Northumberland county

Toward natural asset management in

Northumberland County

Ontario

Summary of inventory results and recommendations
September 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 a Canadian not-for-profit that 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.

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Table of Contents

1 Purpose

This document summarizes the results of a project to develop a natural asset inventory in Northumberland County, Ontario, and documents steps the local government can take to proceed to a full natural asset management initiative.

2 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, 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 better 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. The Municipal Natural Assets Initiative (MNAI) uses methodologies and tools rooted in standard asset management and provides a range of advisory services to help local governments implement them. MNAI has developed the methods and tools 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.

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

What is a natural asset inventory?

Natural asset inventories provide details on the types of natural assets a local government relies upon, their condition, and the risks they face. As depicted in Figure 1 and explained in detail in the Annex, a natural asset inventory is the first component of the Assessment phase. The Assessment phase, in turn, is the first of three phases of a full natural asset management project. By itself, an inventory will not give a sense of asset value but is an essential first step in the full natural asset management project.

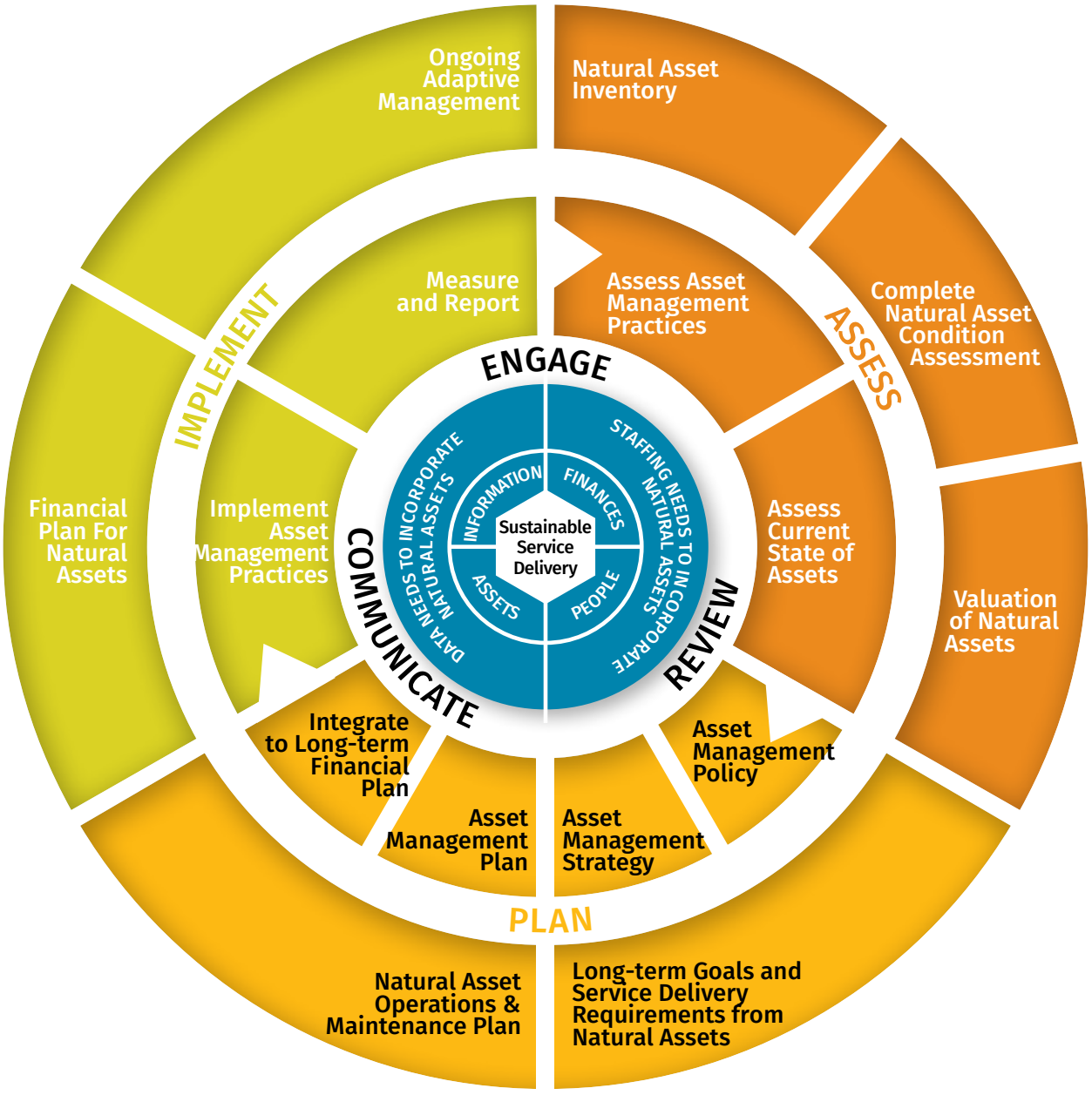

Figure 1: *The Asset Management Process. MNAI has adapted this for use with natural assets.*

3 Local government context

3.1. General

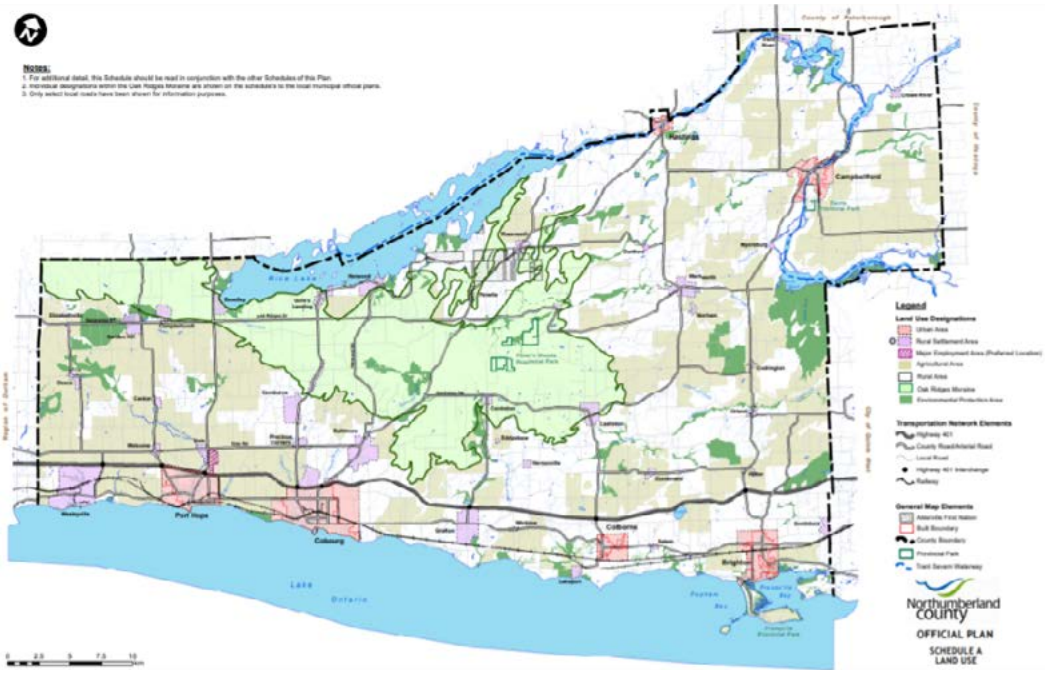

Figure 2: Northumberland County[2].

Northumberland County (population ~90,000) is a predominantly rural upper-tier municipality in Ontario. It consists of seven member municipalities and is on the traditional territory of the Mississaugas. Northumberland County appreciates its long-standing relationship with the Alderville First Nation and intends to collaborate with it to manage its natural assets[3].

Northumberland County's 2019-2023 Strategic Plan recognizes Northumberland County Forest (NCF) as a critical component and it is drafting a Forest Master Plan to prioritize the natural assets. The Forest Service Strategic Plan has three pillars - ecology, forestry and recreation - which link to current corporate priorities.

The highest priority municipal services that natural assets provide Northumberland County include air purification, groundwater recharge, and flood management. They also aim to mitigate the climate change risks of wildfire, drought and loss of species and habitat.

Northumberland County's main objective in natural asset management is to improve decision-making and the allocation of funds, where necessary, to manage natural assets.

This requires an increased awareness and appreciation of natural assets that includes evaluating them, understanding the services they provide, and communicating the resulting information to political leaders, staff and the public.

2 *Northumberland County Official Plan. (2016, November). Retrieved April 2021 from www.northumberland.ca/en/business-and-development/official-plan.aspx#Download-the-maps-and-policies-from-the-Official-Plan*

3 *Wikipedia. Retrieved April 2021 from en.wikipedia.org/wiki/Northumberland_County,_Ontario*

3.2. Asset management readiness assessment

As part of inventory development, MNAI helps local governments determine their overall state of asset management maturity. To do this, MNAI has adapted the Federation of Canadian Municipalities (FCM)'s asset management readiness assessment tool[4] to help local governments measure their progress on both asset management and natural asset management in four competency areas, with each area describing outcomes based on five levels of progress or maturity.

The completed readiness assessment helps local governments prioritize actions that increase their effectiveness in managing all assets, including natural ones.

Competency 1: Policy & Governance

Northumberland County is at a very early stage of adoption of natural asset management and at a relatively early stage organization-wide for engineered assets. It has identified the benefits it would like asset management to deliver to support organizational objectives for both engineered and natural assets, but it does not yet have an asset management policy in place. It has established performance measures to monitor progress on asset management but does not yet include progress related to natural asset management. This MNAI inventory project is Northumberland County's first step in incorporating natural asset management.

Competency 2: People & Leadership

Northumberland County has formed a cross-functional asset management team that is accountable for asset management. Asset management roles and responsibilities have been added to staff job descriptions for members of the team. The team does not yet formally include anyone with responsibility for natural asset management. Council has demonstrated buy-in and support for asset management and has approved funding for priority improvements related to Northumberland County's engineered infrastructure, but it is not yet aware of the resourcing needs to make progress on natural asset management.

Competency 3: Data & Information

Northumberland County has a good data foundation for its engineered asset inventory with basic inventory data for all major engineered assets, including information on asset condition and performance of critical engineered assets. It also has some level-of-service information and some information on the condition and performance of its forest assets that has guided Forest Master Plan development. This MNAI inventory project will strengthen the data foundation for natural assets.

4 *See fcm.ca/sites/default/files/documents/resources/tool/asset-management-readiness-scale-mamp.pdf for details*

Northumberland County is quite advanced in terms of financial data for engineered assets. It has calculated the cost-of-service delivery for all critical assets, understands the trade-offs between investment and quality-of-service delivery and uses this information to refine its financial plans. Because it is at an early stage of inventorying and developing an understanding the role of natural assets in service delivery, it does not yet have financial data associated with natural assets.

Competency 4: Planning & Decision-making

Northumberland County has a structured approach to investment planning and sets priorities using similar criteria across departments based on the goals and objectives of the organization's corporate strategic plan; however, it hasn't yet applied the approach consistently across the organization. Asset management plans are based on short- and long-term issues and priorities and address most service areas. The plans include basic needs-forecasting and risk management strategies for critical engineered assets and do not yet incorporate needs related to natural assets.

Northumberland County prepares annual capital and operating budgets based on an annual reassessment of risks and current needs. It has a five-year capital plan and updates it annually. It also updates its long-term financial plan annually and understands the risks associated with its investment gap.

With respect to natural asset management, some commitments have been made to conserve and protect critical natural assets and/or areas, but these have not yet translated into formal natural asset management plans. Northumberland County is also beginning to build in capital, operating and maintenance costs related to its forest assets through its Forest Master Plan.

4 Natural asset inventory

4.1. Inventory overview

MNAI's natural asset inventories have two main components to express natural asset information: an asset registry (which is a tabular representation of the data) and an online dashboard. MNAI provided the registry to Northumberland County in an Excel file and the dashboard as a website address. Information on the condition of the assets is a subset of the inventory and is depicted in both the registry and dashboard.

4.2. Inventory data

To establish the inventory, MNAI obtained data from Northumberland County and the province of Ontario. MNAI combined the spatial data layers to establish a comprehensive depiction of natural assets. Table 1 describes the data sources used to develop the inventory and condition assessment.

TABLE 1: SUMMARY OF DATA SOURCES

DATASET NAME	SOURCE	PURPOSE
Forests	Northumberland	Used special management zones, wetlands data, and forest data to form the base Natural Asset Inventory.
Wetlands	Northumberland	Served as input for wetland data as the boundaries of the polygons better aligned with available satellite imagery for the area.
SOLRIS	Province of Ontario, Ontario GeoHub	Transportation areas of the SOLRIS data were removed from the base inventory files and the non-natural landcovers. Used a 100 m area around Northumberland to assess adjacent land use on the Natural Assets.
Trails	Northumberland	Each trail file was merged together and used to estimate the length of trails (km) that cut through each asset.
Major Roads	Northumberland	Merged with Access Routes and Forest Roads to serve as the basis to estimate Road Density in and around each natural asset.
Forest Roads	Northumberland	Merged with Major Roads and Access Routes to serve as the basis to estimate Road Density in and around each natural asset.
Access Routes	Northumberland	Merged with Major Roads and Forest Roads to serve as the basis to estimate Road Density in and around each natural asset.
Special Management Zones	Northumberland	Used to identify areas based on treatment history and to further break down landcover types for the area of interest, particularly to ID barren areas for the base inventory.
Forest Boundary	Northumberland	Used to clip other datasets to the boundary of interest for this study and to create buffers to serve as clipping files to reduce the extent of larger datasets (such as SOLRIS).
Ontario Watershed Boundary	Northumberland	Used to split the polygons for the different levels of the inventory based on which watershed each asset was located in.

The inventory project defined a total of 1189 individual assets, covering 2,304 hectares (ha), as noted in Table 2. The majority of this area was cultural plantation, followed by forests.

TABLE 2: SUMMARY OF NATURAL ASSETS BY TYPE

NATURAL ASSET TYPE	NUMBER OF ASSETS	TOTAL AREA (HA)	AVERAGE ASSET AREA (HA)
Cultural Plantation	495	1,220	2.47
Deciduous Forest	321	487	1.52
Mixed Forest	176	370	2.10
Forest	104	136	1.31
Coniferous Forest	34	21	0.63
Meadow	34	43	1.27
Swamp	15	24	1.58
Open Forest	5	1	0.28
Shrub Bog	3	0.5	0.16
Treed Fen	2	0.1	0.05
Total	**1,189**	**2,304**	**1.94**

Figure 3 shows the spatial distribution of the natural assets presented in Table 2 and Table 3.

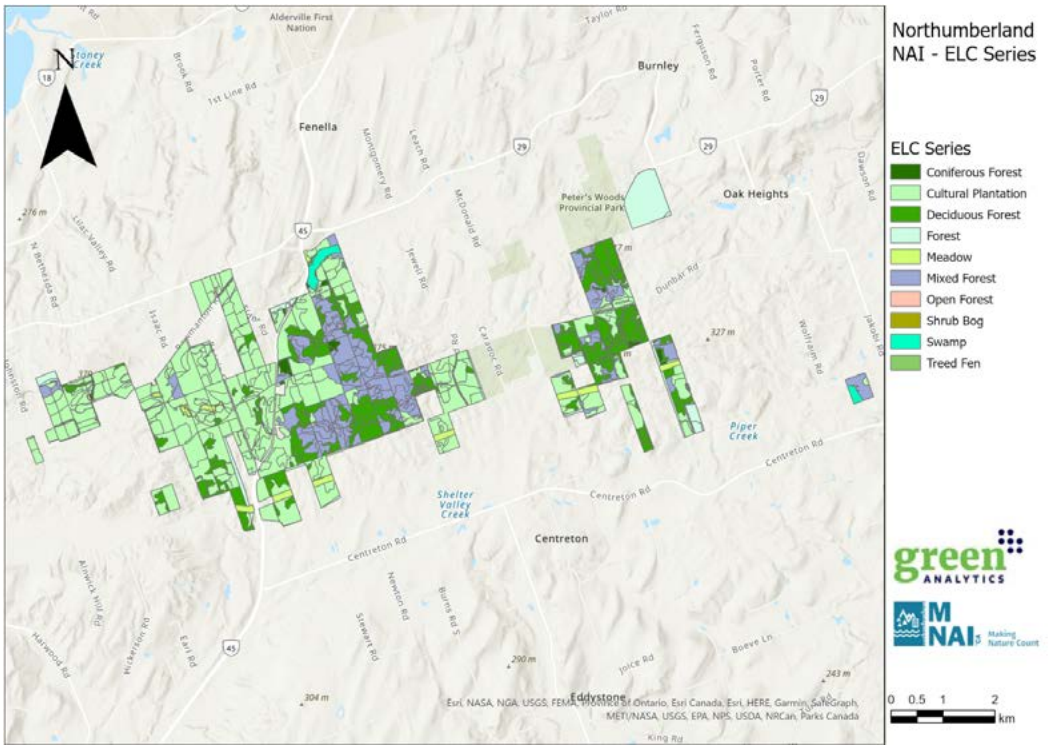

***Figure 3**: Spatial distribution of natural assets.*

4.3. Asset registry

Each asset within the inventory has a unique identification number that allows individual assets to be selected, analyzed, and the corresponding data manipulated as required. For example, changes in condition can be noted for individual assets. Information on each asset is housed in an asset registry. Table 3 is an excerpt from Northumberland County's registry showing natural asset characteristics and details.

TABLE 3: EXCERPT FROM THE REGISTRY

ELC Series Natural Asset Inventory

Asset ID	ELC Series	Area (ha)	Trail Length (km)	Interior Forest Area (ha)	% Interior Forest	Relative Size Score	Permeability Score	Road Density (km/km²)	Road Density Score	Adjacent Land Score	Total Score	Subwatershed	Special Management Zone Code	SPMZ Reserve Type	SPMZ Management Action
BOS1	BOS	0.00	0.00	0.00	0.00	5	10	5.18	1	9	25	Trent River - Crowe River	SMZ-WET-03	Wetland	Maintain
BOS2	BOS	0.05	0.00	0.00	0.00	5	10	0.00	10	10	35	Trent River - Crowe River	SMZ-WET-03	Wetland	Maintain
BOS3	BOS	0.43	0.00	0.00	0.00	10	10	3.05	1	10	31	Trent River - Crowe River			None
CUP1	CUP	0.02	0.00	0.00	0.00	1	10	5.98	1	10	22	Trent River - Crowe River	SMZ-WET-03	Wetland	Maintain
CUP10	CUP	3.99	0.27	2.19	54.93	5	10	4.41	1	10	26	North Lake Ontario Shoreline			None
CUP100	CUP	0.84	0.00	0.61	71.92	1	10	2.90	1	10	22	Trent River - Crowe River	SMZ-SAV-02	Savannah	Maintain
CUP101	CUP	0.01	0.00	0.01	99.95	1	10	0.00	10	10	31	Trent River - Crowe River	SMZ-FOR-06	Natural Forest	Restore
CUP102	CUP	2.10	0.56	0.73	34.86	1	10	4.68	1	10	22	Trent River - Crowe River	SMZ-FOR-17	Oak Woodland	Maintain
CUP103	CUP	3.72	0.16	0.00	0.00	5	10	5.85	1	9	25	North Lake Ontario Shoreline			None
CUP104	CUP	2.78	0.11	0.71	25.67	1	10	3.94	1	9	21	North Lake Ontario Shoreline			None
CUP105	CUP	1.78	0.34	0.38	21.10	1	10	0.00	10	10	31	Trent River - Crowe River			None
CUP106	CUP	3.99	0.72	2.41	60.31	5	10	2.98	1	10	26	Trent River - Crowe River			None

4.4. Online dashboard

Inventories may provide more insights when characterized visually in a dashboard, which enables users to explore different aspects of the data. For instance, natural asset information can be quickly summarized by watershed area, or, if users want to dive into the specifics of forest assets, they can quickly filter the data to focus on that particular asset. Figure 4 is a screenshot from the dashboard that MNAI provided to Northumberland County. The full version can be accessed at *go.greenanalytics.ca/Northumberland*.

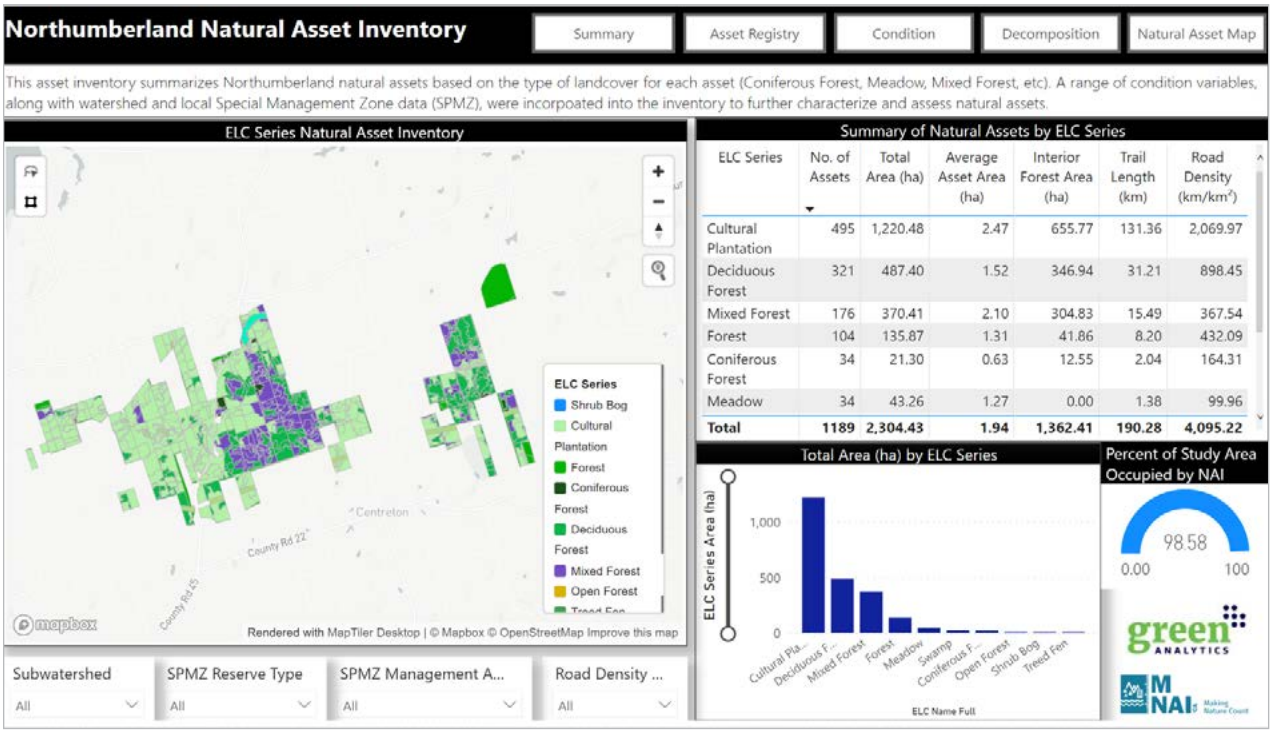

Figure 4: Screenshot of main inventory summary.

4.5. Condition of natural assets

Documenting the condition of natural assets is a key aspect of natural asset inventories. A natural asset condition assessment provides an understanding of both the ecological health of natural assets, and the ability of natural assets to provide services. This information, in turn, can support the effective management of natural assets, be reflected in the registry and the dashboard, and updated over time.

MNAI completed a desktop-based condition assessment and built it into the inventory to provide an initial understanding of the status of the natural assets for Northumberland County. Table 5 summarizes the condition assessment steps and indicators.

TABLE 4: CONDITION ASSESSMENT APPROACH AND INDICATORS

Indicator	Description & Methods for Quantification	Data used to Quantify Indicator*
Relative asset size	For each natural and semi-natural asset type, total area is calculated and a rank is assigned to the assets within each class based on its percentile score. Natural assets within the top third of the ranking (e.g., the largest assets within a class) received a 3, those within the middle third of the ranking received a 2, and those within the bottom third of the ranking received a 1.	Natural asset inventory

TABLE 4: CONDITION ASSESSMENT APPROACH AND INDICATORS

Indicator	Description & Methods for Quantification	Data used to Quantify Indicator*
Road density	Measures the density of the roads in and around the assets according to high density (assets with more than 2km of roads per km squared), medium density (assets with between 1km and 2km of roads per km squared) and low density (assets with less than 1km of road per km squared).	Natural asset inventory plus spatial representations of roads
Surface permeability	The permeability of surfaces is ranked on a scale of nil to high depending on the type of landcover present. Urban areas, roads and industrial areas are ranked as nil. Assets within impervious surfaces are assigned as low permeability. Agriculture and shrublands are ranked as medium. Wetlands, waterbodies and forests are ranked as high.	Natural asset inventory, spatial representations of land uses and roads, as well as the Global Man-made Impervious Surfaces Dataset from NASA *data.nasa.gov/dataset/Global-Man-made-Impervious-Surface-GMIS-Dataset-Fr/dkf4-4bi3*
Adjacent land use	Considers the distance to, and the nature of, the area surrounding natural assets. Intense land uses (e.g., airports) in close proximity to natural assets result in a poor rating, while distant land uses that are less intense (e.g., agriculture) result in a good rating. If there are no human land uses within 100 m of the assets, the assets are scored 10. If there are intensive land uses within 100 m of the assets, the score is 0.	Natural asset inventory plus spatial representation of land use as well as intensity rankings of land uses

Once conditions were allocated to each asset, an overall score was derived for the project area. The maximum possible score for an asset was 40, based on a possible 10 points for each of 4 categories:

- Road density as low (10), medium (5) or high (1).
- Surface permeability rated as high (10), medium (5), low (1), or nil (0).
- Adjacent intensive land use (0 for intense land uses, otherwise 10).
- Relative asset size where the largest 3rd areas receive 10, 5 for middle 3rd, and 1 point for the lowest 3rd.

The total condition score was then converted into a rating scale:

- **Good -** assets with a score of 30 or higher
- **Fair -** assets with a score between 20 to 29
- **Poor -** assets with a score between 10 to 19
- **Very Poor -** assets with a score lower than 10

Figure 5 summarizes the natural asset condition assessment results as per the online dashboard.

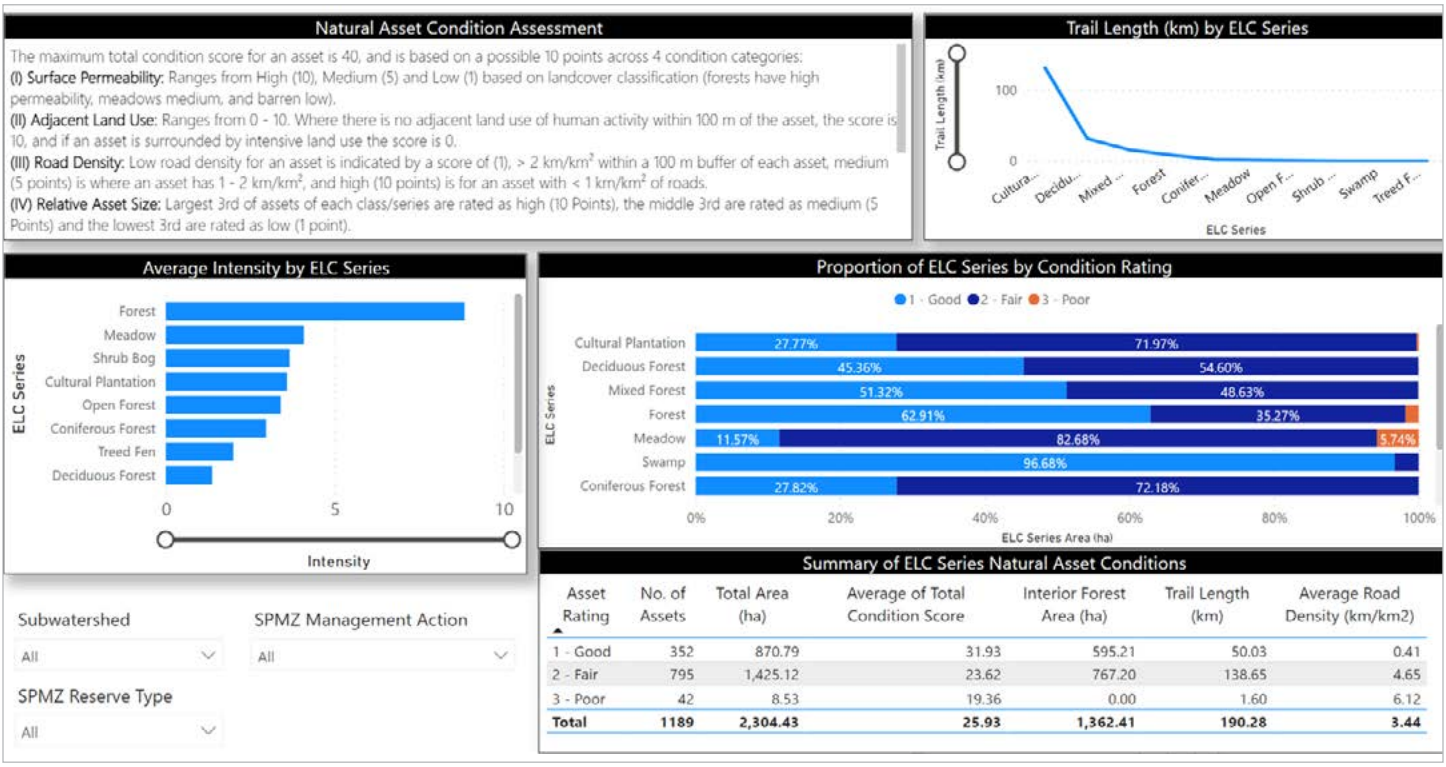

Figure 5: Screenshot of condition assessment details.

Overall, about 871 ha (or 38 per cent) of natural assets were assessed in good condition and 1,425 ha (or 62 per cent) were assessed in fair condition.

Table 5 summarizes condition ratings and Figure 6 summarizes condition by natural asset type.

TABLE 5: SUMMARY OF NATURAL ASSET CONDITION RATINGS

Condition Rating	Number of Assets	Total Area (ha)	Average Condition Score
Good	352	871	32
Fair	795	1,425	24
Poor	42	9	19
Total	**1,189**	**2,304**	**26**

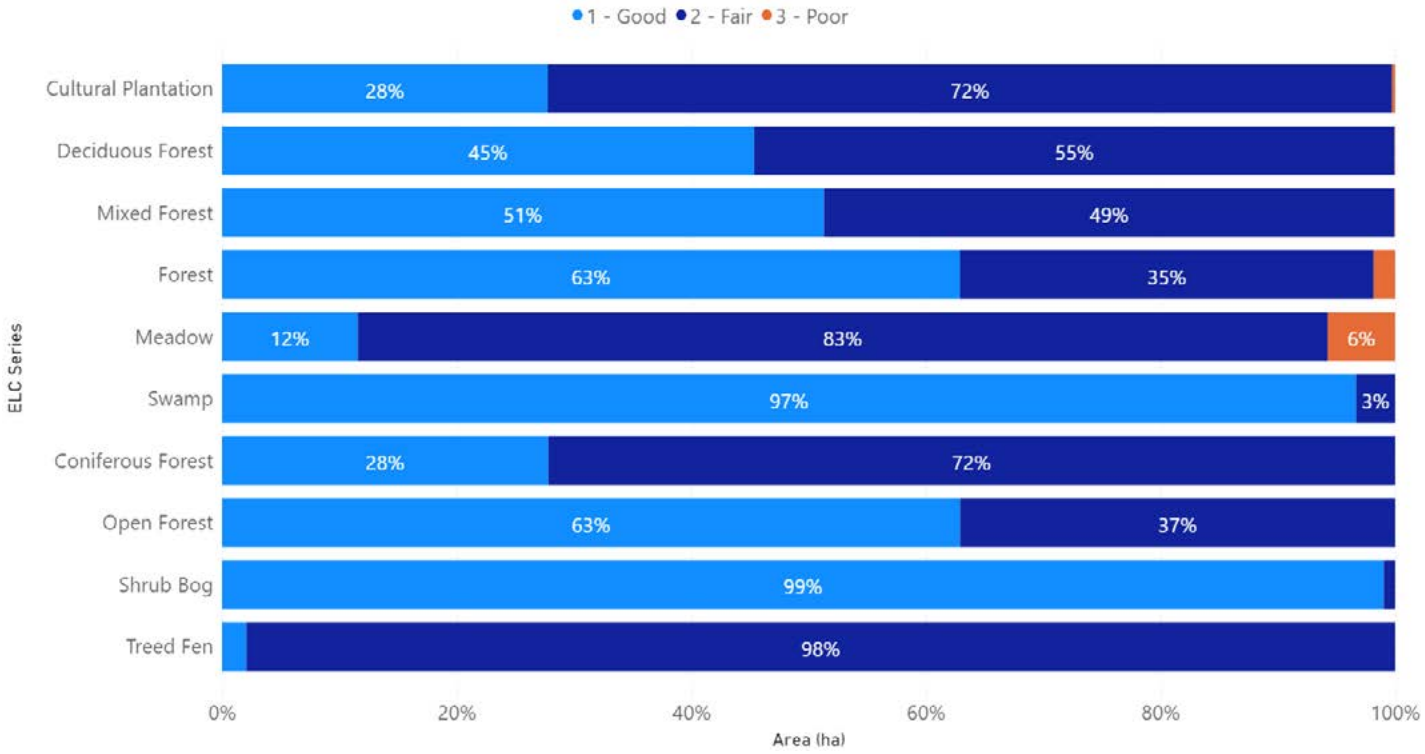

Figure 6: Summary of condition rating by natural asset type

4.6. Maintaining the inventory

Inventories are not static. Both the registry and the dashboard can be expanded as new information becomes available. For example, asset condition might improve as a result of restoration efforts, or new studies may add insights on the condition of the assets. New data can be reflected in the asset registry and subsequently in the online dashboard as it becomes available. Furthermore, the level of desired detail may evolve as asset management readiness increases or as areas of natural management focus emerge. However, inventories should grow in detail and sophistication only insofar as they remain aligned with the capacity of the communities to maintain them, and the uses to which they will be put. Their evolution and development should be a function of the monitoring, reporting and lessons of the asset management cycle and be driven by the imperative of ensuring sustainable, cost-effective delivery of services to the community, which is the core of asset management.

5 Risk identification

5.1. Risk identification tool overview

Identifying risks facing natural assets can help local governments prioritize their management of natural assets. To this end, MNAI provides local governments with a tool entitled *Risk Identification Process in the Development of Natural Asset Inventories* and guidance in self-administering it.

Risk management is a four-stage process that includes risk identification, analysis of probability and consequence, development of risk mitigation strategies, and control and documentation. The use of the risk identification tool informs the first and second stages of risk management through the identification of top risks to natural assets and their associated services, and a high-level analysis of impacts and consequences.

Risk types relevant to natural asset management typically include:

- **Service risk:** the risk of an asset failure that directly affects service delivery.
- **Strategic risk:** the risk of an event occurring that impacts the ability to achieve organizational goals.
- **Operations and maintenance risk:** risks related to poor asset controls and oversight, which can lead to poor record-keeping and poor monitoring of asset.
- **Financial risk:** risks related to the financial capacity of Northumberland County to maintain municipal services.
- **Political risk:** risks related to the nature of municipal politics.

5.2. Using the risk identification tool

Using the risk tool, Northumberland County considered possible risks that the loss of natural asset functions could pose to built infrastructure, personal health and safety, and private property, including:

- Overuse or inappropriate use of trails
- Dumping
- Forest fire
- Invasive species
- Development pressure
- Pollutant loading from urban, agriculture, and industrial activities
- Drought
- Erosion
- Lack of prescribed burns and restoration plans
- Lack of integrated pest management
- Mesophication

- Off trail / trespassing
- Forest harvesting / food
- Fauna levels
- Off-leash / out-of-control dogs

Each risk was then ranked low, medium or high according to the probability of an impact occurring and the relative magnitude of its negative consequences. To assess impact and consequence, Northumberland County considered four questions:

1/ what impact is likely to happen?

2/ what is the consequence of that impact happening?

3/ what can be done to mitigate the probability of impact and/or consequence?

4/ what cues will signal the need for mitigation?

5.3. Results of the risk identification process

The risk identification process revealed:

- 7 high-level risks (overuse or inappropriate use of trails, invasive species, lack of prescribed burns and restoration plans, lack of integrated pest management plan, *mesophication*, off-trail/trespassing, and off-leash/out-of-control dogs)
- 2 medium-level risks (forest fire and erosion)
- 4 low-level risks (dumping, pollutants, drought, and forest harvesting/food)
- 1 unknown-level risk (fauna levels)

In terms of scope, the identified risks affect natural assets across Northumberland County, particularly in the vicinity of trails and the forests and meadows of the special management zones. The identified risks have the potential to negatively impact engineered assets, property, and residents' personal health and safety.

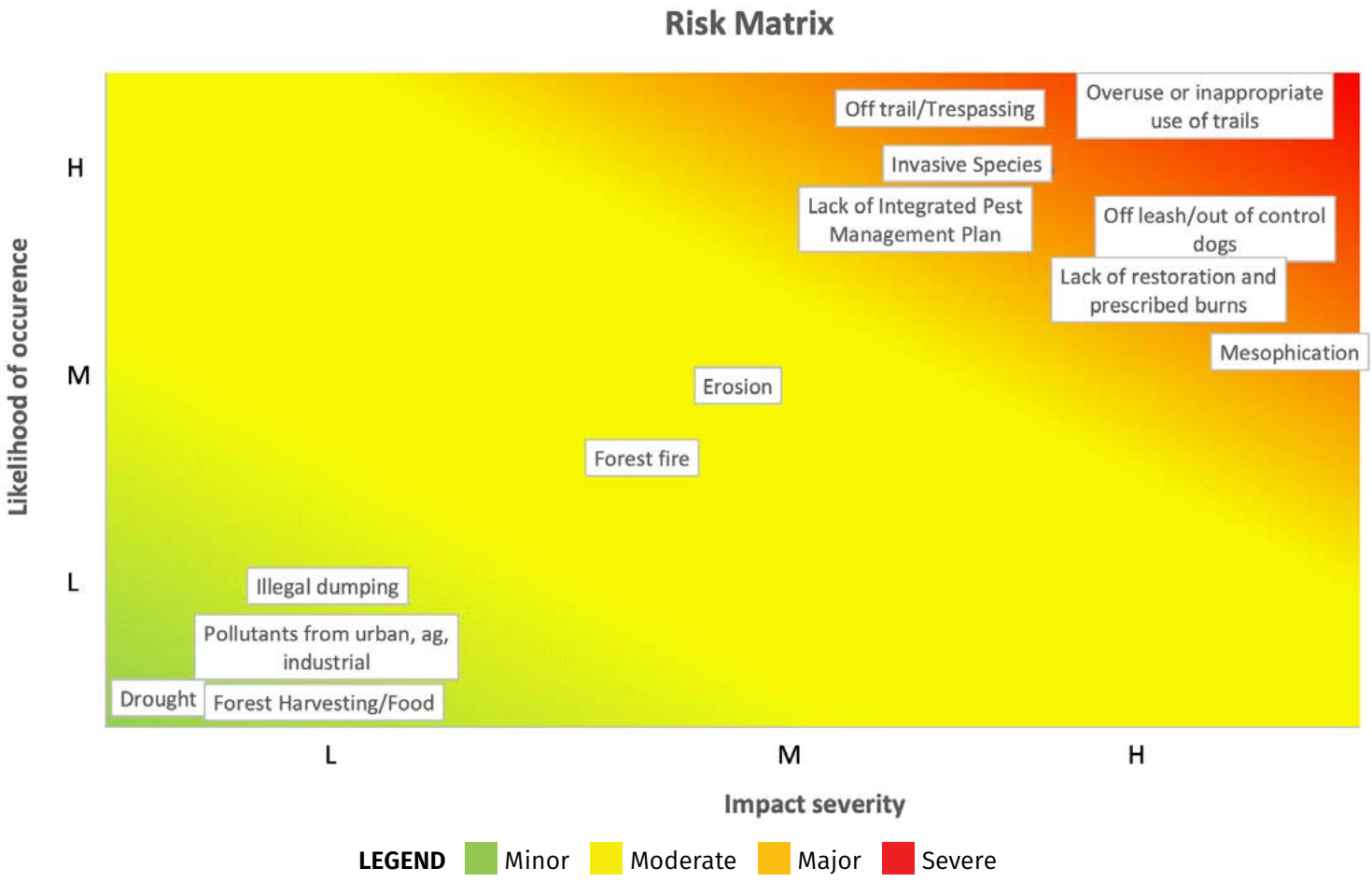

Figure 7: Results of risk management process

6 Recommendations

This section provides insights that can be gained from considering both the inventory - including the condition and risk assessments - and the asset management readiness assessment. It is divided into (6.1) potential priorities for the local government (6.2) possible actions for the further development of the inventory, and (6.3) steps Northumberland County can consider to advance to a full natural asset management initiative.

6.1. Potential priorities for the local government

Combining the results of the condition assessment with the outcomes of the risk identification highlights potential priorities on which Northumberland County could focus natural asset management efforts. These are grouped here in three areas: (i) overuse or inappropriate use of trails, (ii) invasive species, and (iii) forest hazard management.

- **Overuse or inappropriate use of trails:** Northumberland County manages a trail network of more than 118 km that offers recreational opportunities to approximately 100,000 visitors per year[5]. There are three high-level risks to trail integrity: overuse or inappropriate use, off-trail use and trespassing, and off-leash and out-of-control dogs. These risks are ongoing and manageable or tolerable at current levels. Overuse and inappropriate use areas and/or trails incorrectly aligned for drainage occurs in trails intersecting natural assets near the Fire tower, Lookout Mountain, and Dunbar Road. Off-trail use and trespassing is a concern along the hydro line. Off-leash and out-of-control dogs is a concern in the trailhead and major trail systems including Carstairs, Woodland, Morris and Beagle Club. To address these issues, Northumberland County provides public education, maintains and rehabilitates degraded trails, evaluates new trail locations against user experience, ecological, and financial considerations, and will incorporate trail infrastructure into asset management processes beginning in 2023.[6]
- **Invasive species:** Invasive species are an imminent and unmanageable high-level risk to all natural assets, particularly along trails. While some invasive species are tolerable, many are not. Invasive species can reduce resiliency, increase climate-related risks, negatively impact biodiversity, impair terrestrial and aquatic ecological services, lower property values, and increase municipal costs to maintain, control and eradicate target species. They can also impact engineered assets such as roads. To-date, Northumberland County has implemented conservation programs that remove invasive species, completed vegetation surveys to document changes, engaged partners to share information, helped fund and promote projects, and improved scientific understanding and land management procedures.[7] It has also identified the lack of an integrated pest management plan as a high-level risk to forests and all assets. The Forest Master Plan, which as noted is under development, identifies both this risk and steps to address it, including the development of an inventory, five-year plans, and associated staffing.[8]
- **Forest hazards:** The Northumberland County Forest Services manages 2,225 hectares of largely forested land and has achieved Forest Stewardship Council certification. The latter recognizes forest management that meets environmental, social and economic objectives. Two high-level forest risks were identified: the lack of a standardized operating plan to address monitoring, restoration, and prescribed burns; and *mesophication*, a feedback loop that transitions forest structure from fire-tolerant species[9] and their associated open forest structure

5 *Northumberland County, 2021.*
6 *Northumberland County, 2021a.*
7 *Northumberland County, 2021b.*
8 *Northumberland County, 2021a.*
9 *Nowacki and Abrams, 2008.*

to dense forest dominated by fire-sensitive species. These risks can impact forest and meadow assets (i.e., tallgrass prairie, savanna and meadow) within the special management zone (areas designated for particular management owing to significant ecological values). The Forest Master Plan aims to address these risks through commitments to the development of an inventory and operating plan (both of which will be updated every five years), silvicultural effectiveness monitoring, and staffing to meet Plan requirements.

Table 6 lists and provides brief descriptions of risk mitigation strategies.

TABLE 6: RISK MITIGATION STRATEGIES

Condition Rating	Number of Assets
Accept	Risk may be acceptable if probability and consequences are small
Minimize	Risk under local government's control that warrants exposure reduction
Share	Partners in a project permit the sharing of larger risks to reduce it for each
Transfer	Insurance, fixed price contracts, and other risk transfer tools

6.2. Opportunities to strengthen natural asset management at an organization-wide level

Northumberland County is at a relatively early stage of asset management in the policy and governance competency area for both engineered and natural assets. It does not have an asset management policy or roadmap to guide asset management progress. A short-term opportunity could be to develop both a strategy and a roadmap that incorporate objectives for both engineered and natural assets. These governance documents would help build a structured approach to asset management across the organization and educate Council on the benefits of integrated approaches that include natural assets.

Another short-term opportunity is to ensure that a member of the asset management team with appropriate skills is made responsible for integrating natural asset management into the asset management practices in the organization.

Northumberland County has made progress on natural asset management related to its forest assets through its Forest Master Plan, currently under development. Council has also demonstrated support for priority initiatives to improve natural asset management and incorporate it into core asset management business practices. A next step will be to determine resource requirements to make more progress following the completion of the inventory project. Steps could include developing a natural asset management strategy

or roadmap to guide activities over the next 1-3 years. Activities could include strengthening monitoring of natural assets to improve condition and performance information, understanding the value of services provided by natural assets, developing levels-of-service targets, and creating operations and maintenance plans for natural assets deemed high risk.

Northumberland County could also ensure that natural asset management considerations are incorporated into any future updates of asset management plans for core services and into financial planning for infrastructure.

6.3. Possible actions for the further development of the inventory

Based on the inventory, Northumberland County could consider the following, regardless of whether or not it pursues a full natural asset management process. These are mostly incremental measures:

- Expand the risk identification to include field verification of results.
- Determine acceptable levels of risk to Northumberland County's risk mitigation strategies (see Table 6).
- Further develop the condition assessment and risk assessment using local climate projections, land use modelling, and other data already at their disposal.
- Identify linkages between services and assets and assess the condition of, and risks to, the assets from the perspective of their ability to deliver services.
- Share the inventory with adjacent local governments to stimulate collaboration within the watershed.
- Add more condition ratings - for example, dominant tree species and canopy cover, which also links to mesophication.
- Initiate or enhance monitoring - for example, using gauges, water level sensors, and loggers to improve understanding of trends, feed into condition ratings of assets, and gather information for modelling.
- Maintain interest and momentum in natural asset management to move towards a full natural asset management project.

6.4. Steps to a full natural asset management project

If Northumberland County wishes to proceed with a full natural asset management project, including implementation, it will need to consider the following steps:

1/ **Confirm scope, roles and responsibilities**. Undertake a meeting or workshop to confirm (a) assumptions [for example, that water management and development pressure are the primary services of concern] (b) roles, responsibilities, and capacities (c) community capacity to undertake a larger project.

2/ **Fill essential knowledge gaps**. If discussions on scope and certainty and related data needs for modelling indicate the need for additional data, these could be filled.

3/ **Modelling**. Modelling the levels of service that natural assets currently provide and the levels of service under different potential management, local climate change projections, and rehabilitation or restoration scenarios, is central to natural asset management as it gives communities the ability to explore how different actions will affect the health and corresponding performance of natural assets.

4/ **Economic assessment**. The economic assessment component provides a market-based indication of (a) the current value of the services from natural assets if they had to be provided by an engineered means, and (b) the costs and values of different interventions in terms of service delivery.

5/ **Planning**. This step allows local governments to explore different scenarios such as "what happens to the services provided by the wetland if there is significant building upstream?" or "what happens to the services if the forest is restored?" Using modelling, changes in service levels can be understood and quantified. Corresponding values can also be determined through continued economic assessment. Based on the foregoing, local governments can begin to consider and prioritize actions ranging from status quo to planning, regulatory, financial operations, maintenance, acquisition, and monitoring interventions.

6/ **Implementation**. MNAI can provide ongoing advice / guidance on policy pieces and integration of the above information for 12-18 months. After that, the local government, together with local partners and service providers, would ideally have the capacity to continue these efforts on their own.

7/ **Ongoing monitoring**. It is essential to continue monitoring the project to learn whether interventions are working and to share lessons and learnings from other communities undertaking natural asset management. MNAI would typically stay involved with the community for three years through a monitoring arrangement to be established with the communities.

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Annex: Results of Northumberland County's risk identification

This Annex contains the results of Northumberland County's use of MNAI's risk identification tool, which they self-administered with guidance from MNAI. Table 7 was the main product from the exercise.

Step 1: Identification of risks

Common Risks to Natural Assets:

- Overuse of trails / dumping
- Flooding (current and future)
- Forest fire
- Invasive species
- Development pressure
- Pollutant loading from urban, agricultural, or industrial sources (e.g., overuse of salt on roads)
- Drought (current and future)
- Erosion
- Ice jams
- Storm surge
- Lack of flood hazard mapping
- Lack of land management plans
- Lack of monitoring reports
- Construction activity
- Political policy change

Step 2: Complete survey

TABLE 7: SIMPLIFIED RISK IDENTIFICATION SURVEY

Risk	Ranking (L/M/H)	Assets Affected	Location	Notes
1. High concentrated use/inappropriate use (high speed, banking, use out of season)/ incorrect alignment of trails	H	Any assets intersecting locations noted	Fire tower, Lookout Mountain, Dunbar Road trails	Manageable and ongoing.
2. Dumping	L	Any assets intersecting locations noted	Trailheads, along hydro lines	Tolerable and ongoing.
3. Forest Fire	M	Cultural plantations, mixed and deciduous forests, and meadows		Ongoing, potentially increasing with climate change and use of the forest.
4. Invasive Species	H	All assets, especially along trail sides within assets		Imminent, unmanageable; some species tolerable but many not.
5. Pollutants from urban, ag, industrial	L	Assets along County Road 45	County Road 45	Manageable and tolerable.
6. Drought	L	Cultural Plantation	Cultural Plantation within the Forest	Ongoing, potentially increasing with climate change and use of the forest.
7. Erosion	M	Assets next to noted trails	Fire tower and Lookout Mountain trails	Ongoing, manageable.
8. Lack of standardized Five-year Operating Plan and restoration to address monitoring, restoration, and prescribed burns	H	SMZ Forest and meadow Assets within SMZ noted as tallgrass prairie, savanna or meadow	SMZ	This is noted in the new Forest Master Plan which will be addressed through inventory and five-year plans and staffing.

TABLE 7: SIMPLIFIED RISK IDENTIFICATION SURVEY

Risk	Ranking (L/M/H)	Assets Affected	Location	Notes
9. Lack of Integrated Pest Management Plan	H	Forest, all assets		This is noted in the new Forest Master Plan which will be addressed through inventory and five-year plans and staffing.
10. Mesophication	H	SMZ Forest and meadow Assets within SMZ	SMZ	This is being addressed through inventory, planning, restoration, and staffing. Ongoing, intolerable.
11. Off-trail/ Trespassing	H	Assets along the hydro line	Hydro line	Ongoing, tolerable at current level.
12. Forest Harvesting/ Food	L	Deciduous and mixed forests within trailhead areas	Carstairs, Woodland, Morris and Beagle Club Trails	Ongoing, tolerable at known level. Monitoring to get more data on levels and impact.
13. Fauna levels (Deer)	Unk	Deciduous and mixed forests		This is being addressed through plots to determine deer population numbers.
14. Off-leash/out-of-control dogs	H	Assets in trailhead and major trail systems	Carstairs, Woodland, Morris and Beagle Club Trails	Ongoing, tolerable at current level.

Municipal Natural Assets Initiative