draft) – Mitigation measures for restoration associated with development  Gap: Invasive species management plan (City-wide)	Policy Alignment and Implementation: EIMS can identify priorities for habitat restoration; needs support from Invasive species management plan  Provincial Strategies: Invasive Species Management Strategy for BC (2018-2022) describes management priorities and key areas of action
Objective 8.2: Increase the amount of land protected for its ecological values.	EIMS: Identifies and prioritizes valuable natural areas that may be considered for protection.  Policy: Natural Environment DPA (Draft); Riparian Areas DPA (Draft); Parks, Recreation and Cultural Services Master Plan Gap: Natural areas acquisition strategy	Policy Alignment and Implementation: Can provide direction for acquisition and/or protection of natural areas International Strategies: Portland Natural Areas Acquisition Strategy
Objective 8.3: Address development growth in balance with environmental protection objectives and encourage new development to minimize environmental impacts.	EIMS: Prioritizes natural assets (e.g., important habitats, connectivity corridors) that can be included in a green infrastructure network and provides management recommendations in the urban matrix.  Policy: Natural Environment DPA (Draft)  Gap: n/a	Policy Alignment and Implementation: May provide guidance for designation of Natural Environment DPA. Can be supported by green infrastructure plan and more specific biodiversity design guidelines.  International Strategies: Design for Biodiversity (London); Design standards to minimize night time lighting and light pollution: Bird-friendly Building Design 2019 standards (American Bird Conservancy).  Local Strategies: City of Surrey Biodiversity Design Guidelines (in progress)
Goal 9: The urban forest is protected and enhanced		
Objective 9.1 Consider adopting an Urban Forest Strategy to protect, plant and manage trees in Pitt Meadows to create a diverse, resilient and beautiful urban forest on public and private lands across the City.	EIMS: Inventory identifies natural assets of management concern (e.g., mature forest) using SEI, other data and community engagement.  Policy: n/a Gap: Detailed tree inventory; Urban Forest Strategy not developed	Policy Alignment and Implementation: EIMS can support and be supported by Urban Forest Strategy.  Local Strategies: Urban Forest Strategy (e.g., City of Vancouver – plan to restore or enhance 25 hectares of natural area)
Objective 9.2: Support the implementation of a tree preservation bylaw.	EIMS: Inventory identifies natural assets of management concern (e.g., mature trees/forests, wildlife trees).  Policy: n/a  Gap: Tree preservation bylaw; Detailed tree inventory;  Development guidelines for wildlife trees.	Policy Alignment and Implementation: Tree bylaw can support and be supported by EIMS.  Local Strategies: City of Surrey Tree Protection Bylaw
Objective 9.3: Sustain and expand the urban forest through sound management strategies which enhance their potential as carbon sinks.	EIMS: Inventory can identify natural assets that may be prioritized for protection and/or restoration to support multiple goals, including carbon sequestration.  Policy: N/a Gap: Climate Change Adaptation Strategy	Policy Alignment and Implementation: EIMS can support and be supported by an Urban Forest Strategy and Climate Change Adaptation Strategy  Local Strategies: City of Vancouver Urban Forest Strategy and Climate Change Adaptation Strategy

Where do we want to be?	Where are we now?	How do we get there?
OCP goals and objectives	Existing policies, bylaws, actions and gaps	Best practices and implementation
Objective 9.4: Promote and encourage the protection and designation of indigenous, significant trees and wildlife trees.	EIMS: Inventory identifies natural assets (e.g., mature trees, wildlife trees) and management recommendations  Policy: Natural Areas DPA (Draft); Riparian Areas DPA (Draft)  Gap: Tree preservation bylaw; Development guidelines for wildlife trees; Develop an Urban Forest Strategy.	Policy Alignment and Implementation: EIMS can support and be supported by Environmental DPAs and tree bylaw
Goal 10: Soil quality is protected	EIMS: Inventory identifies natural assets of management concerns (e.g., soil quality)  Policy: Soil Removal and Fill Deposition Regulation Bylaw; Farmland Protection DPA (Draft)  Gap: Soil management strategy	Policy Alignment and Implementation: n/a
Category: Local Systems		
Goal 4: Protect and enhance ground and surface water qu	uality through best practices for integrated rainwater mand	agement
Objective 4.1: Maintain or improve the water quality discharged to the natural environment.	EIMS: Identifies natural assets (e.g., wetlands, forests) that provide ecosystem services such as water filtration Policy: Drainage System Protection Bylaw; Riparian Areas DPA Gap: Green infrastructure guidelines	Policy Alignment and Implementation: EIMS can be integrated into Low Impact Development guidelines Local Strategies: City of Surrey Biodiversity Design Guidelines (in progress)
Goal 5: Flood protection measures throughout Pitt Meadows are maintained and improved	EIMS: Identifies natural assets such as wetlands and forests that can increase resilience to flood events.  Policy: Floodplain Designation and Construction Bylaw  Gap: Climate Change Adaptation Strategy to plan for future flood scenarios and risks/vulnerabilities/opportunities associated with green infrastructure	Policy Alignment and Implementation: EIMS can be integrated with Low Impact Development guidelines, flood preparedness planning and Climate Change Adaptation Strategy
Goal 6: Municipal infrastructure needs are efficiently and	sustainably met while protecting public health, safety and	the environment
Objective 6.2: Future infrastructure is planned and constructed with the effects of climate change in mind.	EIMS: Identifies important natural assets that can help improve resiliency to climate change Policy: OCP describes environmental challenges associated with climate change; Gap: No climate adaptation goals/objectives within OCP specific to fish, wildlife and ecosystems; No Climate Change Adaptation Strategy	Policy Alignment and Implementation: EIMS can be integrated with Climate Change Adaptation Strategy
Goal 7: Green infrastructure reduces the burden on city se	ervices and contributes to the ecological health of the comn	nunity
General	EIMS: Identifies important natural assets (e.g., forest) that can potentially be connected as part of a green infrastructure network  Gap: Implementation of green infrastructure at site level (e.g., engineered or enhanced assets); green infrastructure guidelines/standards	Policy Alignment and Implementation: EIMS can provide framework for formalized Green Infrastructure Network Plan. International Strategies: EU Strategy on Green Infrastructure — Objective to restore ecosystem health, connect natural areas, and support biodiversity to enable ecosystems to deliver their many services to people and nature  Local Strategies: City of Surrey Biodiversity Conservation Strategy
Objective 3.1: The City incorporates green infrastructure into its building projects whenever possible.	EIMS: Includes recommendations to include natural assets as site-level green infrastructure Policy: n/a	Policy Alignment and Implementation: EIMS can support/be supported by green infrastructure plan and design guidelines

Where do we want to be?	Where are we now?	How do we get there?
OCP goals and objectives	Existing policies, bylaws, actions and gaps	Best practices and implementation
	<b>Gap:</b> Guidelines on specific site-level green infrastructure interventions (e.g., green roofs, bioswales)	International Strategies: Biodiversity Design Guidelines (Design for Biodiversity, London);  Provincial Strategies: Credit Valley Low Impact Development Stormwater Management Planning and Design Guide (Ontario)
Objective 3.2: Incorporate green infrastructure requirements into new and re-developments.	EIMS: Identifies important natural assets that can potentially be connected as part of a green infrastructure network Policy: Natural Areas DPA Gap: Guidelines on specific site-level green infrastructure (e.g., engineered assets like green roofs)	Policy Alignment and Implementation: EIMS can support/be supported by green infrastructure plan and design guidelines International Strategies: Biodiversity Design Guidelines (Design for Biodiversity, London)
Category: Parks and Recreation		
Goal 1: Parks and open space connect people to nature a	nd provide a peaceful respite	
Objective 1.1: Find innovative opportunities to create parks and open spaces.	EIMS: Identifies important natural assets that can potentially be included within park system Policy: Parks, Recreation and Cultural Services Master Plan Gap: Updated Parks, Recreation and Cultural Services Master Plan required	Policy Alignment and Implementation: EIMS may provide guidance to updated Parks, Recreation and Cultural Services Master Plan International Strategies: Natural Areas Acquisition Strategy (Portland)
Objective 1.2: Use open space to create connections.	EIMS: Identifies important habitats that can potentially be connected as part of a green infrastructure network;  Policy: Parks, Recreation and Cultural Services Master Plan  Gap: Green Infrastructure Network Plan to formalize network	Policy Alignment and Implementation: EIMS could provide framework for Green Infrastructure Plan; EIMS could support identification and prioritization of greenways and blueways under an updated Parks, Recreation and Cultural Services Master Plan  Local Strategies: City of Surrey Biodiversity Conservation  Strategy
Goal 4: The Ecological Values of Parks and Open Spaces of	are Maintained and Enhanced	,
Objective 4.1: Support compatible activities in City parks and open spaces to advance environmental stewardship goals (e.g., volunteer stewardship activities, invasive plant management, environmental art)	EIMS: Community engagement to help identify and raise awareness of important natural assets across the City; Policy: Parks, Recreation and Cultural Services Master Plan Gap: Updated Parks, Recreation and Cultural Services Master Plan	Policy Alignment and Implementation: EIMS may provide guidance to updated Parks, Recreation and Cultural Services Master Plan
Objective 4.2: Collaborate with Metro Vancouver, community groups and government agencies to minimize the further introduction and spread of invasive species in the area, and to develop an invasive species management plan to prevent, eradicate, contain, and control the spread of invasive species within the municipality.	EIMS: Identifies and assesses condition of important natural assets. Includes general management recommendations (e.g., restoration) to address specific risks (e.g., invasive species);  Policy: n/a Gap: Invasive Species Management Plan	Policy Alignment and Implementation: EIMS may highlight priority areas for habitat restoration that can be addressed by more specific actions under an Invasive Species Management Plan  Provincial Strategies: Invasive Species Management Strategy for BC (2018-2022) describes management priorities and key areas of action; Invasive Plant Management Strategy for British Columbia  Local Strategies: Yard Waste and Refuse Strategy (includes disposal)
Objective 4.3: Prioritize the retention of healthy, mature vegetation in the City's parks and open spaces wherever possible. Where significant trees cannot be reasonably accommodated in site planning (e.g., conflict with utilities and	EIMS: Inventory identifies natural assets of management concern (e.g., mature trees, wildlife trees).  Policy: Natural Areas DPA	Policy Alignment and Implementation: EIMS can support and be supported by Urban Forest Strategy and municipal Environmental Management Plan

Appendix D: Pitt Meadows EIMS – Policy Summary and Gap Assessment

Where do we want to be?	Where are we now?	How do we get there?
OCP goals and objectives	Existing policies, bylaws, actions and gaps	Best practices and implementation
services or tree hazard), demonstrate integration and	Gap: Tree Preservation Bylaw; Urban Forest Strategy not	
replacement of significant vegetation on site.	developed; Environmental Management Plan (specific to	
	municipal operations)	
Objective 4.4: Progressively eliminate the use of cosmetic/ non-	EIMS: Identifies and assesses condition of important natural	Policy Alignment and Implementation: EIMS may highlight
essential pesticides as well as neonicotinoids on all lands except	assets. Includes general management recommendations (e.g.,	priority areas for habitat restoration that can be addressed by
to treat high risk invasive plants and educate the public	restoration) to address specific risks (e.g., invasive species);	more specific actions under an Invasive Species Management
regarding environmentally friendly alternatives to conventional	Policy: Pesticide Use Control Bylaw	Plan
pesticides.	Gap: Invasive Species Management Plan	International Strategies: The National Pollinator Strategy; For
		Bees and Other Pollinators in England

#### 4.0 POTENTIAL FOLLOW-UP CONSIDERATIONS

The gaps identified in Table 1 include gaps that represent small to large investments in modifying existing - or creating new - bylaws, plans, strategies, and standards. Based on findings within the gap analysis (Table 1), the new bylaws, plans, strategies, guidelines, and standards that could be considered by the City of Pitt Meadows going forward, include those listed below. Additional, details for additions or extensions to plans, policies, bylaws, etc., are included in gaps identified in Table 1.

- Tree Preservation Bylaw
- Agriculture and Natural Areas Stewardship Plan, including plans for Biodiversity
- Natural Areas Acquisition Strategy
- Urban Forest Strategy
- Soil Management Strategy
- Invasive Species Management Strategy
- Updated Parks and Recreation Master Plan
- Natural Asset Inventory
- Environmental Management Strategy for Municipal Operations
- Climate Change Adaptation Strategy (and GHG Emission Reduction Strategy)
- Green Infrastructure Network Plan and Standards

#### 5.0 REFERENCES

American Bird Conservancy. 2019. *Bird-friendly Building Design*. https://abcbirds.org/wp-content/uploads/2019/04/Bird-Friendly-Building-Design\_Updated-April-2019.pdf. Retrieved January 22, 2019.

City of Portland. 2006. Natural Areas Acquisition Strategy.

https://www.portlandoregon.gov/parks/44698#!/action=viewmore&type=latestPages. Retrieved January 29, 2020.

Clevenger, Tony. 2011. Planning Considerations for Wildlife Passage in Urban Environments – Best Practice Guideline.

https://www.edmonton.ca/city\_government/documents/PDF/PlanningConsiderationsforWildlifePassag einUrbanAreas.pdf. Retrieved January 29, 2020.

Department for Environment, Food and Rural Affairs (DEFRA) United Kingdom. 2014. The National Pollinator Strategy; For Bees and Other Pollinators in England www.gov.uk/government/publications. Retrieved February 2, 2020.

European Commission. 2020. The European Union Strategy on Green Infrastructure.

https://ec.europa.eu/environment/nature/ecosystems/strategy/index\_en.htm. Retrieved January 28, 2020.

European Commission. 2020. Biodiversity Strategy.

https://ec.europa.eu/environment/nature/biodiversity/strategy/index\_en.htm. Retrieved January 28, 2020.

European Union Business and Biodiversity Platform. 2011. Agriculture Sector and Biodiversity Conservation Best Practice Benchmarking;

environment/biodiversity/business/assets/pdf/sectors/FINAL\_Agriculture.pdf. Retrieved February 1, 2020.

Hunter, Philip. 2014. Brown is the new green: Brownfield sites often harbour a surprisingly large amount of biodiversity. EMBO Rep. 2014 Dec; 15(12): 1238–1242. Published online 2014 Nov 5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4264926/. Retrieved February 6, 2020.

London Development Agency. Design for Biodiversity.

http://downloads.gigl.org.uk/website/design4Biodiversity.pdf. Retrieved January 20, 2020.

National Fish, Wildlife and Plants Climate Adaptation Partnership (NFWPCAP). 2012. National Fish, Wildlife and Plants Climate adaptation Strategy. Association of Fish and Wildlife agencies, Council on Environmental Quality, Great Lakes Indian Fish and Wildlife Commission, National Oceanic and Atmospheric administration, and U.S. Fish and Wildlife Service. Washington, DC.

Department for Environment, Food and Rural Affairs (DEFRA) United Kingdom. 2014. The National Pollinator Strategy; For Bees and Other Pollinators in England www.gov.uk/government/publications. Retrieved February 2, 2020.

# APPENDIX E – ROLES AND RESPONSIBILITIES FOR IMPLEMENTATION FRAMEWORK



# ROLES AND RESPONSIBILITIES FOR IMPLEMENTATION FRAMEWORK

January 14, 2022

PREPARED AND REVIEWED BY

Zoetica Environmental Consulting Services

**SUBMITTED TO**City of Pitt Meadows

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**Document Title:** Roles and Responsibilities for Implementation Framework

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		as Appendix E of final			
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AppE.R000	14-Jan-2022	Revised for Final EIMS	C. Chui	H. Bears	H. Bears
		Report			

# Appendix E: Pitt Meadows EIMS – Roles and Responsibilities for Implementation Framework

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#### 1.0 INTRODUCTION

Effective management of the City's natural assets will require a variety of expertise and cooperation amongst a diverse range of stakeholders. This memo provides a summary of recommended roles and responsibilities associated specifically with implementation of various priority initiatives and actions within of the Environmental Inventory and Management Strategy (EIMS) in the City of Pitt Meadows.

Recommended roles consider the need for sufficient internal staff capacity to manage and implement the EIMS. Successful implementation will also require that the City will expand upon its engagement and coordination with First Nations and stakeholders, including other local and regional governments, government agencies, private landowners, the agricultural community, environmental stewardship groups and NGOs.

The responsibilities described reflect the expectations associated with each role. Setting clear expectations helps to focus time, effort and resources, and supports a coordinated and adaptable team approach that can better achieve EIMS goals and objectives over the long term.

It is recognized that the current memo is not meant to be prescriptive, nor are all the envisioned roles meant to be implemented simultaneously. The necessity for each role will ultimately depend on the uptake and internal prioritization of the various programs and recommendations within the road map of the EIMS over time. The need for these roles and responsibilities will depend on how busy the City gets with environmental management projects. This memo is simply meant to be a resource to go back to for ideas on delegation of tasks as projects unfold within the City.

This document is complementary to *EIMS Management Framework: Policy and Action Recommendations* (Section 5.0 of the *Pitt Meadows EIMS Final Report*) and *Monitoring: Performance Indicators and Benchmarks* (Section 6.0 of the *Pitt Meadows EIMS Final Report*).

#### 2.0 CURRENT ROLES AND RESPONSIBILITIES UNDERTAKEN BY THE CITY

Currently, several departments and internal working groups support environmental planning, monitoring, stewardship, and protection in the City. These environmental roles are broken down by department and working groups below. In every case, the environment roles identified below are a subset of staff members' responsibilities.

#### Planning and Development

- Environmental review of development and planning applications
- Policy review and updates regarding environmental and sustainability matters
- Strategic planning and project management
- Support Council and other departments with information/advice on environmental matters
- Respond to referrals from the Province on applications for instream works, water tenure, habitat offsetting, and other environmental permits
- Provide a contact for community and external inquiries on environmental matters
- Prepare grant applications for environmental projects and initiatives
- Liaise with other levels of government, external agencies, First Nations, and other organizations
- Report on greenhouse gas (GHG) emissions (prepare annual CARIP report)
- Provide presentations and reports to staff, advisory committees, and Council on environmental matters and City initiatives

#### **Bylaw Enforcement**

- Investigate environmental complaints
- Enforce relevant municipal bylaws
- Refer environmental infractions to provincial and federal agencies as appropriate

#### **Engineering and Operations**

- Process soil deposit and extraction permit applications
- Coordinate management of invasive species
- Support monitoring and City-led habitat remediation efforts
- Provide mapping and GIS support for environmental planning and initiatives
- Liaise with Metro Vancouver on management of the Regional Greenway Network

#### Parks, Recreation, and Culture

- Manage invasive species in the City's parks and recreation areas
- Developing a Parks, Recreation, and Culture Master Plan
- Coordinate community events
- Liaise with Metro Vancouver on management of the Regional Greenway Network and regional parks in Pitt Meadows

#### Communications

- Coordinate community outreach
- Respond to media inquiries

#### **Green Team**

- Work with internal departments to enhance corporate sustainability
- Assist with grant applications
- Support community outreach and events
- Educate staff on environment and sustainability issues

# 3.0 EIMS IMPLEMENTATION FRAMEWORK - RECOMMENDED ROLES AND RESPONSIBILITIES

Roles for implementation of the EIMS have been broadly categorized as internal and external. Roles discussed here in relation to external groups, identified in **Table 3-1**, have recommended actions for the City to take in terms of liaison and coordination with those groups. Many of the suggestions are in addition to, or in replacement of, existing staff resources, roles, and responsibilities. The roles and associated responsibilities are related to the management objectives (from the draft **2020 OCP**) and performance indicators described in **Monitoring: Performance Indicators and Benchmarks** (Section 6.0 of the *Pitt Meadows EIMS Final Report*). Responsibilities fall under four general categories:

- 1. *Policy and Regulation* (P/R) related actions that create and support a management framework for the City's natural assets;
- 2. Funding and Resources (F/R) related actions that improve the City's capacity to manage its natural assets on private and public land. Capacity can be assessed in terms of personnel, training and equipment. Funding to increase capacity can be provided directly through City budget or indirectly through grants and/or other mechanisms to support management of natural assets;
- 3. Engagement/Education (E/E) related actions that increase community awareness of the City's natural assets and associated benefits; and,
- 4. Maintenance and Monitoring (M/M) related actions to maintain and inventory the City's natural assets (including their condition). Monitoring also helps assess management performance over time to determine the relevance and effectiveness of project-specific actions and adapt to changing conditions.

Focal areas are also included, where relevant, to provide additional context for roles and responsibilities that are newly envisioned. These focal areas may include the development, implementation, and alignment of existing and proposed City policies<sup>i</sup> that will support management of natural assets. Focal areas may also follow opportunities for partnerships and external fund acquisitions for environmental projects that are desired by various groups within the Table below.

Table 3-1. Roles and responsibilities recommended for undertakings within multiple identified focal areas.

Roles/Department		Responsibilities						
		P/R	F/R	E/E	M/M	Focal Areas		
Internal	Planning and Development - Environmental Planner*	x	×	x	x	<ul> <li>Plan and monitor environmental programs including the natural asset indicators outlined in the EIMS;</li> <li>Assess potential environmental effects of potential projects;</li> <li>Ensure regulatory compliance;</li> <li>Liaise with public and private sector;</li> <li>Search, apply for, acquire, and issue funding and grants from outside sources (e.g., grants from provincial and federal governments; grants available to municipalities and partnering stewardship groups, First Nations, or NGOs) to further the advancement of environmentally focused programs;</li> <li>Coordinate the development, implementation and alignment of City policies to support natural assets and green infrastructure network;</li> <li>Attend Metro Vancouver Environmental Advisory Committee meetings;</li> <li>Be involved in the development of the Parks, Recreation Master Plan such that parks are managed to support EIMS goals and objectives; and,</li> <li>Coordinate with relevant external stakeholders and First Nations to ensure that natural assets are integrated into the updated Parks and Recreation Master Plan.</li> </ul>		
	Planning and Development – GIS Technician*			х	х	- Assist the Environmental Planner and manage natural asset inventory and related information within GIS to support decision-making and operations; and,		

Appendix E: Pitt Meadows EIMS – Roles and Responsibilities for Implementation Framework

						- Update GIS databases on an annual basis and make maps that help to elucidate and highlight environmental planning considerations of Pitt Meadows for public outreach.
	Engineering and Operations (E&O) Liaison (with environmental planner)	х		х		<ul> <li>Dedicate staff to coordinate with environmental planner and integrate natural assets into E&amp;O</li> <li>Manage activities within E&amp;O to support EIMS goals and objectives. Example activities include implementation of green infrastructure (i.e., engineered natural assets, wildlife-friendly lighting, and road crossings); and,</li> <li>Develop an Environmental Management Strategy for Municipal Operations.</li> </ul>
External	Katzie First Nation	x	x		x	<ul> <li>Identify opportunities and willingness to collaborate with Katzie First Nation to achieve mutual objectives for management of shared natural assets;</li> <li>Encourage information sharing with Katzie First Nation to support implementation of the EIMS;</li> <li>Liaise with the Katzie First Nation on decisions that relate to natural assets management;</li> <li>Develop a working agreement and collaborate on finding capacity funding to help facilitate environmental planning with Katzie First Nation;</li> <li>Dedicate one council member to meet regularly with Katzie First Nation;</li> <li>Coordinate to share Council meeting agendas for both Councils between the City of Pitt Meadows and Katzie First Nation on a regular basis to increase awareness and transparency; and,</li> <li>It is noted that these focal areas should be considered draft at present; they should be discussed and amended in collaboration with Katzie First Nation.</li> </ul>
	PM Agricultural Advisory Committee (AAC)	x		x		- Liaise with AAC to promote and encourage use of agricultural best practices that support goals and objectives of the EIMS. For example, the Farmland Advantage program; also encourage the pursuit of projects through the Farmland Advantage programs; - In collaboration with the AAC, encourage development of Agriculture and Natural Areas Stewardship Plan that protects farmland and City's natural assets and increases resilience to potential future climate impacts such as drought and flooding Support farming community by raising awareness of benefits provided by City's natural assets; and, - Provide staff and/or online city resources to facilitate agricultural-related permit applications, and to ease the burden of complicated environmental legislation and requirements. This could be tied with encouraging the pursuit of projects through the Farmland Advantage program.
	PM Environmental Advisory Committee (EAC)*	x		x		- If resources and funding can be made available, establish EAC to support implementation of EIMS and ongoing management of natural assets. Committee to advise on environmental issues, decisions, and direction; - EAC includes council member plus key and knowledgeable members of the community; - The EAC could include representatives from all of the community environmental groups. Under the current committee structure, advisory groups can apply to Council for project funding through the business planning process. Designation of the EAC as the primary liaison with environmental groups would formalize the request/liaison process, facilitate partnership building, and minimise staff resources needs; and, - Suggest inviting a representative member of the Katzie First Nation.
	Metro Vancouver Environmental Advisory Committee (MVEAC)	х	х	х	х	- Actively and regularly participate in MVEAC meetings and presentations with environmental planner and/or Parks, Recreation and Culture staff; and, - Use MVEAC to increase knowledge of ongoing programs and to find ways to dovetail work with Pitt Meadows goals.
	Pitt Meadows Environmental Network (PMEN)		х	х	х	- Liaise with PMEN to support inventory and monitoring of City's natural assets.
	Watershed Watch Salmon Society (WWSS)		х	х	х	- Work with WWSS to inventory and monitor natural assets, including water quality and fish/fish habitat; and, - Partner with WWSS to seek and acquire funding to support management and enhancement of natural assets, riparian habitat, and solutions to enhance fish movement.
	Friends of the Katzie Slough (FKS)		х	х	х	- Work with FKS to identify projects supporting goals and objectives of the EIMS, particularly those supporting natural asset inventory and monitoring, habitat restoration, and invasive plant management.

Appendix E: Pitt Meadows EIMS – Roles and Responsibilities for Implementation Framework

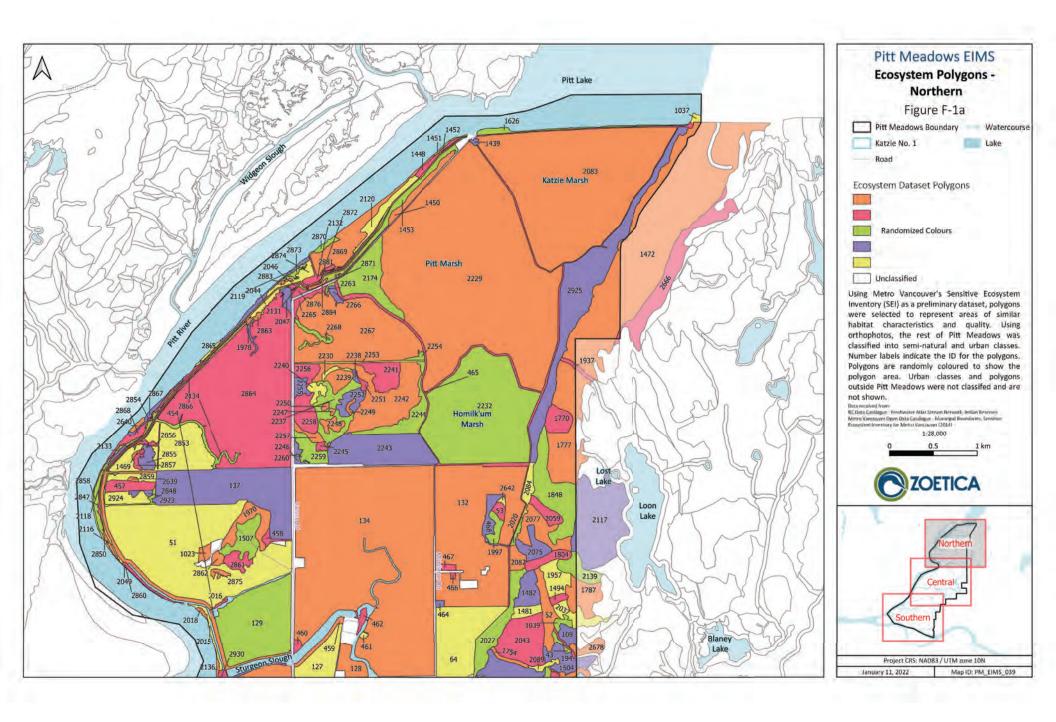
Alouette River Management Society (ARMS)		х	х	х	- Work with ARMS to identify projects supporting goals and objectives of the EIMS, particularly those supporting fish and fish habitat on the Alouette River.
Alouette Field Naturalists (AFN)		х	х	х	- Liaise with AFN to support inventory and monitoring of City's natural assets.
Metro Vancouver (MV)	х	х			- Work with MV to coordinate local and regional management of natural assets. Priority areas for coordination include greenway/blueway development and acquisition/management of natural areas to support regional objectives for carbon neutrality.
City of Maple Ridge/ City of Port Coquitlam	х				- Work with environmental planner to coordinate local and regional management of natural assets. Priority areas for coordination include green infrastructure network planning to improve connectivity and habitat restoration on shared watercourses.
BC Ministry of Environment and Climate Change Strategy (ECCS)	х	х			- Coordinate with ECCS to improve management of natural assets and agricultural land around Pitt-Addington Marsh.
BC Ministry of Agriculture (AGRI)	х	х	x		- Work with AGRI to encourage implementation of best practices that support a sustainable agriculture industry and protection of natural assets; and, - Raise awareness and encourage uptake of Environmental Farm Plan Program.
BC Conservation Data Centre (BC CDC)				Х	- The internal GIS specialist for the City should work with the BC CDC to update the City's knowledge of reported sightings of species that are at risk Provincially or Federally, to keep apprised of up-to-date information with management implications.
Fisheries and Oceans Canada (DFO)	х				- Work with DFO to identify projects that improve fish and fish habitat and increase knowledge of City's natural assets.
Canadian Wildlife Services/Environment and Climate Change Canada (CWS/ECCC)				х	- Ensure that at least one internal City staff works with CWS/ECCC by seeking advice from them on any management plans that relate to management of Species at Risk or migratory birds/bird nests.
Simon Fraser University (SFU) and other research institutions		х		х	- Develop and encourage continued partnerships with research institutions to support management of City's natural assets.
Environmental Consultants (QEP designations)				х	- A RFQ could be issued to identify appropriate environmental consulting agencies and QEPs in advance for use on an as-needed basis.

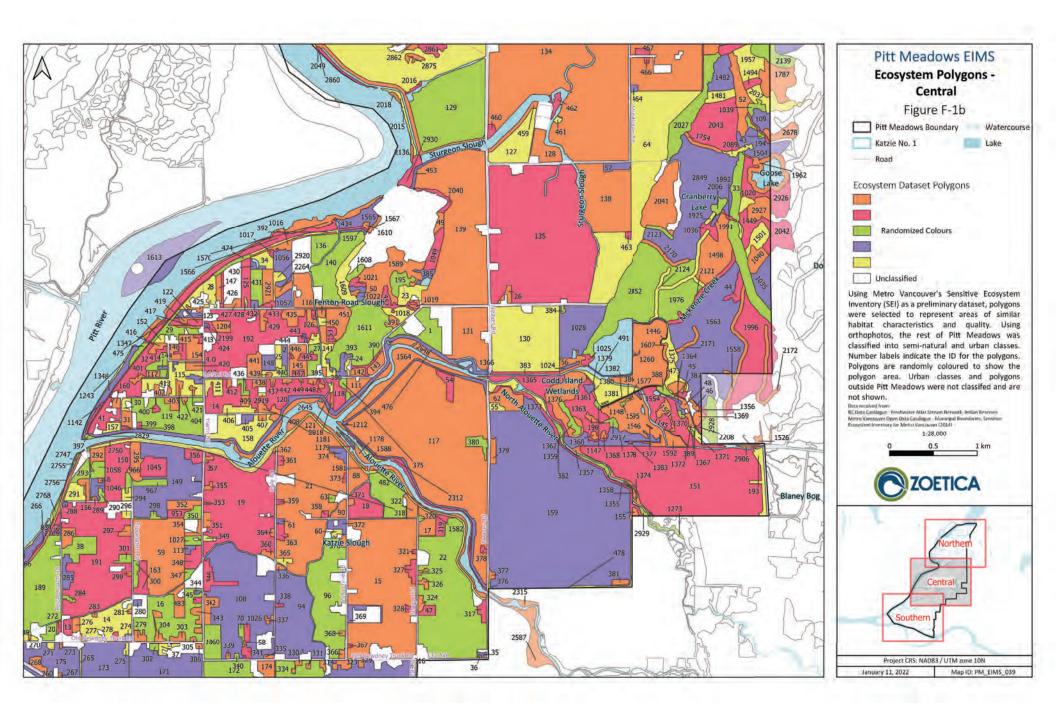
<sup>\*</sup> Role/Department does not currently exist

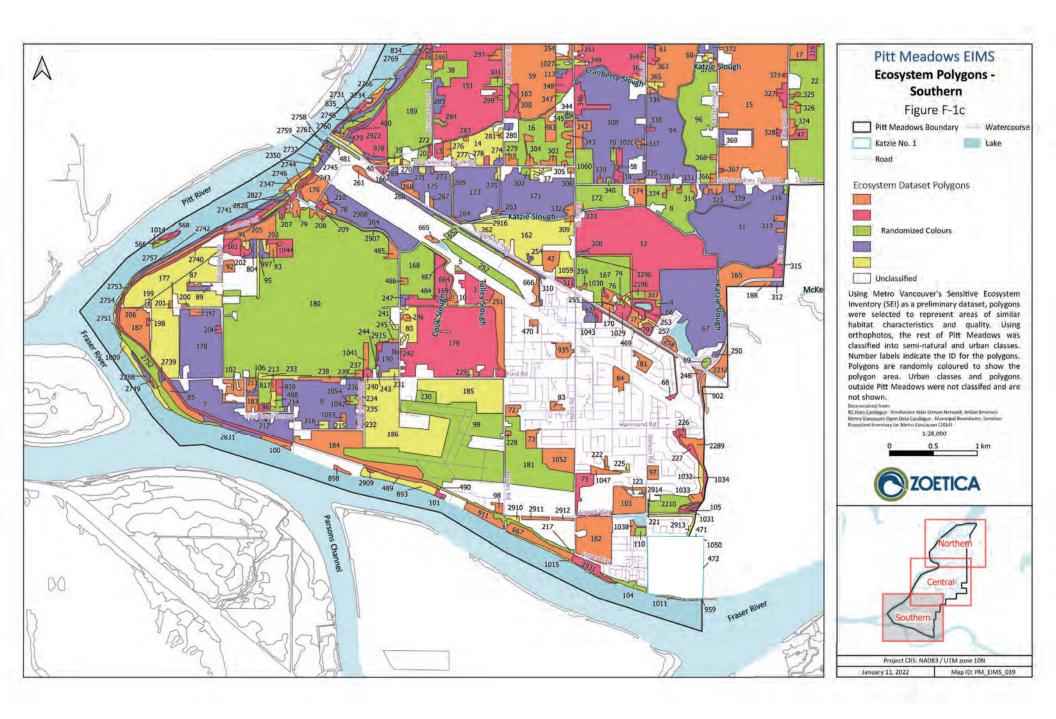
- 2020 Official Community Plan
- Development Permit Areas for Farmland Protection, Natural Environment, Steep Slopes and Riparian Areas;
- Tree Preservation Bylaw;
- Agriculture and Natural Areas Stewardship Plan, including plans for Biodiversity;
- Natural Areas Acquisition Strategy [perhaps as part of a larger Land Acquisition Strategy];
- Urban Forest Strategy;
- Soil Management Strategy;
- Invasive Species Management Strategy;
- Updated Parks and Recreation Master Plan;
- Natural Asset Inventory;
- Environmental Management Strategy for Municipal Operations;
- Climate Change Adaptation Strategy (and GHG Emission Reduction Strategy); and,
- Green Infrastructure Network Plan and Standards.

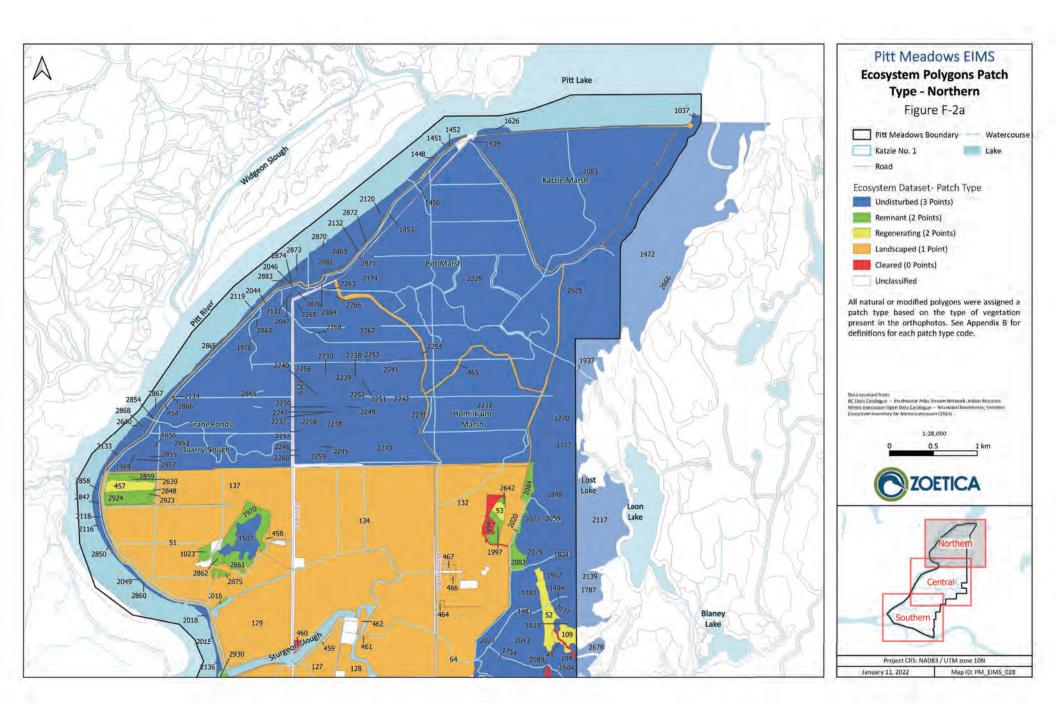
<sup>&</sup>lt;sup>i</sup> Existing and proposed policies include, but are not limited to:

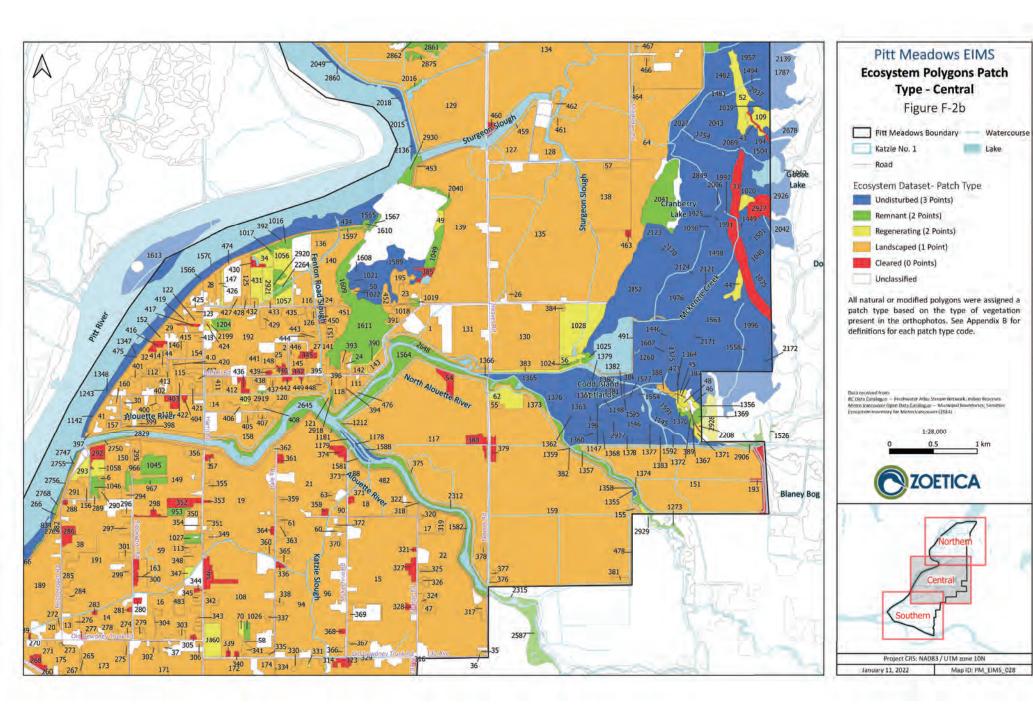
# APPENDIX F – HABITAT QUALITY ASSESSMENT: ANALYTICAL MAPS

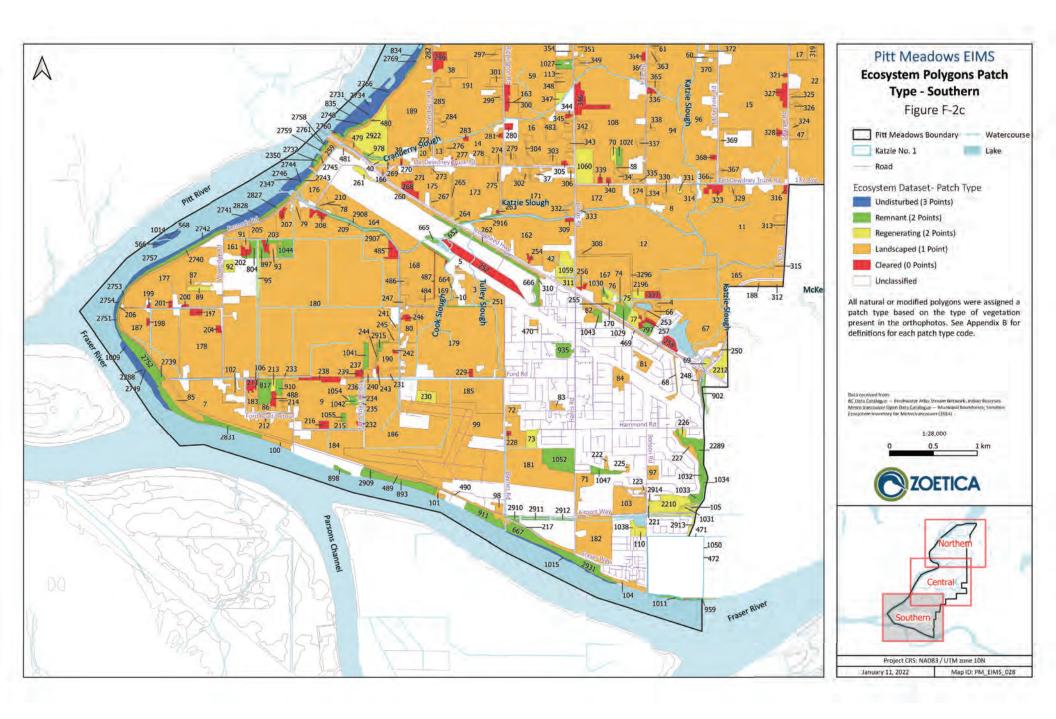


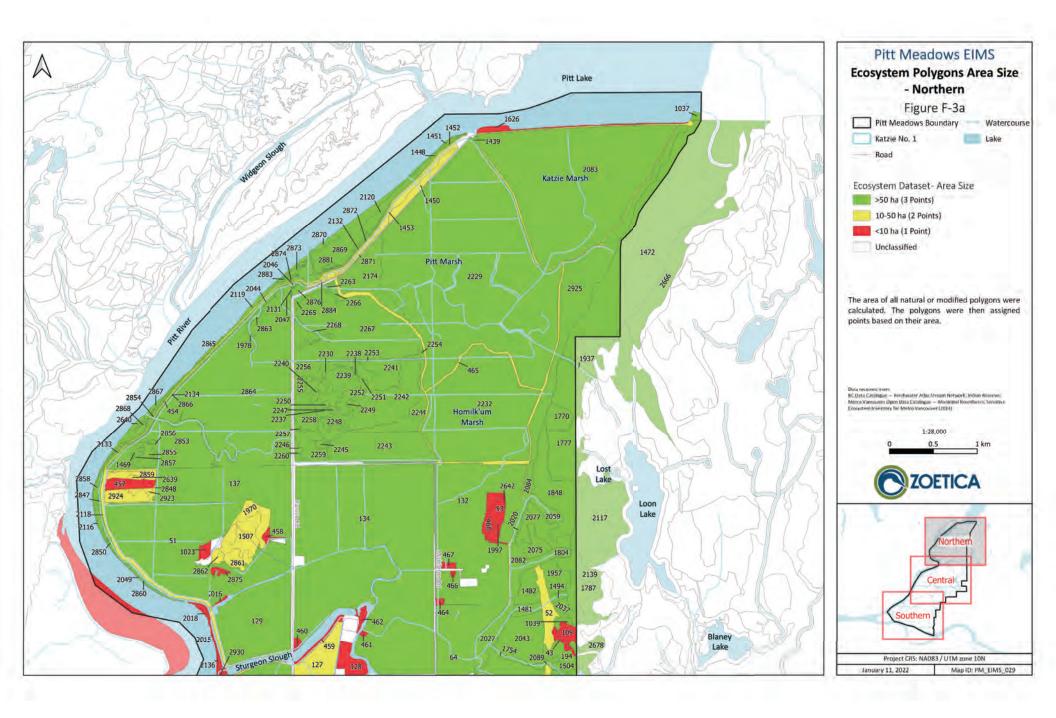


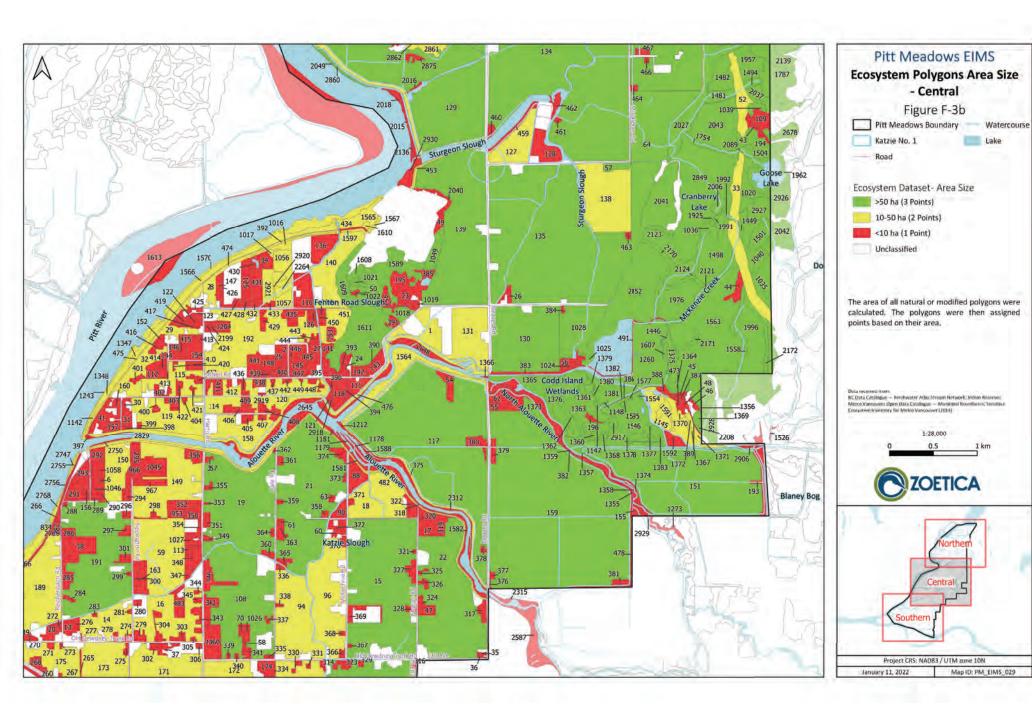


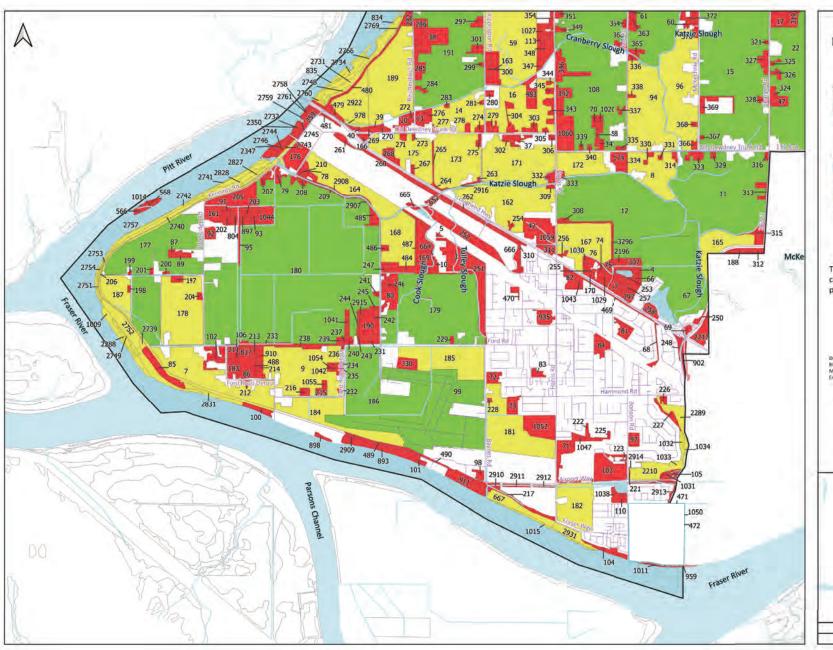


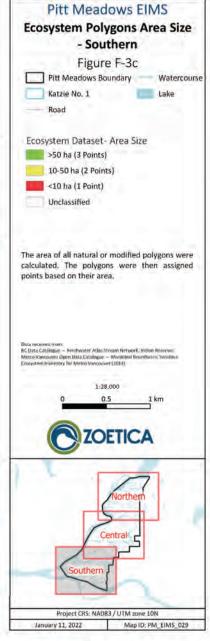


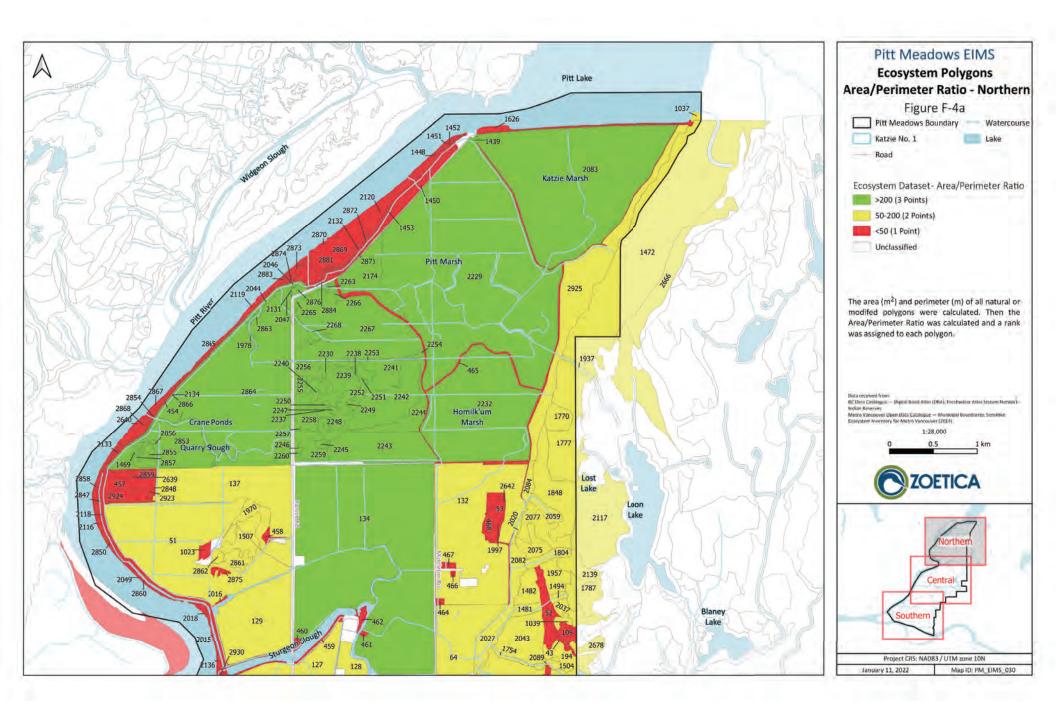


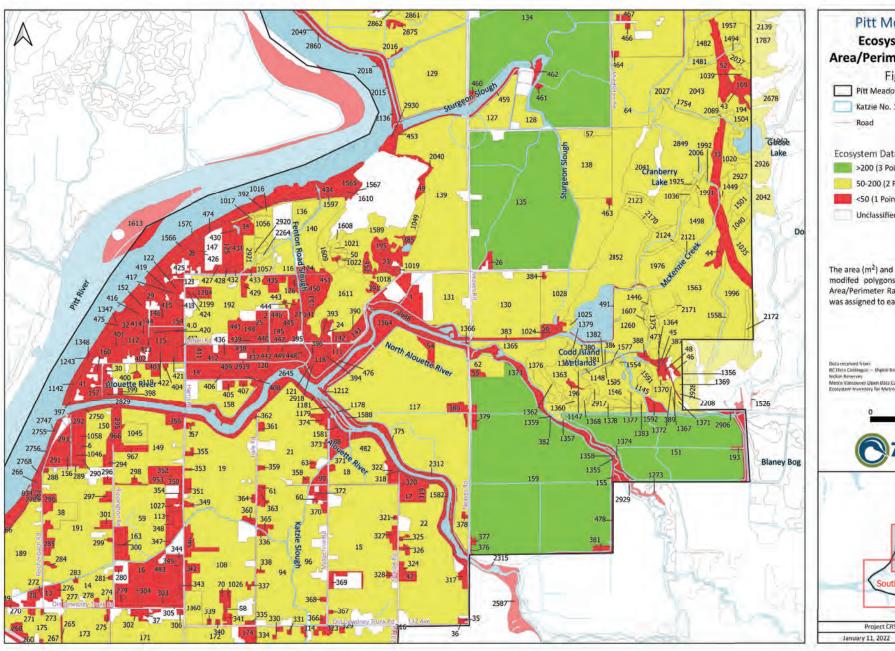


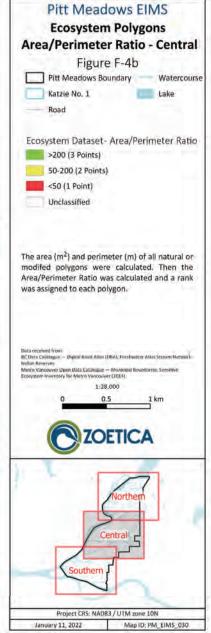


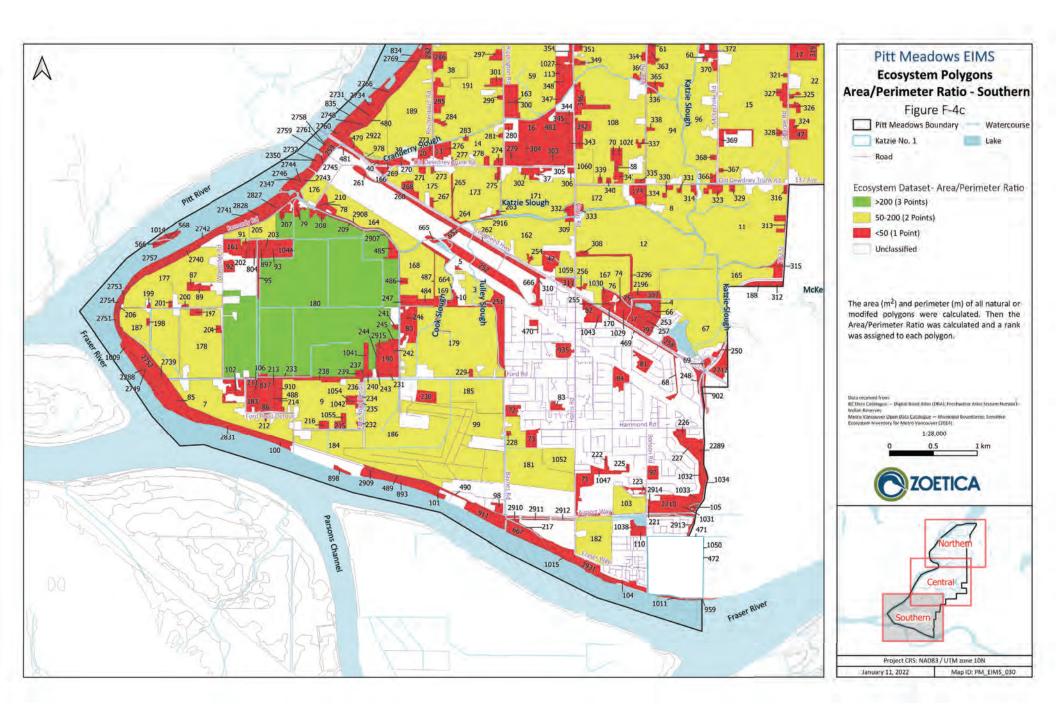


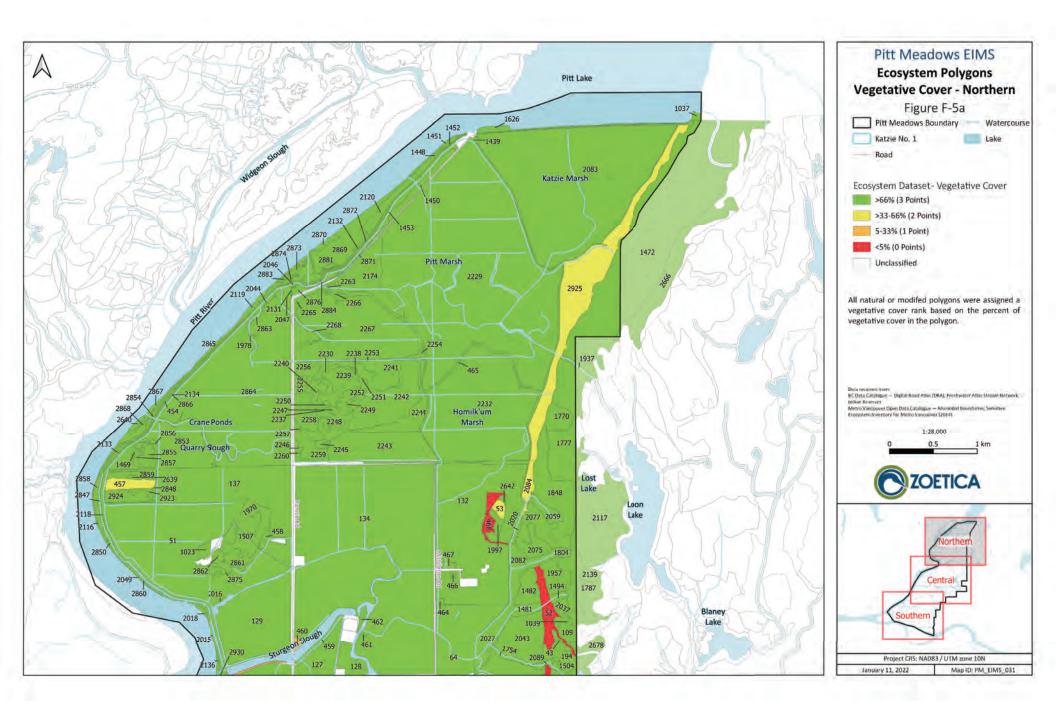


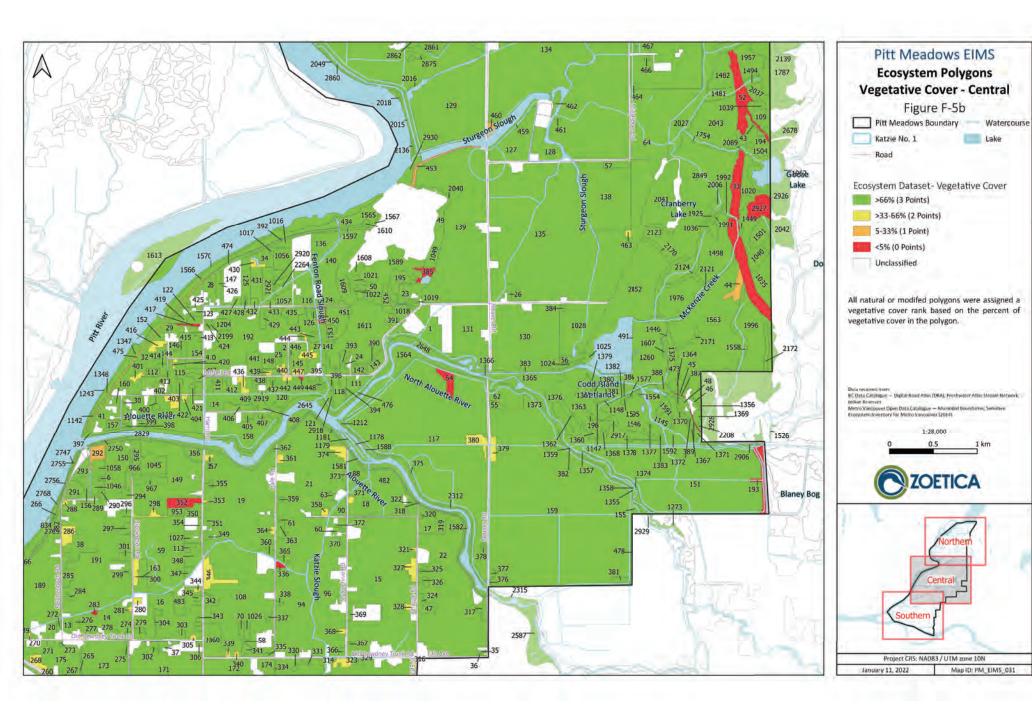


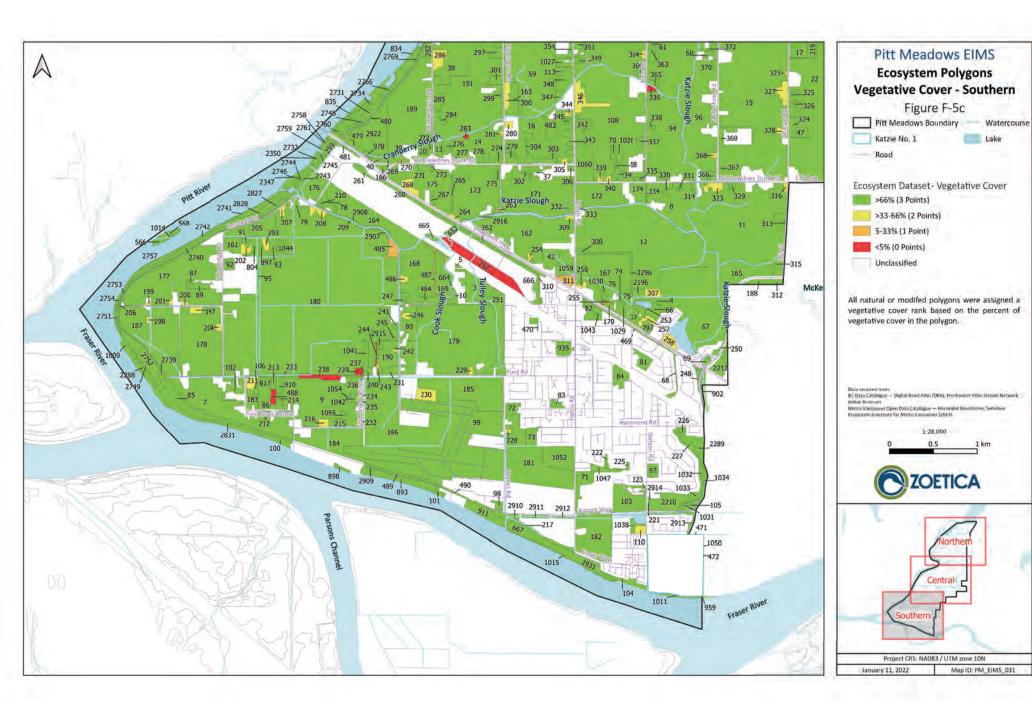


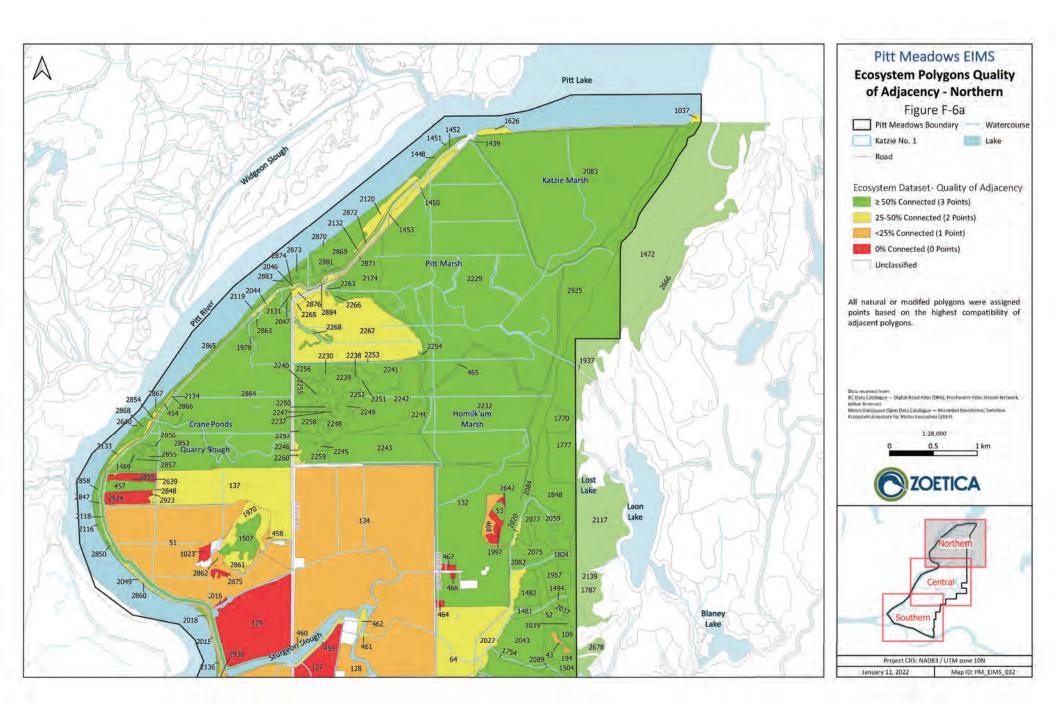


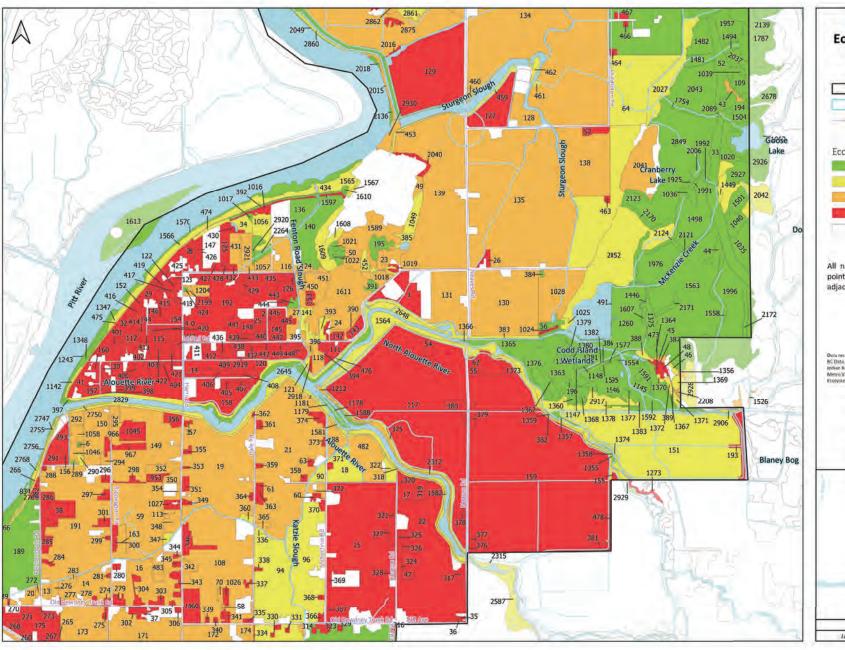


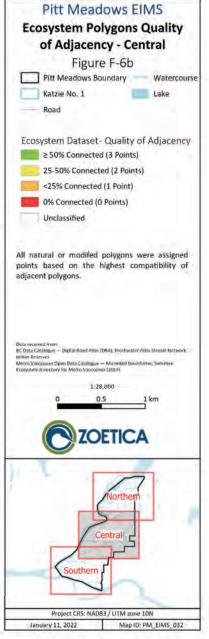


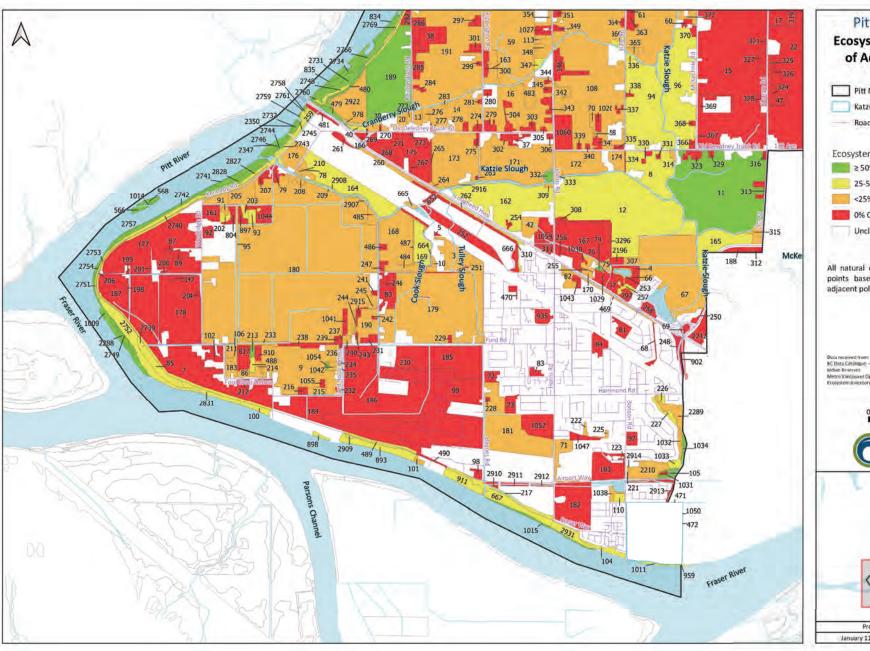




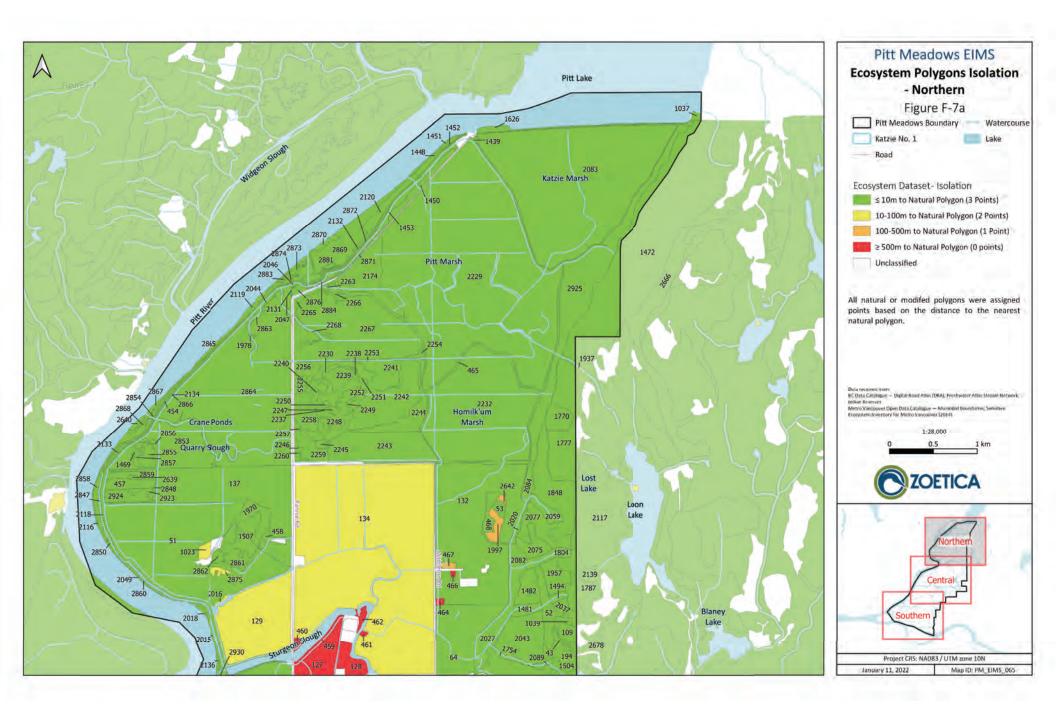


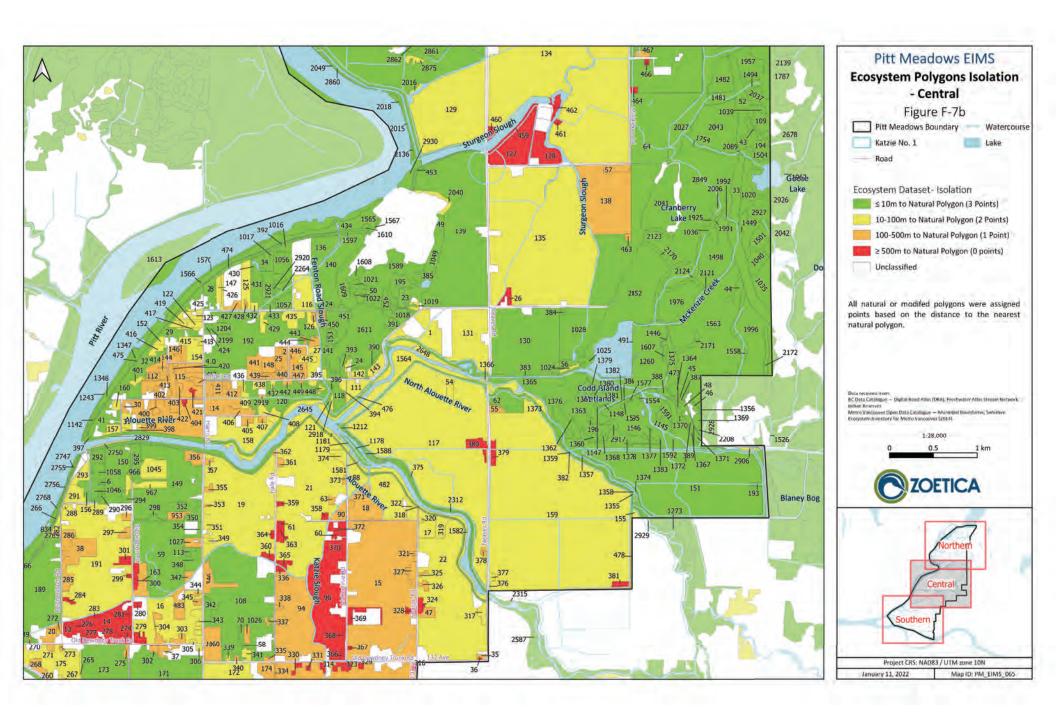


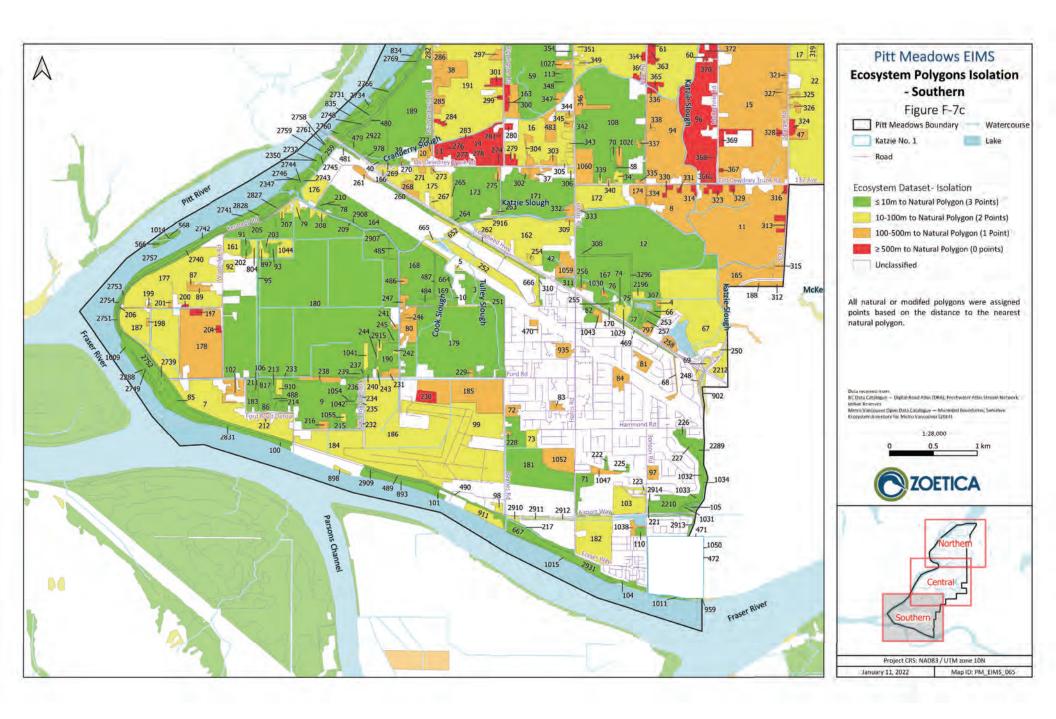


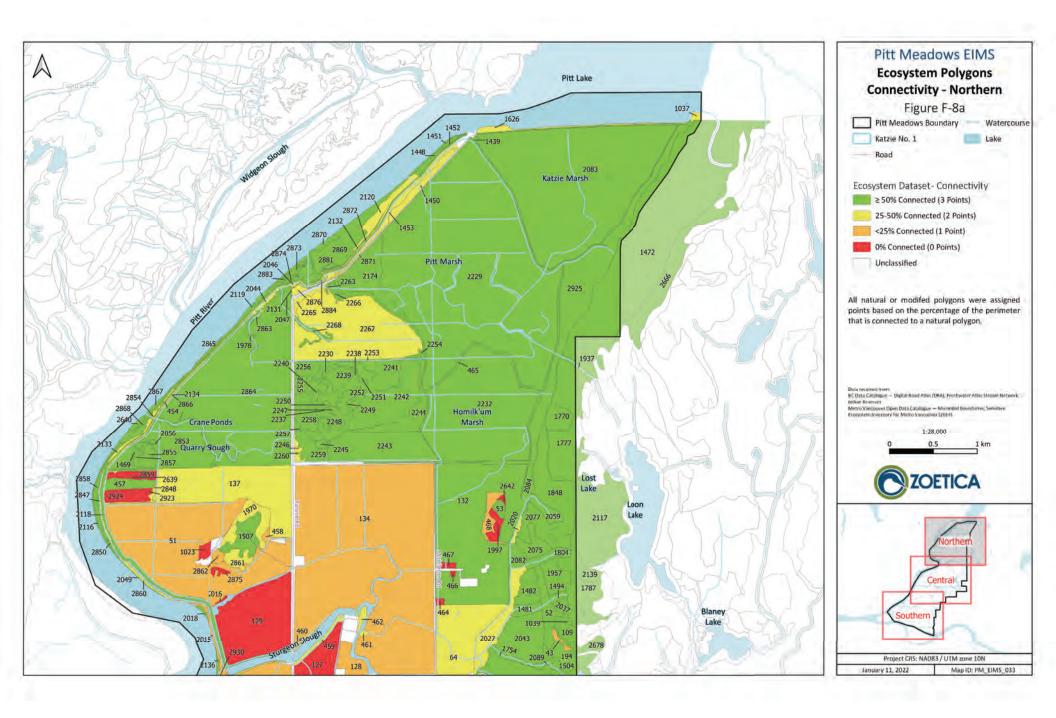


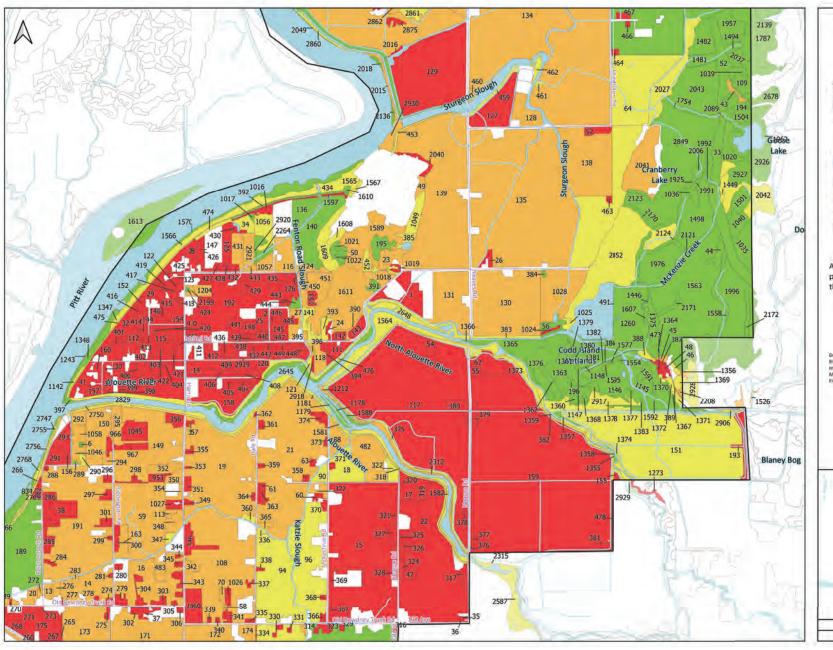


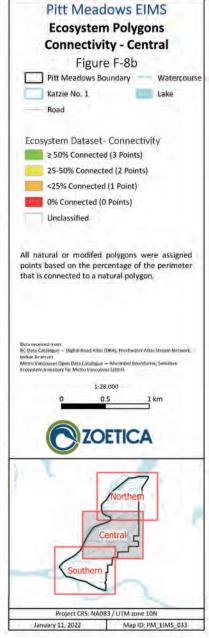


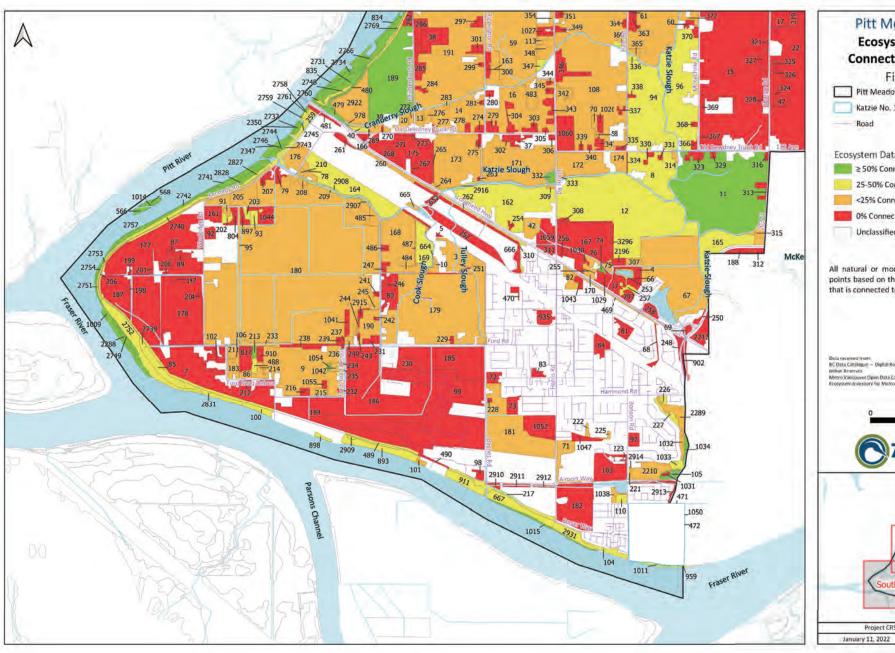


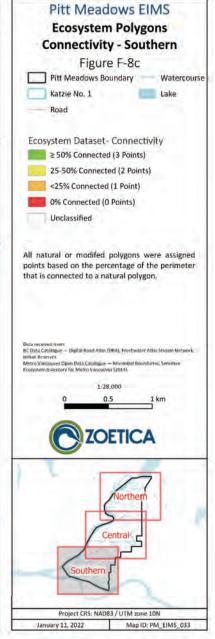


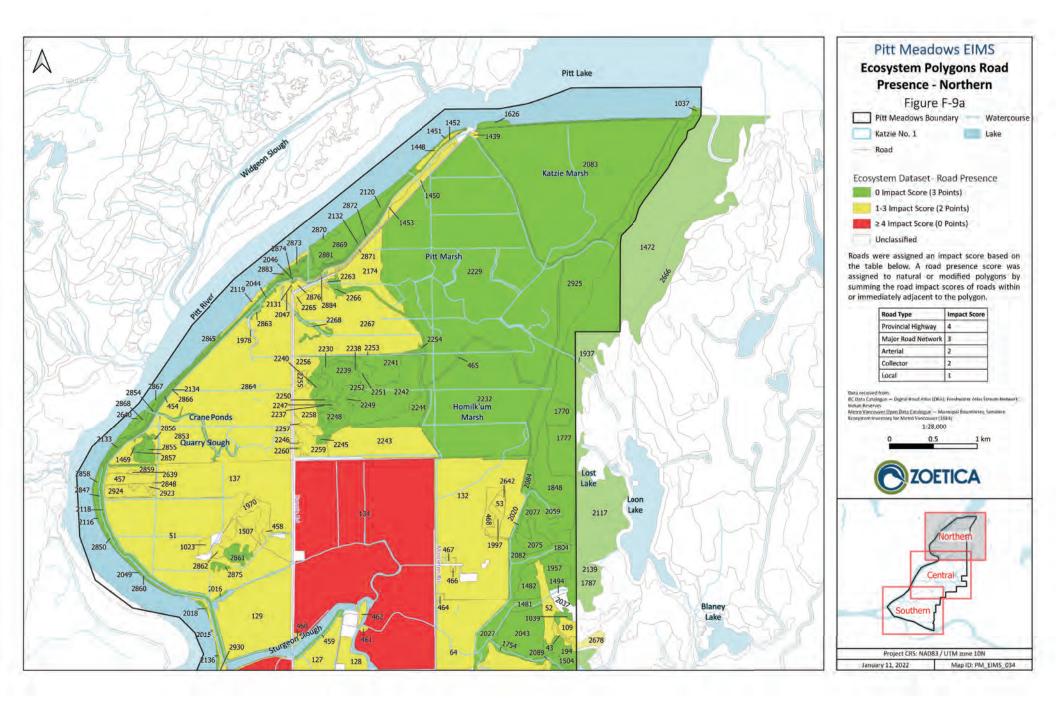


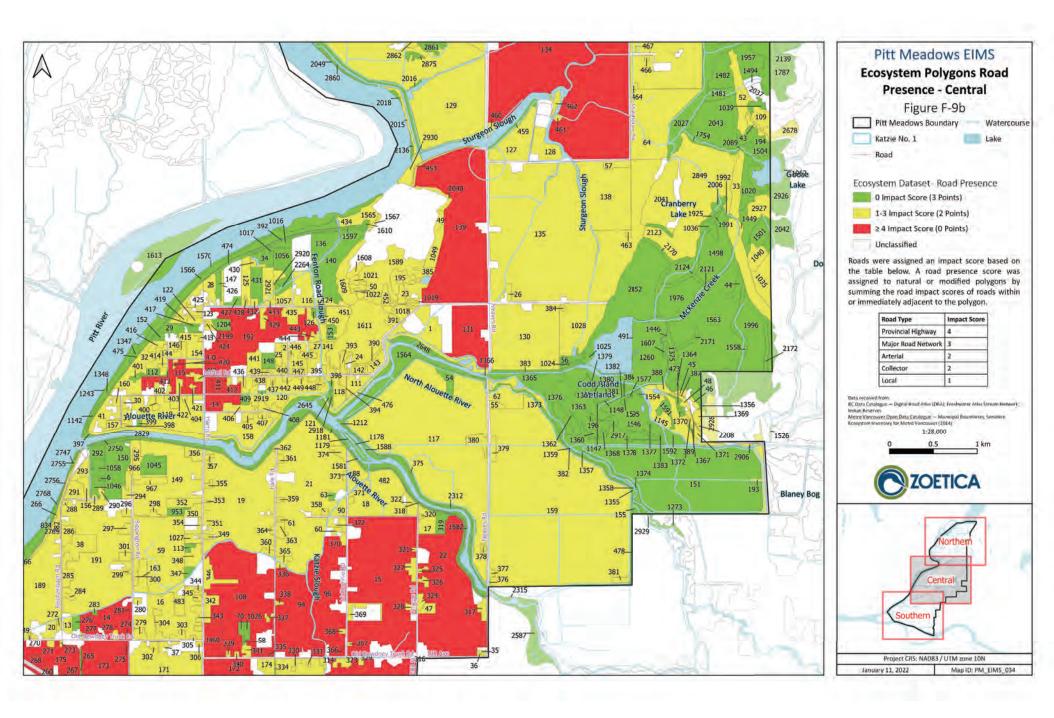


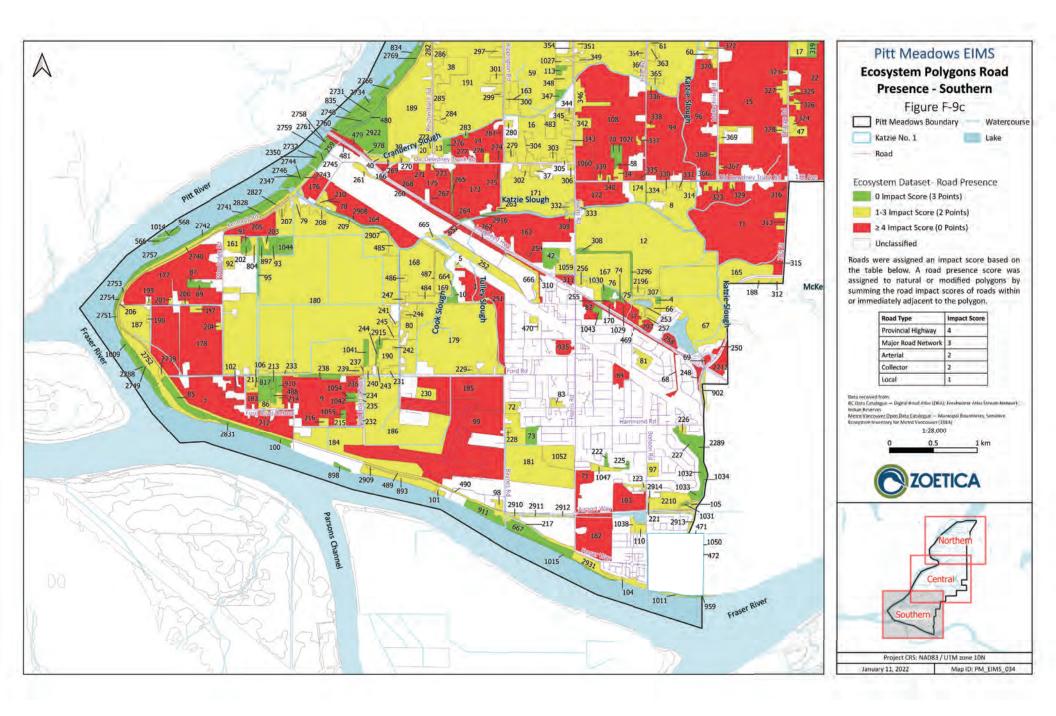


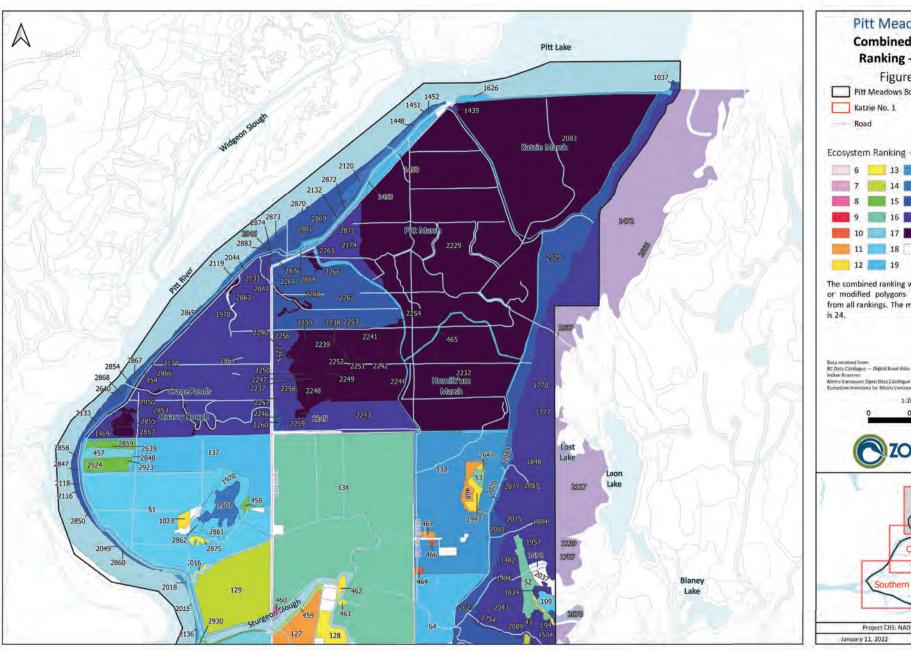


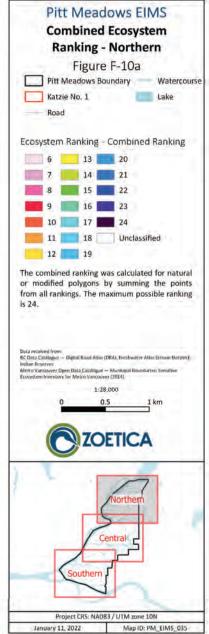


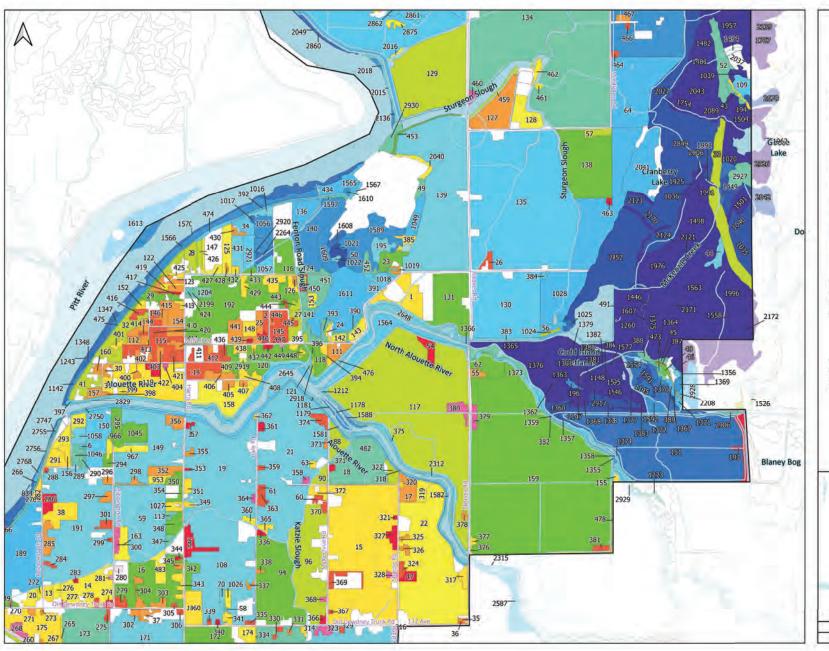


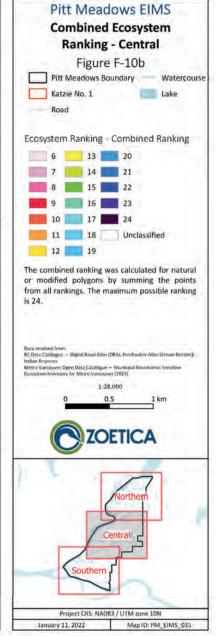


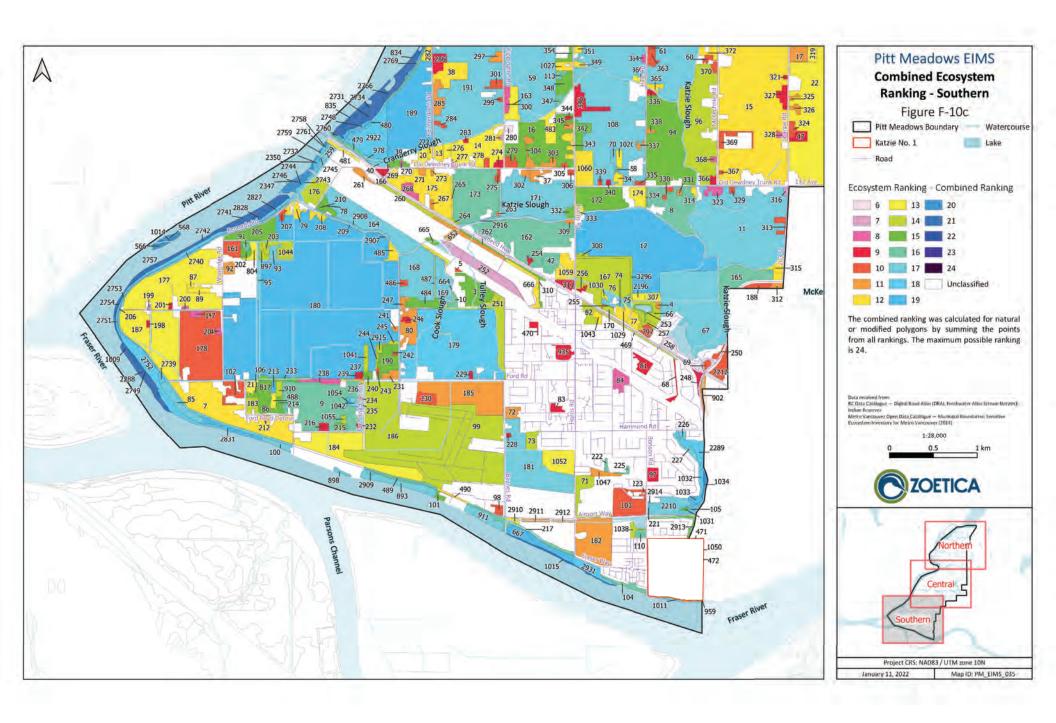












## APPENDIX G – MATRIX OF HABITAT SUITABILITY FOR SPECIES OF CONSERVATION CONCERN

Data from the BC Species and Ecosystems Explorer (BCSEE) were investigated for species of conservation concern (SCC) potentially occurring in Pitt Meadows. Both provincial and federal conservation statuses, as assessed by the BC Conservation Data Centre (CDC) and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), respectively, were considered. Data were initially downloaded on December 14, 2020 using the following search criteria, which resulted in 129 species:

"BC Conservation Status:Red (Extirpated, Endangered, or Threatened) OR Blue (Special Concern)

OR COSEWIC Status: Endangered OR Threatened OR Special Concern

AND Distribution: Native OR Endemic (Yes, Probable, or Breeding) OR Probable Endemic

AND 'Municipalities':Pitt Meadows

AND Habitat Types:

Agriculture, Anthropogenic, Forest, Grassland/Shrub, Lakes, Riparian, Stream/River, Subterranean, Wetland Sort Order: Scientific Name Ascending"

However, only one fish species (white sturgeon) appeared on this list. Another search was conducted on January 8, 2021 using the following criteria, which resulted in 15 fish species:

"Fish, Freshwater OR Fish, Marine

AND BC Conservation Status:Red (Extirpated, Endangered, or Threatened) OR Blue (Special Concern)

OR COSEWIC Status: Endangered OR Threatened OR Special Concern

AND Distribution: Native OR Endemic (Yes, Probable, or Breeding) OR Probable Endemic

AND 'Municipalities':Pitt Meadows Sort Order:Scientific Name Ascending"

This second search revealed that the "missing" species did not have information in the 'Habitats (Type / Subtype / Dependence)' field and were, thus, excluded from the initial search results.

In general, BCSEE results were overly conservative and included a number of species that are very unlikely or unlikely to occur in Pitt Meadows, except perhaps as accidentals. Zoetica manually vetted all results by analyzing species ranges, habitat requirements, and known occurrence data from the BCSEE, the Electronic Atlas of the Wildlife of British Columbia (E-Fauna BC)<sup>31</sup>, and British Columbia's Coast Region: Species and Ecosystems of Conservation Concern<sup>32</sup>.

Only species that are known to occur (e.g., known occurrences in Pitt Meadows) or possibly occur (e.g., based on species ranges, known occurrences in neighbouring jurisdictions, suitable habitat available) within the City of Pitt Meadows were included in the matrix below (n=67).

<sup>31</sup> https://ibis.geog.ubc.ca/biodiversity/efauna/

<sup>32</sup> https://ibis.geog.ubc.ca/biodiversity/factsheets/

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**Table G-1**. Matrix of habitat suitability for species of conservation concern potentially occurring in the City of Pitt Meadows.

Habitat Species	Scientific name	BC List	COSEWIC	cu	HE	PA	CF	DF	MF	LA	РО	ST	GB	RF	RH	RS	RO	во	FE	MA	sw	MU	Total Habitats per Species
		•				-	M	AMM	ALS				-	-				-	-		-		
Townsend's Big-eared Bat	Corynorhinus townsendii	Blue	-				Х	Х	Х					0									4
Snowshoe Hare, washingtonii subspecies	Lepus americanus washingtonii	Red	-				х	х	Х					0	0	0							6
Little Brown Myotis	Myotis lucifugus	Yellow	Endangered				Х	Х	х					0		0							5
Pacific Water Shrew	Sorex bendirii	Red	Endangered				Х					Х	Х	Х	Х	Х		х	Х	х	х		10
Trowbridge's Shrew	Sorex trowbridgii	Blue	-				?		х					Х									3
Long-tailed Weasel, altifrontalis subspecies	Mustela frenata altifrontalis	Red	-	х	Х	Х	х	Х	Х				Х	Х	Х	х	0	Х	Х	Х	х		15
			-					BIRDS	;														
Northern Goshawk, laingi subspecies	Accipiter gentilis laingi	Red	Threatened	0	0	0	Х		Х					Х									6
Western Grebe	Aechmophorus occidentalis	Red	Special Concern							Х	Х									Х			3
Great Blue Heron, fannini subspecies	Ardea herodias fannini	Blue	Special Concern	0	0	0	Х	Х	Х	Х	Х			Х	0					Х	Х	Х	13
Short-eared Owl	Asio flammeus	Blue	Special Concern	0	0	0					0				Х					Х			6
American Bittern	Botaurus Ientiginosus	Blue	-	0	0	0				Х	Х				?					Х			7
Rough-legged Hawk	Buteo lagopus	Blue	Not at Risk	0	0	0									0			Х	Х	Х	Х		8
Green Heron	Butorides virescens	Blue	-							Х	Х	0		Х	Х	Х				х	х		8
Common Nighthawk	Chordeiles minor	Yellow	Special Concern	0	0	0	Х	Х	Х	Х	Х	0	0				Х	Х	Х	Х	Х		15
Evening Grosbeak	Coccothraustes vespertinus	Yellow	Special Concern				Х	Х	Х					Х									4
Olive-sided Flycatcher	Contopus cooperi	Blue	Special Concern				Х		0		Х			Х				0	0		0		7
Tundra Swan	Cygnus columbianus	Blue	-	х	Х	Х				Х	Х	0			0			х	Х	х	Х	0	12

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Species Habitat	Scientific name	BC List	COSEWIC	CU	HE	PA	CF	DF	MF	LA	РО	ST	GB	RF	RH	RS	RO	во	FE	MA	sw	MU	Total Habitats per Species
Black Swift	Cypseloides niger	Blue	Endangered							Х	Х	Х						х	х	х	Х		7
Horned Lark, strigata subspecies	Eremophila alpestris strigata	Red	Endangered	Х	Х	Х											0						4
Peregrine Falcon, anatum subspecies	Falco peregrinus anatum	Red	Not at Risk	Х	Х	Х				Х	Х	0	0		Х		Х	Х	Х	Х	Х		13
Barn Swallow	Hirundo rustica	Blue	Threatened	х	Х	Х	0	0	0	Х	Х	Х	0	0	О	0		х	Х	Х	Х		17
Caspian Tern	Hydroprogne caspia	Blue	Not at Risk							Х		Х	0							0			4
Yellow-breasted Chat	Icteria virens	Red	Endangered		0			0	0					0		Х							5
California Gull	Larus californicus	Blue	-	Х	Х	Х				Х	Х	0	0							х			8
Long-billed Curlew	Numenius americanus	Blue	Special Concern	Х		Х																0	3
Band-tailed Pigeon	Patagioenas fasciata	Blue	Special Concern	0		0	Х	0	Х					Х									6
American White Pelican	Pelecanus erythrorhynchos	Red	Not at Risk							Х	Х	0								0			4
Double-crested Cormorant	Phalacrocorax auritus	Blue	Not at Risk				0			0		0					Х						4
Barn Owl	Tyto alba	Red	Threatened	Х	Х	Х			О				0	0	0	0				o			9
Purple Martin	Progne subis	Blue	-	0	0	0	0	0				0		0				Х	Х	х	х		11
Western Screech-Owl, kennicottii subspecies	Megascops kennicottii kennicottii	Blue	Threatened		?	?	?		?					?									5
Lewis's Woodpecker	Melanerpes lewis	Blue	Threatened	О	0	0	Х	Х						Х									6
Lark Sparrow	Chondestes grammacus	Blue	-	0	0	0																	3
Black-crowned Night- heron	Nycticorax nycticorax	Red	-	0	0	0					Х	0				Х				Х	Х		8
Gyrfalcon	Falco rusticolus	Blue	Not at Risk	Х	Х	Х				Х	Х	0						Х	Х	Х	х	х	11
Surf Scoter	Melanitta perspicillata	Blue	-							Х	Х			Х	0	0							5
Marbled Murrelet	Brachyramphus marmoratus	Blue	Threatened				Х			0		0		Х			0						5

Species Habitat	Scientific name	BC List	COSEWIC	CU	HE	PA	CF	DF	MF	LA	РО	ST	GB	RF	RH	RS	RO	во	FE	MA	sw	MU	Total Habitats per Species
	-	-	-	-	-	REPT	ILES (	SNAKE	s, tur	TLES)					-	-	_		-				
Painted Turtle - Pacific Coast Population	Chrysemys picta pop. 1	Red	Threatened							х	Х		Х	х	Х	х		Х	Х	Х	Х		10
							AN	1РНІВІ	ANS														
Northern Red-legged Frog	Rana aurora	Blue	Special Concern					0		Х	Х	Х	Х	Х	Х	Х		Х	Х	Х	Х		12
Western Toad	Anaxyrus boreas	Yellow	Special Concern				Х	Х	Х	Х	Х	Х	Х	Х	Х	Х		Х	Х	Х	Х		14
Oregon Spotted Frog	Rana pretiosa	Red	Endangered							Х	х	х	х	Х	х	Х		Х	Х	Х	Х		11
Coastal Tailed Frog	Ascaphus truei	Yellow	Special Concern									Х		Х									2
								FISHE	S														
White Sturgeon (Lower Fraser River population)	Acipenser transmontanus pop. 4	Red	Threatened							?	?	Х											3
Brassy Minnow - Pacific Group	Hybognathus hankinsoni - Pacific group	Blue	-							Z	Z	Z								Z			4
Cutthroat Trout, clarkii subspecies	Oncorhynchus clarkii clarkii	Blue	-							Z		Z											2
Bull Trout - South Coast Population	Salvelinus confluentus pop. 28	Blue	Special Concern									Z											1
Pygmy Longfin Smelt	Spirinchus sp. 1	Red	Data Deficient							Z													1
Eulachon	Thaleichthys pacificus	Blue	Endangered / Threatened									Z											1
Green Sturgeon	Acipenser medirostris	Blue	Special Concern									(?)											1
							ı	NSECT	rs														
Johnson's Hairstreak	Callophrys johnsoni	Red	-				Х																1
Emma's Dancer	Argia emma	Blue	-							Х	Х	Х			Х	Х							5
Grappletail	Octogomphus specularis	Red	-									х		Х		Х							3
Zerene Fritillary, bremnerii subspecies	Speyeria zerene bremnerii	Red	-					Х															1

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Species Habitat	Scientific name	BC List	COSEWIC	CU	HE	PA	CF	DF	MF	LA	РО	ST	GB	RF	RH	RS	RO	во	FE	MA	sw	MU	Total Habitats per Species
Autumn Meadowhawk	Sympetrum vicinum	Blue	-						0	Х	Х	Х			Х	Х							6
Monarch	Danaus plexippus	Red	Endangered	х	х	х																	3
Blue Dasher	Pachydiplax longipennis	Blue	-							Х	Х	0		Х						Х			5
Dun Skipper	Euphyes vestris	Blue	Threatened																				0
					MC	LLUSC	S (BIV	ALVES	S, GAST	ROPO	DS)												
Western Thorn	Carychium occidentale	Blue	-						Х														1
Oregon Forestsnail	Allogona townsendiana	Red	Endangered						Х														1
							VASCI	JLAR F	PLANTS	;													
American Sweet-flag	Acorus americanus	Blue	-							Х	Х				О	0				О	О		6
Vancouver Island beggarticks	Bidens amplissima	Blue	Special Concern																	Х		Х	2
Washington Springbeauty	Claytonia washingtoniana	Red	-				?		?														2
Yellowseed False Pimpernel	Lindernia dubia var. dubia	Blue	-															Х	Х	Х	Х		4
Pink Water Speedwell	Veronica catenata	Blue	-								Х				Х					Х			3
Streambank Lupine	Lupinus rivularis	Red	Endangered									Х										0	2
Henderson's Checker- mallow	Sidalcea hendersonii	Blue	-																	?			1
	Total Species per Habita	at		21	21	22	21	15	20	28	27	30	12	27	21	18	6	16	16	31	20	6	-

**Table G-2.** Legend for habitat codes and habitat use codes presented in Table G-1. Habitat types and subtypes are from the British Columbia Species and Ecosystems Explorer data.

Code	Habitat Subtype	Habitat Type
CU	Cultivated Field	
HE	Hedgerow	Agriculture
PA	Pasture/Old Field	
CF	Conifer Forest – combined Dry, Mesic (average), Moist/wet	
DF	Deciduous/Broadleaf Forest	Forest
MF	Mixed Forest (deciduous/coniferous mix)	
LA	Lake	Lake
РО	Pond/Open Water	Lake
ST	Stream/River	Stream/River
GB	Gravel Bar	
RF	Riparian Forest	Dinasias
RH	Riparian Herbaceous	Riparian
RS	Riparian Shrub	
RO	Rock/Sparsely Vegetated Rock	Rock/Sparsely Vegetated Rock
ВО	Bog	
FE	Fen	Wetland
MA	Marsh	vetiand
SW	Swamp	
MU	Mudflat - Intertidal	Other Unique Habitats
	Habitat Use	
Х	Obligate OR Facultative, frequent use	
0	Facultative, occasional use	
?	Unknown	
Z	For fish species where habitat types were not indicated in BCS information found in 'Global Habitat Comments' field. Habitat be obligate/frequent use. The exception is where Zoetica enterivers in Metro Vancouver is poorly understood.	use for these species was assumed to