

Maximizing Natural Asset Management Efforts

Infrastructure Service Values in the Regional District of Central Okanagan, British Columbia



March 2024



Invest in Nature

The Natural Assets Initiative (NAI) is a Canadian not-for-profit that is changing the way local governments — an increasingly, other watershed agencies — deliver everyday services, increasing the quality and resilience of infrastructure at lower costs and reduced risk. The NAI team provides scientific, economic, and municipal expertise to support and guide local governments in identifying, valuing, and accounting for natural assets in their financial planning and asset management programs, and developing leading-edge, sustainable, and climate-resilient infrastructure.

On behalf of the Regional District of Central Okanagan (RDCO):

The RDCO acknowledges our presence on the traditional, ancestral, and unceded tɾɪxʷúlaʔxʷ (land) of the syilx / Okanagan people who have resided here since time immemorial. We recognize, honour, and respect the syilx / Okanagan lands upon which we live, work, and play.

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Table of Contents

Executive Summary	3
Introduction	5
Context	6
Figure 1: Natural Asset Management Process (Adapted from Asset Management BC)	7
STEP 1 Establish a project team	8
Table 1: Project Leads	8
Table 2: Local Expert Advisory Group (LEAG) Members	9
STEP 2 Define the Project Area and Confirm SAR/CH	10
Table 3: Source Data for Spatial Distribution of Endangered or Threatened Animal and Plant Species	10
Figure 2: Map of Outer Boundaries and Buffers with Observations of Species of Interest	11
Figure 3: Map of RDCO boundary	12
STEP 3 Gather and Process Natural Asset Data	13
Table 4: Datasets Used to Map Natural Assets within the RDCO Boundary	13
STEP 4 Map Natural Assets and SAR/CH	14
Figure 4: Natural Assets Within the RDCO Boundary	14
Table 5: Summary of Natural Assets by Asset Type in the RDCO	15
Figure 5: Map of Critical Habitat for Animal Species at Risk (SAR) in the RDCO Project Area	15
Figure 6: Map of Critical Habitat for Animal Species at Risk (SAR) in the RDCO in Relation to Natural Assets	16
Figure 7: Map of Critical Habitat for Plant Species at Risk (SAR) in the RDCO Project Area	17
Figure 8: Map of Critical Habitat for Plant Species at Risk (SAR) in the RDCO in Relation to Natural Assets	18
STEP 5 Consider Priority Ecosystem Services	18
Figure 9: Ecosystem Services Diagram	19
Table 6: Services Identified During LEAG Meeting	20
Table 7: Ecosystem Services and Relevant Natural Asset Types	21
STEP 6 Identify Management Actions	22

STEP 7	Cost-Benefit Analysis Methodology	25
	Table 8: Ecosystem Service Values	28
	Cost-Benefit Analysis	28
	Management Action 1:	
	Parkland acquisition to increase connectivity	29
	Table 9: Landcover Types in Areas Identified for Management Action 1	30
	Table 10: Cost-Benefit Results of Management Action 1 (Parkland Acquisition)	32
	Figure 10: Cost benefit results for Management Action 1 (Parkland Acquisition)	32
	Management Action 2:	
	Tax Incentives for Preservation of Natural Assets on Farmland	32
	Figure 11: Proposed Areas for Management Action 2 (Tax Incentives)	33
	Table 11: Cost-Benefit Results of Management Action 2 (Tax Incentives)	35
	Figure 12: Cost-Benefit Results for Management Action 2 (Tax Incentives)	35
	Management Action 3:	
	Acquisition of a Sensitive Ecosystem	36
	Figure 13: Proposed area for Management Action 3 (Acquisition of Sensitive Ecosystems)	36
	Table 12: Cost-Benefit Results of Management Action 3 (Acquisition of Sensitive Ecosystems)	38
	Figure 14: Cost-Benefit Results for Management Action 3 (Acquisition of Sensitive Ecosystems)	38
	Conclusion.	39
	Next Steps.	40
	References.	41
	Appendix A – Local government management tools for Species at Risk and Critical Habitat	44
	Table 13: Management Tools for SAR and CH for Local Governments	44
	Appendix B – Primary studies utilized to estimate ecosystem service values.	51
	Table 14: Primary Studies used for Ecosystem Service Value Estimates	51
	Appendix C – Detailed Net Present Values of Benefits	53
	Table 15: Net Present Value of Benefits for Individual Ecosystem Service – Management Action 1	53
	Table 16: Net Present Value of Benefits for Individual Ecosystem Service – Management Action 2	54
	Table 17: Net Present Value of Benefits for Individual Ecosystem Service – Management Action 3	55

Executive Summary

This document summarizes an exercise — referred to as the “Project” — undertaken by the Natural Assets Initiative (NAI) with the Regional District of Central Okanagan (RDCO) and the City of Kelowna (the “Partners”) to advance their natural asset management efforts by identifying and prioritizing management actions related to natural assets that benefit Species at Risk (SAR), Critical Habitat (CH) and the provision of core local government services.

Specifically, the Project objectives were to:

- Understand the nature and extent of overlap between natural assets that provide local government services and natural assets that are relevant to local SAR/CH.
- Identify management actions that benefit both natural assets for local government service delivery, and SAR/CH.
- Conduct a cost-benefit analysis (CBA) of management actions and their outcome on service delivery to demonstrate benefits to natural assets and SAR/CH.

The first step in the process was to identify and engage a project team. For this, NAI developed a team consisting of:

- Project leads responsible for managing and undertaking the content work.
- Local expert advisory group (LEAG) whose purpose was to provide expert, local advice and perspectives.

The project leads and LEAG members met at key stages throughout the project to advise on:

- 1/ The proposed project area
- 2/ The priority ecosystem service/s
- 3/ Management actions that could benefit NA and SAR/CH

With respect to defining the project area, the group concluded that it was preferable to focus on **ecosystems** at risk rather than SAR, and to define the project study area as the entire RDCO. Before discussing management actions, the Partners explored the ecosystem services to which the management actions might be geared. After significant engagement with the LEAG, three priority ecosystem services were identified: the provision of fresh water; the regulation/moderation of stormwater; and carbon sequestration. These services were then the focus of the management actions and the cost-benefit analysis (CBA).

With the priority services established, the next step in the approach was to identify natural asset management actions for inclusion in the CBA. Management actions were refined through multiple steps that included a policy scan and literature review, assessment of stressors and challenges to SAR management in the study area, and development of criteria for prioritizing management actions.

This process resulted in the selection of three priority management actions.

Action 1: Parkland acquisition to increase connectivity: The first management action explored relates to parkland acquisition to consider the benefits of linking regional, city and provincial or national parks to maximize SAR/CH and the priority ecosystem services. The CBA for this action considered the cost of the action in relation to the ecosystem service benefits received from its implementation (including benefits related to SAR/CH). The CBA revealed the net gain associated with this action:

- \$175,875,499 at a 0% discount rate with a benefit cost ratio of 6.15, meaning for every dollar invested, \$6.15 in benefits are realized.
- \$125,714,161 at a 2% discount rate and a benefit-cost ratio of 5.81, meaning for every dollar invested, \$5.81 in benefits are realized.
- \$92,859,053 at a 4% discount rate and the resulting benefit cost ratio is 5.49, meaning for every dollar invested \$5.49 in benefits are realized.

Action 2: Tax incentives for the preservation of natural assets on farmland: The second management action considers tax incentives for wetland and stream protection on agricultural land reserves (ALR) and Non-ALR lands. The CBA for this action considered the cost of the action in relation to the ecosystem service benefits received from its implementation (including benefits related to SAR/CH). The CBA revealed the net gain associated with this action:

- \$15,529,829 at a 0% discount rate, with a benefit cost ratio of 2.55, meaning for every dollar invested, \$2.55 in benefits are realized.
- \$10,298,615 at a 2% discount rate, with a benefit cost ratio of 2.31, meaning for every dollar invested, \$2.31 in benefits are realized.
- \$6,969,867 at a 4% discount and the resulting benefit cost ratio is 2.10, meaning for every dollar invested, \$2.10 in benefits are realized.

Action 3: Acquisition of threatened/at risk ecosystem: The final management action proposes acquisition of a sensitive ecosystem — Ponderosa Pine. The CBA for this action considered the cost of the action in relation to the ecosystem service benefits received from its implementation (including benefits related to SAR/CH). The CBA revealed the net gain associated with this action:

- \$250,033,780 at a 0% discount rate, with a benefit cost ratio of 1.36, meaning for every dollar invested, \$1.36 in benefits are realized.
- \$188,051,955 at a 2% discount rate, with a benefit cost ratio of 1.21, meaning for every dollar invested, \$1.21 in benefits are realized.
- \$146,100,582 at a 4% discount and the resulting benefit cost ratio is 1.08, meaning for every dollar invested \$1.08 in benefits are realized.

As is demonstrated by the results of the CBA, there are gains to be made by pursuing management actions targeted at service delivery and SAR/CH. The three management actions explored in this analysis result in net gains, as the benefits derived from the actions outweigh the costs of taking the actions. Indeed, the management actions resulted in significant benefits in the provision

of fresh water, water regulation and SAR/CH along with carbon sequestration and storage. SAR/CH was the most significant benefit realized, often showing results 4 to 10-fold higher than other individual ecosystem service net benefits.

Introduction

This document summarizes an exercise undertaken by the Natural Assets Initiative (NAI) with the Regional District of Central Okanagan (RDCO) and the City of Kelowna (the “Partners”) to advance their natural asset management efforts by identifying and prioritizing management actions related to natural assets that benefit Species at Risk (SAR), Critical Habitat (CH) and the provision of core local government services.

Specifically, the project objectives were to:

- Understand the nature and extent of overlap between natural assets that provide local government services and natural assets that are relevant to local SAR/CH.
- Identify management actions that benefit both natural assets for local government service delivery and SAR/CH.
- Conduct a cost-benefit analysis of management actions and their outcomes on service delivery to demonstrate benefits to natural assets and SAR/CH.

The project builds off work completed by NAI in the Comox Valley, British Columbia, in March 2019.

This report is organized as follows:

- The **Context** chapter provides an overview of natural assets and natural asset management, along with the connection between natural asset management and SAR/CH.
- Following the Context, a series of chapters speak to the main steps in the project, starting with the need to **Establish a Project Team** (*Step 1*).
- The **Define Project Area and Confirm SAR/CH** (*Step 2*) chapter describes the need to identify the geographic area of interest for the project.
- The **Gather and Process Natural Asset Data** (*Step 3*) chapter identifies the numerous data sources that were employed in the project.
- The **Map Natural Assets and SAR/CH** (*Step 4*) chapter presents the geographic location and distribution of natural assets in relation to SAR/CH.
- The **Consider Priority Ecosystem Services** (*Step 5*) chapter provides an overview of the discussion and outcomes of a meeting with local experts to identify priority ecosystem services for the RDCO and the City of Kelowna.
- The **Identifying Management Actions** (*Step 6*) chapter articulates the process and outcomes of collaboration with local experts and the

project partners to identify management actions that are relevant to the local context as well as SAR/CH.

- The **Cost-Benefit Analysis (CBA)** (*Step 7*) chapter presents the results of a cost-benefit analysis of the management actions.
- The **Conclusion** summarizes the findings, limitations and articulates next steps in this area of study.

Context

What are natural assets?

Natural assets refers to the stock of natural resources or ecosystems that a municipality, regional district, or other form of local government can rely upon or manage for the sustainable provision of one or more local government services.¹

Why manage natural assets

A growing number of local governments, watershed agencies, and other natural resource stewards recognize that it is as important to understand, measure, manage and account for natural assets as it is for engineered ones. Doing so can enable local governments to provide core services such as stormwater management, water filtration, and protection from flooding and erosion, as well as *additional* services such as those related to recreation, health, and culture. Outcomes of what is becoming known as municipal natural asset management (NAM) can include cost-effective and reliable delivery of services, support for climate change adaptation and mitigation, and enhanced biodiversity.

How to manage natural assets

There are numerous ways for local governments to manage natural assets. NAI uses methodologies rooted in standard asset management and provides advisory services to help local governments implement NAM.

NAI has developed an approach and tools with significant investments, piloting, refinement, peer review, and documentation of lessons in multiple Canadian provinces. NAI's mission is to make natural asset management a mainstream practice in Canada, and for local governments to accept and use the methodologies and tools in standard ways across the country.

The outer ring in *Figure 1* describes the main steps involved in NAM. The steps are based on the Asset Management for Sustainable Service Delivery: A BC Framework, which depicts the continual cycle of asset management through three phases: Assess, Plan, and Implement. NAI has developed methods and tools to integrate natural asset considerations at each step of this process with significant investments, piloting, refinement, peer review, and documentation of lessons in multiple Canadian provinces.

¹ <https://mnai.ca/media/2018/02/finaldesignedsept18mnai.pdf>

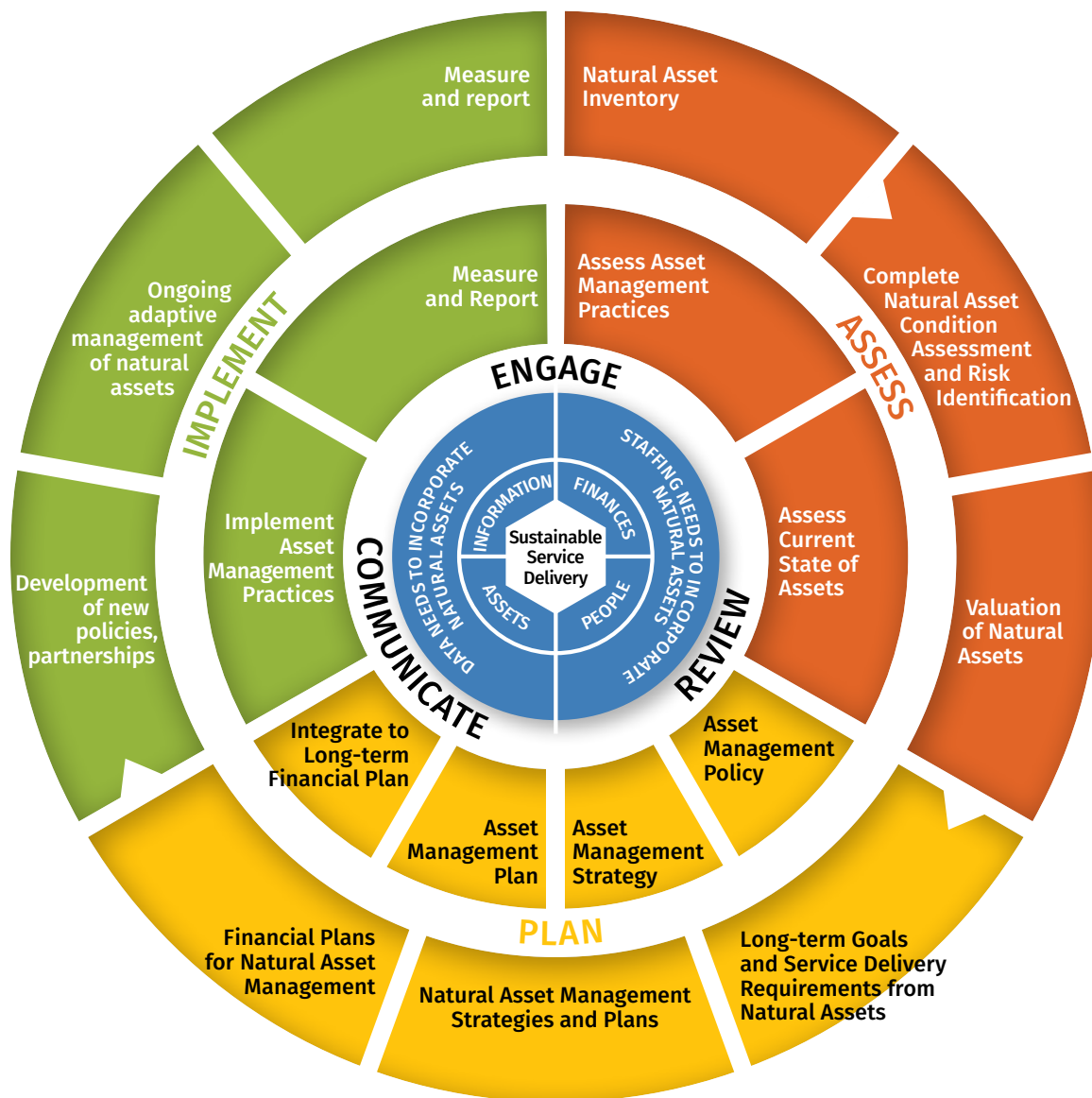


Figure 1: Natural Asset Management Process (Adapted from Asset Management BC)

Why consider Species at Risk and Critical Habitat in NAM

In NAI's methodology, the primary objective of NAM is to understand, measure and manage the contribution of natural assets to the provision of core *local government services* (e.g., drinking water filtration, flood mitigation), with the local government being the primary beneficiary of the services. NAI's methods and tools focus primarily on this objective.

A secondary objective is to understand, measure, and manage the contribution of nature to other outcomes that may be of less direct relevance to the local government and asset management, but which are nevertheless important. Examples include health, recreational, cultural, or aesthetic values; they might also include SAR and CH. Beneficiaries of these *additional services* include the general public, or subsets of it.

NAI methods and tools in relation to this second objective are somewhat limited. Considering both primary *and* secondary objectives in NAM may “stack” or optimize efforts and outcomes, NAI has thus invested in developing an approach for considering SAR/CH along with NAM considerations.

This project is an opportunity to: **(a)** understand the nature and extent of overlap between natural assets that provide local government services and those that are relevant to SAR/CH in a single location; **(b)** based on this, to identify management actions that benefit both SAR/CH and local government service outcomes in that location; and **(c)** further refine an approach that can be applied in other jurisdictions.

Project relevance is underscored by the well-defined connection between biodiversity and service delivery from natural assets. Protecting SAR and CH can contribute to stronger biodiversity, and, although the mechanisms have not yet been defined or researched, may also support many types of natural asset service delivery.

Within the context presented above, the NAI team embarked on a project with the RDCO and the City of Kelowna to understand the overlap between SAR/CH and natural assets, along with actions for managing one of these for the benefit of both. As is described below, the process began with the identification and engagement of a project team.

STEP 1 Establish a project team

The first step in the process is to identify and engage a project team. For this project, NAI developed a team consisting of:

- **Project leads** responsible for managing and undertaking the content work.
- **A local expert advisory group (LEAG)** whose purpose is to provide expert, local advice, and perspectives to ensure successful completion of the project and support the development and implementation of an approach that enables the local governments to integrate SAR and CH considerations into their natural asset management efforts.

The project leads were from NAI, the RDCO and the City of Kelowna (Table 1).

Table 1: Project Leads

Name	Representation
Michelle Molnar	NAI
Amy Taylor	Green Analytics as technical leads for NAI
Kevin Horrocks	Green Analytics as technical leads for NAI
Mimi Miller	RDCO
Joline McFarlane	City of Kelowna

LEAG members represented a range of perspectives, as is noted in Table 2.

Table 2: Local Expert Advisory Group (LEAG) Members

Name	Affiliation	Expertise
Tracy Guidi	City of Kelowna	Sustainability Coordinator
Jennifer Miles	City of Kelowna	Environmental Coordinator
Tara Bergesen	City of Kelowna	Urban Forestry Supervisor
Stefan Johansson	City of Kelowna	Park & Landscape Planner
Joline McFarlane	City of Kelowna	Asset Manager
Rod McLean	City of Kelowna	Utility Planning Manager
Scott Boswell	OCCP	Program Manager
Brittany Nichols	RDCO	Environmental Planner
Dave Orlando	RDCO	GIS Analyst
Mimi Miller	RDCO	Asset Management Analyst
Jason Schleppe	Ecoscape Environmental Consultants Ltd.	Registered Professional Biologist
Lael Parrott	UBC Okanagan	Professor of Earth and Environmental Sciences
Mathieu Bourbonnais	UBC Okanagan	Assistant Professor, Earth, Environmental and Geographic Sciences
Eva Antonijevic	Okanagan Nation Alliance	Natural Resource Researcher
Anna Warwick Sears	OBWB	Executive Director - OBWB
Todd Kemper	Canadian Wildlife Services	Conservation Biologist

**Special thank you to staff at the City of Kelowna and the RDCO for their contributions.*

The project leads and LEAG members met at key junctures throughout the project to advise on:

- The proposed project area, by considering the following questions:
 - ☐ How large does the study area need to be to encompass SAR/CH?
 - ☐ What are the geographic boundaries of local governments?
 - ☐ How do watershed boundaries align with political boundaries and SAR/CH?
 - ☐ What ecosystem services do the NA within potential project boundaries provide?
- The ecosystem service/s to be the focus of the study (e.g., stormwater management, drinking water supply, wastewater treatment, recreation, carbon storage, etc.)
- Available data sources for NA and SAR/CH
- Management actions that could benefit NA and SAR/CH that are applicable and relevant to the RDCO
- Data gaps and means to fill them

The LEAG was essential to this project and helped ground it in local realities. The individuals involved:

- Had knowledge regarding the presence and habits of local SAR/CH that could not be obtained from provincial, federal, or other data.
- Understood and/or are involved in local government and related land use processes.
- Brought a First Nations worldview and knowledge to the project.
- Inform and validate potential management actions for natural assets and SAR/CH

STEP 2 Define the Project Area and Confirm SAR/CH

Step 2 involved defining the project area as well as confirming the SAR/CH that will be the focus of the assessment. For this, the LEAG was presented with a series of maps depicting various ranges for SAR/CH within the RDCO. A total of 26 animal species listed as endangered or threatened by the provincial government and listed as endangered or threatened under COSEWIC (Committee on the Status of Endangered Wildlife in Canada) were presented to the group along with a list of six (6) plant species with the same designations. Datasets used to demonstrate the spatial distribution of the animal and plant species are presented in Table 3.

Table 3: Source Data for Spatial Distribution of Endangered or Threatened Animal and Plant Species

Name of GIS File	Source	Purpose
Regional Districts	iMap BC Platform	Used to scope datasets to Regional of Central Okanagan.
BC Species & Ecosystems Explorer Output Table for SAR in the Okanagan Regional Districts	BC Species & Ecosystems Explorer	Used as an initial list of all SAR in the Okanagan regional districts.
SAR_puboccurrences.shp	CDC iMap Server	Used to confirm presence of spatial data for SAR in RDCO.
Wildlife_Habitat_Approved.shp	CDC iMap Server	Used to confirm presence of spatial data for SAR in RDCO.
Wildlife_Habitat_Proposed.cpg.shp	CDC iMap Server	Used to confirm presence of spatial data for SAR in RDCO.
Wildlife_Species_Inventorey_IndecentalObservations.shp	CDC iMap Server	Used to confirm presence of spatial data for SAR in RDCO.
Wildlife_Species_Inventory.shp	CDC iMap Server	Used to confirm presence of spatial data for SAR in RDCO.
Critical Habitat for Federal SAR	CDC iMap Server	Used to confirm presence of spatial data for SAR in RDCO.
Showy Phlox EBAR Data	Canada - EBAR Range Mapping NatureServe	Information on where the Showy Phlox can potentially be found in the RDCO.

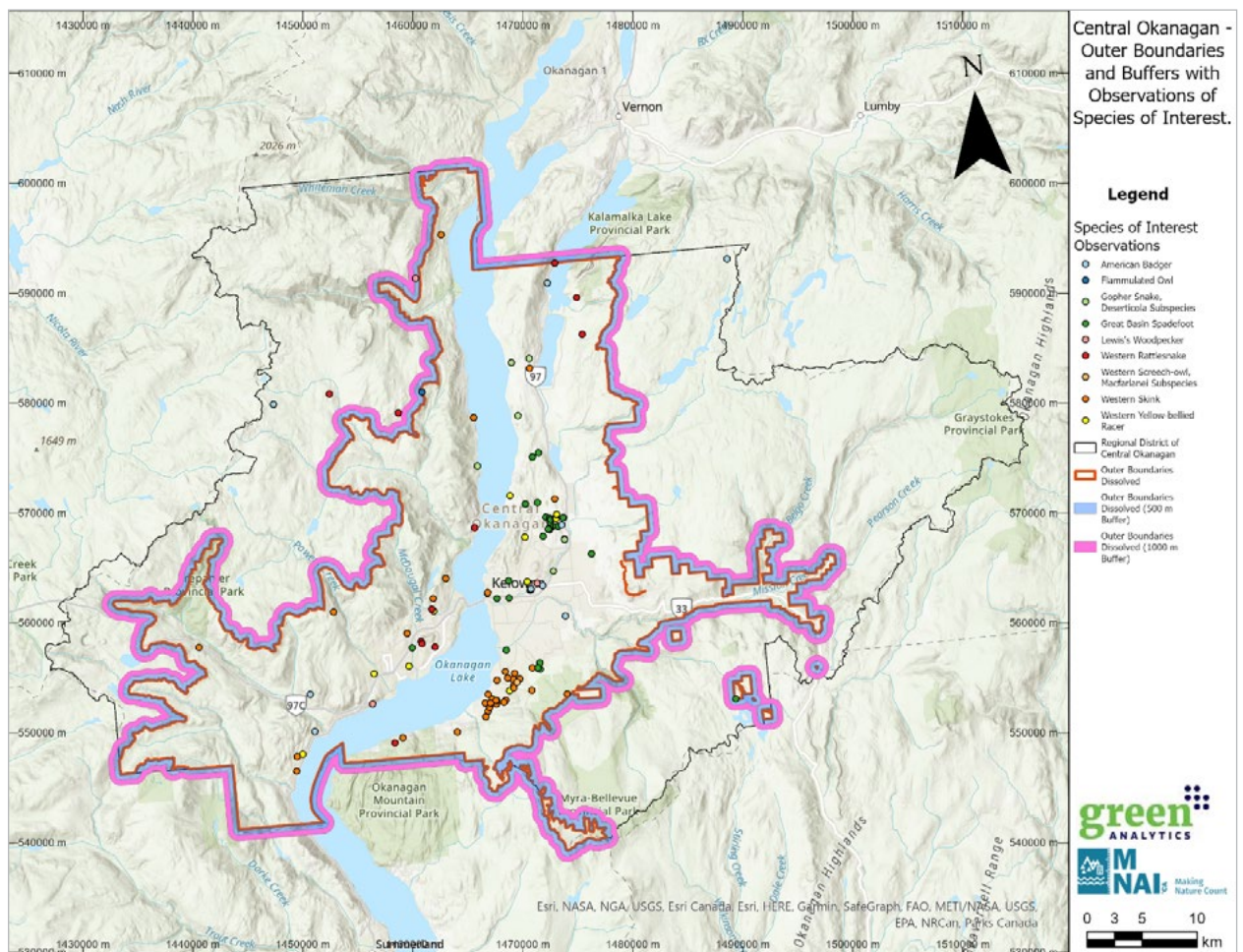
During the first LEAG meeting, the group discussed the species lists regarding several considerations, including their geographic distribution, data availability, habitat characteristics, ecosystem service provision, and how representative they may or may not be of other species within the RDCO.

At a second LEAG meeting, several possible boundaries were presented to the group. Specifically, spatial boundaries for the following were presented:

- Sensitive Ecosystem Inventory (SEI) from the Province of British Columbia, which depicts data related to at risk and vulnerable ecosystems.
- Biogeoclimatic zones for the Interior Douglas Fir and Ponderosa Pine, whose distribution covers the highest risk habitats and species within the RDCO.
- Private land designations, as these are the areas most at risk of development within the RDCO.

The outermost boundary from these amalgamated datasets was then articulated in a map along with observations of species at risk. The result is shown in Figure 2.

Figure 2: Map of Outer Boundaries and Buffers with Observations of Species of Interest

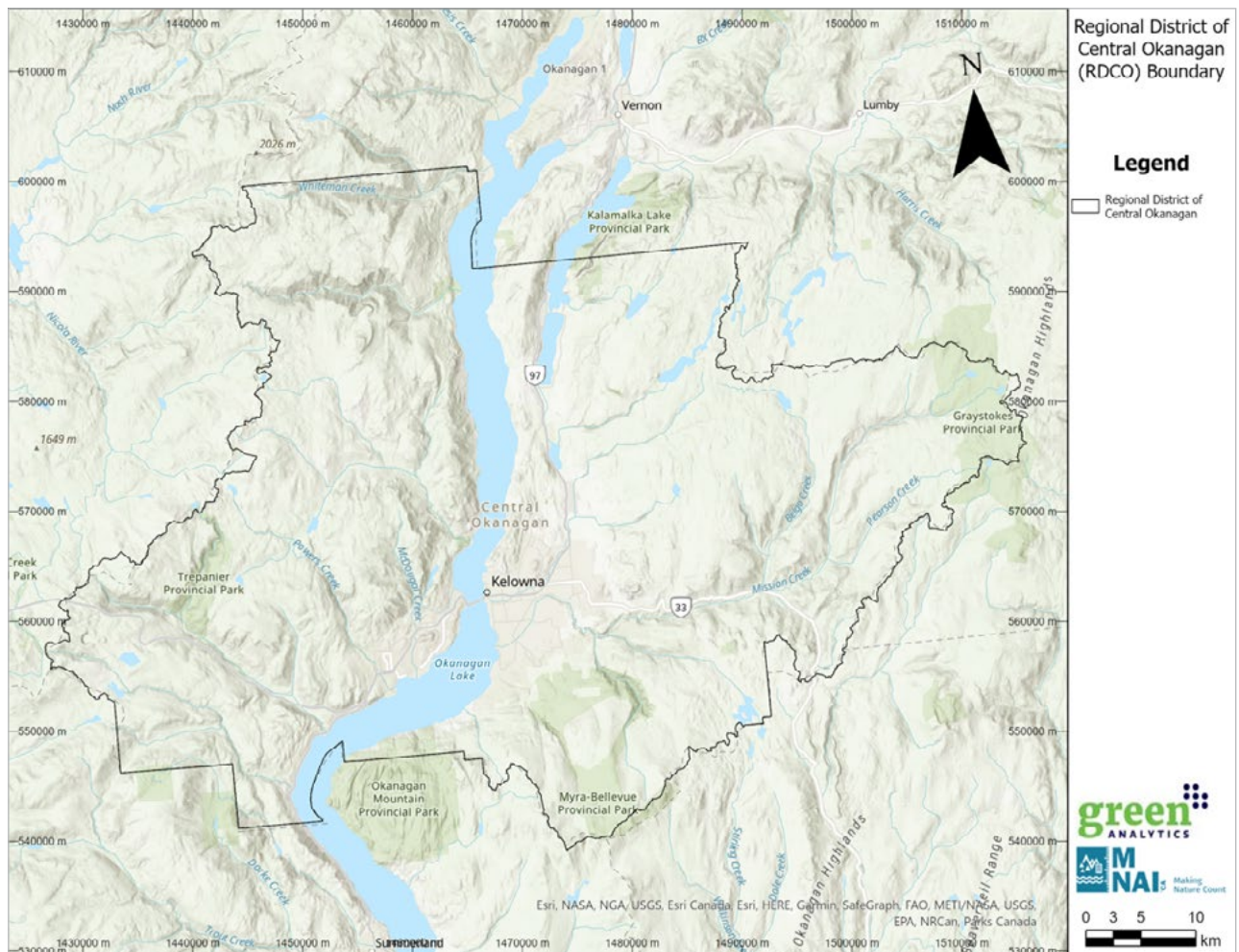


The LEAG considered the different variations of the boundaries and the trade-offs, focusing on one area of the RDCO versus another in terms of the distribution of natural assets, the services provided by natural assets, and the distribution of SAR and CH across the region. Ultimately, the group concluded that it was preferable to focus on ecosystems at risk rather than species at risk and to define the project study area as the entire RDCO. The rationale for choosing the larger boundary includes:

- The larger boundary is consistent with a long-term view
- The biogeoclimatic zones within the RDCO are shifting
- The RDCO boundary captures the drinking water watersheds
- The RDCO boundary encompasses provincial land which speaks to the need for coordination across government levels

The location and jurisdictional boundary for the RDCO is depicted in Figure 3.

Figure 3: Map of RDCO boundary



STEP 3 Gather and Process Natural Asset Data

The third step in the process involved gathering and processing data for the natural assets within the RDCO. These are summarized in Table 4.

Table 4: Datasets Used to Map Natural Assets within the RDCO Boundary

Descriptive Name	Source	Purpose
RDCO Lakes	RDCO Open Data Catalogue	A small number of lakes not featured in the VRI dataset were inserted into the landcover data to capture missing assets.
Buffered Provincial Road Network	Government of Canada Open Data	Buffered roads were inserted into the base landcover data to account for breaks between assets not reflected in the original data.
RDCO Buildings	RDCO Open Data Catalogue	Used to account for impervious surfaces in the area, and to reclassify VRI polygons that were previously natural but had recently been developed.
Kelowna Buildings	Kelowna Open Data Catalogue	Used to account for impervious surfaces in the area, and to reclassify VRI polygons that were previously natural but had recently been developed.
RDCO Lakes	RDCO Open Data Catalogue	A small number of lakes not featured in the VRI dataset were inserted into the landcover data to capture missing assets.
Sensitive Ecosystem Inventory	RDCO Open Data Catalogue	Used as a supplementary source of wetlands, forest, and grasslands, not captured with the VRI.
2014 Agricultural Land Use Inventory (ALUI)	Okanagan Basin Water Board	Used as main source of landcover for agricultural and enhanced assets (built-up pervious, treed). Also used to insert smaller grassland assets not captured with the VRI.
2020 Vegetation Resource Inventory	BC Open Data Catalogue	The British Columbia Land Cover Classification Scheme Level 1 was used as the primary source of landcover for natural areas.

STEP 4 Map Natural Assets and SAR/CH

Once the relevant datasets for the RDCO were collected, they were combined using GIS and clipped to the RDCO boundary. The type and extent of the various natural assets were then delineated and quantified. Figure 4 demonstrates the location and extent of natural assets within the RDCO.

Figure 4: Natural Assets Within the RDCO Boundary

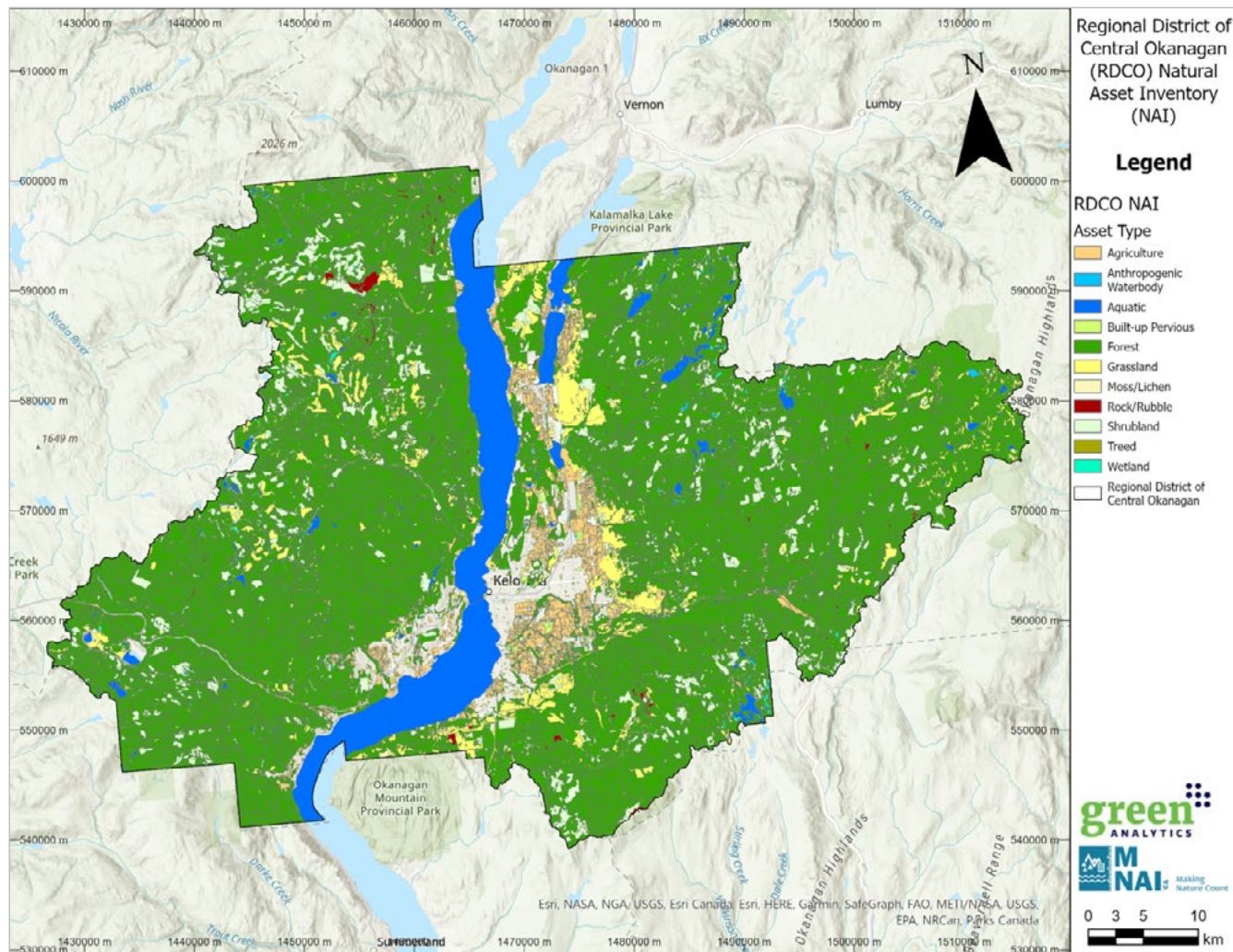


Table 5 quantifies the natural assets by asset type, demonstrating the type and extent of assets present within the boundary. Forest assets, the most dominant asset type, occupy over half of the RDCO boundary. Aquatic assets, those representing natural water sources, were next most prominent at 7.68% of the area. This was followed by grasslands and shrublands, each at around 5% of the RDCO area. Wetlands comprised a relatively small amount of the study area, at less than 1% of the RDCO area.

Table 5: Summary of Natural Assets by Asset Type in the RDCO

Asset Type	Area (ha)	% of RDCO
Agriculture	7,312	2.32 %
Anthropogenic Waterbody	118	0.037 %
Aquatic	24,166	7.68 %
Built-up Pervious (Manicured Greenspace)	1,758	0.56 %
Forest	229,910	73.09 %
Grassland	16,356	5.20 %
Moss/Lichen	83	0.026 %
Rock/Rubble	864	0.27 %
Shrubland	16,698	5.30 %
Treed (Urban Forest)	714	0.23 %
Wetland	961	0.31 %
TOTAL	298,940	95.03 %

The natural asset inventory can then be considered in light of the location and extent of SAR habitat. Figure 5 shows generic and localized areas for SAR animals within the RDCO.

Figure 5: Map of Critical Habitat for Animal Species at Risk (SAR) in the RDCO Project Area

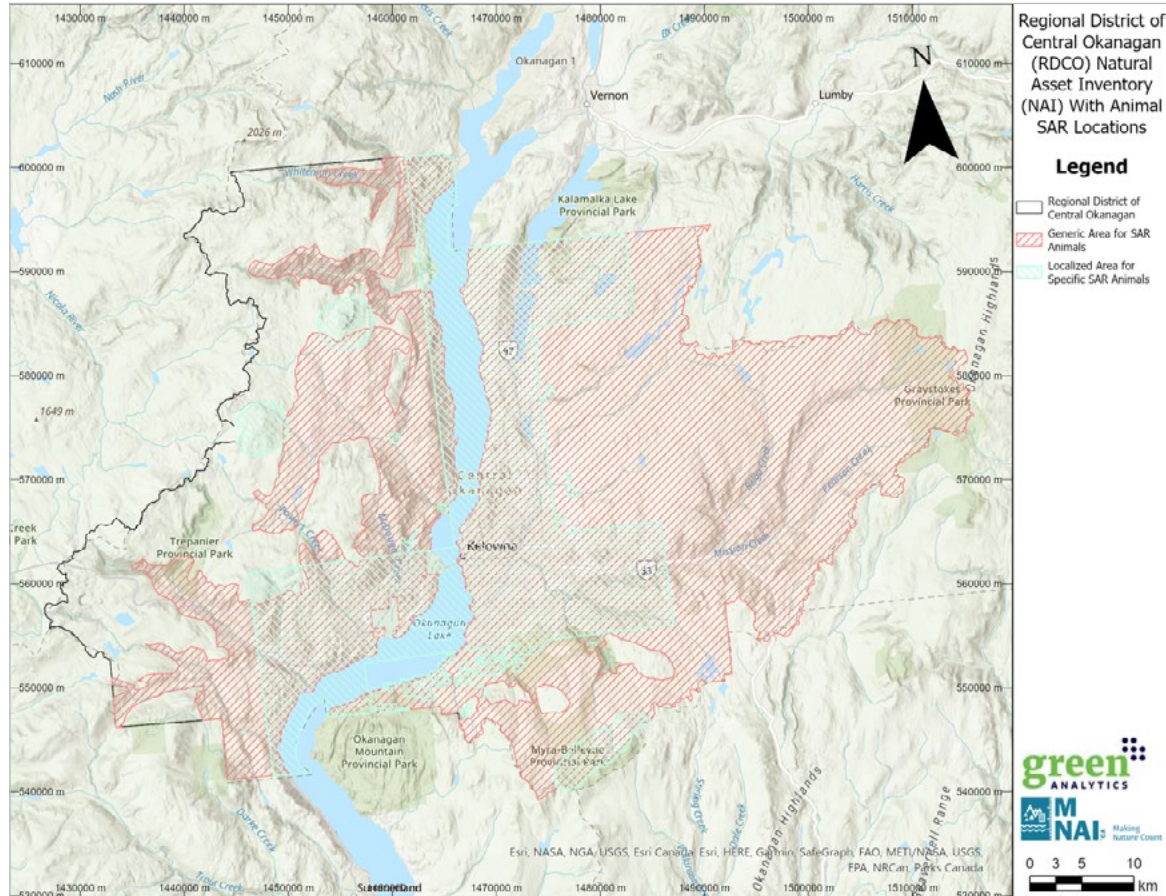
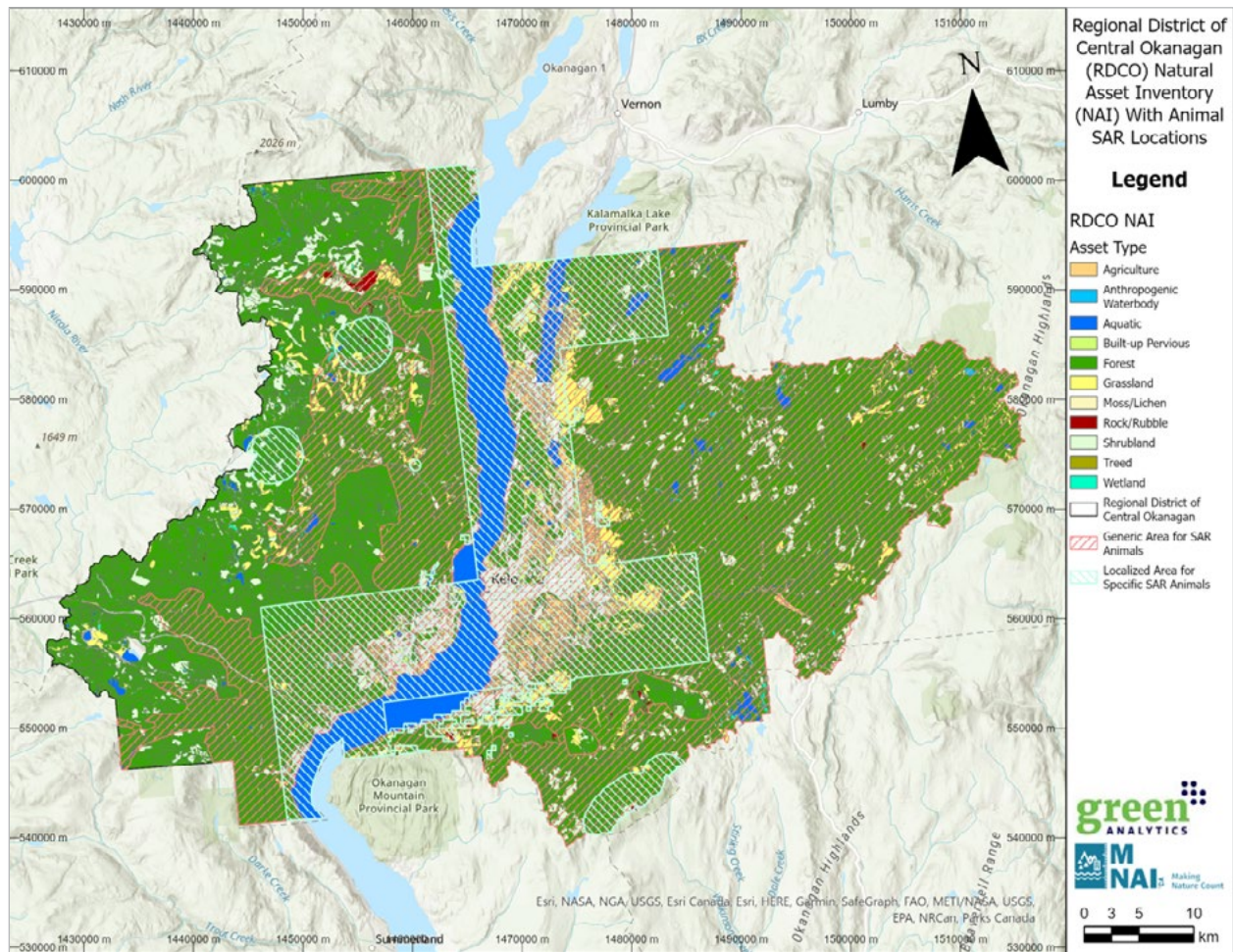


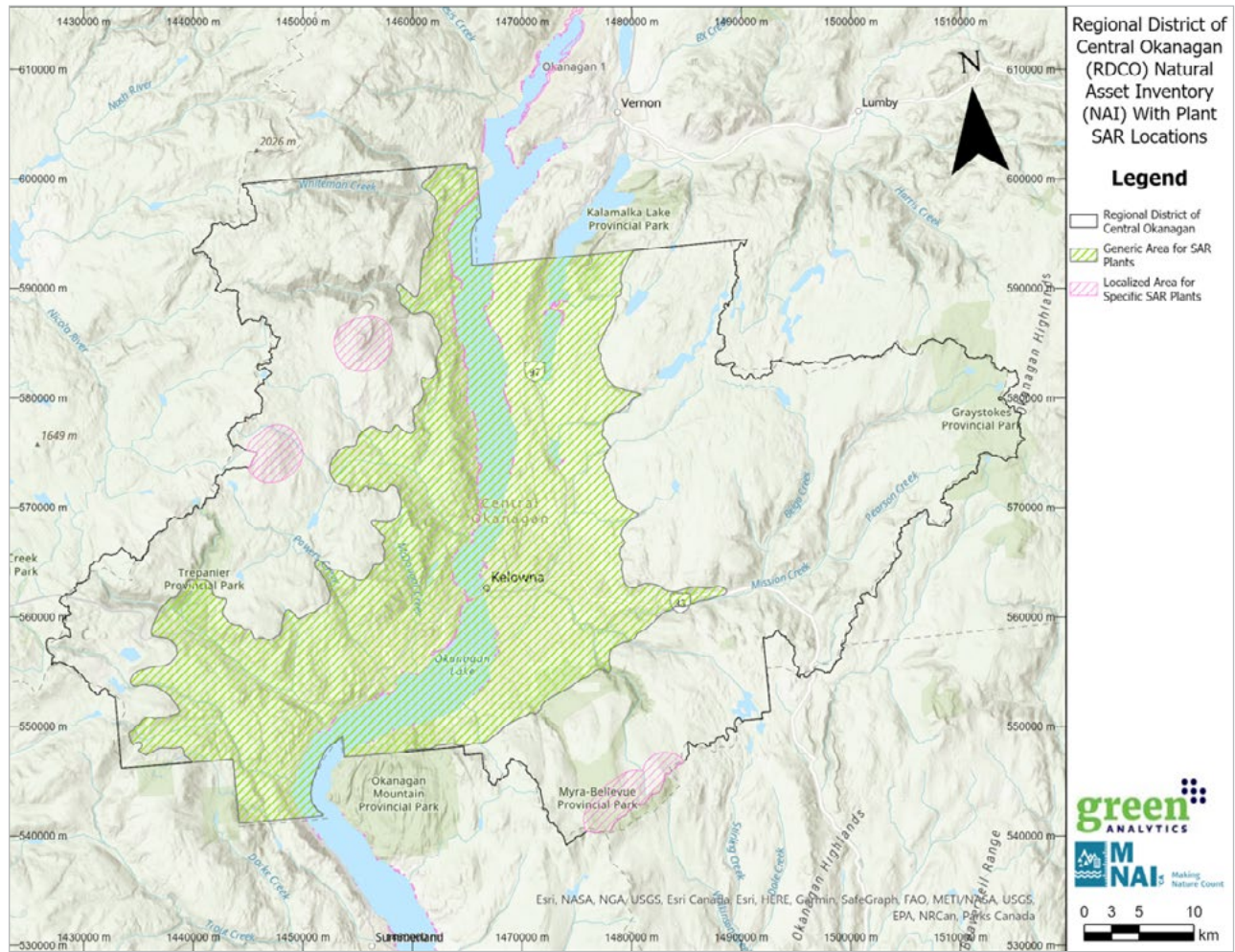
Figure 6 shows the above (habitat for SAR animals within the RDCO) in relation to the location and extent of natural assets.

Figure 6: Map of Critical Habitat for Animal Species at Risk (SAR) in the RDCO in Relation to Natural Assets



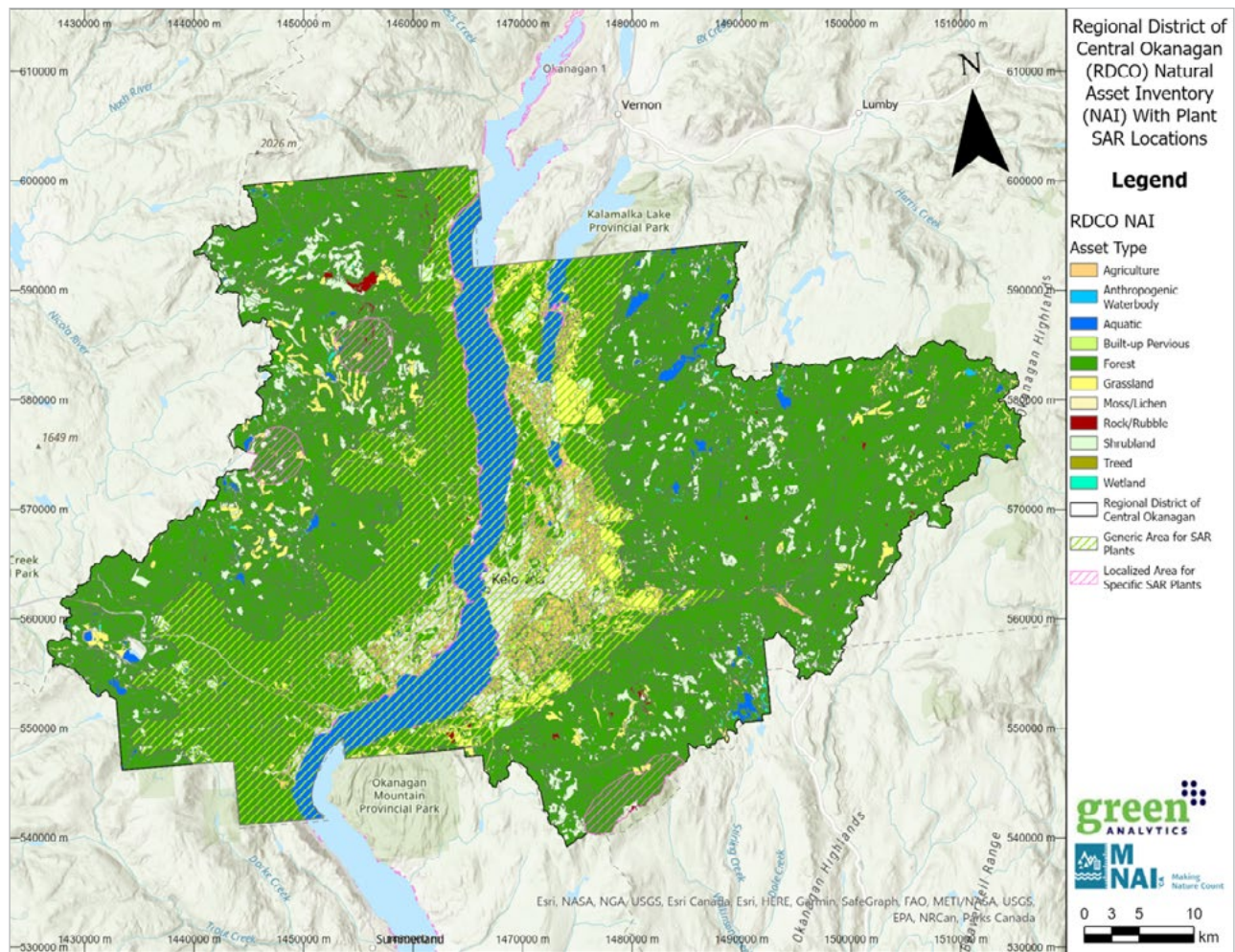
The same consideration can be given to SAR plants. To that end, Figure 7 shows generic and localized areas for SAR plants within the RDCO.

Figure 7: Map of Critical Habitat for Plant Species at Risk (SAR) in the RDCO Project Area



Building on the figure above, Figure 8 considers the location and extent of SAR plants in relation to the location and extent of natural assets within the RDCO.

Figure 8: Map of Critical Habitat for Plant Species at Risk (SAR) in the RDCO in Relation to Natural Assets

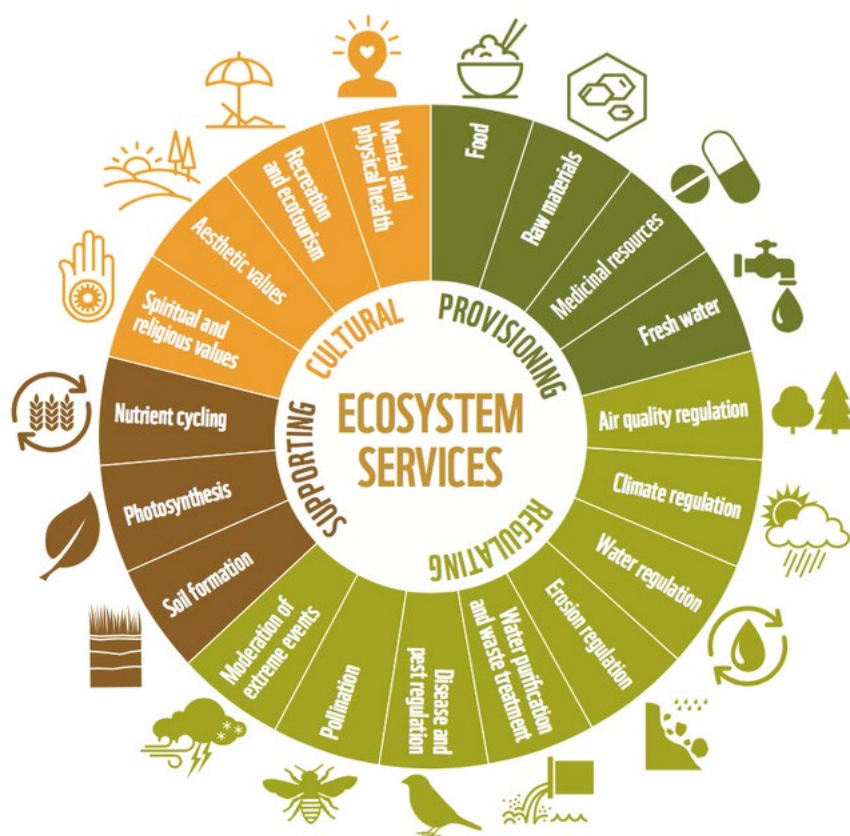


STEP 5 Consider Priority Ecosystem Services

Before discussing management actions ([Step 7](#)), the Project Partners explored the ecosystem services to which management actions might be geared. It is useful to identify priority ecosystem services as doing so helps managers understand the nature and extent of overlap between natural assets that deliver local government services (or ‘co-benefits’) and natural assets that are relevant to SAR and CH in a single location. This way, management actions that benefit both SAR/CH and local government service outcomes in a given location can be identified and evaluated.

The objective at this stage of the project was to work with the LEAG to identify high priority services for further consideration in the context of management actions. To that end, using Figure 9 as a prompt, a preliminary discussion of ecosystem services took place during the second and third LEAG meetings.

Figure 9: Ecosystem Services Diagram²



The conversation resulted in the identification of the services defined in [Table 6](#).

² Source: *WWF Living Planet Report (2016)*

Table 6: Services Identified During LEAG Meeting

Service	Definition
Regulation of freshwater quantity, location, and timing (i.e., stormwater management)	For direct uses by people and indirect use by biodiversity and natural habitats. [Source: IPBES 2018]
Fresh water (i.e., drinking water)	Ecosystems play a vital role in providing cities with drinking water, as they ensure the flow, storage, and purification of water. Vegetation and forests influence the quantity of water available locally. [Source: TEEB 2011]
Carbon storage and sequestration	Ecosystems regulate the global climate by storing greenhouse gases. As trees and plants grow, they remove carbon dioxide from the atmosphere and effectively lock it away in their tissues; thus, acting as carbon stores. [TEEB 2011]
Moderation of extreme events	Ecosystems and living organisms create buffers against natural disasters, thereby preventing or reducing damage from extreme weather events or natural hazards including floods, storms, tsunamis, avalanches, and landslides. For example, plants stabilize slopes, while coral reefs and mangroves help protect coastlines from storm damage. [TEEB 2011]
Food provisioning	Ecosystems provide the conditions for growing food. Food comes principally from managed agro-ecosystems, but marine and freshwater systems, forests and urban horticulture also provide food for human consumption. [TEEB 2011]
Pollination	Insects and wind pollinate plants which is essential for the development of fruits, vegetables, and seeds. Animal pollination is an ecosystem service mainly provided by insects but also by some birds and bats. [TEEB 2011]
Cultural aspects	Ecosystems contribute to the ability of Indigenous people to maintain a connection to their culture and heritage. [MNAI 2022]
Physical and mental health	Walking and playing sports in green space is a good form of physical exercise and helps people to relax. The role that green space plays in maintaining mental and physical health is increasingly becoming recognized, despite difficulties of measurement. [TEEB 2011]
Tourism	Ecosystems and biodiversity play an important role for many kinds of tourism, which in turn provides considerable economic benefits and is a vital source of income for many countries. Cultural and eco-tourism can also educate people about the importance of biological diversity. [TEEB 2011]

Following the meeting, background materials (the definitions above and the table below) on ecosystem services were distributed to the LEAG along with a survey asking participants to rank the services in order of priority given the RDCO context.

Table 7: Ecosystem Services and Relevant Natural Asset Types

Ecosystem Service	Forest	Water	Built-up Pervious	Grassland	Beach	Shrubland	Wetland	Rock	Agriculture
Regulation of freshwater quantity, location, and timing									
Fresh water									
Carbon storage and sequestration									
Moderation of extreme events									
Food provisioning									
Pollination									
Cultural aspects									
Physical and mental health									
Tourism									

The survey resulted in the following ranking of services:

- 1/ Provision of fresh water
- 2/ Regulation/moderation of stormwater
- 3/ Carbon storage and sequestration
- 4/ Food provision
- 5/ Pollination
- 6/ Cultural aspects
- 7/ Health benefits
- 8/ Tourism

It was recognized by the group that while this ranking is useful for the purposes of the current exercise, all of these services are critical to the RDCO and the City of Kelowna. The top three ecosystem services are quantified in the cost-benefit analysis.

STEP 6 Identify Management Actions

With the priority services established, the next step in the approach was to identify natural asset management actions for inclusion in a cost-benefit analysis. Management actions were refined through multiple steps that included a policy scan and literature review, assessment of stressors and challenges to SAR management in the study area, and development of criteria for prioritizing management actions.

NATURAL ASSET MANAGEMENT ACTIONS – WORKING DEFINITION

Natural asset management actions refer to the management of natural assets such as land, water, soil, plants, and animals, with a particular focus on how management activities support service delivery and thus affect the quality of life for both present and future generations.

Natural asset management deals with managing the way in which people and natural landscapes interact. It recognizes that people and their livelihoods rely on the health and productivity of natural landscapes, and their actions as stewards of the land play a critical role in maintaining this health and productivity. At a holistic level, it brings together land use planning, water management, biodiversity conservation, and the future sustainability of industries like agriculture, mining, tourism, fisheries, and forestry. Management actions may include Regional Growth Strategies, Official Community Plans, Community Engagement, and changes to municipal bylaws.

This project is focused on a subset of management actions. To be incorporated into a cost-benefit analysis, natural asset management actions need to be capable of quantification and measurement. We need to identify where the management action will have an impact, *when*, and *estimate* the costs and benefits of implementing it. Examples include land purchase, land and water restoration projects, and incentives for best management practices on private lands. See [Appendix A](#) for an overview of management actions.

The literature and policy scan results were the focus of the fourth LEAG meeting, with the goal of identifying management actions that would meet a set of criteria, including:

- Target natural assets that deliver priority ecosystem services
- Target natural assets that are relevant to SAR/CH
- Actions which can be mapped
- Actions which the RDCO and or the City of Kelowna have jurisdictional authority over
- Can be pursued through cooperation with other levels of government
- Have funding available to support their implementation

During the meeting, a number of management actions were identified and discussed, including: land acquisition (purchase, donation, expropriation); zoning (e.g., conservation designations); bylaws (which regulate or prohibit certain activities or prescribe methods for carrying out activities); tax instruments (including tax credits/deductions/charges to incent preferred actions) and fees or charges (to deter undesirable actions).

Following the fourth LEAG meeting, an additional LEAG meeting was held to uncover stressors and core challenges to SAR management. Stressors included urban development, agricultural expansion, political will, climate change, fire suppression, pollution, cumulative impacts, and lack of connectivity. Challenges included lack of ecosystem data, lack of management guidelines, counter-productive incentives that encourage loss of natural assets, competing political priorities, lack of valuation of ecosystem services, and the need for stronger regional collaboration.

Lastly, a meeting was held with City of Kelowna staff to review potential management actions with the goal of removing any actions that are not viable. Follow up meetings were held with project partners to identify data sources for potential priority management actions.

This process resulted in the selection of three priorities for scenario analysis:

- 1/ Parkland acquisition to increase connectivity:** The first management scenario explored relates to parkland acquisition to consider the benefits of linking regional, city, and provincial or national parks to maximize benefits to SAR/CH and the priority ecosystem services. This management action supports local government objectives within Kelowna and the RDCO, and has funding mechanisms to support implementation (e.g., parkland DCCs, lease or land sale, grants, community amenity contributions, general taxation). It addresses the 'lack of connectivity' stressor and would help to mitigate several challenges, such as the lack of valuation of ecosystem services, and the need for stronger regional collaboration.

SUPPORTING POLICIES AND OBJECTIVES

The City of Kelowna's 2040 Official Community Plan contains park objectives. These include:

- Acquire new parks to enhance livability throughout the city.
 - Policy 10.1.4 sets a target of 1km of linear parks and 2.2ha of active parks per 1,000 new population to serve growth.
 - Policy 10.1.15 speaks to the preservation of a diversity of Natural Areas for habitat and ecosystem conservation, including ecosystem connectivity corridors.
- Ensure parks and public spaces are connected to each other and accessible for all citizens.
 - Policy 10.2.1 speaks to connected parks that link active parks, public spaces, natural areas, and the waterfront with green corridors.
 - Policy 10.2.4 and 10.2.5 addresses the need for urban linear parks and linear parks, whereas 10.2.8 addresses the acquisition of linear parks.
- Ensure parks reflect their unique natural and cultural context.
 - Policy 10.3.5 addresses recognition and celebration of Indigenous culture

- Increase public access to water.
 - Policy 10.4.2 identifies linear park priorities.
 - Policy 10.4.3 prioritizes linear parks along the waterfront.
- Encourage partnerships to acquire and deliver parks and public spaces.

The RDCO's Long-Range Planning documents include:

- Regional Growth Strategy (2013), which identifies 10 regional issues, one of which relates to Ecosystems and directs the Regional District to be responsible stewards of natural ecosystems to protect, enhance and restore biodiversity in the region.
- OCPs for Electoral Areas
- Regional Parks and Greenways Plan for the Central Okanagan (2008) that proposes future regional park land acquisition and management planning. Two regionally significant interests are identified:
 - Regional Parks will secure "regionally significant" natural and human heritage park areas.
 - The Regional Parks system will strive to develop a "Greenway Network" of park spaces which represent and help conserve a diverse range of Central Okanagan natural environments.

2/ Tax incentives for preservation of natural assets on farmland: The second management scenario proposes tax incentives for wetland and stream protection on agricultural land reserves (ALRs) and non-ALR lands. It is supported in high-level policy documents. In the City of Kelowna, agricultural supports are encouraged in the 2023 – 2026 Council Priorities. While this action wouldn't be implemented by the RDCO, it could be supported at the regional level as it relates to a number of goals of the Regional Growth Strategy, including: the objective to 'Preserve and support sustainable agricultural activities and land base that enhances local agriculture through the strengthening of best practices'. It primarily addresses the LEAG-identified key challenge of counter-productive incentives that encourage loss of natural assets on marginal farmlands.

SUPPORTING POLICIES AND OBJECTIVES

The City of Kelowna's 2023 – 2026 Council Priorities includes Agriculture as one of its six priorities. Progress on measures to protect agriculture include:

- % of farmland that is being actively farmed, is being maintained or is increasing (% of agriculture land that is actively farmed)

The Regional Growth Strategy includes the objective to:

- *Preserve and support sustainable agricultural activities and land base that enhances local agriculture through the strengthening of best practices.*

- 3/ Acquisition of threatened/at risk ecosystem:** The final management scenario proposes acquisition of a sensitive ecosystem — Ponderosa Pine. The City of Kelowna mapped sensitive ecosystems in 2007, which are recognized and protected through the 2040 Official Community Plan, as well as the RDCO's Regional Growth Strategy. This management action aims to protect a sensitive ecosystem through acquisition. While this management action is focused in Kelowna, it can be encouraged and supported by the RDCO.

SUPPORTING POLICIES AND OBJECTIVES

The City of Kelowna's Official Community Plan 2040 includes the following objectives which support this management action:

- Objective 12.8. Invest in ecosystem services and green infrastructure to mitigate and adapt to a changing climate. This includes Policy 12.8.2 Green Infrastructure Investment to help mitigate the urban heat island effect.
- Objective 14.2. Protect and expand a healthy and viable urban forest. This includes Policy 14.2.5. Significant Tree Protection to promote tree protection and planting measures to protect indigenous, heritage, **significant** and wildlife trees.
- Objective 14.5. Protect and restore environmentally sensitive areas from development impacts. This includes Policy 14.5.3. Environmentally Sensitive Area Protection Tools.

The Regional Growth Strategy includes the goal to 'be responsible stewards of natural ecosystems to protect, enhance and restore biodiversity in the region'. The following policies support this vision:

- Encourage cooperation for the management of regional biodiversity practices as outlined in the Okanagan Biodiversity Strategy.
- Encourage collaboration to adopt consistent terminology, policies and actions that support the protection and conservation of environmental features and watersheds within the Region.

STEP 7 Cost-Benefit Analysis Methodology

A cost-benefit analysis (CBA) provides a framework for identifying, quantifying, and comparing the costs and benefits of a proposed project or management action, where costs and benefits are realized at different points in time. This requires an understanding of what the policy or management action provide in terms of benefits (defined as increases in human well-being) and costs (defined as reductions in human well-being). The final decision is informed by a comparison of the total costs and benefits, measured in dollars, and is represented through:

- **Net Present Value (NPV)** which is the current value of all future cash flows – both positive and negative – over the entire life of a project or management action. Holding all else constant, actions with a positive NPV are worth undertaking, while those with a negative NPV are not.

- **Benefit-Cost Ratio (BCR)** is an indicator that reflects the relationship between the relative costs and benefits of a project or management action. If the BCR is greater than 1, the project or management action is expected to deliver a positive NPV.

Environmental CBAs involve two important considerations: how to capture non-market values, and how to reflect the current value of future costs and benefits. Each are addressed in turn below.

Discounting future flows of money is common when performing a CBA to reflect the assumption that a dollar today is better than a dollar tomorrow. The use of a high discount rate assumes that the benefits humans reap in the present are more valuable than the benefits provided to future generations. The use of a low discount rate can recognize a project or management action which could provide benefits over a long period of time, affecting future generations. To reflect ecological timeframes, this project included a 2% discount rate (which is considered low and often used in social CBA), a 4% discount rate (which is a RDCO's standard discount rate) and a 0% discount rate (which reflects values remains constant over time). A topic that is currently being debated in the field of environmental and ecological economics is whether a negative discount rate should be used in environmental CBAs to reflect that nature generally appreciates in value when it is well managed.

Many ecosystem services do not have direct market prices, so it has been historically difficult for municipalities to account for their value in decision making — they are often taken for granted as free gifts from nature. When natural assets are taken for granted, it is easy to manage them poorly, which can lead to a decline in service provision to the detriment of communities. Fortunately, over the last 40 years, economists have devised techniques to estimate the economic value of some ecosystem service benefits to aid in making better decisions about how natural assets should be managed. These can be grouped into three broad categories: 1) direct market valuation approaches; 2) revealed preference approaches; and 3) stated preference approaches.

- 1/ **Direct market valuation** methods derive estimates of ecosystem goods and services from related market data.
- 2/ **Revealed preference** methods estimate economic values for ecosystem goods and services that directly affect the market prices of some related good.
- 3/ **Stated preference** methods obtain economic values by asking people to make trade-offs among sets of ecosystem or environmental services or characteristics.

Ideally, a valuation of ecosystem services should involve detailed ecological and economic studies of each ecosystem of interest for each land cover type, utilizing one or more of the above valuation techniques. Unfortunately, undertaking such studies is expensive and time consuming. The benefit transfer

approach can be used to indicate an order-of-magnitude values for a range of services to prioritize natural assets for a natural asset inventory. This approach was used in this study and followed the steps below to arrive at the values used in the CBA.

- 1/ Identify the ecosystem services to be valued for each asset class being considered (see chapter 7)
- 2/ Conduct a literature review to identify relevant primary studies. Once services were identified, a literature review was initiated to identify studies from Canada or neighbouring countries with similar demographics.
- 3/ Assess the relevance and quality of study site values for transfer. Identified studies were assessed against a set of criteria, including scientific soundness, empirical methodology, and relevance to the project area.
- 4/ Transfer value estimate from study primary study to project area. To calculate total benefits, the annual per hectare values of the identified priority services need to: (1) be multiplied by the total area of the land class; and (2) totalled for the region. Values can be provided as both total values/year and value per hectare/year.

Average estimates derived from a literature review were employed. Specifically, estimates for this management action relied on three studies, including Molnar (2015), Dodds et al. (2004); and MNAI (2022). A benefit transfer approach that utilized primary studies completed in regions with a similar ecological and socio-economic context was employed with an acceptable methodology, and peer reviewed. Additional details can be found in [Appendix B](#).

Carbon storage was established by first estimating the volume (m³) of biomass in the watershed, which was obtained from the British Columbia Vegetated Resources Inventories (VRI) dataset. That was then converted that value to tonnes of carbon using the standard Canadian biomass-to-carbon conversion factor of 0.5³, and lastly multiplying that value by the B.C. carbon tax of \$65/tCO_{2e}. Converting this price to tonnes of carbon based on relative atomic weights gives a price of \$17.73/tC (1 tonne of carbon = 3.667 tonnes of CO_{2e}). Note that these storage values are not annual values. The volume of carbon stored in the above ground biomass will increase annually as vegetation grows. [Appendix B](#) provides a brief description of the studies used for this project.

To estimate the value of SAR/CH, a dollar/person estimate for SAR was assigned to the population in the RDCO. NAI obtained this value from a recent study⁴ completed in New Brunswick that estimated the cost per person of targeted management strategies to conserve 40 species over 25 years, and then transferred the value of \$36/person. Applying this value to the population aged

3 This is the “standard value for biomass-to-carbon conversion” used in the Carbon Budget Model of the Canadian Forest Sector (Kull et al. 2019, p. 2)

4 Camaclang et al., 2020.

20 and up within the watershed results in a value of \$5,644,980 per year. [Table 6](#) presents the ecosystem service values used in the project.

Transferring values from the New Brunswick study brings limitations that should be acknowledged. The primary study assessed both species at risk and ecological communities and sought to identify management actions suited to the ecosystems of eastern Canada. NAI did not consider ecological communities in this project or recognize differing ecosystems, but NAI determined that the reliance upon local knowledge and the similarities in socio demographics within North America, coupled with a paucity of valuation studies for SAR, makes it relevant for consideration. The resulting estimate is based on an approach called “priority threat management,” where experts identify conservation strategies for species at risk and complete a cost-benefit analysis to identify the most cost-effective options. Nonetheless, it should be clear that precise values are unknown, and the values presented should be regarded as order of magnitude estimates.

Table 8 presents the ecosystem service values used in the project.

Table 8: Ecosystem Service Values

Ecosystem Service	Asset Type	\$ / Hectare / Year or \$ / Household / Year (2022 CDN dollars)
Provision of Fresh Water	Forest	\$2,643.93/ha/yr
	Grassland	\$36.76/ha/yr
	Wetland	\$2,643.93/household/yr
Water Regulation	Forest	\$2,095.10/ha/yr
	Grassland	\$8,826.62/ha/yr
	Wetland	\$1,878/ha/yr
Climate Sequestration	Forest	\$272/ha/yr
	Grassland	\$142/ha/yr
	Water & Wetland	\$434/ha/yr
Carbon Storage*	Forest	\$17.73/tC
	Grassland	\$17.73/tC
	Wetland	\$17.73/tC
SAR/CH	All	\$36/person

* Carbon storage is valued at a point-in-time.

Cost-Benefit Analysis

At a high level, the analysis involved the following steps:

- 1/ Identify the spatial areas to which the management actions will be targeted
- 2/ Measure the area (hectares) that will be subject to each management

action

- 3/ Quantify the value of the ecosystem service (i.e., stormwater management) provided by natural assets within the target areas
- 4/ Quantify the cost of the management actions
- 5/ Calculate a benefit-cost ratio for each management action (value of service provision in relation to cost of action)
- 6/ Quantify the benefit of the SAR/CH present within the target areas
- 7/ Calculate the benefit-cost ratio for the management actions taking into consideration the value of the ecosystem service (stormwater management) as well as the value of the SAR/CH (value of service provision as well as value of SAR/CH in relation to cost of action)

Management Action 1: Parkland acquisition to increase connectivity

The first management scenario explored relates to parkland acquisition to consider the benefits of linking regional, city and provincial or national parks to maximize species at risk critical habitat and the priority ecosystem services.

This management action is supported by the City of Kelowna's Official Community Plan (OCP) that lays out how to implement Imagine Kelowna's vision.⁵ The City is in the process of developing a Parks Master Plan⁶ and adheres to Parkland Acquisition Guidelines (2010), wherein the various types of city parks are described. Two classes of passive parks were targeted for acquisition: Linear Parks and Natural Area Parks. Natural area parks are publicly owned parklands that remain in their natural state, often housing environmentally significant areas and supporting recreation where it doesn't conflict with ecological conservation. Linear parks provide non-vehicular movement and link points of interest throughout the city.

In the RDCO, this action is supported by the RDCO's Regional Growth Strategy (2013), and the Parks Legacy Program (2017), which lays out the direction for future acquisition of Regional Parks. Regional Trails and Greenways are noted as an acquisition interest, serving as a natural corridor between streams and the Okanagan Lake. Greenway goals are further articulated in the Regional Parks and Greenways Plan (2008), where their purpose is to link provincial, regional, and major municipal parks that provide recreational and habitat links with open spaces.

To identify the spatial areas to which this management action will be applied, a number of scenario acquisition areas were developed. It is important to note these are hypothetical scenarios and have not been assessed with staff according to their acquisition guidelines. The purpose here is to provide an indicative assessment of the costs and benefits of this management action.

⁵ City of Kelowna (2018).

⁶ City of Kelowna (2023).

To arrive at a scenario, potential park areas were that identified. The areas maximize connectivity, SAR/CH habitat, and priority ecosystems. The existing area of parkland already protected was then excluded, which resulted in the spatial extent of lands for acquisition. To estimate the extent of parkland for acquisition we utilized acquisition targets from previous long-range plans and capital budgets. Table 9 provides the hypothetical hectares of land by asset type for the locations identified for this action.

Table 9: Landcover Types in Areas Identified for Management Action 1

Asset Class	Total Hectares
Forest	65.2
Grassland	20
Wetland	15
Total	100.2

This action was developed with the following assumptions:

- Land acquisition occurs over 16 years to align with Kelowna's OCP timeline
- Ecosystem service benefits are fully realized at the time of acquisition and applied at the scale of the management action
- Per household values are applied at a regional scale for SAR/CH

With the target natural assets identified, the costs and benefits of this management scenario were calculated.

COSTS OF MANAGEMENT ACTION #1

The cost of this management action was calculated as the sum of:

- (i) cost to acquire lands⁷ and;
- (ii) monitoring, operations, and maintenance costs to maintain the land, water, and other natural resources.⁸

The present value of the costs was calculated over a 30-year period assuming a discount rate of 0%, 2% and 4%. The use of discount rates (i.e., assigning weights to future impacts) has been developed to assist with comparing costs and benefits that occur at different points in time, where a higher rate indicates less influence of future costs and benefits on present values.

⁷ Land acquisition costs were estimated from the City of Kelowna's parkland budget for linear and natural area parks and the Greenways costs from their 5-year historical budget.

⁸ Percentage of capital expenditures as identified in the City of Kelowna's 10-yr capital plan: Appendix 302 and RDCO's 5-year capital plan for regional parks. This amounts to 2.87% of capital costs in the City of Kelowna and 2.46% of capital costs in the RDCO.

The present values of the cost of this action were estimated at:

- \$24,584,854 assuming a 0% discount rate
- \$18,459,589 assuming a 2% discount rate
- \$14,311,988 assuming a 4% discount rate

BENEFITS OF MANAGEMENT ACTION #1

The priority benefits of this management action include the value of fresh water, water regulation, climate sequestration and carbon storage provision by the area. While the protection, enhancement, and management of natural assets provides a wide range of benefits, the analysis focused on water-related benefits and climate benefits, given the importance of water management and risks associated with climate change in the region. To arrive at estimates of nature's contribution to the priority benefits, ecosystem service values were calculated by applying dollar/hectare or dollar/household estimates for ecosystem services by landcover types present within the identified area.

It is important to note that each hectare of natural assets can have a very different contribution to the priority ecosystem services based on socio-economic, biophysical, and geographical features. Ideally, a valuation of ecosystem services should involve detailed ecological and economic studies of each ecosystem of interest for each land cover type. As mentioned, such studies are expensive and time consuming. The benefit transfer approach used in this analysis provides indicative or order-of-magnitude values for services to help prioritize management actions to protect, enhance, and manage land, water, and other natural resources.

It should be noted these values are a subset of the ecosystem services that could be associated with Management Action #1. A detailed break-down of the net present values for Management Action #1 is provided in [Table 15](#) in Appendix C.

The present values of the benefits of this action were estimated at:

- \$151,290,646 assuming a 0% discount rate
- \$107,254,572 assuming a 2% discount rate
- \$78,547,066 assuming a 4% discount rate

Considering the NPV of costs against the NPV of benefits provides the NPV of the management action, which is the current value of all future cash flows — both positive and negative — over the entire life of a project or management action.⁹ The results can be reflected through the BCR indicator that reflects the relationship between the relative costs and benefits of the management action. The Parkland Acquisition Management action has a BCR range of 6.16 – 5.49, meaning for every dollar invested, anywhere from \$5.49 to \$6.15 in benefits are realized (\$6.15 in benefits are realized for every dollar invested at a 0% discount

⁹ Please refer to page 25 for the description of Net Present Value and the cost-benefit analysis methodology used for this study.

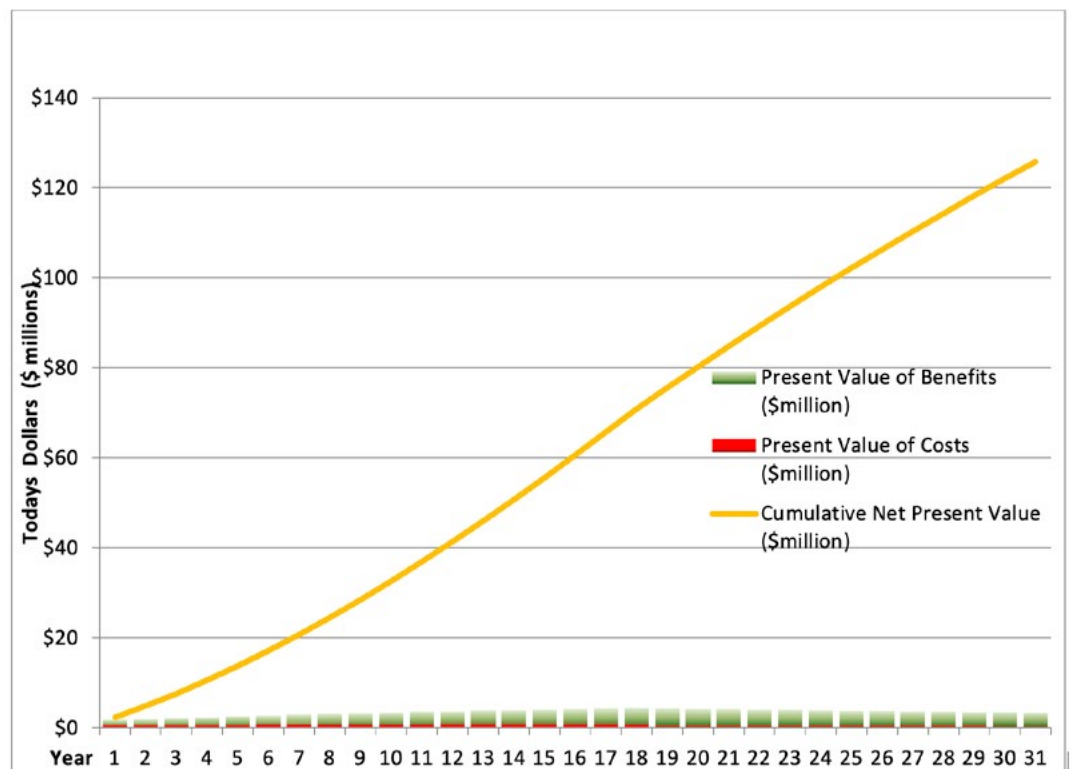
rate; \$5.81 in benefits are realized for every dollar invested at a 2% discount rate; and \$5.49 in benefits are realized for every dollar invested at a 4% discount rate).

Table 10: Cost-Benefit Results of Management Action 1 (Parkland Acquisition)

	0% Discount Rate	2% Discount Rate	4% Discount Rate
NPV of Costs	\$24,584,854	\$18,459,589	\$14,311,988
NPV of Benefits	\$151,290,646	\$107,254,572	\$78,547,066
NPV	\$175,875,499	\$125,714,161	\$92,859,053
BCR	6.15 %	5.81 %	5.49 %

Figure 10 depicts the distribution of costs and benefits at a 2% discount rate over the 30-year period for Land acquisition Management Action #1. The 2% discount rate was chosen to show the mid-rate.

Figure 10: Cost benefit results for Management Action 1 (Parkland Acquisition)



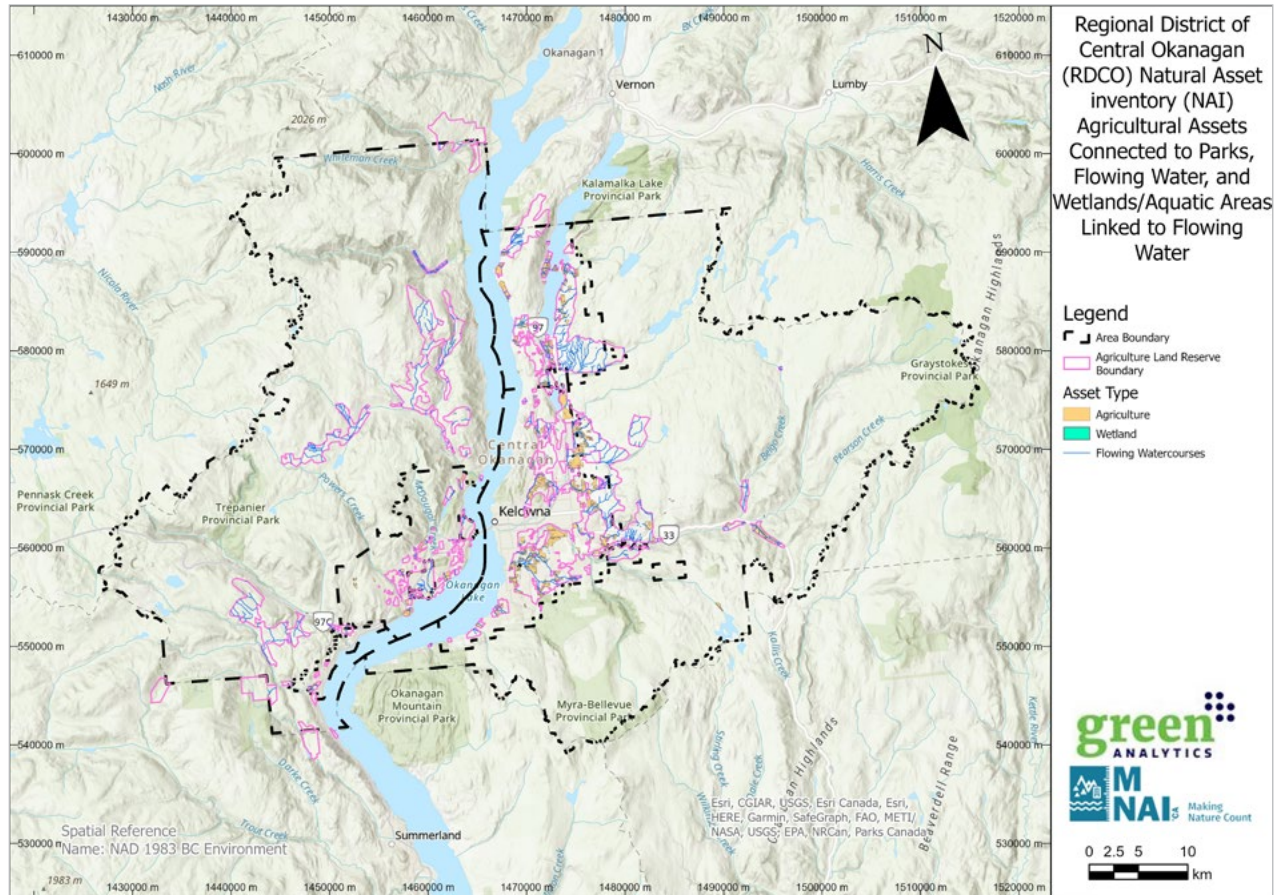
Management Action 2: Tax Incentives for Preservation of Natural Assets on Farmland

The second management action proposes tax incentives for wetland and stream protection on ALR and Non-ALR lands. The project considered lost property taxes on preserved areas of farmland, and the action is supported in high-level policy documents. In Kelowna, agricultural supports are encouraged in the 2023 – 2026 Council Priorities. While this management action would not be implemented by the RDCO, it could be supported at the regional level as

it relates to a number of goals of the Regional Growth Strategy, including: the objective to ‘Preserve and support sustainable agricultural activities and land base that enhances local agriculture through the strengthening of best practices’. It primarily addresses the LEAG-identified key challenge of counter-productive incentives that encourage loss of natural asset on marginal farmlands.

The spatial area was determined by identifying agricultural lands within Kelowna that maximize SAR/CH and the priority ecosystem services. The proposed areas for this management action are shown below in Figure 11.

Figure 11: Proposed Areas for Management Action 2 (Tax Incentives)



This action was developed with the following assumptions:

- Program uptake is minimal for the first 5 years (0.5% of farms or 2 farms) and increases to 15% of farms (121 farms) over 30 years
- Ecosystem service benefits are fully realized at the time of participation in the program
- Per household values are applied at a regional scale for SAR/CH

The cost of this management action was calculated as the sum of:

- (i) Lost tax revenue to the City of Kelowna;¹⁰
- (ii) O&M (lidar; monitoring & enforcement);¹¹
- (iii) Riparian restoration costs.¹²

The present value of the costs was calculated over a 30-year period assuming a discount rate of 0%, 2% and 4%.

The present values of the cost of Management Action #2 were estimated at:

- \$4,375,985 assuming a 0% discount rate
- \$3,110,808 assuming a 2% discount rate
- \$2,245,061 assuming a 4% discount rate

The priority benefits of this management action include the value of fresh water, water regulation, climate sequestration, carbon storage and SAR/CH provision by the area. While the protection, enhancement and management of natural assets provides a wide range of benefits, the analysis focused on water-related benefits and climate benefits, given the importance of water management and risks associated with climate change in the region. To arrive at estimates of nature's contribution to the priority benefits, ecosystem service values were calculated by applying dollar/hectare or dollar/household estimates for ecosystem services by landcover type present within the identified area. A detailed break-down of the net present values for Management Action #2 is provided in *Table 16* in *Appendix C*.

The present values of the benefits of this action were estimated at:

- \$11,153,845 assuming a 0% discount rate
- \$7,187,809 assuming a 2% discount rate
- \$4,724,806 assuming a 4% discount rate

Considering the NPV of costs against the NPV of benefits provides the NPV of the management action, which is the current value of all future cash flows – both positive and negative – over the entire life of a project or management action. The results can be reflected through the BCR indicator that reflects the relationship between the relative costs and benefits of the management action. The Parkland Acquisition Management action has a BCR range of 6.16 – 5.49, meaning for every dollar invested anywhere from \$2.55 to \$2.10 in benefits are

¹⁰ Lost revenue was determined by applying the average value per hectare of \$84,016 (source: Farm Credit Canada) to the estimated extent of wetlands / streams in the management action and applying the tax rate of 4.4725% (source: City of Kelowna https://www.kelowna.ca/sites/files/1/docs/city-hall/property_tax_rates_for_website_2022.pdf)

¹¹ Assumed \$5k/yr for first 5 years, increasing to \$20k as program uptake increases over 30 years.

¹² Based on estimated per cent of restoration required provided by City staff and restoration cost estimated by Province of BC Socio-Economic and Environmental Assessment of Beneficial Management Practices 2012

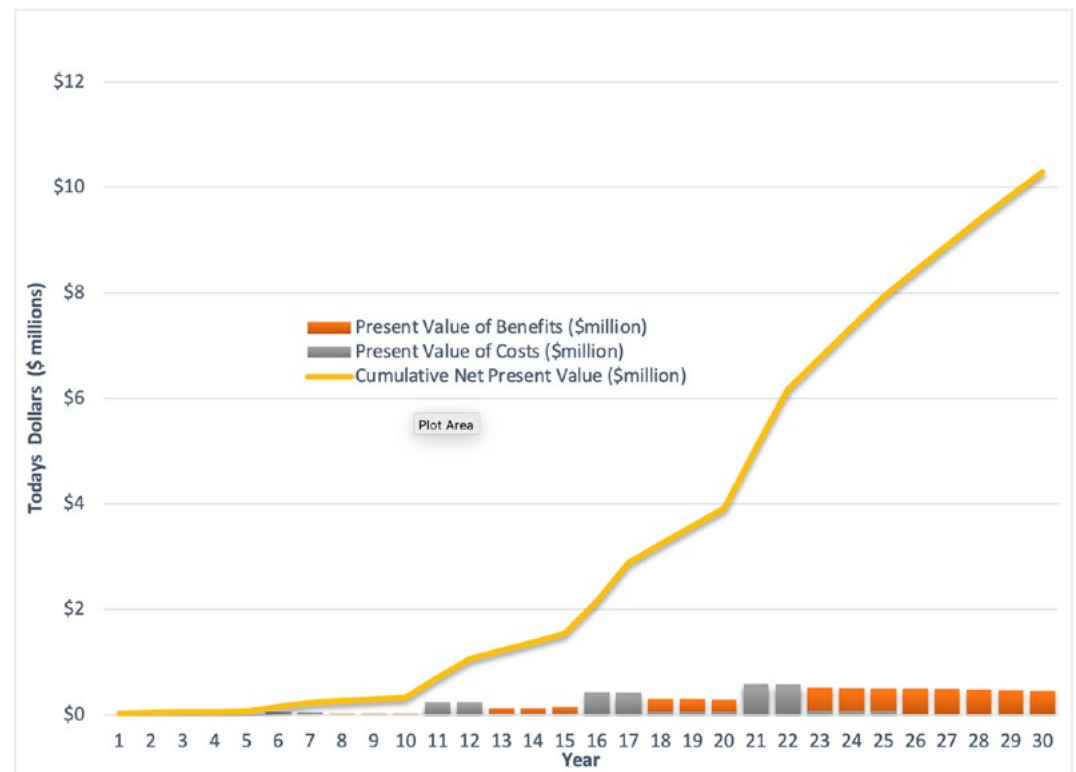
realized (\$2.55 in benefits are realized for every dollar invested at a 0% discount rate; \$2.31 in benefits are realized for every dollar invested at a 2% discount rate; and \$2.10 in benefits are realized for every dollar invested at a 4% discount rate).

Table 11: Cost-Benefit Results of Management Action 2 (Tax Incentives)

	0% Discount Rate	2% Discount Rate	4% Discount Rate
NPV of Costs	\$4,375,985	\$3,110,808	\$2,245,061
NPV of Benefits	\$11,153,845	\$7,187,809	\$4,724,806
NPV	\$15,529,829	\$10,289,616	\$6,969,867
BCR	2.55%	2.31%	2.10%

Figure 12 depicts the distribution of costs and benefits at a 2% discount rate over the 30-year period for the Management Action #2. The 2% discount rate was chosen to show the mid-rate.

Figure 12: Cost-Benefit Results for Management Action 2 (Tax Incentives)

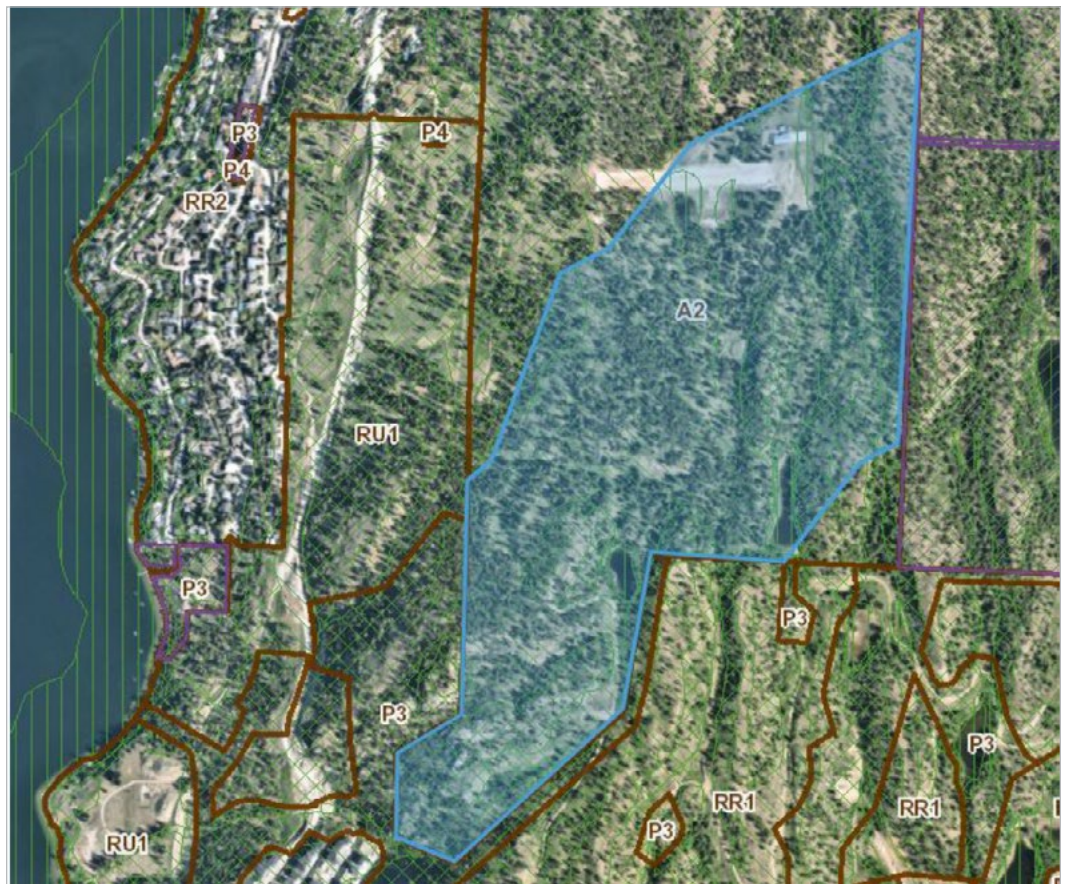


Management Action 3: Acquisition of a Sensitive Ecosystem

The final management action focuses on the acquisition of sensitive ecosystems, particularly Ponderosa Pine. It is supported in high-level policy documents. In the City of Kelowna, it is supported by the 2040 OCP and the 2023-2026 Council Priorities, which recognizes the Environment as a cornerstone value of the City. While this management wouldn't be implemented by the RDCO, it could be supported at the regional level as it relates to a number of goals of the Regional Growth Strategy.

The spatial extent of this area was identified by City of Kelowna and is shown in Figure 13 below.

Figure 13: Proposed area for Management Action 3 (Acquisition of Sensitive Ecosystems)



This action was developed with the following assumptions:

- Land acquisition occurs over 16 years to align with City of Kelowna's OCP timeline
- Ecosystem service benefits are fully realized at the time of acquisition
- Per household values are applied at a regional scale for SAR/CH

The cost of this management action was calculated as the sum of:

- (i) cost to acquire land¹³ and;
- (ii) monitoring, operations, and maintenance costs to maintain the land, water and other natural resources.¹⁴

The present value of the costs was calculated over a 30-year period assuming a discount rate of 0%, 2% and 4%.

The present values of the cost of management action #3 were estimated at:

- \$105,850,748 assuming a 0% discount rate
- \$85,096,921 assuming a 2% discount rate
- \$70,158,755 assuming a 4% discount rate

The priority benefits of this management action include the value of provision of fresh water, water regulation, climate sequestration, carbon storage and SAR/CH provision provided by the area. [Table 10](#) below provides the net present value of each ecosystem service, was calculated over a 30-year period assuming a discount rate of 0%, 2% and 4%. A detailed break-down of the net present values for Management Action #3 is provided in [Table 17](#) in [Appendix C](#).

The present values of the benefits of this action were estimated at:

- \$144,183,032 assuming a 0 per cent discount rate
- \$102,955,034 assuming a 2 per cent discount rate
- \$75,941,828 assuming a 4 per cent discount rate

Considering the NPV of costs against the NPV of benefits provides the NPV of the management action, which is the current value of all future cash flows – both positive and negative – over the entire life of a project or management action. The results can be reflected through the BCR indicator that reflects the relationship between the relative costs and benefits of the management action. The Protection of Sensitive Ecosystems Management action has a BCR range of 6.16 – 5.49, meaning for every dollar invested anywhere from 1.36 to 1.08 in benefits are realized (\$1.36 in benefits are realized for every \$1 invested at a 0% discount rate; \$1.21 in benefits are realized for every dollar invested at a 2% discount rate; and \$1.08 in benefits are realized for every dollar invested at a 4% discount rate).

¹³ Land acquisition costs were estimated from the City of Kelowna's parkland budget for linear and natural area parks and the Greenways costs from their 5-year historical budget.

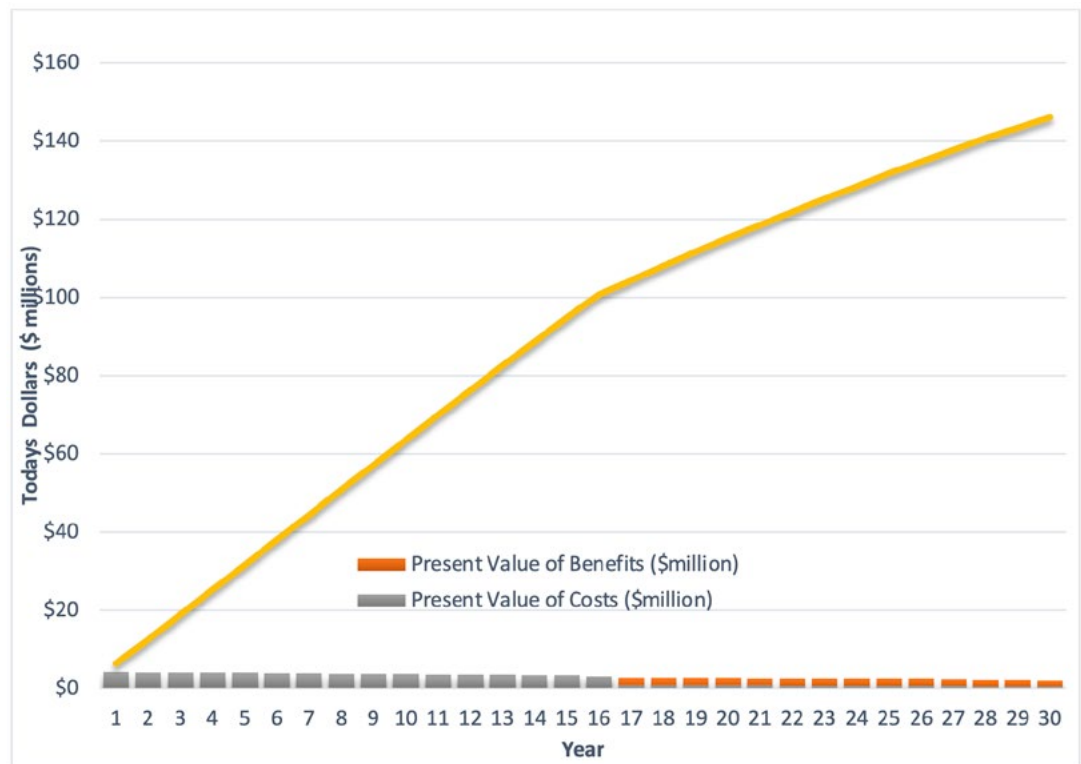
¹⁴ Percentage of capital expenditures as identified in the City of Kelowna's 10-yr Capital Plan. This amounts to 2.87% of capital costs in the City of Kelowna.

Table 12: Cost-Benefit Results of Management Action 3 (Acquisition of Sensitive Ecosystems)

	0% Discount Rate	2% Discount Rate	4% Discount Rate
NPV of Costs	\$105,850,748	\$85,096,921	\$70,158,755
NPV of Benefits	\$144,183,032	\$102,955,034	\$75,941,828
NPV	\$250,033,780	\$188,051,955	\$146,100,582
BCR	1.36 %	1.21 %	1.08 %

Figure 14 shows the distribution of costs and benefits for Management Action #3 at a 2% discount rate. The 2% discount rate was chosen to show the mid-rate.

Figure 14: Cost-Benefit Results for Management Action 3 (Acquisition of Sensitive Ecosystems)



Conclusion

The number of Canadian local governments engaged in NAM is growing steadily. As norms and standards for NAM emerge, the rate at which local governments adopt the practice will increase. As the practice evolves, there will be an important opportunity for NAI to ensure that the methodology for NAM enables local governments to consider services and corresponding values that may not contribute directly to core service deliver outcomes, but which are nevertheless important.

This project was a step towards doing this in the context of SAR and CH. The results are by no means exhaustive but provide a strong basis for continuing to implement and refine this effort in other contexts. As is demonstrated by the results of the cost-benefit analysis, there are gains to be made by pursuing management actions targeted at service delivery and SAR/CH. The three management actions explored in this analysis result in net gains; the benefits derived from the actions outweighed the costs of taking the actions. Indeed, the management actions resulted in significant benefits in the provision of fresh water, water regulation and SAR/CH along with carbon sequestration and storage. SAR/CH was the most significant benefit realized, often showing results 4 to 10-fold higher than other individual ecosystem service net benefits.

Next Steps

This project lays the foundation for considering SAR/CH in the context of natural asset management. Several next steps have been identified that will further the work of RDCO and the City of Kelowna in this endeavor. They are:

- 1/ Include** Asset Management and Natural Assets in the next Regional Growth Strategy amendment to align with current practice. The current Strategy was developed in 2013, when the language and concepts of Asset Management and Natural Assets were not common.
- 2/ Include** a Regional Natural Asset Policy development project in the Regional Growth Strategy Priority Projects Plan. A regional approach will provide decision makers a broader scope when working with natural assets and when developing other regional plans (i.e., Regional Housing Strategy, Regional Transportation Plan, and general regional planning activities).
- 3/ Include** Natural Assets as recognized assets in other City and RDCO strategies and policies (i.e., Corporate Asset Management Strategies, natural asset valuations).
- 4/ Update** land use policies and by-laws to mitigate low condition, high value & high risks to natural assets (risks captured in previous inventory projects).
- 5/ Strengthen** multi-jurisdictional collaboration and governance for Natural Assets. Ensure effective management of natural assets outside of the jurisdiction of RDCO & the City to protect critical services they provide to the community. This is particularly relevant for natural assets that occur on private lands (e.g., management action #2).
- 6/ Expand** CBA to include other priority co-benefits, which will likely improve the business case for natural asset manage.
- 7/ Communicate** the results of this project and build awareness of the service delivery value of the Watershed.
- 8/ Update** land acquisition policies to support the acquisition and maintenance of natural assets for the purposes of protecting the ecosystems services they provide (e.g., limit trail development in areas of sensitive habitat).

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Appendix A - Local government management tools for Species at Risk and Critical Habitat

A scan of tools for the management of species at risk and critical habitat was completed as a component of the MNAI Species at Risk tool. While there are few tools designed explicitly for local government management of species-at-risk and their critical habitat, a number of tools exist for managing environmentally sensitive ecosystems. This scan does not offer a catalogue of all species at risk and critical habitat management tools, as that was outside the scope of the overall project.

This study uses a three-part classification to organize policies: (1) public ownership, (2) regulation, and (3) market-based instruments. No single instrument – market-based or conventional – will be appropriate for all environmental problems. Which instrument, or combination of instruments, is best in any given situation depends upon characteristics of the specific environmental problem, and the sociopolitical, and economic context.

Table 13: Management Tools for SAR and CH for Local Governments

Management Tool	Explanation	Benefits	Challenges	Example(s)
1/ Land Acquisition Tool				
Land purchase	Buying of land of known importance to species at risk in order to conserve and protect it.	■ Permanent protection for critical habitat. ■ Monitoring can be used for public education. ■ Establishes an economic value for habitat that supports species at risk. ■ A land acquisition strategy can be prepared to identify program objectives, desired land characteristics and acquisition criteria, as well as funding options for ongoing maintenance.	■ Can be cost prohibitive for local governments. ■ Application process can be arduous, requiring considerable staff capacity. ■ Violations to protected areas are difficult to enforce as infractions are usually dealt with through the courts. ■ Ongoing costs to maintain and manage land.	City of Edmonton's Natural Areas Reserve Fund earmarked for purchase of natural areas in Edmonton's tablelands; <i>Parkland Purchase Reserve Fund</i> earmarked for land in the river valley and ravines system. City of Portland's Land Acquisition Strategy earmarked for recreational needs and protection of natural and cultural resources.

1/ Land Acquisition Tool

Private land donation	Conservation of private land through a federal tax benefit for conservation and protection (often land important for species at risk).	■ Permanent protection for critical habitat. ■ Tax incentives for transfer of land (e.g., Eco Gifts Program). ■ Establishes an economic value for habitat that supports species at risk.	■ Can be counter-productive if acquired land is poorly managed. ■ Difficult to target priority lands.	Donation of Riverside Ranch, AB to protect westslope cutthroat trout and bull trout.
Expropriation of Land	Through provincial and federal legislation, government can expropriate critical habitat for the conservation and recovery of a legally listed species at risk.	■ Provides a high degree of protection. ■ Monitoring can be used for public education.	■ Not a common practice. ■ Application process can be arduous, requiring considerable staff capacity.	Land development in La Prairie, QC halted to protect Western chorus frog.

Management Tool

Explanation

Benefits

Challenges

Example(s)

2/ Regulatory Tools

Planning Documents (e.g., Official Community Plans/Municipal Plans, Regional Growth Strategies, Watershed Conservation Plans, Asset Management Plans)	Planning documents are long-term policy directives prepared for a particular area. They often include environmentally significant areas and can be an important component of critical habitat and at-risk species protection.	■ Creates local or regional vision. ■ Can foster greater discussion, collaboration and cooperation on a regional scale. ■ Provides a mechanism to monitor change and the effectiveness of local policies. ■ Informs the designation of greenways, developed areas and protected areas. ■ Provides wider context for considering development proposals and associated applications for variance permits.	■ Requirement for unanimous approval by member municipalities can lead to compromises that weaken social, economic, and environmental goals. ■ Few effective enforcement mechanisms. ■ Plans can generally be weakened through amendments. ■ Implementation can be slow if there are no or few related policies currently in place.	Nottawasaga Valley Integrated Watershed Management Plan brought together stakeholders from across the watershed to develop and implement strategies to promote a sustainable and resilient watershed. City of Hamilton's Biodiversity Action Plan (in progress) to conserve and restore the region's biodiversity.
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2/ Regulatory Tools

Zoning Tools

(e.g., Development Permit Areas; Local Service Areas; Greenbelts, Urban Containment Boundaries; Cluster Zoning and Development)

Conservation zoning is a straightforward way to keep development out of environmentally sensitive areas. It is often used to reinforce environmental protection goals and to correct outdated zoning that failed to consider sensitive areas. As long as zoning does not restrict public use of the land, local governments can enforce zoning for ecosystem protection.

- When used with other tools, zoning can be an effective way to protect critical habitat and natural infrastructure from development.
- Local governments do not have to pay compensation to landowners for changes in the value of land due to rezoning enacted in the public interest.
- Zoning is better received when it can be communicated as a tool to meet the goals of a community-wide planning process (e.g., OCP).
- Enforcement mechanisms are available.

- May promote urban sprawl by pushing residential development and other activities to regions where there are fewer restrictions.
- Can be politically unpopular because it can decrease the value of property by limiting its uses.

Capital Regional District Green/Blue Spaces Strategy to create a corridor of protected wilderness and parkland stretching from Saanich Inlet in the east to the Sooke Basin of British Columbia.

City of Whitehorse's Boundary Pre-feasibility Study identifies natural values present, the general development suitability for different land uses, along with the opportunities, constraints and technical challenges the City of Whitehorse must consider.

City of Saskatoon's Green Network combines aquatic areas, green areas, urban forest, trails and greenways into a connected system of natural, enhanced and engineered assets to protect and restore habitat and promote well-being.

2/ Regulatory Tools

Environmental Bylaws (e.g., Watercourse Protection Bylaw; Rainwater Management Bylaw; Landscaping Bylaw; Tree Protection Bylaw; Soil Removal & Deposit Bylaw; Pesticide Use Bylaw; Invasive Species Bylaw; Subdivision Servicing Bylaw; Development Cost Charge (DCC) Bylaw; Environmental Impact Assessment)	Bylaws are a finer-scale approach to protecting critical habitat. Bylaws are designed to regulate or prohibit certain activities and prescribe methods of carrying out activities. They can serve proactive or reactive purposes. Proactive bylaws generally require landowners to obtain permits before undertaking certain activities, whereas reactive bylaws permit government staff to enforce a bylaw after the offence has taken place.	- Can set more stringent standards for individual ecological features. - Opportunity for public education, particularly with proactive bylaws. - Provides potential for rehabilitation. - Can address stressors to critical habitat (e.g., pollution, invasive species). - Provides opportunity to address incremental changes to critical habitat.	- Standards can be too stringent or costly to administer. - Can create trade-offs (e.g., tree protection for dense development). - Can be difficult to enforce without adequate resources (e.g., staff and training resources). - Ongoing monitoring and enforcement needed. - Requires landowners and developers to be aware of and understand bylaws and standards. - Standards could hinder innovation.	The Town of Gibsons amended its DCC bylaw and now collects development cost charges for improvements to natural areas. The Town of Moncton's By-Law Z213 implements minimum elevation requirements for development to be above 10.5 metres for climate change adaptation.
Performance Bonds and Covenants	Performance bonds and covenants are proactive tools to prevent or remedy damage to critical habitat from development. Performance bonds act as a security deposit that a municipality can use for habitat restoration if unintentional damage from development occurs. A conservation covenant identifies land or portions of land that development must preserve.	- Provides protection for critical habitat without the expense of purchasing it. - Can be tailored to specific ecological features. - Acts as both a carrot and a stick, since the bond is returned if development preserves critical habitat. - Conservation organizations can hold covenants and assume monitoring requirements.	- Remediation can be more costly than the performance bond. - Covenants lack accessible enforcement mechanisms (court is generally the only option). - Covenants are perceived to decrease property values.	The <i>Acadian Marshes - Percival River Salt Marsh Natural Area</i> was acquired by Island Nature Trust (PEI) through donation in two parcels. The municipality of Kommininvest, Sweden issued its inaugural Green Bond in March 2016 to encourage investment in climate solutions, which supported over 60 investment projects in 40 Swedish municipalities and regions

Management Tool	Explanation	Benefits	Challenges	Example(s)
3/ Market-Based Tools				
Environmental Tax Instruments (e.g., Water Pricing; Waste pricing; subsidies)	Environmental tax instruments aim to shift the tax burden from things that are socially desirable, such as employment, income, and investment, to things that are undesirable, like pollution, resource depletion, and waste. The goal is to help the environment and community health without hurting the economy. Environmental taxes can be structured to be revenue-neutral (i.e., total tax revenues remain unchanged), revenue-positive (i.e., total tax revenues increase) or revenue-negative (i.e., total tax revenues decrease), depending on how much tax revenue is recycled and public attitudes toward taxes.	■ Helps government protect critical habitat while also providing financial flexibility. ■ Diversifies revenue streams. ■ Addresses social equity challenges (e.g., not asking everyone to pay into environmental challenges regardless of one's contribution to the problem or one's income level).	■ Significant education required to overcome the public's dislike of taxes. ■ The public is sensitive to increases in highly visible taxes (e.g., property taxes). ■ Increased resources required for administration of programs. ■ Significant information required to set effective tax rate.	The South Saskatchewan Water Management Plan was approved in 2006 and enables water transfers in the South Saskatchewan River basin. The City of Beaconsfield, QC, charges households directly for their disposed waste, through pay-as-you-throw (PAYT) programs. These programs charge households based on the size of their garbage bin or by the quantity of garbage bags they put at the curb.

3/ Market-Based Tools

Bonuses, Fees and Charges

(e.g. nitrogen and phosphorous levy, water source protection incentive programs; density bonus)

Correcting price signals can be a very effective tool to protect critical habitat, since price is proven to be a strong motivator for behavioural change. Because participation is voluntary (i.e. you can choose not to purchase an item or develop in a particular location), there is generally less resistance to changes in price than equivalent changes in levels of taxation. In addition, fees and charges can bolster and diversify local government revenues. These tools are most effective when government staff is properly educated and enforcement mechanisms are well resourced.

- Changes in prices usually invoke quick responses in behaviour
- Changes culture of local government over time
- Diversifies government revenues
- Can be tailored to specific issues or ecological components
- Provides opportunity for public education

- Instances of the rebound effect¹⁵ could be observed
- Few opportunities for local governments to control prices
- Considerable information needed to set appropriate fees, charges, and subsidies.

Ontario municipalities can offer grants to encourage landowners to take action. For example, a municipality could offer a grant to owners of septic systems to cover the cost of an inspection.

Salt Spring Island uses density bonusing to secure public parkland and recreational lands.

¹⁵ The rebound effect refers to increased consumption that results from actions that increase efficiency and reduce consumer costs. For example, an improvement in a vehicle's fuel efficiency does not usually result in a proportional reduction in fuel use, because drivers of fuel-efficient vehicles find that they can afford to drive more. As a result, they reinvest a portion of potential energy savings on comfort. The difference between the potential fuel savings and the actual savings is the Rebound Effect.

3/ Market-Based Tools

Creating Markets (e.g. payment for ecosystem services)	The use of environmental taxes, charges, and subsidies assumes that governments have sufficient information to set an effective tax rate, which is exceedingly difficult with ecosystem services. These difficulties are heightened when differences in ecosystem services require governments to apply a different tax, fee, or subsidy at every site. Regulation faces similar problems, since governments need considerable information to design effective rules. In contrast, under certain conditions, creating markets for critical habitat and ecosystem services can improve societal well-being even under incomplete information.	■ Does not require perfect knowledge of critical habitat and ecosystem services in a region ■ Promotes innovation ■ A monetary value is established for critical habitat and ecosystem services.	■ Large transaction costs ■ Inefficient when there are few buyers and sellers ■ Unable to use when ownership cannot be defined and enforced ■ Unable to use when there is uncertainty about the attributes of critical habitat and ecosystem services.	Farmland Advantage is a research and development project that works with farmers to protect and conserve critical, natural values in British Columbia, Canada.
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Appendix B – Primary studies utilized to estimate ecosystem service values

Table 14: Primary Studies used for Ecosystem Service Value Estimates

Ecosystem Service	Land Class	Value (2022 C\$)	Study	Study Description
Water Supply	Forest & shrubland	\$2,643.93	Sound Investment: Measuring the return on Howe Sound's Ecosystem Assets	This study estimated the value of water-filtration services by forests and wetlands in the study area's watersheds. The economic value for the benefit of water filtration was based on the potential increase in water-treatment costs if the current forest/wetland cover declined from its current average cover. Thus, the value is based on the additional cost for water treatment if the current natural cover declined.
	Grassland	\$36.76	Comparing Ecosystem Goods and Services Provided by Restored and Native Lands	Water-supply values were based on estimates of damage to water quality due to soil erosion for each state, provided by Claassen and colleagues (2001). The average dollar value of per metric ton of soil lost was multiplied by the amount of soil conserved in restored or native habitat per hectare of land.
	Water & wetland	\$2,643.93	Sound Investment: Measuring the return on Howe Sound's Ecosystem Assets	This study estimated the value of water-filtration services by forests and wetlands in the study area's watersheds. The economic value for the benefit of water filtration was based on the potential increase in water-treatment costs if the current forest/wetland cover declined from its current average cover. Thus, the value is based on the additional cost for water treatment if the current natural cover declined.
Water Regulation	Forest & shrubland	\$2,095.10	Sound Investment: Measuring the return on Howe Sound's Ecosystem Assets	The economic value of water regulation by forests is calculated as an avoided cost value using CITYgreen software. Analysis of the study area's total forest cover was assessed in terms of the avoided construction costs for water runoff control if the current forest cover was removed and converted for urban land use.
	Grassland	\$13.54	Comparing Ecosystem Goods and Services Provided by Restored and Native Lands	Water regulation values were determined by the proportion of vegetation types, soil characteristics, and area of a given ecoregion). Runoff curve values for each of the land-cover types in each ecoregion were determined. For each ecoregion, the ratio of the saturation values for the current land-cover type to the values for the completely restored land-cover type yielded the percentage improvement per hectare, determined by multiplying the area of a given ecoregion by its percentage of improvement from current land-cover values to restored values.
	Water & wetland	\$8,826.62	Sound Investment: Measuring the return on Howe Sound's Ecosystem Assets	This study estimates the dollar-per-acre values of wetland systems for flood protection in two Western Washington communities currently experiencing frequent flooding. Cost estimates for engineered hydrologic enhancements to wetlands currently providing flood protection are used to establish proxies for the value of the flood protection these same wetlands currently provide.

Carbon Sequestration	Forest & shrubland	\$272/ha/yr	Grindstone Creek Watershed Natural Assets Management Project	That study relied on an assumed sequestration rate from Green Analytics (2020) of 1.29 tC/ha/yr for forests and 2.06 tC/ha/yr for wetlands, which converts to 4.73 tCO ₂ e/ha/yr and 7.55 tCO ₂ e/ha/yr respectively. These rates were multiplied by the 2025 social cost of carbon (\$57.51/tCO ₂ e) to arrive at a sequestration rounded value of \$213/ha/yr (2020 C\$) for forests, and \$340/ha/yr (2020 C\$) for wetlands. Multiplying these values by the area of forest and wetlands in the relevant management action RDCO provides a rough annual carbon sequestration benefit.
	Grassland	\$142		
	Water & wetland	\$434		
Carbon Storage	Forest & shrubland	Storage carbon values varied by management action.	British Columbia Vegetated Resources Inventories (VRI) dataset	Carbon storage estimated by first estimating the volume (m ³) of biomass in the watershed, which was obtained from the British Columbia Vegetated Resources Inventories (VRI) dataset. We then converted that value to tonnes of carbon using the standard Canadian biomass-to-carbon conversion factor of 0.5 ¹⁶ , and lastly multiplying that value by the B.C. carbon tax of \$65/tCO ₂ e. Converting this price to tonnes of carbon based on relative atomic weights gives a price of \$17.73/tC (1 tonne of carbon = 3.667 tonnes of CO ₂ e).
	Grassland			
	Water & wetland			
SAR/CH	All	\$36/person/yr	Prioritizing threat management across terrestrial and freshwater realms for species conservation and recovery	Study completed in New Brunswick that estimated the cost per person of targeted management strategies to conserve 40 species over 25 years, and then transferred the value of \$36/person. We transferred the value from a per person to a per household value by applying this value to the population aged 20 and up within the watershed.

¹⁶ This is the “standard value for biomass-to-carbon conversion” used in the Carbon Budget Model of the Canadian Forest Sector (Kull et al. 2019, p. 2)

Appendix C – Detailed Net Present Values of Benefits

Management Action 1: Parkland Acquisition to Increase Connectivity

Table 15: Net Present Value of Benefits for Individual Ecosystem Service – Management Action 1

Ecosystem Service	Natural Asset Type	\$ / Hectare / Year (2022 CDN dollars)	NPV* by Ecosystem Service (0% discount rate)	NPV* by Ecosystem Service (2% discount rate)	NPV* by Ecosystem Service (4% discount rate)
Provision of Fresh Water	Forest	\$2,643.93	\$3,959,634	\$2,749,291	\$1,965,310
	Grassland	\$36.76	\$16,960	\$11,777	\$8,419
	Wetland	\$2,643.93	\$910,575	\$632,409	\$452,073
Water Regulation	Forest	\$2,095.10	\$3,137,460	\$2,178,575	\$1,557,334
	Grassland	\$8,826.62	\$6,249	\$4,339	\$3,102
	Wetland	\$1,878	\$3,079,396	\$2,142,845	\$1,534,977
Climate Sequestration	Forest	\$272	\$407,328	\$282,839	\$202,186
	Grassland	\$142	\$65,516	\$45,493	\$32,520
	Water & Wetland	\$434	\$149,500	\$103,810	\$74,208
Carbon Storage*	Forest	\$17.73/tC	\$83,550	\$82,727	\$81,927
	Grassland	\$17.73/tC	\$6,288	\$6,226	\$6,166
	Wetland	\$17.73/tC	\$4,529	\$4,485	\$4,441
SAR	All	\$36/ person/yr	\$24,584,854	\$18,459,589	\$14,311,988
Total	Forest		\$7,587,972	\$3,806,757	\$50,207
	Grassland		\$95,013	\$50,207	\$2,065,699
	Water & wetland		\$4,144,000	\$2,065,699	
	SAR				

Management Action 2: Tax incentives for preservation of natural assets on farmland

Table 16: Net Present Value of Benefits for Individual Ecosystem Service – Management Action 2

Ecosystem Service	Natural Asset Type	\$ / Hectare / Year (2022 CDN dollars)	NPV* by Ecosystem Service (0% discount rate)	NPV* by Ecosystem Service (2% discount rate)	NPV* by Ecosystem Service (4% discount rate)
Provision of Fresh Water	Water & wetlands	\$2,643.93	\$6,625,969	\$4,558,462	\$3,195,016
Carbon Storage*	Water & wetlands	\$1,878	\$11,955,845	\$7,994,053	\$5,453,680
Climate Sequestration	Water & wetlands	\$434	\$4,775,264	\$3,370,910	\$2,417,953
Carbon Storage*	Water & wetlands	\$17.73/tC	\$4,380,006	\$3,114,789	\$2,249,004
SAR/CH	All	\$36/person/yr	\$5,296,685	\$3,703,632	\$2,634,459
Total	Forest		\$15,529,829	\$10,298,616	\$6,969,867

* Carbon storage is valued at a point-in-time.

Management Action 3: Parkland Acquisition to Increase Connectivity

Table 17: Net Present Value of Benefits for Individual Ecosystem Service – Management Action 3

Ecosystem Service	Natural Asset Type	\$ / Hectare / Year (2022 CDN dollars)	NPV* by Ecosystem Service (0% discount rate)	NPV* by Ecosystem Service (2% discount rate)	NPV* by Ecosystem Service (4% discount rate)
Provision of Fresh Water	Forest & shrubland	\$2,643.93	\$12,333,933	\$8,680,776	\$6,279,782
	Grassland	\$36.76	\$31,320	\$22,064	\$15,977
	Water & wetland	\$2,643.93	\$93,595	\$65,592	\$47,768
Water Regulation	Forest & shrubland	\$2,091.10	\$9,728,006	\$6,838,968	\$4,940,265
	Grassland	\$13.54	\$11,536	\$8,127	\$5,885
	Wetland	\$8,826.61	\$312,462	\$220,176	\$159,471
Climate Sequestration	Forest & shrubland	\$272	\$1,268,880	\$893,054	\$646,046
	Grassland	\$142	\$120,984	\$85,230	\$61,716
	Water & Wetland	\$434	\$15,364	\$10,826	\$7,841
Carbon Storage*	Forest & shrubland	\$17.73/tC	\$163,283	\$161,674	\$160,112
	Grassland	\$17.73/tC	\$6,656	\$6,591	\$6,527
	Wet Water & wetland land	\$17.73/tC	\$63	\$62	\$61
SAR	All	\$36/person/yr	\$120,096,950	\$85,961,534	\$63,610,376
Total NPV of benefits			\$144,183,032	\$102,955,034	\$75,941,828

* Carbon storage is valued at a point-in-time.

