Preliminary A2A Frontenac Arch Conservation Action Plan

A2A | Algonquin to Adirondacks Collaborative

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Cover Photo: David Miller

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This document is intended to convey the results of a Trillium SEED grant to prepare a Conservation Action Plan in the Frontenac Arch area of the A2A Region. Prepared in partnership with the Frotenac Arch Biosphere reserve, the project involved application of the Open Standards for the Practice of Conservation collborative planning process through engagement from over 20 stakeholders and building on the foundation established by the Nature Conservancy of Canada through their Conservation Action Plan for the Frontenac Arch.

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GLOSSARY

Definitions are from the *Open Standards for the Practice of Conservation (Conservation Measures Partnership, 2013)* and the *Foundations of Success Training Manual (FOS, 2009).*

Action Plan – A description of a project's goals, objectives, and strategies that will be undertaken to abate identified threats and make use of opportunities.

Activity – A specific action or set of tasks undertaken by project staff and/or partners to reach one or more objectives. Sometimes called an action, intervention, response, or strategic action. (See relationship to strategies below.)

Adaptive Management – The incorporation of a formal learning process into conservation action. Specifically, it is the integration of project design, management, and monitoring, to provide a framework to systematically test assumptions, promote learning, and supply timely information for management decisions.

Assumption – A project's core assumptions are the logical sequences linking project strategies to one or more targets as reflected in a results chain diagram. Other assumptions are related to factors that can positively or negatively affect project performance **–** see also risk factor.

Biodiversity Target – A synonym for conservation target.

Conceptual Model – A diagram that represents relationships between key factors identified through situation analysis that are believed to impact or lead to one or more conservation targets. A good model should link the conservation targets to threats, opportunities, stakeholders, and key intervention points (factors – threats, opportunities, or targets – in a conceptual model where a team can develop strategies that will influence those factors. It should also indicate which factors are most important to monitor.

Conservation Target – An element of biodiversity at a project site, which can be a species, habitat, or ecological system that a project has chosen to focus on. All targets at a site should collectively represent the biodiversity of concern at the site. Synonymous with biodiversity target.

Contributing Factor – A factor identified in an analysis of the project situation that is a driver of, or opportunity to address, a direct threat. Often an entry point for conservation actions. For example, "logging policies" or "demand for fish". Sometimes called a root cause or underlying cause.

Direct Threats – Primarily human actions that immediately degrade one or more conservation targets. For example, "logging" or "fishing." They can also be natural phenomena altered by human activities (e.g., increase in extreme storm events due to climate change). Typically tied to one or more stakeholders. Sometimes referred to as a "pressure" or "source of stress." Compare with indirect threat.

Evaluation – An assessment of a project or program in relation to its own previously stated goals and objectives. See monitoring and compare to audit.

Factor – A generic term for an element of a conceptual model including direct and indirect threats, opportunities, and associated stakeholders. It is often advantageous to use this generic term since many factors – for example tourism – could be both a threat and an opportunity. Also known as root causes or drivers.

Goal – A formal statement detailing a desired impact of a project, such as the desired future status of a target. A good goal meets the criteria of being *linked to targets, impact oriented, measurable, time limited,* and *specific.*

Impact – The desired future state of a conservation target. A goal is a formal statement of the desired impact.

Indicator – A measurable entity related to a specific information need such as the status of a target/factor, change in a threat, or progress toward an objective. A good indicator meets the criteria of being: *measurable, precise, consistent,* and *sensitive*.

Indirect Threat – A factor identified in an analysis of the project situation that is a driver of direct threats. Often an entry point for conservation actions. For example, "logging policies" or "demand for fish". Sometimes called a root cause or underlying cause.

Key Ecological Attribute (KEA) – Aspects of a target's biology or ecology that if present, define a healthy target and if missing or altered, would lead to the outright loss or extreme degradation of that target over time.

Monitoring – The periodic collection and evaluation of data relative to stated project goals and objectives.

Objective – A formal statement detailing a desired outcome of a project such as reducing a critical threat. A good objective meets the criteria of being: *results oriented, measurable, time limited, specific,* and *practical.* If the project is well conceptualized and designed, realization of a project's objectives should lead to the fulfillment of the project's goals and ultimately its vision. Compare to vision and goal.

Outcome – The desired future state of a threat or opportunity factor. An objective is a formal statement of the desired outcome.

Program – A group of projects which together aim to achieve a common broad vision. In the interest of simplicity, this document uses the term "project" to represent both projects and programs since these standards of practice are designed to apply equally well to both.

Project – A set of actions undertaken by a defined group of practitioners – including managers, researchers, community members, or other stakeholders – to achieve defined goals and objectives. The basic unit of conservation work. Compare with program.

Project Area – The place where the biodiversity of interest to the project is located. It can include one or more "conservation areas" or "areas of biodiversity significance" as identified through ecoregional assessments. Note that in some cases, project actions may take place outside of the defined project area.

Scope – The broad geographic or thematic focus of a project.

Strategy – A set of actions with a common focus that work together to achieve specific goals and objectives by targeting key intervention points, integrating opportunities, and limiting constraints. A good strategy meets the criteria of being: *linked, focused, feasible,* and *appropriate.*

Target – Shorthand for biodiversity/conservation target.

Threat – A human activity that directly or indirectly degrades one or more targets. Typically tied to one or more stakeholders. See also direct threat and indirect threat.

Viability Assessment – A flexible and powerful methodology based on sound ecological principles that helps address the challenges of defining healthy targets and setting appropriate and measurable goals.

Vision – A description of the desired state or ultimate condition that a project is working to achieve. A complete vision can include a description of the biodiversity of the site and/or a map of the project area as well as a summary vision statement.

Vision Statement – A brief summary of the project's vision. A good vision statement meets the criteria of being *relatively general, visionary,* and *brief.*

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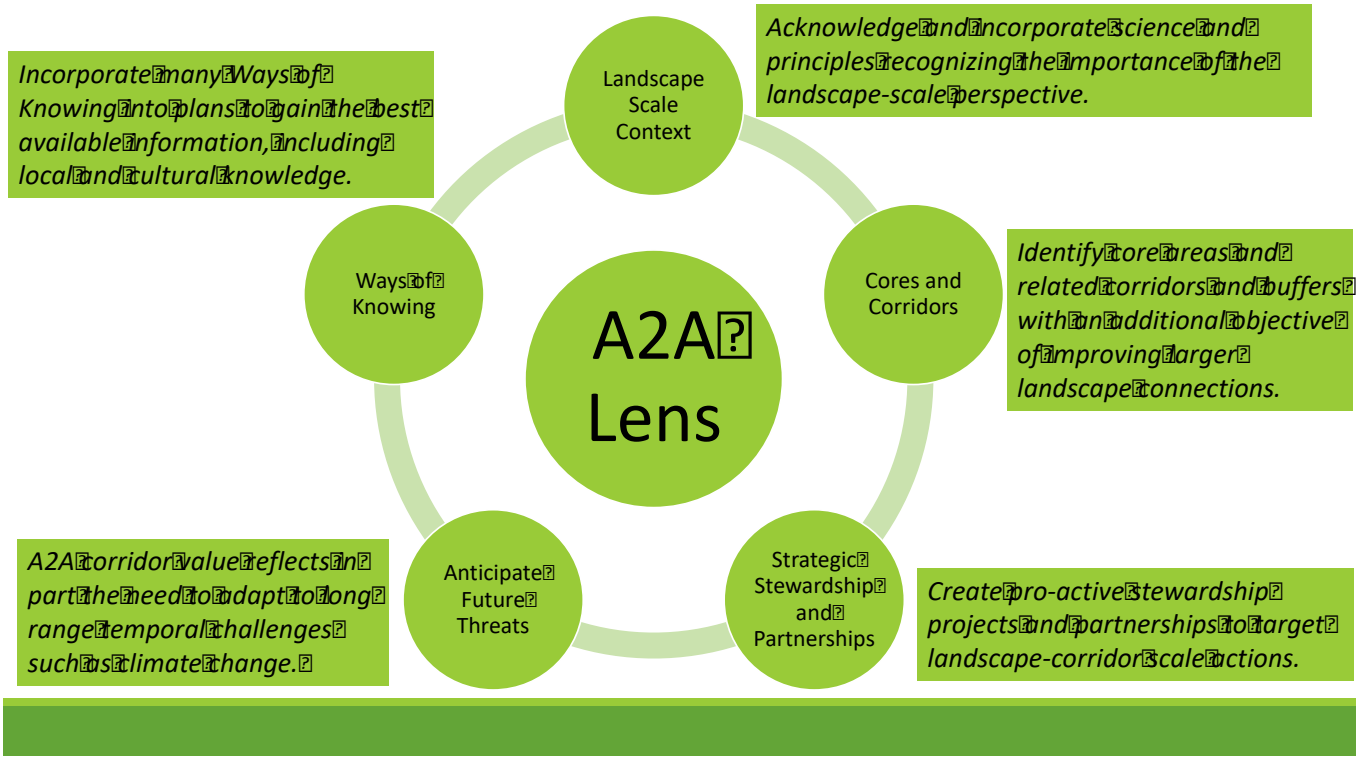
1. INTRODUCTION

1.1 Background

In 2017, the Algonquin to Adirondacks Collaborative (A2A) developed a landscape scale "A2A Lens" approach to applying the Conservation Action Planning (CAP) Framework within the Algonquin to Adirondack (A2A) corridor. The goal is to pilot this lens approach while developing a local Conservation Action Plan and establishing the necessary process and evidence to apply our landscape scale Lens to multiple Conservation Action Plans across the A2A corridor.

Figure 1. The A2A Lens developed in Phase I of the FA CAP project



A2A CAP Project: Phase 2

In 2018-2019, with the help of a Trillium SEED Grant, A2A facilitated the development of this Conservation Action Plan (CAP) for the Frontenac Arch (FA) focal area. The CAP is intended to complement and enhance ongoing conservation work by various organizations, including the Nature Conservancy of Canada's (NCC) Frontenac Arch Natural Area Conservation Plan III. One of the goals of the CAP is to ensure that conservation and community activities and investment in the FA area are as collaborative, strategic, efficient and measurable as possible.

Open Standards for the Practice of Conservation

The CAP is being developed using the *Open Standards for the Practice of Conservation* methodology developed by the Conservation Measures Partnership and which is used by NCC and many hundreds of organizations and agencies around the world. The Open Standards Adaptive Management loop outlines the key steps in the conservation planning process (Figure 2). Each step is explained in detail in the framework document.

Figure 2. Open Standards Adaptive Management Loop (CMP 2013)

Conservation Action Plan Template

The key components of the A2A Frontenac Arch Conservation Action Plan (FA CAP) are defined in Table 1. The definitions are derived from the *Foundations of Success (2009).*

Table 1. Components of the A2A Frontenac Arch Conservation Action Plan

Project Scope	Defines the broad parameters of the project.
Vision	A general statement of the desired state or ultimate condition that a project is working to achieve. It is relatively general, visionary and brief.
Conservation Targets	An element of biodiversity at a project site, which can be a species, habitat/ecological system, or ecological process that a project has chosen to focus on. All targets at a site should collectively represent the biodiversity concern at the site. Synonymous with biodiversity target.
Target Viability Assessment	A process to measure the health of the conservation targets. Provides a way for the project team to specify to the best of their knowledge what a healthy target would look like.
Target Threat Assessment	A threat is a human activity that directly or indirectly degrades one or more targets. The threat assessment is a method for rating impact of the threats on the conservation targets in a systematic way in order to identify where conservation strategies and actions should be focused.
Conceptual Model	A diagram that portrays what is happening at a project site (tool for documenting situation analysis). It shows the major forces (threats and opportunities) that are influencing biodiversity and lays out the causal relationships among those forces. It also identifies the strategies to abate the threats.
Target Goals	A formal statement detailing the desired future status of a target. Follow the "SMART" criteria: specific, measurable, achievable, results-oriented and timelimited.
Results Chains	A graphical depiction of a projects core assumption, the logical sequence linking project strategies to one or more targets. Lays out hypothesized relationships.
Action Plan	A description of a project's goals, objectives, and strategies that will be undertaken to abate identified threats and make use of opportunities.
Monitoring Plan	The plan for monitoring the project. It includes information needs, indicators, methods, spatial scale, locations, timeframe and roles and responsibilities for collecting data.

Development of the Science Background

The background work for this workshop is the **Nature Conservancy of Canada**'s Frontenac Arch Natural Area Conservation Plan, 3rd Edition, 2018-2028. This background information provides an excellent foundation to develop a community led CAP in the Frontenac Arch focal area. This was further refined through a Science Workshop for this project held on April 25th in Brockville.

During the development of the NCC Frontenac Arch NACP III, a team of NCC ecologists and biologists with intimate knowledge of the current state of the ecosystems and species at risk populations in the Frontenac Arch focal area went through the steps in the Conservation Action Plan process.

This included: refining a list of conservation targets for the focal area, completing a target viability assessment and identifying and rating key threats affecting the conservation targets. This background information was reviewed with project advisors and shared with a number of stakeholders. Many of the organizations taking part in this CAP may have provided comments on or viewed a copy of the NACP.

This Frontenac Arch NACP Third Edition was the starting point for the A2A Frontenac Arch CAP. It is important to remember that the Frontenac Arch NACP was not written from the perspective of a community-led CAP. This opens up opportunities to reconsider many aspects of the CAP process, to ensure the diverse perspectives in the Frontenac Arch focal area are represented.

2. METHODOLOGY

2.1 Conservation Action Planning Workshops and Webinar

This Situation Analysis for the A2A Frontenac Arch CAP (A2A FA CAP) area was developed primarily on the basis of information gathered during four days of Conservation Action Planning (CAP) workshops in the spring 2019, as well as a July 2019 webinar and document review by a number of participants at various stages of the process. The workshop content and participant representation are summarized by below:

1. Workshop 1: The first workshop was held on April 25 and was attended primarily by local science experts and conservation practitioners. An introduction to the CAP process was provided, and participants discussed the appropriate project scope and vision statement, and developed conservation targets and key ecological attributes for the viability assessment. Some key threats were also discussed.
2. Workshop 2: The next workshop was held over two days (May 6 and 7) in Gananoque, and was attended by science experts, municipal planners and a local stewardship

practitioners. The workshops focused on reviewing and building upon the work completed at the first workshop. Discussions focused on threats to conservation targets, contributing factors to those threats, goals, opportunities, and some preliminary conservation strategies.

3. Workshop 3: The third workshop was held on June 4 in Gananoque and was focused on developing strategies to address high priority threats at key intervention points.
4. Webinar: A half-day webinar was held on July 25 to discuss the final draft of the report, with an emphasis on discussing, evaluating and prioritizing the conservation strategies.

Existing gaps in the threat assessments, strategies and other component of the CAP will need to be addressed in future iterations of the A2A FA CAP process.

2.2 Open Standards for the Practice of Conservation

The adaptive management framework *Open Standards for the Practice of Conservation* (*Open Standards*) (CMP 2013) is being used to guide the development and implementation of the A2A Frontenac Arch Conservatio Action Plan project. The *Open Standards* is a science-based five step adaptive management cycle which brings together common concepts, approaches, and terminology in conservation project design, management and monitoring. The specialized software Miradi was used to develop key components of the Situation Analysis and Integrated Conservation Action Plan including: the viability assessment, threat assessment, conceptual models, and results chains. The *Open Standards* is an iterative process that uses best available information. Due to the adaptive nature of the framework, the Situation Analysis and other components of the CAP can be updated at any time as new information becomes available.

3. REGIONAL CONTEXT

3.1 Ecological Context

Geographic Scope

The Nature Conservancy's Frontenac Arch Natural Area Conservation Plan III (NCC 2019) (NCC-FANACP) definition, as follows, was used as the starting point for the A2A FA CAP scope discussion: "The Frontenac Arch, also called the Frontenac Axis, is found in the eastern section of the Great Lakes Ecoregion. This Natural Area (NA) extends from the St. Lawrence River, just east of Kingston north to just beyond the Frontenac Provincial Park region….The NA boundary is largely based on the Ecological Site District (Ecodistrict) 6E-10 (Westport) (Crins et. al 2009) with some modifications to include the full extent of some biodiversity targets and landscape connectivity….The boundary…includes portions of the Precambrian granites and metamorphic bedrocks characteristic of the Canadian Shield but which had not been included in the boundary of ecological site district 6E-10 because of the coarser scale of the surface feature mapping. The modified boundary includes additional examples of characteristic forests and

species and includes all Ontario occurrences of the globally rare Pitch Pine Granite Barrens ecosystem."

Discussions during the first A2A FA CAP workshop revised the geographic scope to reflect both the biophysical properties of the landscape as well as the collaborative nature of A2A, which includes a broad range of government and non-goverment organizations with a complex array of overlapping jurisdictions and areas of activity. These include federal and provincial agencies, conservation authorities, land trusts and a variety of other organizations.

The updated A2A Frontenac Arch CAP area boundary thus corresponds to Ecodistrict 6E-10 (Westport) with some modifications to include the full extent of a composite of the Frontenac Arch Biosphere Reserve area and NCC-FANACP III area, as well as some watershed considerations along the northern edge. The CAP area also includes adjacent waters of the St. Lawrence Seaway (Figure 1). A 10 km "buffer" was also mapped to emphasize that the A2A FA CAP boundary should not be considered a hard line, but more of a transitional area between areas with some ecological distinctiveness that relates to geology, physiography, topography, soils, land use, local climate, etc. There is continuous exchange of resources such as water and air, and movement of biota, with adjacent areas.

The FA CAP area thus overlaps with Anishinaabe (Algonquin) and Haudenosaunee (Iroquois) lands and covers a region from Brockville and Gananoque, to lands north of the City of Kingston, including Harrowsmith, Verona and Westport. It encompasses and area of approximately 2,900 km^2 (or 5,895 km^2 with the 10 km buffer).

Physical Context

The Frontenac Arch is an approximatley ~100 km-long and ~50 km-wide expanse of largely exposed Precambrian bedrock extending across southeastern Ontario in the Kingston – Thousand Islands area, linking the Precambrian rocks of the Canadian Shield that cover central and northern Canada with those of the Adirondack Mountains in the northeastern United States (NCC 2019). The A2A Frontenac Arch CAP area occupies the southeastern portion (approximately half) of Ecodistrict 6E-10, the only ecodistrict in southern Ontario's Ecoregion 6E in which the igneous and metamorphic bedrock predominate.

According to White (1993), ecodistrict 6E-10 "…is a moderately broken landscape with thin, impoverished, drought-prone soil, frequent blocked drainage, numerous small wetlands, many various-sized lakes, frequent bedrock exposures and rock barrens, and frequent cliffs and escarpments. Large portions of the [ecodistrict] consist of tilted and alternating layers of erosion-resistant igneous rocks and more easily eroded marbles. The result of this structural arrangement is a 'ridge and valley' topography consisting of often long bare humpbacked granitic ridges alternating with valleys of moist to wet forests and wetlands. Igneous rock cliffs and escarpments are common."

The physical landscape of the Frontenac Arch has been profoundly influenced by glaciation, with much of the upland areas having been scoured of surface materials by the glaciers (White 1993). The glacial Lake Iroquois covered the extreme southern part of the Frontenac Arch, leaving behind clay deposits that occur in a "knob and flat" pattern amongst the frequent igneous rock outcrops (the "knobs"). The frequent depressions and broken drainage patterns of the ecodistrict also result in large numbers of small, isolated organic (peat and muck) deposits. Four major landforms were identified by Chapman and Putnam (1984): shallow till and rock ridges (72%), bare rock ridges and shallow till (10%), organic (muck and peat), and clay plain (8%). Sand plain (1%) and kame moraine (<1%) also occur (Figure 1).

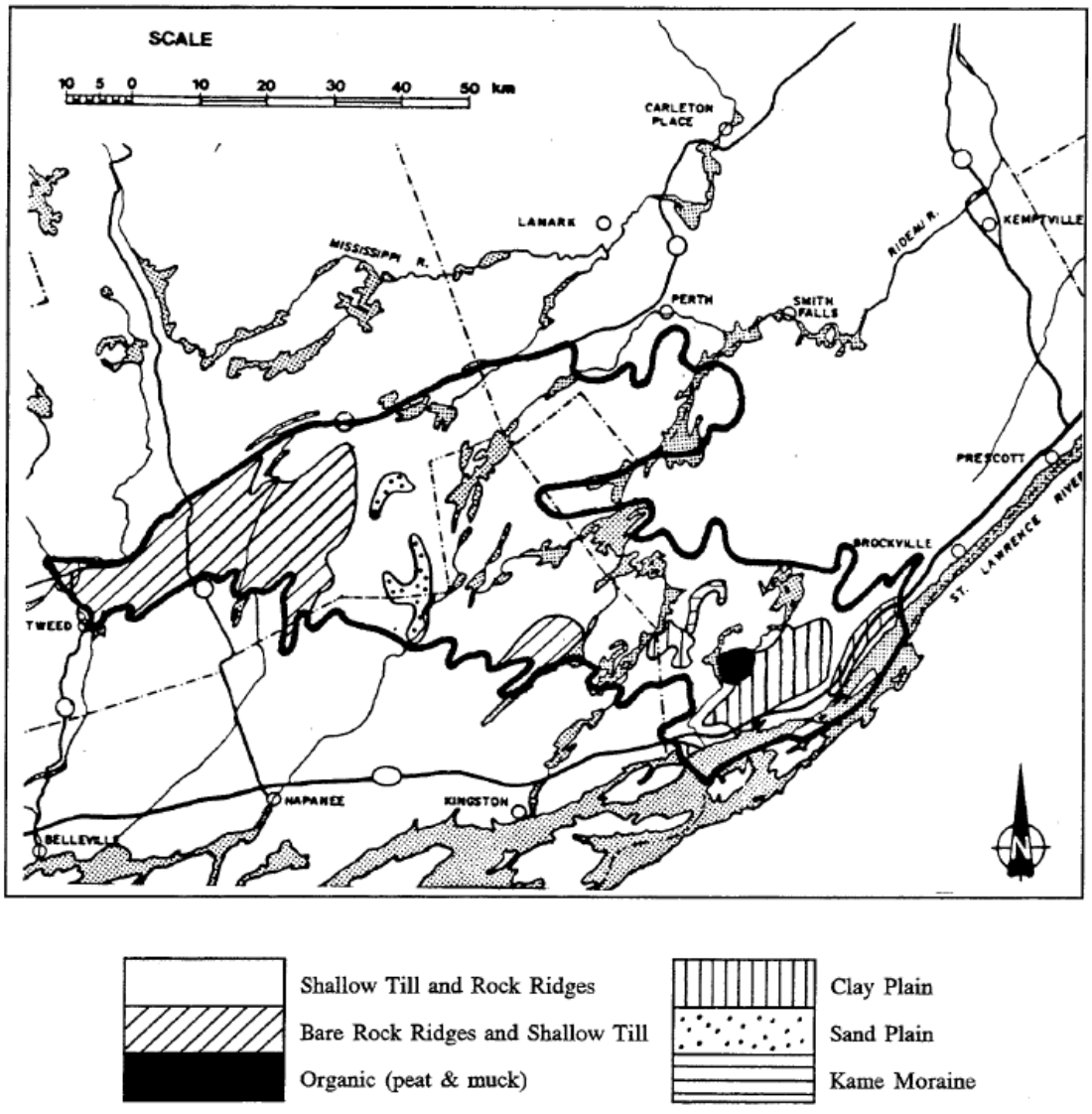
Land Cover

The forests of the Frontenac Arch are predominantly mixed to deciduous, dominated by Sugar Maple, American Beech, Yellow Birch, Eastern Hemlock, with Eastern White Pine and Red Pine also frequent, particularly on the dry bedrock ridges (White 1993). Other tree species frequently occurring under suitable conditions include White Spruce, Balsam Fir, Trembling Aspen, Paper Birch, Red Oak and Basswood. Treed wetlands are dominated by combinations of Eastern White Cedar, Tamarack, Black Spruce, Black Ash, Red Maple and White Elm. The forests of the Frontenac Arch also have distinct southern affinities, and are the only area in Canada in which Pitch Pine occurs, making the forests more allied with those of the Northern Appalachians than of the Algonquin Highlands (NCC 2019).

The northwestern portion of the Frontenac Arch CAP area is heavily forested on shallow till with frequent bedrock ridges (White 1993). This area has a preponderance of marbles and other less acidic metamorphic rock, which results in a greater diversity of flora, with a relatively high concentration species with more southern distribution. The clay plains of the extreme southeastern portion of the CAP area, the "Leeds Knobs and Flats", have largely been converted to agriculture, but historically are believed to have supported a high diversity of southern flora (White 1993), many of which are still present in the patches of natural area that remain. The Thousand Islands themselves are the granitic "knobs", projecting out of the waters of the St. Lawrence River.

Wetlands in the Frontenac Arch area include emergent aquatic and open water marshes, which occur on the "organic" landform, and are commonly associated with wet basins, along rivers, and in the shallows of lakes. The most common marsh type is dominated by Common Cattail, but a considerable diversity of small patch open water communities occur (White 1993). Deciduous and mixed swamps are also common in low-lying areas, including river flood plains. Red Maple, White Cedar and Black Ash are the most common tree species. Coniferous swamps are uncommon, and are typically dominated by White Cedar and Tamarack where they occur (White 1993). Speckled Alder and willow-dominated thicket swamps, as well as open bogs, are common in wet basins, whereas open fens and treed bogs are rare but present.

Figure 3. Landforms of Ecodistrict 6E-10 (White 1993)



Lakes and rivers are common, with lakes predominating in the western and northern portions of the Frontenac Arch, and the St. Lawrence, Gananoque Rivers being the dominant waterbodies in the south and east. Natural cover along the shorelines of the lakes and rivers varies from being extensive in many northern and western areas, and largely fragmented by cottage and other development in the south and east.

Table 2. Terrestrial Land Cover in the Frontenac Arch area (NCC 2019)[1]

Land-cover type	NCC NACP Area (ha)	% NCC NACP	A2A FA CAP Area (ha)	Proportion of A2A FA CAP Area	% of classified** CAP area	Relevant Conservation Target*
Forest	98,739.2	57.55%	127,432.7	44.3%	51.4%	Forests
Open Water	35,914.7	20.93%	45,955.3	16.0%	18.5%	Aquatic Systems
Wetland	12,918.9	7.53%	31,534.6	11.0%	12.7%	Wetlands
Agriculture	6,071.4	3.54%	6,071.4	15.9%	2.4%	n/a
Agriculture - Row Crops	2,056.5	1.2%	14,251.2	4.9%	5.7%	n/a
Agriculture - Hay, Pasture, Grassland	9,808.6	5.73%	9,808.8	3.4%	4.0%	Forests* / R & A
Developed Areas	2,482.7	1.45%	4,948.7	1.7%	2.0%	n/a
Roads	2,321.4	1.35%	5,359.8	1.9%	2.2%	n/a
Rock Barren	830.1	0.48%	831.0	0.3%	0.3%	Forests
Aggregate/Mining Areas	282.4	0.16%	481.9	0.2%	0.2%	n/a
Agriculture - Hedge Row	126.5	0.07%	1,174.3	0.4%	0.5%	Forests*
Utility Corridor	9.8	0.01%	9.8	<0.1%	<0.1%	Forests* / R & A
Plantation	4.0	0.00%	225.0	0.1%	0.1%	Forests*
Cliff	2.3	0.00%	2.3	<0.1%	<0.1%	Forests*
Undifferentiated	0.0	0.00%	39,711.3	13.8%**	16.0%**	
Total	**171,568.5**		**287,798.7**			

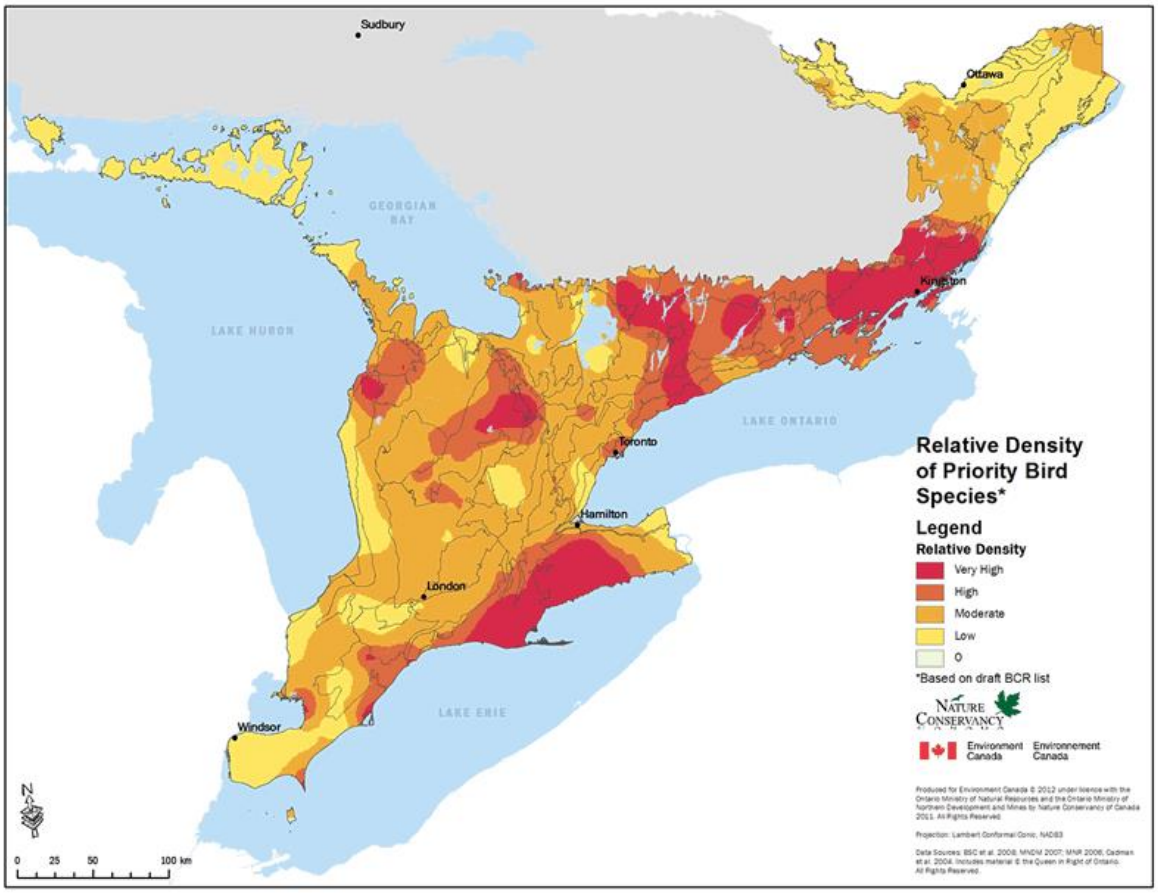
* - Some naturally-occurring non-forested (e.g., cliffs and rock barrens) land cover types are considered "nested" within the matrix "Forest" conservation target. Some anthropogenic land cover types (e.g., utility corridors, grasslands, pasture, hayfields and hedgerows) are associated with both "Forest" and "Reptile and Amphibian" conservation targets because they may provide habitat (e.g., movement corridors, feeding areas) for nested terrestrial targets (e.g., Gray Ratsnake, other herpetofauna, birds, insects).
** - The "Undifferentiated" or "unclassified" land cover category probably includes agriculture as well as other land cover types.

[1] NCC-FANACP (NCC 2019): "Several sources of data were used for the land cover-type delineation and area calculations. To determine the extent of rare habitats and biodiversity targets in the NA, a combination of data sources were used including Ecological Land Classification (ELC) (Lee et al. 1998) data from NCC, Sustaining What We Value multi-partner project (SWWV), Southern Ontario Land Resource Information System (SOLRIS), the Agriculture and Agri-Food Canada 2016 Crop Inventory (AAFC Crop Inventory) and Ontario Hydro Network (OHN). Some air photo interpretation and NCC reconnaissance were used to refine land cover data. The sources listed … were all used to calculate target size. These layers were coordinated in such a way that data overlaps resulted in the data determined most accurate to drive the final statistics, with preference given in order to NCC, SWWV, SOLRIS, then AAFC Crop Inventory data. All data layers were then clipped to the NACP boundary and the area of each land cover type was calculated in hectares."

Significant Features

According to NCC (2019), "The Frontenac Arch supports globally significant biodiversity, important ecological functions and a large number of rare and imperilled species (Wichert et al. 2005, Phair et al. 2005). This area is a significant area of ecological overlap between northern species, and southern species at the northern end of their ranges (Beschel et al. 1962, Bell 1976a and 1976b). The result is a narrow band supporting one of the highest densities of rare species in Ontario (McMurtry et al. 2008). In addition, the Arch serves as a migration and dispersal corridor for many species, especially forest-obligate birds and wide-ranging mammals. The Frontenac Arch is known, in particular, for its rich, southern-influenced forests and its high diversity of reptiles, amphibians and birds (e.g., de Vos 1964, Bell 1976b, OMNR 2005).
Two ecological systems are identified and tracked within the Frontenac Arch by NHIC: Pitch Pine Treed Granite Barren (G3G5 S1) and Graminoid Coastal Meadow Marsh (G2? S2). Approximately 26 % of the NA is identified within the Terrestrial Conservation Blueprint (Henson and Brodribb 2005) and approximately 28 % of the NA is identified within the Aquatic Conservation Blueprint (Phair et al. 2005)." The importance of the Frontenac Arch to biological diversity is exemplified by the "very high" diversity of priority breeding bird species (Figure 4).

Figure 4. Relative density of priority bird species in southern Ontario (ECCC 2015)



The list of significant species presented in Appendix A presents all nationally listed (COSEWIC) and provincially listed species at risk (Committee on the Status of Species at Risk in Ontario [COSSARO]), provincially tracked species (S1-S3S4), and all globally rare species (G1-G3G4), as well as their associations with the conservation targets of the A2A FA CAP. The primary data source used to develop the significant species was the NCC- FANACP (NCC 2019), which derived its information from the NHIC (2018) Element Occurrence (EO) database, NCC's Frontenac Arch property species records, and citizen science bird records from eBird. The list in Appendix A is an adaptation of the table in the NCC-FANACP that accounts for the modified conservation targets of the FA CAP (i.e., addition of "Aquatic Systems" and "Reptiles and Amphibians" and removal of "Surrogate Grasslands"). Fifty-four designated species at risk (SAR) occur in the A2A FA CAP area, with COSEWIC listing 16 of them as Endangered, 25 as Threatened and 13 as Special Concern federally. Provincially, COSSARO lists 17 as Endangered, 18 as Threatened, and 19 as Special Concern. An additional nine globally-rare (ranked G1 to G3G4) and 94 provincially rare tracked species are documented for the area (five of them only known from historical records).

One vegetation community type, Pitch Pine Treed Granite Barren, may be globally rare (G3G5) and is found nowhere else in Ontario (ranked S1, or extremely rare, by NHIC) or Canada.

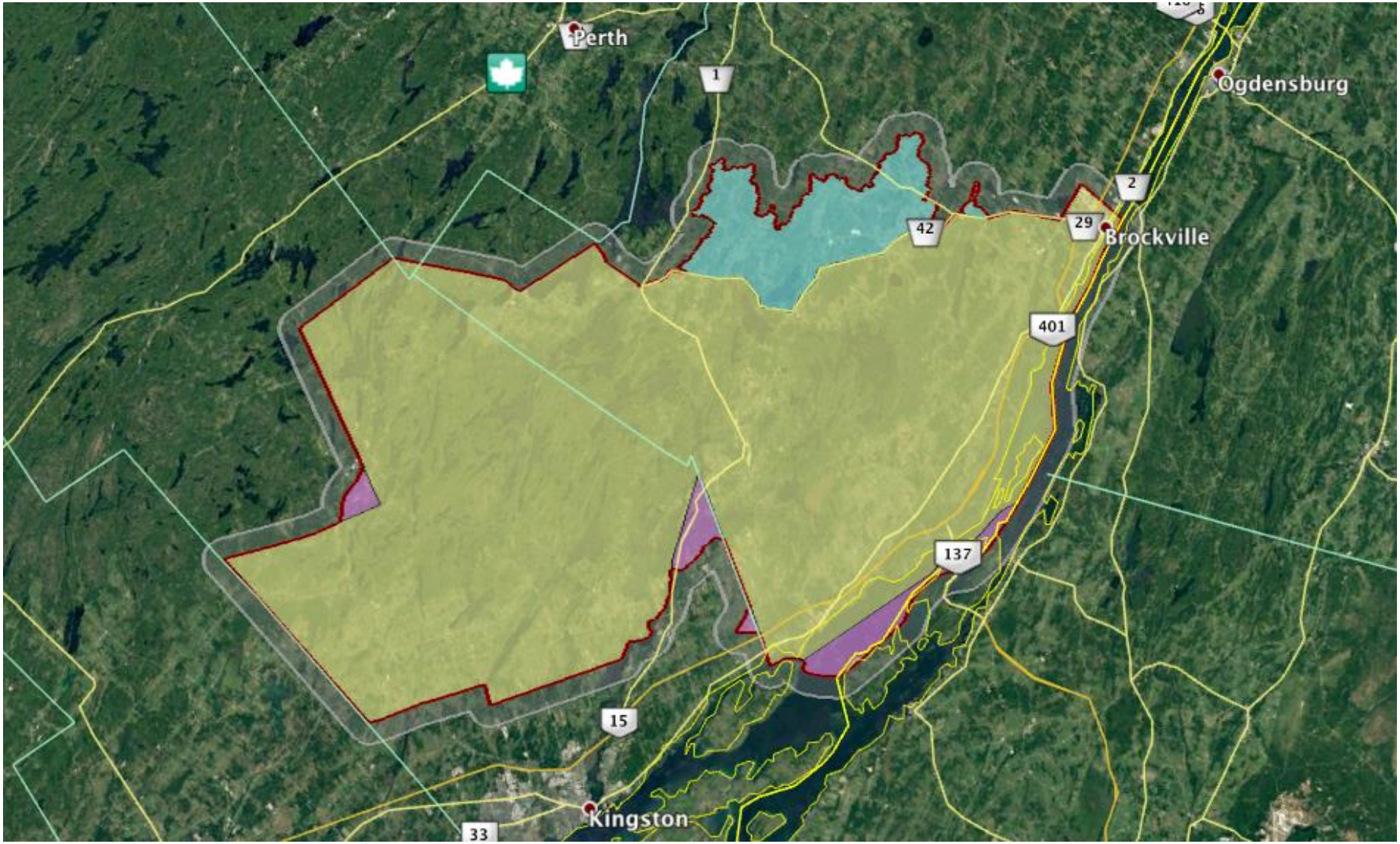


Figure 5. The A2A Frontenac Arch CAP area

3.2 Cultural and Socioeconomic Context

The A2A Frontenac Arch CAP area overlaps with the traditional territories of the Mohawk Nation at Akwesasne to the east, the Tyendinaga Mohawk Territory to the west, and the Algonquins of Ontario to the north. The Frontenac Arch region has a long history of human use, with evidence of hunting and fishing dating back at least 7,000 years (NCC 2019).

According to NCC 2019: "Lands were granted by the Crown after the American War of Independence, and especially after the War of 1812. As a result of this settlement, farming operations were established on the land and timber came under heavy harvest. By the mid-1800s, most of the timber in the area (primarily oak and pine) had been cleared and exported to Europe for ship-building (Keddy 1994). As farming increased further all that remained of the forest were fragmented patches. Dairy and hay farming were the most fruitful types of farming, as the soil tended to be poor and included granite outcrops. Eventually the majority of farming in the area was abandoned and the abandoned farmlands experienced the successional growth of shrubs, followed by pioneer trees such as Northern Prickly-ash (*Zanthoxylum americanum*), Staghorn Sumac (*Rhus typhina*), Eastern Red-cedar (*Juniperus virginiana*) and elm (*Ulmus* spp.) (FABN 2007). Approximately 42,000 acres (17,000 hectares) of agricultural land exists in the NA.

"In the 20th century, the [Frontenac Arch] was affected by two large infrastructure projects: the construction of the Thousand Islands International Bridge (1937-1938) and the opening of the St. Lawrence Seaway in 1959. With this development, an increase in automotive and ship transport was inevitable to the area (FABN 2007).

"Today, land uses vary from urban to suburban residential development, agricultural lands [Figure 5], park and conservation lands and recreational and tourism uses. The area has become a renowned vacation site, and sport fishing has become extremely popular in the region due to the populations of Largemouth Bass (*Micropterus salmoides*), Smallmouth Bass (*Micropterus dolomieu*), Lake Trout [*Salvelinus namaycush*], Northern Pike (*Esox lucius*) and Muskellunge (*Esox masguinongy*) (FABN 2007).

"The Frontenac Arch Biosphere Reserve was established by UNESCO in 2002. The Biosphere Reserve concept is a model for sustainable community development that encourages economic development without damage to the rich cultural history of the area (hunting/gathering, immigration/settlement, natural resources, industry, leisure and tourism) and the natural environment which has sustained the quality of life in this area. Linking conservation to sustainable development is the ultimate challenge in an area which has uniquely important cultural history and environmental features. The Biosphere reserve concept enables stakeholders to contribute local knowledge and experience to the achievement of conservation and development goals. Residents in the area have a strong sense of identity, awareness of

their roots and are sensitive to the rhythms of the landscape they live in. They share a fervent commitment to protect the unique cultural and natural resources of the region for future generations (FABN 2007).

“The areas that encompass the greatest portion of the Frontenac Arch…are Rideau Lakes Township, South Frontenac Township and Leeds and the Thousand Islands Township. The most significant urban areas that influence the [area] are the City of Kingston (a small portion of the city lies within the [CAP area]) and the Town of Gananoque (most of which lies within the [CAP area]). Census data for these areas shows that the population growth rates between 2011 and 2016 were as follows: 2.4% (Kingston), 2.0% (Leeds and Thousand Islands Township), 1.2% (Rideau Lakes Township), 2.9% (South Frontenac) and -0.7% (Gananoque) (Statistics Canada 2017). The area hosts a rich history of summer homes, which can be traced back to the early 20th century when extremely wealthy citizens summered along the St. Lawrence River. Today, the number of second homes (usually cottages or summer home properties) in these three townships reflects the century-old trend, with 25 to 36 % of homes reported as second dwellings in Leeds and the Thousand Islands, South Frontenac and Rideau Lakes Townships (Statistics Canada 2011). There is a growing trend for development of estate homes rather than cottages, and a resident population has been gradually replacing the cottage population.

“The number of natural resources, agriculture and related jobs in the Frontenac region in 2016 was 1,055. This represents 1.36% of the total occupations. 735 of these jobs were in Kingston, and 40 in Gananoque. (Statistics Canada 2017) The most popular occupations in the Frontenac regions were sales and service (~25%), business, finance, and administration (~13%) and education, law, social and government services (18%). In 2016, 22% of census respondents reported travelling outside of the Frontenac Region to work. 82% of the overall workforce primarily relied on cars, trucks, and vans to commute, with 22% travelling over 30 minutes to get to work (Statistics Canada 2017).

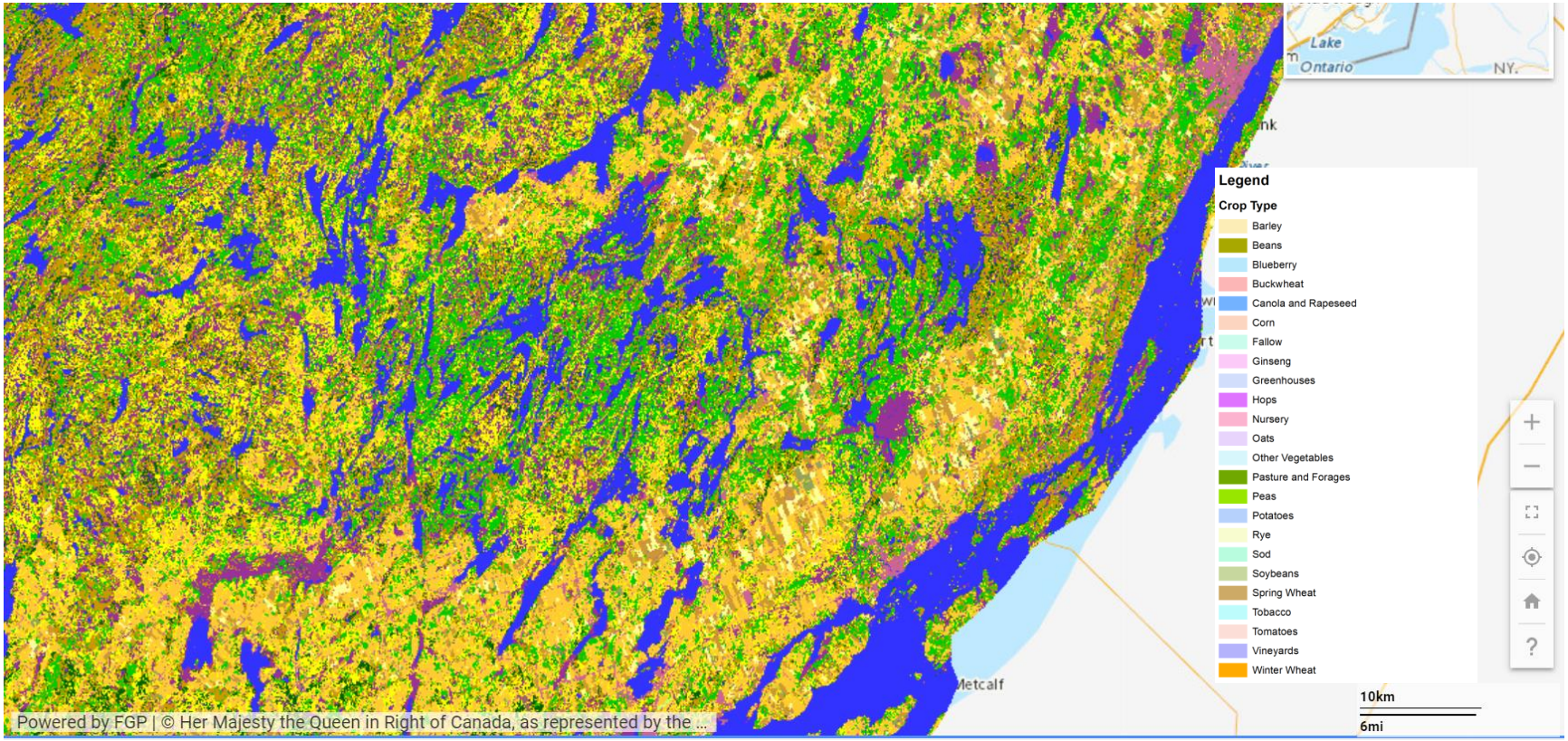


Figure 6. Annual Crop Inventory in the Frontenac Arch area

(Agriculture and Agri-Food Canada 2019 https://open.canada.ca/data/en/fgpv_vpgf/ba2645d5-4458-414d-b196-6303ac06c1c9)

).

3.3 Conservation and Stewardship Context

The Frontenac Arch area has retained much of its natural integrity due to the conservation and stewardship initiatives spearheaded by private landowners, government, conservation authorities, and not-for-profit organizations that share a shared vision of habitat connectivity and protected conservation values. These include Parks Canada - Thousand Islands National Park (TINP), Ontario Ministry of Natural Resources and Forestry (OMNRF), Ontario Nature (ON), Thousand Islands Watershed Land Trust (TIWLT), Rideau Waterway Land Trust (RWLT), Land Conservancy for Kingston, Frontenac, Lennox and Addington (LCKFLA), Algonquin to Adirondacks Collaborative (A2A), Queen's University, Cataraqui Region Conservation Authority (CRCA), the Rideau Valley Conservation Authority (RVCA) and the Frontenac Arch Biosphere Network (FAB). Conservation organizations active on the United States side of the Frontenac Arch include The Nature Conservancy (TNC), the Adirondack Land Trust (ALT), Thousand Islands Land Trust (TILT), the Indian River Lakes Conservancy, the New York Department of Environmental Conservation, and the US Fish & Wildlife Service (FWS) (NCC 2019). Government-supported conservation work, through federal and provincial species at risk stewardship funds, forestry initiatives, protected areas, as well as tax and funding incentives, has also contributed significantly to research, stewardship, land protection and ecological restoration in the Frontenac Arch area. Private landowner conservation and stewardship efforts have also long been supported by Conservation Authorities and not-for-profit organizations the area.

Protected Areas and Conservation Lands

According to NCC (2019), approximately 85% of the [Frontenac Arch] area is in private ownership, while 10 % of the NA is under provincial or federal regulation as federal and provincial parks and provincial wildlife areas, or as conservation lands under ownership of a non-government agency (e.g., NCC, other land trusts, Conservation Authorities, Queen's University or Ontario Nature).

Nature Conservancy of Canada (NCC)

NCC currently owns and manages over 4,800 acres (1,942 hectares) of land in the area, but has also assisted numerous partners in the acquisition of an additional 7,375 acres (2,985 hectares). Since 2007, NCC has been making targeted efforts on the Frontenac Arch, securing key properties and assisting partners, especially land trusts, in their conservation efforts.

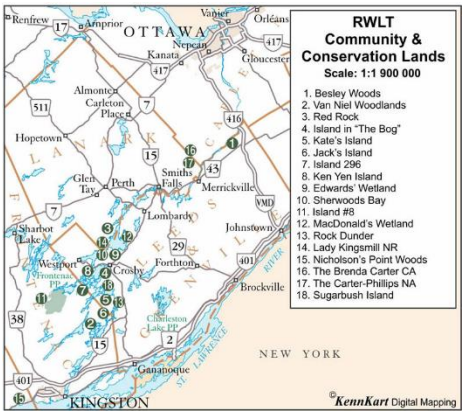
Land Conservancy for Kingston, Frontenac, Lennox and Addington

The Land Conservancy now protects eight properties with a total area of 220 hectares (540 acres), providing habitats for 19 species at risk. To preserve these habitats for all the animal and plant species that thrive there, most Land Conservancy properties are not open to the public. They are nature reserves for the purpose of conservation.

The Land Conservancy holds conservation easements on two properties, totaling 85 hectares (212 acres), one near Westport and the other on the Salmon River, with 990 meters of shoreline. A conservation easement limits further human use of the land, preserving natural features in perpetuity.

Finally, the Conservancy has developed a Natural Heritage Plan to assist with identifying high habitat diversity areas that may be priorities for our land conservation and stewardship activities. We used data from Land Information Ontario and other sources creating map layers, for example, wetlands, forest cover, and already protected areas. The conservation goal is to maintain enough wild habitat to support native plants and animals and to maintain connections between these habitats.

Rideau Waterway Land Trust

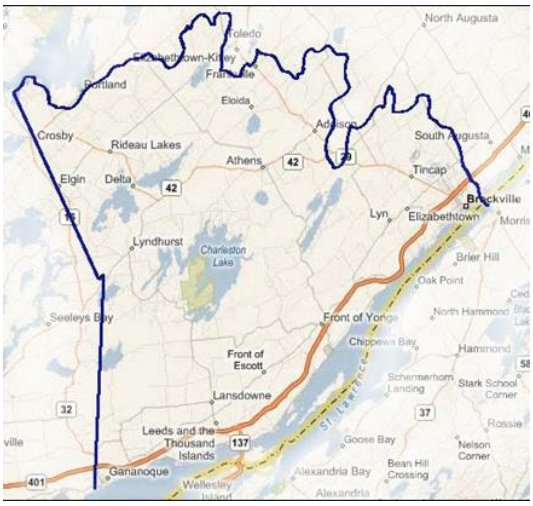


The Rideau Waterway Land Trust (RWLT) is a charitable organization established in 1996 with a mission to preserve important natural lands and habitats in the Rideau Corridor and foster a healthy future for our communities. The RWLT is governed by an elected volunteer Board of Directors. These volunteers come from a variety of backgrounds, including land-use planning, environmental management, education, law, finance and fundraising.

The RWLT has been able to preserve 19 significant properties through ownership and conservation easement while expanding its area of interest to include all the communities within the Rideau Corridor from Kingston to Ottawa. (see http://www.rwlt.org/)

Thousand Islands Watershed Land Trust

TIWLT pursues its mission to "permanently protect land in the Thousand Islands watershed region through acquisition or conservation agreements, and to achieve good land management through stewardship agreements and education" through a number of mechanisms.



In addition to Conservation Agreements (legal covenants between landowners and a Land Trust that define downstream preservation of land conservation values), donation agreements (transfer of ownership to the Land Trust) and land purchases for transfer to third-party stewards such as national or provincial parks, TIWLT acts as a broker to facilitate the transfer of lands from private to public ownership in cases where this can result in the preservation of appropriate land conservation values.

Leeds-Grenville Stewardship Council

The Leeds – Grenville Stewardship Council is a unique program in which a volunteer, community-based group works on environmental enhancement projects. It is a credible forum and resource for the many community-based stewardship/ environmental groups in our community and works extensively with the partners throughout the Frontenac Arch area. Projects include sustainable forestry, stream restoration and buffering, education and awareness, and species at risk work. http://www.lgstewardship.ca/

Natural Heritage System Planning

Natural Heritage System (NHS) planning plays an important role in conserving natural features and habitats in Ontario. Under the Planning Act, the Provincial Policy Statement (PPS) considers natural heritage to include those features and areas that are important for their environmental and social value, and states that “natural features and areas shall be protected for the long term” (OMMAH 2014). Within the A2A FA CAP area, such natural features include: significant wetlands, significant coastal wetlands, significant woodlands, significant wildlife habitat, and significant areas of natural and scientific interest (ANSI).

Official Plan was adopted xxxx and recently underwent a five year review in xxxx. It contains policies related to the conservation of Natural Heritage Features, Provincially Significant Features, a Natural Heritage Systems Strategy, and the Frontenac Arch Biosphere Reserve

Table 3. Land protection in the Frontenac Arch area (NCC 2019)

Land ownership	Conservation status	Area (ha)	Proportion of the Frontenac Arch area (%)
Parks Canada - Thousand Islands National Park	Protected	2247.71	1.31
Ontario Parks (OP) Charleston Lake PP (with Sheffield NCC partnered property) & Frontenac PP	Protected	7629.12	4.45
Gananoque Provincial WA	Protected	533.12	0.31
Conservation Authority Areas Cataraqui Region Conservation Authority Rideau Valley Conservation Authority	Protected	1487.40	0.87
Rideau Watershed Land Trust **Land Conservancy of Kingston, Frontenac, Lennox & Addington** **Thousand Islands Watershed Land Trust**	Protected	820.59	0.48
Ontario Nature	Protected	193.68	0.11
Nature Conservancy of Canada	Protected	1964.56	1.15
Queens University Biological Station	Protected	3238.61	1.89
Kingston Field Naturalists	Protected	186.63	0.11
The Ontario-St Lawrence Development Commission	Protected	45.57	0.03
County Forest	Protected	76.40	0.04
Crown	Protected	26.42	0.02
Total Protected Ownership		**18,449.79**	**10.75%**
Policy Areas	**Conservation status**	**Area (ha)**	**Proportion of the NA (%)**
Provincially Significant Wetland	Policy	9382.87	5.47
Areas of Natural and Scientific Interest	Policy	14089.96	8.21
Habitat of Endangered & Threatened Species	Policy	?	?
Managed Forest Tax Incentive Program	Policy	?	?
Municipal Environmentally Significant Areas	Policy	?	?
Other	**Conservation status**	**Area (ha)**	**Proportion of the NA (%)**
Important Bird Area	Stewardship & Outreach	42744.49	24.91

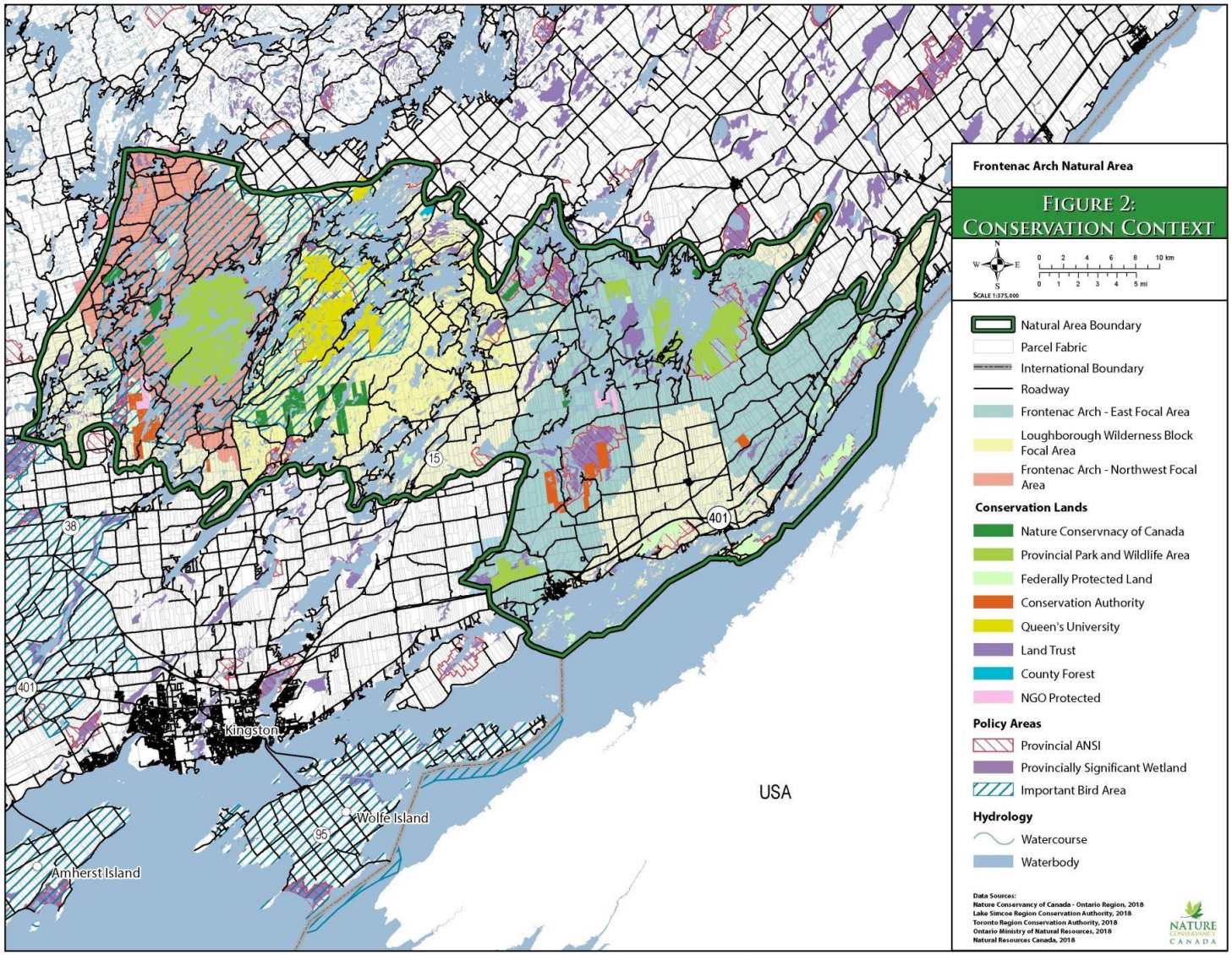


Figure 7. Land protection in the Frontenac Arch area (NCC 2019)

Government Supported Stewardship

Several federal and provincial Grant and Contribution programs have supported conservation initiatives in the Priority Place. These programs fund local stewardship projects that address conservation priorities such as species at risk and their critical habitat, wetland conservation, the Great Lakes, and waterfowl.

Habitat Stewardship Program (HSP)

National Wetland Conservation Fund (NWCF)

Species at Risk Stewardship Fund (SARSF)

The OMNRF administers the Species at Risk Stewardship Fund which encourages individuals and organizations in Ontario to get involved in protecting and recovering SAR through stewardship.

Species at Risk Farm Incentive Program (SARFIP)

The Species at Risk Farm Incentive Program (SARFIP) provides funding to agricultural landowners across Ontario interested in supporting SAR on their lands through habitat creation, enhancement, and protection. Activities can apply to cropland, wetland, woodland, shorelines, stream banks and grasslands. The program is supported by the OMNRF through the Species at Risk Stewardship Fund and ECCC through the Habitat Stewardship Program for Species at Risk.

National & International Conservation Initiatives

There are a number of National and International Conservation Initiatives for which activities may have been implemented in the Frontenac Arch area for which have goals in common with the A2A FA CAP. These initiatives are summarized below for reference.

Canada-U.S. Water Quality Agreement

The Great Lakes and St. Lawrence River are immensely valuable to Canadians for social, economic and environmental reasons, and ensuring their sustainability for future generations is vital. To address this priority, the Great Lakes Water Quality Agreement between Canada and the United States was signed in 1972 and amended in 2012. Through this Agreement, both countries reaffirmed and agreed to strengthen their previous commitments as a measure against current and eventual water quality threats. The St. Lawrence River is identified as an Area of Concern (AOC) as part of this Agreement.

The North American Waterfowl Management Plan (NAWMP)

The North American Waterfowl Management Plan (NAWMP) is an international partnership to conserve waterfowl populations and sustainable landscapes; it engages those committed to the

conservation of waterfowl in Canada, the United States and Mexico. Environment and Climate Change Canada provides implementation funding for activities such as land acquisition, conservation easements, wetland restoration and habitat management.

Eastern Habitat Joint Venture (EHJV)

The EHJV is a partnership of governmental and non-government members aiming to secure and restore bird habitat in Eastern Canada. Operating under the NAWMP, the partnership has representatives from the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), OMNRF, ECCC through the CWS, Bird Studies Canada, DUC, and NCC. The objectives of this venture are to increase bird populations, promote healthy landscape for wildlife and people, as well as engage various stakeholders, including citizens and private industries. The EHJV prioritizes the conservation of waterfowl habitat, however it also protects habitat for shorebirds, waterbirds and landbirds. Funding for different projects comes from the US North American Wetlands Conservation Act, US Fish and Wildlife Service, ECCC and Wildlife Habitat Canada. Since 1989, the EHJV has spent $158 million to protect over 400,000 hectares and restore over 190,000 hectares of degraded wetland habitats across Ontario.

4. BIODIVERSITY ANALYSIS

4.1 Conservation Targets

In the *Open Standards*, conservation targets are selected to encompass the full range of native biodiversity, features and species of conservation importance within the scope of the project or conservation action plan (CAP).

As a starting point, conservation target selection for the A2A Frontenac Arch (FA) CAP was based on the three targets identified by The Nature Conservancy of Canada (NCC) in their third iteration of the Frontenac Arch Natural Area Conservation Plan (FA NACP) (NCC 2019), namely: *Forest Matrix, Wetlands* and *Surrogate Grasslands*. A dedicated discussion during the first CAP workshop on April 25 resulted in the addition of two conservation targets and the removal of one from the NCC (2019) suite.

The targets added for the A2A FA CAP were: *Aquatic Systems* (including the St. Lawrence and other river systems, as well as lakes), which were not a focus of the terrestrially-oriented FA NACP; and *Reptiles and Amphibians,* which were deemed to require specific consideration because habitat-based strategies likely would not ensure their viability due to the high susceptibility of many of these taxa to road mortality, poaching for the pet trade and deliberate persecution. The NCC (2019) *Surrogate Grasslands* target was dropped because it was considered to be entirely dependent on agricultural practices and not a naturally-occurring ecosystem within the A2A FA CAP area. As a result, the four conservation targets selected for the FA CAP were *Forests, Wetlands, Aquatic Systems*, and *Reptiles and Amphibians.*

Each of the four conservation targets are defined and the justification for their selection is provided. The finer elements of biodiversity of particular conservation importance associated with the conservation targets (i.e., “nested targets”) are also listed.

Conservation Target: Forests

Target Definition: The Forests conservation target includes all forested ecosystems in the A2A Frontenac Arch (FA) CAP area. It includes associated naturally-occurring open “small patch” communities such as rock barrens (including the rare Pitch Pine Treed Granite Barren type), successional terrestrial thickets, hedgerows and may also include naturally-occurring meadows and grasslands (e.g., regenerating former agricultural fields and pastures). The Forests target also includes treed swamps, meaning that there is overlap with the "Wetland" target. Viability ratings, threats and strategies that relate to Forests may therefore also apply to treed wetlands in the FA CAP area.

Ecological Justification: According to NCC (2019), the Frontenac Arch “forest matrix system…is Alleghanian in nature, with a high proportion of southern species such as hickories (*Carya* spp.), White Oak (*Quercus alba*)…and Rock Elm (*Ulmus thomasii*). This is not typical of the hardwood forests found on the Canadian Shield (Beschel et al. 1962). Globally rare community types

found within this matrix system include Pitch Pine Treed Granite Barrens. This community supports several species at risk."

Nested Targets:

Ecological Communities: Pitch Pine Treed Granite Barrens, Bare Rock Ridge and Shallow Till Forest Complex.

Mammals: Wide-ranging mammals including Fisher, Black Bear, Moose and Eastern Wolf. Also at-risk and declining bats, namely, Eastern Small-footed Myotis, Northern Myotis, Tri-colored Bat, Little Brown Bat, Eastern Small-footed Myotis.

Birds: Canada Warbler, Cerulean Warbler, Chimney Swift, Common Nighthawk, Eastern Wood-Pewee, Golden-winged Warbler, Louisiana Waterthrush, Olive-sided Flycatcher, Peregrine Falcon (nesting on cliffs within the forest matrix), Prairie Warbler (shrub rock barrens within the forest matrix), Red-headed Woodpecker, Whip-poor-will, Wood Thrush

Reptiles: Gray Ratsnake, Common Five-lined Skink (rock barrens within forest matrix), Eastern Milksnake, Eastern Ribbonsnake (wetland forest ecotone), Blanding's Turtle (woodland ponds), Spotted Turtle (hibernacula in treed coniferous swamps)

Amphibians: Salamanders and anurans that breed in woodland vernal pools.

Invertebrates: Early Hairstreak, Giant Swallowtail

Vascular Plants: American Ginseng, Autumn Coralroot, Blunt-lobed Woodsia, Broad Beech Fern, Butternut, Large-bract Tick-trefoil, Long's Sedge, Narrowleaf Wild Leek, Panicled Hawkweed, Perfoliate Bellwort, Pitch Pine, Purple Twayblade, Purple-stemmed Cliffbrake, Puttyroot, Puttyroot, Ram's-head Lady's-slipper, Round-leaved Tick-trefoil, Round-leaved Yellow Violet, Rue-anemone, Rugulose Grapefern, Shining-branch Hawthorn, Sweet Pignut Hickory, Triangle Moonwort, White-tinged Sedge, Woodland Muhly

Please refer to Appendix A for a complete list of nested targets.

Conservation Target: Wetlands

Target Definition: This conservation target encompasses all wetlands in the Frontenac Arch CAP area (primarily swamps and marshes), including the coastal wetlands along the St. Lawrence River. It is well described and evaluated by the terrestrially-focused NCC NACP (NCC 2019).

Ecological Justification: The justification for selecting Wetlands as a conservation target is adapted from NCC (2019), which was considered applicable to the overlapping and slightly larger A2A Frontenac Arch CAP area. The Wetlands target supports globally rare community types and several species at risk.

Compared to other areas of southern Ontario, the Frontenac ARch boasts a large percentage of wetland cover, providing connectivity and dispersal opportunities for a variety of wetland dependent birds, mammals, invertebrates, reptiles, and amphibians. That said, over the past two centuries there has been extensive wetland loss in the FA CAP Area (Table 4). Based on a detailed study of county by county wetland conversion across southern Ontario by Ducks Unlimited Canada (DUC 2010) found that approximately 65% of wetlands have been lost in the counties that overlap with the A2A FA CAP area. The DUC (2010) was based on coverage that did not include some of the northern portions of the FA CAP area counties, areas which are also not part of the FA CAP area, meaning that the figures in Table 4 probably approximate the actual wetland conversion that has occurred within the CAP area over the past two centuries.

Table 4. Wetland conversion statistics for counties covering the A2A FA CAP area (DUC 2010)

County	Wetland hectares pre-1800	% cover pre-1800	Wetland hectares 1967	% cover 1967	Wetland hectares 1982	% cover 1982	Wetland hectares 2002	% cover 2002	Wetland % loss 2002
Frontenac (southern part)	29,910	14.6	12,695	6.2	14,236	6.9	9,078	4.4	**69.7**
Leeds	56,278	23.8	24,335	10.3	24,868	10.5	23,017	9.7	**59.1**
Lennox & Addington (southern part)	38,365	24.3	12,031	7.6	14,145	9.0	11,033	7.0	**71.2**
Total	**124,553**	**20.8**	**49,061**	**8.2**	**53,249**	**8.9**	**43,128**	**7.2**	**65.4**

Nested Targets:

Birds: Bald Eagle, Black Tern, Black-crowned Night-Heron, Common Nighthawk, Henslow's Sparrow, King Rail, Least Bittern, Louisiana Waterthrush, Olive-sided Flycatcher

Reptiles: Eastern Ribbonsnake, Blanding's Turtle, Eastern Musk Turtle, Northern Map Turtle, Snapping Turtle, Spiny Softshell, Spotted Turtle

Amphibians: Western Chorus Frog

Fish: American Eel, Cutlip Minnow, Eastern Silvery Minnow, Grass Pickerel, Greater Redhorse, Lake Sturgeon, Pugnose Shiner

Invertebrates: Eastern Floater, Eastern Pondmussel, Green-striped Darner, Lilypad Clubtail, Monarch, Spindle Lymnaea

Vascular Plants: Buttonbush Dodder, Eastern Mosquito Fern, Field Sedge, Field Thistle, Green Arrow Arum, Halberd-leaved Smartweed, Hay Sedge, Houghton's Flatsedge, Lakecress, Long's Sedge, Northern Bladderwort, Nuttall's Waterweed, Thread-like Naiad

Please refer to Appendix A for a complete list of nested targets.

Conservation Target: Aquatic Systems

Definition: This conservation target includes lakes, rivers, the St. Lawrence Seaway and associated littoral and riparian zones within the Frontenac Arch CAP area. It shares a number of features, processes and threats with the Wetlands target, for which the NCC NACP provides a good description and assessment. However, Aquatic Systems also face a number of unique threats and anthropogenic influences in the Frontenac Arch area, and it was felt that for this reason they warrant specific attention as a target to facilitate customized conservation strategies as needed.

This target includes the Gananoque and Rideau systems as well as the St. Lawrence River. The Rideau system is primarily controlled by water management associated with the canal, the Gananoque is primarily controlled by hydroelectric power management, and the St. Lawrence water levels are primarily controlled for ship traffic. The target also includes smaller tributaries, some of them controlled by anthropogenic factors such as dams and culverts, while some have natural water flows that would typically be regulated by beavers.

Ecological Justification: The inclusion of the Aquatic Systems allows for consideration to be given to the protection of water quality, healthy fish, turtle and aquatic invertebrate populations, as well as the recovery of rare and at-risk aquatic flora and fauna.

Nested Targets:

Birds: Bald Eagle, Bank Swallow, Black-crowned Night-Heron, Louisiana Waterthrush.

Reptiles: Blanding's Turtle, Eastern Musk Turtle, Northern Map Turtle, Snapping Turtle, Spiny Softshell, Spotted Turtle

Amphibians: Bullfrog (declining)

Fish: American Eel, Cutlip Minnow, Eastern Silvery Minnow, Grass Pickerel, Greater Redhorse, Lake Sturgeon, Pugnose Shiner

Invertebrates: Cyrano Darner, Eastern Floater, Eastern Pondmussel, Green-striped Darner, Lilypad Clubtail

Vascular Plants: Ogden’s Pondweed, American Water-willow, Eastern Mosquito-fern, Green Arrow-arum, Lakecress, Northern Bladderwort, Nuttall’s Waterweed, Thread-like Naiad

Conservation Target: Reptiles and Amphibians

Definition: This target focuses on all herpetofauna that are particularly vulnerable to road mortality and/or that are subject to poaching and/or persecution. This target focuses on all herpetofauna that are particularly vulnerable to road mortality and/or that are subject to poaching and/or persecution.

Ecological Justification: *Reptiles and Amphibians* was selected as a discreet conservation target because habitat-based conservation strategies will not necessarily improve the viability of these taxa without complementary actions relating to reducing road mortality (especially) (Eigenbrod et al. 2009, Glista et al. 2008, Jochimsen et al. 2014), poaching for the pet trade and food, and, for some species, direct persecution. Different taxonomic groups and species will require different actions. For example, salamanders of the Ambystoma genus are vulnerable to roadkill in early spring as they travel from hibernacula to breeding sites in vernal pools in woodlands. Female turtles are especially vulnerable to vehicle collisions in late spring and early summer when they travel from wet habitats to terrestrial egg-laying sites (typically sandy or gravelly locations, including road embankments). Snakes are particularly prone to road mortality when they warm themselves on roads (especially paved roads), which are typically warmer than the air temperature on cool sunny days in spring and (especially) autumn, as well as at night. Efforts by various agencies, NGOs and academic researchers to identify road mortality hotspots have been ongoing in the Frontenac Arch area for a number of years. Blanding's and Spotted turtles are particularly vulnerable to poaching, as are some snake taxa, and snake persecution due to unwarranted fear continues to be a concern although frequency and level of impact on populations is not well documented. Deliberate vehicle killings of turtles and snakes on roads has also been widely documented anecdotally and by scientific research (e.g., Ashley et al. 2007, Crawford and Andrews 2016).

Nested Targets:

Amphibians: Blue-spotted Salamander, Yellow-spotted Salamander, Eastern Newt, American Toad, Northern Leopard Frog, Green Frog, Bullfrog and other anurans.

Reptiles: Common Five-lined Skink, Eastern Milksnake, Eastern Ribbonsnake, Eastern Gartersnake, Smooth Greensnake, Dekay's Brownsnake, Northern Redbelly Snake, Northern Ringneck Snake, Northern Watersnake, Gray Ratsnake, Blanding's Turtle, Eastern Musk Turtle, Midland Painted Turtle, Northern Map Turtle, Snapping Turtle, Spotted Turtle

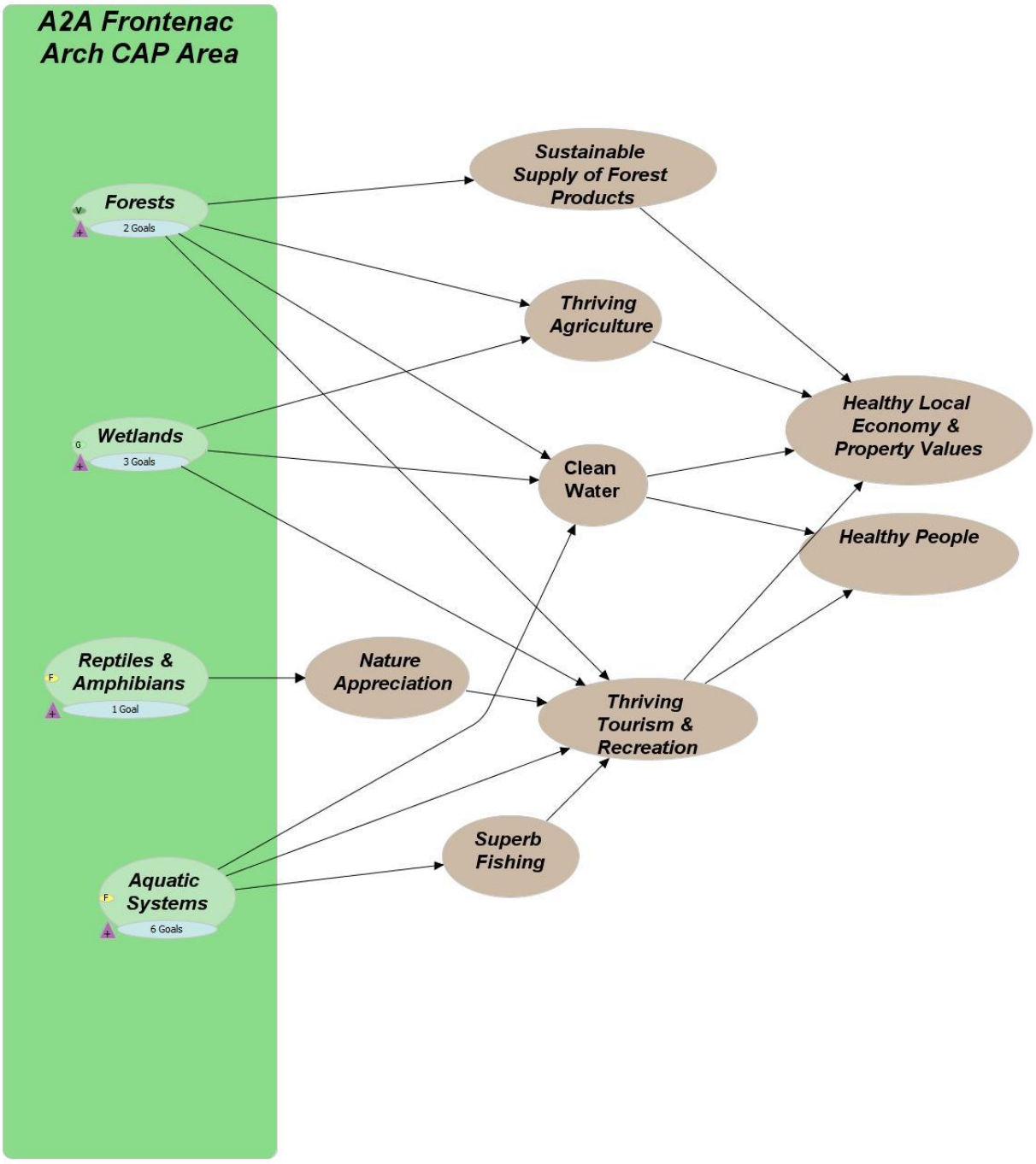
4.2 Ecosystem Services and Human-Wellbeing Targets

The FA CAP participants regularly emphasized the importance of articulating and appreciating the connections between the health of ecologically-based conservation targets and human health, prosperity and quality of life in the Frontenac Arch area. Services essential to human wellbeing that are provided by healthy ecosystems include and Human-wellbeing Targets were identified. Ecosystem services associated with a healthy natural environment include water quality, flood control, erosion control, climate regulation, carbon sequestration, fish and wildlife habitat, food products, sources of medicine, pollination, recreational opportunities, physical and mental health benefits, educational opportunities, nature appreciation and spiritual values.

In the FA CAP area (Figure 7), healthy, well-stewarded forests will provide a sustainable supply of forest products, including wood for construction and furniture, maple syrup, and foods associated with forest flora and fauna (e.g., berries, wild leeks, mushrooms, wild game). Forests contribute to thriving agricultural economy by providing pollinators, supplying soil nutrients, reducing soil erosion and filtering agricultural runoff. Wetlands serve as critically-important groundwater recharge areas, and also provide food, pollinators and recreational opportunities such as hunting, fishing and nature appreciation. Healthy aquatic systems are associated with clean drinking water, fishing and many forms of water-based recreation. In addition to contributing to nature appreciation and natural heritage education, reptiles and amphibians are important elements of the food webs essential to the ecological integrity of Frontenac Arch ecosystems.

Models for governance structure for integration of conservation with human wellbeing in the Frontenac Arch may be explored at biosphere reserves elsewhere in Canada. According to Edge and McAllister (2009): "The quest for sustainable communities might be fostered by a new 'place-based' governing approach that engages civil society and other actors in local decision-making processes. In Canada, lessons can be learned from the establishment and maintenance of biosphere reserves by networks of local communities of interests and other organisations. Biosphere reserves are created to promote conservation, biodiversity and sustainable livelihoods. Municipal and public participation in these reserves can be encouraged, promoting a local sense of place as well as sustainable community and regional development. An examination of two Canadian biosphere reserves, Riding Mountain and Long Point, illustrates how local governments and these reserves might assist each other in their mutual goals of long-term sustainability while offering a worthwhile model of local collaborative, place-based governance."

Figure 8. Links between ecological conservation targets and human wellbeing targets



4.3 Direct Threats

Threat Rating and/or Asessment is a method which aims to explicitly and objectively identify and assess the threats impacting a conservation target (FOS 2009). The direct threats to the conservation targets in the A2A FA CAP area were identified and assessed based on scope, severity and irreversibility in the Miradi software (Table 6). The threat assessment was completed on the basis of discussions with participants at the April and May CAP workshops, with additional input during document review.

For consistency and comparison among conservation projects, the International Union for Conservation of Nature (IUCN) direct threat categories were used to the extent possible. Some threat names have been adjusted to make them more applicable to the threats in the A2A FA CAP area.

Based on the threat assessment (Tables 5), the greatest threats to biodiversity in A2A FA CAP area include habitat fragmentation and degradation associated with residential development, roads, dams and culverts, shoreline vegetation management and shoreline hardening. Direct road mortality is a major threat to the Reptiles and Amphibians target, while invasive aquatic species and personal water craft (PWCs) are having a significant impact on Wetlands and Aquatic Systems targets.

Table 5. Threat Rating Summary[2]

Threats \ Targets	Forests	Wetlands	Reptiles & Amphibians	Aquatic Systems	Summary Threat Rating
Climate change (temperature extremes, severe weather, drought, habitat impacts)	High	High	High	High*	High
Fragmentation by residential development	Medium	Medium	Medium*	Very High	High
Invasive aquatic species		Medium		Very High	High
Dams and culverts		Low		High	Medium
Direct road mortality			High		Medium
Fragmentation by roads	Medium	Medium	Medium	Medium*	Medium
Hyperabundant native species	Medium		Medium*		Medium
Shoreline vegetation management				Medium*	Low
Shoreline hardening and development				Medium*	Low
Speedboats, PWCs		Low		Medium	Low
Cash crop farming	Medium			Low	Low
Invasive terrestrial species	Medium				Low
Plant-affecting diseases and pests	Medium				Low
Habitat loss/fragmentation by mines, pits and quarries	Medium				Low
ATVs/ ORVs	Low	Low	Low*		Low
Livestock farming	Low	Low		Low*	Low
Collecting and persecution of terrestrial animals	Low	Low	Need data		Low
Gathering terrestrial plants	Low				Low
Fragmentation by unsustainable forestry practices	Low				Low
Fire suppression	Low				Low
Algal blooms				Low*	Low
Garbage				Need data	Low
Overall	**High**	**Medium**	**High**	**Very High**	**High**

[2] Threat ratings with an asterisk (*) were rated author (Jalava) based on workshop discussions and/or NCC (2019); these ratings in particular need expert verification, quantitative data and/or broader participant input. Threats marked as "Need data" were identified but not rated due to time or expertise limitations at the workshops.

Table 6. Underlying threat assessment criteria (FOS 2009) for ratings presented in Table 5

Key Terminology – Threat Assessment (FOS 2009)

Direct Threat: "A human action that immediately degrades one or more conservation targets".

Indirect Threat: "A factor identified in an analysis of the project situation that is a driver of direct threats. Often an entry point for conservation actions".

Scope: "The proportion of the target that will likely be affected by the threat within 10 years under current circumstances".

Severity: "Attempts to categorize the level of damage to the conservation target expected in the next ten years".

Irreversibility: "The degree to which the effects of a threat can be reversed and the target affected by the threat restored, if the threat no longer existed".

	Very High	High	Medium	Low
Scope	The threat is likely to be pervasive in its scope, affecting the target across all of most (71-100%) of its occurrence/population.	The threat is likely to be widespread in its scope, affecting the target across much (31-70%) of its occurrence/population.	The threat is likely to be restricted in its scope, affecting the target across some (11-30%) of its occurrence/population.	The threat is likely to be very narrow in its scope, affective the target across a small proportion (1-10%) of its occurrence/population.
Severity	Within the scope, the threat is likely to destroy or eliminate the target, or reduce its population by 71-100% within 10 years or 3 generations.	Within the scope, the threat is likely to seriously degrade/reduce the target or reduce its population by 31-70% within 10 years or 3 generations.	Within the scope, the threat is likely to moderately degrade/ reduce the target or reduce its population by 11-30% within 10 years or 3 generations.	Within the scope, the threat is likely to only slightly degrade/reduce the target or reduce its population by 1-10% within 10 years or 3 generations.
Irreversibility	The effects of the threat cannot be reversed and it is very unlikely that the target can be restored, and/or it would take more than 100 years to achieve this.	The effects of the threat can technically be reversed and the target restored, but it is not practically affordable and/or it would take 21-100 years to achieve this.	The effects of the threat can be reversed and the target restored with a reasonable commitment of resources and/or within 6-20 years.	The effects of the threat are easily reversible and the target can be easily restored at a relatively low cost and/or within 0-5 years.

Threats with Very High or High Rating for One or More Conservation Targets

Climate Change

Climate change is an all-pervasive threat with high potential to impact all conservation targets of the A2A FA CAP. According to OCCIAR (2015), "climate change will affect biodiversity in many ways by altering species relationships and changing the distribution and configuration of habitats, which could result in community reassembly in ecosystems throughout Ontario." More mobile species with relatively large geographic ranges with northern range boundaries in Ontario likely may benefit from climate change, while habitat availability for less mobile species with southern range boundaries in the province may contract, increasing threats from parasitism, competition and other biotic stresses.

Life cycle changes resulting from warmer winter and spring temperatures include earlier onset of breeding by amphibians and earlier occupation of breeding habitat and emergence of hatchlings by bird species (OCCIAR 2015). Warming water temperatures continue to change the distribution and volume of temperature-dependent aquatic habitat, with habitat for coldwater species such as Lake Trout decreasing and warmwater habitat for species like Smallmouth Bass increasing (OCCIAR 2015). Warmer water temperatures will increase the likelihood and frequency of algal blooms, impacting the functions and species composition of aquatic systems.

At the landscape scale, increased extreme weather events such as heavy precipitation, extreme winds and drought will affect ecosystem-level responses through forest fires, blowdowns and flooding. In addition, climate change will compound other cumulative effects to modify ecosystem composition, structure and function (OCCIAR 2015). These include human-induced stressors such as habitat fragmentation, water pollution, deforestation and wetland drainage, these changes can significantly affect survival and adaptation ability of species. Given that it is a relatively intact landscape providing connectivity to ecosystems to the north and south, the Frontenac Arch may be considered a critically important climate change refugium and corridor for biota to shift distribution in response to changing conditions.

Climate Change	Scope	Severity	Irreversibility	Overall
Forests	Very High	High	High	High
Wetlands	Very High	High	High	High
Aquatic Systems	Very High	High	High	High
Reptiles & Amphibians	Very High	High	High	High

Fragmentation by Residential Development

This threat includes fragmentation through parcel severance and development of recreational homes and subdivisions, as well as the intensified re-development of smaller island lots According to NCC (2019), "There has been a significant increase in the development of cottages and estate homes in forested areas of the Frontenac Arch over the past 20 years, a trend that

will continue in the immediate future because of the relative proximity of these areas to the growing Kingston market and the trends of greater commute distances and working remotely. Two areas are of particular concern: 1) between Frontenac Provincial Park and Queen's University Biological Station between Loughborough Lake in the south and Devil Lake and Buck Lake in the north; and 2) between the Beverly Lakes, Charleston Lake Provincial Park and the St. Lawrence River….Fragmentation occurs through a wide variety of human activities and natural phenomena, such as development or hardening of shorelines. The greatest single source of fragmentation is residential development, especially recreational second home and estate home development. Once developed, reversing habitat fragmentation is difficult, as the land is divided between multiple owners, and building projects can destroy viable habitat." The threat is expected to increase in severity as the regional population increases and demand for cottage and retirement living continues to grow.

The County of Frontenac applies a 150m "area of influence" from the high water mark of water bodies >8ha with respect to development applications along St. Lawrence. All other smaller water bodies use the provincial criteria for wetlands. These measures limit development to lower-intensity, residential uses. However, environmental impact studies are rarely undertaken, although conservation authority staff normally do a site visit for subdivisions fewer than five lots. South Frontenac at one time had criteria that triggered environmental impact studies. On islands in the St. Lawrence, any new lots must be >2.5ha. DFO is now mostly just SAR focused. Parks Canada does have some ecologically-based restrictions that apply to permissible activities on water lots. One issue is that the County lacks capacity and resources to do a natural heritage study, or to develop its own Greenbelt-like plan or policy.

The scope of this threat in the A2A FA CAP area is rated as medium, and the severity is high. The overall threat magnitude is high. This threat is considered virtually irreversible, and is a medium threat to the Forests, Wetlands and Reptiles and Amphibians targets, and a very high rated threat to the Aquatic Systems target due to the associated shoreline impacts that typically occur with waterfront development in particular.

Fragmentation by Residential Development	Scope	Severity	Irreversibility	Overall
Forests	Medium	Medium	Very High	Medium
Wetlands	Medium	Medium	Very High	Medium
Aquatic Systems	High	High	Very High	Very High
Reptiles & Amphibians	Medium	Medium	Very High	Medium

Invasive Aquatic and Wetland Species

Invasive species displace and compete with native species, often resulting in decreased biodiversity and disruption of natural ecosystem processes. Invasive aquatic fauna of concern in the Frontenac Arch area include Dreissenid mussels, also known as Zebra Mussels (*Dreissena polymorpha*) and Quagga Mussels (*Dreissena bugensis*), which are present in relatively low densities in many of the lakes in the natural area, particularly in the interconnected

waterbodies of the Rideau Waterway (NCC 2019). Rusty Crayfish (*Orconectes rusticus*) and Spiny Waterflea (*Bythotrephes longimanus*) are also potentially significant invaders of freshwater lakes and streams (NCC 2019). Many smaller, isolated waters in the natural area are presently free of these invasive invertebrates because of their remoteness and, in the case of Zebra Mussels, pH levels. These invasives threaten are believed to be directly responsible for the decline of the Endangered Eastern Pondmussel (*Ligumia nasuta*) and alter aquatic ecosystems by disrupting zooplankton and phytoplankton populations, nutrient cycling and water clarity (ECCC and US EPA 2017).

According to NCC (2019): "The Old World genetic population of Common Reed (*Phragmites australis*) is the most significant non-native invasive species in eastern Ontario and is rapidly changing the dynamics of open wetlands, displacing native Cattails (*Typha* spp.) (OMNR 2011). Common Reed is abundant and increasing throughout the natural area where municipal drainage maintenance operations have contributed significantly to its spread at culvert locations along most roadways. While Common Reed is effectively managed with ongoing herbicide treatments in seasonally dry areas on NCC-owned properties, there are currently no herbicides licensed for use against Common Reed growing in water in Ontario. This means this species cannot be controlled in the wetlands where it is most abundant. Without collaboration from neighbouring land owners, the threat of Common Reed will be extremely difficult to reverse, as re-infestation is highly likely…

"Local populations of Purple Loosestrife (*Lythrum salicaria*) have been documented on a handful of properties in the NA. This invasive, perennial plant has a persistent tap root, and seeds which can lie dormant for many years. It is tolerant to disturbance and drought, which allows it to grow in meadows, marshes, floodplains, roadsides, and rocky crevices. When given sufficient light, the plant is one of the fastest growing herbaceous species in the wetland environment, increasing the risk of it out-competing native species. Purple Loosestrife populations alter nutrient cycling in wetlands, since the leaves of the plant decompose before those of native species. This results in nutrients being flushed from the wetland earlier in the season, which can delay amphibian development. Nutrient cycling changes can also lead to reduced species diversity....Populations do not appear to be spreading rapidly, and therefore it is considered a low risk [in the Frontenac Arch area].

"The presence of Common Frogbit (*Hydrocharis morsus-ranae*) in aquatic ecosystems and wetlands negatively impacts both ecological processes and recreational use. The development of large, free-floating vegetation mats limits recreational activities such as boating, fishing, and swimming. This species also reduces the growth of native, submerged aquatic plants, and sites with high densities of Common Frogbit show less diversity of aquatic animals....NCC has been managing this threat via manual removal of the plant, however it is recorded as widespread and abundant in some open water communities throughout the [Frontenac Arch]. Controlling smaller populations should be the focus of stewardship activities as they can easily become a larger management issue if not controlled effectively...At present, manual removal of the plant is the only viable control solution. However, this is labour intensive, and is not effective for reversing the threat in the [Frontenac Arch]."

Additional data is needed to fully understand the scope and severity of aquatic and wetland invasive invertebrates and plants in the A2A FA CAP area. However, given the ongoing and projected increases in human activity, the risks these species pose are expected to increase. The overall threat of aquatic invasive species is rated as medium on the Wetlands target and very high on the Aquatic Systems target.

Invasive Aquatic & Wetland Species	Scope	Severity	Irreversibility	Overall
Forests				
Wetlands	Medium	High	High	Medium
Aquatic Systems	Very High	Very High	High	Very High
Reptiles & Amphibians				

Dams and culverts

This threat includes dams, culverts, ditching, fill and artificial ponds, which impact natural water level dynamics and the connectivity of aquatic systems, often creating barriers to the movement of aquatic fauna, notably migratory fish. These factors may also contribute to invasions by exotic aquatic flora and fauna. Structures that affect natural water level fluctuations are of particular concern in shoreline and coastal areas that are particularly reliant on natural flood regimes. This is a particularly significant threat to wetland ecosystems, which are sensitive to water inflow and outflow.

There is just one valve on the St. Lawrence River system. There are 57 dams on Rideau system; because of its importance as a navigable waterway, the Rideau is not going to be significantly "de-regulated". There are at least 6 dams on the Gananoque River system. According to NCC (2019), within the NCC NACP Area, there are eight lock gates, 22 dams and 938 road-stream intersections.

Based on Cataraqui Region Conservation Authority (CRCA) mapping, there are approximately 40 dams in the A2A FA CAP area. They are operated by CRCA (~10), Fortis Generation (~14), MNRF (3), Parks Canada (4) and municipalities (~6). Combined, these dams almost certainly impact the vast majority of waterways in the area, but it is possible that smaller waterways not affected by human-made dams comprise over 10% of the watersheds.

The magnitude of this threat on the Wetlands target is nonetheless considered low, due to its medium scope and severity. However, because of the barriers to movement of aquatic fauna and the overall impacts of dams and culverts on natural waterflow regimes, the threat is rated as high for the Aquatic Systems target. Although no rating has been made for the Reptiles and Amphibians target, dams and culverts in the A2A FA CAP area undoubtedly act as barriers to the movement of these species.

Dams and Culverts	Scope	Severity	Irreversibility	Overall
Forests				
Wetlands	Medium	Medium	Low	Low
Aquatic Systems	High	High	Medium	High
Reptiles & Amphibians				

Direct Road Mortality

This threat includes direct road kill, as well as predation of herpetofauna by turkeys, corvids and mammals (see also "hyperabundant native species" threat, below) along roads (e.g., turtle eggs, basking snakes). The threat of linear infrastructure such as roads is a leading cause of mortality for reptiles and amphibians (Jackson 2000, Daigle 2010). In Canadian federal and provincial recovery documents, road networks are recognized as a severe threat for most at-risk herpetofauna. Roads and traffic negatively affect wildlife populations in four main ways: 1) habitat loss 2) traffic mortality 3) resource inaccessibility, and 4) population subdivision (Jaeger et al. 2005). The degree of road mortality is highly influenced by road width, traffic volume and traffic speed, the type of road surface (e.g., gravel or paved) and location (e.g., near wetlands).

Different taxonomic groups and species are impacted by roads in different ways and at different times of year. For example, salamanders of the Ambystoma genus are vulnerable to roadkill in early spring as they travel from hibernacula to breeding sites in vernal pools in woodlands. Female turtles are especially vulnerable to vehicle collisions in late spring and early summer when they travel from wet habitats to terrestrial egg-laying sites (typically sandy or gravelly locations, including road embankments). Snakes are particularly prone to road mortality when they warm themselves on roads (especially paved roads), which are typically warmer than the air temperature on cool sunny days in spring and (especially) autumn, as well as at night. Deliberate vehicle killings of turtles and snakes on roads has also been widely documented anecdotally and by scientific research (e.g., Ashley et al. 2007, Crawford and Andrews 2016).

Efforts by various agencies, NGOs and academic researchers to identify road mortality hotspots have been ongoing in the Frontenac Arch area for a number of years (e.g., Bradford 2003, Urquhart et al. 2018, and many others).

This threat is rated as "high" in scope, severity and irreversibility for the Reptiles and Amphibians target.

Direct Road Mortality	Scope	Severity	Irreversibility	Overall
Forests				
Wetlands				
Aquatic Systems				
Reptiles & Amphibians	High	High	High	High

Threats with Medium Rating for One or More Conservation Targets

Fragmentation by roads

According to NCC (2019): "The [Frontenac Arch] includes a variety of road types including major four-lane and two-lane highways (Highway 401 and Highway 15 respectively), all the way to cottage and fire lanes. Roads have both direct and indirect effects on ecosystems. Firstly, road collisions can be a major source of mortality for amphibians and reptiles that may use the roads for either basking or nesting (Crowley 2007), for birds and butterflies that are hit while resting on or flying over the road at low altitudes, and for wide-ranging mammals that may use the roads as travel corridors (Clevenger et al. 2002, McPherson 2005). Indirect effects of roads can extend much further than just the lands adjacent to the road corridor. Roads can isolate populations of species from one another, impact wildlife corridors, provide incompatible and discontinuous cover for rare native species, and can degrade natural habitats by introducing invasive species and by creating edge effects, pollution and physical disturbance (Crowley 2007). Current known impacts of roads in the [Frontenac Arch area] include pollution (from road salt and debris) and road mortalities. In the [Frontenac Arch area] the highest density of roads is concentrated around shorelines, corresponding to the highest density of development. In addition to the effect of high road density, traffic speed also has both direct and indirect impacts such as increased noise pollution. It is anticipated that increased development will put further pressure on the [Frontenac Arch area], impacting [all conservation] targets. This will result in more fragmentation, and increase the severity and irreversibility of the threat."

Because most Ontario herpetofauna require a variety of different habitat types to complete their life cycles (e.g., hibernacula, egg-laying sites, feeding areas, basking sites, etc.) availability of extensive "roadless" patches with a diversity of natural habitats (e.g., forests, wetalnds and aquatic systems) will be critical to the long term viability of herpetofauna in the A2A CAP area. Table 7 presents how much of each SOLRIS land cover type occurs >100 m and >250m from roads.

Fragmentation by Roads	Scope	Severity	Irreversibility	Overall
Forests	High	Medium	High	Medium
Wetlands	High	Medium	High	Medium
Aquatic Systems	Medium	Medium	High	Medium
Reptiles & Amphibians	Medium	Medium	High	Medium

Table 7. Extent of "roadless" land cover by type in the A2A FA CAP area

SOLRIS Landcover	**Frontenac Arch Region**	
	Area coverage (km^2)	
	> 100m From Roads	**> 250m From Roads**
Sparse Treed	4.839075	4.662225
Forest	23.826150	17.263125
Coniferous Forest	21.467700	16.291575
Mixed Forest	351.035325	268.466625
Deciduous Forest	480.309300	371.957175
Treed Swamp	147.092400	116.762625
Thicket Swamp	85.565025	71.738775
Fen	0.607500	0.498375
Bog	0.986850	0.890775
Marsh	121.269375	97.535925
Open Water	395.885250	318.678075
Plantations - Tree Cultivated	2.626425	1.496475
Hedge Rows	9.815625	6.320025
Tilled	149.625900	94.209525
Undifferentiated / Agriculture	541.389825	338.340600

Hyperabundant native species

Several problematic native species, many of which have flourished in human-altered and predator-deficient environments, directly degrade their habitats and also prey on other native species (McLeod 2019ab). High levels of White-tailed Deer browsing can cause significant negative impacts on forest understorey composition. Common subsidized mesofauna, including the Northern Raccoon (*Procyon lotor*), the Striped Skunk (*Mephitis mephitis*), the Virginia Opossum (*Didelphis virginiana*), the Wild Turkey (*Meleagris gallopavo*) and the American Crow (*Corvus brachyrhynchos*), each of which threaten wildlife and their nests. Raccoons are especially problematic, preying on turtle and bird nests. These species often prey on herpetofauna as they cross or bask on roads, as well as opportunistically feeding on the carnage of the same taxa caused by vehicle collisions. Most species of amphibians and reptiles in the Frontenac Arch area are likely preyed upon by raccoons at some stage in their life, inhibiting population growth.

Hyperabundant Native Species	Scope	Severity	Irreversibility	Overall
Forests	High	Medium	Medium	Medium
Wetlands				
Aquatic Systems				
Reptiles & Amphibians	High	Medium	High	Medium

Shoreline vegetation management

In natural situations, shorelines are areas of especially high biological diversity because they provide a variety of critical functions and resources for a great variety of terrestrial and aquatic species. In fact, many species are specifically adapted to living at the interface between land and water. Shoreline vegetation has a stabilizing effect on the soil, reducing erosion along the shoreline and filtering harmful run-off, thereby maintaining water quality. Vegetated buffers can produce or re-establish edge habitats between aquatic and land ecosystems, creating corridors vital to the movement of many species (especially reptiles, many of which require a variety of habitat types in order to feed, breed, lay eggs, thermoregulate and hibernate). Naturally-vegetated shorelines provide cover for species to move safely from one habitat patch to another. Removal or alteration of shoreline vegetation, including wetland species found in the shallows along the shoreline, can therefore have major impacts on the health of aquatic, wetland and terrestrial environments and species. Natural shoreline vegetation is also an important element of the beauty of the Frontenac Arch landscape.

In the A2A FA CAP area, shoreline vegetation management activities include outright clearing of terrestrial and aquatic vegetation, planting of lawns and exotic species (some of them invasives), and damage to vegetation by boat propellers. The severity, scope and irreversibility of shoreline vegetation management in the A2A FA CAP area was tentatively rated by the lead author as medium, based in part on interpretation of participant input at the CAP workshops.

Shoreline Vegetation Management	Scope	Severity	Irreversibility	Overall
Forests				
Wetlands	?	?	?	?
Aquatic Systems	Medium	Medium	Medium	Medium
Reptiles & Amphibians				

Shoreline hardening and development

Closely related to “shoreline vegetation management” with some of the same impacts, shoreline “hardening” involves installation of structures, such as walls or riprap at the water’s

edge to protect waterfront property. It may also include the construction of piers or docks. Wensinck and Tiegs (2016) found that "shorelines hardened by riprap differed from their natural counterparts in structure and function, with particularly pronounced effects in terrestrial shoreline habitats. Hardened shorelines were steeper and drier, and sediments were orders of magnitude larger than on natural shorelines…and natural shorelines had much greater quantities of wrack [deposited vegetation], than riprap shorelines in summer and autumn…Invertebrate community composition in terrestrial habitats also differed between shoreline types, with snails and beetles more abundant on natural shorelines and ants more abundant on riprap." The authors conclude that "riprap shorelines differ greatly from natural shorelines in their structure and functioning, particularly in terrestrial habitats, and possess attributes of 'novel ecosystems'." Other effects of shoreline hardening include disruption of natural patterns of erosion and deposition, which may have impacts on down-current ecosystems such as sand spits, sand bars and dune systems.

While many of the shoreline areas of the A2A FA CAP area are naturally "hard" because they are bedrock or otherwise rocky, in some areas such as along the Rideau system, filling (illegal or unregulated; gabian baskets, rip-rap) and shore hardening are probably increasing with intensification and demand in the A2A FA CAP area. Lambert and Van Wieren (2017) state that "riparian zones (near to shoreline area) are the intersection of aquatic and terrestrial habitats, and are host to a variety of wildlife and plants, including many species at risk….Research has indicated that impermeability of shoreline riparian zones should not exceed 7-10% to reduce water quality impacts and that streams should remain 75% vegetated to protect ecosystem functions."

Shoreline Hardening & Development	Scope	Severity	Irreversibility	Overall
Forests				
Wetlands	?	?	?	?
Aquatic Systems	Medium	High	High	Medium
Reptiles & Amphibians				

Speedboats, PWCs

Recreational boating removes aquatic vegetation, creates water and noise pollution, and increases turbidity. Boats also stress, injure and kill vulnerable wildlife. Large wakes created by fast-moving water craft also disturb coastal wetland vegetation and fauna, notably turtles. According to NCC (2019): "Water-based recreational activities have had a significant ecological impact on the [Frontenac Arch area]. Such activities include boating, especially the use of personal watercraft, tubing, water skiing and fishing. Impacts include, but are not limited to,

disturbance to wildlife, shoreline nesting birds, shoreline and aquatic vegetation, and the introduction of non-native flora and fauna (e.g., Zebra Mussel), where the ecological impact potentially increases in shallower confined waterways (Jalava et al. 2005). Water quality concerns resulting from boating include fuel spills, combustion residues from marine engines and the discharge of contaminated water (grey water) (Chow-Fraser 2006, Schiefer et al. 2006)."

Speedboats & PWCs	Scope	Severity	Irreversibility	Overall
Forests				
Wetlands	Medium	Low	Medium	Low
Aquatic Systems	High	Medium	Medium	Medium
Reptiles & Amphibians				

Cash crop farming

Fragmentation and degradation of surrounding forested areas has occurred in the A2A FA CAP area with the expansion of farming in areas with arable land. Some conversion to cash crops is still occurring in the area because of global market demand and profitability. Unmitigated cash crop farming can result in erosion and high nutrient inputs to wetlands and aquatic systems, leading to algae blooms and reduced water quality. Agricultural land use in the central portion of the NA is a principal barrier to the east-west connectivity. The decline in farming seen over the past few decades has recently reversed in areas east and west of the FA with woodlots being removed and replaced with corn and soybean; however, there are limited opportunities for economically-viable conversions on the FA because of the generally shallow soils and the relatively small areas suitable for profitable agriculture.

The removal or upgrade of farm buildings can affect wildlife that use such structures as habitat, such as Barn Swallows and reptiles. Agricultural equipment can harm and kill wildlife, including species at risk such as Blanding's and Snapping turtles and numerous grassland birds.

Tile drainage is often a component of the farming practices, with potentially significant impacts on hydrological systems (Blann et al. 2009). According to Gedlinski (2014): "Agricultural drainage tiles (ADTs)...transform fine-grained, poorly drained soils into highly productive farmland. Because of their design and function, they also pose a number of detrimental consequences related to water quality, stream bank erosion, a loss of wetland areas, increased baseflows, and flooding intensity....ADTs provide unique field-to-water pathways for a number of agricultural pollutants, the most critical of which are nutrients. Since ADTs bypass traditional conservation practices used to mitigate the environmental impact of row crop agriculture, contaminants often reach streams with very little, if any, attenuation. ADTs also represent a major alteration in...hydrology as they greatly enhance the connectivity between fields and

streams. As a result, natural storage areas that once occupied the landscape and gradually released water to streams have been lost, water tables have been lowered, and baseflows have increased. Because of their profound effect on contaminant transport and hydrology, it's now realized that ADTs play a significant role in nutrient loading...streams and rivers. To mitigate the negative effect of ADTs on water quality, a strategic combination of targeted management practices and new technologies is needed. These include traditional soil conservation practices, new regulations, constructed wetlands, bioreactors, controlled drainage management, and re-routing tile drainage as sub-surface flow across riparian buffers."

On the other hand, according to OSCIA (2019): Controlled tile drainage (CTD) "significantly reduces nutrient loss from tile drainage systems. Research by Agricultural and Agri-Food Canada (AAFC) and South Nation Conservation has shown significant reductions in the export of ammonium (57%), nitrate (65%) and phosphorus (63%) during the growing season. On a subwatershed scale, mass load of total nitrogen in waterways was reduced by 50 to 100% compared to conventional tile drainage. However, CTD has been tied to increases in surface runoff and deep percolation as a result of the higher water table. Conservation measures to control risk of sediment and nutrient loss to surface waterways should be considered, including timing of fertilizer application. Adjustment to water levels may be required during periods of high rainfall."

Cash Crop Farming	Scope	Severity	Irreversibility	Overall
Forests	Medium	Very High	Medium	Medium
Wetlands	Medium	Medium	Medium	Medium
Aquatic Systems	Low	Low	Medium	Low
Reptiles & Amphibians	?	?	?	?

Invasive Terrestrial Species

Non-native invasive species have negative impacts on natural systems as they compete with native species for food and habitat, transmit diseases or parasites, they may hybridize with native counterparts, and their presence alters habitat. Many invasive plants cannot be used by native wildlife (e.g., for food, as host plants, as shelter), reducing overall species richness and ecological integrity.

According to NCC (2019), "Invasive herbaceous woodland plants are found on the majority of NCC properties in the Frontenac Arch, and threaten forest targets in the NA. There is a documented history of manual and chemical control in the NA for herbaceous woodland invasives. Garlic Mustard is a common invasive species throughout forests of eastern North America, and has well known competitive and allelopathic effects (Stinson et al. 2006). It has been associated with reduced breeding success in ground nesting birds, reduced diversity of

native herbaceous species, and reduced germination and growth of woody species (Stinson et al. 2006). Without intervention, it is expected that this threat has the ability to severely limit the diversity of native herbaceous plants in the forest understory, including species at risk such as American Ginseng (*Panax quinquefolius*). As the scope and severity of invasive infestations increases, the practical ability of NCC staff to reverse the effects is severely limited.

"Japanese Knotweed (*Fallopia japonica*) can severely degrade wetland, mesic, forest and riparian habitats. The dense stands can block sunlight by 90%, severely limiting the growth of native species. Despite the root systems of Japanese Knotweed being strong, they are generally not as dense as native species. This can lead to bank instability and erosion. These can also interfere with recreational activities, such as swimming, boating, and fishing (Anderson 2012)."

"European Swallow-wort (*Cynanchum rossicum*) commonly known as Dog-strangling Vine, is a highly invasive plant which thrives in a variety of soil, light and temperature conditions. It is found throughout the [Frontenac Arch] in forest ecosystems, and outcompetes native vegetation, choking it out as it reaches for the light (Sanderson and Antunes 2013). A combination of cutting and chemical control has shown to reduce populations of European Swallow-wort in forest understories (DiTommaso et al. 2013). European Swallow-wort is primarily controlled in the [Frontenac Arch by NCC staff] by chemical application, but the scope and severity of the infestation increases the difficulty of eradicating it. Japanese Knotweed is less abundant in the [area], and therefore control methods are more effective. As the scope and severity of invasive infestations increases, the practical ability…to reverse the effects is severely limited.

"Non-native invasive shrubs have are found in patches throughout the [Frontenac Arch], and threaten the forest target. Species such as Buckthorn (*Rhamnus cathartica*), Glossy False Buckthorn (*Frangula alnus*), Tatarian Honeysuckle (*Lonicera tatarica*), Black Locust (*Robinia pseudoacacia*), Scotch Pine (*Pinus sylvestris*), and Apple (*Malus* spp.) have the largest impacts on forest understory biodiversity. These species reduce the abundance of native vegetation that supports high levels of invertebrate diversity, which impacts the breeding success of birds and other wildlife that depend on insects for food (Tallamy 2009). Invasive shrubs are actively controlled on NCC-owned properties via cutting and herbicide application. The control of non-native invasive woody species is an ongoing threat in the natural area, which is unlikely to be successful at completely eradicating targeted species. However, progress has been made in reducing and eradicating small populations. As the scope and severity of invasive infestations increases, the practical ability of NCC staff to reverse the effects is severely limited."

Other terrestrial invasive species of concern in the A2A FA CAP area include feral domestic cats (*Felis catus*), which prey on birds, small mammals, amphibians and reptiles (Woods et al. 2003) and non-native earthworms, which consume the leaf litter (impacting the survival of tree

seedlings, ferns, wildflowers), change the physical and chemical properties of the soil, adversely affecting many native species (OISAP 2019).

NCC (2019) rates the scope, severity and irreversibility as well as the overall impact of terrestrial invasive species on the Forests target in the FA area as medium.

Invasive Terrestrial Species	Scope	Severity	Irreversibility	Overall
Forests	Medium	Medium	Medium	Medium
Wetlands				
Aquatic Systems				
Reptiles & Amphibians				

Plant-affecting diseases and pests

According to NCC (2019), "Emerald Ash Borer (EAB) (*Agrilus planipennis*), a non-native beetle introduced to North America from Asia in the early 2000s, may devastate all native species of ash in Canada. As of 2017 EAB has been found in Toronto, Montreal and Ottawa with localized outbreaks detected in Leeds and Grenville Counties in 2011 (Forest Invasives Canada 2018). Post-infestation research in Michigan, the North American epicentre of EAB, has shown that high ash mortality (>95%) negatively impacts the regenerating forest canopy in several ways. No new regeneration of Ash was observed once mortality reached 95%, leaving only those saplings too young to be infected. The increase in woody debris caused by simultaneous Ash death is predicted to alter soil microbial communities, nutrient cycling, carbon cycling, and hydrology. Additionally, invasive species were found to establish more readily in gaps on the forest floor compared to native species (Klooster et al. 2018).

"Many of the forests of the Frontenac Arch have several species of ash as a significant component and thus EAB may be expected to cause significant changes in the ecological dynamics of matrix forests on the Arch in the future. Based on outbreaks in other areas it may be safe to predict losses as high as 99% but it since research on the full impact of EAB on forest canopies is relatively new, further information should be gathered as it becomes available."

Plant-affecting Diseases & Pests	Scope	Severity	Irreversibility	Overall
Forests	High	Medium	High	Medium
Wetlands				
Aquatic Systems				
Reptiles & Amphibians				

Habitat loss/fragmentation by mines, pits and quarries

Given that Ontario passed a new Mining Act which included an automatic withdrawal of Crown mineral rights under privately held surface rights in Southern Ontario, the greatest remaining threat in terms of mineral extraction in the Frontenac Arch area according to NCC (2019) is "aggregate extraction on private lands…Most aggregate extraction that impacts the Frontenac Arch occurs on Ordovician limestone deposits on the edge of the Arch or in discrete pockets within the Arch but also includes some deposits of marbleized limestone on the Arch proper. The prospect of aggregate development directly threatens many of the biodiversity targets in the [Frontenac Arch] through habitat loss, ecosystem degradation/loss and fragmenting connectivity between natural habitats and corridors. Extracting resources below the water table can disrupt the groundwater flow and therefore the water flow."

The effects of such habitat destruction can be difficult to reverse or mitigate without considerable rehabilitation efforts and costs.

Habitat Loss / Fragmentation by Mines, Pits & Quarries	**Scope**	**Severity**	**Irreversibility**	**Overall**
Forests	Low	Very High	High	Medium
Wetlands				
Aquatic Systems				
Reptiles & Amphibians				

Threats with Low rating

All-terrain Vehicles (ATVs) and Off-road Vehicles (ORVs)

According to NCC (2019), "A variety of issues are associated with the use of ATVs and off-road motorised vehicles in the [Frontenac Arch area]. These include soil compaction and erosion, stream sedimentation, trampling of native vegetation, spreading invasive species, wildlife mortality and disturbance (Switalsi and Jones 2012)."

The severity, scope, threat magnitude, irreversibility and threat to the Forest, Wetland and Reptile & Amphibian targets is rated as low.

ATVs & ORVs	Scope	Severity	Irreversibility	Overall
Forests	Low	Low	Low	Low
Wetlands	Low	Low	Low	Low
Aquatic Systems				
Reptiles & Amphibians	Low	Low	Low	Low

Livestock Farming & Ranching

Livestock access to waterways negatively impacts water quality by increasing nutrients and turbidity, while causing bank erosion. Poor management of livestock density can lead to overgrazing and result in increased erosion and nutrient runoff. Runoff from livestock yards or improper manure storage also contribute to nutrient loading in the aquatic systems. According to NCC (2019), "There have been several periods in the past 20 years when landowners have cleared large areas of forest to increase production. While this was once a larger threat in the [Frontenac Arch area], the agricultural economy is currently depressed and is not anticipated to be a large threat in the next five years, unless economic trends change."

The severity, scope, threat magnitude, irreversibility and threat to the Forest, Wetland and Aquatic Systems targets is rated as low.

Livestock Farming & Ranching	Scope	Severity	Irreversibility	Overall
Forests	Low	Low	Low	Low
Wetlands	Low	Low	Low	Low
Aquatic Systems	Low	Low	Low	Low
Reptiles and Amphibians				

Collecting and Persecution of Terrestrial Animals

Persecution and collection of reptiles and turtles are considered a Canada-wide threat to reptiles and amphibians (NCC 2019). Blanding's and Spotted turtles are particularly vulnerable to poaching, as are some snake taxa, and snake persecution due to unwarranted fear continues to be a concern although frequency and level of impact on populations is not well documented. This threat is most likely to occur in areas of the Frontenac Arch with more intensive development and more recreational users. Education and outreach activities around protecting snakes and turtles, as well as the remoteness of large portions of the area, limit the severity and scope of this threat.

Collecting & Persecution of Terrestrial Animals	Scope	Severity	Irreversibility	Overall
Forests				
Wetlands				
Aquatic Systems				
Reptiles and Amphibians	Low	Low	Low	Low

Gathering Terrestrial Plants

According to NCC (2019), "American Ginseng (*Panax quinquefolius*) is valued as a medicinal herb. Collection of American Ginseng is one of the greatest threats to this species in Ontario (Robbins 1998). The 2000 status report (COSEWIC 2000) states that harvest has affected 55% of the surveyed sites in Ontario. That number has likely increased in the 18 years since this report. There has been a known harvest within the [Frontenac Arch area] for American Ginseng…. Orchids are valued for their ornamental beauty. Orchids are sometimes collected by enthusiasts or trampled by photographers….Some of the orchids within in the NA include the globally rare Ram's-head Lady's-slipper (*Cypripedium arietinum*) and Eastern Prairie White-fringed Orchid (*Platanthera leucophaea*), as well as other ornamental orchids such as Pink Lady's-slipper (*Cypripedium acaule*), Large Yellow Lady's-slipper (*C. parviflorum* var. *pubescens*) and Rose Pogonia (*Pogonia ophioglossoides*)….These are generally slow growing and delicate species, and it is problematic to reverse the damage caused by collecting from the wild." NCC monitors populations of vulnerable terrestrial plants at their properties to determine the scope and severity of gathering.

Gathering Terrestrial Plants	Scope	Severity	Irreversibility	Overall
Forests	Low	Low	Low	Low
Wetlands				
Aquatic Systems				
Reptiles and Amphibians				

Fragmentation by unsustainable forestry practices

According to NCC (2019), forestry has historically been a contributor to habitat fragmentation and habitat loss on a large scale in the Frontenac Arch and it currently occurs on both public and private lands, but at a minor and declining scale. Unsustainable forestry practices can have significant negative impacts on populations of forest interior birds, including the Threatened Cerulean Warbler, for which the A2A FA CAP area is one of very few strongholds in Canada. However, most private land and virtually all Crown land forests in the Frontenac Arch area are

managed responsibly (Bull pers. comm. 2019). The scope, severity, irreversibility and overall rating for this threat is therefore rated as low.

Fragmentation by Unsustainable Forestry	Scope	Severity	Irreversibility	Overall
Forests	Low	Low	Low	Low
Wetlands				
Aquatic Systems				
Reptiles and Amphibians				

Fragmentation by unsustainable forestry practices

NCC (2019, citing NRC 2005), notes that fire has historically been a significant ecological process within the Frontenac Arch. Notably the significant Pitch Pine Treed Granite Barren is a fire-dependent system. Both surface fires and stand replacement fires were likely common in this type of community, with mosaic, patchy effects (Small et al. 2005). Fire suppression inhibits recruitment of Pitch Pine. However, on poor growing sites such as the rocky outrcops of the Frontenac Arch, the Pitch Pine communities persist simply due to lack of competition.

The scope, severity, irreversibility and overall rating for this threat is therefore rated as low.

Fire Suppression	Scope	Severity	Irreversibility	Overall
Forests	Low	Low	Low	Low
Wetlands				
Aquatic Systems				
Reptiles and Amphibians				

Garbage

Lake Opinicon is used heavily by tourists in the summer and every year remarkable amounts of waste are cleaned up. While garbage dumping in other waterbodies of the A2A FA Arch area requires better documentation, it should be noted as a potential threat to lake health and biodiversity (Schoepf pers. comm. 2019). Residential garbage dumping and littering can negatively affect water quality, plants, and wildlife, especially reptiles. Turtles are particularly vulnerable to garbage because they ingest and get tangled in discarded plastic (McLeod 2019). The low rating for this threat is tentative, as more information is required to appropriately rate this threat.

Garbage	Scope	Severity	Irreversibility	Overall
Forests				
Wetlands				
Aquatic Systems	Low	Low	Low	Low
Reptiles and Amphibians				

Algal blooms

A combination of factors including excessive nutrient (e.g., phosphorus and nitrogen) levels, warm temperatures and high levels of sunlight can spur the onset of an algal bloom. Typically such abnormal levels of nutrients originate from agricultural run-off (e.g., fertilizers, manure), urban wastewater, and leaking septic systems. Many types of algae form blooms and some, such as Microcystis, can contain toxins or other noxious chemicals or pathogens that can be harmful both fish, birds and humans. Masses of decaying algae may from blooms that lie at the bottom of lakes can deplete the supply of oxygen, creating dead zones where fish are unable to survive (OBC 2015). Algal toxins may also contaminate drinking water, causing serious human health issues, such as gastrointestinal discomfort and in severe cases, liver damage. Algae blooms can also interfere with recreational activities such as swimming, boating and fishing (OBC 2015).

In the Frontenac Arch area, the CRCA (2018) Watershed Report Card grades are all “B’s” and “C’s”, with E. coli levels are low except in the vicinity of the two main urban areas. However, all ten monitoring stations had total phosphorous levels above the Provincial Water Quality Objectives, potentiantially causing excessive plant growth in streams and nuisance algae blooms on lakes.

The tentative “low” threat rating for algal blooms was made by the lead author (Jalava), not by CAP participants, based in part on workshop discussions and the above statements in CRCA (2018).

Algal Blooms	Scope	Severity	Irreversibility	Overall
Forests				
Wetlands				
Aquatic Systems	Low	Low	Low	Low
Reptiles and Amphibians				

4.4 Viability Assessment

Viability assessment is a method identified by the *Open Standards* for assessing the health of a conservation target. It uses the best available information and does not require perfect information. The process is meant to be iterative and adaptive (FOS 2013).

In order to determine the current health of the conservation targets in the A2A FA CAP area, a viability assessment was completed with help of the Miradi software. The following steps were attempted, with varying levels of success depending on availability of relevant data and expertise:

1. Identification of at least three Key Ecological Attributes (KEAs) for each conservation target. KEAs fall within the categories: size, condition and landscape context (Figure 8).
2. Identification of measurable indicators for each KEA.
3. Identification of an acceptable range of variation for each indicator (the viability rating scale, Figure 8).
4. Identification of a measurement value for each indicator.
5. Documentation of rating and measurement sources.

The viability assessment was completed using the best available information given the time and resources available. Data gaps and assumptions have been documented throughout. As the A2A FA CAP is an adaptive plan, the viability assessment is expected to be further refined at different stages of the project. Overall results of the viability assessment are described below.

Box 2. Key Terminology - Viability Assessment.

Viability: Broadly, the status or "health" of a population of a specific plant or animal species (FOS 2009).

Key Ecological Attribute (KEA): An aspect of a target's biology or ecology that, if missing or altered, would lead to the loss of that target over time (FOS 2009).

Indicator: A unit of information measured over time that documents changes in a specific condition (here, changes in a KEA) (FOS 2009).

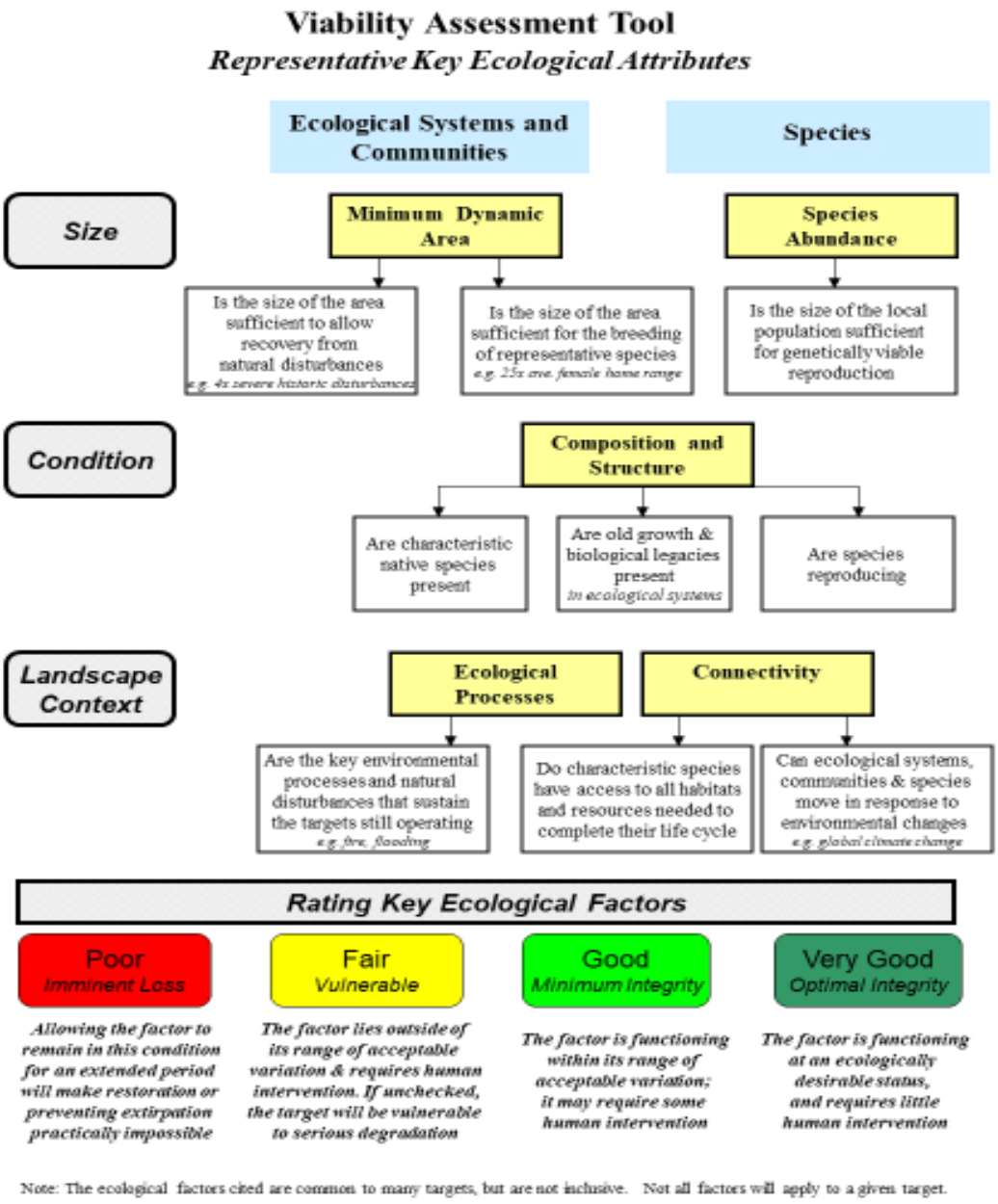
Size: A measure of the area of the conservation target's occurrence (for an ecosystem target) or abundance of the target's occurrence (for a species or population target) (FOS 2009).

Condition: A measure of the biological composition, structure and biotic interactions that characterize the space in which the target occurs (FOS 2009).

Landscape Context: An assessment of the target's environment including: a) ecological processes and regimes that maintain the target occurrence such as flooding, fire regimes and other kinds of natural disturbance and b) connectivity that allows species targets to access habitat and resources or allows them to respond to environmental change through dispersal or migration (FOS 2009).

Viability Ratings: A project's scale of what is very good, good, fair, or poor for a given indicator for a given target. Viability ratings are often quantitatively defined, but they can qualitative as well. In effect, by establishing this rating scale, the project team is specifying its assumption as to what constitutes a "conserved" target versus one that is in need of management intervention (Miradi V. 4.4.0, 2017).

Figure 9. Viability Assessment Tool (FOS 2013)



For the A2A FA CAP, each of the four conservation targets was rated on the basis of the three *Open Standards* viability assessment criteria (i.e., landscape context, condition, and size) described above, where supporting data or information was readily available. An overall viability rating, based on the calculated *Open Standards* algorithm in Miradi, was generated.

The results of this viability assessment are summarized below. Please refer to Appendix B for complete lists of the key ecological attributes (KEAs) and indicators that were discussed by the FA CAP participants as having potential to inform the viability ratings and future monitoring. The KEAs and indicators are based on those used for the same (or equivalent) conservation targets in other CAP projects, as well as on specific recommendations by the 2019 Frontenac Arch CAP workshop participants. This process was not fully completed due to time constraints and challenges accessing supporting information. More work will be required to better identify, select and rate the KEAs and indicators for most conservation targets of this CAP.

Conservation Target: Forests

The viability assessment for the *Forests* target is based largely on NCC (2019), which participants of the A2A FA CAP agreed accurately represented the viability of the Forests target.

Landscape Context: Good

Ecological connectivity of *Forests* within the FA CAP area is rated as good. NCC (2019) notes that one forest tract is nearly 30,000 ha and several forest blocks are 4,000-5,000 ha in size, suggesting an adequate level of ecological connectivity across the landscape for forest viability (e.g., Anderson 2001, Anderson and Bernstein 2003, Fahrig 2003, Beazley et al. 2010), especially in the Western Frontenac Arch and Loughbaorough Wilderness focal areas. According to NCC (2019), ecological disturbance in the FA is within the natural range of variation, with the exception of wildfire, which is deliberately suppressed for safety and economic reasons.

Condition: Good

The overall condition of *Forests* in the Frontenac Arch area is rated as good. According to NCC (2019), the forest matrix is comprised of extremely rich native forests of with strong southern affinities (Beschel et al. 1962) and natural processes are intact. There is limited internal fragmentation except by trails and mostly secondary and tertiary roads. Across much of the area, forest patches are naturally fragmented by lakeshore and river systems. Variety of age classes (young, medium, old) and diversity of forest types is generally high.

On the other hand, both the Pitch Pine and Bare Rock Ridge systems are fire-dependent and are therefore being impacted to some degree by fire suppression (NCC 2019). NCC (2019) speculates that these community types may expand due to predicted warmer conditions, more severe droughts, and more frequent and severe wind and ice storm events associated with climate change. Such factors create canopy gaps and may also increase downed woody fuel, potentially increasing the likelihood of naturally-occuring wildfire. In some of the forest tracts,

non-native taxa are common, including Buckthorn (*Rhamnus cathartica*) and Eurasian grass species (NCC 2019).

The Frontenac Arch area supports a viable population of Gray Ratsnake, and wide-ranging mammals such as American Black Bear (*Ursus americanus*), Eastern Wolf (*Canis lupus*) and Fisher (*Pekania pennanti*) persist in the area (NCC 2019). Connectivity between forest patches appears to be within minimum recommended thresholds, but should be maintained at or near current levels (Environment Canada 2013).

Size: Very Good

According to NCC (2019), the >72% forest cover of the terrestrial (i.e., non-open water) portion of Frontenac Arch is the highest percentage in southern Ontario. Based on GIS analysis done specifically for the A2A FA CAP area, over 100,000 ha of forest and treed swamp is >100 m from the nearest road, and almost 80,000 ha is >250m from roads. Such high areal extent of interior forest is also exceptional for southern Ontario, and would be expected to provide suitable habitat for healthy populations of area-sensitive forest interior species.

Overall Viability Rating: Very Good

The forest complex is extensive and in generally good condition. It supports area-sensitive birds such as Cerulean Warbler (*Setophaga cerulea*) and Red-shouldered Hawk (*Buteo lineatus*), indicating that minimum area requirements are met. Climate trajectories suggests the forest types of the Frontenac Arch may expand and shift northwards. In order to accommodate the potential for increased storms from climate change, it has been estimated that protected landscapes need to be 50-100 times larger than average disturbance patches in order to maintain a relative equilibrium of habitats (Shugart and West 1981). In such landscapes, the proportions of different successional stages (from early-successional to old growth) would be relatively constant over time, even though the sites occupied by different stand types would change. On this basis, minimum recommended area for cores in southern Ontario would be roughly between 2500-5000 acres (1000-2000 hectares), conditions currently met in the Frontenac Arch area.

Conservation Target: Wetlands

The viability assessment for the *Wetlands* target is based largely on NCC (2019), which participants of the A2A FA CAP agreed accurately reflected the viability of the conservation target.

Landscape Context: Very Good

According to NCC (2019), in the Frontenac Arch area most wetland units are interconnected hydrologically and tied to intact upland habitats, a key to wetland viability (e.g. Hudson et al. 1992, Hanson et al. 2008). According to NCC (2019), based on GIS analysis “from a variety of

sources," over 80% of extant wetlands in the area are within 30 m of other wetlands, providing a rationale for the tentative "Very Good" rating.

Condition: Good

According to NCC (2019), native biodiversity in the wetlands of the Frontenac Arch is high (Norris pers comm. 2012, NHIC 2018, Hanson et al. 2008). Invasive species are present, but generally do no dominate in most of wetlands. Fisheries communities in the NA are good with some areas of high sensitivity (Queen's University 2008). Several rare native freshwater turtle species breed in the Frontenac Arch area (Ontario Nature 2019).

Size: Good

Large areas of mostly unaltered wetlands remain. There are many wetlands of a variety of sizes, types and hydro periods, with at least one wetland covering more than 400 hectares, the Wiltse Creek Wetlands adjacent to Gananoque Lake north of Marble Rock in the Frontenac Arch East focal area (NHIC 2018). That said, there has been significant loss of wetlands in eastern Ontario due to land use change, generally to agriculture (past) and development (current). Ducks Unlimited Canada (2010) has calculated that wetland loss in Ontario is over 70%, and, according to FA CAP participants, historical wetland loss in the Frontenac Arch area may be as high as 85% overall.

Overall Viability Rank: Good

Although some threats exist and there has been significant overall wetland loss, the wetland systems in the Frontenac Arch area are considered to be in good overall condition.

Conservation Target: Aquatic Systems

The viability assessment for the *Aquatic Systems* target is based in part on indicator measures relating to the health of Key Ecological Attributes (KEAs) identified by participants of the A2A FA CAP (during the CAP workshops and draft document review), when such data were available.

Landscape Context: Fair

The landscape context for the Aquatic Systems target is rated as "fair" primarily because of the number of dams potentially disrupting natural processes and species movement, as well as the extent of shoreline (and associated processes) impacted by hardening, vegetation clearing, and other modifications (e.g., docks). Based on Cataraqui Region Conservation Authority (CRCA) mapping, there are approximately 40 dams in the FA CAP area. They are operated by CRCA (~10), Fortis Generation (~14), MNRF (3), Parks Canada (4) and municipalities (~6). Combined, these dams almost certainly impact the vast majority of waterways in the area, but it is possible that smaller waterways not affected by human-made dams comprise over 10% of the watersheds.

Condition: Fair

A variety of indicators relevant key ecological attributes of aquatic systems of the Frontenac Arch area are monitored by conservation authorities, Parks Canada, other agencies and NGOs.

Size: Good

The extent and configuration of aquatic systems in the Frontenac Arch has not changed significantly due to human impacts. However, it is debatable as to whether heavily controlled waterways such as the Rideau should be considered intact aquatic systems, hence the "good" rather than "very good" rating for size.

Overall Viability Rank: Fair

Conservation Target: Reptiles and Amphibians

Most herpetofaunal populations in the Frontenac Arch area are probably declining due to road mortality, habitat loss, persecution, collection for pet trade and introduced pathogens. However, relative to other parts of southern Ontario, populations are probably viable and relatively robust. Time constraints prevented drawing on, summarizing and synthesizing the extensive past and ongoing herpetofaunal research and monitoring in the Frontenac Arch area, notably by Queens University, Parks Canada (PCA 2016), and various NGOs including A2A (e.g., Urquhart et al. 2018) for the purposes of this viability assessment. As a result, the ratings provided here should be considered tentative "rough guesses".

Landscape Context: Fair

The tentative "fair" rating is based on an estimate of 50-60% of habitat mosaics for reptiles and amphibians within the A2A FA CAP area is >100m from roads (refer to Table 7, above). A robust assessment of the landscape context should consider configurations of functional Gray Ratsnake, turtle and other herpetofaunal movement corridors. All life cycle habitat requirements (hibernacula, gestation sites, nesting sites, feeding/summering sites, etc.) for all nested herpetofaunal species should not broken by roads, especially at locations of high importance (e.g., access to breeding ponds, egg laying sites and hibernacula).

Suggested measures include percent of the Frontenac Arch habitat mosaic that is (250m / 100m) "interior" (i.e., roadless, or mitigated with ecopassages and barrier fencing – e.g., refer to Aresco 2003) natural habitat. Another potential high-level measurement tool would be percent forest cover within "critical habitat" for species at risk that has been mapped as *Species At Risk Act, 2003*, requirements. Suggest using a normalizing metric as Gray Ratsnake critical habitat changes based on available observations. In this case, the metric could be overall forest cover divided by the total critical habitat area. This would also be a good metric for many snakes and some salamanders (Lambert pers. comm. 2019).

Condition: Unknown

Size: Unknown

Amphibian population sizes and trends can be (and are being) monitored at a coarse level via the Marsh Monitoring Program (MMP). Declining trends indicated by the MMP may be (and likely often are) associated with factors other than road mortality (or poaching or persecution), but if declines are found to be greater at monitoring sites near high-traffic roads, road mortality might be a cause. More data are required to assess the overall Reptile and Amphibian target on the basis of the size criterion.

Overall Viability Rank: Fair

Overall viability rating for Reptiles and Amphibians in the Frontenac Arch area is probably "fair" or "good", based on Open Standards definitions: "Fair – Outside acceptable range of variation; requires human intervention. Good – Indicator within acceptable range of variation; some intervention required for maintenance."

5. CONSERVATION GOALS AND PRELIMINARY STRATEGIES

5.1. Conservation Goals

The following twelve conservation goals were developed for the A2A Frontenac Arch CAP by participants during the workshops, webinar and document review processes are presented in tabular format below. In the table below, each of the twelve goals is listed after the conservation target with which it is most closely associated.

Conservation Targets Goals	Notes
Forests	
1. **Maintain forest extent and diversity at 65% of the Frontenac Arch**	This goal supports maintaining the extent (i.e., type, age classes, ecotype diversity and species composition) of forest habitat, especially along and near wetlands, waterways and shorelines. It may include reintroduction of extirpated taxa and invasive species control, as necessary, especially in the context of climate change. An effective and efficient approach may be to maintain and restore suitable ecological conditions (extent, quality, connectivity, etc.) for extirpated taxa to re-establish, which would also allow for species to adjust ranges in response to climate change. Baseline information on forest diversity and proportionality of matrix, large patch and small patch communities can be derived in part from site district report (White, D.J. 1993. Life Science Areas of Natural and Scientific Interest in Site District 6-10. A Review and Assessment of Significant Natural Areas. OMNR, Eastern Region, Kemptville. 122 pp. + map), as well as original Forest Resource Inventory and more recent Ecological Land Classification mapping, where available.
2. **Frontenac Arch forest connectivity supports viable populations of wide-ranging native fauna and the dispersal needs of native forest flora**	This goal supports improving forest connectivity through restoration, especially in the more fragmented eastern part of Frontenac Arch.

Conservation Targets Goals	Notes
Wetlands	
3. **Frontenac Arch area supports viable populations of representative wetland species guilds.**	Representative wetland species guilds for the Frontenac Arch may be derived from original wetland evaluations, ANSI reports, and other inventory projects. Marsh Monitoring Program by citizen scientists throughout the FA area provides a reliable, standardized, low-cost monitoring tool for certain indicator species. Thousand Islands National Park monitors 15 wetland sites using the Marsh Monitoring Program bird and frog protocols, as well as three other variables (i.e., water quality, invasive species and GIS-based landscape amount measures). Species-based monitoring could be supplemented with some form of remote sensing or GIS -based monitoring tool to track changes to particular wetlands, their composition, etc.
4. **Maintain the extent, composition and configuration of the full suite of representative wetland ecotypes.**	Baseline information on forest diversity and proportionality of matrix, large patch and small patch communities could be derived in part from site district report (White, D.J. 1993. Life Science Areas of Natural and Scientific Interest in Site District 6-10. A Review and Assessment of Significant Natural Areas. OMNR, Eastern Region, Kemptville. 122 pp. + map). Wetland evaluations available on file from the Ministry of Natural Resources and Forestry also provide good baseline data on extent, proportionality and species composition of wetland types for those sites that have been evaluated.
5. **Extent of functional wetlands in Frontenac Arch area increased [% to be determined] by 2050**	Given that ~65% of wetlands have been lost across the FA area (DUC 2010), a goal of doubling the current extent of functional wetland has been suggested. Restoration efforts should focus on shoreline wetlands as well as wetlands (including ephemeral ponds) not identified as provincially significant. Ensure wetland functions and ecological services are maintained. Key will be to communicate the value, importance, significance of wetlands to decision-makers and the public.

Conservation Targets Goals	Notes
Aquatic Systems	
6. **Flashiness of non-St. Lawrence & Rideau aquatic systems mimics historical levels**	The Frontenac Arch generally has shallow, clay-based soils over bedrock, so stormwater policies likely have considerable influence on water level fluctuations. The flashiness of a stream reflects how quickly flow in a river or stream increases and decreases during a storm. Flashy streams are common in urbanized areas because stormwater runoff reaches the waterways much more quickly than it would under natural conditions. The Richard-Baker Flashiness Index (R-B Index) reports changes in short term daily flows relative to average yearly flows. When stormwater flows into creeks at a higher volume and at a faster rate relative to natural conditions, the R-B flashiness index increases. Watersheds in the FA area are currently rated at 1-2 Standard Deviation (SD) (fair), and the goal is to improve flashiness to <1 SD (good). The R-B Index may be used as an indicator of the effectiveness of strategies using existing monitoring data (e.g., Water Survey of Canada gauging stations and provincial flow assessment tools like Ontario Flow Assessment Tool). Historical fluctuations need to be understood to establish a baseline. Further research is likely necessary to reconstruct the historical flow regimes of the various river systems in the Frontenac Arch for comparison with current degrees of fluctuation. Implications of dam removal on flow regimes will need to be taken into consideration as well.
7. **Flashiness of St. Lawrence Seaway and Rideau systems increased**	This goal is to support and build on Plan 2014 IJC 2014), the International Joint Commission report on inflows and outflows in the Great Lakes, which provides context, goals and recommendations on how to re-establish more natural water level fluctuations on the St. Lawrence River, to restore ecologically important processes like wetland flushing and sand movement. Historical fluctuations need to be understood to establish a baseline.
8. **Improve and maintain water quality**	The high-level goal is for the relevant conservation authority watershed report cards and Parks Canada water quality monitoring ratings to improve from the current “fair” (or equivalent) to “good”. A suggested long term goal is for untreated water in the Frontenac Arch area to be potable.

Conservation Targets Goals	Notes
9. **Restore and maintain native aquatic biodiversity**	This goal includes restoring and maintaining viable populations of migratory fish such as American Eel, Muskellunge, as well as Lake and Brook trout, other native fishes, herpetofauna, aquatic invertebrates and plants. An assessment of status should be possible once a particular suite of species for monitoring is selected. It should be noted that some rare species may be very difficult to monitor (and may not be indicative of overall health); certain suites of generally more common taxa may be easier to monitor, with more readily available data from existing programs. Within the St. Lawrence River component, priority effort may best be directed toward species at risk like Lake Sturgeon, American Eel and Eastern Pond Mussel and their respective habitats.
10. **Full range of natural shoreline features and processes is present across [% to be determined] watersheds by [timeframe to be determined].**	Natural or naturalized shorelines: a) reduce harmful run-off (fertilizers and pesticides; soil particles; road salt and other chemicals; vehicle fluids such as gasoline; waste from pets, livestock, septic leachate, etc.) that can cause algae blooms and excessive weed growth; b) significantly reduce shoreline erosion and improves overall shoreline resilience; c) improve overall biodiversity (both terrestrial and aquatic) and discourage hyperabundant Canada Geese; d) result in overall improved water quality. Natural shoreline features and processes will require clear definition. Shorelines could be evaluated and rated based on different types of alterations. Remote sensing data may be used, as Cataraqui Region Conservation Authority has LIDAR data, Drape will be available in spring 2020. However, remotely-sensed "natural cover" mapping may not capture hardened shoreline, other smaller-scale modifications and non-native vegetation. Environment and Climate Change Canada has shoreline environmental sensitivity mapping (based on visual inspections) available for the St. Lawrence section of Frontenac Arch area.
11. **Connectivity of aquatic systems sufficient to allow for life cycle movements of all native fish and herpetofauna by [timeframe to be determined].**	Connectivity includes unimpeded water flow as well as naturally vegetated riparian buffers. Strategies to achieve this goal may involve a combination of dam decommissioning where feasible, mitigation through water level regulation that emulates natural fluctuations, and other forms of mitigation (e.g., installing fish ladders). The degree of fish passage restriction issues within the Frontenac Arch area needs to be determined, and should include inoperative or constricted culvert installations along watercourses.

Conservation Targets Goals	Notes
Reptiles & Amphibians	
12. **Maintain and enhance the species richness, abundance and long-term viability of reptiles and amphibians in the Frontenac Arch area.**	This goal focuses on species at risk and declining taxa, particularly those vulnerable to road mortality, poaching and persecution.

5.2. Preliminary Conservation Strategies

The following 20 strategies were identified by A2A Frontenac Arch CAP collaborators as having potential to maintain and enhance the viability of the four conservation targets by addressing key threats to those targets. Each strategy is expected to contribute to achieving one of more goals of the A2A Frontenac Arch CAP.

To help prioritize future action by A2A Frontenac Arch CAP collaborators, each strategy was rated for potential impact and feasibility using Open Standards criteria presented below:

Strategy Effectiveness Rating Criteria

Potential Impact – Degree to which the strategy (if implemented) will lead to desired changes in the situation at your project site

- **Very High –** The strategy is very likely to completely mitigate a threat or restore a target.
- **High –** The strategy is likely to help mitigate a threat or restore a target.
- **Medium –** The strategy could possibly help mitigate a threat or restore a target.
- **Low –** The strategy will probably not contribute to meaningful threat mitigation or target restoration.

Feasibility – Degree to which your project team could implement the strategy within likely time, financial, staffing, ethical, and other constraints

- **Very High –** The strategy is ethically, technically, AND financially feasible.
- **High –** The strategy is ethically and technically feasible, but may require some additional financial resources.
- **Medium –** The strategy is ethically feasible, but either technically OR financially difficult without substantial additional resources.
- **Low –** The strategy is not ethically, technically, OR financially feasible.

Seven of the strategies involve higher-level, multi-faceted outreach, partnership-building, awareness-raising and education activities, potentially addressing many or all of the conservation goals of the CAP. Two strategies aim to promote ecologically-friendly infrastructure improvements. One strategy is specifically focused on wetland conservation. Six strategies are focused on restoring the physical conditions, functions and ecological features that support healthy aquatic systems, aquatic biodiversity and clean water. Four strategies are primarily oriented towards maintaining healthy forests and supporting a sustainable forest industry.

Combined, the implementation of these strategies should contribute to the human wellbeing targets: 1) a sustainable supply of forest products; 2) thriving agriculture; 3) clean water; 4) nature appreciation; 5) superb fishing; 6) thriving tourism and recreation; 6) healthy local economy and property values; and 7) healthy people.

1. High-level outreach strategies to benefit all conservation targets

Strategy	Details See diagram for *strategy-contributing factor-threat-target* linkages	Target(s) / Goal(s)	Potential Impact	Feasibility	Comments
1.a. Engage key community leaders to champion CAP	This strategy is consistent with the mandates and work of the Frontenac Arch Biosphere Reserve Network (FABN) and A2A. The community at large needs to take ownership of the CAP for it to successfully achieve its goals. Leadership and strong support must come from a diversity of sectors that are not necessarily normally aligned with the conservation community. This overarching strategy applies to most (if not all) of the more specific strategies of the A2A FA CAP. Clear articulation of the links between conservation actions and human wellbeing targets (cultural, economic, health, etc.) will be required. Peer-to-peer approaches are often most effective, so the key will be to work with sector representatives who are willing to listen and work with the conservation groups, and who are best equipped to influence their peers.	All Targets / All Goals	HIGH	HIGH	This should be considered a long term, ongoing strategy that should lead to broader and stronger community and decision-maker support for the CAP. Groups with particularly strong influence over FA CAP conservation target viability include tourism operators, agriculture, transportation planners (county and provincial roads departments) and shoreline property owners. Tourism operators, waterfront property owners and anglers would be influential allies with respect to strategies to enhance aquatic connectivity and improve water quality. FABN recently initiated an Advisory Council to achieve a similar purpose. Additional resources will likely be needed to enable successful meetings and to ensure relevant projects can be launched. Although their focus is primarily on land acquisition, the Land Conservancy for Kingston, Frontenac, Lennox & Addington (LCKFLA) is open to exploring ways to assist with this strategy. Community leaders, like politicians, may change over time, so the impact may be temporary unless long term support is in place. It should also be recognized that different threats need to be addressed at different scales (provincial, regional, local, etc.), with implications on overall effectiveness of the strategy as well as which "community leaders" would be best to engage to achieve specific results. Considerable coordination and information dissemination will be required with this strategy, and its effectiveness will still depend, to a certain degree, on local government buy-in.

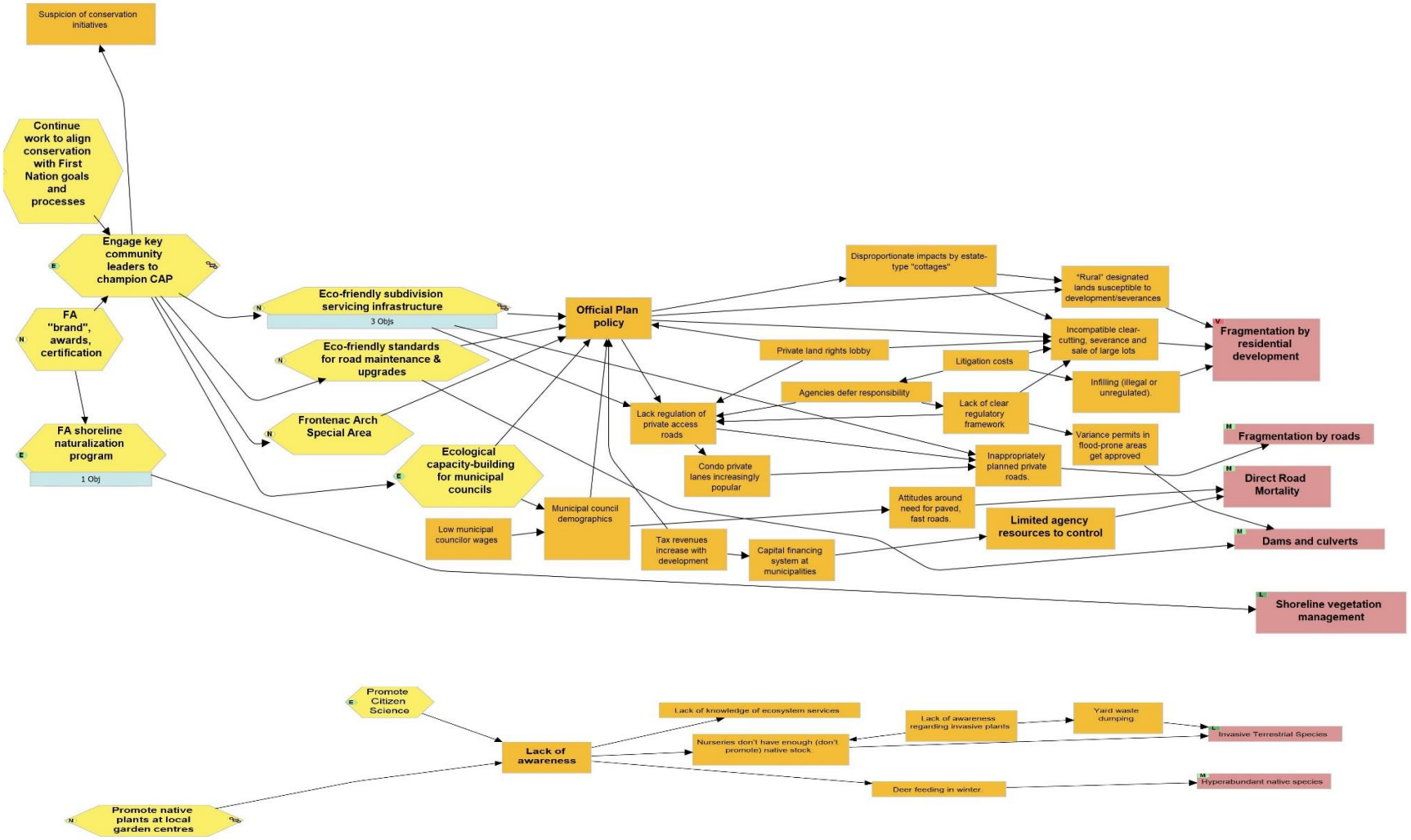
Strategy	Details See diagram for *strategy-contributing factor-threat-target* linkages	Target(s) / Goal(s)	Potential Impact	Feasibility	Comments
1.b. Continue work to align conservation activities with First Nation goals and processes	This strategy is consistent with Frontenac Arch Biosphere Reserve's and A2A's work. The A2A FA CAP area overlaps with the traditional territories of the Mohawks of the Akwesasne and Tyendinaga first nations, and northern portions fall within the ancestral lands of Algonquin Nation.	All Targets / All Goals	VERY HIGH	MED*	Alignment with and support from First Nations will strengthen and enhance CAP efforts. Such efforts should be undertaken in the context of "Ethical Space" (ICE 2018) and "two-eyed seeing" (e.g., http://www.integrativescience.ca/Principles/TwoEyedSeeing/) principles, Reconciliation at the national level, treaty rights, responsibilities and obligations, and local First Nations initiatives, programs and projects. The strategy could involve cultural sensitivity training, as well as supporting the development of Indigenous Protected and Conserved Areas (IPCAs) and the Indigenous Guardians program (https://www.canada.ca/en/environment-climate-change/services/environmental-funding/indigenous-guardians-pilot-program.html). A group in Gananoque is endeavouring to create a small Indigenous park. * "Medium" rating relates to capacity issues at First Nations, as well as historical factors.

Strategy	Details See diagram for *strategy-contributing factor-threat-target* linkages	Target(s) / Goal(s)	Potential Impact	Feasibility	Comments
1.c. Support ecological capacity-building for municipal councils	This strategy aims to improve the ecological literacy of decision-makers at the municipal council level. The approach should emphasize how good stewardship actions improve ecosystem services and thereby contribute to the human wellbeing targets.	All Targets / Goals 1,2,3 4,5,6,8,9, 10,11,12	HIGH	HIGH	Given the demands on most municipal council members and the rate of turnover, long term resources will need to be dedicated to keep this in place and effective. An effective approach may be to focus capacity-building on the more permanent Chief Administrative Officers and municipal planners who regularly interact with councils. FABN has capacity and some influence to implement this strategy. Creative and effective communications tools will need to be developed or acquired for council members and others to be receptive. LCKFLA met with all municipalities and townships during the development of their Natural Heritage Plan (NHP). While response was universally positive, it has been difficult with a totally volunteer base to follow up directly with the municipalities (all were sent hard copies of our NHP).
1.d. Promote citizen science and action alongside best management practices	The many well-run citizen science initiatives build awareness and knowledge, create interest and support for conservation, provide evidence of success, as well as opportunities for social interaction and community building. Citizen science can be integrated with other strategies for greater impact.	All Targets / Goals 1,2,3 4,5,6,8,9, 10,11,12	HIGH	HIGH	Excellent large scale initiatives include eBird, iNaturalist, Bumble Bee Watch, eButterfly, Marsh Monitoring Program, Ontarior Reptile and Amphibian Atlas, the upcoming Ontario Breeding Bird Atlas, Christmas Bird Counts, Project Feeder Watch, Canadian Lakes Loon Survey, Ontario Invasive Species Reporting Program, various fish and water monitoring programs, and several others.

Strategy	Details See diagram for *strategy-contributing factor-threat-target* linkages	Target(s) / Goal(s)	Potential Impact	Feasibility	Comments
1.e. Promote Frontenac Arch as a Special Area	This strategy would need broad community support, strongly-motivated leaders and extensive resources (lobbying and outreach) to reach fruition. Strong leadership and long-term commitment will be needed. A short term strategy would be to undertake feasibility study, which in and of itself would likely require substantial resources to bring to life. A strong argument and assessment of the impact of this strategy on environmental and socio-political factors will be necessary. This is an objective of the Frontenac Arch Biosphere Network. It could be linked to conservation authority mandates and to efforts in other biosphere reserves. Even though it does not have a legislated special planning framework like the Niagara Escarpment and Oak Ridges Moraine (Greenbelt), the Long Point World Biosphere Reserve receives considerable "special" attention from government (e.g., Environment and Climate Change Canada's Focal Area) and non-government organizations such as ALUS Canada (ALUS 2018), The Nature Conservancy of Canada, and many others), with dedicated human and financial resources (e.g., LPWBR 2013) to promote protection, conservation and stewardship efforts. Beyond Ontario, the Yellowstone to Yukon Conservation Initiative could be looked to for approaches to promoting special status for A2A and the Frontenac Arch.	All Targets / All Goals	HIGH	MED	Common cross-sectoral values would need to be highlighted in a campaign. With the Niagara Escarpment it was the magnificence and beauty of the escarpment itself (threatened by aggregate extraction) and the Bruce Trail. For the Oak Ridges Moraine it was drinking water. "Common values" for the Frontenac Arch could include: the diversity of aquatic systems providing resources and opportunities to an array of sectors; source water protection and water quality (for drinking water, recreation, fishing); the landscape as a corridor for response to climate change; sustainable tourism; reversing biodiversity loss; and the economic benefits of environmental sustainability overall. An approach could be to show what the landscape will look like in 20 years without special stewardship, conservation planning and ecological restoration. The Frontenac Arch could serve as a "barometer" with specific metrics for tracking climate change issues for Eastern North America – a real-life laboratory for special research initiatives tailored to exploring climate change impacts, implications, mitigation strategies and adaptation strategy successes and failures. This might require an initiative to engage multiple universities to establish some form of interdisciplinary research collaboration (e.g., PEARL lab in High Arctic or Experimental Lakes Area in NW Ontario). The strategy could also include a "Frontenac Greenway" Habitat Restoration Program, to restore and maintain connectivity of forests and wetlands between critical core areas (e.g., Thousand Islands and Charleston Lake). An objective would be to engage and collaborate closely with hunting and fishing groups to support healthy terrestrial and aquatic habitat, and preventing the spread of invasive species.

Strategy	Details See diagram for *strategy-contributing factor-threat-target* linkages	Target(s) / Goal(s)	Potential Impact	Feasibility	Comments
1.f. Frontenac Arch "brand", awards, certification	This strategy could include a "Green Awards" equivalent for the Frontenac Arch, including recognition for eco-friendly infrastructure planning, building design (Biosphere-friendly homes), Biosphere-certified businesses, FSC-certified forestry, “Green Agriculture”, MFTIP-participating woodlot owners, “Green Marine” marinas, golf course certifications, participants in a "Shoreline Challenge" (see separate strategy), habitat restoration projects, etc.	All Targets / Goals 1,2,3, 4,5,6,8,9, 10,11,12	MED	MED	FABN has models from other national biospheres that could be followed with some financial input.
1.g. Promote native plants at local garden centres and with the public	Awareness of the benefits of gardening with native plants is growing rapidly, and one way in which landowners can be empowered to make a significant contribution to biodiversity conservation at a very local, hands-on scale. Many excellent resources are available, such as the WWF-Carolinian Canada "In the Zone" program and "Grow Me Instead" of the Ontario Invasive Plant Council.	All Targets / Goals 1,2,3, 4,5,9,10,11, 12	MED	MED	This could be a lower cost initiative that is practical and could be taken on by local groups for awareness-raising and widespread penetration into the population. Climate change should be taken into account, as it is possible that the suite of “native” species best suited to local conditions may be different in the future. Another concern is the movement of fill and how people dispose of invasive material. A potential complementary strategy would be an invasive plant pick-up twice a year, working partnership with municipalities. Collected material would likely have to be incinerated or buried.

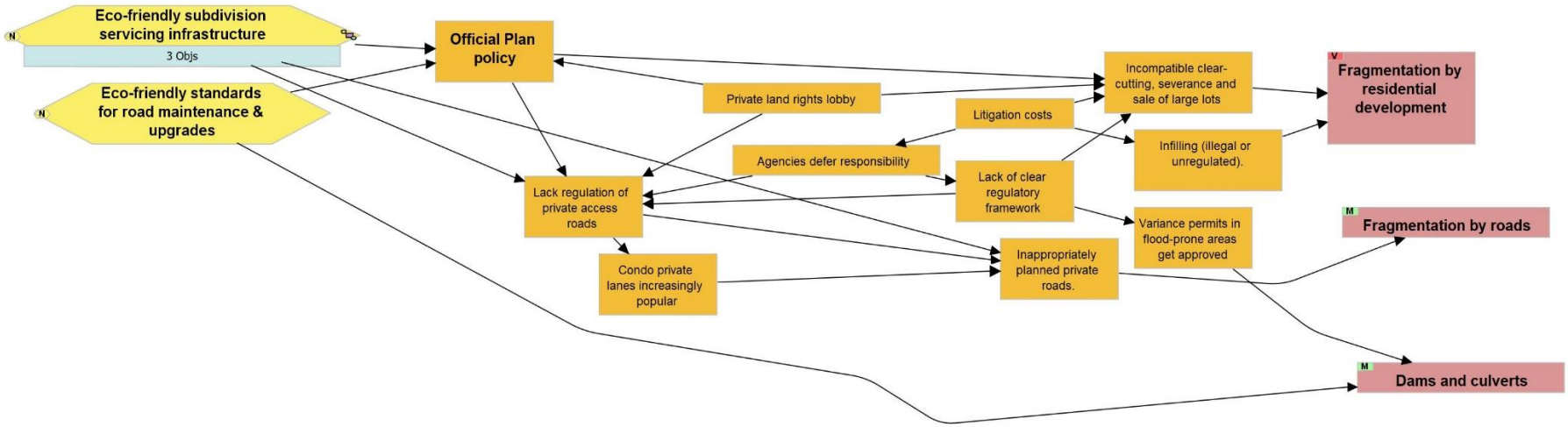
Figure 10. High-level outreach strategies to benefit all conservation targets



2. Strategies supporting eco-friendly infrastructure and Reptiles and Amphibians

Strategy	Details See diagram for *strategy-contributing factor-threat-target* linkages	Target(s) / Goal(s)	Potential Impact	Feasibility	Comments
2.a. Eco-friendly subdivision servicing infrastructure	This strategy involves outreach to developers, municipality city councillors, planning committee of adjustments, conservation authority, existing residents, home purchasers (marketplace) to adopt and apply the most current ecologically-friendly standards for subdivision servicing infrastructure.	All Targets / Goals 1,2,3, 4,5,8,11,12	HIGH	MED	This strategy would benefit from specific examples and further elaboration. Timeframe: Municipal election in 3 years (2 years to put together lobby). Socioeconomic considerations include instinctive pushback to changing rules and regulations, and potential risk to regulatory agencies.
2.b. Eco-friendly standards for road maintenance & upgrades	This strategy involves: a) convincing relevant decision-makers that such standards are a high priority; b) developing and providing guidance tools for transportation planners and maintenance managers to implement mortality mitigation at known road crossing locations (e.g., eco-passages, barrier fencing, speed bumps, signage, seasonal closures); c) raising public awareness and educating with respect to ecologically friendly road design. Existing supporting resources include Andrews et al. (2015), Markle et al. (2017), Turtle Guardians (2017) and MTO (2019).	Reptiles & Amphibians, Aquatic Systems / Goals 3,4,5, 6,9,11,12	HIGH	MED	The strategy could include creating and distributing outreach materials that broadcast levels of road mortality (16,000 DOR/yr) and their impacts on SAR populations, and highlighting the co-benefits of such conservation actions (e.g., slowing down also saves people's lives). Key activities could include developing a presentation for target groups based on the most recent science and research from universities (e.g. combination of Queens Engineering with Queens University Biological Station researchers) and tracking trends such that improvements can be demonstrated. To build awareness and capacity for transportation planners (who are often working with long term, fixed budgets and are thus harder to influence, especially for major thoroughfares like Highway 401), an approach could be to focus on regional roads and prepare costed "cookbooks" of road design (i.e., comparing the financial and environmental costs and benefits of different designs). Most county roads are the same width and configuration, so this could feasibly be done with limited resources. Another possible approach would be a township by township "eco-friendly roads" report card.

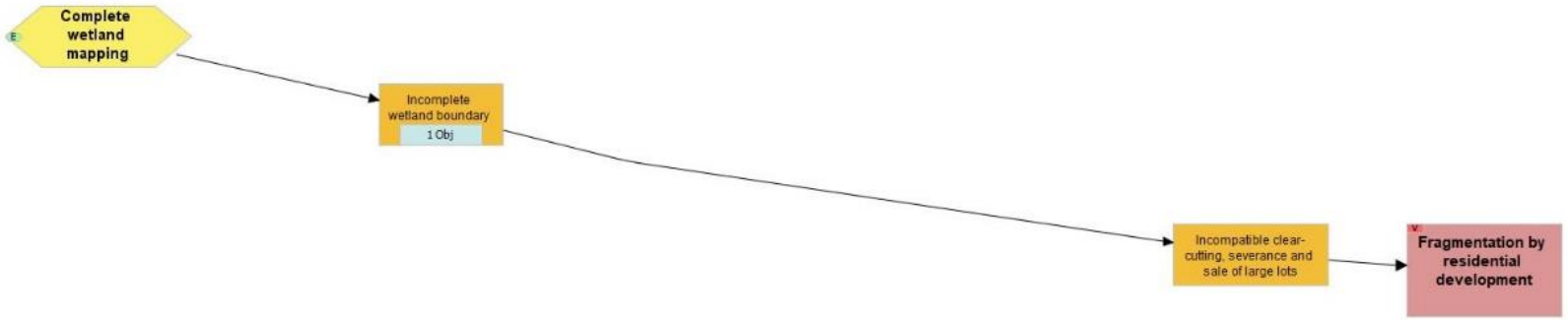
Figure 11. Strategies supporting eco-friendly infrastructure and Reptiles and Amphibians



3. Strategies supporting conservation of Wetlands

Strategy	Details See diagram for *strategy-contributing factor-threat-target* linkages	Target(s) / Goal(s)	Potential Impact	Feasibility	Comments
3. Complete wetland mapping	Completing wetland mapping for the Frontenac Arch is a relatively straightforward exercise requiring moderate investment of relevant agency resources (led by OMNRF). This goal will support more accurate and comprehensive protection of wetlands via the municipal planning process.	Wetlands / Goals 3,4,5, 6,8,9,10, 11,12	HIGH	HIGH	This is a straightforward strategy with high potential impact because of the official plan implications. A challenge is that most unmapped wetlands are on private land which require access. That said, these days much of the mapping can be done using remote imagery and GIS tools, and there may be collaboration and resource-pooling opportunities between government, academic institutions and NGOs to complete the mapping. Remote sensing is highly feasible to identify sites. Landowner permission is the main challenge with respect to feasibility at fine scale.

Figure 12. Strategies supporting conservation of Wetlands



4. Strategies primarily supporting conservation of Aquatic Systems

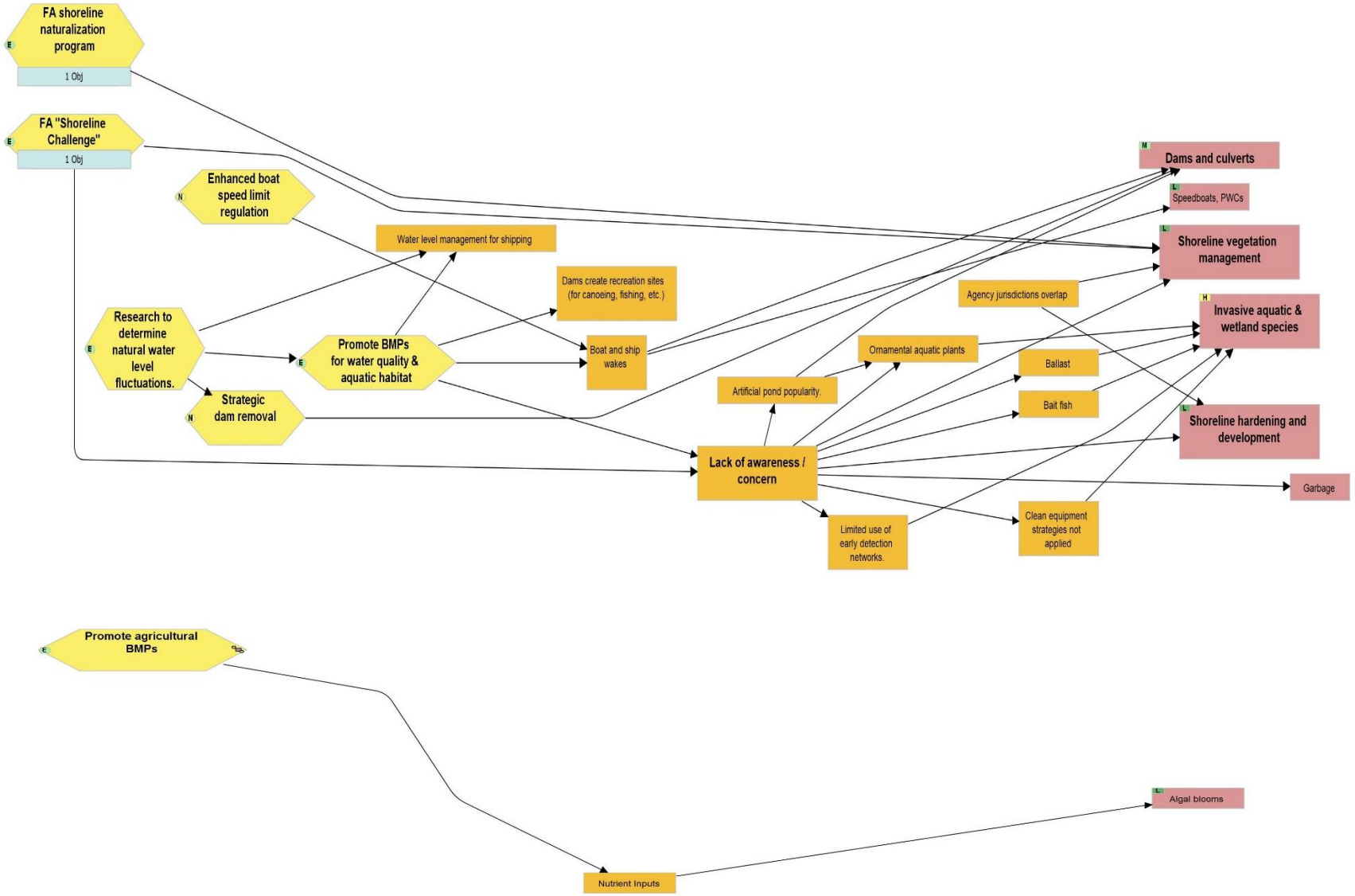
Strategy	Details See diagram for *strategy-contributing factor-threat-target* linkages	Target(s) / Goal(s)	Potential Impact	Feasibility	Comments
4.a. Frontenac Arch "Shoreline Challenge"	A Frontenac Arch focused "Shoreline Challenge" program could be modeled on the highly successful Charleston Lake initiative in which every landowner on the lake is surveyed for their specific impact and provided a list of suggestions about how to be good shoreline stewards. Five awards per year are announced for best stewarded shoreline properties on the lake. Peer pressure is very effective. Shoreline restoration workshops have been ongoing since inception of the program in mid-2000's. Key stakeholders to engage include: lakefront cottagers, waterfront associations, agricultural community, conservation authorities, municipalities, MNRF, DFO, Parks Canada, Watersheds Canada and recreational users (anglers, boaters).	All Targets (especially Aquatic Systems, Reptiles & Amphibians) / Goals 1,2,3, 4,5,6,8,9 and especially 10,11,12	HIGH	VERY HIGH	Outreach will be an important aspect of this strategy, and should aim for target-group buy-in. Concerns that may need to be overcome include reduced access to and visibility of shorelines. There are resources available from other Canadian biospheres. This is a strategy that has proven to have impact in other biosphere reserves. Cataraqui Region Conservation Authority has a Lake Protection Workbook as well: https://www.crca.ca/wp-content/uploads/PDFs/2019-LakeProtectionWorkbook.pdf. Queen's University has lake rating program that might be useful as a monitoring and motivational tool (e.g., to create competition between local cottage associations). This initiative could potentially be expanded to include tributaries with "best farm steward" awards (e.g., for fencing preventing livestock access to streams and wetlands, riparian restoration).

Strategy	Details See diagram for *strategy-contributing factor-threat-target* linkages	Target(s) / Goal(s)	Potential Impact	Feasibility	Comments
4.b. Frontenac Arch shoreline naturalization program	This strategy could be closely associated with the "Shoreline Challenge" (above). It involves supporting, promoting and expanding the Rideau Valley Conservation Authority shoreline naturalization program throughout Frontenac Arch area. The "Love Your Lake" program of Watersheds Canada has resources, grants and case studies that could support a Frontenac Arch-wide program.	All Targets (especially Aquatic Systems, Reptiles & Amphibians) / Goals 1,2,3, 4,5,6,8,9 and especially 10,11,12	HIGH	HIGH	With adequate funding this strategy can be effective. Being strategic with the naturalization areas could be beneficial. The biggest challenge for naturalization is along the heavily-developed St. Lawrence River. Different types of and options for "naturalization" need to be articulated, since the concept of "naturalization" may be threatening to some waterfront landowners. A case study exists in the Frontenac Arch area. The Desert Lake Association is participating in the "Love Your Lake" program. Not all property owners are on board, and there is a recent development in which a large cottage was built and a path clear cut from the building right down to the shoreline on a steep slope. This initiative should be looked to to inform an expanded program in the Frontenac Arch area.
4.c. Promote Best Management Practices for water quality and aquatic habitat	Federation of Ontario Cottage Associations has excellent shoreline stewardship resources: https://foca.on.ca/shoreline-owners-guide-to-healthy-waterfronts/https://foca.on.ca/wp-content/uploads/2016/06/FOCA_ClimateChange_ManagingYourShoreline_FINAL_2016.pdf	All Targets (especially Aquatic Systems, Reptiles & Amphibians) / Goals 1,2,3, 4,5,6,8,9 and especially 10,11,12	HIGH	HIGH	Ample resource materials are available, and include DFO/MNR archives from the old "Aquatic Habitat Training Program" materials. An emphasis on the benefits of shoreline habitat as a way to build bio-resilience could be an effective educational approach education. In any case, additional resources will be required over the long term to provide this "extension" function. This program may be less useful for St. Lawrence River issues, where, given the high water levels, shoreline hardening seems to be increasing.

Strategy	Details See diagram for *strategy-contributing factor-threat-target* linkages	Target(s) / Goal(s)	Potential Impact	Feasibility	Comments
4.d. Enhanced boat speed limit regulation	Establish and enforce no-motorboat or no-wake zones in sensitive areas (e.g., within and near coastal wetlands) to conserve aquatic vegetation and fauna.	All Targets (especially Aquatic Systems, Reptiles & Amphibians) / Goals 3, 4,6,9 and especially 11,12	HIGH	HIGH	This strategy could be easily implemented as long as relevant authorities are supportive and have the capacity and resources to ensure compliance. There is already a proposal before the Township of Leeds and the Thousand Islands to standardize and lower speed zones: http://www.leeds1000islands.ca/en/governing/st-lawrence-river-nautical-speed-zone-study.aspx#
4.e. Promote agricultural BMPs	Excellent environmental best practices resources are available for farmers from organizations like the Ontario Soil and Crop Improvement Association, OMAFRA, ALUS (ALUS 2018) and many others. The strategy would be to determine which of the available resources are most relevant address the high priority agriculture-related threats of the Frontenac Arch CAP (e.g., tile drains impacting natural waterflows; nutrient and pesticide inputs from run-off; cattle access to waterways and wetlands; soil erosion).	All Targets (especially Aquatic Systems) / Goals 1,2,3, 4,5,6,8,9, 10,12	HIGH	HIGH	Many sites around Great Lakes have been having success targeting nutrients through the 4rcertified.org or 4Rcertified.ca programs. They are looking to expand. This strategy may require coordination and some additional study to locate and prioritize agricultural threats on the landscape. It has been noted that the limited supply of arable land in the Frontenac Arch area presents opportunities to work with farmers to create/restore/protect habitat.

Strategy	Details See diagram for *strategy-contributing factor-threat-target* linkages	Target(s) / Goal(s)	Potential Impact	Feasibility	Comments
4.f. Strategic dam removal	The goal of dam removal is to restore the physical conditions that allow for historical water level fluctuations, flow volumes, and the movement of characteristic species, notably fish. Each case must be evaluated individually using an environmental assessment-type process. In some situations, dam removal may do more ecological harm than good, and in other cases dam removal is likely not politically, socially or economically desirable (e.g., on the Rideau system). Highlighting the positive impacts for people (e.g., dam removal can actually reduce flooding) will be important. There are many well-established programs in other jurisdictions (notably in the United States, with the Kennebec River in Maine being a good example) that have developed effective decision-making tools, and include published case studies where decisions and results have been tracked.	Aquatic Systems / Goals 6,8,9, 10,12 and especially 11	HIGH	MED	There was differing opinion among participants on the feasibility of this strategy. Building strong community support, good planning, and an opportunistic approach were elements associated with higher success. Ecological benefits have been shown in case studies to be very high. American Rivers web site has many tools, videos and case studies: https://www.americanrivers.org/threats-solutions/restoring-damaged-rivers/ , https://www.americanrivers.org/2019/06/twenty-years-of-dam-removal-successes-and-whats-up-next/ Wisconsin Rivers Citizens guide to Dam removal: https://www.wisconsinrivers.org/wp-content/uploads/2017/10/Dam-Removal-A-Citizens-Guide-to-Saving-Rivers.pdf Stream connectivity information: https://streamcontinuity.org/ Dam decommissioning and removal in Ontario, including the decision-making process and factors to consider: https://www.ontario.ca/page/dam-decommissioning-and-removal

Figure 13. Strategies primarily supporting conservation of Aquatic Systems

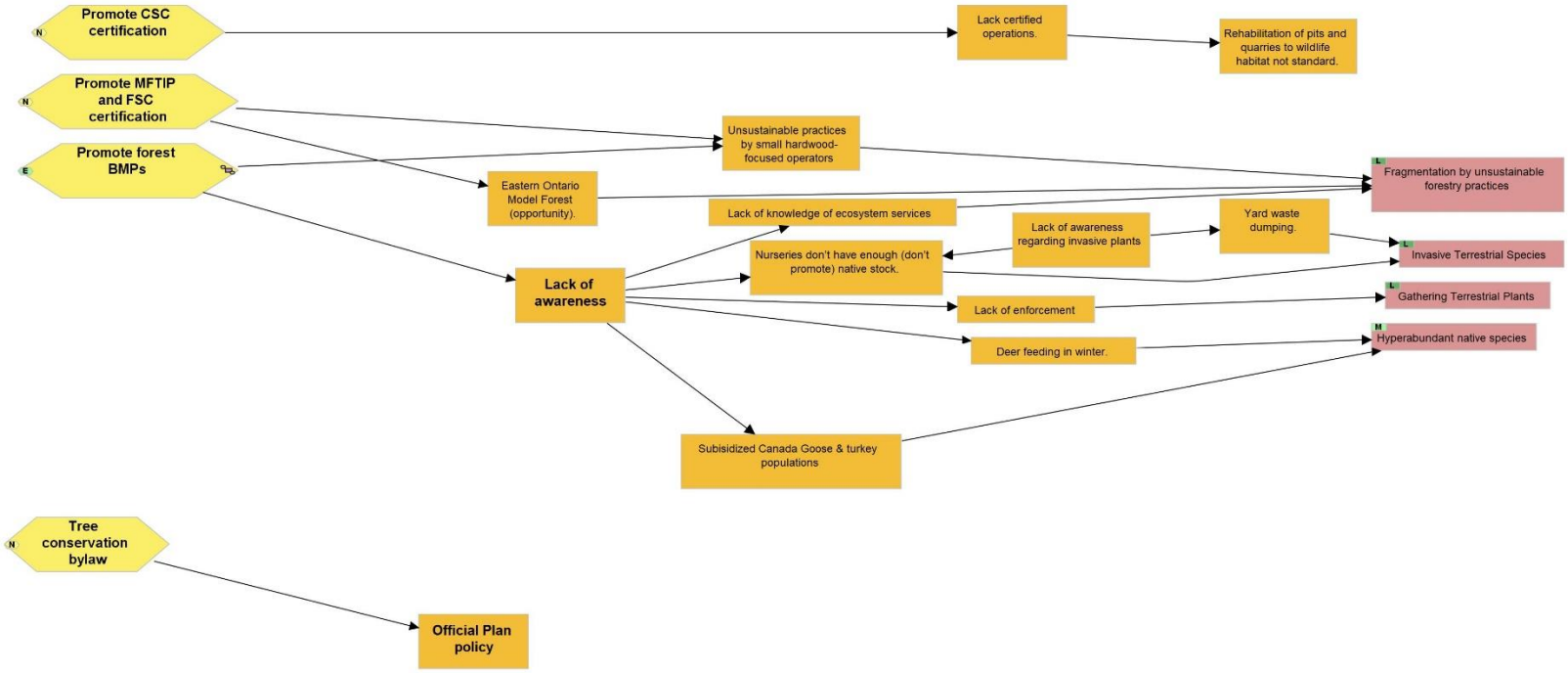


5. Strategies primarily supporting conservation of Forests and terrestrial systems

Strategy	Details See diagram for *strategy-contributing factor-threat-target* linkages	Target(s) / Goal(s)	Potential Impact	Feasibility	Comments
5.a. Promote forest best management practices	Excellent "best practices" resources are available from groups like the Ontario Woodlot Association, Ontario Ministry of Natural Resources and Forestry, Eastern Ontario Model Forest, Forest Stewardship Council and others. This strategy would require determining which materials are most relevant to addressing priority threats to the Forests conservation target of the Frontenac Arch and getting these resources to the forestry practitioners and woodlot owners who: a) manage ecologically significant forest stands; b) have influence with their peers.	Forests (and other targets) / Goals 1, 2	HIGH	HIGH	Considerations noted by participants include potential for this to be labour-intensive, and a possible relatively low “new recruit” rate because those inclined to be good stewards already are doing so. There has been considerable success in the area for forest BMPs and MFTIP/FSC (next strategy) already. Educating municipalities, especially, on what healthy forests look like could lead to more informed planning and better forest-related policies.

Strategy	Details See diagram for *strategy-contributing factor-threat-target* linkages	Target(s) / Goal(s)	Potential Impact	Feasibility	Comments
5.b. Promote MFTIP and FSC certification	MFTIP = Managed Forest Tax Incentive Program (administered by Ontario Ministry of Natural Resrouces and Forestry) FSC = Forest Stewardship Council "The two types of FSC certification are:- for forest owners and managers, forest management certification is a guarantee your processes and operations meet FSC standards; - for businesses manufacturing or trading forest products, chain of custody certification verifies that products are handled correctly at every stage of production – from forest to shelf." (https://ca.fsc.org/en-ca/certification)	Forests (and other targets) / Goals 1,2	HIGH	MED	Eastern Ontario Model Forest would be an obvious partner or lead organization for this. LCKFLA has successfully transferred a MFTIP into Conservation Land Tax on one property and are in process of transferring this on another property.
5.c. Promote CSC certification	CSC = "Cornerstone Standards Council" Aggregate site operators can demonstrate that they have met the Standard's requirements through an extensive audit and become CSC certified sites. CSC now has certified five pits and quarries in Ontario: https://environmentaldefence.ca/2018/07/06/improvements-aggregate-practices-rely-voluntary-efforts-industry/	Forests (and other targets) / Goals 1,2,3, 4,5,8,12	MED	HIGH	There are 69 pits and quarries in the Frontenac Arch Biosphere Reserve covering a total area of 1,173 ha based on Land Information Ontario data (Lambert pers. comm. 2019). Incentive to participate has been reduced with recent changes to relevant provincial policy (Bell pers. comm. 2019). There is quite a significant amount of aggregate licenced area in the northwestern part of the Frontenac Arch. Ecologically appropriate/beneficial rehabilitation should be emphasized. It would reflect well if quarries in Frontenac Arch area had CSC certification.
5.d. Tree conservation bylaw	The great majority of upper tier and many lower tier municipalities in southern Ontario have tree conservation bylaws, some more effective than others. In some areas tree bylaws can become highly politicized.	Forests (and other targets) / Goals 1,2,6, 8,10,12	MED	MED	This is potentially a politically sensitive and polarizing issue and is therefore rated relatively low as a strategy, but raising the issue provides an opportunity to educate municipal councils on the benefits of tree cover. Should this strategy be selected for implementation, drawing on the experiences (both positive and negative) of other municipalities with tree conservation policies or bylaws would help inform same for Frontenac Arch municipalities.

Figure 14. Strategies primarily supporting conservation of Forests and terrestrial systems



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APPENDIX A: NESTED SPECIES TARGETS

Adapted for A2A Frontenac Arch CAP from NCC (2019). Only those species considered nationally or provincially at-risk or rare (S1 to S3S4) are listed below; please refer to main body of text for additional nested targets.

Common name	Scientific name	Species type	COSEWIC status	Provincial status	G-rank	S-rank	Conservation Target				Other notes[3]
							Forests	Wetlands	Aquatic	Rept. & Amph.	
Western Chorus Frog	*Pseudacris triseriata pop. 1*	Amphibian	THR	SC	G5TNR	S4		x		x	Great Lakes - St. Lawrence - Canadian Shield Population
Bald Eagle	*Haliaeetus leucocephalus*	Bird		SC	G5	S2N,S4B		x	x		E - Verified extant (viability not assessed)
Bank Swallow	*Riparia riparia*	Bird	THR	THR	G5	S4B		x	x		E - Verified extant (viability not assessed)
Barn Swallow	*Hirundo rustica*	Bird	THR	THR	G5	S4B	x	x			E - Verified extant (viability not assessed)
Black Tern	*Chlidonias niger*	Bird	THR	SC	G4G5	S3B		x			E - Verified extant (viability not assessed)
Black-crowned Night-heron	*Nycticorax nycticorax*	Bird			G5	S3B,S3N		x	x		
Bobolink	*Dolichonyx oryzivorus*	Bird	THR	THR	G5	S4B					E - Verified extant (viability not assessed)
Canada Warbler	*Cardellina canadensis*	Bird	THR	SC	G5	S4B	x				
Cerulean Warbler	*Setophaga cerulea*	Bird	THR	THR	G4	S3B	x				E - Verified extant (viability not assessed)

[3] Based primarily on NCC (2019)

Common name	Scientific name	Species type	COSEWIC status	Provincial status	G-rank	S-rank	Conservation Target				Other notes[3]
							Forests	Wetlands	Aquatic	Rept. & Amph.	
Chimney Swift	*Chaetura pelagica*	Bird	THR	THR	G5	S4	x				
Common Nighthawk	*Chordeiles minor*	Bird	THR	THR	G5	S4B	x	x			
Eastern Meadowlark	*Sturnella magna*	Bird	THR	THR	G5	S4B					E - Verified extant (viability not assessed)
Eastern Wood-Pewee	*Contopus virens*	Bird	SC	SC	G5	S4B	x				
Golden-winged Warbler	*Vermivora chrysoptera*	Bird	THR	SC	G4	S4B	x				H - Historical
Henslow's Sparrow	*Ammodramus henslowii*	Bird	END	END	G4	SHB		x			H - Historical
King Rail	*Rallus elegans*	Bird	END	END	G4	S2B		x			E - Verified extant (viability not assessed)
Least Bittern	*Ixobrychus exilis*	Bird	THR	THR	G4G5	S4B		x			E - Verified extant (viability not assessed)
Louisiana Waterthrush	*Parkesia motacilla*	Bird	THR	THR	G5	S3B	x	x	x		H - Historical
Olive-sided Flycatcher	*Contopus cooperi*	Bird	THR	SC	G4	S4B	x	x			
Peregrine Falcon	*Falco peregrinus anatum*	Bird	SC	THR	G4T4	S3B	x	x			Nests on cliffs (within Forest matrix), hunts over open areas, including wetlands.
Piping Plover	*Charadrius melodus*	Bird	END	END	G3T3	S1B					X - Extirpated (No suitable habitat) Requires extensive sand beaches for nesting.
Prairie Warbler	*Setophaga discolor*	Bird			G5	S3B	x				H - Historical

Common name	Scientific name	Species type	COSEWIC status	Provincial status	G-rank	S-rank	Conservation Target				Other notes[3]
							Forests	Wetlands	Aquatic	Rept. & Amph.	
Red-headed Woodpecker	*Melanerpes erythrocephalus*	Bird	THR	SC	G5	S4B	x				
Whip-poor-will	*Antrostomus vociferus*	Bird	THR	THR	G5	S4B	x				
Wood Thrush	*Hylocichla mustelina*	Bird	THR	SC	G5	S5B	x				
American Eel	*Anguilla rostrata*	Fish	THR	END	G4	S1?		x	x		
Cutlip Minnow	*Exoglossum maxillingua*	Fish	SC	THR	G5	S1S2		x	x		H - Historical
Eastern Silvery Minnow	*Hybognathus regius*	Fish			G5	S2		x	x		E - Verified extant (viability not assessed)
Grass Pickerel	*Esox americanus vermiculatus*	Fish	SC	SC	G5T5	S3		x	x		E - Verified extant (viability not assessed)
Greater Redhorse	*Moxostoma valenciennesi*	Fish			G4	S3		x	x		H - Historical
Lake Sturgeon (Great Lakes - Upper St. Lawrence River population)	*Acipenser fulvescens pop. 3*	Fish	THR	END	G3G4	S2		x	x		E - Verified extant (viability not assessed)
Pugnose Shiner	*Notropis anogenus*	Fish	END	THR	G3	S2		x	x		H - Historical
A Lichen	*Heterodermia hypoleuca*	Fungus or Lichen			G5	S1S2	x				E - Verified extant (viability not assessed)
A Lichen	*Flavoparmelia baltimorensis*	Fungus or Lichen			G5?	S1S2	x				E - Verified extant (viability not assessed)

Common name	Scientific name	Species type	COSEWIC status	Provincial status	G-rank	S-rank	Conservation Target				Other notes[3]
							Forests	Wetlands	Aquatic	Rept. & Amph.	
A Lichen	*Arthothelium spectabile*	Fungus or Lichen			GNR	S1?	x				E - Verified extant (viability not assessed)
Flooded Jellyskin	*Leptogium rivulare*	Fungus or Lichen	SC		G3G5	S3		x			E - Verified extant (viability not assessed)
Pale-bellied Frost Lichen	*Physconia subpallida*	Fungus or Lichen	END	END	GNR	S3	x				CD - Fair or poor estimated viability
Cyrano Darner	*Nasiaeschna pentacantha*	Invertebrate			G5	S3		x	x		E - Verified extant (viability not assessed)
Early Hairstreak	*Erora laeta*	Invertebrate			GU	S2	x				H - Historical
Eastern Floater	*Pyganodon cataracta*	Invertebrate			G5	S2		x	x		E - Verified extant (viability not assessed)
Eastern Pondmussel	*Ligumia nasuta*	Invertebrate	SC	SC	G4	S1		x	x		E - Verified extant (viability not assessed)
Giant Swallowtail	*Papilio cresphontes*	Invertebrate			G5	S3	x	x			
Green-striped Darner	*Aeshna verticalis*	Invertebrate			G5	S3		x	x		H - Historical
Lilypad Clubtail	*Arigomphus furcifer*	Invertebrate			G5	S3		x	x		H - Historical
Monarch	*Danaus plexippus*	Invertebrate		SC	G5	S2N,S4B		x			
Mottled Duskywing	*Erynnis martialis*	Invertebrate	END	END	G3	S2					H - Historical
Rusty-patched Bumble Bee	*Bombus affinis*	Invertebrate	END	END	G2	S1					H - Historical
Spindle Lymnaea	*Acella haldemani*	Invertebrate			G3	S1		x			
Algonquin / Eastern Wolf	*Canis sp. (cf. lycaon)*	Mammal	THR	THR	GNR	SNR	x				

Common name	Scientific name	Species type	COSEWIC status	Provincial status	G-rank	S-rank	Conservation Target				Other notes[3]
							Forests	Wetlands	Aquatic	Rept. & Amph.	
Northern Myotis	*Myotis septentrionalis*	Mammal	END	END	G1G2	S3	x				F - Failed to find
Tri-colored Bat	*Perimyotis subflavus*	Mammal	END	END	G2G3	S3?	x				F - Failed to find
Little Brown Bat	*Myotis lucifugus*	Mammal	END	END	G5	S4	x				
Eastern Small-footed Myotis	*Myotis leibii*	Mammal		END	G4	S2S3	x				H - Historical
Common Five-lined Skink (Southern Shield population)	*Plestiodon fasciatus pop. 2*	Reptile	SC	SC	G5	S3	x				H - Historical
Eastern Milksnake	*Lampropeltis triangulum*	Reptile			G5	S3	x	x		x	H - Historical
Eastern Ribbonsnake	*Thamnophis sauritus*	Reptile	SC	SC	G5	S3	x	x		x	E - Verified extant (viability not assessed)
Gray Ratsnake (Frontenac Axis population)	*Pantherophis spiloides pop. 1*	Reptile	THR	THR	G5	S3	x			x	E - Verified extant (viability not assessed)
Blanding's Turtle	*Emydoidea blandingii*	Reptile	END	THR	G4	S3	x	x	x	x	E - Verified extant (viability not assessed)
Eastern Musk Turtle	*Sternotherus odoratus*	Reptile	SC	SC	G5	S3		x	x	x	H - Historical
Midland Painted Turtle	*Chrysemis picta marginata*	Reptile	SC	SC	G5T5	S4		x	x	x	E – Verified extant
Northern Map Turtle	*Graptemys geographica*	Reptile	SC	SC	G5	S3		x	x	x	H - Historical

Common name	Scientific name	Species type	COSEWIC status	Provincial status	G-rank	S-rank	Conservation Target				Other notes[3]
							Forests	Wetlands	Aquatic	Rept. & Amph.	
Snapping Turtle	*Chelydra serpentina*	Reptile	SC	SC	G5	S3		x	x	x	E - Verified extant (viability not assessed)
Spiny Softshell	*Apalone spinifera*	Reptile	END	END	G5	S2		x	x	x	H - Historical
Spotted Turtle	*Clemmys guttata*	Reptile	END	END	G5	S2		x	x	x	E - Verified extant (viability not assessed)
(Potamogeton hillii X P. zosteriformis)	*Potamogeton x ogdenii*	Vascular plant	END	END	G1G2	SH		x	x		H - Historical
American Ginseng	*Panax quinquefolius*	Vascular plant	END	END	G3G4	S2	x				CD - Fair or poor estimated viability
American Water-willow	*Justicia americana*	Vascular plant	THR	THR	G5	S2		x	x		AB - Excellent or good estimated viability
Autumn Coralroot	*Corallorhiza odontorhiza*	Vascular plant			G5	S2S3	x				E - Verified extant (viability not assessed)
Blunt-lobed Woodsia	*Woodsia obtusa*	Vascular plant	THR	END	G5	S1	x				C - Fair estimated viability
Broad Beech Fern	*Phegopteris hexagonoptera*	Vascular plant	SC	SC	G5	S3	x				A - Excellent estimated viability
Butternut	*Juglans cinerea*	Vascular plant	END	END	G4	S2?	x				E - Verified extant (viability not assessed)
Buttonbush Dodder	*Cuscuta cephalanthi*	Vascular plant			G5	S2		x			H - Historical
Deerberry	*Vaccinium stamineum*	Vascular plant	THR	THR	G5	S1	x				C - Fair estimated viability
Deer-tongue Witchgrass	*Dichanthelium clandestinum*	Vascular plant			G5?	S2	x				

Common name	Scientific name	Species type	COSEWIC status	Provincial status	G-rank	S-rank	Conservation Target				Other notes[3]
							Forests	Wetlands	Aquatic	Rept. & Amph.	
Downy Goldenrod	*Solidago puberula*	Vascular plant			G5	S2	x				H - Historical
Eastern Mosquito Fern	*Azolla caroliniana*	Vascular plant			G5	S1S2		x	x		H - Historical
Field Sedge	*Carex conoidea*	Vascular plant			G5	S3		x			H - Historical
Field Thistle	*Cirsium discolor*	Vascular plant			G5	S3	x	x			
Fogg's Goosefoot	*Chenopodium foggii*	Vascular plant			G2G3	S2?	x				H - Historical
Forked Panicgrass	*Dichanthelium dichotomum*	Vascular plant			G5	S2	x				H - Historical
Green Arrow Arum	*Peltandra virginica*	Vascular plant			G5	S3		x	x		E - Verified extant (viability not assessed)
Hairy Bedstraw	*Galium pilosum*	Vascular plant			G5	S3	x				H - Historical
Halberd-leaved Smartweed	*Persicaria arifolia*	Vascular plant			G5	S3		x			E - Verified extant (viability not assessed)
Hay Sedge	*Carex argyrantha*	Vascular plant			G5	S2?	x	x			
Houghton's Flatsedge	*Cyperus houghtonii*	Vascular plant			G4?	S3		x			H - Historical
Lakecress	*Armoracia lacustris*	Vascular plant			G4?	S3?		x	x		D - Poor estimated viability
Large Toothwort	*Cardamine maxima*	Vascular plant			G5	S3	x				
Large-bract Tick-trefoil	*Desmodium cuspidatum var. cuspidatum*	Vascular plant			G5T5?	S3	x				
Long's Sedge	*Carex longii*	Vascular plant			G5	SH	x	x			E - Verified extant (viability not assessed)
Narrowleaf Wild Leek	*Allium burdickii*	Vascular plant			G4G5	S1?	x				

Common name	Scientific name	Species type	COSEWIC status	Provincial status	G-rank	S-rank	Conservation Target				Other notes[3]
							Forests	Wetlands	Aquatic	Rept. & Amph.	
Northern Bladderwort	*Utricularia ochroleuca*	Vascular plant			G4?	SH		x	x		
Nuttall's Waterweed	*Elodea nuttallii*	Vascular plant			G5	S3		x	x		E - Verified extant (viability not assessed)
Pale False Mannagrass	*Torreyochloa pallida var. pallida*	Vascular plant			G5	S2					E - Verified extant (viability not assessed)
Panicled Hawkweed	*Hieracium paniculatum*	Vascular plant			G5	S2	x				H - Historical
Perfoliate Bellwort	*Uvularia perfoliata*	Vascular plant			G5	S1	x	x			
Pitch Pine	*Pinus rigida*	Vascular plant			G5	S2?	x				H - Historical
Purple Twayblade	*Liparis liliifolia*	Vascular plant	THR	THR	G5	S2S3	x				C - Fair estimated viability
Purple-stemmed Cliffbrake	*Pellaea atropurpurea*	Vascular plant			G5	S3	x				H - Historical
Puttyroot	*Aplectrum hyemale*	Vascular plant			G5	S2	x	x			CD - Fair or poor estimated viability
Ram's-head Lady's-slipper	*Cypripedium arietinum*	Vascular plant			G3	S3	x				H - Historical
Round-leaved Tick-trefoil	*Desmodium rotundifolium*	Vascular plant			G5	S2	x				H - Historical
Round-leaved Yellow Violet	*Viola rotundifolia*	Vascular plant			G5	SH	x	x			H - Historical
Rue-anemone	*Thalictrum thalictroides*	Vascular plant			G5	S3	x				H - Historical
Rugulose Grapefern	*Sceptridium rugulosum*	Vascular plant			G3	S2?	x				C - Fair estimated viability

Common name	Scientific name	Species type	COSEWIC status	Provincial status	G-rank	S-rank	Conservation Target				Other notes[3]
							Forests	Wetlands	Aquatic	Rept. & Amph.	
Shining-branch Hawthorn	*Crataegus magniflora*	Vascular plant			G3G5	S3	x				H - Historical
Six-weeks Fescue	*Vulpia octoflora*	Vascular plant			G5	S1S2	x	x			H - Historical
Slim-flowered Muhly	*Muhlenbergia tenuiflora*	Vascular plant			G5	S2	x	x			H - Historical
Stiff Gentian	*Gentianella quinquefolia*	Vascular plant			G5	S2	x				H - Historical
Sweet Pignut Hickory	*Carya glabra*	Vascular plant			G5	S3	x				
Thread-like Naiad	*Najas gracillima*	Vascular plant			G5?	S2		x	x		
Triangle Moonwort	*Botrychium lanceolatum*	Vascular plant			G5	S3	x				H - Historical
White-tinged Sedge	*Carex albicans var. albicans*	Vascular plant			G5T5	S3	x				H - Historical
Woodland Muhly	*Muhlenbergia sylvatica*	Vascular plant			G5	S2?	x	x			H - Historical

APPENDIX B: CONSERVATION TARGET VIABILITY ASSESSMENT TABLE

The table below presents the key ecological attributes (), indicators () and (where available) measures (), that were used to assign viability ratings for each of the conservation targets (), based on the three standard criteria of landscape context, condition and size (see Figure 8 in main body of report). More information is available in the associated Miradi file and Appendix C, below.

Item	Status	Type	Poor	Fair	Good	Very Good	Source
Aquatic Systems	Fair						
Natural water level fluctuations	Fair	Condition					
% surface water that is part of unregulated system							
water flow meter data	Fair						
:							Rough Guess
Richard-Baker Flashiness Index	Fair		No annual water level variation	Limited annual water level variation	More natural variation in annual water levels	Approximates unregulated water level cycles	Rough Guess
:							Expert Knowledge
Flashiness			>2 standard deviation from mean	1-2 standard deviation from mean	<1 standard deviation from mean		
Species composition	Fair	Condition					
% native vs. non-native invasive							
Benthic organism composition	Fair		>5.76	5.01-5.75	4.26-5.00	<4.25	
: 5.01-5.75				5.01-5.75			Intensive Assessment
Water quality		Condition					

Item	Status	Type	Poor	Fair	Good	Very Good	Source
Road salt and other ice-melting chemical concentrations							
Water temperature							
Phosphorus concentrations							
Lake Trout and Brook Trout populations							
Drinking water							
Naturally-vegetated (native) zones along wetlands, watercourses and lakes		Landscape Context					
Extent of 30m-wide unfragmented riparian/shoreline buffer (use GIS)			<50%	50-74%	75-99%	100%	Expert Knowledge
Extent of 250m-width unfragmented riparian/shoreline (use GIS)			<50%	50-74%	75-99%	100%	Expert Knowledge
Naturally vegetated lake shorelines			<50%	50-74%	75-99%	100%	
Unhardened shoreline					>93%	100%	
Naturally-vegetated lake shorelines							
Connectivity of waterways	Fair	Landscape Context					
Perched culverts							
: % of culverts negatively impacting fish/fauna movement							Not Specified
Muskellunge migrations							Not Specified

Item	Status	Type	Poor	Fair	Good	Very Good	Source
Number of dams disrupting ecological processes and species movement	Fair		<10%	11-50%	51-90%	>90%	Not Specified
: % of waterways not disrupted by dams				% of waterways not disrupted by dams			Rough Guess
American Eel migrations							Not Specified
Forests	Very Good						
Size / extent of characteristic communities / ecosystems	Very Good	Size					
% cover (ha) of forest in NA	Very Good		<30 (<51,000 ha)	30 (51,000 ha)	40 (69,000 ha)	50 (86,000 ha)	External Research
: 4						4	Rapid Assessment
Size / extent of characteristic communities / ecosystems	Very Good	Condition					
% cover/ ha of interior forest	Very Good		<3% (<5,000 ha)	3% (5,000 ha)	7% (12,000 ha)	10% (17,000 ha)	External Research
: 4						4	Rapid Assessment
Reptiles & Amphibians	Fair						
Naturally-vegetated (native) zones along wetlands, watercourses and lakes							
Extent of 30m-wide unfragmented riparian/shoreline buffer (use GIS)			<50%	50-74%	75-99%	100%	

Item	Status	Type	Poor	Fair	Good	Very Good	Source
Extent of 250m-width unfragmented riparian/shoreline (use GIS)			<50%	50-74%	75-99%	100%	
Percent wetland area bordered by forest			<40%	40-60%	>60%		
Anuran population size		Not Specified					
Anuran populations based on call monitoring.							
SAR herpetofauna populations		Size					
Gray Ratsnake population size			imperiled	declining	stable	increasing	Onsite / Project Research
Gray Ratsnake populations							
Large, intact habitat mosaics	Fair	Landscape Context					
% of FA habitat mosaic that is interior (>250m/>100m from roads, or mitigated with ecopassages and barrier fencing)	Fair		<50% (>100m)	50-60% (>100m)	>60% (>100m)	>60 (>250m)	
:							Rough Guess
Wetlands	Good						
Landscape pattern (mosaic) & structure	Very Good	Not Specified					
% of wetlands within 30 m proximity to other wetlands	Very Good		<40	40	60	80	External Research
: 4						4	Rapid Assessment

Item	Status	Type	Poor	Fair	Good	Very Good	Source
Naturally-vegetated (native) zones along wetlands, watercourses and lakes							
Extent of 250m-width unfragmented riparian/shoreline (use GIS)							
Extent of 30m-wide unfragmented riparian/shoreline buffer (use GIS)							
Size / extent of characteristic communities / ecosystems	Fair	Size					
Percent Protected Wetlands	Fair		<10	10	20	>40	External Research
: 2.5				2.5			Rapid Assessment
Extent of wetland types	Fair						
: GIS land cover data for wetlands (classified to ecotype)				GIS land cover data for wetlands (classified to ecotype)			Expert Knowledge
Species composition / dominance	Good	Condition					
Presence of Common Reed	Good		Dominant (>60%)	Abundant (40-60%)	Occasional (10-40%)	Rare (<10%)	Rough Guess
: 3.5					3.5		Rapid Assessment
Representative amphibian populations							
Representative marsh bird populations							

APPENDIX C: CONSERVATION GOALS AND NOTES ON POTENTIAL INDICATORS FOR MONITORING

The table below presents the conservation goals (⬭) of the A2A FA CAP, as well as potential indicators (▲) (with rough, unedited notes) discussed by CAP participants that could potentially be monitored to track the condition of the key ecological indicators of the conservation targets. Additional relevant indicators may be available through the Conservation Measures Partnership / Foundations of Success networks, in Shear et al. (2003) and other sources.

Item	Notes
⬭ **Flashiness of non-St. Lawrence/Rideau aquatic systems reduced to historical levels**	The flashiness of a stream reflects how quickly flow in a river or stream increases and decreases during a storm. Flashy streams are common in urbanized areas because stormwater runoff reaches the water-ways much more quickly than it would under natural conditions. The Richard-Baker Flashiness Index (R-B Index) reports changes in short term daily flows relative to average yearly flows. When stormwater flows into creeks at a higher volume and at a faster rate relative to natural conditions, the R-B flashiness index increases.Currently rated as fair (1-2 SD, Richard - Baker Flashiness Index), goal is to improve flashiness to <1 SD.
▲ % surface water that is part of unregulated system	Surface area of lakes is easily determined, rivers and streams are harder to determine width, but two sub-measures (e.g., lake surface area and stream length) could be used.
▲ American Eel migrations	Number of waterways accessible for eel spawning?
▲ Drinking water	Could the goal be potability of untreated water, where feasible, in lakes, rivers and streams? E. coli levels are low except for the two urban areas. (CRCA 2018 Watershed Report Card). Any e-coli is bad for drinking water but under 200 is the threshold for safe swimming. Many fish are less impacted by these bacteria.
▲ Extent of 250m-width unfragmented riparian/shoreline (use GIS)	250m is ideal minimum width for key species like Blanding's Turtle
▲ Extent of 30m-wide unfragmented riparian/shoreline buffer (use GIS)	30m is the standard width in planning and regulatory context. Unfortunately, much of the habitat alteration typically occurs within the 30m, and the intact habitat tends to be >30m from the shoreline.
▲ Flashiness	The flashiness of a stream reflects how quickly flow in a river or stream increases and decreases during a storm. Flashy streams are common in urbanized areas because stormwater runoff reaches the water-ways much more quickly than it would under natural conditions. The Richard-Baker Flashiness Index (R-B Index) reports changes in short term daily flows relative to average yearly flows. When stormwater flows into creeks at a higher volume and at a faster rate relative to natural conditions, the R-B flashiness index increases. Quebec and Atlantic Parks Canada, water level variation is index, flashiness, mean low water levels, 20-year timescale, good less than 1 SD from mean, statistical threshold- historical data needs to be analysed to determine mean values- gauging station data, 2 standard deviation (SD) is fair, more than 2 SD from mean is poor
▲ Lake Trout and Brook Trout populations	Lake Trout and Brook Trout populations are excellent indicators because: a) they involve species that can and will be embraced by multiple key sectors of society; b) strategies to improve their populations will potentially benefit multiple conservation targets; c) their needs involve multiple aspects of water quality (water temperatures, oxygen levels, lack of pollution, guilds of aquatic insects); d) healthy trout populations are easily associated with multiple human wellbeing benefits (recreation, water quality, food, ecotourism, etc.).
▲ Muskellunge migrations	Number of waterways accessible for muskellunge spawning and feeding.Muskellunge are highly migratory between spawning and feeding areas. Muskies Canada has a chapter in Gananoque. They know where the nursery areas for the muskies are, and may monitor migrations. Parks Canada tracks juvenile presence at monitoring locations. Metric would likely be presence/absence by site to some other measure
▲ Naturally vegetated lake shorelines	Extent of lake shoreline not allocated to cottaging (lots & occupancy)/human habitation (communities)
▲ Naturally-vegetated lake shorelines	Extent of lake shoreline not allocated to cottaging (lots & occupancy)/human habitation (communities)
▲ Number of dams disrupting ecological processes and species movement	Need to know current number and locations, etc., of dams, etc. (just one valve on the St. Lawrence system; 57 dams on Rideau system, which is not going to be significantly "de-regulated"; at least 6 dams on the Gananoque River system). Some of the impacts of dams can be mitigated with fish ladders and by regulating water flows to mimic natural fluctuations, so presence or absence of dams isn't necessarily the best or sole measure.
▲ Perched culverts	Bridges are usually more ecologically benign than culverted stream crossings. Oval culverts are generally better for wildlife movement than round. Bridge and culvert location data and numbers are easily obtained. Perched culverts are barriers to fish and amphibian movement. Indicator would be the % of perched culverts where

Item	Notes
	amphibians and fish can't cross because the culvert is too high. Citizen science could be a way to get the perched culvert data. See also Aresco (2003). Many municipalities find that culverts need to be replaced, providing an opportunity to make long-term improvements for conservation (such as designed ecopassages and barrier fencing). MTO issues guidelines for municipalities to follow. MTO has responsibility for Thousand Islands Parkway and Highway 401, but the county and municipalities need to deal with smaller roads. The challenge with this as an indicator is that the data may reside in numerous places but is not organized anywhere. The height of perch affects different fish species differently. A more manageable monitoring approach might be to select river and stream layers with roads and determine how many crossings are serviced by bridges or open bottom culverts.
▲ Richard-Baker Flashiness Index	The flashiness of a stream reflects how quickly flow in a river or stream increases and decreases during a storm. Flashy streams are common in urbanized areas because stormwater runoff reaches the water-ways much more quickly than it would under natural conditions. The Richard-Baker Flashiness Index (R-B Index) reports changes in short term daily flows relative to average yearly flows. When stormwater flows into creeks at a higher volume and at a faster rate relative to natural conditions, the R-B flashiness index increases. Thresholds from NCC KEAs (interpolated from Baird & Associates 2006, and other sources).
▲ Unhardened shoreline	% of shoreline that is not artificially hardened (measures and monitoring could be limited to the more developed areas).
▲ water flow meter data	Requires rating thresholds (perhaps R-B Flashiness Index is sufficient).
⬭ **Flashiness of St. Lawrence Seaway and Rideau systems increased to approximate historical levels**	This goal is to support and build on Plan 2014, the International Joint Commission report on inflows and outflows in the Great Lakes, which provides context, goals and recommendations on how to re-establish more natural water level fluctuations on the St. Lawrence River, to restore ecologically important processes like wetland flushing and sand movement.
▲ % surface water that is part of unregulated system	Surface area of lakes is easily determined, rivers and streams are harder to determine width, but two sub-measures (e.g., lake surface area and stream length) could be used.
▲ American Eel migrations	Number of waterways accessible for eel spawning?
▲ Drinking water	Could the goal be potability of untreated water, where feasible, in lakes, rivers and streams? E. coli levels are low except for the two urban areas. (CRCA 2018 Watershed Report Card). Any e-coli is bad for drinking water but under 200 is the threshold for safe swimming. Many fish are less impacted by these bacteria.
▲ Flashiness	The flashiness of a stream reflects how quickly flow in a river or stream increases and decreases during a storm. Flashy streams are common in urbanized areas because stormwater runoff reaches the water-ways much more quickly than it would under natural conditions. The Richard-Baker Flashiness Index (R-B Index) reports changes in short term daily flows relative to average yearly flows. When stormwater flows into creeks at a higher volume and at a faster rate relative to natural conditions, the R-B flashiness index increases. Quebec and Atlantic Parks Canada, water level variation is index, flashiness, mean low water levels, 20-year timescale, good less than 1 SD from mean, statistical threshold- historical data needs to be analysed to determine mean values- gauging station data, 2 standard deviation (SD) is fair, more than 2 SD from mean is poor
▲ Lake Trout and Brook Trout populations	Lake Trout and Brook Trout populations are excellent indicators because: a) they involve species that can and will be embraced by multiple key sectors of society; b) strategies to improve their populations will potentially benefit multiple conservation targets; c) their needs involve multiple aspects of water quality (water temperatures, oxygen levels, lack of pollution, guilds of aquatic insects); d) healthy trout populations are easily associated with multiple human wellbeing benefits (recreation, water quality, food, ecotourism, etc.).
▲ Naturally-vegetated lake shorelines	Extent of lake shoreline not allocated to cottaging (lots & occupancy)/human habitation (communities)
▲ Number of dams disrupting ecological processes and species movement	Need to know current number and locations, etc., of dams, etc. (just one valve on the St. Lawrence system; 57 dams on Rideau system, which is not going to be significantly "de-regulated"; at least 6 dams on the Gananoque River system). Some of the impacts of dams can be mitigated with fish ladders and by regulating water flows to mimic natural fluctuations, so presence or absence of dams isn't necessarily the best or sole measure.
▲ Richard-Baker Flashiness Index	The flashiness of a stream reflects how quickly flow in a river or stream increases and decreases during a storm. Flashy streams are common in urbanized areas because stormwater runoff reaches the water-ways much more quickly than it would under natural conditions. The Richard-Baker Flashiness Index (R-B Index) reports

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	changes in short term daily flows relative to average yearly flows. When stormwater flows into creeks at a higher volume and at a faster rate relative to natural conditions, the R-B flashiness index increases. Thresholds from NCC KEAs (interpolated from Baird & Associates 2006 and other sources).
▲ water flow meter data	Requires rating thresholds (perhaps R-B Flashiness Index is sufficient).
⬭ **Improve and maintain water quality**	High-level goal is for the relevant watershed report cards (of conservation authorities) and Parks Canada water quality monitoring ratings to improve from the current "fair" (or equivalent) to "good". A suggested long term goal is for untreated water in the FA area to be potable.
▲ American Eel migrations	Number of waterways accessible for eel spawning?
▲ Benthic organism composition	Cataraqui Region Conservation Authority benthic monitoring data available from mid-1950s on. St. Lawrence Islands National Park data available from ~2007 on.
▲ Drinking water	Could the goal be potability of untreated water, where feasible, in lakes, rivers and streams? E. coli levels are low except for the two urban areas. (CRCA 2018 Watershed Report Card). Any e-coli is bad for drinking water but under 200 is the threshold for safe swimming. Many fish are less impacted by these bacteria.
▲ Extent of 250m-width unfragmented riparian/shoreline (use GIS)	250m is ideal minimum width for key species like Blanding's Turtle
▲ Extent of 30m-wide unfragmented riparian/shoreline buffer (use GIS)	30m is the standard width in planning and regulatory context. Unfortunately, much of the habitat alteration typically occurs within the 30m, and the intact habitat tends to be >30m from the shoreline.
▲ Flashiness	The flashiness of a stream reflects how quickly flow in a river or stream increases and decreases during a storm. Flashy streams are common in urbanized areas because stormwater runoff reaches the water-ways much more quickly than it would under natural conditions. The Richard-Baker Flashiness Index (R-B Index) reports changes in short term daily flows relative to average yearly flows. When stormwater flows into creeks at a higher volume and at a faster rate relative to natural conditions, the R-B flashiness index increases. Quebec and Atlantic Parks Canada, water level variation is index, flashiness, mean low water levels, 20-year timescale, good less than 1 SD from mean, statistical threshold- historical data needs to be analysed to determine mean values- gauging station data, 2 standard deviation (SD) is fair, more than 2 SD from mean is poor
▲ Lake Trout and Brook Trout populations	Lake Trout and Brook Trout populations are excellent indicators because: a) they involve species that can and will be embraced by multiple key sectors of society; b) strategies to improve their populations will potentially benefit multiple conservation targets; c) their needs involve multiple aspects of water quality (water temperatures, oxygen levels, lack of pollution, guilds of aquatic insects); d) healthy trout populations are easily associated with multiple human wellbeing benefits (recreation, water quality, food, ecotourism, etc.).
▲ Naturally vegetated lake shorelines	Extent of lake shoreline not allocated to cottaging (lots & occupancy)/human habitation (communities)
▲ Naturally-vegetated lake shorelines	Extent of lake shoreline not allocated to cottaging (lots & occupancy)/human habitation (communities)
▲ Number of dams disrupting ecological processes and species movement	Need to know current number and locations, etc., of dams, etc. (just one valve on the St. Lawrence system; 57 dams on Rideau system, which is not going to be significantly "de-regulated"; at least 6 dams on the Gananoque River system). Some of the impacts of dams can be mitigated with fish ladders and by regulating water flows to mimic natural fluctuations, so presence or absence of dams isn't necessarily the best or sole measure.
▲ Phosphorus concentrations	Monitored by Ministry of Environment Conservation and Parks out of the Dorset Environmental Science Centre using volunteers as part of the Lake Partner Program. "All ten stations have total phosphorous (TP) levels that are above the Provincial Water Quality Objectives. These high TP levels can cause excessive plant growth in streams and nuisance algae blooms on lakes." (CRCA 2018 Watershed Report Card)
▲ Road salt and other ice-melting chemical concentrations	Acceptable is 20-30mg / litre.Might also be calculated based on MTO annual/monthly usage data (tonnage/km).
▲ Unhardened shoreline	% of shoreline that is not artificially hardened (measures and monitoring could be limited to the more developed areas).
▲ Water temperature	Measured by conservation authorities and Parks Canada.Influenced 70% or more by air temperature; the other typical influences are changes in groundwater/headwater and riparian shade (Lambert pers. comm. 2019).
⬭ **Maintain and enhance the species richness, abundance and long-term viability of reptiles and amphibians in the FA area.**	Goal focuses on species at risk and declining taxa, particularly those vulnerable to road mortality, poaching and persecution.

Item	Notes
▲ % of FA habitat mosaic that is interior (>250m/>100m from roads, or mitigated with ecopassages and barrier fencing)	Habitat mosaic includes forests (at least 10% of patch) and wetlands (at least 10% of patch), and in the case of Gray Ratsnake, could include old fields. Metrics from “How Much Habitat Is Enough” (p. 12) relating to roadless wetland areas on the Shield. How Much Disturbance Is Too Much” (p. 50): Recommended Guidelines: Avoid the development of permanent roads in Regional Habitat Mosaics and Local Habitat Mosaics and decommission temporary roads promptly.{A positive guideline that talks about the nature of the habitat mosaic, such as ‘over X% of a habitat mosaic should be interior/undisturbed habitat’, vs. a guideline that speaks to the amount of disturbance, would be preferred]Where new roads within Regional Habitat Mosaics and Local Habitat Mosaics are considered essential:· accommodate for substantial buffers between important wetlands and roads wherever possible;· avoid locating roads where important wetlands occur on both sides; and,· implement mitigation measures based on the most current tools and data. Need more info on land cover, species specific habitat “mosaic” needs, species population trends
▲ Anuran populations based on call monitoring.	Based on Marsh Monitoring Program data (per species). Baseline could be based on earliest available MMP monitoring data.
▲ Extent of 250m-width unfragmented riparian/shoreline (use GIS)	30m-width is good for Musk Turtle, 250m would be better for Blanding’s Turtle. Adjacent/nearby forest cover also helps maintain wetland quality and productivity for birds and other taxa of conservation importance
▲ Extent of 30m-wide unfragmented riparian/shoreline buffer (use GIS)	30m-width is good for Musk Turtle, 250m would be better for Blanding’s Turtle. Adjacent/nearby forest cover also helps maintain wetland quality and productivity for birds and other taxa of conservation importance
▲ Gray Ratsnake population size	Based on Gray Ratsnake hibernaculum emergence studies.Queens University Biological Station past and current survey data.
▲ Gray Ratsnake populations	Based on Queens University hibernacula emergence monitoring (ongoing)
▲ Percent wetland area bordered by forest	Could this be lumped with “Extent of 30m-wide/250m-wide unfragmented riparian/shoreline buffer (use GIS)”? Herrmann et al. (2005) found within a 250 to 1,000 metres radius of the breeding pool, less than 40 percent cover supported "depauperate" levels of diversity, while more than 60 percent cover ensured healthy species richness and abundances.o Eigenbrod et al. (2008) found frog species richness was generally positively correlated to areas of high forest cover (i.e., greater than 60 percent) in distances up to 1,500 metres from the breeding ponds.o Homan et al. (2004) examined critical habitat thresholds for two pool-breeding, forest dependent amphibians (i.e., Spotted Salamander and Wood Frog) and found that thresholds varied depending on the spatial scale ranging from 32 to 88 percent, and varied inversely for the salamander versus the frog, possibly reflecting the greater dispersal requirements of the salamander.o Mazerolle et al. (2005) correlated increased Green Frog occurrence with increased with percent forest cover within 1,000 metres of breeding ponds.o Veysey et al. (2009) hypothesize that at the landscape scale at least 30 to 50 percent forest cover would be required to sustain Spotted Salamanders.• In addition to these somewhat local-scale forest cover requirements, there are also regional-scale requirements for many herpetofauna to consider. In a unique landscape scale study, Gibbs et al. (2005) examined changes in frog populations over a 30 year period in various locations across New York state near the Great Lakes and found that pond-breeding metapopulation processes occur at much larger scales than expected (i.e., more than 10 kilometres).” P. 24-25• “While overall forest cover is an important factor for a wide range of fauna, as well as the health of aquatic systems within a given watershed, amphibians require this cover in immediate proximity to their breeding habitats, while for many bird species the specific configuration of the habitat seems to be less of a factor as long as overall cover levels are adequate. The literature suggests this level is, on average, 50 to 60 percent.” Bryan ECCC review of How Much Disturbance Is Too Much by Beacon (2014)
⬭ **Maintain forest extent and diversity at 65% of FA area**	Maintain extent (incl. type, age classes, ecotype diversity and species composition) of forest habitat, especially along/near wetlands, waterways and shorelines. Baseline information on forest diversity and proportionality of matrix, large patch and small patch communities could be derived in part from site district report (White, D.J. 1993. Life Science Areas of Natural and Scientific Interest in Site District 6-10. A Review and Assessment of Significant Natural Areas. OMNR, Eastern Region, Kemptville. 122 pp. + map), as well as original Forest Resource Inventory data.
▲ % cover (ha) of forest in NA	
▲ % cover/ ha of interior forest	
⬭ **Maintain representative wetland species guilds.**	Marsh Monitoring Program by citizen scientists throughout the FA area provides a reliable, standardized, low-cost monitoring tool.
▲ Extent of wetland types	
▲ Percent Protected Wetlands	
▲ Presence of Common Reed	

Item	Notes
▲ Representative amphibian populations	Use Marsh Monitoring Program protocol and data.
▲ Representative marsh bird populations	Use Marsh Monitoring Program protocol and data.
⬭ **Maintain the extent, composition and configuration of the full suite of representative wetland ecotypes.**	Baseline information on forest diversity and proportionality of matrix, large patch and small patch communities could be derived in part from site district report (White, D.J. 1993. Life Science Areas of Natural and Scientific Interest in Site District 6-10. A Review and Assessment of Significant Natural Areas. OMNR, Eastern Region, Kemptville. 122 pp. + map) as well as original wetland evaluations.
▲ % of wetlands within 30 m proximity to other wetlands	
▲ Extent of 250m-width unfragmented riparian/shoreline (use GIS)	
▲ Extent of 30m-wide unfragmented riparian/shoreline buffer (use GIS)	
▲ Extent of wetland types	
▲ Percent Protected Wetlands	
▲ Presence of Common Reed	
⬭ **Restore and maintain native aquatic biodiversity**	This goal includes restoring and maintaining viable populations of migratory fish such as American Eel, Muskellunge, as well as Lake and Brook trout, other native fishes, herpetofauna, aquatic invertebrates and plants.
▲ % native vs. non-native invasive	Parks Canada uses presence/absence of wetland invasives along transects. With fish, the metric is often invasive vs. native biomass.
▲ American Eel migrations	Number of waterways accessible for eel spawning?
▲ Benthic organism composition	Cataraqui Region Conservation Authority benthic monitoring data available from mid-1950s on. St. Lawrence Islands National Park data available from ~2007 on.
▲ Drinking water	Could the goal be potability of untreated water, where feasible, in lakes, rivers and streams? E. coli levels are low except for the two urban areas. (CRCA 2018 Watershed Report Card). Any e-coli is bad for drinking water but under 200 is the threshold for safe swimming. Many fish are less impacted by these bacteria.
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▲ Flashiness	The flashiness of a stream reflects how quickly flow in a river or stream increases and decreases during a storm. Flashy streams are common in urbanized areas because stormwater runoff reaches the water-ways much more quickly than it would under natural conditions. The Richard-Baker Flashiness Index (R-B Index) reports changes in short term daily flows relative to average yearly flows. When stormwater flows into creeks at a higher volume and at a faster rate relative to natural conditions, the R-B flashiness index increases. Quebec and Atlantic Parks Canada, water level variation is index, flashiness, mean low water levels, 20-year timescale, good less than 1 SD from mean, statistical threshold- historical data needs to be analysed to determine mean values- gauging station data, 2 standard deviation (SD) is fair, more than 2 SD from mean is poor
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▲ Muskellunge migrations	Number of waterways accessible for muskellunge spawning and feeding.Muskellunge are highly migratory between spawning and feeding areas. Muskies Canada has a chapter in Gananoque. They know where the nursery areas for the muskies are, and may monitor migrations. Parks Canada tracks juvenile presence at monitoring locations. Metric would likely be presence/absence by site to some other measure
▲ Naturally-vegetated lake shorelines	Extent of lake shoreline not allocated to cottaging (lots & occupancy)/human habitation (communities)

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Number of dams disrupting ecological processes and species movement	Need to know current number and locations, etc., of dams, etc. (just one valve on the St. Lawrence system; 57 dams on Rideau system, which is not going to be significantly "de-regulated"; at least 6 dams on the Gananoque River system). Some of the impacts of dams can be mitigated with fish ladders and by regulating water flows to mimic natural fluctuations, so presence or absence of dams isn't necessarily the best or sole measure.
Perched culverts	Bridges are usually more ecologically benign than culverted stream crossings. Oval culverts are generally better for wildlife movement than round. Bridge and culvert location data and numbers are easily obtained. Perched culverts are barriers to fish and amphibian movement. Indicator would be the % of perched culverts where amphibians and fish can't cross because the culvert is too high. Citizen science could be a way to get the perched culvert data. Many municipalities find that culverts need to be replaced, providing an opportunity to make long-term improvements for conservation (such as designed ecopassages and barrier fencing). MTO issues guidelines for municipalities to follow. MTO has responsibility for Thousand Islands Parkway and Highway 401, but the county and municipalities need to deal with smaller roads. The challenge with this as an indicator is that the data may reside in numerous places but is not organized anywhere. The height of perch affects different fish species differently. A more manageable monitoring approach might be to select river and stream layers with roads and determine how many crossings are serviced by bridges or open bottom culverts.
Water temperature	Measured by conservation authorities and Parks Canada.Influenced 70% or more by air temperature; the other typical influences are changes in groundwater/headwater and riparian shade (Lambert pers. comm. 2019).
Restore and maintain shoreline integrity (full range of natural features and processes).	Natural or naturalized shorelines: a) reduce harmful run-off (fertilizers and pesticides; soil particles; road salt and other chemicals; vehicle fluids such as gasoline; waste from pets, livestock, septic leachate, etc.) that can cause algae blooms and excessive weed growth; b) significantly reduce shoreline erosion and improves overall shoreline resilience; c) improve overall biodiversity (both terrestrial and aquatic) and discourages hyperabundant Canada Geese; d) results in overall improved water quality.
American Eel migrations	Number of waterways accessible for eel spawning?
Drinking water	Could the goal be potability of untreated water, where feasible, in lakes, rivers and streams? E. coli levels are low except for the two urban areas. (CRCA 2018 Watershed Report Card). Any e-coli is bad for drinking water but under 200 is the threshold for safe swimming. Many fish are less impacted by these bacteria.
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Phosphorus concentrations	Monitored by Ministry of Environment Conservation and Parks out of the Dorset Environmental Science Centre using volunteers as part of the Lake Partner Program. "All ten stations have total phosphorous (TP) levels that are above the Provincial Water Quality Objectives. These high TP levels can cause excessive plant growth in

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▲ Unhardened shoreline	% of shoreline that is not artificially hardened (measures and monitoring could be limited to the more developed areas).
▲ water flow meter data	Requires rating thresholds (perhaps R-B Flashiness Index is sufficient).
▲ Water temperature	Measured by conservation authorities and Parks Canada.Influenced 70% or more by air temperature; the other typical influences are changes in groundwater/headwater and riparian shade (Lambert pers. comm. 2019).
⬭ **Restore connectivity of aquatic systems**	Connectivity includes unimpeded water flow as well as naturally vegetated riparian buffers. Should involve a combination of dam decommissioning where feasible, mitigation through water level regulation that emulates natural fluctuations, and other forms of mitigation (e.g., installing fish ladders)
▲ % surface water that is part of unregulated system	Surface area of lakes is easily determined, rivers and streams are harder to determine width, but two sub-measures (e.g., lake surface area and stream length) could be used.
▲ American Eel migrations	Number of waterways accessible for eel spawning?
▲ Drinking water	Could the goal be potability of untreated water, where feasible, in lakes, rivers and streams? E. coli levels are low except for the two urban areas. (CRCA 2018 Watershed Report Card). Any e-coli is bad for drinking water but under 200 is the threshold for safe swimming. Many fish are less impacted by these bacteria.
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water flow meter data	Requires rating thresholds (perhaps R-B Flashiness Index is sufficient).
Water temperature	Measured by conservation authorities and Parks Canada.Influenced 70% or more by air temperature; the other typical influences are changes in groundwater/headwater and riparian shade (Lambert pers. comm. 2019).
Restore forest connectivity, especially in eastern part of FA area.	Improve forest connectivity, especially in the more fragmented eastern part of FA area.
% cover (ha) of forest in NA	
% cover/ ha of interior forest	
Strategically restore XX ha of wetlands by 2050	Given that ~80% of wetlands have been lost across the FA area, a goal of doubling the current extent of functional wetland has been suggested.
% of wetlands within 30 m proximity to other wetlands	
Extent of 250m-width unfragmented riparian/shoreline (use GIS)	
Extent of 30m-wide unfragmented riparian/shoreline buffer (use GIS)	
Extent of wetland types	
Percent Protected Wetlands	
By 2025, shoreline naturalization in FA exceeds shoreline habitat loss.	
By 20XX, shoreline naturalization in FA exceeds shoreline habitat loss.	
Drinking water	Could the goal be potability of untreated water, where feasible, in lakes, rivers and streams? E. coli levels are low except for the two urban areas. (CRCA 2018 Watershed Report Card). Any e-coli is bad for drinking water but under 200 is the threshold for safe swimming. Many fish are less impacted by these bacteria.
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Naturally-vegetated lake shorelines	Extent of lake shoreline not allocated to cottaging (lots & occupancy)/human habitation (communities)
Unhardened shoreline	% of shoreline that is not artificially hardened (measures and monitoring could be limited to the more developed areas).
Complete wetland boundary mapping for FA by 202X	Largely a desktop exercise requiring provincial-level investment
% of wetlands within 30 m proximity to other wetlands	
Extent of 250m-width unfragmented riparian/shoreline (use GIS)	
Extent of 30m-wide unfragmented riparian/shoreline buffer (use GIS)	
Extent of wetland types	
Percent Protected Wetlands	
Percent wetland area bordered by forest	Could this be lumped with "Extent of 30m-wide/250m-wide unfragmented riparian/shoreline buffer (use GIS)"? o Herrmann et al. (2005) found within a 250 to 1,000 metres radius of the breeding pool, less than 40 percent cover supported "depauperate" levels of diversity, while more than 60 percent cover ensured healthy species richness and abundances.o Eigenbrod et al. (2008) found frog species richness was generally positively correlated to areas of high forest cover (i.e., greater than 60 percent) in distances up to 1,500 metres from the breeding ponds.o Homan et al. (2004) examined critical habitat thresholds for two pool-breeding, forest dependent amphibians (i.e., Spotted Salamander and Wood Frog) and found that thresholds varied depending on the spatial scale ranging from 32 to 88 percent, and varied inversely for the salamander versus the frog, possibly reflecting the greater dispersal requirements of the salamander.o Mazerolle et al. (2005) correlated increased Green Frog occurrence with increased with percent forest cover within 1,000 metres of breeding ponds.o Veysey et al. (2009) hypothesize that at the landscape scale at least 30 to 50 percent forest cover would be required to sustain Spotted Salamanders.• In addition to these somewhat local-scale forest cover requirements, there are also regional-scale requirements for many herpetofauna to consider. In a unique landscape scale study, Gibbs et al. (2005) examined changes in frog populations

Item	Notes
	over a 30 year period in various locations across New York state near the Great Lakes and found that pond-breeding metapopulation processes occur at much larger scales than expected (i.e., more than 10 kilometres).” P. 24-25• “While overall forest cover is an important factor for a wide range of fauna, as well as the health of aquatic systems within a given watershed, amphibians require this cover in immediate proximity to their breeding habitats, while for many bird species the specific configuration of the habitat seems to be less of a factor as long as overall cover levels are adequate. The literature suggests this level is, on average, 50 to 60 percent.” Bryan ECCC review of How Much Disturbance Is Too Much by Beacon 2014
▲ Representative amphibian populations	Use Marsh Monitoring Program protocol and data.
▲ Representative marsh bird populations	Use Marsh Monitoring Program protocol and data.