Integrating Species at Risk Considerations Into Natural Asset Management

Results of a pilot project and considerations for future projects

March 2021

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Municipal Natural Assets Initiative

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Making Nature Count

Invest in Nature

The Municipal Natural Assets Initiative (MNAI) is changing the way municipalities deliver everyday services, increasing the quality and resilience of infrastructure at lower costs and reduced risk. The MNAI 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.

Acknowledgements

Local expert advisory group members: **Joy Wade**, Fundy Aqua Services; **Paul Grant**, Fisheries and Oceans Canada; **Jason Straka**, B.C. Conservation Data Centre; **Cory Frank**, K'ómoks First Nation; **Jim Palmer**, Morrison Creek Streamkeepers; **Jan Gemmell**, Morrison Creek Streamkeepers; **Ryan O'Grady**, MNAI Associate; **Tatsuyuki Setta**, City of Courtenay; **Karin Albert**, Village of Cumberland; **Mark Harrison**, Comox Valley Regional District; **Tim Ennis**, Comox Valley Land Trust (Group Chair)

Funders:

This report was developed with assistance from Environment and Climate Change Canada

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Please cite as:

Municipal Natural Assets Initiative. (2021). Integrating species at risk considerations into natural asset management: Results of a pilot project and considerations for future projects. Victoria, British Columbia, Canada. MNAI.ca

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Purpose

This report summarizes efforts to develop and test an approach that would enable local governments to integrate species at risk (SAR) and critical habitat (CH) considerations into their natural asset (NA) management efforts.

The report describes both the steps and analysis undertaken for the pilot site at the Morrison Creek Watershed within the Comox Valley Regional District on Vancouver Island, British Columbia, and considerations for how the approach could be refined and applied elsewhere. It will thus be of interest both to those wishing to advance work in the pilot site, and to local governments who may wish to replicate and refine the approach elsewhere.

Introduction

What are municipal natural assets

The term *municipal natural assets* refers to the stock of natural resources or ecosystems that a municipality, regional district, First Nation, or other form of local government could 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 recognize that it is as important to understand, measure, manage and account for natural assets as it is for engineered assets. 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* 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 and the Municipal Natural Assets Initiative (MNAI) helps them do so by using methodologies and tools rooted in standard asset management, and providing advisory services to help local governments implement them.

The outer ring in Figure 1 describes the main steps involved in asset management. The steps are based on the Asset Management for Sustainable Service Delivery: A BC Framework[2], which depicts the continual cycle of asset

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1 mnai.ca/media/2018/02/finaldesignedsept18mnai.pdf

2 A document published by Asset Management BC (2013) www.assetmanagementbc.ca management through three phases: Assess, Plan and Implement. MNAI 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. MNAI's mission is to make natural asset management a mainstream practice across Canada, and in support of this, for local governments to accept and use the methodologies and tools in standard ways across the country.

Figure 1: the main steps in asset management. Source: Asset Management B.C.

Why consider species at risk (SAR) and critical habitat (CH) in natural asset management

In MNAI's methodology, the primary objective of natural asset management 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. MNAI's methods and tools focus primarily on this objective.

A secondary objective is to understand, measure and manage the contribution of natural assets to other outcomes that may be of less direct relevance to the local government and asset management, but which are nevertheless important. Examples could include health, recreational, cultural, or aesthetic values; they might also include species at risk and critical habitat. The general public, or subsets of it, benefit from these *additional services*.

Methods and tools in relation to this second objective are limited. There is an imperative to fill this gap, as considering both primary and secondary objectives in natural asset management may "stack" or optimize efforts and outcomes.

This project, therefore, is an opportunity to:

- **a/** understand the nature and extent of overlap between natural assets that provide local government services and natural assets that are relevant to SAR and CH in a single location,
- **b/** based on this, to identify management actions that benefit both SAR and local government service outcomes in that location, and
- **c/** develop an approach that can be refined and transferred in future applications. The approach is hereafter referred to as the "pilot SAR tool."

Project relevance is underscored by the well-defined connection between biodiversity and service delivery from natural assets. Protecting SAR and CH contributes to biodiversity and may support many types of service delivery.

The project idea originated at a multi-stakeholder workshop that MNAI facilitated in the Comox Valley, British Columbia, in March 2019. The meeting was part of efforts to better understand and manage natural assets in the Comox Lake Watershed. Meeting participants noted there are 39 species in the area listed under the federal *Species At Risk Act (SARA)*, of which 22 are threatened or endangered, and that there are additional species on the provincial list of species at risk. The group supported developing a tool or approach to determine how SAR might be considered in future natural asset management efforts in the Comox Valley or elsewhere. Accordingly, MNAI, with funding from Environment and Climate Change Canada (ECCC), developed this project.

Scope and limitations

The pilot SAR tool has only been tested in one location. Additional piloting, refinement, and peer review are required before definitive conclusions can be drawn about where and how it might best be applied. Furthermore, this report was written before the identified management actions could be implemented; long-term monitoring would be required to determine their efficacy. Therefore, this report offers considerations for future efforts rather than specific recommendations. Limitations to the analysis of management actions are described in Step 8, below.

Report organization

This report is organized according to the eight main steps taken to develop and test the pilot SAR tool together with corresponding lessons and considerations for future applications.

Main steps, findings and considerations

This chapter describes the project design, pilot site selection, each of the eight steps taken at the pilot site to integrate SAR and CH into natural asset management, and considerations for other locations.

Pilot SAR tool design

During the initial project scoping and design phase, MNAI developed an overall framework for considering SAR and CH in a natural asset management context as depicted in Figure 2. The framework is to identify areas of intersection between the standard MNAI approach to natural asset management (described above) and logical opportunities to consider the SAR pilot tool. MNAI then used this framework to define and develop the eight project steps shown in Figure 3.

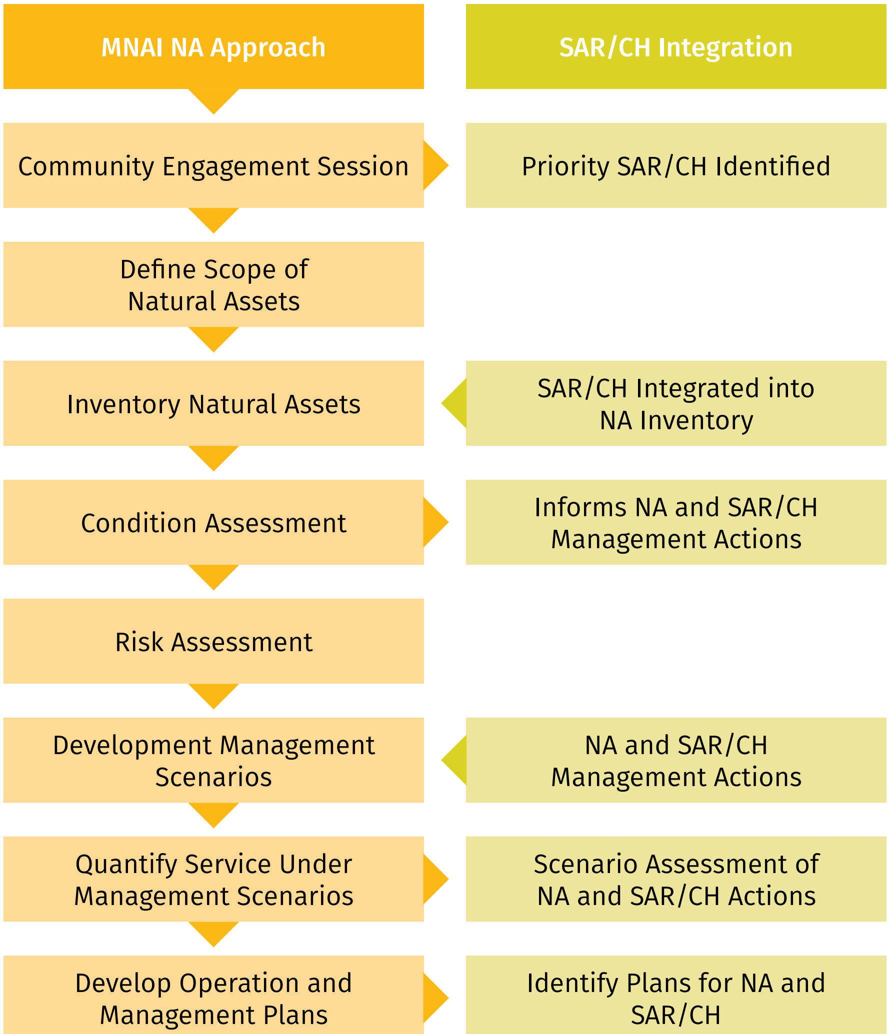

***Figure 2**: MNAI natural asset framework showing points of intersection between natural asset management and the pilot SAR tool.*

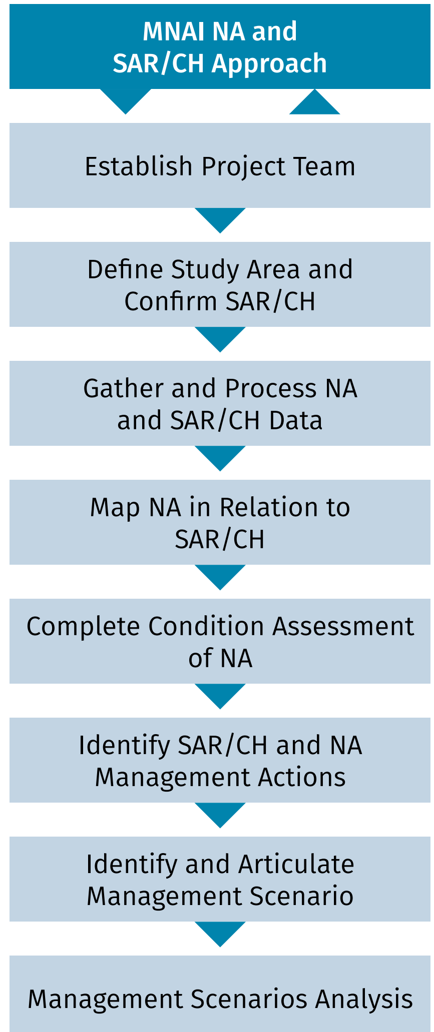

***Figure 3**: The eight project steps of the MNAI SAR and CH assessment around which the report is organized.*

STEP 1 Establish a project team

The first step in the process is to identify and engage a team.

MORRISON CREEK WATERSHED PILOT PROJECT

To develop the pilot SAR tool, MNAI developed a team consisting of:

- **Project leads** responsible for managing and undertaking the content work.
- **A local expert advisory group** that provided advice, validation, guidance and perspective.

Project leads were from MNAI; the local expert advisory group members are listed in Table 1.

NAME	AFFILIATION	EXPERTISE / ROLE
Joy Wade	Fundy Aqua Services	Consulting Biologist, lamprey specialist
Paul Grant	Fisheries and Oceans Canada	SARA Science Coordinator, Pacific Region
Jason Straka	B.C. Conservation Data Centre	Program Ecologist
Cory Frank	K'ómoks First Nation	Director, Guardian Watchmen Department
Jim Palmer	Morrison Creek Streamkeepers	Director, Freshwater Ecologist Technician
Jan Gemmell	Morrison Creek Streamkeepers	President
Ryan O'Grady	MNAI Associate	Engineering, Local Government, Project Devel.
Tatsuyuki Setta	City of Courtenay	Manager of Community and Sustainability Planning
Karin Albert	Village of Cumberland	Senior Planner
Mark Harrison	Comox Valley Regional District	Manager of Parks
Tim Ennis	Comox Valley Land Trust	Conservation biology

Table 1: *Local expert advisory group members*

The project leads and local expert advisory group members met at key junctures to discuss and determine:

1/ The proposed project area. This was determined by considering the following questions:
- How large does the study area need to be to encompass SAR and their habitat/CH?
- What are the geographic boundaries of local governments?
- How do watershed boundaries align with political boundaries and SAR and their habitat/CH?
- What ecosystem services do the natural assets within potential project boundaries provide?

2/ The ecosystem service/s to be the focus of the study (e.g., stormwater management, drinking water supply, wastewater treatment, recreation, carbon storage).

3/ Criteria for identifying which species to focus on and, based on this, the selection of species.

4/ Data sources for natural assets and SAR and their habitat/CH.

5/ Data gaps and the means to fill them.

6/ Modelling and scenario results.

CONSIDERATIONS FOR FUTURE PROJECTS

The local expert advisory group 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 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 First Nations knowledge to the project

The presence of a single, local expert focal point, a conservation biologist from the Comox Valley Land Trust, was also invaluable to help identify the community experts. Based on this experience, future project proponents should consider a single local focal point or developing an expert group that includes, at a minimum:

- Local government staff responsible for planning and managing natural assets and SAR and CH
- Local biologists/ecologists (e.g., a biologist familiar with relevant SAR and CH or a biologist responsible for the SAR from the relevant government departments)
- First Nations
- Local conservation/stewardship groups (e.g., Streamkeepers, Land Trusts)

A guiding project team should likely be composed of natural asset management practitioners or others with extensive knowledge of natural asset management; an environmental economist to guide the analysis of alternative management actions; and a data and GIS expert to gather and manipulate data.

STEP 2 Define project area and confirm SAR

Step 2 involves defining a specific project area and the SAR to be included in any analysis.

MORRISON CREEK WATERSHED PILOT PROJECT

A well-defined project area is required for the project. Following confirmation of funding from ECCC, MNAI, in consultation with the local expert advisory group, selected the Morrison Creek Watershed as the area in which to develop and pilot the SAR tool.

The Morrison Creek Watershed, depicted in Figure 4, is approximately 98 per cent privately owned, 2 per cent Crown owned, and is 908 ha in size. Approximately 43 per cent is in Electoral Area C of the Comox Valley Regional

District (CVRD), 16 per cent is within the City of Courtenay's boundaries, and 41 per cent is within the Village of Cumberland's boundaries. Organizations such as the Nature Trust, the Comox Valley Land Trust, and Ducks Unlimited protect 9 per cent in some way. Most protected areas are located around the creek. Not all protected areas within the watershed are of high quality from a habitat perspective; some, for example, contain picnic tables and other recreational facilities. As a result of the private ownership, data availability is poor. This is typical of many areas on Vancouver Island, meaning the area is representative of a larger sample of land in B.C. and thus a useful place to develop the SAR tool.

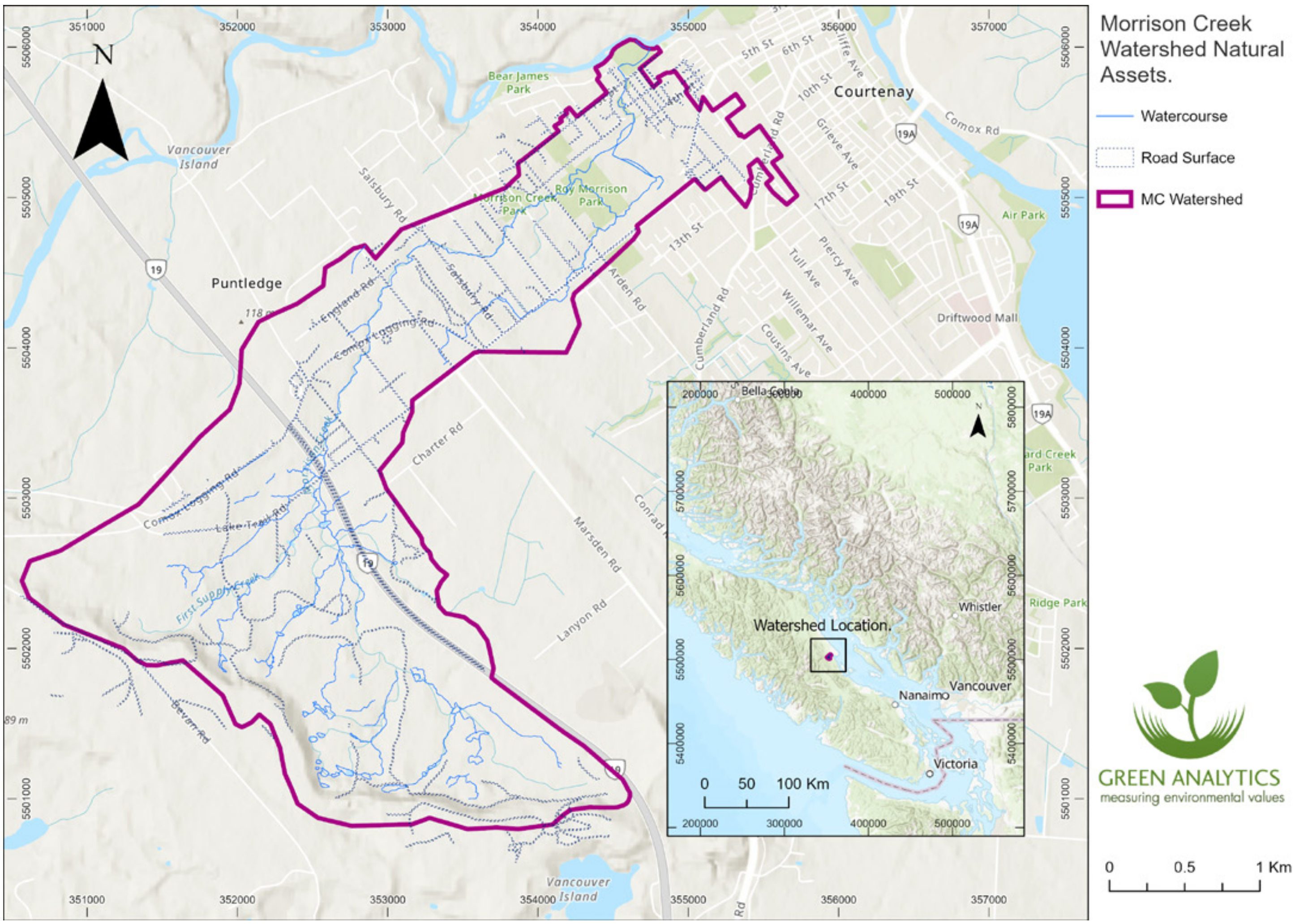

Figure 4: The location and boundary of the Morrison Creek Watershed

Once the study area was defined, it was necessary to identify the SAR and their associated habitat or CH that would be the focus of the approach.

As a first step, MNAI identified all SAR that could be relevant to the project area by:

- Extracting species names from the B.C. Conservation Data Centre iMap,[3] using one query for Red and Blue provincial species; and
- Extracting species assessed as threatened or special concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and those listed under Schedule 1 of the Species at Risk Act (SARA).

MNAI merged the two lists to create one list of all possible species relevant to the project area (Table 2).

Common Name	COSEWIC	Species at Risk Act (SARA)	B.C. Status
Western Brook Lamprey (Morrison Creek pop.)*	Endangered	Schedule-1	Red
Little Brown Bat	Endangered	Schedule-1	Yellow
Western Painted Turtle (Pacific coast pop.)*	Threatened	Schedule-1	Red
Olive-sided Flycatcher	Threatened	Schedule-1	Blue
Barn Swallow	Threatened	Schedule-1	Blue
Common Nighthawk	Threatened	Schedule-1	Yellow
Northern Red-legged Frog	Special Concern	Schedule-1	Blue
Great Blue Heron (fannini subspecies)	Special Concern	Schedule-1	Blue
Band-tailed Pigeon	Special Concern	Schedule-1	Blue
Common Woodnymph (incana subspecies)	N/A	N/A	Red
Cutthroat Trout (clarkii subspecies)	N/A	N/A	Blue
Roosevelt Elk	N/A	N/A	Blue
Townsend's Big-eared Bat	N/A	N/A	Blue
Northern Pygmy-owl (swarthii subspecies)	N/A	N/A	Blue
* Watershed includes designated Critical Habitat			

***Table 2:** Endangered species located in the Morrison Creek Watershed*[4]

3 www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/conservation-data-centre/explore-cdc-data/known-locations-of-species-and-ecosystems-at-risk/cdc-imap-theme

4 ***Table Source:** Comox Valley Land Trust*

The MNAI team discussed the list above with the local expert advisory group, and a decision was taken to identify for the project a subset of species representing a broad array of taxonomic groups including a fish, a bird, a reptile, an amphibian, a mammal and an invertebrate. This was done primarily to keep the project manageable, within budget, and focussed on SAR most likely to be found in the project area and therefore most relevant.

Using professional judgement and local knowledge and research, the team first refined the list to the Morrison Creek Lamprey, the Barn Swallow, Little Brown Bat, and Common Wood-nymph. The team then added the Painted Turtle because Environment and Climate Change Canada (ECCC) has mapped CH for it through the Morrison Creek watershed. The team also added the Northern Red-legged Frog because it is used as a focal species in the City of Courtenay's Urban Forest Strategy, which links to their Official Community Plan.

Common Name	Scientific Name	Image
Western Brook Lamprey (Morrison Creek pop.)	Lampetra richardsoni pop. 1	
Barn Swallow	Hirundo rustica	
Little Brown Bat	Myotis lucifugus	
Common Wood-nymph	Cercyonis pegala ssp. incana	
Painted Turtle (Pacific Coast pop.)	Chrysemys picta pop. 1	

Common Name	Scientific Name	Image
Northern Red-legged Frog	Rana aurora	

Table 3: Final list of species referenced in the development of the pilot SAR tool

The local expert advisory group was essential to selecting priority species. They provided guidance on data and on 'downscaling' high-level understandings of species dispersal and behaviour including, for example, direct expert observations and data on the Red-legged Frog, which in turn made the project more focussed. They also assisted in dealing with scant and conflicting data relating to the Little Brown Bat. In this case, a decision was made regarding the type of data acceptable for the project purposes, specifically, identifying veteran trees and older age class stands instead of relying on LiDAR data.

MNAI consulted primary literature to gain an accurate local understanding of the Barn Swallow.

CONSIDERATIONS FOR FUTURE PROJECTS

Project leads should consider defining the project area and associated SAR in close collaboration with local experts as their advice is vital to ensure project focus and relevance. For example, some species may be federally or provincially listed but known to local experts - whose expertise may be considerably more detailed - to have limited local significance. It may be necessary to identify additional experts to ensure sufficient depth of knowledge of the area and the species.

Once the project area has been defined, a project boundary needs to be defined using Geographic Information System (GIS) software. Boundaries may correspond with political, watershed, sub-watershed areas, or other relevant land definition.[5] The boundary should be confirmed with the local experts.

5 *MNAI has determined that watershed boundaries, while more complex from an ownership and jurisdiction perspective, are typically the best unit at which to undertake natural asset management.*

The COSEWIC list of assessed species is a useful starting place to identify SAR in the project area as it is national in scope. This list can be supplemented with species identified at the provincial level. Once an overall list of SAR has been identified, it may be desirable from the perspectives of time, budget and relevance to narrow it to about six representative species. Criteria for doing so may include:

- CH is relevant to a priority local government service (e.g., stormwater management).
- Species are taxonomically diverse (a bird, a fish, a plant).
- Indicator species that are easily monitored.
- Umbrella species (i.e., located in more than one location in the study area).
- Important to ecosystem functions (e.g., the keystone species concept).
- Availability of data.

The perspective of at least one expert biologist or other expert with detailed local knowledge of SAR and CH is a likely essential starting point to prioritizing. Primary literature reviews may also be important.

STEP 3 Gather and process natural assets and SAR and CH data

The third step involved gathering and processing data for both the natural assets and the SAR and CH in the project area.

MORRISON CREEK WATERSHED PILOT PROJECT

Natural assets and related data

The table below identifies data sources that were used to delineate specific natural assets in the project area.

Data Set	Source	Purpose
Watershed Boundary	Morrison Creek Streamkeepers	To define project area for Morrison Creek Watershed pilot.
Land Cover	Agriculture and Agri-food Canada	To define the type and extent of natural assets within the project area.
Governance	Census Subdivision Boundaries, iMapBC	To identify land ownership and administration boundaries.
Watercourses	Municipality of Courtenay BC Open Data website	To identify major waterways in study area.
Building Footprints	Municipality of Courtenay BC Open Data website	To identify locations and extent of buildings in Morrison Creek Watershed.
Roads	BC Digital Roads Atlas, from iMap BC	To identify locations and extent of roads in Morrison Creek Watershed.
Topographic Base Map	ESRI Canada	To identify locations and extent of protected areas within Morrison Creek Watershed.
Parcel Data	iMapBC	To identify locations and extent of protected areas within Morrison Creek Watershed.

Table 4: Datasets used to map the natural assets within the Morrison Creek Watershed boundary

SAR and CH data

MNAI collected data on the location and extent of each species in the Morrison Creek Watershed. For the Morrison Creek Lamprey and Western Painted Turtle, MNAI used CH mapping from ECCC. For the remainder, primary literature was used to develop simple habitat models; one for each species. The habitat modelling parameters for each species were established using the same method as in the City of Courtenay Urban Forest Strategy and are presented below. These parameters were confirmed with the local expert advisory group.

NORTHERN RED-LEGGED FROG (RANA AURORA) HABITAT[6]

Connectivity Model Parameters	Red-Legged Frog
Median dispersal distance	100 m
Max dispersal distance	2.5 km
Min patch size	<0.1 ha
Land cover types	Mature moist forest
	Marshes ponds ditches springs stream banks
Migration	From breeding areas (wetlands) to upland (moist) forest areas as per dispersal distances above.
Dispersal road limited?	Yes
Dispersal water limited?	No

LITTLE BROWN BAT HABITAT[7]

Connectivity Model Parameters	Little Brown Bat
Median dispersal distance	1.5 km
Max dispersal distance	3.2 km
Min patch size	4 ha
Land cover types	**Foraging** - Wetlands and Lakes (preferred feeding areas) and small clearings (pasture, meadow, forest openings)
	Roosts - Veteran Trees/snags in decay classes 2-6 in second-growth forests, or large trees (decay class 2-6) in old-growth forests. Preferably Douglas-fir and NOT Cedar. Human structures (incl attics, under siding, sheds)
	Movement Corridors - Riparian corridors, trails, old roads (all with appropriate vegetation architecture), absence of tall shrubs under canopy
Migration	This species seasonally moves from over-wintering areas (hibernacula) to spring/summer/fall roosting and feeding areas. Dispersal to hibernacula not included here.
Dispersal road limited?	No
Dispersal water limited?	No

The 2018 federal recovery strategy includes CH mapping for the Little Brown Bat. Critical habitat for this species is currently defined as only including hibernacula. Due to data deficiencies and a desire to not publicise the known locations of hibernacula, CH is currently defined in the recovery strategy as

6 www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_red_legged_frog_e1.pdf

7 a100.gov.bc.ca/appsdata/acat/documents/r41093/01W09_Campbell_bats_1389824792126_9824261658.pdf; www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/recovery-strategies/little-brown-myotis-2018.html#toc10

a 50km x 50km UTM grid[8] in which known hibernacula occur. On Vancouver Island, there are four such grids of which one includes the Comox Valley, but is centred outside the project area. The recovery strategy suggests there is a desire to expand the definition of CH to include other habitat types that are used at other times of the year, but insufficient data limits the definition of CH at this time. The Comox Valley Land Trust is actively accumulating this habitat data through a 3-year research project and has expert insights and unpublished data supporting this assessment.

BARN SWALLOW HABITAT[9]

Connectivity Model Parameters	Barn Swallow
Median dispersal distance	400 m
Max dispersal distance	5,000 m
Min patch size	2 ha
Land cover types	**Nesting** - Barns and sheds: rural, agricultural
	Foraging - Agricultural, especially hayfields; wetlands, estuaries and riparian areas
Migration	This species is a neo-tropical migrant present in our area March/April to August/September. Dispersal distance to over-wintering habitat not included here.
Dispersal road limited?	No
Dispersal water limited?	No

8 UTM stands for Universal Transverse Mercator, a plane coordinate grid system consisting of 60 zones, each 6 degrees of longitude in width. The zones are numbered 1 to 60, beginning at 180-degrees longitude and increasing to the east. Source: www.usgs.gov/faqs/what-does-term-utm-mean-utm-better-or-more-accurate-latitudelongitude?qt-news_science_products=0#qt-news_science_products

9 https://doi.org/10.1111/j.1365-2664.2010.01873.x; Birds of British Columbia. Vol III. Passerines: Flycatchers through Vireos. UBC Press; Snapp, B. 1976. The Condor. Vol. 78, No. 4, pp. 471-480 (10 pages); and https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.104225/Hirundo_rustica

COMMON WOOD-NYMPH DISPERSAL[10]

Connectivity Model Parameters	Common Wood-nymph
Median dispersal distance	1 km
Max dispersal distance	5 km
Min patch size	50 ha
Land cover types	Old field
	Grass- and sedge-dominated communities
	Riparian woodlands
	Willow-dominated riparian shrub buffers
Dispersal road limited?	Yes
Dispersal water limited?	No

The Common Wood-nymph requires grasses and/or sedges as larval food plants. Adults access nectar on flowers and sap from willow shrubs and trees. Development, including roads, negatively affects their density and distribution.

CONSIDERATIONS FOR FUTURE PROJECTS

EXAMPLES OF FEDERAL AND PROVINCIAL DATA

British Columbia: Vegetation Resource Inventory (VRI) or Sensitive Ecosystem Inventory (SEI) may be available and appropriate for delineating natural assets.

Ontario: Ecosystem Land Classification (ELC) or Southern Ontario Land Resource Information System (SOLRIS) data may be appropriate.

For regions where provincial data lacks, the Agriculture and Agri-Food Canada (AAFC) dataset may prove useful.

If CH has been determined for a focal species at a scale that is meaningful to a natural asset management project, then it should be used. If it is not available, then determining habitat of each focal species through modelling will be required. Identifying the type, location and extent of relevant natural assets (e.g., forests, wetlands, riparian areas, shrublands, grasslands) in the project area is essential, as is the ability to depict this information spatially. Federal, provincial, municipal, third party reports/studies, and expert observation data can all be valuable in this connection. It would be important to work with local species experts to identify any key habitat attributes that are not normally considered as part of natural asset condition (such as veteran trees for bats, basking logs for turtles, etc.) and to consider this information as appropriate in step 5.

10 ***Klinkenberg, Brian. (Editor) 2019. E-Fauna BC:*** *Electronic Atlas of the Fauna of British Columbia [efauna.bc.ca]. Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver. [Accessed: 2020-05-26 10:14:21 AM]; Butterflies of BC (Guppy and Shepard); BC Status Report; iNaturalist occurence observations; Davros, N. et al. Butterflies and Continuous Conservation Reserve Program Filter Strips: Landscape Considerations. Wildlife Society Bulletin (1973-2006) Vol. 34, No. 4, Special Section: Farm Bill Contributions to Wildlife Conservation (Nov. 2006), pp. 936-943 (8 pages).*

A data hierarchy (giving priority to one dataset over another) may be useful for datasets that cover the same natural assets so it can be ranked according to age, type and quality. Data can then be integrated into a multi-attribute dataset according to the hierarchy.

Asset and sub-asset identification schemes for the natural assets may be helpful. For example, an asset class could be forest and a sub-class could differentiate between coniferous and deciduous forests.

Data deficiencies should be identified by considering both locations for which natural asset data is not available and where the quality and detail are in question. The project team, drawing on local experts as needed, can then fill the gaps. If gaps cannot be addressed, this must be acknowledged and the implications made clear.

Data on SAR presence and dispersal may be readily available; it may also be possible to identify existing SAR and habitat modelling for the project area and where it exists, integrate spatial outputs (e.g., maps showing the spatial distribution of the SAR and associated habitat) or recreate the outputs using GIS techniques.

Tabular SAR observation data may also be available for the project area; local experts can have an important role in determining this. To depict observation data spatially, it may be useful to determine their spatial attributes, transfer it to vector format, and integrate the information into the spatial layers for the project area.

Another approach is to use authoritative references to model the expected SAR habitat location and extent by identifying potential breeding and foraging areas, using published dispersal distances and minimum habitat patch sizes. Data to depict a SAR habitat spatially include:

- Median dispersal distance and maximum dispersal distance
- Minimum patch size
- Applicable/preferred natural asset types
- Road limitations to dispersal
- Water limitations to dispersal

Resulting GIS outputs can be assessed against observation data and confirmed with the community expert group. This was the approach MNAI took for some species in this pilot project.

STEP 4 Map natural assets in relation to SAR and their habitat/CH

This step involves mapping the type and extent of the natural assets within the project area in relation to the SAR and their habitat/CH. Areas of overlap between the natural assets and the SAR habitat/CH signify areas where management actions may benefit both natural assets and SAR.

MORRISON CREEK WATERSHED PILOT PROJECT

Mapping Natural Assets

MNAI used GIS to integrate datasets identified in Step 3 into a depiction of the project area, then delineated and quantified the type and extent of the various natural assets. The result is presented in Figure 5, which shows the location and extent of key natural assets within the Morrison Creek Watershed.

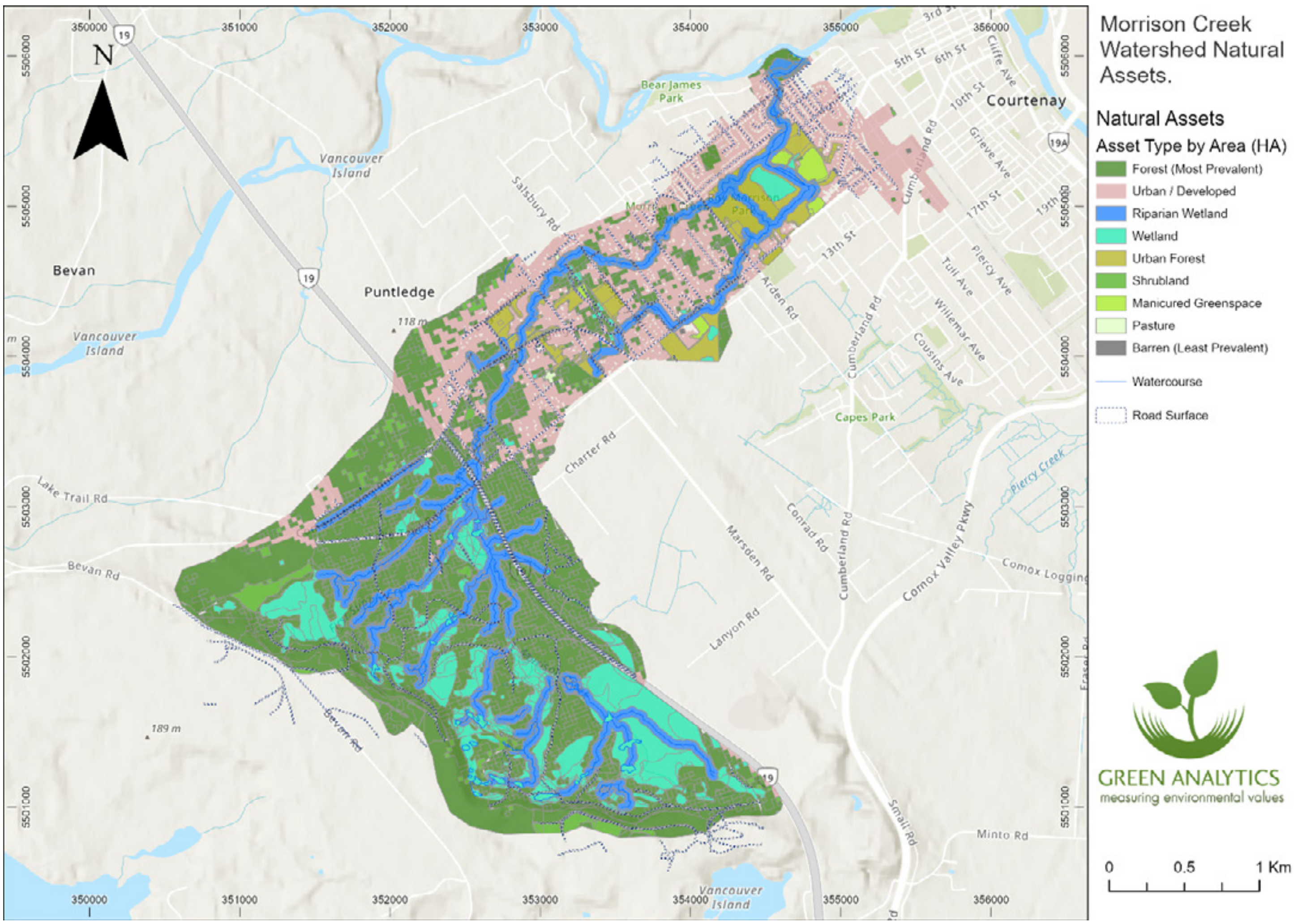

Figure 5: Natural assets within the Morrison Creek Watershed

Forests are the dominant natural assets and occupy over half of the natural asset area within the watershed. Wetlands and riparian wetlands are the next most prominent asset types at over 15 per cent and 19 per cent of the natural asset area, respectively. Table 5 is a tabular depiction of the natural assets in the watershed. The total area of the watershed (908 ha) occupied by natural assets is 700 ha.

Asset Type	Area (ha)	% of Natural Asset Area
Forest	385.8	55.1%
Manicured Greenspace	11.1	1.6%
Pasture	0.6	0.1%
Riparian Wetland	136.6	19.5%
Shrubland	19.6	2.8%
Urban Forest	37.0	5.3%
Wetland	109.3	15.6%
TOTAL	**700.1**	**100.0%**

Table 5*: Summary of natural assets by asset type in the Morrison Creek Watershed*

Mapping SAR habitat/CH

The maps below show the type of natural assets relevant to each of the six priority SAR, beginning with the Lamprey (Figure 6). The legend for each map shows the color associated with each of the SAR.

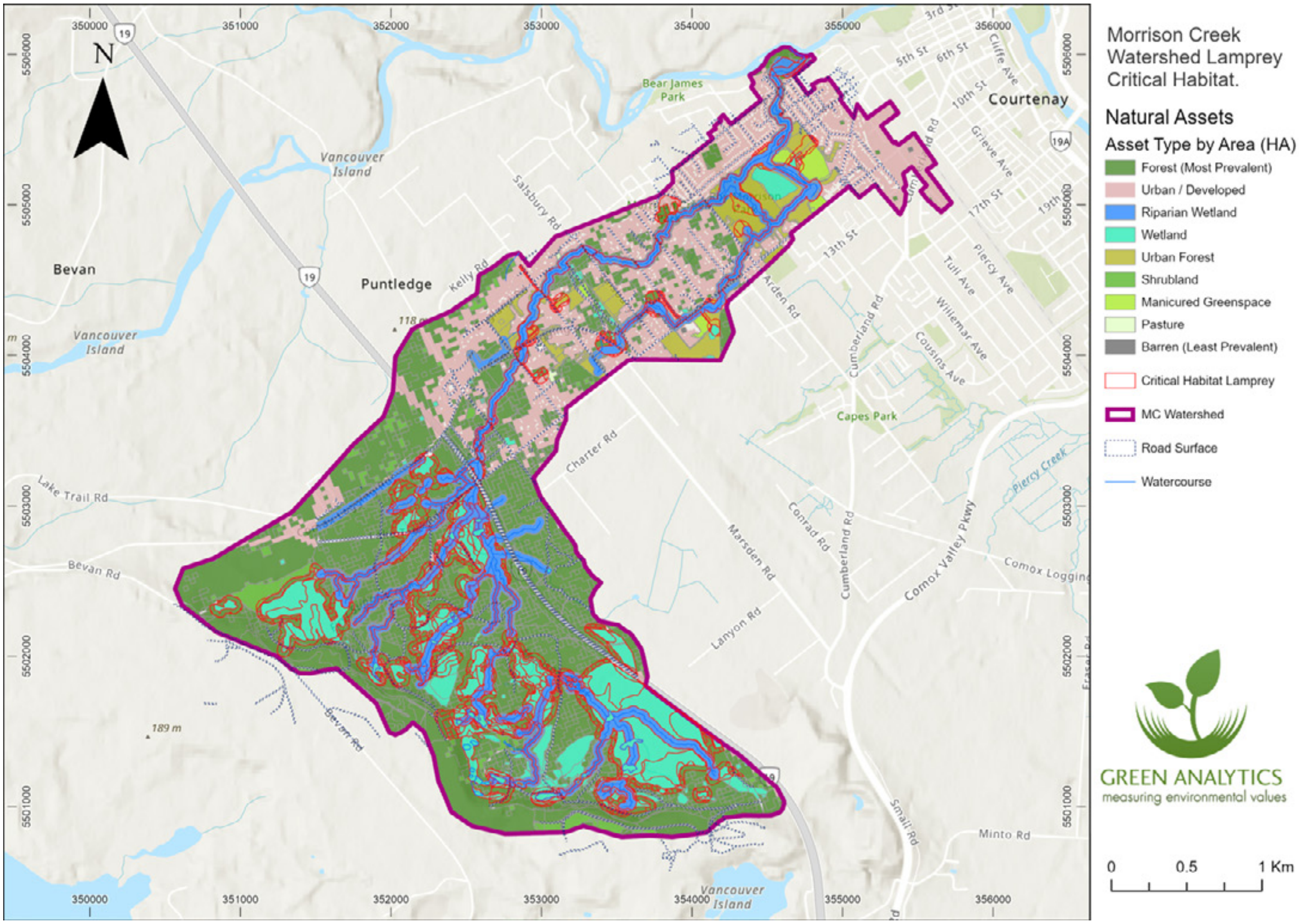

Figure 6: Morrison Creek Lamprey critical habitat within the Morrison Creek Watershed

Table 6 shows the breakdown of natural assets associated with the Morrison Creek Lamprey CH. The figures demonstrate a high reliance on forested, wetland and riparian assets.

Asset Type	Area (ha)	% of Natural Asset Area
Forest	50.7	22%
Manicured Greenspace	1.0	0%
Pasture	0.1	0%
Riparian Wetland	90.7	38%
Shrubland	0.6	0%
Urban Forest	4.9	2%
Wetland	88.0	37%
Total	**236.0**	**100%**

Table 6: Natural assets associated with Lamprey critical habitat

Figure 7 illustrates the CH for the Western Painted Turtle within the Morrison Creek Watershed.

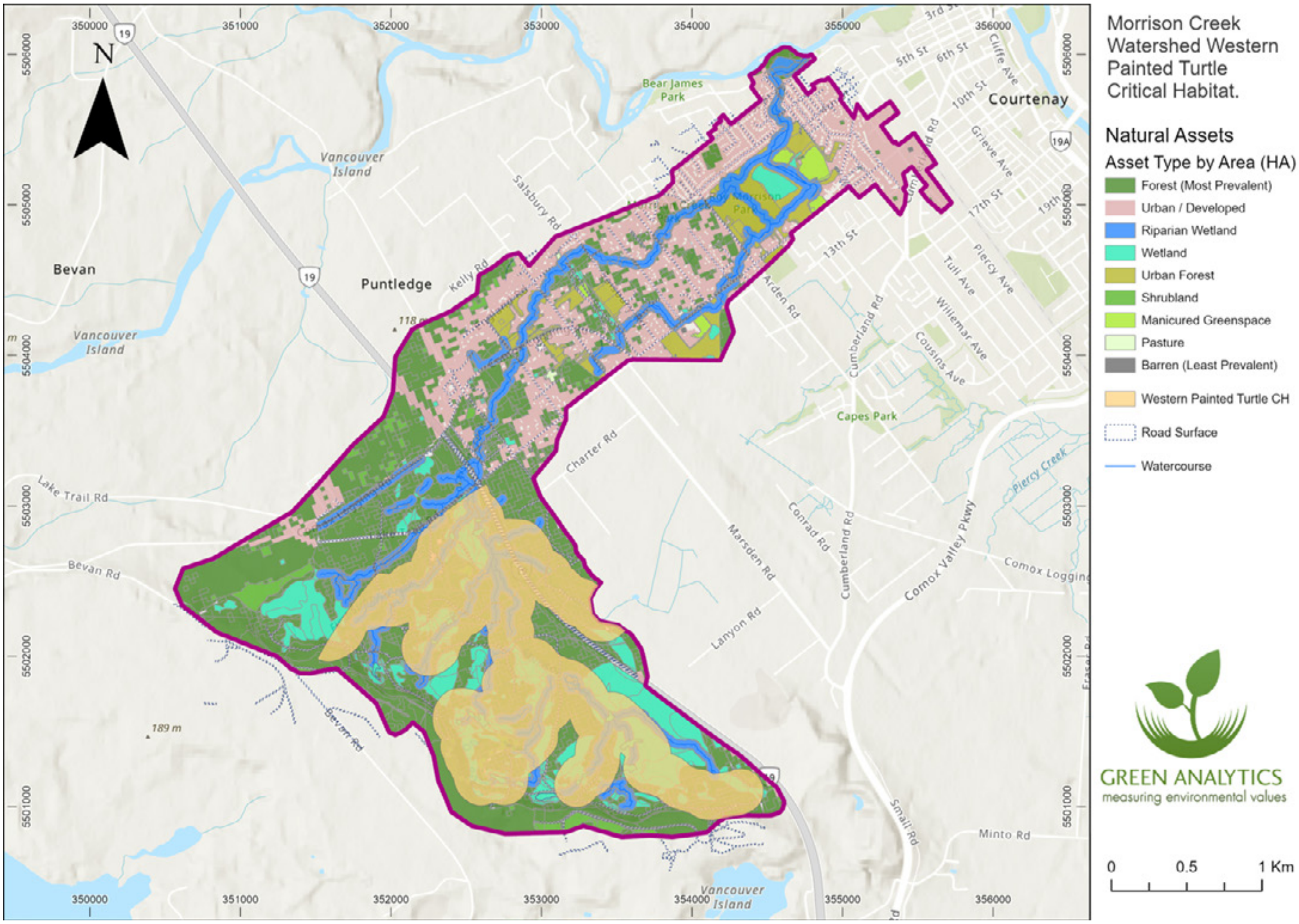

Figure 7: Western Painted Turtle critical habitat within the Morrison Creek Watershed

Table 7 shows the breakdown of natural assets associated with the Western Painted Turtle CH. The figures demonstrate a high reliance on forested, wetland and riparian wetland assets.

Asset Type	Area (ha)	% of Natural Asset Area
Forest	125.5	52%
Riparian Wetland	54.6	23%
Shrubland	2.7	1%
Urban / Developed		0%
Wetland	57.5	24%
Total	**240.3**	**100%**

Table 7: Natural assets associated with Western Painted Turtle critical habitat

Figure 8 illustrates the habitat[11] for the Red-legged Frog within the Morrison Creek Watershed.

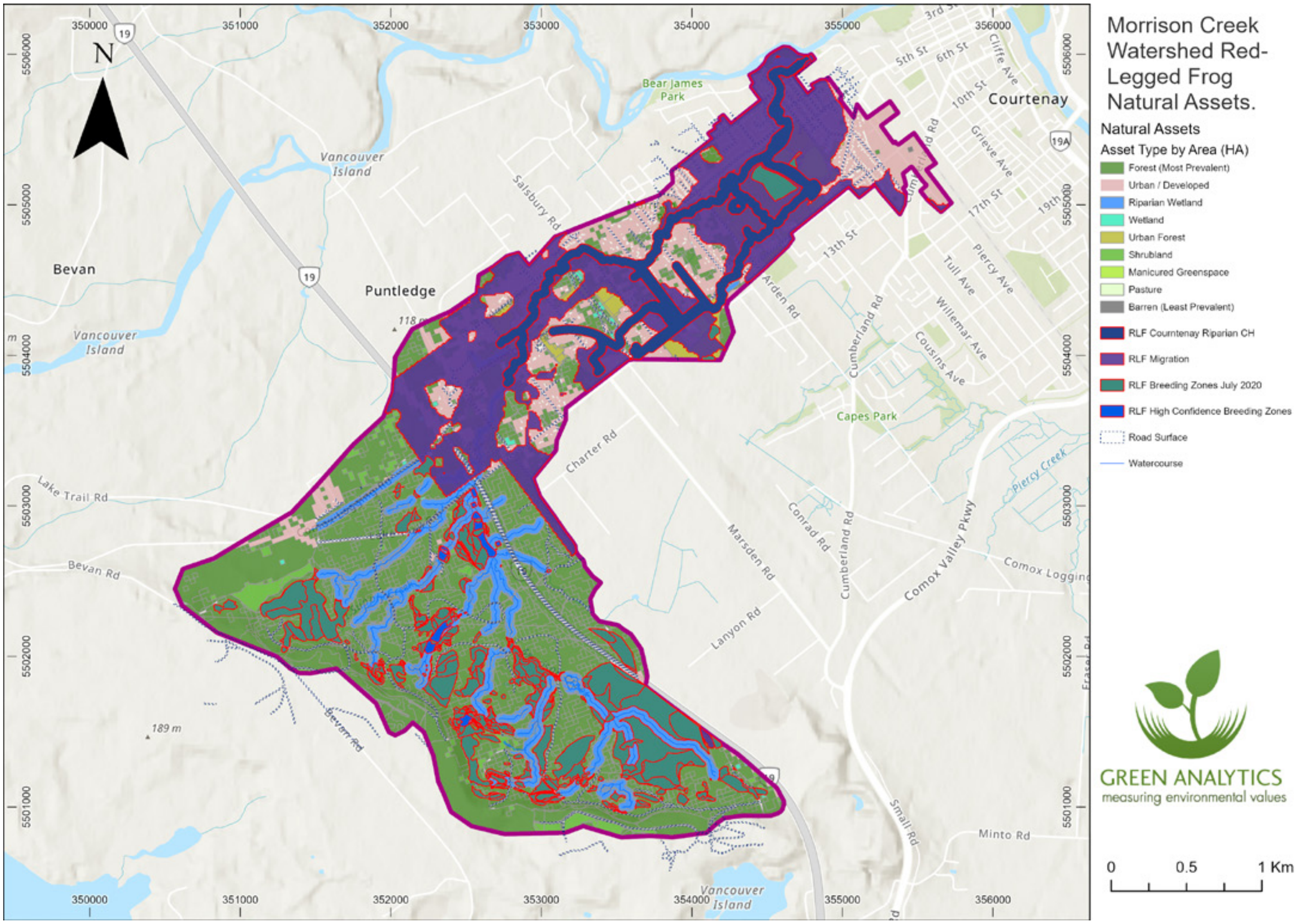

Figure 8: Northern Red-legged Frog habitat within the Morrison Creek Watershed

11 Critical habitat, a legal designation, has not been designated for the Red-legged Frog within the Morrison Creek Watershed and therefore the term "habitat" is used here.

Table 8 shows the breakdown of natural assets associated with the Red-legged Frog habitat. The figures demonstrate a high reliance on forested, wetland and riparian wetland assets.

Asset Type	Area (ha)	% of Natural Asset Area
Forest	54.5	21%
Manicured Greenspace	11.0	4%
Pasture	0.4	0%
Riparian Wetland	57.8	22%
Shrubland	2.2	1%
Urban Forest	29.4	11%
Wetland	107.6	41%
Total	**262.8**	**100%**

Table 8: *Natural assets associated with Red-legged Frog habitat*

Figure 9 illustrates the habitat for the Little Brown Bat within the Morrison Creek Watershed.

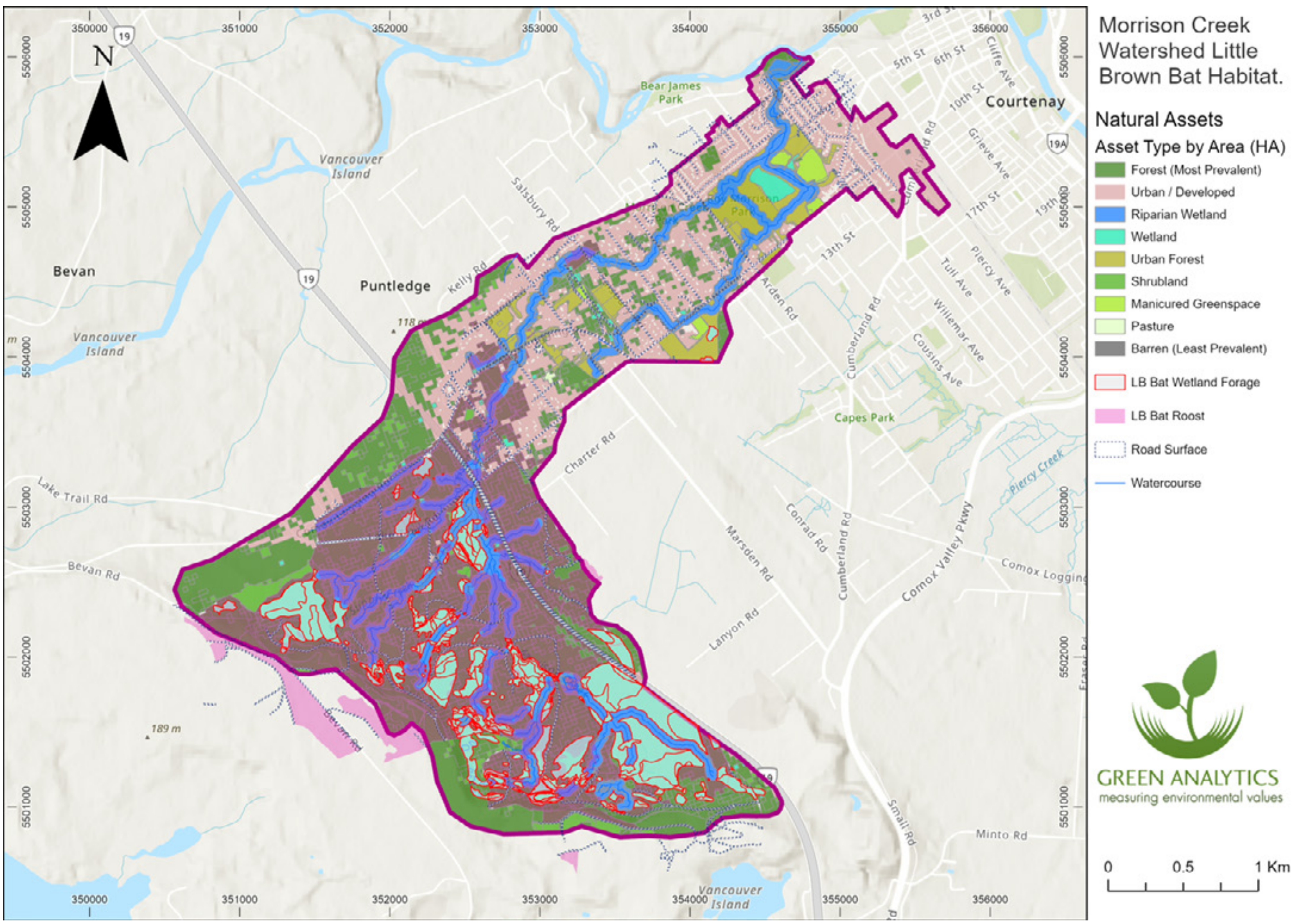

Figure 9: *Little Brown Bat habitat within the Morrison Creek Watershed*

Table 9 shows the breakdown of natural assets associated with the Little Brown Bat habitat. The figures demonstrate a high reliance on forested assets.

Asset Type	Area (ha)	% of Natural Asset Area
Forest	231.6	59%
Riparian Wetland	56.5	14%
Wetland	103.0	26%
Total	**391.1**	**100%**

Table 9: *Natural assets associated with Little Brown Bat habitat*

Figure 10 illustrates the habitat for the Barn Swallow within the Morrison Creek Watershed.

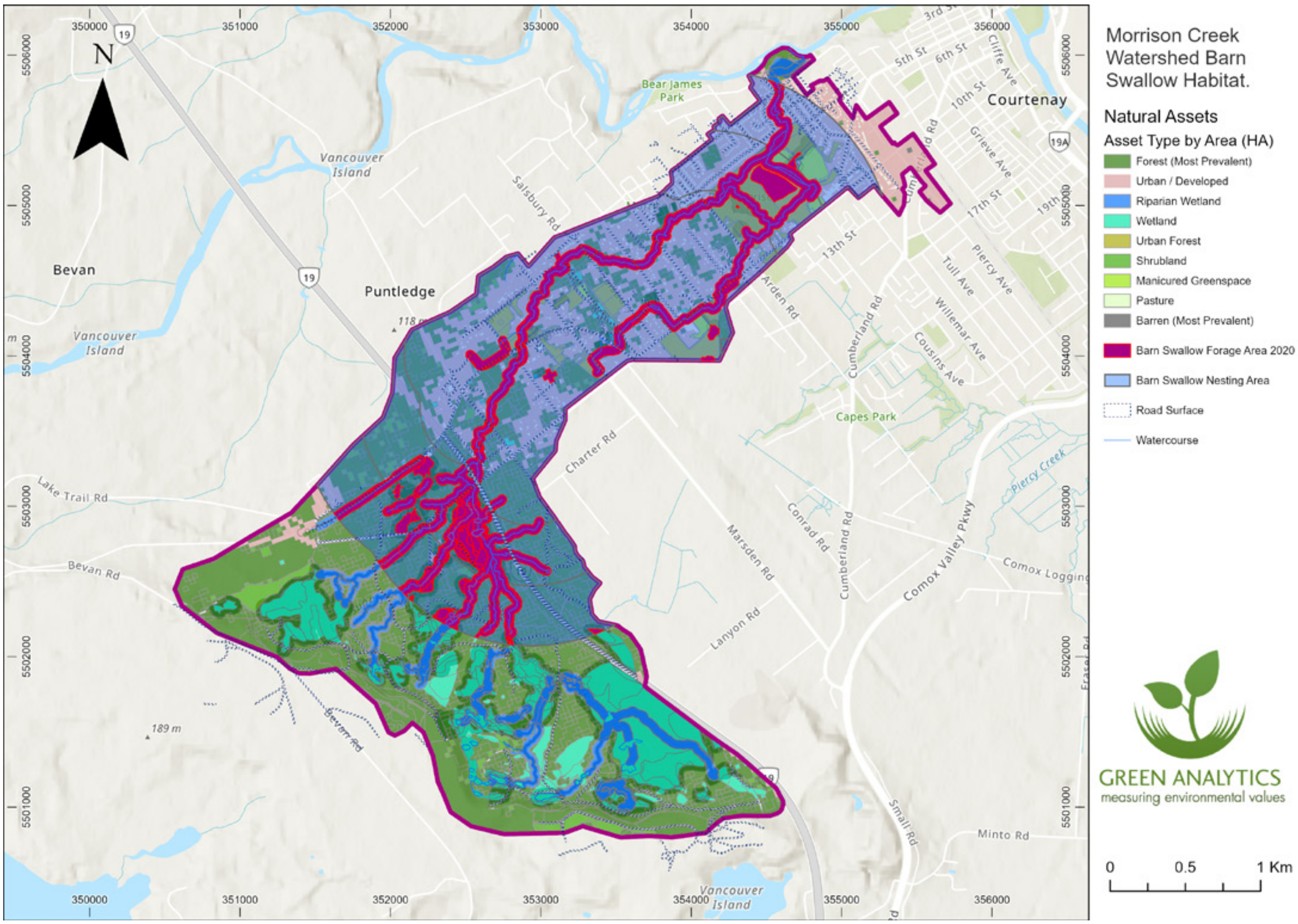

Figure 10: *Barn Swallow habitat within the Morrison Creek Watershed*

Table 10 shows the breakdown of natural assets associated with the Barn Swallow habitat. The figures demonstrate a high reliance on forested assets.

Asset Type	Area (ha)	% of Natural Asset Area
Forest	179.5	53%
Manicured Greenspace	11.1	3%
Pasture	0.6	0%
Riparian Wetland	86.5	26%
Shrubland	6.3	2%
Urban Forest	37.0	11%
Wetland	17.3	5%
Total	**338.4**	**100%**

Table 10: *Natural assets associated with Barn Swallow habitat*

Figure 11 illustrates the habitat for the Common Wood-nymph within the Morrison Creek Watershed. In this case, three likelihood levels are demonstrated for the habitat. These reflect the range of uncertainty associated with the habitat for the Common Wood-nymph within the Morrison Creek Watershed.

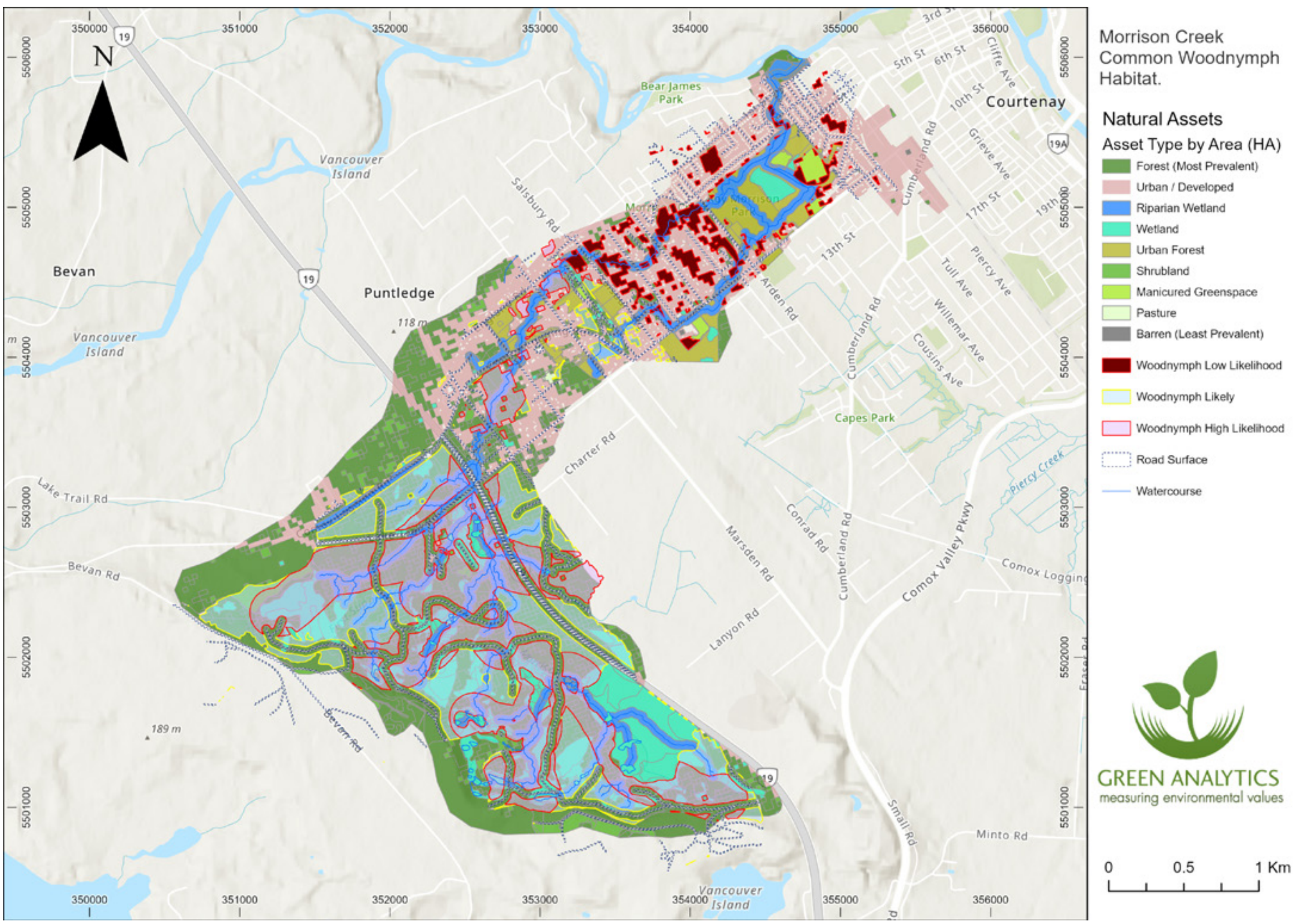

Figure 11: *Common Wood-nymph habitat within the Morrison Creek Watershed*

Table 11 shows the breakdown of natural assets associated with the Common Wood-nymph habitat by likelihood level. The figures demonstrate a high reliance on forested assets across all likelihood levels.

	Low Likelihood		Likely		High Likelihood	
Asset Type	**Area (ha)**	**% of Area**	**Area (ha)**	**% of Area**	**Area (ha)**	**% of Area**
Forest	13.0	63%	72.7	62%	90.7	53%
Manicured Greenspace	1.2	6%	19.3	16%	42.1	25%
Riparian Wetland	6.4	31%	2.2	2%	3.0	2%
Wetland			23.9	20%	34.5	20%
Total	**20.6**	**100%**	**118.0**	**100%**	**170.4**	**100%**

***Table 11**: Natural assets associated with Common Wood-nymph habitat*

CONSIDERATIONS FOR FUTURE PROJECTS

This step is primarily about data integration and analysis and requires significant involvement from a GIS analyst. It flows directly from the preceding steps in that it is about using GIS to integrate data sets identified in Step 3 within project boundaries, and then overlaying this with spatial representations of species habitat. Provided the data from previous steps are sound, this should be relatively straightforward for a GIS analyst.

A degree of judgement may be required in determining which natural assets or natural asset subsets to depict, as these may vary with the local government services that are of interest. For example, natural assets that provide stormwater management may be distinct from those that provide recreation services. This underscores the importance of having local government experts engaged in the project.

STEP 5 Complete a condition assessment for natural assets in the project area

Assessing the condition of natural assets in the project area is essential. Natural asset condition influences their ability to provide local government services, resiliency to threats, and habitat that is suitable for SAR. A condition assessment thus provides valuable information on how well natural assets function in relation to their ability to provide specific services. A baseline condition assessment can also be used to assess changes in the level of service provision that result from impacts or interventions that may either improve or degrade asset conditions. Condition assessments can be done with differing levels of detail from desktop reviews, to reviews of past studies, to field observations, and combinations thereof.

MORRISON CREEK WATERSHED PILOT PROJECT

A pilot condition assessment approach was developed for this project that can be modified for other areas. The pilot approach relied heavily on Ballin et al. (2017), who identified and categorized wetland and riparian habitats as either degraded or intact in the Puntledge River watershed of which Morrison Creek is a tributary. This approach is described below. Their work reflects orthophoto interpretation current to 2014 and includes a road density layer and 2017 update of Comox Valley Conservation Partnership (CVCP) data from Landsat analysis on forest harvesting. To supplement the results from the Ballin et al. (2017) report, the Province of British Columbia's vegetation resources inventory data, and LiDAR data gathered on behalf of the CVRD in 2018, was also used.

Assessing riparian areas and wetlands condition

Ballin et al. (2017) classify riparian areas and wetlands as either Category 1 (intact) or Category 2 (degraded) based on intersections between riparian areas and wetlands and development layers in GIS.

"Development layers" in this context includes urban and agricultural land cover, roads, and recently harvested areas, with "recently harvested" meaning anything less than 25 years old. Project Watershed, through the CVCP, completed the "recently harvested" data layer based on Landsat and other remotely sensed data from 1992-2013 and then updated in Ballin et al. (2017).

The assumption that riparian areas and wetlands occurring within young forests (>25-80 years) have hydrologically recovered following a disturbance (e.g., forest harvesting) may be untrue in some cases as, historically, logging practices did not always take account of riparian or wetland health and some legacy challenges may remain. However, some attributes of watershed health, including those identified in a Riparian Proper Functioning Condition Assessment[12], do recover over time.

Assessing the condition of soil

The infiltration of precipitation and the downslope movement of water through soils (interflow) to receiving surface water is a key hydrological process significantly affecting peak-flows and base-flows. Roads and associated ditches and culverts can significantly affect the interflow process. The density of roads in a given area can be useful as a measure of such impairment to soil interflow processes. Road density is often included as an indicator of hydrologic impairment in watershed assessments. It was the approach selected for this pilot.

12 A PFC assessment is a tool to gauge riparian area function and its trajectory towards improved or diminished function. See for example www.blm.gov/programs/natural-resources/wetlands-and-riparian/riparian-health

As a default approach for completing a condition assessment, road density thresholds can be obtained from watershed assessments elsewhere; in the context of this specific area, MNAI used those for Northeast Vancouver Island established by the Forest and Range Evaluation Program (thresholds for elsewhere in Canada would be different from those employed here).[13]

Assessing the condition of forests

Forest condition can be assessed using a measure of the equivalent clear-cut area (ECA). This approach is derived from the Forest Practices Code for British Columbia from 1999 and was selected for this pilot.[14] ECA measures hydrological risk from anthropogenic forest disturbance activities. ECA considers the relative proportion of a watershed that has been harvested, taking into consideration the area that has "recovered" in hydrological terms through forest regeneration over time. It can be considered for areas above and below an 800m threshold in elevation. In coastal British Columbia, the 800m threshold delineates the snowpack zone (this delineation would vary by location). Above 800m, the role of forest cover is more pronounced in retaining sub-canopy snow for slowly releasing meltwater and avoiding rapid melting in forest openings (e.g., clearcuts) that increase peak flows in the spring. Below 800m, the condition assessment can be applied at the sub-basin scale.

Thresholds for ranking condition

It is important to identify specific condition rankings that can then be integrated into GIS layers. Table 12 shows source data, condition variables and condition thresholds used to inform condition assessment rankings (high, medium, low) for riparian areas, wetlands, soils and forests, and how high (good condition), medium and low (poor condition) rankings were established. These thresholds were employed in the Morrison Creek Watershed pilot project.

Asset	Inventory Data Source	Condition variable	Condition Threshold		
			H	M	L
Riparian areas and Wetlands	Ballin et al. (2017)	Category 1/2	1	nil	2
Soils	Ballin et al. (2017)	Road Density (km/km^2)	<1	1.0 – 2.0	>2
Forests	Ballin et al. (2017)	ECA/Sub-basin	<15%	15 – 30%	>30%

Table 12: Condition assessment sources, variables and thresholds.

13 A Province of BC program to support sustainable management of BC's forest and range resources under the Forest and Range Practices Act by monitoring and evaluating the condition of resource values and effectiveness of resource practices.

14 British Columbia, Ministry of Forests, Forest Practices Code of British Columbia, Coastal Watershed Assessment Procedure Guidebook (CWAP), Interior Watershed Assessment Procedure Guidebook (IWAP), Second edition, Version 2.1, April 1999.

Figure 12 depicts condition assessment results for the Morrison Creek Watershed project area as spatial data. Condition assessment results are not available for the entire watershed boundary due to data gaps; these are represented as blank spaces within the project boundary.

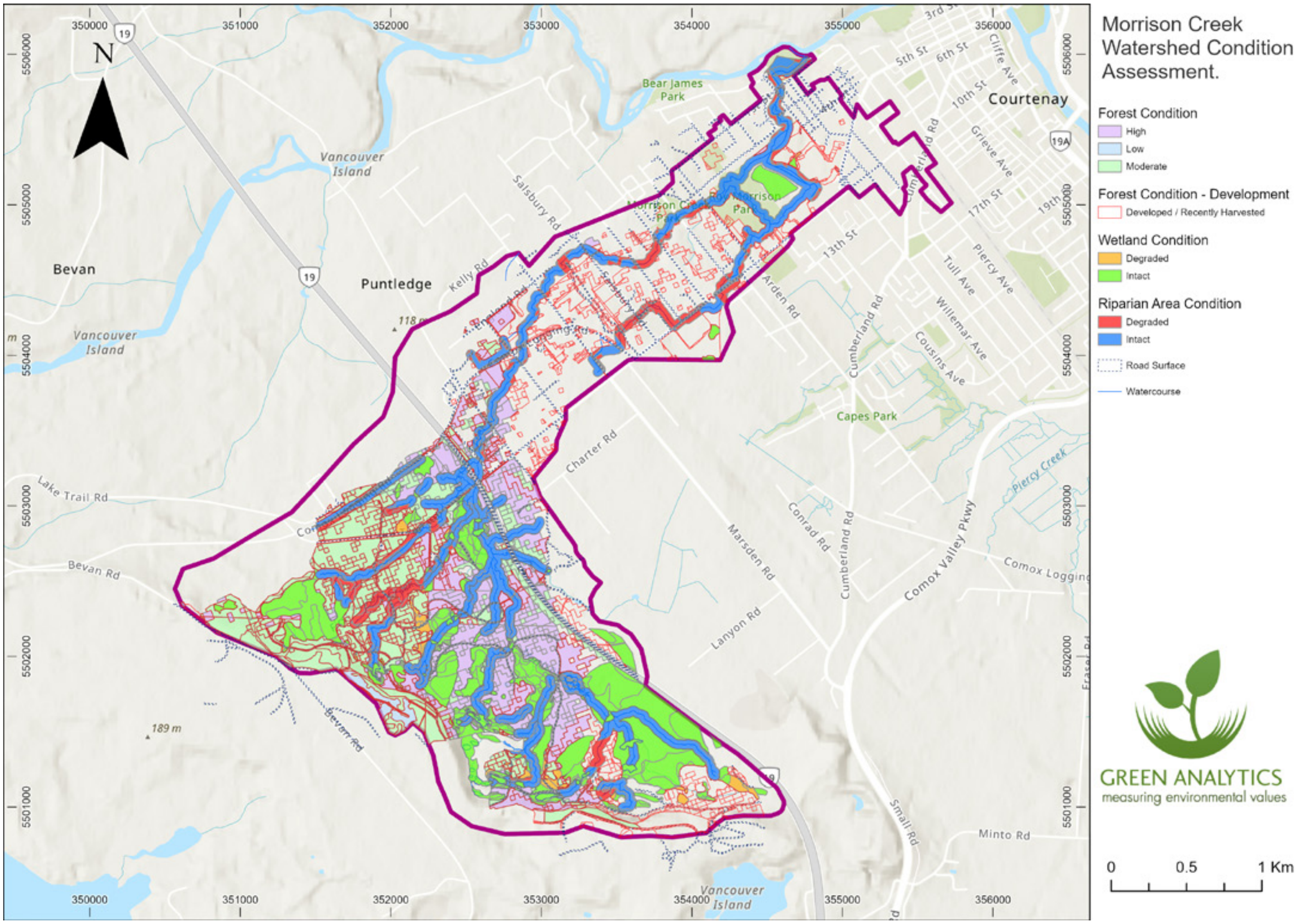

Figure 12: Morrison Creek Watershed condition assessment results

The results indicate that the majority of the forest condition ranks as high and moderate condition. There is a small area of low condition forests along the western boundary of the watershed. Of the area for which condition results were generated, approximately 188 ha of land is designated as developed or recently harvested. A total of 28 ha of riparian areas were identified as degraded, and 108 ha as intact. Just over 100 ha of wetlands were identified as intact, while 6 ha of wetlands were identified as degraded.

CONSIDERATIONS FOR FUTURE PROJECTS

It is vital to develop a holistic understanding and representation of natural asset health. As noted, this can be done at varying levels of detail according to project budget and scope.

A point of emphasis in this project that would be important in other locations is that natural asset health must be understood both in terms of its ability to provide local government services and its underlying ecological health and resilience. To illustrate, a wetland that functionally stores floodwater and is thus useful to a local government but which is unhealthy with respect to ecosystem structure, composition, connectivity or biodiversity, cannot reasonably be considered 'healthy.' Therefore, principles of ecological function, diversity, and connectivity should be integrated into an understanding of natural asset condition alongside its narrower ability to provide a given service.

NATURESERVE CONDITION STANDARD

The not-for-profit NatureServe provides a standard commonly used in North America to understand natural asset condition. It states that condition is a qualitative measure of the biotic and abiotic factors, structures, and processes within an Element Occurrence (EO), and the degree to which they affect its continued existence.

Components of this EO rank factor are:

7/ Reproduction and health (for species) - evidence of regular, successful reproduction; age distribution for long-lived species; persistence of clones; vigor, evidence of disease affecting reproduction/survival;

8/ Development/maturity (for communities) - stability, old-growth;

9/ Ecological processes - degree of disturbance by logging, grazing; changes in hydrology or natural fire regime;

10/ Species composition and biological structure - richness, evenness of species distribution, presence of exotics;

11/ Abiotic physical/chemical factors - stability of substrate, physical structure, water quality (excluding processes).

Source: www.natureserve.org

There is, as yet, no standard approach for assessing natural assets according to both local government service delivery and underlying ecological health and resilience. However, there are accepted approaches for assessing natural assets only for the latter (i.e., ecological health distinct from ability to provide local government services) as depicted in the box, *NatureServe condition standard*.

While condition assessment specifics may vary according to data availability, these approaches can be used as a basis for determining asset health.

Furthermore, the pilot approach could be replaced or supplemented by results from existing condition assessments that may be available for a project area; here, the advice of community experts would be valuable.

Ultimately, and with further experience, a norm or standard for integrated condition assessments relevant to both SAR and CH *and* local government service delivery may be warranted. Upon completion of the condition assessment, discussion with local experts may be useful to test and / or obtain feedback on results. Data gaps can be identified and discussed at that time.

STEP 6 Develop a comprehensive list of potential management actions

Step 6 involves identifying management actions that have the potential to benefit both SAR and natural assets.

MORRISON CREEK WATERSHED PILOT PROJECT

Upon completion of the natural asset condition assessment, MNAI identified potential natural asset management actions, which are defined broadly as the strategic, legal, financial, program or other measures that could benefit both local government service delivery and SAR. This list is in Annex.

As a starting point in the pilot project, the local expert advisory group members were asked to review the list and identify potential actions in several categories, including:

- Government education/capacity
- Strategy, bylaw, policy
- Programs, financing, investments and operations
- External engagement, awareness and partnerships

This resulted in a comprehensive list of possible actions deemed to be locally relevant. Then, for each action, the local expert advisory group members identified how the action linked to SAR and how it linked to natural asset management.

CONSIDERATIONS FOR FUTURE PROJECTS

This step provides the basis for developing priority scenarios to explore in detail (Step 7). Engaging the expert advisory group in the identification of management actions ensures the local relevance of identified actions.

STEP 7 Develop priority scenarios to explore in detail

This step involves reducing the comprehensive list developed in Step 6 to a set of priority actions that will be the focus of the scenario analysis, the final step.

MORRISON CREEK WATERSHED PILOT PROJECT

The comprehensive list of management actions was assessed to determine the most prevalent survey responses, to identify what could feasibly be modelled using GIS, to consider current policy trends and community directions, and to determine for which actions data was available to support analysis. This resulted in the selection of three priorities for scenario analysis:

1/ A property tax incentive to protect 30-metre buffers around intact riparian areas.

2/ Land acquisition for particularly high-condition assets.

3/ Environmental development permit area guidelines (EDPA guidelines)[15] regulations requiring restorative re-development of low-condition assets.

These were presented to the local expert advisory group along with a proposal for how to model them in Step 8; they received confirmation as being relevant and worth pursuing.

CONSIDERATIONS FOR FUTURE PROJECTS

Criteria to support prioritization can include:

- The ability to spatially model the application of the management action/scenario
- The availability of data and information to support an analysis of the costs and benefits of the actions
- Condition assessment results
- Common themes in the results of the survey of potential actions

Identified priority management actions should be vetted with community experts to ensure relevance and support.

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15 *Under the Local Government Act, B.C. local governments may designate areas of land as development permit areas in order to achieve a number of different community goals, such as the form and character of development or the protection of the natural environment, its ecosystems and biological diversity. Lands so designated allow the local government to impose requirements for development of those lands. It is important to note that development permit area requirements are triggered only when a development proposal is made for land alteration, subdivision, and new construction or substantial additions to existing structure and local governments also provide exemptions. www2.gov.bc.ca/gov/content/governments/local-governments/planning-land-use/land-use-regulation/development-permit-areas*

STEP 8 Developing and analyzing scenarios for priority actions

The final step is developing and analyzing scenarios for each management option selected in Step 7. The details of the analysis will depend on the management actions under consideration and local priorities. In the Morrison Creek Watershed pilot project, the objective of the scenarios was to estimate the *cost of management actions in relation to the benefit of the stormwater services provided by the natural assets and the benefits associated with SAR*.

Ideally, a valuation of the benefits of species at risk and critical habitat would involve detailed ecological and economic studies for each service provided; however, undertaking such studies is expensive and time consuming. As such, MNAI employed the benefit transfer approach to evaluate non-market SAR services. This was achieved by transferring a benefit estimate from a peer-reviewed, North American study to ensure a similar demographic and ecosystem[16]. Like any economic analysis, this methodology has strengths and weaknesses, although these limitations should not detract from the core finding that species at risk and critical habitat produce a significant economic value to society.

MORRISON CREEK WATERSHED PILOT PROJECT

Overall, the scenario analysis and development involved the following:

1/ Identify spatial areas to which the management actions will be targeted.

2/ Measure in hectares the area subject to each management action.

3/ Estimate the value of the ecosystem service (in this case stormwater management) provided by the natural assets within the target areas.

4/ Estimate 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/ Estimate the benefit of the SAR 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 (value of service provision as well as value of SAR in relation to cost of action).

The steps involved with analyzing these management scenarios are described below.

16 Farber et al., 2006.

SCENARIO 1: PROPERTY TAX INCENTIVE TO PROTECT 30-METRE BUFFERS AROUND INTACT RIPARIAN AREAS

To estimate the spatial area targeted by this action, a 30-metre buffer was designated in GIS around riparian areas within the project area. Then, the total area within the buffer, by land cover type, was calculated. Riparian areas already protected were excluded, as were areas identified for land acquisition (Scenario 2) and for EDPA (**Scenario 3**). The resulting 30-metre buffer area is depicted below.

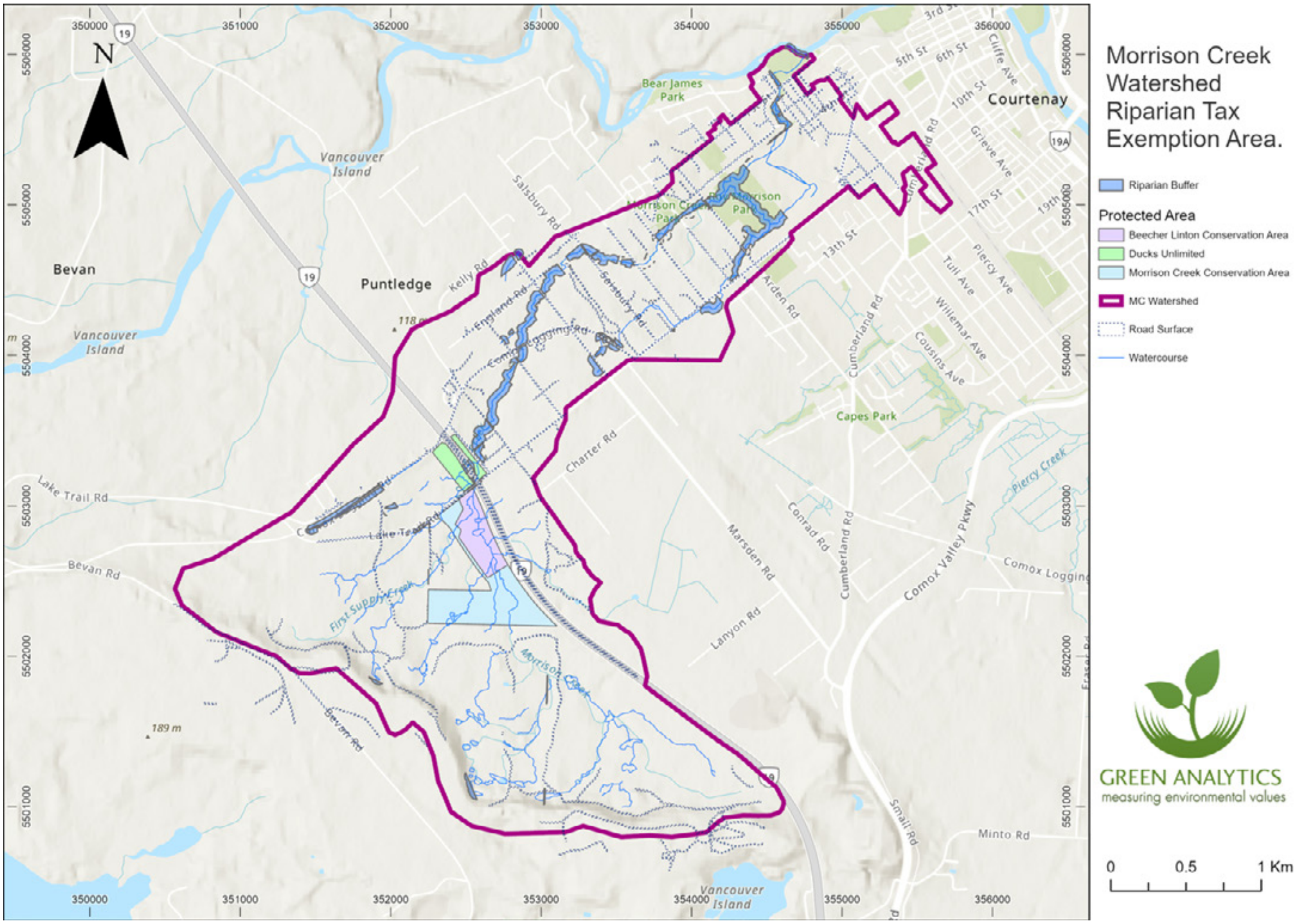

Figure 13: Riparian buffer (30m) around watercourses in the Morrison Creek Watershed, excluding land captured in Scenarios 2 and 3

Then, the costs and benefits of this management scenario were calculated. The cost of this management action was calculated as: (i) the 'landowner program', which includes the development of information on the incentive to property owners and local government websites, and working with the property owner(s) to develop the required covenant (ii) covenant review, which includes time for the relevant land trust and local government to review the covenant language and legal costs to finalize and register covenants (iii) covenant monitoring from a land trust, and (iv) administrative and legal costs (e.g., land surveys and appraisals. MNAI did not include forgone tax revenue from land protected within the 30-metre buffer as this was deemed negligible based on similar initiatives in the Islands Trust area. The present value of the costs was calculated over a 30-year period assuming discount rates of 2 per cent and 5 per cent. The present value of the cost of the riparian tax incentive scenario was estimated at $212,958 assuming a 2 per cent discount rate, and $165,338 assuming a 5 per cent discount rate.

The *benefit* of this management action is the value of stormwater services provided by the area within the buffer. For the purposes of this project, stormwater service value was calculated by applying dollar/ha estimates for stormwater services by landcover type to the area of the land cover types present within the 30-metre buffer.

It is important to note that each hectare of natural assets can have a very different contribution to stormwater management based on biophysical and geographical features. For the purposes of this project, average estimates derived from a literature review and existing MNAI research were used. These provide order of magnitude relationships between natural assets and stormwater management; detailed stormwater modelling and valuation would provide more precise and rigorous results.

The estimates for this scenario relied in particular on Saini et al. (2018), who estimated the stormwater capacity of natural assets in Ontario's Peel Region. Saini et al. (2018) relied on replacement cost values of $175/m^3 for stormwater, assuming wetlands, forests and open spaces are replaced by *detention ponds*, using as a basis work in the Town of Gibsons, B.C.; and, $460/m^3 replacement costs of stormwater, assuming isolated wetlands are replaced by an *infiltration chamber*. The latter was assessed via the *Low Impact Development Lifecycle Costing Tool*.[17] These figures were then converted to values/ha, which in turn were converted to annual amounts by amortizing the amounts over the effective life of detention ponds or infiltration chambers (Table 13). The dollar/ha/year values were assigned to the area within the riparian buffer to estimate the stormwater service associated with the natural assets within that area.

Asset Type	Per Hectare	Hectare / Year
Forests	$61,425	$1,755
Open Green Spaces	$22,050	$630
Wetlands		
Palustrine	$43,050	$1,230
Isolated	$81,213	$10,828
Riverine	$3,850	$110

Table 13: *Stormwater Capacity Values*

17 sustainabletechnologies.ca/lid-lcct/

Considering these benefits in light of the cost of the management action results in a net present value for the riparian buffer scenario of $330,345 at a 2 per cent discount rate and $244,750 at a 5 per cent discount rate. The resulting benefit-cost ratio for the acquisition scenario is 11:20.

The results presented above do not account for benefits associated with the SAR. To estimate the value of this service, a dollar/person estimate for SAR was assigned to the population surrounding the Morrison Creek Watershed. MNAI obtained this value from a recent 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 $33/person.[18] Applying this value to the population aged 20 and up within the watershed results in a value of $10,372 per year. MNAI then scaled this value to the percentage of the watershed involved in this study to arrive at an annual value of $859. Over a 30-year time period at a discount rate of 2 per cent, the present value of the SAR benefit is $19,049. Over a 30-year time period at a discount rate of 5 per cent, the present value of the SAR benefit is $12,887.

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 options suited to the ecosystems of eastern Canada. MNAI did not consider ecological communities in this project or recognize differing ecosystems, but MNAI 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.

Adding this benefit to the stormwater services provided by the assets within the riparian buffer area results in a net present value for the riparian buffer scenario of $349,394 and a benefit-cost ratio of 16:25, assuming a 2 per cent discount rate over 30 years. At a 5 per cent discount rate, the net present value of this scenario is $257,637 and the benefit-cost ratio is 5.6E+15: 1.0E+16..

18 Camaclang et al., 2020.

Figure 14 depicts the distribution of costs and benefits over the 30-year period for tax incentive option.

OPTION 1: RIPARIAN TAX INCENTIVE

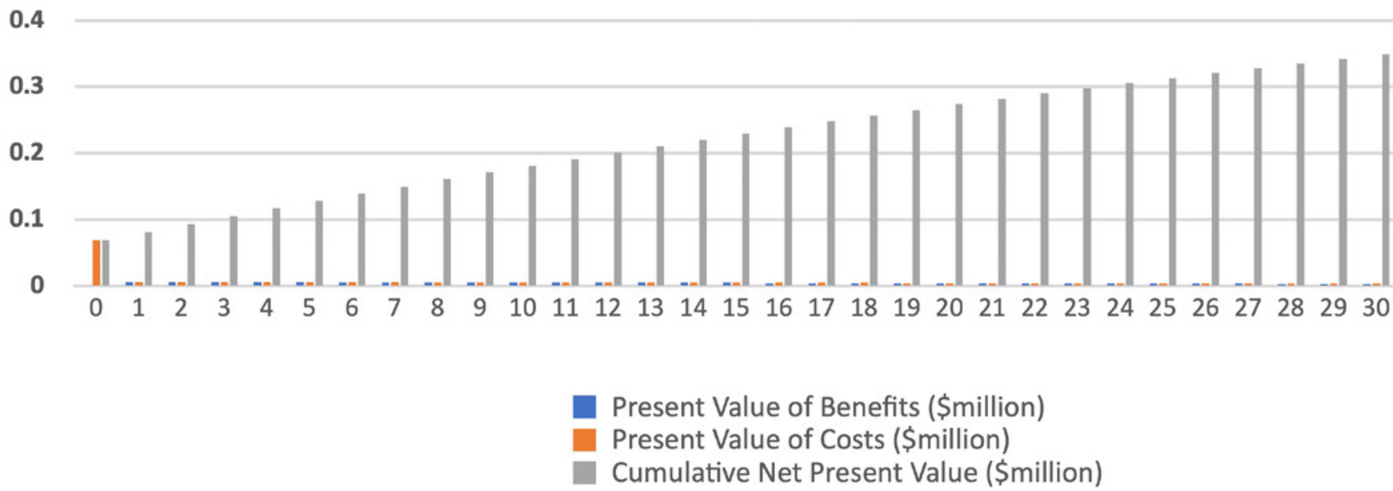

Figure 14*: Distribution of costs and benefits over the 30-year period for tax incentive option.*

The results of this option assume 100 per cent of identified property owners take advantage of the tax incentive. Future refinements could involve phasing in participation in the incentive (e.g., 25 per cent, 50 per cent, 75 per cent) to determine the viability and success of this option should participation be less than full.

SCENARIO 2: LAND ACQUISITION

The second management scenario explored in the context of Morrison Creek relates to land acquisition. As with the tax incentive scenario, the first step was to select land for acquisition and hence protection. This was done by obtaining a spatial boundary of land within the headwaters of the Morrison Creek Watershed that local conservation groups have identified as a priority for purchase. The area within the acquisition boundary was calculated and delineated by land cover type. Figure 15 illustrates the location of the acquisition boundary.

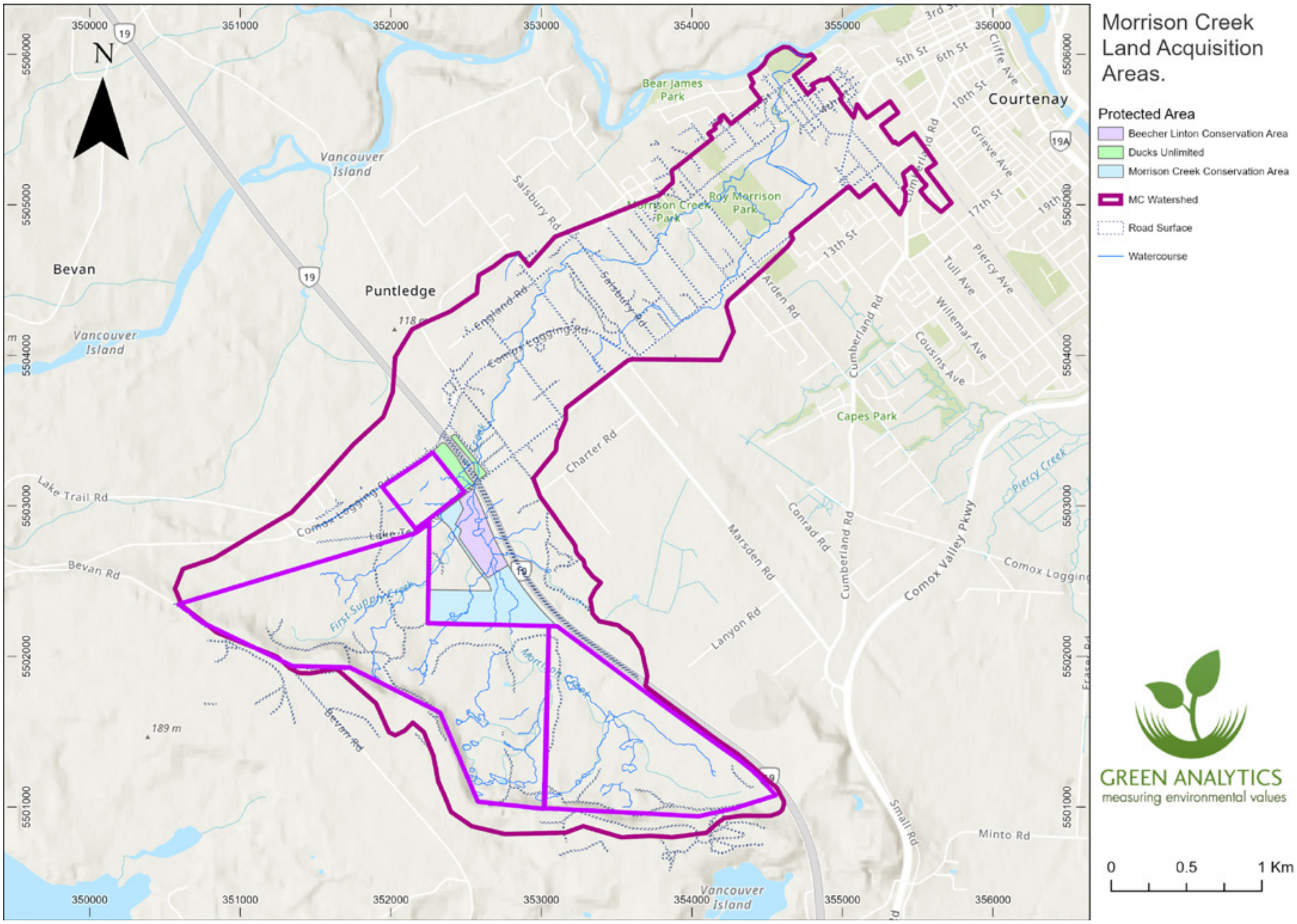

Figure 15: Location of land acquisition areas within Morrison Creek Watershed

Figure 16 illustrates the type and extent of natural assets within the land acquisition areas.

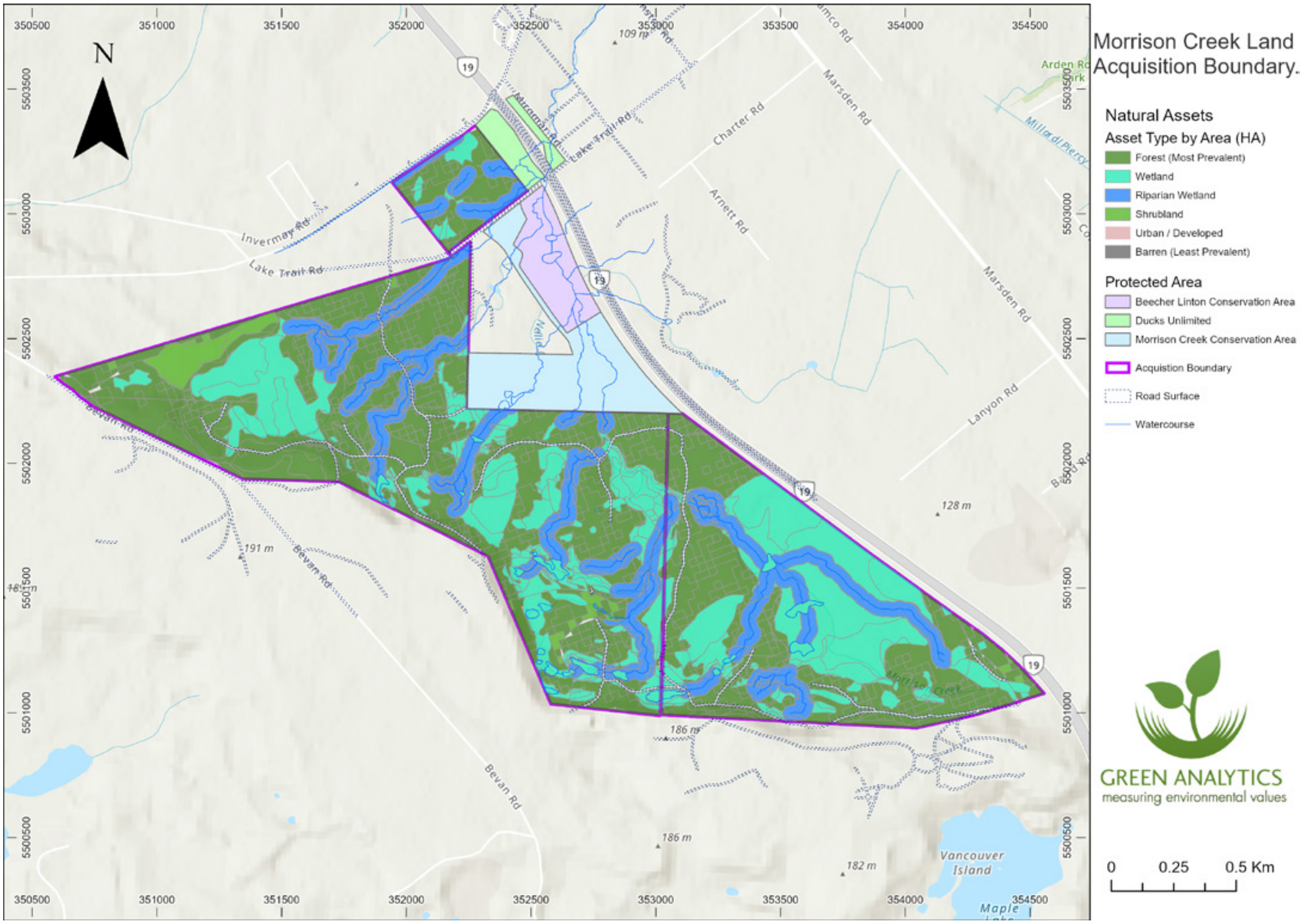

Figure 16: Land acquisition area and associated natural asset types

With the relevant area/s established, the costs and benefits of this management scenario were calculated. The cost of this management action was based on the purchase price of the land identified for acquisition. Purchase prices were estimated as the product of comparable land values from BC Assessment and the estimated value of timber. The present value of the purchase was calculated assuming acquisition takes place in 2 phases over a 30-year period in years 1 and 3, with discount rates of 2 per cent and 5 per cent. In addition, annual restoration and monitoring costs of $50,000 in year 1 and $180/ha/yr ($53,806/year) were incorporated into the analysis, based on the advice of the local expert advisory committee. The present value of the cost of the acquisition scenario was estimated to be $5,555,852 assuming a 2 per cent discount rate, and $5,035,595 assuming a 5 per cent discount rate.

The benefit of this management action is the value of stormwater services provided by the area within the acquisition boundary. As was the case with the riparian buffer, a benefits transfer approach was employed to estimate the stormwater services associated with the acquisition scenario. The values dollar/ha/year assigned to the land cover types within the acquisition area are presented in Table 13.

The present value of the stormwater services for the acquisition areas was calculated over a 30-year period assuming discount rates of 2 per cent and 5 per cent. The present value was estimated to be $8,765,426 assuming a 2 per cent discount rate, and $6,045,637 assuming a 5 per cent discount rate.

Considering these benefits in light of the cost of the management action results in a net present value of the land acquisition scenario of $14,321,277 at a 2 per cent discount rate and $11,081,232 at a 5 per cent discount rate. The resulting benefit-cost ratio for the acquisition scenario is 79:50.

The results presented above do not account for benefits associated with the SAR. To account for benefits associated with SAR, a willingness-to-pay estimate for SAR of $33/person was applied to the population aged 20 and up within the watershed, again using Camaclang (2020). The resulting value was estimated at $10,732 per year. Over a 30-year time period at a discount rate of 2 per cent, the present value of the SAR benefit is $248,608. Over a 30-year time period at a discount rate of 5 per cent, the present value of the SAR benefit is $171,468.

Adding the SAR benefit to the stormwater services provided by the assets within the acquisition area results in a net present value for the acquisition scenario of $14,569,885 and a benefit-cost ratio of 81:50, assuming a 2 per cent discount rate over 30 years. At a 5 per cent discount rate, the net present value of this scenario is $11,252,701 and the benefit-cost ratio is 123:100.

Figure 17 below depicts the distribution of costs and benefits over the 30-year period for the land acquisition option.

OPTION 2: LAND ACQUISITION

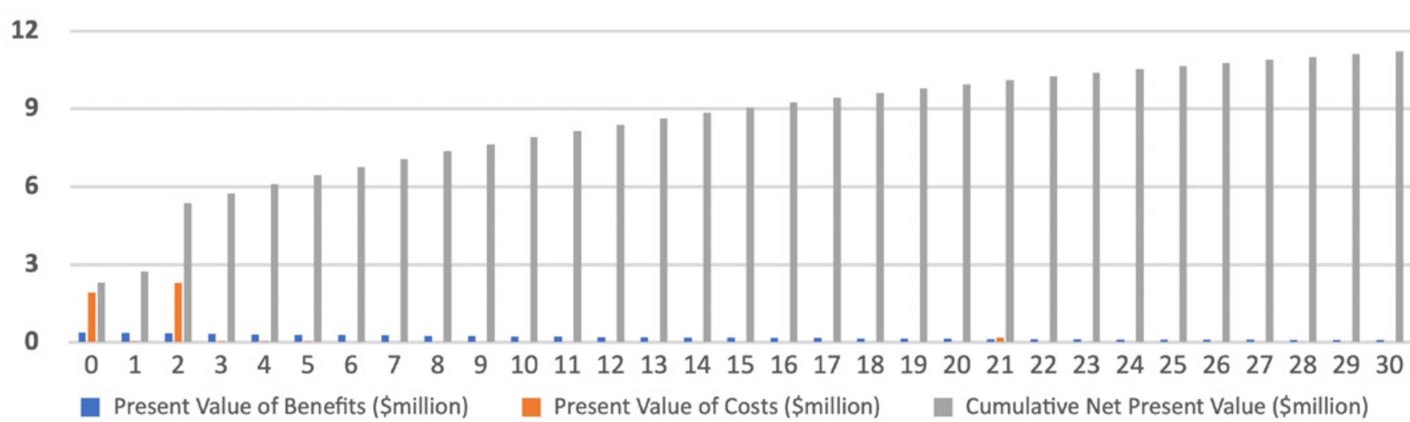

***Figure 17**: Distribution of costs and benefits over 30 years for the land acquisition option*

SCENARIO 3: ENVIRONMENTAL DEVELOPMENT PERMIT AREAS

B.C. local governments may designate areas of land as development permit areas to be used for eligible purposes including protection of the natural environment, its ecosystems and biological diversity.[19] EDPAs are triggered, per the Local Government Act, by specific actions such as land alteration, subdivision and, in some cases, building permits. They can require both the restoration of land, as well as the protection of the existing natural environment. This management action simulates an improvement in the condition of degraded assets as a result of EDPA regulations. The first step, as with the preceding scenarios, was to establish the land to which the management scenario applies. Two EDPA options were then considered. The first includes all lands within the watershed that ranked in poor condition. The second includes all lands within the watershed that ranked poor, but excludes areas associated with the land acquisition scenario. The figures below depict these EDPA scenarios.

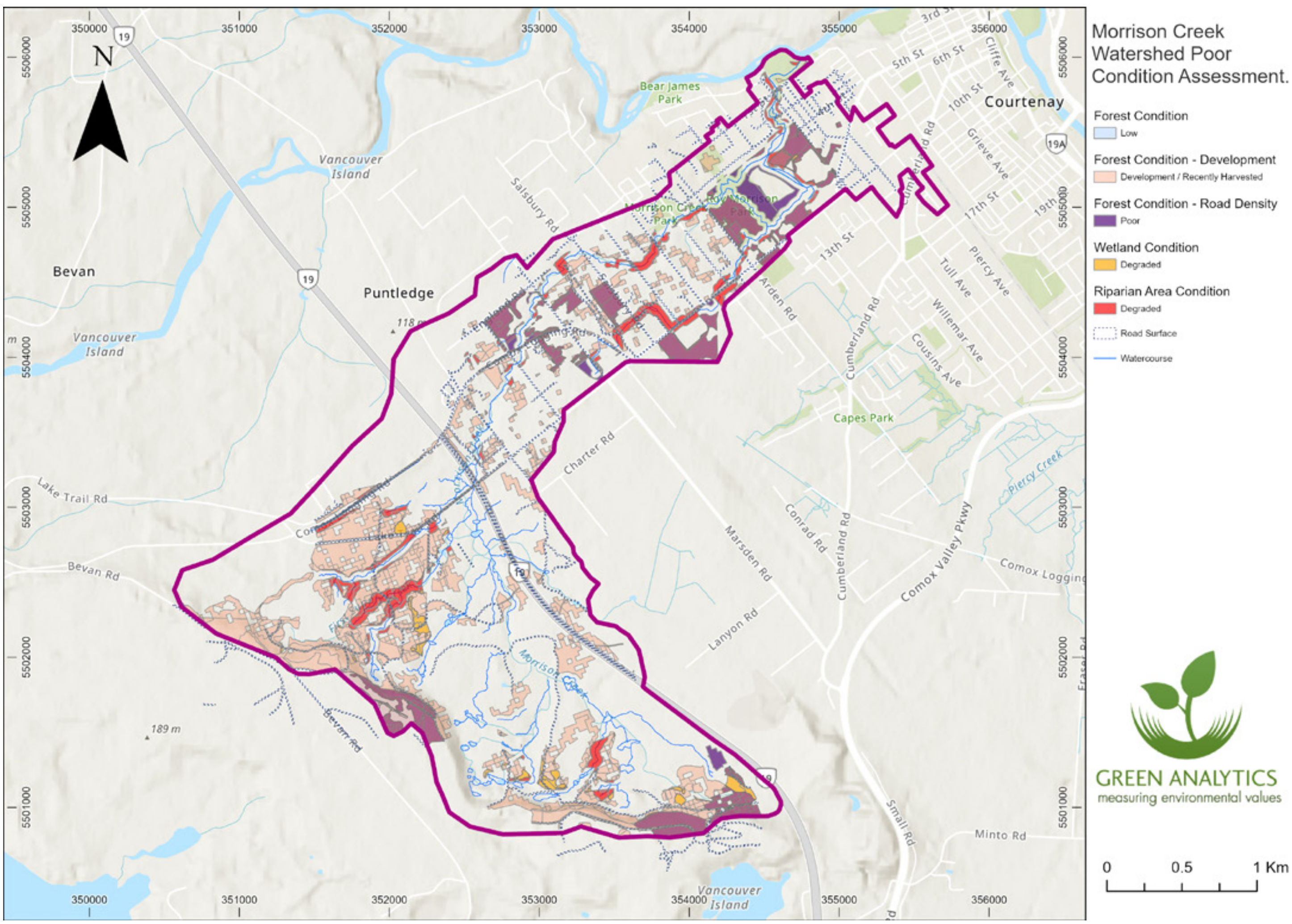

Figure 18: Natural assets rated poor within the Morrison Creek Watershed

19 www2.gov.bc.ca/gov/content/governments/local-governments/planning-land-use/land-use-regulation/development-permit-areas

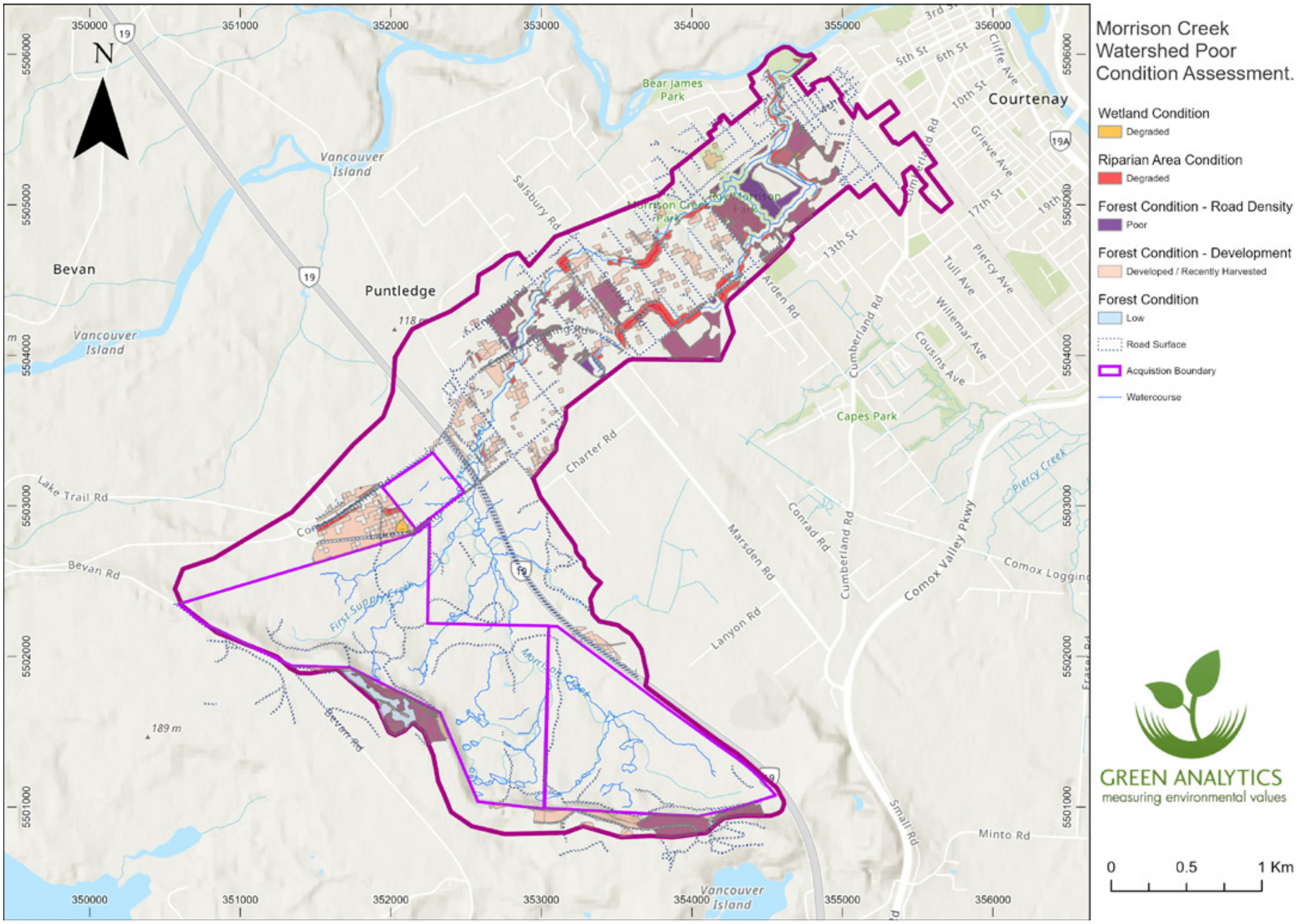

Figure 19: Natural assets ranked poor within the Morrison Creek Watershed, excluding land acquisition areas

With the relevant area/s established, the costs and benefits of this scenario were calculated. Costs were based on the cost of restoring degraded lands. The Cost to restore and manage forests, riparian wetlands and open green spaces, in turn, was based on the Credit Valley Conservation Authority Cost Calculator (in publication). The resultant estimate of $1,500/ha was reviewed with the local expert advisory group, which agreed this is a reasonable estimate of costs. The estimated cost of isolated and palustrine wetland restoration was based on a 2016 study by Tyndall & Bowman,[20] which itemized cost/acre for various restoration activities. Based upon discussions with the local expert advisory group, costs related to wetland plants and planting, wetland buffer seeds, and seeding buffer were totaled and converted to $/ha CDN 2020 or $2,745/ha. Finally, monitoring costs of $1,250/year were included at the recommendation of the local expert advisory group.

The present value of the restoration costs was calculated over a 30-year period with discount rates of 2 per cent and 5 per cent. The present value of the cost

20 *Tyndall & Bowman, 2016*

of the EDPA scenario assuming the EDPA applies to the entire watershed was estimated to be $1,587,542 assuming a 2 per cent discount rate, and $1,493,643 assuming a 5 per cent discount rate. The present value of the cost of the EDPA scenario assuming the EDPA does not apply to areas captured by the acquisition scenario was estimated to be $168,815 assuming a 2 per cent discount rate, and $153,656 assuming a 5 per cent discount rate.

The benefit of this management action is the increased value of stormwater services provided by the restored areas. A benefits transfer approach was employed to estimate the stormwater services associated with this scenario. This scenario differs from those above because here, the service benefit estimation assumes a change in land cover type over time, from land cover types with low stormwater service benefits to land cover types with high stormwater service benefits. As such, to estimate the value of stormwater services resulting from this scenario, the values/ha assigned to the EDPA was $18,191 in year 6 (assuming benefits aren't realized for the first 5 years) and increased to $454,777 in year 30 (the stormwater service value associated with forests).

Considering these benefits in light of the cost of the management action results in a net present value for the watershed-wide EDP scenario of $5,401,629 at a 2 per cent discount rate and $3,556,857 at a 5 per cent discount rate. The resulting benefit-cost ratio for the watershed-wide EDPA scenario is 12:5. Considering these benefits in light of the cost of the management action results in a net present value for the EDPA scenario excluding acquisition lands of $2,690,785 at a 2 per cent discount rate and $1,517,898 at a 5 per cent discount rate. The resulting benefit-cost ratio for the EDPA scenario excluding acquisition lands is 747:50.

The above results do not account for benefits associated with SAR. To account for benefits associated with SAR and CH, a willingness-to-pay estimate for SAR of $33/person was applied to the population aged 20 and up within the watershed and adjusted to account for the portion of the watershed in this management option.[21] The resulting value was estimated at $10,304 per year. Over a 30-year time period at a discount rate of 2 per cent, the present value of the SAR benefit is $86,409. Over a 30-year time period at a discount rate of 5 per cent, the present value of the SAR benefit is $46,742.

Adding the SAR benefit to the stormwater services provided by the assets within the EDPA results in a net present value for the watershed-wide EDPA option of $5,488,038 and a benefit-cost ratio of 123:50, assuming a 2 per cent discount rate over 30 years. Excluding the acquisition area, the benefit-cost ratio is 763:50 at a 2 per cent discount rate. At a 5 per cent discount rate, the net present value of the watershed-wide EPDA option is $3,603,599 and the benefit-cost ratio is 141:100. In the second option that excludes the acquisition area, the net present value is $1,547,109 and the benefit-cost ratio is 907:100 at a 5 per cent discount rate.

21 Based on Camaclang (2020).

Figures 20 and 21 below depict the distribution of costs and benefits over the 30-year period for the EDPA options.

OPTION 3: EDPA (FULL WATERSHED)

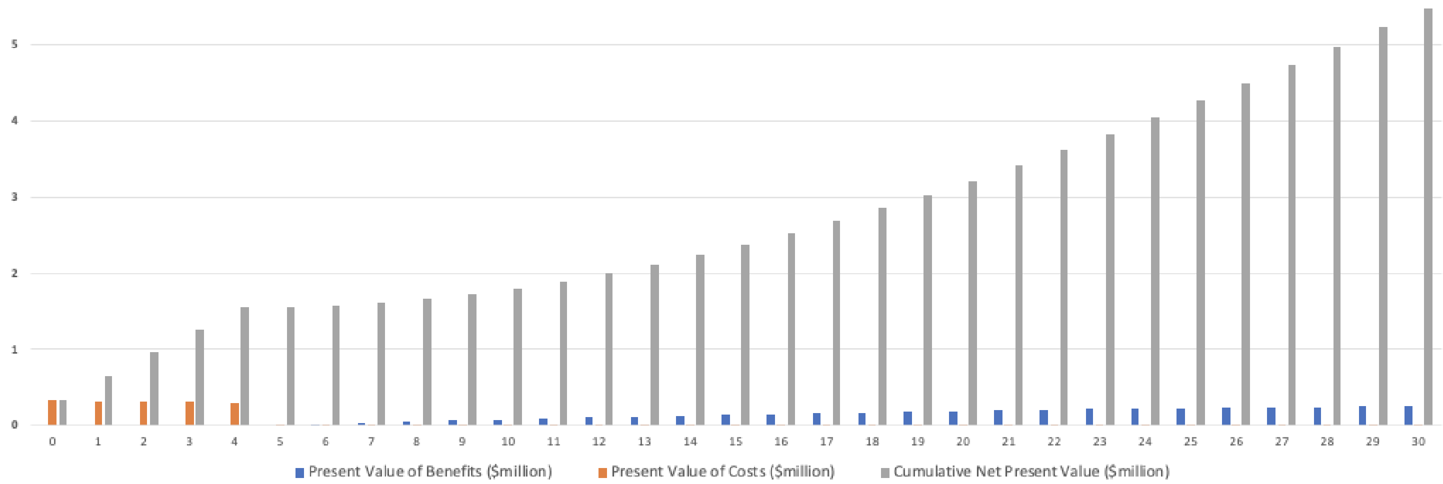

Figure 20: *Distribution of costs and benefits over the 30-year period for the first EDPA option (all watershed natural assets rated poor).*

OPTION 4: EDPA (PARTIAL WATERSHED)

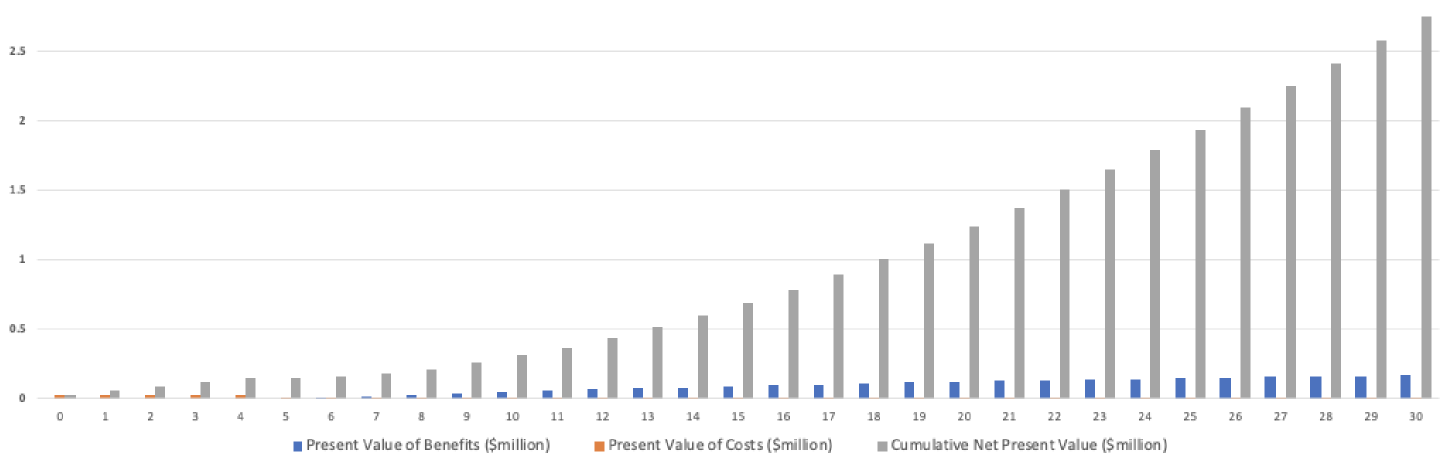

Figure 21: *Distribution of costs and benefits over the 30-year period for the second EDPA option (all watershed natural assets rated poor minus acquired lands).*

COMPARISON OF MANAGEMENT OPTIONS BENEFIT COST RATIO

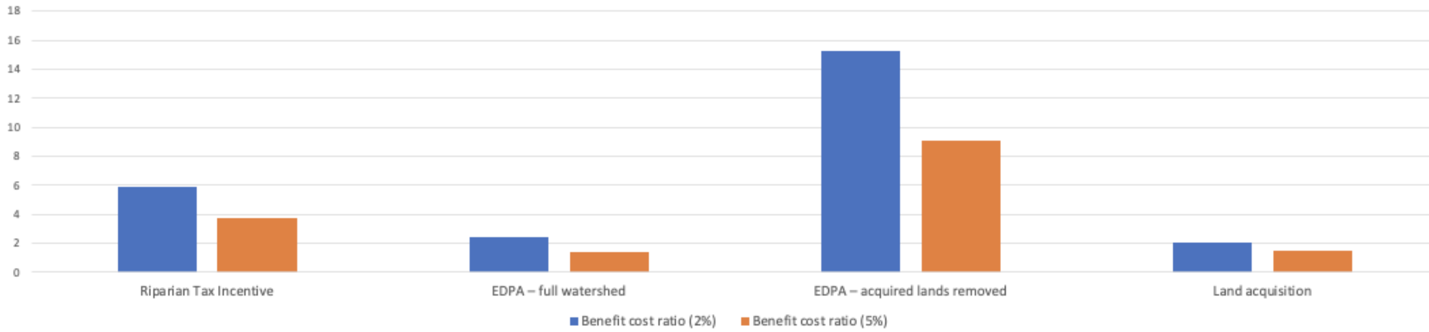

***Figure 22**: Comparison of Management options Benefit Cost Ratio: Magnitude of benefits over cost over 30 Years.*

Figure 22 shows the magnitude of benefits over costs, at both a 2% discount rate and a 5% discount rate over 30 years. For example, the Riparian Tax Incentive management option analysis revealed that the benefits of this option (at a 2% discount rate) are 5.84 times more than the cash outlay over 30 years. At a 5% discount rate, the benefits are 3.73 times more than the cash outlay.

CONSIDERATIONS FOR FUTURE PROJECTS

This step is an opportunity to develop and model real-world scenarios based on the priority actions. So if, for example, restoration was identified as a priority action, then the project leads and community experts would need to develop realistic assumptions for how much restoration could occur, where, and what service provision improvements this could lead to. This information can then be represented spatially.

The timeframe for analysis was set at 30 years to represent a planning horizon. Based upon the preferred management option, a different timeframe could be used to refine the analysis. This would require re-visiting the assumptions pertaining to the frequency of costs and the realization of benefits. For example, there may be unique costs and benefits associated with having complete control over the land base under the land acquisition scenario.

A variety of other analyses could be considered, including determining a return on investment for different options or conducting a multiple criteria decision analysis, to recognize variables that are difficult to monetize such as political acceptability or equity. Other services beyond stormwater management could also be considered. Details will depend on the management actions under consideration but should generally involve the following:

- Identify the spatial areas to which management actions would be targeted.
- Model and measure the condition or function of natural assets resulting from the management action.

- Estimate the value of the service resulting from the management actions.
- Estimate the cost of the management actions.
- Assign a benefit to the value of the SAR and CH.

It is important to note that the tools explored through this project in Scenarios 1 to 3 are applicable in B.C. Local governments receive their authority from the provinces through provincial legislation, so different management tools may be applicable to SAR and CH protection in other provinces. A pan-Canadian program requires buy-in from provincial governments across the country to update legislation in each province to give local governments the authority to implement relevant tools.

Conclusion

The number of local governments engaged in natural asset management is growing steadily. As norms and standards for natural asset management emerge, the rate at which local governments adopt the practice will also increase.

As the practice evolves, there will be an important opportunity to ensure that natural asset management enables local governments to consider not only core services, but also additional services and values that may not contribute directly to asset management 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 both optimizing SAR and CH and local government service options in the Comox Valley, and for refining and replicating the approach in other contexts.

In the Comox Valley, an immediate next step could be to present project results to local government Councils, the Regional Board and K'ómoks First Nation. This will provide an opportunity to, for example, explore EDPAs in the region to protect riparian areas and improve habitat connectivity for SAR. The detailed maps of proposed EDPAs and cost-benefit analysis demonstrates that targeted EDPAs are cost-effective, delivering $9-$15 dollars of benefits for every dollar spent. However, as the report points out, they have a serious limitation in that long-term compliance with EDPA requirements is difficult to monitor. Solutions to this would have to be explored. Other services beyond stormwater management could also be considered in future scenario development, and more precise quantification of stormwater management values could be determined through modelling.

Nationally, there is a strong imperative to replicate the project. As one example, the federal government, in collaboration with the provinces and territories, has agreed to the implementation of the Pan-Canadian Approach to Transforming Species at Risk Conservation in Canada. This approach is intended to shift from a single-species approach to conservation, to one that focuses on multiple species and ecosystems. The pilot SAR tool could prove useful to this effort. To contribute meaningfully to the Pan-Canadian Approach to Transforming Species at Risk Conservation in Canada or other national efforts, and the goal of protecting SAR, CH and biodiversity, it will be important to:

- Identify and work with, initially, a small number of other local governments that wish to pilot the approach.
- Once the approach has been replicated, subject it to peer review.
- Further refine the methodology and develop a strategy for scale-up.
- Identify areas where national norms and standards may be appropriate, for example, related to condition assessments that comprise both ecological and service delivery considerations, and explore options with standard-setting organizations.
- Get buy-in from provincial governments to update legislation in each province that would give local governments the authority to implement some of the tools, as not all will be available in other provinces.

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Annex
Local government management tools for SAR and CH

This Annex contains an overview list of possible management tools that MNAI provided to the local expert advisory group as a starting point for determining locally relevant tools. The references for this Annex are included in the overall document references list.

Introduction:

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 do 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 project 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.

1/ Land Acquisition Tool				
Management Tool	**Explanation**	**Benefits**	**Challenges**	**Example(s)**
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; *Parkland Purchase Reserve Fund* 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.

Management Tool	Explanation	Benefits	Challenges	Example(s)
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.

2/ Regulatory Tools

Management Tool	Explanation	Benefits	Challenges	Example(s)
Planning Documents (e.g., Official Community Plans/Municipal Plans, Regional Growth Strategies, Watershed Plans, Biodiversity 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.

2/ Regulatory Tools (cont'd)				
Management Tool	**Explanation**	**Benefits**	**Challenges**	**Example(s)**
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.

Management Tool	Explanation	Benefits	Challenges	Example(s)
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 *Acadian Marshes - Percival River Salt Marsh Natural Area* was acquired by Island Nature Trust (PEI) through donation in two parcels.

3/ Market-Based Tools				
Management Tool	**Explanation**	**Benefits**	**Challenges**	**Example(s)**
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.

Municipal Natural Assets Initiative

MNAI.CA

Making Nature Count

Website: *MNAI.ca*