Evaluating the Status of Wildlife Habitat Loss and Degraded Wildlife Populations' Beneficial Use Impairments in the Toronto and Region Area of Concern

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Prepared for
The Toronto and Region Remedial Action Plan (RAP)

Toronto and Region Conservation
for The Living City®

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1. INTRODUCTION

1.1. Context

The Laurentian Great Lakes contain 21% of the world's surface fresh water (US EPA 2017). These waters provide drinking water to millions of people and provide habitat for numerous species of fish, invertebrates, birds and mammals. The Great Lakes Water Quality Agreement (GLWQA) is a bi-national agreement first signed in 1972 after pollution problems were identified in Lakes Erie and Ontario (Krantzberg 2012). The development and implementation of Remedial Action Plans (RAP) for Areas of Concern (AOC) were added as an Annex to the 1978 GLWQA to provide community-based environment protection and remediation (Krantzberg 2012).

The Toronto and Region AOC is one of 43 AOCs identified by the GLWQA. The Toronto and Region AOC extends along the north shore of Lake Ontario from Etobicoke Creek in the west to the Rouge River in the east. The 200 000-hectare area includes the Toronto waterfront and six watersheds: Etobicoke Creek, Mimico Creek, Humber River, Don River, Highland Creek and Rouge River.

The Toronto and Region RAP was developed to remediate the AOC and is being administered by the Toronto and Region Conservation Authority (TRCA). The six watersheds within the AOC are all within the TRCA's jurisdiction, which extends beyond the AOC to include three additional watersheds, Duffins Creek, Petticoat Creek and Carruthers Creek (see Box 1). The actions laid out within the RAP to achieve remediation goals are the joint responsibility of government agencies, TRCA, municipalities in the AOC, watershed councils, non-governmental organizations, property owners and residents of the AOC.

Box 1: TRCA's jurisdiction

Under the Conservation Authorities Act, TRCA has regulatory jurisdiction over nine watersheds and a portion of the Lake Ontario shoreline. Containing all or parts of eighteen different municipalities, it is one of the largest of the 36 conservation authorities in Ontario and is certainly among the most urbanized with the highest population and population density. Draining from the Oak Ridges Moraine, Peel Plains, South Slope, and Iroquois Sand Plain, TRCA's watersheds are: Etobicoke Creek, Mimico Creek, Humber River, Don River, Highland Creek, Rouge River, Petticoat Creek, Duffins Creek, Carruthers Creek.

The jurisdiction also includes small areas that drain directly to Lake Ontario, such as Frenchman's Bay. The Lake Ontario shoreline portion of TRCA's jurisdiction spans approximately 60 kilometres from Marie Curtis Park (Mississauga) in the west, to the Ajax waterfront in the east, and extends into Lake Ontario to a point defined by the Territorial Division Act. However, it excludes some of the central waterfront that is under the jurisdiction of the Toronto Port Authority.

Source: The Living City Policies (TRCA, 2014)

The actions within the RAP are broken into remedial objectives for degraded uses, called Beneficial Use Impairments (BUIs). The Toronto and Region AOC has had 11 BUIs listed, with the first being listed in the Metro Toronto Stage 1 document entitled *Environmental Conditions and Problem Definition* (RAP, 1989).

Of the 11 BUIs listed for the Toronto and Region AOC, two relate to wildlife: “Loss of fish and wildlife habitat” and “Degradation of fish and wildlife populations”. The following report will focus on the wildlife habitat and populations portion of these two closely associated BUIs. The status of fish habitat and fish populations in the AOC are outside the scope of this report.

This report will first focus on the assessment of wildlife habitat in the AOC and TRCA’s jurisdiction. The second part of the report will focus on the status of wildlife populations in the AOC in comparison to a reference watershed that falls outside the AOC, but within TRCA’s jurisdiction.

1.2. Goal and Objectives

The purpose of this project is to collect and analyze natural systems and species data in order to evaluate how the implementation of TRCA’s Terrestrial Natural Heritage System Strategy (TNHSS) has and will contribute to addressing the “Loss of Wildlife Habitat” and the “Degradation of Wildlife Populations” in the Toronto and Region AOC and across TRCA’s entire jurisdiction.

The specific objectives of this project are to:

1. Conduct a rapid assessment of the wildlife habitat change through a natural cover change analysis.
2. Conduct a rapid assessment of the current and future state of wildlife habitat protection through evaluation of the implementation of TRCA TNHSS (2007) in municipal natural heritage systems and related policies.
3. Analyze existing and new terrestrial inventory data and long term fixed monitoring plots data to assess wildlife populations.
4. Synthesize the wildlife habitat and the population assessments to provide key recommendations for re-assessment of the wildlife-related BUIs.
5. Provide case studies to support key messages and recommendations.

1.3. Structure of the Document

Two different but related approaches were used to complete the wildlife habitat assessment and the wildlife population assessment components of this report. This was necessary due to the different level of detail required for each assessment. Chapter 2 describes the details of the wildlife habitat assessment. Chapter 3 focuses on the wildlife population assessment. These two chapters constitute independent reports documenting the results of two distinct studies. Chapter 4 synthesizes the results and discussions from both analyses with illustrations from the field and provides comprehensive recommendations for re-assessment of the wildlife-related BUIs. The six sets of key recommendations are highlighted throughout this report related to each section and are summarized in Chapter 4 to help ensure long term wildlife habitat and populations objective are achieved.

2. WILDLIFE HABITAT ASSESSMENT

2.1. Introduction

The International Joint Commission (IJC) (1991) suggests that the guideline for delisting the "Loss of Fish and Wildlife Habitat" BUI is "when the amount and quality of physical, chemical, and biological habitat required to meet fish and wildlife management goals have been achieved and protected." In addition, it also states that the fish and wildlife habitat is listed as "Impaired" when "fish and wildlife goals have not been met as a result of loss of fish and wildlife habitat due to a perturbation in the physical, chemical or biological integrity of the Boundary Waters, including wetlands" (IJC 1991).

The wildlife habitat assessment evaluates the impairment status of the habitat and informs recommendations for protecting and managing wildlife habitat in the AOC as per IJC's guideline, which is supported by the TRCA's Terrestrial Natural Heritage System Strategy (TNHSS) (2007). TRCA's TNHSS sets out specific goals and targets for wildlife habitat in TRCA's jurisdiction, which aims to establish, protect and restore a network of natural cover (forest, wetland, meadow, successional, bluffs and beach) across the TRCA's jurisdiction with support from its municipal partners. The main objective of the TNHSS is to increase the quantity, quality, and distribution of terrestrial biodiversity and wildlife habitat across the jurisdiction.

Box 2: Natural Heritage System

A natural heritage system is defined in Ontario's Provincial Policy Statement (2014) as: "a system made up of natural heritage features and areas, and linkages intended to provide connectivity (at the regional or site level) and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species and ecosystems. These systems can include natural heritage features and areas, federal and provincial parks and conservation reserves, other natural heritage features, lands that have been restored or have the potential to be restored to a natural state, areas that support hydrologic functions and working landscapes that enable ecological functions to continue. The Province has a recommended approach for identifying natural heritage systems, but municipal approaches that achieve or exceed the same objectives may also be used".

In this study two main aspects were explored:

(i) The changes in natural cover over time were examined to determine how much progress has been made toward the habitat targets outlined in the TNHSS; and

(ii) Municipal natural heritage systems and polices contained in official plans were compared to the TNHSS to infer to what degree current and future wildlife habitat is protected. See Box 2 for the definition of natural heritage system used in the Ontario Provincial Policy Statement (PPS).

2.2. Natural Cover Change Analysis

The increasing pressures from urbanization and associated land use (e.g. residential, parking lots, roads) can have substantial impacts on natural cover (e.g. forest, wetland, meadow). This study examines the readily available ortho-photo interpreted data on natural cover over the period of 2002 to 2013 to conduct a rapid assessment of natural cover change in TRCA's jurisdiction before and after the development of TRCA's TNHSS (2007). The results and discussion provides insights on the apparent changes in habitat quantity and quality across the AOC and the entirety of TRCA's jurisdiction.

2.2.1. Data and Methods

Ortho-photo interpreted natural cover datasets delineating five major natural cover classes (forest, meadow, successional, wetland, beach/bluff) from 2002 and 2013 (TRCA 2002, TRCA 2013) were used to determine the habitat changes in TRCA's jurisdiction, mainly in terms of changes in

(i) Habitat quantity,
(ii) Habitat quality, and
(iii) Habitat types.

Habitat quantity was assessed using the area metric for each habitat class in the 2002 and 2013 natural cover datasets. The overall change in the area of each habitat was calculated and the spatial distribution of these changes were mapped across TRCA's jurisdiction as shown in Figure 1 and generalized to one square kilometer grids as shown in Figure 2. The quality of habitat patches was inferred using a Landscape Analysis Model (LAM) (TRCA 2007). The LAM model scores habitat patches based on size, shape, and matrix influence metrics. The size metric infers that larger patches have higher quality, the shape metric infers that more compact shape with less perimeter to area ratio will have lower edge effects thus higher quality, and matrix influence infers that more natural cover in the neighbourhood surrounding a patch will have positive influence on habitat quality. Based on these matric scores, the habitat patches are ranked from "very poor", "poor", "fair", "good" to "excellent" quality (TRCA 2007).

Given that these datasets include interpretation of aerial photos; they are expected to have some level of error associated with user interpretation. Any major known discrepancies were eliminated from the data and the influence of any remaining error was minimized by focussing the analysis on the general trend in habitat change, both in terms of quantity, quality and broad habitat types. TRCA internal experts were used to validate the general trends.

2.2.2. Results and Discussion

2.2.2.1. Changes in Habitat Quantity

Figure 1 shows the spatial distribution of mapped natural cover patches across TRCA's jurisdiction in 2002 and 2013. This map suggests that over the period of a decade from 2002 to 2013 most of the natural cover areas remained on the landscape and were not converted to other land uses (depicted in brown). However, there are areas where some natural cover was lost (depicted in black) as well as gained (depicted in red). Figure 2 shows the same map in a more generalized format at the resolution of one square kilometer grids that allows for a broader discussion of general patterns where natural cover was lost, gained or remained constant between the two years.

Figure 1 indicates that while most of the natural cover remained constant across the TRCA's jurisdiction from 2002-2013, the distribution of the changes that did occur varied across the region. Urban areas in the southern parts of the jurisdiction showed minimal changes in natural cover, most likely because the changes had already happened in these areas before 2002. Though no further habitat loss is good news in these urban areas, it is important to note that the level of natural cover is generally lower here and thus opportunities should be explored to increase natural cover. This may be through traditional restoration of added natural areas such as forest and wetlands and, if such opportunities are limited, then through implementation of other green infrastructure (see Box 3) opportunities in urban built sections such as green roofs and naturalized parks, parkettes, and enhanced urban forest.

Box 3: Green Infrastructure

Green infrastructure refers to natural green elements (e.g. street trees, forests, wetlands, meadows, soil (gardens and cropland), etc.) and built green elements (e.g. green roofs, bioswales, permeable pavement, etc.) that are present in both urban and rural settings.

Source: The Living City Policies (TRCA, 2014)

Figure 1 also shows that a substantial portion of natural cover loss that occurred was clustered in the urbanizing region of the jurisdiction, especially in the middle reaches of the watersheds. It is likely driven by the urbanization pressures including new development and infrastructure expansion that occurred in these areas during the given time period. In such areas, stronger protection of the natural cover is needed, especially since once these natural cover areas are removed for development it is nearly impossible to gain them back. Nevertheless, it is worth noting that there are some natural cover gains present in these urbanizing regions. Though this is an encouraging finding, some of these gains may be temporary. An example of this is the natural succession of fallow farm fields to early successional stages of vegetation. These areas will likely return back to agricultural uses or be allotted for development as urbanization pressures continue. Some of the other gains may be real change attributed to restoration initiatives and naturalization of the parks and stormwater management ponds. Regardless of these natural cover gains, it is still important to note that concentrated natural cover loss in any particular area has an immediate and disproportionate amount of impact on local habitat

function and wildlife populations. For example, the loss of mature forest may pose risks to the survival of the species that depend on this habitat type for food, shelter, and reproduction. Even if a new forest habitat is created, there can be significant time lag before the lost function is restored, thereby increasing the probability of local species extinctions (Evans et al. 2013).

Figure 1 indicates that most of the natural cover increases are in the northern parts of the jurisdiction. This increase in natural cover may partly be attributed to the restoration of old agricultural fields. TRCA and its partner municipalities along with the province and Non-Governmental Organization (NGO)s have put significant effort and resources into larger-scale tree planting and habitat restoration initiatives, which have likely led to this success (Forest Ontario 2017). TRCA and its partners have recorded over 350 ha of newly established natural cover through restoration projects between 2007-2015 (RAP 2016). Many of these initiatives require that participants hold land of a minimum size to be eligible for tree planting. This allows for efficiency and larger program impact, but it may also limit restoration opportunities in areas with smaller land-holders such as in urban and urbanizing regions. This is combined with the fact that newly urban and urbanizing areas experience rapid increases in land values and likely have the least incentive for conservation and restoration. As discussed earlier, the urbanizing area, unsurprisingly, is where this analysis has shown most of the natural cover loss.

Table 1 provides a summary of the natural cover distribution in 2002 and 2013 for the nine watersheds and the three broad land use zones (urban, urbanizing, and rural). The breakdown of the natural cover highlights the uneven distribution of natural cover across the AOC and the TRCA's jurisdiction. Out of the nine watersheds Humber (in the AOC) and Duffins (outside of AOC) watersheds have the highest natural cover whereas Etobicoke, Mimico, Don, and Highland watersheds have the lowest natural cover. Furthermore, it is interesting to note that in watersheds with more natural cover (e.g. Humber, Duffins), most of this cover is concentrated in a rural zone of the watershed; however, in watersheds with low natural cover (e.g. Etobicoke, Highland) they are categorized to be in the urban zone. This is simply due to the fact that there is mostly only urban zone in these watersheds with low natural cover and they are all in the urban context. In both 2002 and 2013, this distribution remained similar, highlighting that there was generally successful protection of natural cover in these watersheds, though little improvements or enhancements made to increase natural cover.

In addition, in some urban zones (e.g. in the Highland and the Don watersheds) there was a slight decrease in natural cover indicating further habitat loss. This is important point to note, especially in heavily built up watersheds such as Etobicoke, Mimico, Don, and Highland, which have very low natural cover. In such watersheds maintaining the existing natural cover, or even a slight decrease, may compromise the desired habitat function for the wildlife populations quite substantially, because of the cumulative impacts of urban stressors. There should be increased efforts to enhance natural cover, though the opportunities to do so may be limited, especially through traditional restoration approaches. As discussed previously, the opportunities to increase natural cover through innovative approaches such as implementation of other types of green infrastructure, like green roofs and naturalized parks and parkettes, may be critical in these areas. As well, redevelopment zones of the urban area, should seize opportunities for

restoring and remediating remnant features and hazards like woodlands and flood plains so that habitat can be expanded and enhanced in tandem with improving amenity greenspace for the intensified population.

The natural cover quantity target for TRCA's jurisdiction, based on the TRCA TNHSS (2007), is 30% of the landscape with the majority of this area being forests and wetlands. Though there is a general positive trend towards achieving them, the habitat quantity assessment indicates that these jurisdiction wide targets have not yet been met. Each watershed has its own habitat quantity target recognizing the different levels of urbanization within each one as well as the broad land use zones (urban, urbanizing, and rural). Less urbanized watersheds such as Humber and Duffins have higher targets recognizing that they have more natural cover as well as opportunities for restoration and enhancement. For the more urban watersheds with low natural cover and limited opportunities for large scale restoration, the habitat quantity targets are focused on maintaining natural cover at roughly the same proportion as was existing in 2002.

The habitat quantity assessment showed that in general the TNHSS recommendations are being applied as there is a general trend of increasing natural cover in rural parts of the jurisdiction and minimal changes in the urban and urbanizing zones. However, in some parts of the urbanizing areas there is a disproportionate cluster of natural cover loss driven by urban growth.

It is important to gain an understanding of the cumulative effects of existing and new urbanization on habitat quantity to implement specific protection and enhancement measures including restoration initiatives and other innovative green infrastructure implementation measures to prevent further loss and deterioration of remaining habitat and create new ones to enhance the overall habitat function across the AOC and TRCA's jurisdiction.

Box 4: Innovative solutions to increase natural cover

Innovative solutions to provide increased natural cover and other green infrastructure that will support wildlife often requires a combination of applied research and a place-based approach. Some examples are:

- Modify municipal tree planting lists to limit the amount of ornamental and non-native species being planted
- Implement green roof and tree protection bylaws
- Work with local NGOs and TRCA to establish native plant planting programs on residential properties, particularly in areas near existing natural cover
- Work with parks departments to establish meadow and tree cover in park areas.
- Partner with infrastructure authorities to find opportunities to establish new natural cover and build relationships to open dialogue about important habitat prior to the Environmental Assessment process
- Work with golf course managers adjacent to natural cover, to implement management practices that will support bird diversity.

Key Recommendations 1:

- Explore and implement new and innovative approaches to increasing natural cover, including other forms of green infrastructure, in urban and urbanizing areas where the traditional protection and restoration opportunities may be limited. For examples of such innovative methods, see Box 4.
- Promote the need for more proactive and comprehensive natural heritage planning in the areas targeted for future urban development. This planning could be accomplished through the development of sub-watershed plans or other plans that evaluate different development scenarios and design communities that include a natural heritage system and integrated green infrastructure able to maintain and enhance biodiversity.
- Utilize opportunities through comprehensive urban revitalization initiatives for redevelopment and intensification in existing urban areas to expand, remediate and restore remnant or damaged natural features that would provide multiple benefits. For example, the planned Port Lands restoration in Toronto will add wetland habitat and green space for human use.
- Eliminate the cumulative loss of wildlife habitat from urban areas by prioritizing the protection of functional habitat, and where protection is not possible, the mitigation hierarchy of avoid, minimize, mitigate, and compensate should be applied.
- Identify opportunities to improve the habitat contribution of active recreation areas identified in municipal official plans.
- Explore options for land acquisition and securement through infrastructure funding, as an investment in green infrastructure assets.
- Research the extent to which all forms of green infrastructure located within the urban matrix can contribute to wildlife habitat and the overall function of the natural system.

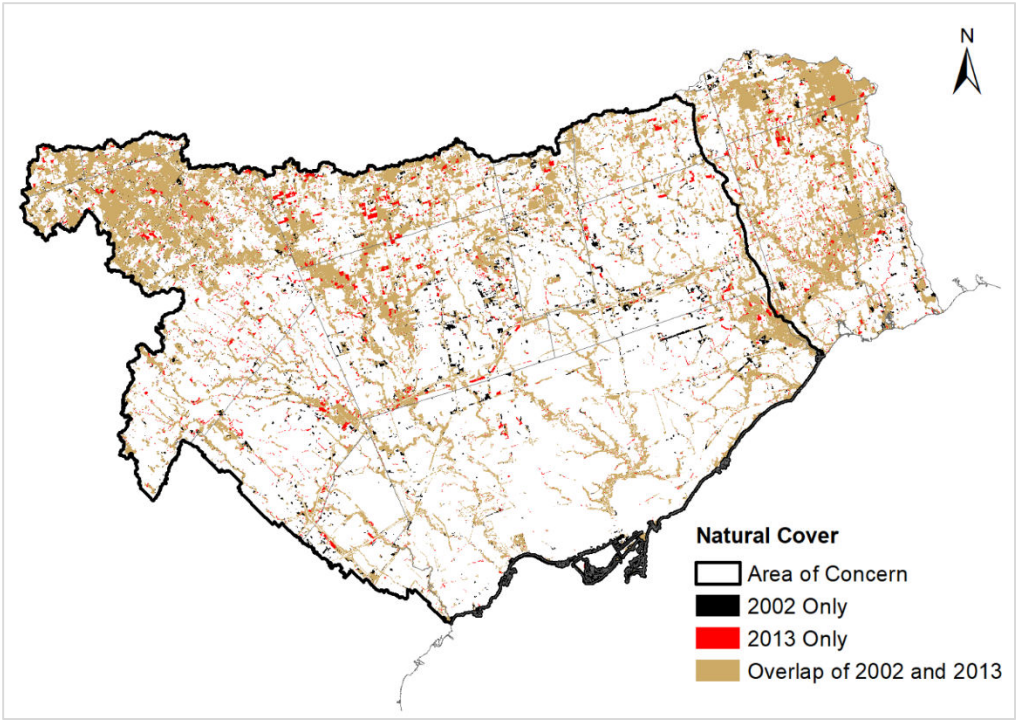


Figure 1. Natural cover in 2002 and 2013 across TRCA's jurisdiction based on aerial photo interpretation. Natural cover observed only in 2002 is shown in black and natural cover observed only in 2013 is red. The areas that were observed as natural cover in 2002 and 2013 are show in light brown.

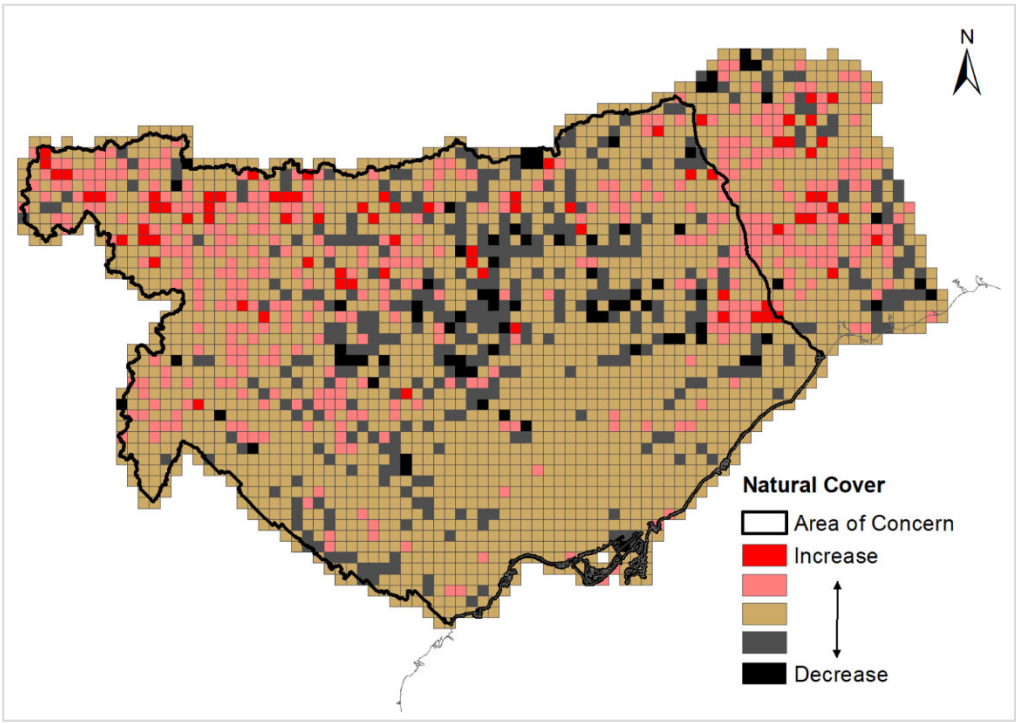


Figure 2: Natural cover change summary between 2002 and 2013 at 1 sq. km resolution. Red indicates increase and black indicates decrease in percent of natural cover from 2002 to 2013. Light brown indicates no significant net change.

Table 1. Natural cover area summary for 2002 and 2013 – by watershed and broad land use zones – in AOC (shaded) and rest of TRCA watersheds.

Watershed Name	2002 Natural Cover (% of the watershed)				2013 Natural Cover (% of the watershed)			
	Watershed	Rural	Urbanizing	Urban	Watershed	Rural	Urbanizing	Urban
Etobicoke	**14%**	3%	1%	10%	**14%**	3%	1%	10%
Mimico	**11%**	0%	0%	11%	**10%**	0%	0%	10%
Humber	**32%**	23%	3%	6%	**33%**	25%	3%	5%
Don	**16%**	2%	0%	14%	**14%**	2%	0%	12%
Rouge	**24%**	15%	2%	7%	**24%**	16%	2%	6%
Highland	**13%**	0%	0%	13%	**11%**	0%	0%	11%
Frenchmans Bay	**25%**	3%	7%	15%	**25%**	4%	7%	14%
Duffins	**40%**	30%	7%	3%	**43%**	32%	8%	2%
Petticoat	**28%**	21%	4%	3%	**30%**	23%	4%	3%
Carruthers	**28%**	15%	8%	5%	**25%**	15%	7%	3%
Waterfront	**10%**	0%	0%	10%	**10%**	0%	0%	10%
AOC (% AOC Area)	23%				23%			
TRCA (% TRCA Area)	25%				26%			

2.2.2.2. Changes in Habitat Quality

TRCA's TNHSS (2007) recognized that in an urban region such as TRCA's jurisdiction, ongoing changes in habitat quality is inevitable. However, the TNHSS established that an overall increase in "good" quality habitat patches across the entire jurisdiction can result in more resilient terrestrial habitat and biodiversity. The Landscape Analysis Model (LAM) developed by TRCA evaluates individual mosaics of habitat patches and ranks them from "poor" to "excellent" quality based on three structural metrics; size, shape, and matrix influence (TRCA 2007). The target system in the TNHSS was developed to have in general majority of habitat patches scoring as "good", recognizing that there are some opportunities for "excellent" patches and other areas will never improve beyond "poor" based on this method (Figure 3).

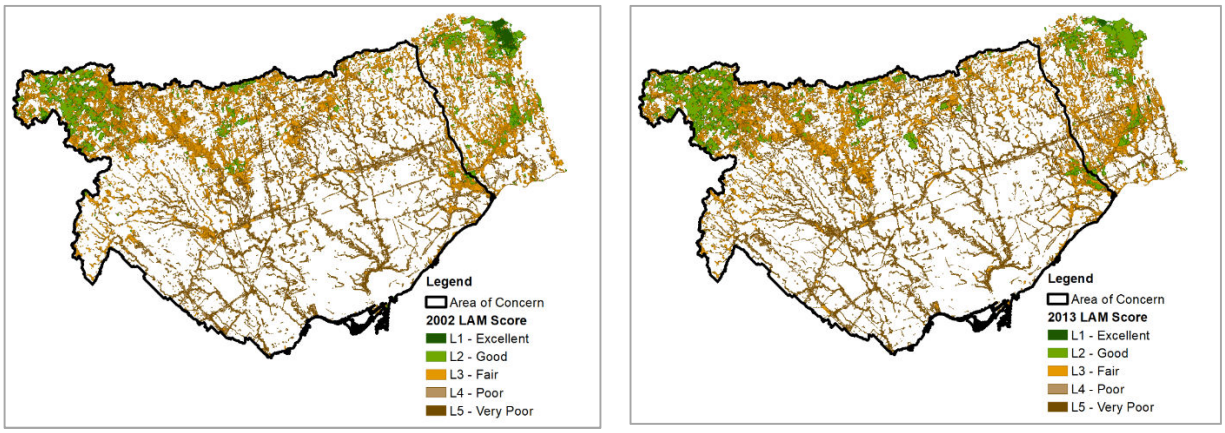
The LAM results for 2002 and 2013 natural cover data (Figure 3 and Table 2) show that there is a substantial increase in the area of "good" habitat patches (approximately 3000 ha), though there are some decreases in "fair" and "excellent" quality (approximately 400 ha) and increases in "poor" and "very poor" quality (approximately 900 ha) across TRCA's jurisdiction. This indicates that though there are negative trends in terms of losses in excellent and increase in poor patches of habitat, the overall increase in the areas of good patches surpasses the negative changes. The increasing urban matrix influence along with habitat loss in some areas might have contributed to the negative changes in the habitat quality. Meanwhile the positive trend may be attributed to the protection and restoration efforts aimed at increasing size and improving the shape of the habitat patches. These changes are mostly visible in the rural zones and in and around conservation areas such as Boyd Conservation Area in the west and Rouge National Urban Park in the east.

It is important to note that the LAM defines habitat quality based only on the structural metric of the habitat patches (size, shape, and matrix influence) calculated through a desktop analysis. Some of the specific results of the analysis may have been influenced by the technical parameters of the model (e.g. the change in a large excellent patch to a good patch from 2002 to 2013 is mainly due to the score being very close to the threshold value between excellent and good, being just above this threshold in 2002 and just below this threshold in 2013). However, the general positive trend is distinct enough to be relevant.

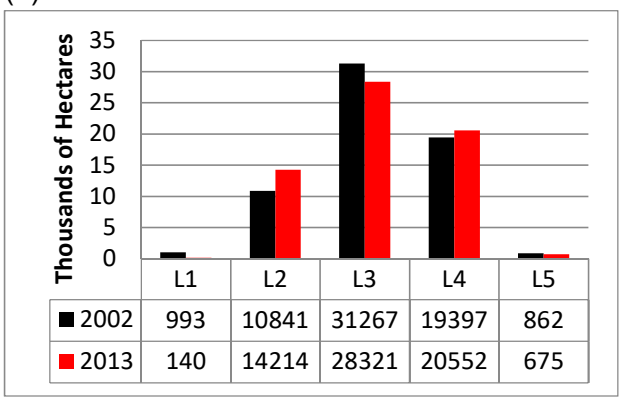
The limitation of the LAM analysis is that it does not account for other direct and indirect effects of urbanization (e.g. road salt, traffic, noise, invasive species, edge effects, hydrological regime shifts). These have various individual and cumulative impacts on habitat quality, thereby lowering overall habitat function (Kociolek et al, 2011 & Lemmen et al, 2008). This is especially problematic in the urbanizing zone of the jurisdiction where, as per earlier discussion, there is less habitat, a higher concentration of habitat loss, and limited opportunities for restoration. The cumulative impact of degradation of habitat quality and loss of habitat quantity in these urbanizing and future urban areas needs to be carefully addressed to ensure functioning habitat in the landscape.

Key Recommendations 2:

- Reduce the overall impacts of new and redeveloped urban communities on adjacent wildlife habitat and natural systems including but not limited to:
    - Ensuring hydrological functions required to support the natural system are maintained
    - Reducing the application of road salt on wildlife and wildlife habitat.
    - Managing human use by designing trails and access points to direct use away from higher functioning habitats.
- Focus land securement efforts in areas where the natural system may be most vulnerable to land use change.
- Work with Municipalities to define the long-term intent of active recreation areas that are located in the NHS and complete complimentary monitoring and research to understand the local impacts of recreational use and the ecological thresholds associated with recreational use.
- Work collaboratively with developers, municipalities and TRCA to implement monitoring programs in areas planned for development that can provide long-term wildlife data throughout the development process to inform mitigation options.



(a) (b)



(c)

Figure 3: Habitat quality based on Landscape Analysis Model (2007) for (a) 2002 Natural Cover Data (b) 2013 Natural Cover Data, and (c) comparison of the areal coverage (ha) of each quality class.

Table 2. Area of the habitat quality based on size, shape, and urban matrix influence calculated using TRCA's Landscape Analysis Model (LAM) on 2002 and 2013 Natural Cover data.

	LRANK	Target System (ha)	2002 (ha)	2013 (ha)	Change (ha)	Trend
Excellent	**L1**	6965	993	140	-853	**-**
Good	**L2**	33810	10841	14214	3373	**+**
Fair	**L3**	20621	31267	28321	-2946	**-**
Poor	**L4**	12329	19397	20552	1155	**+**
Very poor	**L5**	294	862	675	-186	**-**

2.2.2.3. Changes in Habitat Types

An assessment of the changes in the five specific habitat types shows a slight positive trend in all habitat types except meadows (Table 3). Though the increase in most of the habitat types is positive and can be attributed in part to successful habitat protection and restoration efforts, the decrease in meadow habitat raises important questions for habitat conservation in the TRCA's jurisdiction.

Table 3. Approximate changes in habitat type area between 2002 and 2013.

Habitat Type	2002 (ha)	2013 (ha)	Change (ha)	Change trend
Forest	33851	36382	2531	**+**
Meadow	23615	19252	- 4363	**-**
Successional	3150	4787	1637	**+**
Wetland	2572	3263	691	**+**
Beach/bluff	162	180	18	**+**
Overall	63350	63864	514	**+**

Based on the habitat change analysis, meadow habitat loss approximates about 23% of the 2002 meadow habitat, which is equal to about two percent of the TRCA's jurisdiction. This includes a decrease in larger patches of meadow habitat (>=10 ha) that often support sensitive meadow-dependent species across the jurisdiction such as bobolink and meadowlark. Part of this decrease may be explained by the increase in the successional and forest habitat types. Meadows are intrinsically dynamic in nature and undergo natural succession and transition into later successional habitats such as forests, especially in the historically forested ecoregion such as TRCA's jurisdiction. In addition, most of the meadow habitat in the landscape are cultural meadows within the increasingly urbanized areas. This includes farm fields left temporarily fallow, open spaces allocated for development, hydro corridors etc. Some of these areas may be defined as meadow habitat until the intended land use change is undertaken. Meadows are often susceptible to land use conversion, as they are not typically afforded protection in the current policy framework (unless they provide habitat for threatened or endangered species).

Regardless, if these region wide trends in loss of meadow habitat continue, it is likely that meadow-dependent species will decline. This finding is not trivial considering several provincially listed Species at Risk (SAR) and TRCA's regional species of concern are known to be meadow-dependent species such as bobolink, eastern meadowlark, grasshopper sparrow, and monarch butterflies. There are ways to prevent meadow habitat loss and increase overall meadow habitat across the jurisdiction. This includes traditional protection and restoration measures, which is critical especially where large habitat patches (>20 ha) can be attained to provide habitat for area sensitive species such as bobolink. In other cases, more innovative approaches might be required such as providing opportunities for "pop-up" meadows of various sizes throughout the jurisdiction. In rural and future urban areas, this include partnership

projects with agricultural communities and to allow large patches of fast-growing temporary meadows to grow in the farm fields that are left fallow temporarily as a part of regular farming practices. In urban areas implementation of networks of green infrastructure such as naturalized hydro corridors, green roofs, native pollinator gardens on residential or institutional lots can all contribute to meadow habitat. Together these initiatives will provide more meadows of all sizes across the jurisdiction for various meadow dependent species. One of the numerous examples of urban meadow restoration is provided in Box 5.

Box 5: Restoration opportunities for meadow habitat

Hydro corridors are offer an opportunity within the urban matrix to supplement meadow habitat and provide connectivity for pollinators. TRCA's Scarborough Centre Butterfly Trail project is an example of using an alternative land use practice in an urban area to provide a potential habitat corridor.

Key Recommendations 3:

- Incorporate strategic restoration opportunities into existing land securement programs to help ensure lands are available for future habitat restoration.
- Added resources and effort should be directed to restoration across the TRCA's jurisdiction as there remains a significant amount of additional natural cover required to meet the TRCA TNSS target.
- Use strategic system based approaches to identify restoration opportunities that strengthen the overall habitat function and total area of NHS. Resources like TRCA's Integrated Restoration Prioritization should guide restoration efforts.
- Strategic restoration opportunities should be identified within existing urban areas. This could include identifying surplus open manicured areas on private and public land that are in proximity to the existing natural system.
- Existing programs should be supported and new programs developed to target habitat restoration for a number of different land uses such as schools, institutions, infrastructure lands, open lands within commercial areas, industrial lands, and residential lands.
- Develop a regional strategy and implementation plan for the effective conservation and management of meadow habitat that set targets for overall extent and distribution of meadow habitat across the TRCA's jurisdiction and provides long term management recommendations. This should include identifying opportunities to incorporate meadow habitat into urban and urbanizing communities as well as opportunities to partner with the agricultural community.
- Identify the ecological need and potential implications of meadow conservation in TRCA's jurisdiction.
- Clarify and strengthen current policy frameworks meant to protect meadow habitat. in urbanizing areas.

2.3. Spatial Overlay Analysis of the TRCA and the Municipal Natural Heritage Systems

One of the primary policy mechanisms for terrestrial wildlife habitat protection in southern Ontario is the requirement for Natural Heritage System (NHS) identification as outlined in the Provincial Policy Statement (2014). Municipalities are the planning authority for local land use planning decisions and therefore play a critical role in the identification and protection of NHS. A mapped NHS is an important tool for land use planning and can help ensure land use planning decisions are not compromising the ecological, social or economic benefits that natural areas provide. NHS mapping is also an important tool for wildlife conservation objectives, as these systems are essentially maps of primary habitat across the region. Municipal Official Plans (OPs) lay out the rules and policies that direct land use decisions. OPs are key guidance documents that are developed with public input and are approved by Municipal Council. While the land that makes up an NHS can be owned or maintained by various entities (government, institutions, private landowners), the municipality has the responsibility for its protection from detrimental uses or other alterations through its OP. Municipalities are also responsible for the Municipal Class Environmental Assessment process in which they use the NHS policies of their OP to guide the siting, alignment and design of public infrastructure.

A spatial overlap analysis was completed to compare NHSs delineated in municipal OP Schedules with the target Terrestrial Natural Heritage System (TNHS) (TRCA 2007) to:

(i) Understand the extent of TRCA TNHS adoption in municipal OPs (schedules & maps);
(ii) Understand the extent of habitat protection in municipal natural heritage systems;
(iii) Identify the reasons for differences and similarities between TRCA TNHS and municipal NHS; and
(iv) Infer implications for regional biodiversity and habitat.

2.3.1. Data and Methods

Municipal NHS boundary layers were combined with the most up-to-date natural heritage system information from the Oak Ridges Moraine Conservation Plan, the Greenbelt Plan, and the Niagara Escarpment Plan to consolidate an up-to-date municipally adopted (final or in draft form) NHS layer. Federally protected natural heritage in the Rouge National Park, as it existed in 2015, was also included in this layer. The consolidated municipal adopted NHS layer was overlaid with the TRCA target TNHS to assess the extent of overlap between the two (Figure 5). The consolidated NHS spatial overlap data was used in conjunction with the natural cover data and broad land use data to understand the synergies and discrepancies between municipal and TRCA NHS and implications on current and future habitat protection. The results are summarized at the scale of the TRCA's jurisdiction, the nine watersheds (showing east to west pattern), and broad land use zones separating urban, urbanizing, and rural areas (showing north to south pattern).

A more generalized version of the spatial overlap map was created at a resolution of one kilometer square grids showing the broad areas where municipalities had more coverage for protection than TRCA TNHS or vice versa (Figure 6).

2.3.2. Results and Discussion

Figures 5, 6 and Table 4 show the spatial overlap between the TRCA TNHS and consolidated municipal NHS. The results indicate that approximately one third of the TRCA's jurisdiction as well as the AOC is included in the municipal NHS indicating good coverage of NHS for habitat protection. When analysing these data, it is important to note that there are some variations in what constitutes NHS in each municipality.

There is almost 85% overlap between the TRCA TNHS and the consolidated municipal NHS (approximately 60 000 ha). This level of overlap indicates a high rate of adoption of TRCA recommendations by municipalities. Most of the overlap coincides with existing natural cover and areas with some level of policy protection, either as TRCA regulated areas (e.g. within flood plains) or from provincial legislation (e.g. Greenbelt and Oak Ridges Moraine). Nevertheless, 15% of the TRCA TNHS (12000 ha) was not captured within the consolidated municipal NHS. Despite these exclusions, municipal NHS added a further 26 000 ha in their NHS that might offset some of the gaps in habitat, provided that these areas have similar form and function when it comes to habitat and wildlife conservation.

Most of the 12 000 ha of TNHS areas that municipal NHS excluded are either classified as potential natural cover or existing meadows in the TRCA TNHS. This includes agricultural areas that are outside of the Greenbelt or Oak Ridges Moraine plans in rural zone and meadows and/or other open space areas in urban and urbanizing zones. As discussed earlier, this reflects the increased susceptibility of meadows to land use change given that they have limited protection status in the current policy framework. In addition, a few existing forests and wetlands in the TRCA TNHS were also excluded in municipal NHSs, mostly in rural and urbanizing zones. Though it is important to include them in a municipal NHS to prevent habitat loss, further investigation may be needed to confirm that these are in fact still present in the landscape given the time lag between the TRCA TNHS and municipal NHSs. Lastly, data processing errors such as slivers during data clipping or shift in digitizing boundaries also resulted in some mismatch between the TRCA TNHS and municipal NHS. A summary of the reasons for the mismatch between TRCA TNHS and municipal NHS are provided in Box 6.

The 26 000 ha of the jurisdiction that were included in municipal NHSs and not in the TRCA TNHS have the potential to provide additional wildlife habitat. Some of these areas are forests and wetlands that were missed by the TRCA TNHS, likely due to data processing errors. The majority of these are in the uncategorized natural cover type, which means they are not existing habitat and may reflect areas that municipal OPs have targeted for habitat restoration and enhancement. A significant portion of these are agricultural lands in rural areas, especially where there are provincial designations. The watershed analysis also highlighted that the NHS coverage is generally higher in watersheds such as the Humber, Rouge, Duffins, Petticoat, and

Carruthers, which have higher natural cover as well as coverage of provincial plan policies because of the Oak Ridges Moraine Conservation Plan, the Niagara Escarpment Planning & Development Plan and the Greenbelt Plan. This highlights that the provincial policies are generally facilitating NHS protection as intended.

In urban and urbanizing zones, the added areas in municipal NHS constitute areas zoned for different land uses such as active recreation (e.g. golf courses, parks) or institutional and commercial zoning. The watershed analysis also indicated that in the highly urbanized watersheds and along the waterfront additional areas in municipal NHS seem to include active recreation areas, golf courses, and other "open" land uses. These areas are traditionally not included in NHS as defined by TRCA and other conservation authorities. This raises questions regarding whether the added NHS areas are inflating the perception of habitat protection or whether these areas actually provide opportunities to be innovative regarding habitat and wildlife conservation, especially in urban areas where natural cover is low and traditional restoration and protection opportunities may be limited. Cautious and innovative implementation of NHS may be needed in such areas to ensure that these actually function as NHS for habitat and wildlife.

Box 6: Reasons for the mismatch in the TRCA TNHS and municipal NHS

- Difference in NHS definition (natural areas verses active recreation areas/golf courses)
- Coverage of provincial policies (broad swaths of Greenbelt regardless of natural cover)
- Planned land use / zoning issues (areas approved for development)
- Temporal land cover and land use change (2002 versus more recent NHS)
- Data processing errors (data clipping slivers, mapping errors)

Key Recommendations 4:

- Develop additional policy guidance to more fully protect natural habitats not sufficiently addressed in current policy frameworks, particularly in future urban growth areas as these are the most vulnerable to removal.
- Develop protection policies for local natural features not protected under provincial policy, particularly in rural areas that have defaulted to the provincial systems.

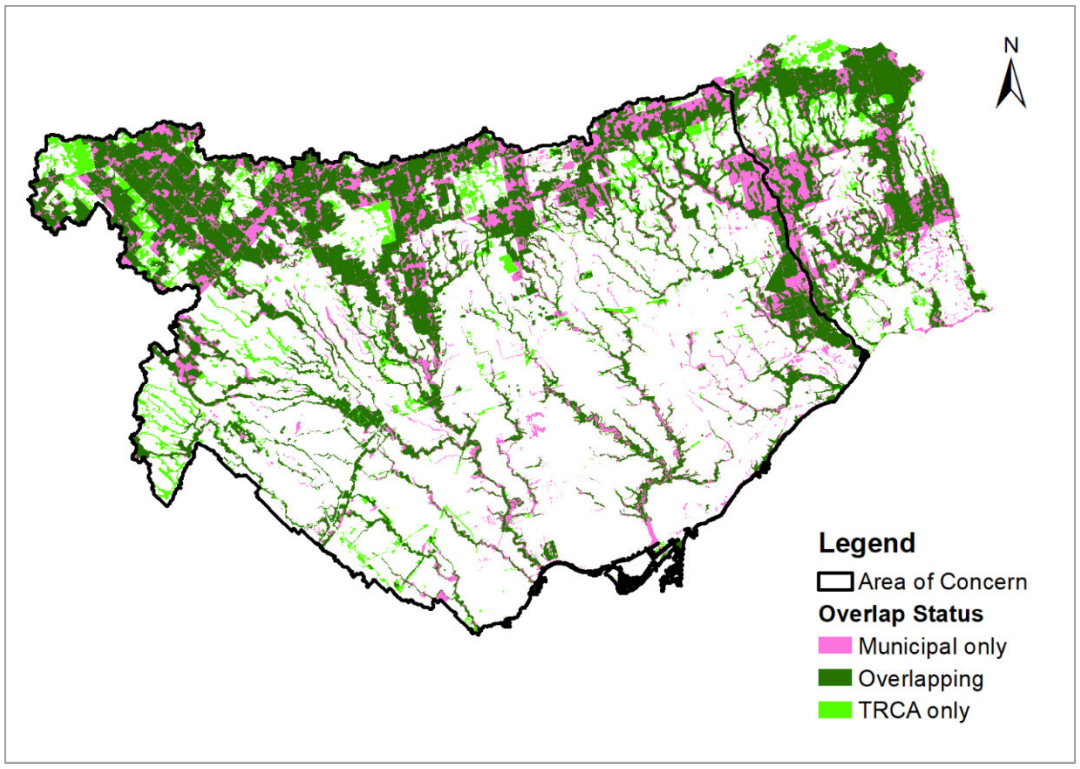


Figure 4: Overlap analysis of municipal NHS (including adopted provincial policies) and TRCA TNHS

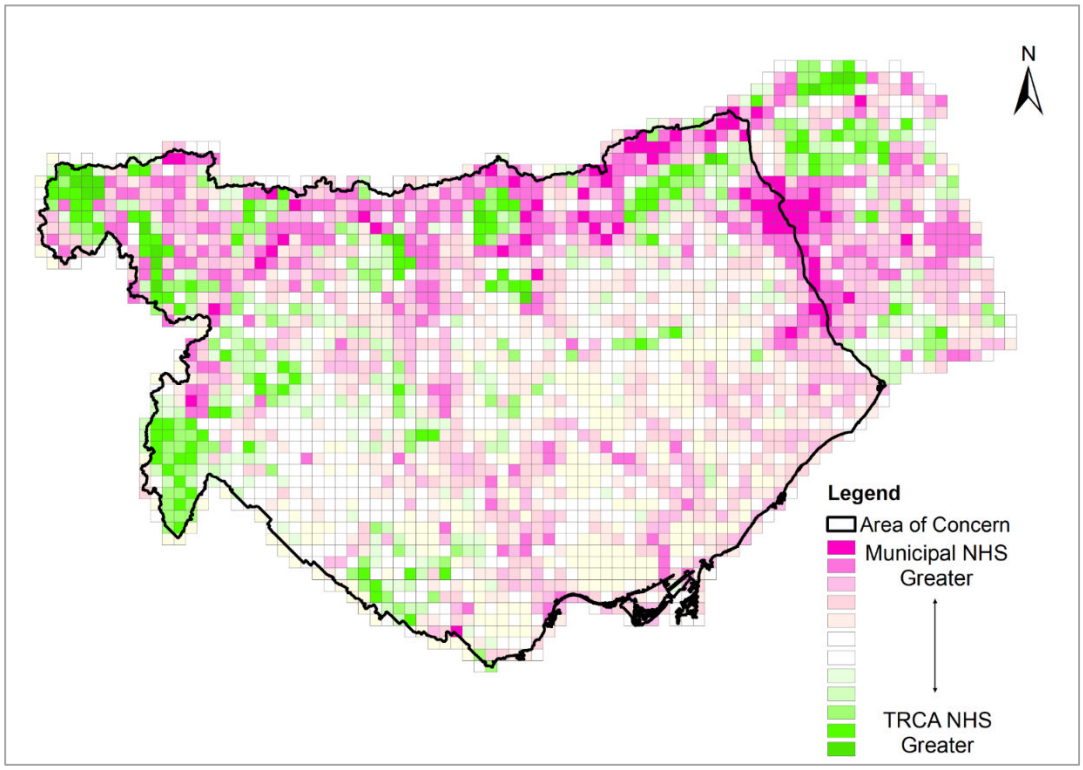


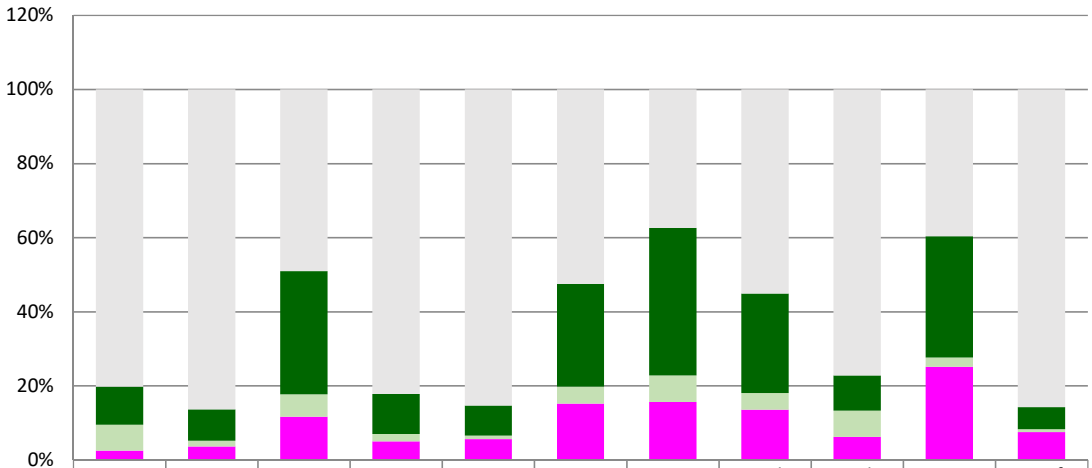
Figure 5: Overlap analysis of municipal NHS and TRCA TNHS at 1 sq. km resolution

Table 4: Overlap analysis by Watersheds and the TRCA region total (last row)

Watersheds	Overlap (ha) (x% of watershed)	TRCA Only (ha) (x% of watershed)	Municipal Only (ha) (x% of watershed)	None NHS (ha) (x% of watershed)	Row Total (ha) (x% of watershed)
Carruthers	1022	171	518	2101	3813
	26.8%	4.5%	13.6%	55.1%	100.0%
Don	3876	719	1791	29420	35806
	10.8%	2.0%	5.0%	82.2%	100.0%
Duffins	11410	2039	4485	10720	28654
	39.8%	7.1%	15.7%	37.4%	100.0%
Etobicoke	2181	1482	526	16976	21165
	10.3%	7.0%	2.5%	80.2%	100.0%
Frenchmans Bay	259	193	168	2094	2713
	9.5%	7.1%	6.2%	77.2%	100.0%
Highland	827	93	573	8665	10157
	8.1%	0.9%	5.6%	85.3%	100.0%
Humber	30285	5480	10628	44685	91078
	33.3%	6.0%	11.7%	49.1%	100.0%
Mimico	651	119	281	6657	7709
	8.4%	1.5%	3.6%	86.4%	100.0%
Petticoat	877	67	675	1064	2683
	32.7%	2.5%	25.2%	39.7%	100.0%
Rouge	9240	1509	5072	17468	33289
	27.8%	4.5%	15.2%	52.5%	100.0%
Waterfront	732	97	912	10456	12197
	6.0%	0.8%	7.5%	85.7%	100.0%
Grand Total:	**61359**	**11970**	**25629**	**150305**	**249263**
	24.6%	**4.8%**	**10.3%**	**60.3%**	**100.0%**

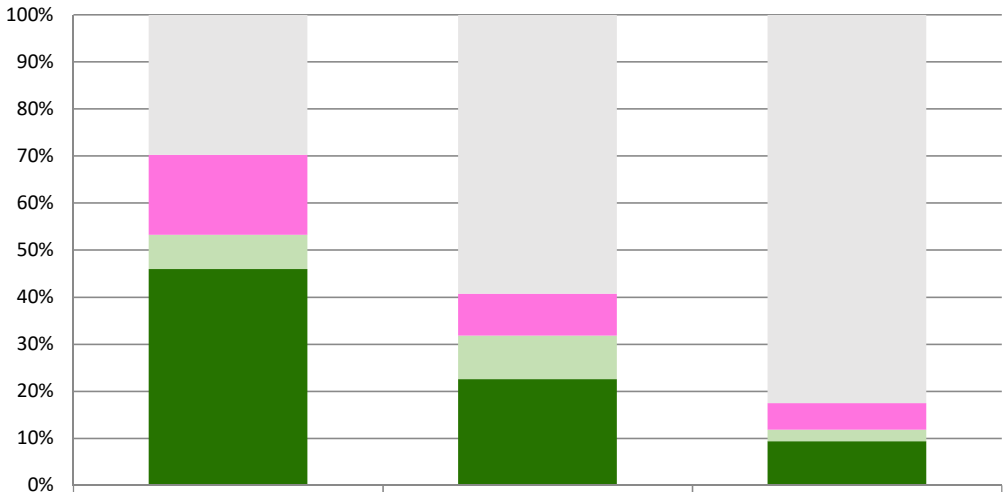
Table 5: Overlap analysis by broad land use and the TRCA region total (last row)

General Land Use	Overlap (ha) (x% of general land use)	TRCA Only (ha) (x% of general land use)	Municipal Only (ha) (x% of general land use)	None NHS (ha) (x% of general land use)	Row Total (ha) (x% of general land use)
Rural	44842	7080	16535	29067	97524
	46.0%	7.3%	17.0%	29.8%	100.0%
Urban	12569	3251	7588	110817	134225
	9.4%	2.4%	5.7%	82.6%	100.0%
Urbanizing	3950	1628	1554	10396	17528
	22.5%	9.3%	8.9%	59.3%	100.0%
Grand Total:	**61361**	**11959**	**25677**	**150280**	**249277**
	24.6%	**4.8%**	**10.3%**	**60.3%**	**100.0%**



	Etobicoke	Mimico	Humber	Don	Highland	Rouge	Duffins	Carruthers	Frenchmans Bay	Petticoat	Waterfront
No NHS	80%	86%	49%	82%	85%	52%	37%	55%	77%	40%	86%
Overlapping	10%	8%	33%	11%	8%	28%	40%	27%	10%	33%	6%
TRCA only	7%	2%	6%	2%	1%	5%	7%	4%	7%	2%	1%
Municipal only	2%	4%	12%	5%	6%	15%	16%	14%	6%	25%	7%

Figure 6: Percent of land covered by each Natural Heritage System (NHS) category - by watershed



	Rural	Urbanizing	Urban
No NHS	30%	59%	83%
Municipal only	17%	9%	6%
TRCA only	7%	9%	2%
Overlapping	46%	23%	9%

Figure 7. Percent of all land across TRCA's jurisdiction in each Natural Heritage System (NHS) category: no NHS, TRCA TNHS only, municipal NHS only, and overlap of TRCA TNHS and municipal NHS - by broad land use

2.4. Policy Analysis related to Municipal Natural Heritage Systems

The intent of Municipal NHS policy is to protect, restore, and enhance natural systems that provides wildlife habitat along with other ecosystem services in support of municipal community objectives. In addition to delineating NHS, it is imperative to have robust policies to ensure the identified habitats and the associated functions are protected and resilient in the face of urbanization. In addition to direct habitat loss there are various indirect impacts of urbanization such as barrier effects from roads, invasive species spread, recreation pressures, pollution, etc. While municipal NHS covers about one third of the TRCA's jurisdictional area, these direct and indirect impacts can undermine the NHS objectives if appropriate protection and enhancement policies are not in place. The size, shape and connectivity of the NHS as well as the human uses permitted in NHS and the policy exceptions all contribute to the size and quality of habitat within the NHS. Additional factors such as competition from invasive species and impacts associated with the changing climate represent further challenges to the effective protection of NHS.

This component of the study evaluated the NHS policies identified by local and regional municipal Official Plans (OPs) as they provide the primary mechanism for implementation of the NHS.

2.4.1. Data and Methods

A rapid assessment of the NHS policies including NHS related Schedules from OPs within TRCA's jurisdiction were systematically reviewed, summarized, and validated by TRCA staff. First, a survey was completed by contacts responsible for NHS policy at each municipality to ensure the most-up-to-date and accurate information was being used for the assessment. This was followed by compilation of all relevant information and a rapid review of the NHS policies in the OPs with input from TRCA planners. The findings were summarized based on the (i) Policy coverage, (ii) Protection status, and (iii) Opportunities for NHS expansion.

Policy coverage included examining which features identified within the PPS were included in OPs. Such features include: Significant Wetlands, Significant Woodlands, Significant valleylands, Significant wildlife habitat, ANSIs, Fish habitat, Habitat of endangered species and threatened species, Vulnerable surface and ground water features, sensitive surface water features, sensitive ground water features, Hazardous lands, flood hazards, erosion hazards. Additionally, natural heritage components of the Greenbelt Plan and the Oak Ridges Moraine Plan were also examined. These components include: sand barrens, savannahs and tallgrass prairies, and alvars, permanent and intermittent streams, lakes and their littoral zones, seepage areas and springs, and wetlands.

Protection status examined buffers, permitted uses, development / site alterations / exceptions. Lastly, opportunity for expansion evaluated to what extent deliberate habitat connections were included in OPs, whether there were expanded NHS (potential areas), restoration areas, land

acquisition areas identified or spoken to. Based on these criteria the NHS policies were ranked generally as Strong, Moderate, and Weak.

2.4.2. Results and Discussion

There was a 100% response rate to the first survey sent out requesting policy relating to NHS, with the majority of municipalities directing to official plans posted on municipal websites. A municipal staff member from each municipality participated in the survey about municipal NHS policy. Results showed that a large majority of municipalities within TRCA's jurisdiction have natural heritage protection measures beyond the level of protection required by the province. Most of the municipalities developed their NHS in consultation with TRCA. Also, the majority of the municipalities have included their NHS as designations as opposed to overlays, which provides stronger protection.

Box 7: Examples of forward thinking NHS policies

The City of Vaughan – requires "precise limits of mapped natural heritage features, and any additions to the mapped network, will be determined through appropriate study undertaken in consultation with the Toronto and Region Conservation Authority and the Province."

The Town of Ajax – speaks to the need for connectivity beyond municipal borders and throughout neighbouring watersheds and municipalities.

The City of Mississauga's "green system" - includes green infrastructure components beyond the NHS and speaks to the importance of managing the green system as an inter-related system.

Overall, most of the municipalities seem to have Moderate strength NHS policies. Many municipalities have a mix of Strong and Weak components within their policy. The major factors that were driving the respective rating was the inclusion (or lack) of buffers beyond minimum requirements surrounding the natural heritage features. Opportunity to expand and to restore natural heritage features was also a common factor driving the overall strength or weakness of the policies. Soma examples of forward thinking NS policies are provided in Box 7.

Municipal NHS policies in TRCA's jurisdiction address many of the recommended policies that were outlined as model policies in the TNHSS and there exist some common strong and weak traits among the policies (Table 6). Strengths identified include explicit system mapping, development exclusions in the NHS, and explicitly stated minimum buffers. Weaknesses include lack of mapped restoration opportunities or explicit plans to enhance/expand the system.

Table 6. Common strong and weak NHS policy traits in municipal Official Plans in TRCA's jurisdiction

Common strong traits	Common weak traits
• mapped NHS (as a designation) • policy protection beyond provincial requirements • defined minimum buffers • prohibition on development or site alteration in the NHS • considerations for adjacent lands	• permitted uses without direction on how impacts will be mitigated or offset • no defined policies for or mapped plans for restoration • little protection of locally significant natural features and areas • defaults to provincial policy in many rural areas resulting in gaps in protection for natural features not subject to the provincial policy

Aspects of the policies that are less strong and could allow for further degradation of wildlife habitat include permitted uses, development and site alteration within the system without directing that consideration for impacts be taken. Policy that clearly outlines the need for assessing impacts of activities can help ensure that cumulative impacts of these activities are not degrading the system.

Another area of policy improvement within the municipal policy identified is the lack of strong wording around buffers. Ontario's Natural Heritage Reference Manual outlines the following benefits of buffers: reduction of encroachment, reduction of light and noise, space for tree-fall, protection of root zones, enhancement of woodland interior, allowance for hunting habits of cats and dogs, locations for trails, attenuation of run-off. Setting a minimum buffer distance of 10 m, as several of the municipalities have, will ensure that this important system component is consistently in place. Nevertheless, there is an increasing recognition that this minimum buffer often does little to mitigate the impacts, thus increasing buffers beyond the minimum will ensure greater protection.

Some municipalities in the rural part of the jurisdiction had provincial natural heritage systems as the default NHS. The provincial natural systems included the Oak Ridges Moraine Conservation Plan, the Greenbelt Plan, and the Niagara Escarpment Plan. These policies provide strong support for NHS protection. However, given that these provincial NHS were developed at a much larger scale, it is important for municipalities to refine them with local context and detailed data on habitat and wildlife. In some areas this refinement has been completed, in others it is yet to be done given that there is less urgency because of limited development pressures and also because there is often lack of resources in smaller municipalities.

Key Recommendations 5:

- More fully incorporate and protect restoration and enhancement areas within municipal official plans.
- Strengthen effective provincial natural heritage policies, particularly for urban communities.
- Develop municipal polices and standards that require green infrastructure, including Low Impact Development, to be more fully integrated into new and redeveloped communities to help support wildlife habitat and wildlife populations.
- Undertake applied research to determine the optimal buffer sizes for different habitats and land use to protect ecosystem function.
- Develop guidance on the required size of buffers taking into consideration the needs of different habitat types and functions and the intensity of the surrounding land use.
- Develop guidance on the intended function of buffers and prohibited land uses and activities within the buffers that would interfere with those functions.
- Develop restoration policies and identify opportunities for restoration of lands adjacent to existing natural cover.
- Develop policies within the Class environmental assessment process under the Environmental Assessment Act for minimum restoration targets and mitigation requirements to compensate for wildlife habitat impacts due to public infrastructure linear alignments, including habitat connectivity.
- Promote a coordinated approach to policy implementation where all levels of government, including conservation authorities, can advance their shared natural heritage objectives more efficiently and effectively.
- Ensure effective implementation of natural heritage policies to help ensure wildlife habitat and wildlife populations are protected and natural heritage objectives are met.

3. WILDLIFE POPULATIONS ASSESSMENT

3.1. Introduction

This component of the study focuses on assessing the status of the wildlife portion of the Degradation of Fish and Wildlife Populations BUI to determine if its beneficial use has been restored. The fish population portion of this BUI will not be addressed within this document but its progress can be found in the most recent progress report: Within Reach: 2015 Toronto and Region Remedial Action Plan Progress Report (Kidd 2016). The objectives of this technical document are

i. To set targets for wildlife populations since no targets were set in the Clean Waters, Clear Choices document (Metro Toronto and Region 1994) or thereafter; and
ii. To assess wildlife populations within the Toronto Region AOC to determine if targets have been met.

3.2. Data and Methods

3.2.1. Target Selection

A literature and internet search was conducted to determine if guidance has been provided previously towards setting targets for this BUI. Several documents were reviewed including guidance documents from the International Joint Commission (IJC), Environment Canada and Bird Studies Canada (BSC) along with targets set by other RAP teams for other AOC's. Guidance has been provided in IJC (1991) and suggests the following delisting guideline for this BUI: "When environmental conditions support healthy, self-sustaining communities of desired fish and wildlife at predetermined levels of abundance that would be expected from the amount and quality of suitable physical, chemical and biological habitat present. An effort must be made to ensure that fish and wildlife objectives for Areas of Concern are consistent with Great Lakes ecosystem objectives and Great Lakes Fishery Commission fish community goals. Further, in the absence of community structure data, this use will be considered restored when fish and wildlife bioassays confirm no significant toxicity from water column or sediment contaminants." – IJC (1991)

Bird Studies Canada has provided recommendations for monitoring techniques that could be used to evaluate this BUI and has provided guidance on parameters that could be used to assess BUI status (Wheeler and Archer 2008). The Marsh Monitoring Program (MMP) is a bi-national program monitoring marsh bird and amphibian populations in marshes throughout the Great Lakes basin. It is primarily volunteer-based; however, the TRCA has adopted the MMP methodology for its Terrestrial Long-term Monitoring Program (LTMP) and shares the data collected with the MMP through a project partnership. Data from the MMP have been used since 1995 to inform AOC wildlife recovery by comparing to reference condition marshes (Wheeler and Archer 2008). Marsh bird and amphibian indices of biotic integrity (IBI's) have been developed using MMP data and can be used to compare to reference conditions (Crewe and Timmermans 2005, Wheeler and Archer 2008).

A Four Agency Framework (US EPA, Environment Canada, the Michigan Department of Environmental Quality and the Ontario Ministry of the Environment) was developed for AOC's shared by Ontario and Michigan and has provided recommendations for developing delisting criteria and these include the following (IJC 2013):

All delisting criteria must be:

i. Measurable (quantitative endpoint that determines when a beneficial use is no longer impaired);
ii. Achievable (reflective of local conditions and respects existing regulations and guidelines);
iii. Be consistent with the applicable federal and state/provincial regulations, objectives, guidelines, standards and policies, when available, and the principles and objectives embodied in Annex 2 and supporting parts of the Great Lakes Water Quality Agreement (GLWQA);
iv. Amenable to actions that will remedy original or on-going cause of impairments.

Several other AOC`s have created delisting criteria/targets for BUI 3 and a summary is provided in Table 7. One of the consistent themes throughout this review is the comparison of AOC wildlife communities to those of reference sites. Based on the recommendation for delisting by the IJC, communities should be self-sustaining and contain populations similar to those "that would be expected from the amount and quality of suitable physical, chemical and biological habitat present". This suggests that comparisons of AOC communities should not be made to reference sites defined as those that are completely unimpacted but those outside the AOC with similar physical, chemical and biological habitat present. Based on this review, targets for the Degradation Wildlife Populations BUI for the Toronto Region AOC were developed and are presented in Table 8.

Table 7: Summary of delisting criteria/targets for the Degradation of Fish and Wildlife Populations BUI (wildlife portion) developed by other RAP teams for other AOC's

AOC	Delisting criteria/target
Detroit River (Detroit River AOC 2009)	- Healthy fish and wildlife populations are determined by resource management agencies to exist within the AOC - Loss of Fish and Wildlife Habitat BUI is delisted - Degradation of Benthos BUI is delisted
Thunder Bay (InfoSuperior 2016)	Monitoring data shows that the wildlife community (at a population level) does not differ significantly from the abundance that would be expected from the amount and quality of physical, chemical and biological habitat typical of the AOC. OR That the wildlife community (at a population level) does not differ significantly from suitable Lake Superior reference sites.
Bay of Quinte (Bay of Quinte 2016)	Each BUI has specific criteria that must be met before its status can be changed to unimpaired: **WP-1 (wildlife priority 1: amphibian community report):** The amphibian community IBI at representative Bay of Quinte coastal wetlands shall not be more than two standard deviations below the 2006-2010 representative site mean that has been corrected for varying conditions in Lake Ontario outside of the AOC from 2006-2010. **WP-2 (breeding birds report):** The breeding bird community IBI at representative Bay of Quinte coastal wetlands shall not be more than two standard deviations below the 2006-2010 representative site mean that has been corrected for varying conditions in Lake Ontario outside of the AOC from 2006-2010. **WP-3 (osprey report):** Presence of nesting osprey including the successful fledging of chicks on, or near, the Bay of Quinte shoreline each year.
Lower Green Bay and Fox River (Wisconsin DNR 2009)	- Furbearers recover to point that otters and mink are present, and abundant muskrat populations are present when emergent marshes present. - A total of 15 nesting pairs of marsh-nesting birds per acre should be present in suitable habitat including a diverse assemblage of rails, grebe, herons, wrens and blackbirds. - Resident nesting waterfowl production totals at least 1 young produced per acre of brood water (MALL, BWTE, WODU, CAGO). - Nesting populations of a diverse array of waterbirds are consistently present when suitable habitat is available (including GREG, GBHE, BCNH, DCCO, COTE,FOTE, HERG, RBGU). - Wildlife community structures within the AOC are statistically similar to populations in unimpacted reference sites of highly productive, warm water freshwater estuaries of the Great Lakes.
Hamilton Harbour (HH RAP 2012)	**Colonial waterbirds:** should have a self-sustaining mixed community (specific targets for number of pairs are provided for RBGU, HERG, DCCO, COTE, CATE, BCNH). **Other wildlife including waterfowl:** No target set for other species of birds or animals, but target for habitat has been suggested which will enhance wildlife population generally.
Ohio AOC's (Ohio EPA 2016)	This beneficial use will be considered restored when the following conditions are met: ODNR's annual Wildlife Population Status Reports or another similar study show a steady or improving healthy, reproducing population of either terrestrial or avian resident species, or other AOC appropriate sentinel species, for at least 3 of the last 5 years (BAEA, OSPR, SACR, GBHE, river otter). Healthy wildlife populations depend on good habitat, so restoration of the Loss of Fish and Wildlife Habitat (BUI 14) is vital for the restoration of wildlife populations. In order to reach the restoration target for wildlife populations, habitat maintenance and improvement need to be emphasized. On private lands, efforts are geared toward incentive programs to improve habitat, especially for agricultural and woodland landowners.

Table 8: Targets for the Degradation of Wildlife Populations BUI for the Toronto Region AOC

Species/taxa	Specific question for assessment	Target
Wetland birds	1. Are the MMP marsh bird IBI values for routes in the Toronto Region AOC within (or above) two standard deviations of the MMP marsh bird IBI values at suitable reference sites outside the AOC between 2011 and 2016? (separate urban and rural assessments)	Within two standard deviations (from 2011-2016)
Wetland frogs	2. Are the MMP amphibian IBI values for routes in the Toronto Region AOC within (or above) two standard deviations of the MMP amphibian IBI values at suitable reference sites outside the AOC between 2011 and 2016? (separate urban and rural assessments)	Within two standard deviations (from 2011-2016)
Forest birds	3. Are forest-dependent bird species richness, forest-dependent bird abundance and the number of L1-L3 bird species measured in forests within the Toronto Region AOC within (or above) two standard deviations of these same parameters measured in forests at suitable reference sites outside the AOC between 2010 and 2017? (separate urban and rural assessments)	Within two standard deviations (from 2010-2017)
Meadow birds	4. Are meadow-dependent bird species richness, meadow-dependent bird abundance and the number of L1-L3 bird species measured in meadows within the Toronto Region AOC within (or above) two standard deviations of these same parameters measured in meadows at suitable reference sites outside the AOC between 2008 and 2017? (separate urban and rural assessments)	Within two standard deviations (from 2008-2017)

3.2.2. Assessment of Wildlife Population Targets

To determine if these targets have been met, assessments were structured to answer the questions in Table 8. This was completed using the TRCA Terrestrial Long-term Monitoring Program (LTMP) data, which is a large-scale monitoring program collecting data on both flora and fauna across the range of habitat types and land uses in the TRCA's jurisdiction (Figure 8). This program has been operating annually since 2008 and uses standardized scientific data collection protocols allowing for valid comparisons among sites and over time.

Wetland bird and frog surveys use Marsh Monitoring Program (MMP) protocols and forest and meadow bird surveys use Ontario Forest Bird Monitoring Program (FBMP) protocols. Both MMP and FBMP protocols use a standardized point count radius and time limit and have multiple visits per season. For detailed summaries of bird and frog monitoring protocols please see TRCA (2016a-d). Data were examined to ensure all visits were completed in each year and those with incomplete surveys were removed from the analysis.

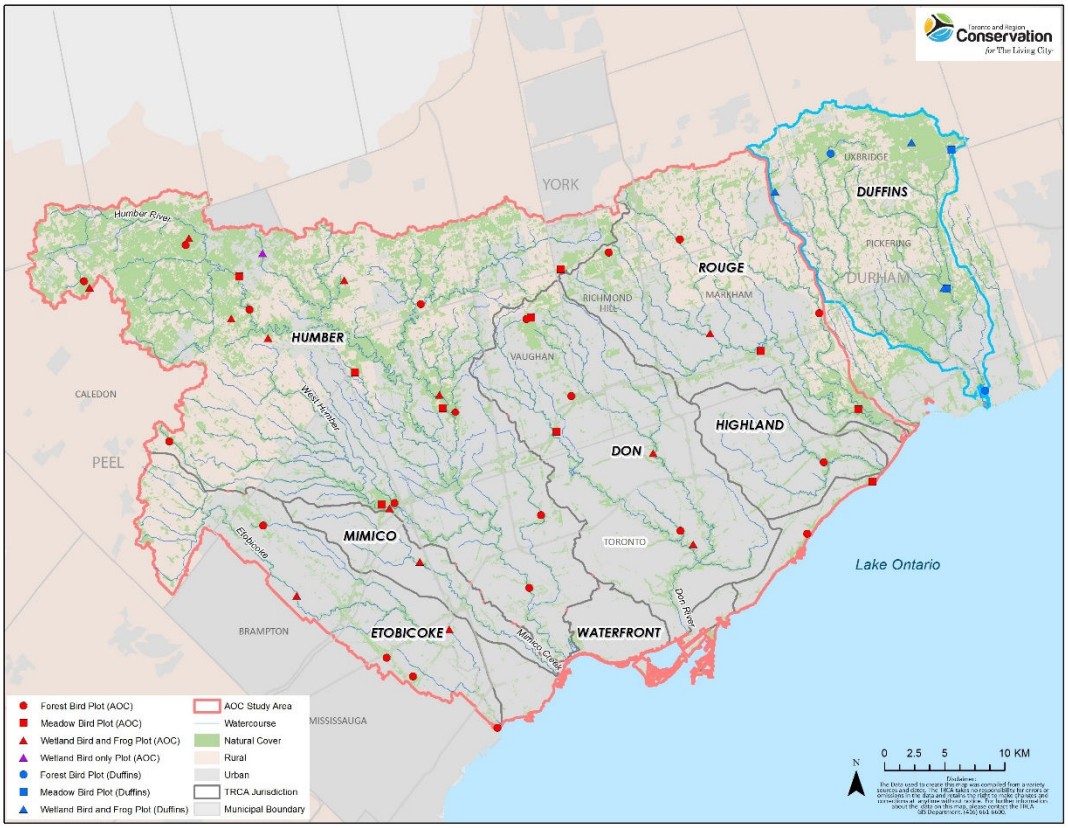


Figure 8: TRCA Terrestrial Long Term Monitoring Program Plot Locations

Several parameters were selected to be compared with reference sites (Table 9). Crewe and Timmermans (2005) developed a marsh bird and amphibian IBI to assess wetland health using data collected through the MMP. This IBI provides a single value (0-100) for each site that represents a combination of several taxa-specific parameters that are sensitive to disturbance in the landscape. Wetlands with a higher IBI score are considered to be in better biological condition than those with a lower IBI score. This IBI was developed using data from across the Great Lakes and is approved for use throughout Lake Ontario.

The L-rank system is a species scoring and ranking system (similar to an IBI) developed at TRCA to provide guidance for natural heritage protection and management within the jurisdiction. The L-rank system uses simple ranks to convey individual species' ecological needs and sensitivities rather than just "rarity" in order to portray such complexities on a simple ordinal scale (TRCA 2010). Fauna L-ranks are based on scores for six criteria including local occurrence, population trends, habitat dependence, area sensitivity, mobility restriction and sensitivity to development. For example, species ranked L1 would have: a limited local occurrence, declining population trends, habitat specialist and area sensitive requirements, restricted mobility and a sensitivity to development. Species ranked L5 would have: a widespread local occurrence, increasing population trends, habitat generalist and non-area sensitive requirements, no mobility restrictions and a tolerance to development. These are extreme examples and species can be ranked L1 through toL5 based on the scores associated with this combination of ecological needs and population status assessments.

Table 9: Parameters selected to be compared between AOC sites and reference sites.

Parameter	Description
Marsh bird IBI	Calculates an IBI score per wetland ranging from 0 (poor quality) to 100 (high quality) using the following avian metrics from Crewe and Timmermans (2005) - Water forager abundance - Water forager richness - Area-sensitive marsh-nesting obligate richness - Area-sensitive marsh-nesting obligate abundance - Indicator species abundance
Amphibian IBI	Calculates an IBI score per wetland ranging from 0 (poor quality) to 100 (high quality) using the following amphibian metrics from Crewe and Timmermans (2005) - Total richness - Woodland species richness - Woodland species occupancy
# L1-L3 species	The number of bird species with L-ranks of L1, L2 or L3. Species ranked L1-L3 are considered species of concern within the jurisdiction due to their apparent intolerance to urbanization.
Forest-dependent bird species richness	The number of bird species (species richness) dependent on forest habitats for nesting. This includes both forest edge and interior species nesting at various heights (low, mid, and upper).
Forest-dependent bird abundance	The number of individual birds (abundance) dependent on forest habitats for nesting. This includes both forest edge and interior species nesting at various heights (low, mid, and upper).
Meadow-dependent bird species richness	The number of bird species dependent on meadow habitats for nesting. This includes species nesting at various heights within meadows (low, mid, and upper).
Meadow-dependent bird abundance	The number of individual birds (abundance) dependent on meadow habitats for nesting. This includes species nesting at various heights within meadows (low, mid, and upper).

Reference sites were selected from the Duffins Creek watershed because it was not included within the boundary of the Toronto Region AOC. Sites within the urban land use zone of the AOC were compared to sites within the urban land use zone of Duffins Creek. Similarly, sites within the rural land use zone of the AOC were compared to sites within the rural land use zone of Duffins Creek. Recall, that these sites within the urban/rural zone of Duffins Creek are not true reference sites (e.g. sites that represent communities that would be present in the absence of any form of anthropogenic disturbance) but were chosen based on the recommendation for delisting in IJC (1991) ". . . at predetermined levels of abundance that would be expected from the amount and quality of suitable physical, chemical and biological habitat present". The

number of reference sites available for comparison in Duffins Creek and the years they were surveyed varied among wetland, forest and meadow LTMP plots (Table 10). There was variation in the range of years surveyed so comparisons between reference sites and AOC sites may use different year ranges based on habitat type (e.g. wetland, forest, meadow).

Table 10: Duffins Creek reference site names by plot type, land use zone and year range used for analysis.

LTMP plot type	Land use zone	Duffins Creek "reference" sites (name, plot ID, year range used for analysis)
Wetland birds and frogs	Rural	Greenwood (WBF-14, 2011-2016) Albright (WBF-17, 2011-2016)
	Urban	Stouffville (WBF-24, 2011-2016)
Forest birds	Rural	Goodwood (FB-20, 2010-2017) Glen Major (FB-21, 2010-2017)
	Urban	Duffins Marsh Woodland (FB-22, 2010-2017)
Meadow birds	Rural	Greenwood (MB-13, 2008-2017) Glen Major (MB-14, 2008-2017)
	Urban	N/A

Patch size and Ecological Land Classification (ELC) community types at LTMP plots were compared between reference sites and five randomly selected rural and urban AOC sites to ensure there were no differences in habitat which may contribute to differences in bird or frog communities. Patch size was determined in ArcGIS (ESRI Inc. 2015) and patch boundaries were defined by any break in the primary habitat type (wetland, forest, meadow) by roads, railway tracks and rivers. Community types within the point count area were visually examined in ArcGIS and the primary habitat type in forests and meadows was determined along with % open water and % habitat cover (ELC community type) for wetlands.

Targets were assessed for AOC sites by determining if their average value was within (or above) two standard deviations of the Duffins Creek sites. Two standard deviations were chosen for several reasons. First, marsh bird and amphibian IBI's have previously been assessed in the Bay of Quinte AOC by setting a target of within two standard deviations of the Lake Ontario average (Bay of Quinte 2016). The Duffins watershed was selected for comparison for this assessment because it fell within TRCA's jurisdiction but was outside the AOC boundary. Credit Valley Conservation (2010) also used standard deviation to determine if monitoring data represent natural variability in a stable system (within one standard deviation) or represent changes in a parameter outside the range of normal variability expected in stable communities (two standard deviations). Credit Valley Conservation (2010) based their assessment on the literature on Statistical Process Control and Maurer et al. (1999) where upper and lower thresholds of a data series are set using standard deviation to objectively distinguish "out-of-control" conditions.

After targets were assessed, differences between sites in the urban and rural land use zones were examined for bird and frog communities using data from within the AOC only. An average value from the year range available was calculated per site and this was used to determine differences between the urban and rural land use zones. Standard t-tests were used if data were not in extreme violation of normality assumptions while Wilcoxon tests were used if data could not be successfully transformed or greatly violated normality assumptions. Results presented within the text are averages unless otherwise indicated.

3.3. Results

Patch size was similar between Duffins reference sites and AOC sites in the urban and rural land use zones for meadows and wetlands. Forest patch size was similar between Duffins sites and AOC sites for the urban land use zone but forest patch size was significantly larger in the rural land use zone at Duffins sites (724 ha) compared to AOC sites (121 ha). East Duffins Headwaters (Glen Major; 1125 ha) within the Duffins Creek watershed was removed from the analysis to attempt to lessen these differences but significant differences remained (Duffins: 324 ha, AOC: 121 ha). These results include comparisons of forest bird communities in the rural zone with East Duffins Headwaters removed. Habitat ELC communities in wetlands, forests and meadows did not show any extreme differences in primary ELC community type between reference sites and AOC sites.

Table 11 shows that all marsh bird and amphibian IBI's for the AOC were within two standard deviations of the IBI values calculated from sites in the Duffins Creek watershed (2011-2016). Marsh bird IBI values were similar between the rural (7.14) and urban (7.51) land use zones within the AOC (t_{12}=0.093, p=0.927). Amphibian IBI values were significantly higher at rural sites (81) compared to urban sites (27) within the AOC (t_{12}=4.82, p<0.001).

Table 12 shows that almost all forest bird parameters for AOC sites were within two standard deviations of values calculated from sites in the Duffins Creek watershed (2010-2017). The number of L1-L3 ranked species at sites in the AOC was outside of (and below) two standard deviations determined from sites in the Duffins watershed. All forest bird parameters were significantly higher at rural sites compared to urban sites within the AOC (all p<0.01).

Table 13 indicates that all meadow bird parameters in the rural land use zone of the AOC were within two standard deviations of values calculated from sites in the Duffins Creek watershed (2008-2017). It is unknown if meadow bird parameters for the urban land use zone portion of the AOC met targets because there were no meadow bird LTMP sites in the Duffins watershed. All meadow bird parameters were similar between the rural and urban land use zones within the AOC (all p>0.598).

Table 11: Wetland bird and frog IBI comparisons between AOC sites and reference sites in the Duffins watershed between urban and rural land use zones between 2011 and 2016 (blue = average Duffins ± two standard deviations; red = average AOC; ✓ = meets target; ✗ = does not meet target; ? = insufficient data to assess if target has been met)

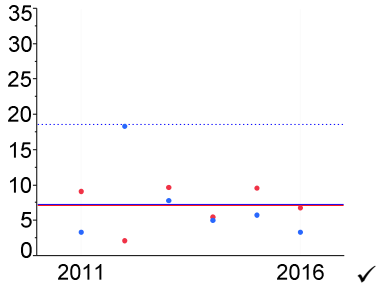
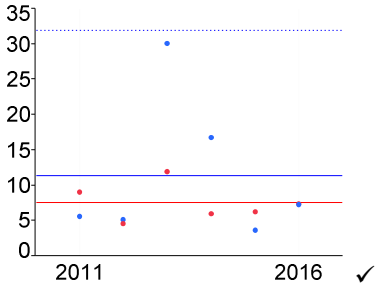
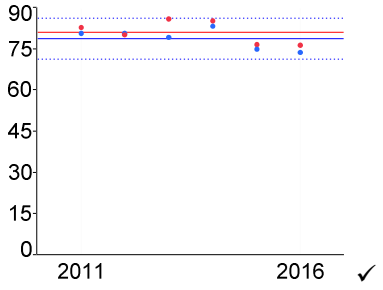
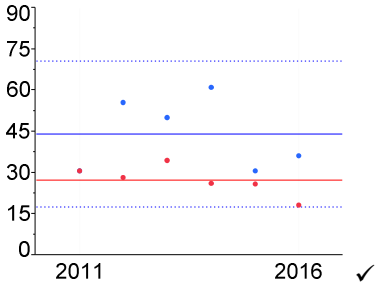
Habitat/ taxa	Parameter	Rural	Urban
Wetland birds	Marsh bird IBI		
Wetland frogs	Amphibian IBI		

Table 12: Forest bird comparisons between AOC sites and reference sites in the Duffins watershed in the urban and rural land use zones between 2010 and 2017 (blue = average Duffins ± two standard deviations; red = average AOC; ✓ = meets target; × = does not meet target; ? = insufficient data to assess if target has been met)

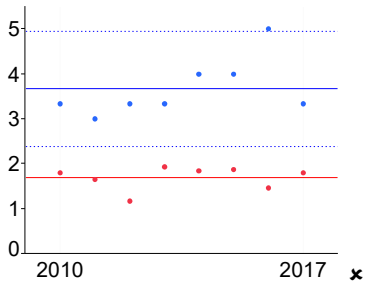
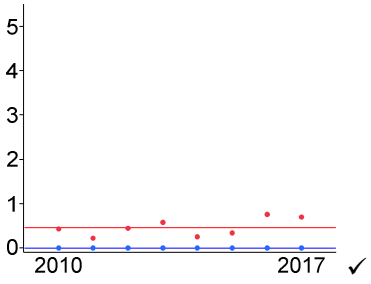
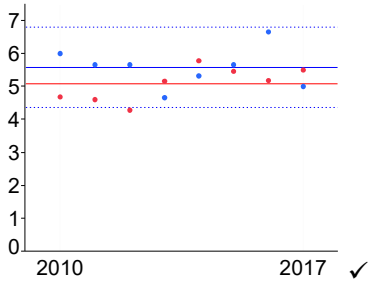
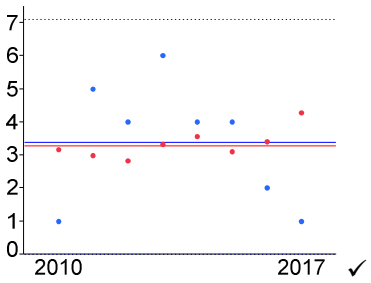
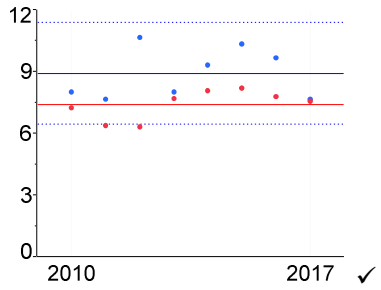
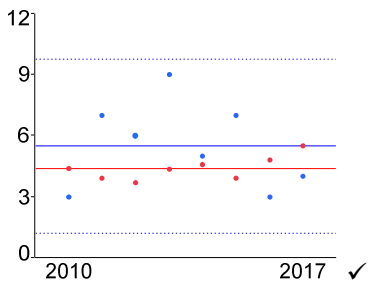
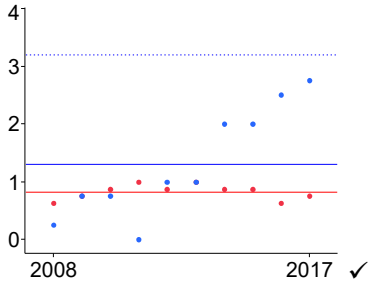
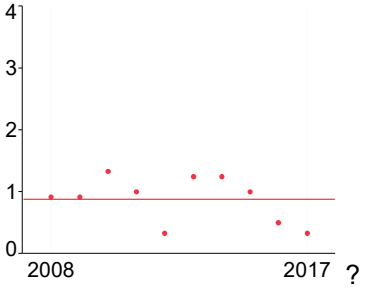
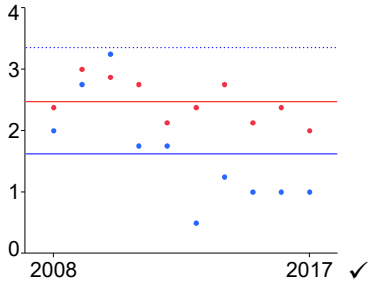
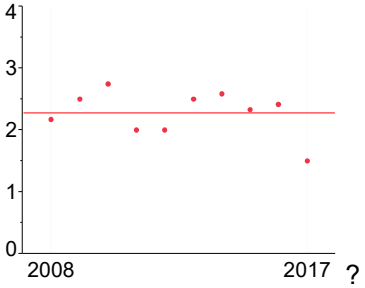
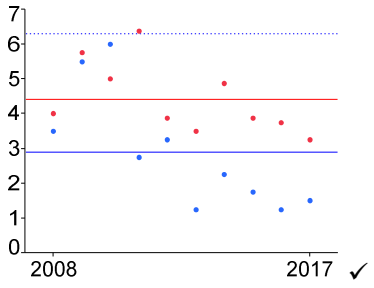
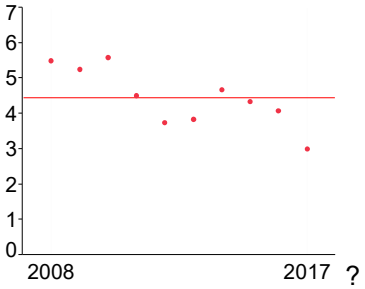
Habitat/ taxa	Parameter	Rural	Urban
Forest birds	# L1-L3 species		
	Forest-dependent bird species richness		
	Forest-dependent bird abundance		

Table 13: Meadow bird comparisons between AOC sites and reference sites in the Duffins watershed in the urban and rural land use zones between 2008 and 2017 (blue = average Duffins ± two standard deviations; red = average AOC; ✓ = meets target; × = does not meet target; ? = insufficient data to assess if target has been met)

Habitat/ taxa	Parameter	Rural	Urban
Meadow birds	# L1-L3 species	 ✓	 ?
	Meadow-dependent bird species richness	 ✓	 ?
	Meadow-dependent bird abundance	 ✓	 ?

3.4. Discussion

Targets were set and assessed for the wildlife portion of the Degradation of Fish and Wildlife Populations BUI for the Toronto Region AOC. Targets have been met for delisting this BUI. Meeting these targets suggests that bird and frog populations within the Toronto Region AOC are within the normal range of variability expected from bird and frog populations within a reference watershed, the Duffins Creek.

Average marsh bird IBI values within the AOC were within two standard deviations of the Duffins marsh bird IBI value in both the urban and rural land use zones. The marsh bird IBI values reported here (rural=7, urban=10) compare well to those found in marshes across the Great Lakes basin (8.7, range 0-62, n=452 routes). Even though marsh bird IBI values compare well to marshes throughout the Great Lakes region and outside the AOC, marshes throughout the Great Lakes basin are subject to numerous stressors similar to the Toronto Region AOC such as infilling, point-source and non-point source pollution, water level regulation and invasive species all of which have direct and indirect impacts on wetland bird communities (Lougheed et al. 2001).

Similar to marsh birds, amphibian IBI values for the AOC were within two standard deviations of the Duffins amphibian IBI value in both the urban and rural land use zones. The amphibian IBI values reported here (rural=81, urban=27, average of both land use zones=54) are similar to the average amphibian IBI value found in marshes across the Great Lakes basin (52, range 0-100, n=517 routes). Even though AOC amphibian IBI values were within target and within the range of marshes throughout the GLs, significantly lower amphibian IBI values were found in marshes in the urban land use zone compared to the rural land use zone. Frogs have previously shown a strong negative relationship with increased urbanization (Knutson et al. 1999). Urban areas are generally less favourable environments for frogs because of the increased density of roads, lack of important adjacent habitat, mortality caused by vehicular traffic and anthropogenic noise (Knutson et al. 1999, Lengagne 2008, Bouchard et al. 2009).

All forest bird parameters in the AOC were within two standard deviations of those in the Duffins Creek watershed except for the number of L1-L3 species in the rural zone. This difference between Duffins and the AOC in the rural zone could be due to differences in patch size. Larger patches generally contain more species based on the species-area relationship originally proposed by Arrhenius (1921). Even though the majority of targets were met in both the urban and rural land use zones, forest bird communities in the urban land use zone had significantly fewer L1-L3 species, fewer forest-dependent bird species and fewer forest-dependent individuals. Urbanization can impact forest bird communities in many ways including a direct loss of habitat and fragmentation, altered predator communities and urban noise (Reijnen et al. 1995, Haskell et al. 2001).

All meadow bird parameters in the rural land use zone of the AOC were within two standard deviations of those in the Duffins Creek watershed. It remains unknown if meadow bird communities in the urban zone have met targets because there were no meadow bird plots in

the urban land use zone of Duffins. Meadow bird communities within the jurisdiction appear to be dynamic in nature with several increases and decreases identified in the number of L1-L3 species, richness and abundance. These changes could be due to meadows changing either naturally or through restoration plantings to later successional community types (e.g. sparse-shrub habitats) which support a different avian community.

3.5. Conclusion

Based on the findings of this component of the report, targets have been met for delisting the wildlife portion of the Degradation of Fish and Wildlife Populations BUI. It is important to remember that while targets have been met for the wildlife portion of this BUI, targets were set based on guidance from the IJC along with those set and used by other AOC's. Based on this guidance, wildlife populations within AOC's are not expected to be restored to pre-settlement conditions but to conditions that reflect the amount and quality of suitable habitat present in the region.

Wildlife populations within the AOC was compared to wildlife populations outside the defined AOC, the Duffins Creek watershed. Although the Duffins Creek watershed is affected by several impacts similar to the AOC such as urbanization in the lower reaches, it is generally regarded to be in better condition than other watersheds in the jurisdiction (e.g. higher forest cover, better water quality). The AOC area also contains several watersheds, or portions of watersheds, that are considered to be in good condition such as the Upper Humber River watershed and the Rouge River watershed.

Almost all comparisons between the AOC and Duffins found lower values for the AOC than Duffins but the fact that almost all of the average AOC values were within two standard deviations of Duffins could be due to the influence of data from these higher quality areas within the AOC. This suggests that while the AOC as a whole has been assessed to have met targets, there are still numerous threats to wildlife as planners and ecologists attempt to meet the need for human settlement and the conservation of wildlife populations and habitat. The storylines highlighted in Chapter 4 will help to highlight some of the current threats to wildlife populations and measures for mitigation.

Key Recommendations 6:

- Monitor populations more closely using existing and new Long Term Monitoring Plots and other data to improve understanding of urbanization impacts on species, especially for meadow species and species that are more sensitive (higher L ranks).
- Monitor populations more closely using existing and new Long Term Monitoring Plots and other data to understand the urban – rural differences in population structure and change.
- Develop short and long term monitoring programs to address targeted research questions to understand impacts and improvements in wildlife populations in relation to the positive and negative changes in habitat and urban matrix.

4. WILDLIFE HABITAT AND POPULATION IN TORONTO AND REGION

4.1. Synthesis

Overall, the natural cover change analysis showed that there is generally little change in the quantity and quality of habitat in the Toronto and region between 2002 and 2013. Nevertheless, there are variations in terms of where the net gains and losses of habitat were occurring. Most gains, both in quantity and quality, were in the rural parts of the jurisdiction, especially in areas protected by the Oak Ridges Moraine Conservation Plan, the Greenbelt Plan, and the Niagara Escarpment Plan and / or where the urbanization pressure is not as severe. Most of the quantity and quality losses were concentrated in the middle reaches of the watersheds that are urbanizing at a rapid rate. Not surprisingly, this affirms that urbanization results in conversion of natural cover into various land uses resulting in habitat loss and / or reduction in quality thereby affecting habitat functions for wildlife. An example of such change is highlighted in Box 8. This emphasizes the need for stronger habitat protection policies and other required mechanisms in the areas that are expected to see future urban expansion.

Since the release of the TNHSS (2007), the vast majority of municipalities within TRCA's jurisdiction have mapped their NHS and created policy to protect it from pressures of urbanization, though the strength of the policies varies. Much of the target TNHS recommended in the TRCA TNHSS has been included in the municipal NHS mapping and/or policies. Additional lands are also protected, particularly provincially defined NHS in the rural areas and the non-traditional areas in urban and urbanizing areas such as active recreation parks and golf courses. Inclusion of these non-traditional NHS areas raises important questions in terms of successful implementation of NHS to achieve habitat and wildlife objectives. As much as it is

Box 8: Habitat loss and degradation continues to affect wildlife population in urbanizing areas

Terrestrial LTMP data have found a disappearance of forest-dependent birds from a forest tract near the intersection of Highways 401 and 403. At some point between 2013 and 2015, approximately 20% of the forest was cleared to add an access ramp between the highways. Bird surveys in this forest consistently recorded forest-dependent species between 2008 and 2014; however, between 2015 and 2017 no forest-dependent species were detected. In addition to habitat loss, indirect impacts such as noise could have affected the ability of these species to communicate effectively and prevented them from establishing territories in this woodlot. In birds, acoustic communication has many functions including territory defence, mate selection and pair bond maintenance (Wiley 1994, Swaddle and Page 2007). While it is not always feasible to eliminate impacts such as noise, it is possible to mitigate some of the effects using structural or operational techniques such as sound barriers and planning the timing of noise to avoid peak breeding season (Blickley and Patricelli 2010). This example highlights the continued vulnerability of wildlife habitat and populations to direct and indirect effects of urbanization, unless there are will and means to mitigate such negative impacts.

good news that these areas add to the overall NHS area, in their current form most of these may have little overall contribution to habitat function. However, if designed appropriately with living green infrastructure, these areas may provide opportunity for habitat enhancement. Cautious implementation of these NHS areas will be required to ensure that NHS objectives are met. In addition, the municipal NHS omitted some parts of the TRCA TNHS as well. Most of the excluded areas seem to constitute potential natural cover that TRCA targeted for restoration and enhancement, more so in rural areas. These areas often have less or no policy protection status such as in most of the ill-defined headwater areas in the north and are more likely to experience land use conversion due to the increasing urbanization pressure in the future.

A rapid comparison of the natural cover change map and the NHS overlay map – in a standardized format of 1 km grids (Figure 8) – highlights three major points in terms of current and future habitat and conservation through implementation of NHS in the TRCA's jurisdiction including the AOC. First, habitat gains between 2002-2013 seem to generally coincide with the same areas where municipal NHS had included additional areas (e.g. ORM, Greenbelt NHS, Rouge Park) reflecting the important contribution municipal and provincial commitments make in achieving NHS goals and objectives. Second, habitat loss between 2002-2013 seem to generally coincide with the same areas where there has municipal NHS had more omission of TRCA TNHS (e.g. middle reaches of Humber and Rouge) indicating that such areas deemed important for the regional system are vulnerable to habitat loss without the protection of municipal policies. Third, some areas outside of municipal NHS that have seen habitat gains in the past (e.g. whitebelt areas in northern Etobicoke, Rouge, Duffins) may be at risk from future development because there are no mechanisms for protection against land use conversion, especially if the habitat is meadow. This highlights a gap in habitat protection policies and may result in future losses.

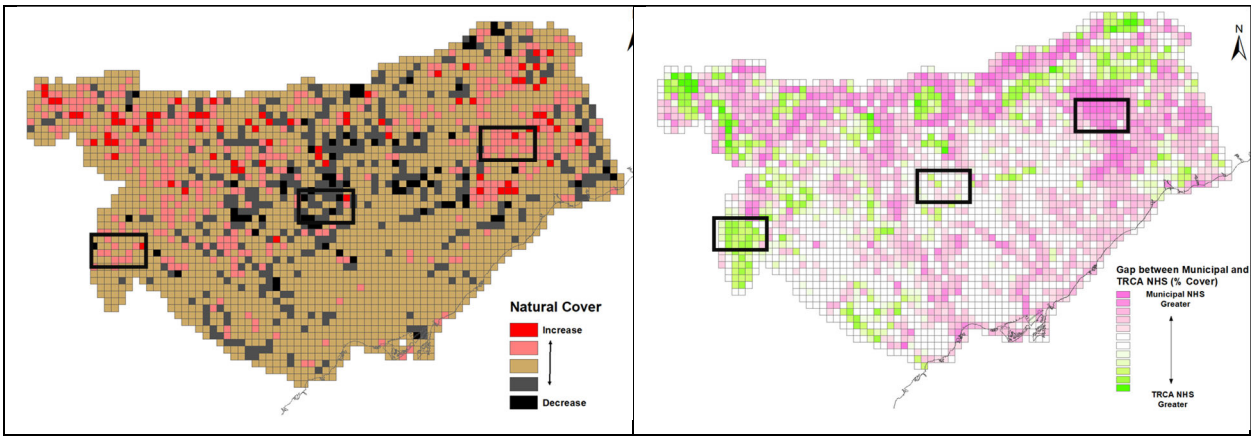


Figure 9: One square kilometer grid showing (a) change in the percent of natural cover per grid from 2002-2013 across TRCA's jurisdiction, (b) Overlap analysis of municipal NHS and TRCA TNHS

This study also highlighted that in addition to the protection of habitat quantity and quality, the quality of the surrounding landscape is also important. There was a general increase in good quality habitat patches, especially in the rural parts of the jurisdiction and in and around conservation areas attributed mostly to the improved size and shape of the habitats. There was however, a slight decrease in excellent patches and increase in poor quality habitat though the actual patch size and shape did not change significantly. Some of this is attributed to the increased urban matrix effect. It is important to manage the quality of the surrounding landscape in order to maintain habitat quality and habitat for wildlife species. The example provided in Box 9 illustrates this point by demonstrating that maintaining a relatively stable habitat patch and a stable urban matrix allows for the wildlife habitat function to persist. This highlights the need to prevent further deterioration of the urban matrix to maintain habitat quality and function.

Box 9: Maintain it and they will stay: Importance of stable habitat and surrounding urban matrix for wildlife

Stable habitat quality, both in terms of patch composition and surrounding matrix, is important for wildlife populations to be stable. The 15 sites inventoried between 2001-2008 and 2009-2017 (at least 10 years apart) indicates that there was little to no change in habitat or urban matrix. Same sites also showed stable bird and frog communities based on the number of species by L rank. This highlights that maintaining relatively stable habitat and surrounding urban matrix does help maintain associated wildlife that are adapted to the given conditions.

L-rank	Interpretation	Number of species	
		Time period 1	Time period 2
L1	Most sensitive, urban intolerant	1	1
L2		16	17
L3		43	42
L4		46	41
L5	Least sensitive, urban tolerant	33	28
L+	Non-native	5	5

In terms of wildlife populations, the assessment conducted in this study showed that marsh birds, forest birds and amphibians are meeting targets as defined in this report. However, the long term monitoring plot data indicated that some of the species that are more sensitive to urbanization such as those that rely on larger and/or well-connected habitat patches continue to be impacted. This is especially true within the urban and urbanizing areas. Box 10 provides an example that illustrates this further. Combined with the findings from the habitat assessment, this highlights the disproportionate amount of habitat loss and degradation in urban/urbanizing areas, which is concerning for the future of wildlife habitat function and populations. Actions should be targeted in urban and urbanizing areas focussed on increasing habitat quantity and maintaining habitat quality such as size, shape, connectivity, and other urban matrix influences.

Box 10: Devil lies in the details: Sensitive wildlife populations & urbanization

Urbanization continues to have impact on habitat and wildlife due to its various direct and indirect effects. Terrestrial LTMP data have detected potential extirpation of ovenbirds from a forest partially converted to a residential development between 2010 and 2012. The development removed natural cover including meadow/successional and a portion of forest that connected two larger forests. At this site ovenbird abundance decreased from a few individuals in 2008-2011 to no ovenbirds in 2016-2017. In comparison, the other large forest tracts that were left intact, ovenbird abundance stayed consistent between 2008 and 2017. This illustrates that the large tracts of habitat are needed across the jurisdiction to provide functioning habitat for area-sensitive species.



Meadow birds, although meeting targets based on the criteria set in the population analysis, continue to decline in abundance across TRCA's jurisdiction and AOC. This is consistent with the natural cover analysis results that show an overall substantial decrease in meadow habitat across the jurisdiction. The illustration of the meadow habitat changes and the implications on meadow dependent species are highlighted in Box 11. Meadows can be a transient habitat type undergoing succession if not actively managed. They are also at greatest risk from urban development due to the limited protection in policy (except under the Species at Risk Act). These factors make meadows vulnerable to land use conversion, particularly in the urbanizing zone where land conversion is at the highest rate. This highlights the need for stronger policy coverage if meadow species and habitat are to be protected into the future.

In addition to the protection of habitat and maintenance of its quality, (e.g. patch size, urban matrix influence) there are additional measures that can be successfully undertaken to enhance the habitat and wildlife populations

Box 11: Changing meadows and meadow dependent species

In meadow sites in the rural zone of the jurisdiction, Terrestrial LTMP data showed an increase in number of Species of Concern (L1-L3). At first, this was thought to be attributed to the increase in meadow dependent species, but further evaluation indicated that this increase was driven by an increase in forest-edge SOC (e.g. blue-winged warbler, Eastern towhee, Nashville warbler). The same sites showed corresponding declines in the number of meadow-dependent SOC (e.g. grasshopper sparrow and bobolink). Upon further investigation, it was noted that the composition of the meadow habitat had changed through natural succession and restoration plantings. This highlights the relationship between changing habitat type such as meadow and associated wildlife species. This emphasizes the need to examine the objectives around particular habitat types. This is important specifically for meadows as there are challenges due to it being transient habitat and largely unprotected, thus more vulnerable to development pressures.

in the TRCA's jurisdiction and AOC. This is especially important in areas where there are degradations that require interventions beyond protection. Restoration of such areas to create functioning habitat have been successfully undertaken in TRCA's jurisdiction such as the example illustrated in Box 12. A thriving population of wildlife has followed the habitat restoration over the past several years indicating wildlife and habitat can flourish amidst urbanization if there is a commitment to effective protection, restoration, and management.

Box 12: Build it and they will come: Restoration success for colonial waterbirds at Tommy Thompson Park

Tommy Thompson Park has provided nesting habitat for colonial waterbirds since the early 1970s. This is one of the reasons the site was designated as a globally significant Important Bird Area. Today the park supports seven species of colonial waterbirds. Ring-billed Gull nest numbers have remained fairly constant since population management ended in the early 2000s. However, Herring Gull nesting has decreased and has even been absent in recent years. Common Tern nesting is supported on reef rafts and engineered islands, but nest success can be affected by mammalian and avian predators. Caspian Terns nest sporadically at the park, impacted by co-nesting Double-crested Cormorants and vegetation succession. Black-crowned Night-Herons nesting declined from their peak in 2000, in part due to mammalian predators. However, they have maintained a fairly steady nesting population in recent years. Great Egrets nest in small, but constant numbers. Double-crested cormorants experienced a remarkable recovery from near regional extirpation, and today the colony at TTP is the largest in North America. TRCA uses a spatial management strategy that allows cormorants nesting opportunities while limiting their impact on trees.

4.2. Recommendations Summary

There are a number of stakeholders implementing very effective programs and initiatives that help to monitor, protect, restore and manage wildlife habitat and wildlife populations. These initiatives should be maintained and strengthened. The following recommendations summarizes the Key Recommendations 1 through 6 provided throughout this report to highlight some additional actions or initiatives that can be undertaken in addition to, and in support of, existing efforts.

4.2.1. Policy and Community Planning

1. Develop additional policy guidance to more fully protect natural habitats not sufficiently addressed in current policy frameworks, particularly in future urban growth areas as these are the most vulnerable to removal.
2. Develop protection policies for local natural features not protected under provincial policy, particularly in rural areas that have defaulted to the provincial systems.
3. Develop restoration policies and identify opportunities for restoration of lands adjacent to existing natural cover.
4. Identify opportunities to improve the habitat contribution of active recreation areas identified in municipal official plans.
5. More fully incorporate and protect restoration and enhancement areas within municipal official plans.
6. Ensure effective implementation of natural heritage policies to help ensure wildlife habitat and wildlife populations are protected and natural heritage objectives are met
7. Develop municipal polices and standards that require green infrastructure, including Low Impact Development, to be more fully integrated into new and redeveloped communities to help support wildlife habitat and wildlife populations.
8. Clarify and strengthen current policy frameworks meant to protect meadow habitat. in urbanizing areas.
9. Strengthen effective provincial natural heritage policies, particularly for urban communities. Promote the need for more proactive and comprehensive natural heritage planning in the areas targeted for future urban development. This planning could be accomplished through the development of sub-watershed plans or other plans that evaluate different development scenarios and design communities that include a natural heritage system and integrated green infrastructure able to maintain and enhance biodiversity.
10. Utilize opportunities through comprehensive urban revitalization initiatives for redevelopment and intensification in existing urban areas to expand, remediate and restore remnant or damaged natural features that would provide multiple benefits. For example, the planned Port Lands restoration in Toronto will add wetland habitat and green space for human use.
11. Eliminate the cumulative loss of wildlife habitat from urban areas by prioritizing the protection of functional habitat, and where protection is not possible, the mitigation hierarchy of avoid, minimize, mitigate, and compensate should be applied.

12. Develop policies within the Class environmental assessment process under the Environmental Assessment Act for minimum restoration targets and mitigation requirements to compensate for wildlife habitat impacts due to public infrastructure linear alignments, including habitat connectivity.
13. Promote a coordinated approach to policy implementation where all levels of government, including conservation authorities, can advance their shared natural heritage objectives more efficiently and effectively.

4.2.2. Land Securement

14. Explore options for land procurement and securement through infrastructure funding, as an investment in green infrastructure assets.
15. Incorporate strategic restoration opportunities into existing land securement programs to help ensure lands are available for future habitat expansion and restoration.
16. Focus land securement efforts in areas where the natural system may be most vulnerable to land use change.

4.2.3. Habitat Restoration

17. Added resources and effort should be directed to restoration across the TRCA's jurisdiction as there remains a significant amount of additional natural cover required to meet the TRCA TNSS target.
18. Use strategic system based approaches to identify restoration opportunities that strengthen the overall habitat function and total area of NHS. Resources like TRCA's Integrated Restoration Prioritization should guide restoration efforts.
19. Strategic restoration opportunities should be identified within existing urban areas. This could include identifying surplus open manicured areas on private and public land that are in proximity to the existing natural system.
20. Explore and implement new and innovative approaches to increasing natural cover, including other forms of green infrastructure, in urban and urbanizing areas where the traditional protection and restoration opportunities may be limited.
21. Existing programs should be supported and new programs developed to target habitat restoration for a number of different land uses such as schools, institutions, infrastructure lands, open lands within commercial areas, industrial lands, and residential lands

4.2.4. Reducing Impacts from Surrounding Land Use

22. Reduce the overall impacts of new and redeveloped urban communities on adjacent wildlife habitat and natural systems including but not limited to:
    - Ensuring hydrological functions required to support the natural system are maintained
    - Reducing the application of road salt on wildlife and wildlife habitat.

- Managing human use by designing trails and access points to direct use away from higher functioning habitats.

23. Develop guidance on the required size of buffers taking into consideration the needs of different habitat types and functions and the intensity of the surrounding land use.
24. Develop guidance on the intended function of buffers and prohibited land uses and activities within the buffers that would interfere with those functions.

4.2.5. Improving Meadow Habitat

25. Develop a regional strategy and implementation plan for the effective conservation and management of meadow habitat that set targets for overall extent and distribution of meadow habitat across the TRCA's jurisdiction and provides long term management recommendations. This should include identifying opportunities to incorporate meadow habitat into urban and urbanizing communities as well as opportunities to partner with the agricultural community.

4.2.6. Research and Monitoring

26. Work with Municipalities to define the long-term intent of active recreation areas that are located in the NHS and complete complimentary monitoring and research to understand the local impacts of recreational use and the ecological thresholds associated with recreational use.
27. Identify the ecological need and potential implications of meadow conservation in TRCA's jurisdiction.
28. Undertake applied research to determine the optimal buffer sizes for different habitats and land use to protect ecosystem function.
29. Research the extent to which all forms of green infrastructure located within the urban matrix can contribute to wildlife habitat and the overall function of the natural system.
30. Monitor populations more closely using existing and new Long Term Monitoring Plots and other data to improve understanding of urbanization impacts on species, especially for meadow species and species that are more sensitive (higher L ranks).
31. Monitor populations more closely using existing and new Long Term Monitoring Plots and other data to understand the urban – rural differences in population structure.
32. Develop short and long term monitoring programs to address targeted research questions to understand impacts and improvements in wildlife populations in relation to the positive and negative changes in habitat and urban matrix.
33. Work collaboratively with developers, municipalities and TRCA to implement monitoring programs in areas planned for development that can provide long-term wildlife data throughout the development process to inform mitigation options.

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