Photo: Michael Runtz

Algonquin Wolf

(*Canis* sp.) in Ontario

Ontario Recovery Strategy Series

Draft

2018

Natural. Valued. Protected.

Ministry of Natural Resources and Forestry

Ontario

About the Ontario Recovery Strategy Series

This series presents the collection of recovery strategies that are prepared or adopted as advice to the Province of Ontario on the recommended approach to recover species at risk. The Province ensures the preparation of recovery strategies to meet its commitments to recover species at risk under the *Endangered Species Act 2007* (ESA) and the Accord for the Protection of Species at Risk in Canada.

What is recovery?

Recovery of species at risk is the process by which the decline of an endangered, threatened, or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of a species' persistence in the wild.

What is a recovery strategy?

Under the ESA a recovery strategy provides the best available scientific knowledge on what is required to achieve recovery of a species. A recovery strategy outlines the habitat needs and the threats to the survival and recovery of the species. It also makes recommendations on the objectives for protection and recovery, the approaches to achieve those objectives, and the area that should be considered in the development of a habitat regulation. Sections 11 to 15 of the ESA outline the required content and timelines for developing recovery strategies published in this series.

Recovery strategies are required to be prepared for endangered and threatened species within one or two years respectively of the species being added to the Species at Risk in Ontario list. Recovery strategies are required to be prepared for extirpated species only if reintroduction is considered feasible.

What's next?

Nine months after the completion of a recovery strategy a government response statement will be published which summarizes the actions that the Government of Ontario intends to take in response to the strategy. The implementation of recovery strategies depends on the continued cooperation and actions of government agencies, individuals, communities, land users, and conservationists.

For more information

To learn more about species at risk recovery in Ontario, please visit the Ministry of Natural Resources and Forestry Species at Risk webpage at: **www.ontario.ca/speciesatrisk**

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Cette publication hautement spécialisée « Recovery strategies prepared under the *Endangered Species Act, 2007* », n'est disponible qu'en anglais en vertu du Règlement 411/97 qui en exempte l'application de la Loi sur les services en français. Pour obtenir de l'aide en français, veuillez communiquer avec recovery.planning@ontario.ca.

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This recovery strategy was prepared in consideration of the comments received during and after the workshops, during telephone conversations, and written comments received on the first draft.

Declaration

The recovery strategy for the Algonquin Wolf was developed in accordance with the requirements of the *Endangered Species Act, 2007* (ESA). This recovery strategy has been prepared as advice to the Government of Ontario, other responsible jurisdictions, and the many different constituencies that may be involved in recovering the species.

The recovery strategy does not necessarily represent the views of all of the individuals who provided advice or contributed to its preparation, or the official positions of the organizations with which the individuals are associated.

The goals, objectives and recovery approaches identified in the strategy are based on the best available knowledge and are subject to revision as new information becomes available. Implementation of this strategy is subject to appropriations, priorities and budgetary constraints of the participating jurisdictions and organizations.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy.

Responsible jurisdictions

Ontario Ministry of Natural Resources and Forestry
Environment and Climate Change Canada – Canadian Wildlife Service, Ontario
Parks Canada Agency

Executive Summary

The Algonquin Wolf (*Canis* sp.) is listed as threatened under the *Endangered Species Act*, *2007*. In 2016, the Algonquin Wolf was recognized by the Committee on the Status of Species at Risk in Ontario (COSSARO) as a "*hybrid group that collectively represents a genetically discrete cluster with distinct morphological characteristics*". The Algonquin Wolf was so named by COSSARO to differentiate it from other populations that have been labelled Eastern Wolf, to specifically indicate that it is a genetically discrete cluster and to acknowledge the hybrid ancestry of this evolutionarily significant unit.

Hybridization among canids in Ontario has been well-documented using morphological and genetic data. The number of genetic samples that have been collected during these studies is extensive. In Ontario, there is general consensus that there has been historical hybridization among three different canid species: Eastern Wolf (*Canis lycaon*), Western Coyote (*Canis latrans*) and Gray Wolf (*Canis lupus*). As a result, there are currently three distinct genetic clusters of canids with differentiated ancestry in central Ontario: Great Lakes Wolf (*Canis lupus* x *lycaon)*, Algonquin Wolf and Eastern Coyote (*C. latrans* var.). Algonquin Wolves are often visually indistinguishable from large Eastern Coyotes or other admixed canids, and larger individuals can be hard to distinguish from Gray Wolves.

In Ontario, the Algonquin Wolf occurs from Killarney Provincial Park east to the Ottawa Valley, and south to Fenelon Falls and Buckhorn. The core of the Algonquin Wolf population in Ontario occurs within Algonquin Provincial Park (APP), where they are the most abundant canid. The continued presence and dominance of Algonquin Wolves in APP, since at least the beginning of the 20th century, is likely due to historical abundance, strong territoriality, assortative mating and high survival due to protection from hunting and trapping.

The distribution of the Eastern (Algonquin) Wolf outside of Ontario includes southern Quebec, north of the St. Lawrence River. Algonquin Wolves were once thought to have occurred across southern Ontario, southern Quebec and into the eastern United States. Currently, the Algonquin Wolf is not believed to occur outside Canada.

The Algonquin Wolf occurs in the Great Lakes-St. Lawrence Forest but is not generally restricted to specific habitat types. They have thrived in large tracts of continuous forested habitat, specifically areas with low human-caused mortality. Persistence and expansion of Algonquin Wolves in the landscape is thought to be primarily limited by two factors: (1) competition and hybridization with other canids, primarily the Eastern Coyote, and (2) increased susceptibility to human-caused mortality (trapping, shooting and vehicular collisions). Rabies and mange have contributed to mortality in the past, but are not consistent threats to the Algonquin Wolf.

The recovery goal is to ensure a self-sustaining population of the Algonquin Wolf within the Algonquin Wolf Recovery Zone (AWRZ) in Ontario.

This recovery strategy focusses on reducing threats to increase population size and geographic range and to protect habitats where Algonquin Wolves can persist and thrive. It is recommended that the development and implementation of recovery approaches involve Indigenous communities, and the public, primarily residents and stakeholders that live and operate within the AWRZ.

The protection and recovery objectives for the Algonquin Wolf are as follows:

1. Mitigate or eliminate known threats, particularly intentional human-caused mortality, to the species and its habitat through harvest regulation, education, and management.

2. Assess changes to the population size, genetic structure, occurrence and mortality rates of the Algonquin Wolf in Ontario.

3. Establish a standardized approach for long-term monitoring of the Algonquin Wolf population in Ontario.

4. Fill key knowledge gaps to better understand:
   a) Population viability;
   b) Location and quality of Algonquin Wolf habitat in Ontario, including identification of areas more favourable to Algonquin Wolves than Eastern Coyotes;
   c) Changes in density and distribution of the Algonquin Wolf and other canid types, and prey species in response to harvest management; and
   d) Human perception of wolves in Ontario and the potential to increase positive human perceptions of their intrinsic and ecological value.

5. Establish an inter-jurisdictional working group for the recovery of the Algonquin Wolf, to monitor recovery efforts, ensure integration among governments and to address key stakeholder concerns.

6. Strengthen the engagement of stakeholders and Indigenous communities in the implementation of recovery approaches for the Algonquin Wolf.

This recovery strategy includes a set of approaches to support the implementation of these objectives.

The following currently occupied areas, as well as the areas that provide a connection between the currently occupied areas, should be considered in developing a habitat regulation for the Algonquin Wolf:

- APP (7,630 km^2) and the 40 surrounding townships, which continue to maintain the highest densities of the Algonquin Wolf with the least Eastern Coyote presence and genetic introgression, as well as representing a source population for areas outside APP.

- Currently occupied and likely occupied areas outside APP including: Killarney Provincial Park (including geographic townships of Allen, Attlee, Bevin, Burwash, Caen, Carlyle, Cox, Curtin, Dieppe, Eden, Foster, Goschen, Halifax, Hansen, Humboldt, Killarney, Kilpatrick, Laura, Roosevelt, Sale, Secord, Servos, Struthers, Tilton, Truman, and Waldie), Kawartha Highlands Signature Site Park (including the geographic townships of Anstruther, Burleigh, Cardiff, Cavendish, Chandos, Harvey, and Monmouth), Queen Elizabeth II Wildlands (including the geographic townships of Anson, Dalton, Digby, Longford, Lutterworth, Minden, and Ryde), and within WMU 47 the former geographic townships of Mowat, Blair, McConkey, Walbridge, Brown and Wilson.

- The areas that provide a connection between these core areas, particularly in the Algonquin Wolf Recovery Zones 1, 2a and 3.

The following features within the Great Lakes-St.Lawrence Landscapes in the AWRZ should be managed for the Algonquin Wolf using current forest management guides (OMNR 2010a, b):

- Forested landscapes with little fragmentation or agricultural clearing including contiguous forest stands of various ages and types (coniferous, hardwood and mixed wood forests);

- Natural habitats such as wetlands and rock barrens mixed with contiguous forest stands that provide for Algonquin Wolf prey populations. Forested areas with low human presence and high Moose densities would be more beneficial to Algonquin Wolf than Eastern Coyote; and

- Natural habitats, including those listed above, that provide dispersal and travel corridors between occupied sites, as well as sites traditionally used for dens or rendezvous sites.

Urban areas, and areas with high human use such as urban centres, industrial areas and primary roads are little used by the Algonquin Wolf and not considered important habitat for the species and are not recommended for inclusion in the habitat regulation.

Table of Contents

List of Figures

List of Tables

APPENDICES

1.0 Background Information

1.1 Species Assessment and Classification

In June 2016, the Eastern Wolf (*Canis lupus lycaon* or *Canis* sp. *cf. lycaon*) in Ontario was renamed the Algonquin Wolf (*Canis* sp.) by COSSARO (Committee on the Status of Species at Risk in Ontario) and re-classified as a threatened species under Ontario's *Endangered Species Act*, *2007* (ESA). The Algonquin Wolf is traditionally referred to as the Eastern Wolf in the literature (Rutledge et al. 2010a, Benson et al. 2012, COSEWIC 2015), which resulted in its classification as either *Canis lycaon* (Wilson et al. 2000) or *Canis* sp. *cf. lycaon* (COSEWIC 2015). Prior to the suggestion (based on initial genetic analysis) by Wilson et al. (2000) to reclassify the species as *C. lycaon*, the species was considered a distinct type of a Gray Wolf subspecies (*C. lupus lycaon* – Algonquin type) (Kolenosky and Standfield 1975, Kyle et al. 2006).

The Algonquin Wolf was recognized by COSSARO (2016) as a "*hybrid group that collectively represents a genetically discrete cluster with distinct morphological characteristics*". Clusters represent genetically distinct groups with differentiated ancestry. Genetic clusters can be identified with statistical analysis (Pritchard et al. 2000, Vaha and Primmer 2006, Hubisz et al. 2009,). Rutledge et al. (2010a) used an ancestry coefficient (Q) of 0.8 or higher to identify Algonquin Wolves as negligibly hybrid (i.e., mostly Algonquin/Eastern Wolf).

The Algonquin Wolf includes all canids with an "inferred ancestry coefficient" (Q) of 0.8 or higher to the Algonquin Provincial Park (APP) wolf population (See **Genetics and Population Structure** and COSSARO [2016]).

The lack of a species name (i.e., *Canis* sp.) reflects the fact that the Algonquin Wolf is recognized as a hybrid group that represents a discrete genetic cluster based on the best available data, while taking into account the genetic uncertainty surrounding the origins of the Eastern Wolf (COSSARO 2016; see **Genetics and Population Structure**). Although COSSARO has chosen to use a different name than COSEWIC (Eastern Wolf), these two taxa are considered to have the same genetic characteristics. There is currently no known pure Eastern Wolf individual or population that can be used as a genetic reference (COSSARO 2016).

This recovery strategy uses the provincial designation of the Algonquin Wolf throughout most of the document; however, much of the literature cited in this document uses the term Eastern Wolf.

Therefore, the species assessment and classification for the recently named Algonquin Wolf must also consider the assessment and classification for the Eastern Wolf, for which the current and historic designations are provided below (Table 1). The Eastern Wolf was previously listed as special concern in 2004 on the Species at Risk in Ontario

(SARO) List. It was listed in Ontario Regulation 230/08 when the ESA took effect in 2008.

The Eastern Wolf was recognized in 2015 as a unique species (*Canis* sp*. cf. lycaon*) by the Committee on the Status of Wildlife in Canada (COSEWIC), and not a subspecies of Gray Wolf (*Canis lupus*), and its status was changed from special concern to threatened in Canada (COSEWIC 2015) (Table 1).

Table 1. Species assessment and classification of the Algonquin Wolf (*Canis* sp.).

Assessment	**Status**
SARO list classification	Threatened
SARO list history	Threatened, Algonquin Wolf (*Canis* sp.) (2016); Special Concern, Eastern Wolf (*Canis lupus lycaon*) (2004)
COSEWIC assessment history	Threatened, Eastern Wolf (*Canis* sp. *cf. lycaon*) (2015); Special Concern, Eastern Gray Wolf (*Canis lupus lycaon*) (2001), Data Deficient, Eastern Gray Wolf (*Canis lupus lycaon*) (1999)
SARA schedule 1	Special Concern, Eastern Wolf (*Canis lupus lycaon*)
Conservation status rankings	G-RANK: G4G5TNR, Eastern Wolf (*Canis lupus lycaon*) N-RANK: N4 Eastern Wolf (*Canis lupus lycaon*) S-RANK: S4, Eastern Wolf (*Canis lupus lycaon*)

The glossary provides definitions for the abbreviations within, and for other technical terms in this document.

1.2 Indigenous Cultural Significance

The wolf is an intricate part of the traditional stories and culture of the Indigenous peoples of North America who, for thousands of years, have shared the land with these animals. The wolf clan is one of the most prominent clans in Ontario's Indigenous culture, including the Anishinaabe (Algonquin, Ojibway, Odawa and Pottawatomi), the Cree, and the Iroquois. The wolf symbolizes love and care for family and community, loyalty and co-operation (OMNR 2005). It is also viewed by different cultures as a stealthy predator, trickster, or creator of land on earth (Grambo 2008, Usik 2015). The currently known range of the Algonquin Wolf extends across several cultures and belief systems, and the cultural significance of the wolf to these cultures varies.

In Anishinaabe culture, the Creator Gitchi-Manitou sent the wolf to be a companion of humans. From this point on both their lives would be intertwined (Usik 2015). For this reason, it is believed the Anishinaabe people are ``ma` ingan``, or intertwined with the wolves. These stories hold the belief that whatever happens to the wolf, will also happen to the Anishinaabe people, and vice versa.

According to Cree legend, Wisagatcak and the wolf were responsible for the creation of land on earth after flooding by beavers (Grambo 2008). It is believed that the wolf brought back the land by using moss it carried by mouth. The relationship between the beaver and wolf, and the influence this relationship has on land and water, is a constant theme in traditional knowledge and stories.

During a workshop attended by First Nation community members from the Eastern Georgian Bay area including Magnetawan First Nation, Shawanaga First Nation and Nipissing First Nation, a resolution was drafted that acknowledges that protection be focused and directed on saving the species as the aboriginal perspective on preserving Turtle Island and the species we share it with, is built on respect (minaadendamowin) and love (zaagi'idiwin) for nature itself. The signatories of the resolution concluded that Traditional Ecological Knowledge along with scientific information must be understood, then utilized prior to and while addressing actions for recovery of the Algonquin Wolf (Appendix A).

1.3 Species Description and biology

History of Hybridization Among Canids in Ontario

Prior to European settlement and subsequent landscape alteration, the distribution of the Eastern Wolf (the ancestor of the Algonquin Wolf) was thought to extend east of the Mississippi River and from the Gulf Coast north to the St. Lawrence and Great Lakes and extreme southeastern Ontario (Wilson et al. 2000, Nowak 2002, Kyle et al. 2006). It is believed that the Gray Wolf (*Canis lupus*), which was once widespread across much of North America, was extirpated from southeastern Ontario between 1850 and 1900 due to landscape alteration and bounty hunting (Kolenosky and Standfield 1975). At the same time, the Eastern Wolf extended its range into central Ontario following a northward expansion of the White-tailed Deer (*Odocoileus virginianus*; Kyle et al. 2006, Wilson et al. 2009), which is a key prey species. Western Coyote (*Canis latrans*), which historically inhabited the prairies and grasslands (Parker 1995), also expanded northward and eastward, with the first record in southeastern Ontario documented in 1919 (Nowak 1979).

Although there remains some debate about the origins of the Algonquin Wolf (see **Genetic and Population Structure**), it is generally understood that during the above described changes in geographic distribution, hybridization occurred among three canid species: Eastern Wolf, Western Coyote and Gray Wolf (Rutledge et al. 2010a, Rutledge et al. 2010b, Wilson et al. 2012, Rutledge et al. 2015; see **Genetic and Population Structure**).

Hybridization among canids in Ontario has been well-documented using morphological and genetic data (e.g., Kolenosky and Standfield 1975, Theberge 1991, Nowak 2002, Wheeldon 2009, Wilson et al. 2009, Wheeldon and White 2009, Rutledge et al. 2010a, Benson et al. 2012); the number of genetic samples collected in Ontario, particularly central and southern Ontario has been extensive (COSEWIC 2015; Figure 1).

As a results of these hybridization events there are currently three recognizable genetic clusters of canids with differentiated ancestry in central Ontario. These are: Great Lakes Wolf (*Canis lupus* x *lycaon)*, Algonquin Wolf, and Eastern Coyote (*C. latrans* var.), as well as highly admixed canids that do not cluster with any particular group (Wheeldon 2009, Rutledge et al. 2010a, Benson et al. 2012; Table 2; Figure 1).

Table 2. Four main canid types referred to in this recovery strategy, including common and scientific name, and description.

Common Name	Scientific Name	Description[a]
Algonquin Wolf (Eastern Wolf)	*Canis* sp.	A hybrid wolf that is highly assigned to the Algonquin Wolf genetic population (Rutledge et al. 2010a, Benson et al. 2012). The Algonquin Wolf is largely limited to APP, although it occurs elsewhere including in and around Kawartha Highlands Signature Site Park, Queen Elizabeth II Wildlands Provincial Park, Wildlife Management Units 47 and 49, and Killarney Provincial Park (Figure 1). They have also been documented in Quebec.
Great Lakes Wolf (Great Lakes-Boreal Wolf, Ontario-type Gray Wolf)	*Canis lupus* x *lycaon*	An historic Gray Wolf – Eastern Wolf hybrid that is highly assigned to the Great Lake Wolf genetic population (Wheeldon 2009, Wheeldon and White 2009). Within the Algonquin Wolf range, the Great Lakes Wolf is largely found in Wildlife Management Units 37, 42 and 47 (Figure 1).
Eastern Coyote (Tweed-type wolf)	*Canis latrans* var.	A hybrid coyote that experienced historical hybridization with Eastern Wolf that is highly assigned to the Eastern Coyote genetic population (Wheeldon 2009), and has genetic material from Eastern Wolf (Rutledge et al. 2010a) and domestic dog (Wheeldon et al. 2013). The Eastern Coyote is distributed across most of southeastern and central Ontario, but is also found in the clay-belt area of northern Ontario (Figure 1).
Admixed canids		Canids that are not highly assigned to a known genetic population.

Notes: sp. is species; highly assigned is $Q \geq 0.80$ for a single *Canis* type (Eastern Coyote, Algonquin Wolf, or Great Lakes Wolf) as highly assigned to that genetic population (Benson et al. 2017).

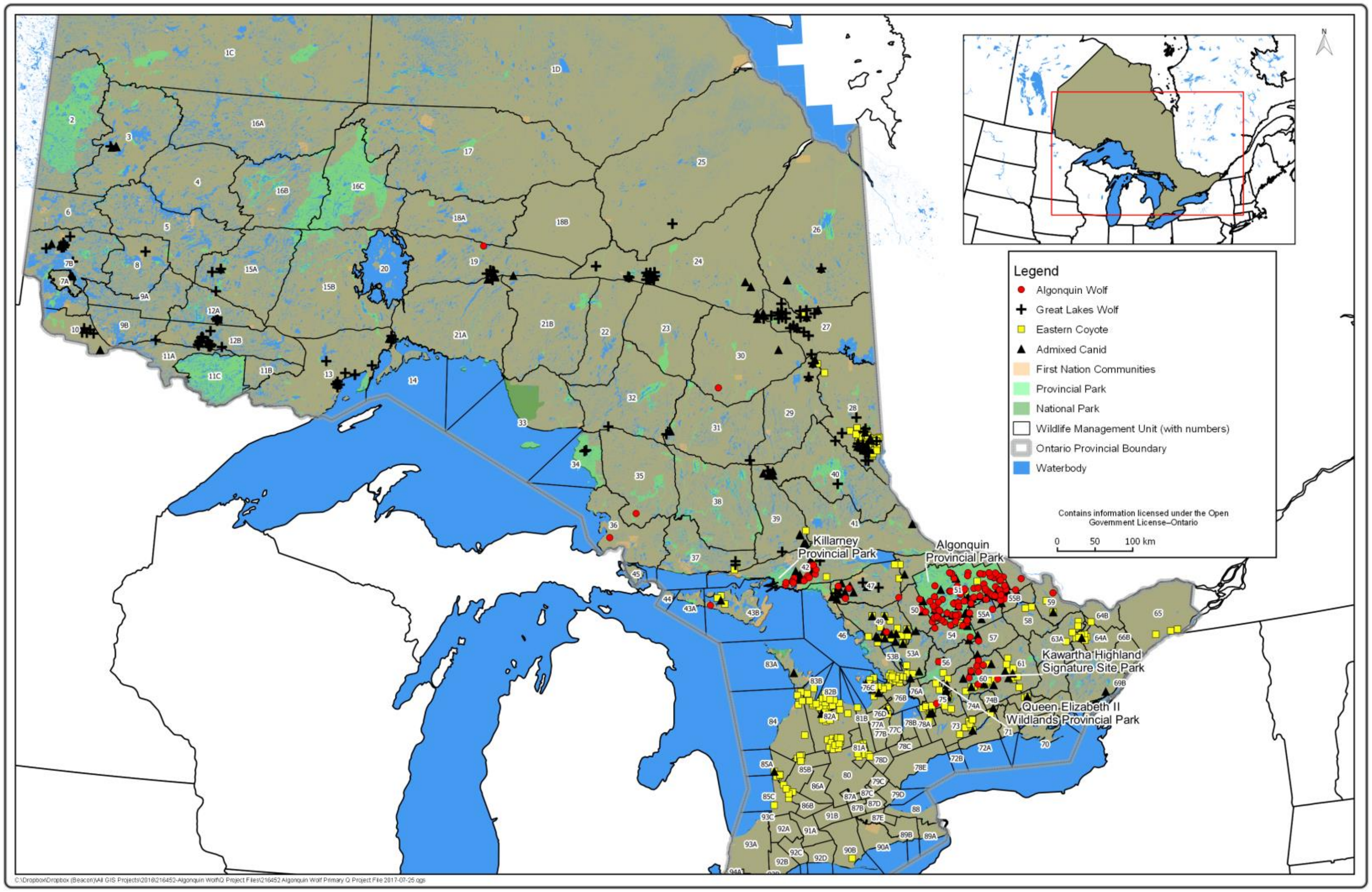

Figure 1. Results of genetic samples collected for three main canid types, including admixed individuals in Ontario (Wheeldon 2009, Rutledge et al. 2010a, Benson et al. 2012, Wheeldon and Patterson 2012, Wheeldon et al. 2013, Rutledge et al. 2016). This figure does not reflect the total distribution or relative abundances of these species.

Morphological Description

Data collected from APP and areas adjacent to APP indicate that average female adult weight is 25.0 kg and average male adult weight is 28.2 kg (Benson et al. 2012). Average body length is 109.3 cm for females and 113 cm for males (Benson et al. 2012). The coat colour is variable among Algonquin Wolves; pure black or pure white Algonquin Wolves are uncommon (Pimlott et al. 1969). Algonquin Wolves typically have more reddish-brown/tawny (cinnamon) colouration, with a reddish colouration on the outer surface of their legs, behind their ears and on their heads, when compared to Gray Wolves (Pimlott et al. 1969). Algonquin Wolves have noticeably larger feet and they often have a darker, duskier colouration than Eastern Coyotes (OMNR 2005). There are subtle differences in the ears and muzzle of the Algonquin Wolf in comparison to the Eastern Coyote and the Gray Wolf.

There is a difference in body size and mass among the different canid types in central Ontario. The Algonquin Wolf is considered to be intermediate to the Eastern Coyote and Great Lakes Wolf (Kolenosky and Standfield 1975, Benson et al. 2012). Associated hybrids generally exhibit intermediate morphological characteristics to the parental groups (Benson et al. 2012). It is hypothesized that ecological factors (including prey size and availability) may be contributing to morphological and genetic variation among canids in Ontario (Wilson et al. 2009).

Given the variation among the three species, small Algonquin Wolves are often visually indistinguishable from large Eastern Coyotes or other admixed canids. Larger individuals can be difficult to distinguish from the Great Lakes Wolf or Gray Wolf (OMNR 2005). Reliable distinction between canids in central Ontario is often not possible in the field based on their physical appearance.

Genetics and Population Structure

There are primarily two different evolutionary scenarios presented in the literature that explain the origin of the Algonquin Wolf.

The first scenario, hypothesized by Wilson et al. (2000) following the completion of preliminary genetic analyses, suggests that the Eastern Wolf was a distinct wolf species that evolved strictly in North America alongside the Western Coyote (see **History of Hybridization in Ontario**). Furthermore, the Eastern Wolf evolved independent of the Gray Wolf, which evolved in Eurasia and subsequently expanded its range to North America. This original work was followed up by additional genetic and genomic analysis that supported this three-species (*C. lupus; C. lycaon; C. latrans*) hypothesis (Rutledge et al. 2010a, Rutledge et al. 2010b, Wilson et al. 2012; Rutledge et al. 2015).

The second scenario hypothesizes that the Algonquin Wolf is the product of either historical (vonHoldt et al. 2011, Sefc and Koblmuller 2016) or recent (vonHoldt et al. 2016) hybridization between Gray Wolves and Western Coyotes. However, this interpretation of data supporting the hybrid origins hypothesis has been contested based on several arguments; primarily because of the lack of representative samples from APP and the absence of evidence that Gray Wolves and Western Coyotes have hybridized in the wild in western North America (Rutledge et al. 2012, Rutledge et al. 2015, Hohenlohe et al. 2017).

Regardless of the ongoing debate about the origin of the Algonquin Wolf, when compared to other canids in Ontario, the Algonquin Wolf emerges as a distinct cohesive genetic unit. This is despite evidence of recent admixture with Eastern Coyotes (*C. latrans* var.), which emerged about 100 years ago as the product of Eastern Wolf x Western Coyote hybridization (Wilson et al. 2000, 2012; see **History of Hybridization in Ontario),** and to a lesser extent with Great Lakes Wolf (*C. lupus lycaon*); which is suggested to have resulted from an historical hybridization event between Gray Wolf and Eastern Wolf (Wheeldon and White 2009, Rutledge et al. 2010a).

The Algonquin Wolf has been identified as a unique species with threatened status by both federal (COSEWIC 2015; as Eastern Wolf) and provincial (COSSARO 2016) committees. Both COSEWIC and COSSARO based their assessments on genetic, morphological (Kolenosky and Standfield 1975; Rutledge et al., 2010a; Benson et al. 2012) and ecological information (Rutledge et al. 2010c; Benson et al. 2017) that clearly differentiates the Algonquin Wolf from surrounding *Canis* types. Furthermore, Traditional Ecological Knowledge from the Mohawk First Nation of Akwesasne notes that more than one type of canid was recognized in the region before European contact, based on differences in body size, temperament, and size of prey consumed (COSEWIC 2015).

Algonquin Wolves have been differentiated from Eastern Coyotes and Gray Wolves through morphological and genetic assessments. The Algonquin Wolf is recognized in Ontario as a ‘species’ by the ESA, which defines a species as “*species, subspecies, variety or genetically or geographically distinct population of animal, plant or other organism, other than a bacterium or virus, that is native to Ontario*” (COSSARO 2016).

Social Structure

The Algonquin Wolf exhibits a similar social structure to other wolf populations in the world (Rutledge et al. 2010c, Benson and Patterson 2013). Algonquin Wolves typically occur in packs that are highly social and territorial (Mills et al. 2008, Benson and Patterson 2013). Pack sizes can range from two to 14 members in APP, and single wolves occasionally hold territories when they are the last surviving member of a pack (Theberge and Theberge 2004). Average pack sizes were reported as 5.9 individuals between 1959 and 1963 (Pimlott et al. 1969), 3.7 from 1988 to 1998 (Theberge and Theberge 2004), 4.2 from 2002 to 2003 (Patterson et al. 2004), and 4.3 from 2007 to 2011 (J. Benson and B. Patterson, unpub. data). Pack size increases as new litters are born, and decrease when offspring disperse between 15 weeks to 36 months of age (Mills et al. 2008).

Life Cycle and Reproduction

Each Algonquin Wolf pack typically has one unrelated breeding pair (COSEWIC 2015). Most female wolves are first ready to breed at >22 months, while males generally are ready to breed between 22 and 34 months (Mech and Boitani 2003). The average length of time an individual wolf will breed is three to four years (Mech and Boitani 2003). Mating occurs in February and pups are born in late April to early May (Mills 2006). Mean litter size is 4.6 ± 0.06 (mean ± SE; *n*=10) pups, although litter sizes can range from two to seven individuals (Mills et al. 2008). Sex ratios at birth are close to equal (Mills et al. 2008).

Algonquin Wolf pups are born in natal dens that are commonly excavated into the ground but also occur in crevices between or under rocks and boulders (Benson et al. 2015), and hollow logs (Pimlott et al. 1969, Voigt 1973). Pups are nursed for the first six weeks at the natal den and are moved in mid-to late June from the natal den to a series of subsequent rendezvous sites (Mills et al. 2008). Rendezvous sites can be used from a few days up to six weeks and are the primary locations for pup rearing activity (Joslin 1967, Voigt 1973, Argue et al. 2008, Benson et al. 2015).

Pups are often left alone at rendezvous sites while other members of the pack are off hunting (Kolenosky and Johnston 1967). Pups do not hunt until they are on average 18 weeks old and when final rendezvous sites are abandoned in the fall (Mills et al. 2008). After they have been weaned, wolf pups rely on other members of the pack to feed them. Wolf pups feed on partially digested food that is regurgitated by adult wolves (Mech 1970). As they grow, they consume solid food that is brought back to the rendezvous site by other pack members or, if by the age of weaning they have enough endurance, they may follow adults to carcasses (Mech and Boitani 2003).

Dispersal and Migration

Dispersal from natal packs for the Algonquin Wolf seems to occur at an earlier age than observed in other wolves, with the earliest recorded being 15 weeks (Mills et al. 2008). The reason for such early juvenile dispersal is unknown (Mills 2006). Yearling wolves have a high dispersal rate, and often travel away from and back to the pack before dispersing (Mech and Boitani 2003, Patterson et al. in review). Algonquin Wolves from APP have been documented as dispersing south to the southern edge of the Canadian Shield, west toward Georgian Bay, and east into Quebec (COSEWIC 2015), south to Queen Elizabeth II Wildlands Provincial Park, and as far north as Nakina, Ontario (Patterson et al. in review). APP appears to be a source for wolves in other areas of Ontario (Benson et al. 2014), although there does not seem to be a directional bias with respect to dispersal (B. Patterson et al. in review).

Seasonal migration has been documented, primarily in Algonquin Wolf populations on the east side of APP and also in WMU 47 (Kolenosky 1972; Figure 2 for reference to WMU). There are well-documented examples of Algonquin Wolves in eastern APP migrating seasonally from their summer ranges to winter concentration areas in the townships bordering the southeast corner of APP (Forbes and Theberge 1996). This behaviour remains prevalent today in eastern APP (B. Patterson pers. comm. 2017c). Benson et al. (2012) found that the majority of radio-collared Algonquin Wolves in western APP remained within their territory during winter months to prey on Moose (*Alces alces*).

Mortality Rates and Causes

Human-caused mortality, including hunting, trapping, poisoning and vehicular collisions, is the major source of mortality for the Algonquin Wolf (Theberge et al. 2006, Rutledge et al. 2010a, Benson et al. 2014).

Prior to a harvest ban (1989 – 1999) that came into effect in December 2001 in the townships surrounding APP, 42 percent (n=67) of deaths were attributed to harvest mortality, and 21 percent (n=33) were attributed to natural causes (Theberge and Theberge 2004, Rutledge et al. 2010c). Most wolves that were killed by harvest mortality were killed in winter while following White-tailed Deer outside of the park (Theberge and Theberge 2004). An additional seven percent (n=11) were killed by unknown causes, three percent (n=5) by vehicular collisions and one death was attributed to poisoning (Theberge and Theberge 2004).

Between 2003 and 2007 (after the harvest ban was implemented around APP) sixteen percent (n=5) of deaths were attributed to harvest mortality, and 84 percent (n=26) to natural causes (Rutledge et al. 2010c).

Benson et al. (2014) radio-tracked 47 canids inside APP between May 2007 and May 2011. During this study, no harvest (e.g., hunting, and trapping) mortality was documented for Algonquin Wolves living in APP and 7.8 percent (n=5) of Algonquin Wolves in APP died from natural causes, 5.2 percent (n=3) from unknown causes and 1.8 percent (n=2) from vehicle collisions.

Benson et al. (2014) also tracked 15 Algonquin Wolves outside APP and the adjacent protected area (2004 to 2006). Of these, 53 percent (n=8) died from hunting and trapping, a similar value to the pre-harvest ban values from APP (i.e., 42 percent). Less than one percent died of natural mortality (n=1) or unknown causes (n=1). Outside APP, survival for the Algonquin Wolf was low, mortality risk was significantly higher than for other canid types outside of APP, and they were significantly more likely to be shot or trapped than any other canid types (see **Limitations and Threats**).

These studies lead to the conclusion that in the absence of hunting and trapping mortality, natural mortality is the most consistent cause of death for Algonquin Wolves.

Natural mortality among adult wolves may be caused by strife (an act of conflict, flight or struggle) among wolves, disease (including mange, and rarely rabies), starvation (Forbes and Theberge 1995, Theberge et al. 2006, Benson et al. 2013), and injury resulting from failed predation on ungulates (Theberge and Theberge 2004, Benson et al. 2014). A rabies epidemic was responsible for the deaths of Algonquin Wolves in 1990 and 1991 in eastern APP (Theberge et al. 1994). In 2007 mange killed approximately 12 percent of the Algonquin Wolves in APP. Although antibodies for canine hepatitis, canine parvovirus, and canine distemper are prevalent, these diseases are not thought to be major contributors to mortality (Theberge et al. 2006, B. Patterson pers. comm. 2017c).

Adult survival is the most important demographic parameter influencing the population growth of the Algonquin Wolf (Patterson and Murray 2008). Therefore, the loss of adults can have long-term repercussions for the population as a whole. Some individuals may live up to 15 years (Theberge and Theberge 2004), but median age for an Algonquin Wolf in APP prior to the 2001 harvest ban was two to three years (Vucetich and Paquet 2000), while the post-ban median age is five years (COSEWIC 2015). Median age may be different for Algonquin Wolves in areas outside APP; however, this is currently not well-understood.

Pup mortality from spring through fall is also thought to be an important factor for population growth in wolves (Fuller et al. 2003). Average annual survival rate of pups was estimated at 0.75 ± 0.06 (mean ± SE; n= 65) in eastern APP, and 0.25 ± 0.07 (mean ± SE; n=40) in western APP (Benson et al. 2013). Within APP, pup mortality was most often caused by natural causes, including starvation and strife (Mills 2006; Benson et al. 2013). Starvation, particularly in western APP, has been attributed to low availability of summer food, especially of American Beaver (*Castor canadensis*) (Benson et al. 2013).

Western APP has a lower density of White-tailed Deer and American Beaver than eastern APP due to its prevailing habitat type (mature tolerant hardwood forest), which is largely protected from timber harvest and which does not favour either of these species.

Prey

Algonquin Wolves consume a range of prey, including White-tailed Deer, American Beaver and Moose (Pimlott et al. 1969, Kolenosky 1972, Voigt et al. 1976, Forbes and Theberge 1996, Loveless 2010, Benson et al. 2017). Snowshoe Hare (*Lepus americanus*) are also consumed in the winter months (Forbes and Theberge 1996). Variations in the densities of White-tailed Deer and Moose have been found to influence the distribution of Algonquin Wolves (Forbes and Theberge 1996; Benson et al. 2012, 2017).

Algonquin Wolves appear to be adaptable, and can change foraging behaviour with fluctuating prey abundance (Forbes and Theberge 1996, Benson et al. 2017). They appear to have shifted their predation patterns over the last 50 years to respond to temporal changes in ungulate distribution (Benson et al. 2017). Specifically, Algonquin

Wolves in APP mainly preyed upon White-tailed Deer in the 1950s and 1960s (Pimlott et al. 1969), as deer was the most abundant ungulate prey at that time (Quinn 2004). More recently, Moose have replaced White-tailed Deer as the dominant ungulate throughout much of APP (Quinn 2004). Recent studies have documented an increasing and viable Moose population in APP and WMU 49 (Murray et al. 2012; OMNRF pers. comm. 2017), even though Algonquin Wolves are the dominant canid. Algonquin Wolves now appear to be preying on a more balanced combination of both White-tailed Deer and Moose (Benson et al. 2017). Recent declines in White-tailed Deer in APP have been attributed to the maturation of the forest, changes to timber harvest practices to follow natural disturbance regimes, reduction in fire extent, and more severe winters (Voigt et al. 1992, Theberge and Theberge 2004). No studies have shown that Algonquin Wolves have inhibited the overall growth of the central Ontario deer population (Forbes and Theberge 1996).

Algonquin Wolves consume Moose through direct predation, or by scavenging Moose that have succumbed to starvation or Winter Tick (*Dermacentor albipictus*) infestations (Forbes and Theberge 1992, Forbes and Theberge 1996, Benson et al. 2017). In western APP, where White-tailed Deer are relatively scarce, Algonquin Wolves killed adult Moose during winter months at rates similar to Gray Wolves (Benson et al. 2017); however, the absence of snow, and the smaller body size of the Algonquin Wolf could potentially limit their access to Moose as a prey item during the summer and fall months (Benson et al. 2013). However, summer Moose kill rates have not been estimated for Algonquin Wolves. The high rate of Moose consumption during the winter months may be due to the fact that the Moose population in western APP is protected from harvest, and populations that are protected from harvest are often characterized by both high density and older age structure (Benson et al. 2017). Moose harvest in APP is only permitted through Indigenous hunting, which occurs primarily in eastern APP. Older Moose are more vulnerable to predation by wolves. Algonquin Wolves also consume Moose calves from early summer to early winter (Patterson et al. 2013). Despite this, canid predation does not appear to be a major cause for mortality in either adult or calf Moose in APP (Forbes and Theberge 1996, Murray et al. 2012, Patterson et al. 2013).

Adult wolves depend on large prey (i.e., White-tailed Deer and Moose) during the winter and on smaller prey (e.g., American Beaver, deer fawns, Moose calves) during the summer months (Pimlott et al. 1969, Voigt et al. 1976, Forbes and Theberge 1996). American Beaver are consumed year round when they are available (Forbes and Theberge 1996). American Beaver densities are typically lower in western APP than in eastern APP (Forbes and Theberge 1996, Benson et al. 2013) due to forest type (mature tolerant hardwood) and limited timber harvesting near waterbodies. American Beaver may also be consumed more frequently when deer populations are low (Voigt et al. 1976, Forbes and Theberge 1996). The current status of American Beaver populations within and outside APP is poorly documented; although, there have been concerns expressed by stakeholders about the potential impact of Algonquin Wolves on local beaver populations.

American Elk (*Cervus elaphus*) occur in the Bancroft area south of APP and are a potential prey source. However, predation of elk by Algonquin Wolves has not yet been documented (B. Patterson pers. comm. 2017c).

Although competition for prey may occur among Algonquin Wolf, Eastern Coyote and Great Lakes Wolf at the landscape scale, Algonquin Wolves generally have exclusive access to prey within their territory without any interference from neighbouring packs (Benson and Patterson 2013, Benson et al. 2013).

Depredation of Livestock

The number of livestock animals killed each year by Algonquin Wolves is poorly understood. In Ontario in 2015/2016, animals identified as wolves in general accounted for 25 percent (110 claims) of the $1.48 million of payment made under the Ontario Wildlife Damage Compensation Program (OMAFRA 2016). However, the number of livestock deaths ascribed specifically to Algonquin Wolf, Gray Wolf and Eastern Coyote is unknown due to the difficulty of field identification of these animals (see **Species Description and Biology** in this report), and the lack of confirmation of the predator in the field. Kills attributed to wolves in 2015/2016 were reported in Algoma, Cochrane, Durham, Greater Sudbury, Hastings, Kenora, Lanark, Manitoulin, Ottawa, Peterborough, Prescott and Russell, Rainy River, Renfrew, Simcoe, Dundas and Glengarry, Sudbury, Thunder Bay, and Timiskaming. All of these areas are outside the known Algonquin Wolf range. Canid related kills in southern Ontario (i.e., Peterborough, Durham, and Hastings) should be attributed to Eastern Coyote. Livestock kills are being attributed to wolves in areas where the wolves are not known to occur. Therefore, the number of kills attributed to wolves in 2015/2016 is an overestimate, given that many of the counties listed above are not known to possess wolves. Payments for kills attributed to wolves were made for 900 head of cattle and 1,563 head of sheep and lambs, as well as a small number of horses and domestic elk (OMAFRA 2016).

Given that the number of livestock producers within central Ontario is relatively low when compared to southern Ontario (unpub. data via OMAFRA pers. comm. 2017), where Eastern Coyotes are the most abundant canid, the risk of predation by Algonquin Wolves is also lower. Livestock producers in central Ontario are predominantly located along the Highway 11 corridor and southeast of APP (unpub. data via OMAFRA pers. comm. 2017).

1.4 Distribution, Abundance and Population Trends

Historical Distribution

The historic range of Eastern Wolf was thought to extend east of the Mississippi River and from the Gulf Coast north to the St. Lawrence and Great Lakes and extreme southeastern Ontario (Wilson et al. 2000, Nowak 2002, Kyle et al. 2006).

Distribution in Ontario

The number of genetic samples collected within and outside of the extent of occurrence has been extensive (COSEWIC 2015). Most of the samples have been collected through a large study undertaken by MNRF that has been underway since 2002 (COSEWIC 2015). Numerous research projects related to the ecology of Algonquin Wolf have been conducted in APP and surrounding areas over the last 50 years (Pimlott *et al*. 1969; Forbes and Theberge 1995; Forbes and Theberge 1996; Wydeven *et al*. 1998; Mills *et al*. 2008; Loveless 2010; Rutledge *et al*. 2010c; Rutledge et al. 2016; Benson *et al*. 2013, 2014 from COSEWIC 2015).

Algonquin Wolves occur from Killarney Provincial Park east to the Ottawa Valley, and south to Fenelon Falls and Buckhorn. There have been a few Algonquin Wolves confirmed through genetic testing from the Sault Ste. Marie and Manitoulin areas (COSSARO 2016; Figure 2), although the status of the individuals is unknown (i.e., resident, disperser or vagrant).

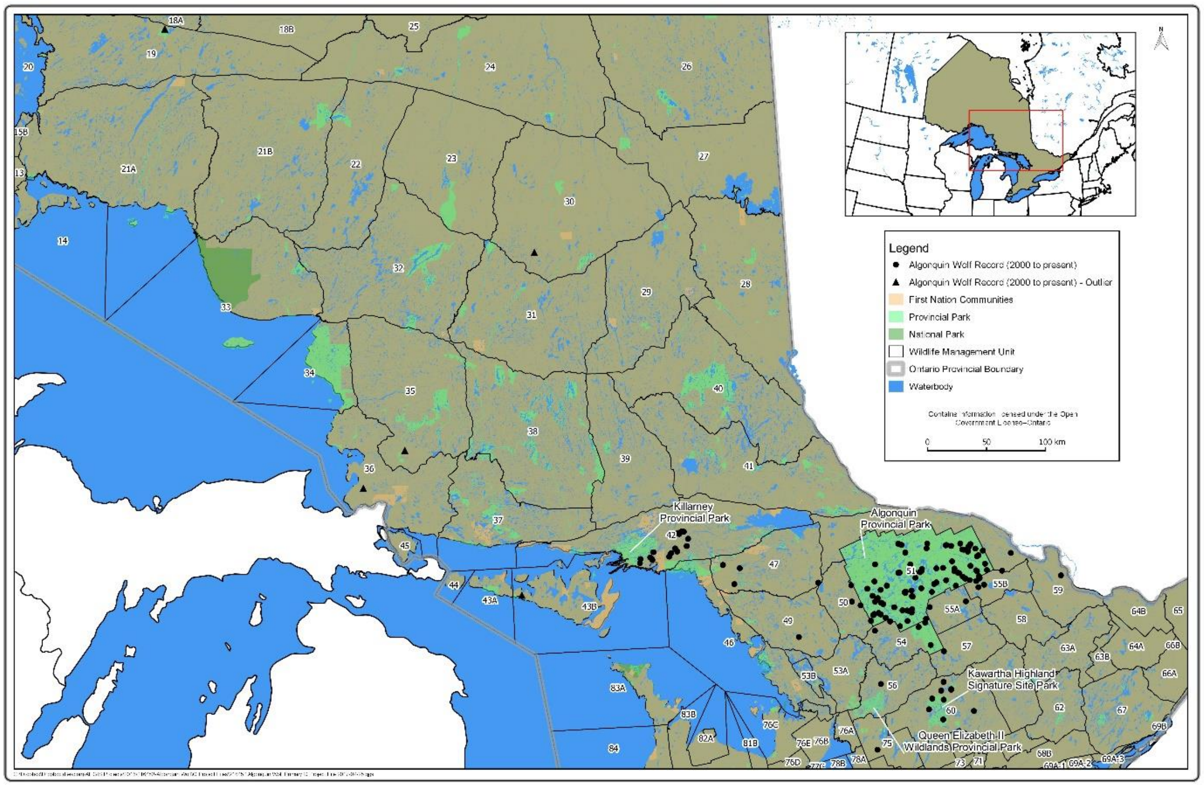

Figure 2. Algonquin Wolf (*Canis* sp.) records in Ontario (Rutledge et al. 2010a; Benson et al. 2012; Rutledge et al. 2016; OMNRF, unpub. data).

The core of the Algonquin Wolf population in Ontario is APP (7,630 km^2) and the area surrounding APP (6,340 km^2) (Figure 3). Sixty-nine percent of the canids in this area are assigned to Algonquin Wolf (Rutledge et al. 2010b). Algonquin Wolves from APP disperse to areas outside APP, and the persistence of Algonquin Wolves outside APP may be sustained through emigration from APP (Benson et al. 2014). However, it is unknown whether individuals move between the northwest portion of APP and Killarney Provincial Park as few wolves have been radio-collared in that area (B. Patterson pers. comm. 2017c). The continued presence and dominance of Algonquin Wolves in APP since at least the beginning of the 20th century is likely due to historical abundance, strong territoriality, assortative mating and high survival due to protection from hunting and trapping (Benson et al. 2014).

Outside APP, known occurrences of Algonquin Wolves are patchily distributed throughout the mixed Great Lakes-St. Lawrence Forest Region of central Ontario. Resident Algonquin Wolves have recently been documented in or near Killarney Provincial Park, Kawartha Highlands Signature Site Park, Queen Elizabeth II Wildlands Provincial Park, WMU 47 and one individual Algonquin Wolf in WMU 49 (Rutledge et al. 2010a, Benson et al. 2012, COSEWIC 2015, Rutledge et al. 2016; Figure 2).

The recovery zone for the Algonquin Wolf in Ontario is estimated to be 39,092 km^2 (Figure 3). The recovery zone was delineated using occurrence data for genetically confirmed Algonquin Wolves. Records from Sault St. Marie and Manitoulin Island (Figure 2) were not included in the recovery zone as these animals were not radio-tracked and their status is unknown (e.g., resident, breeding).

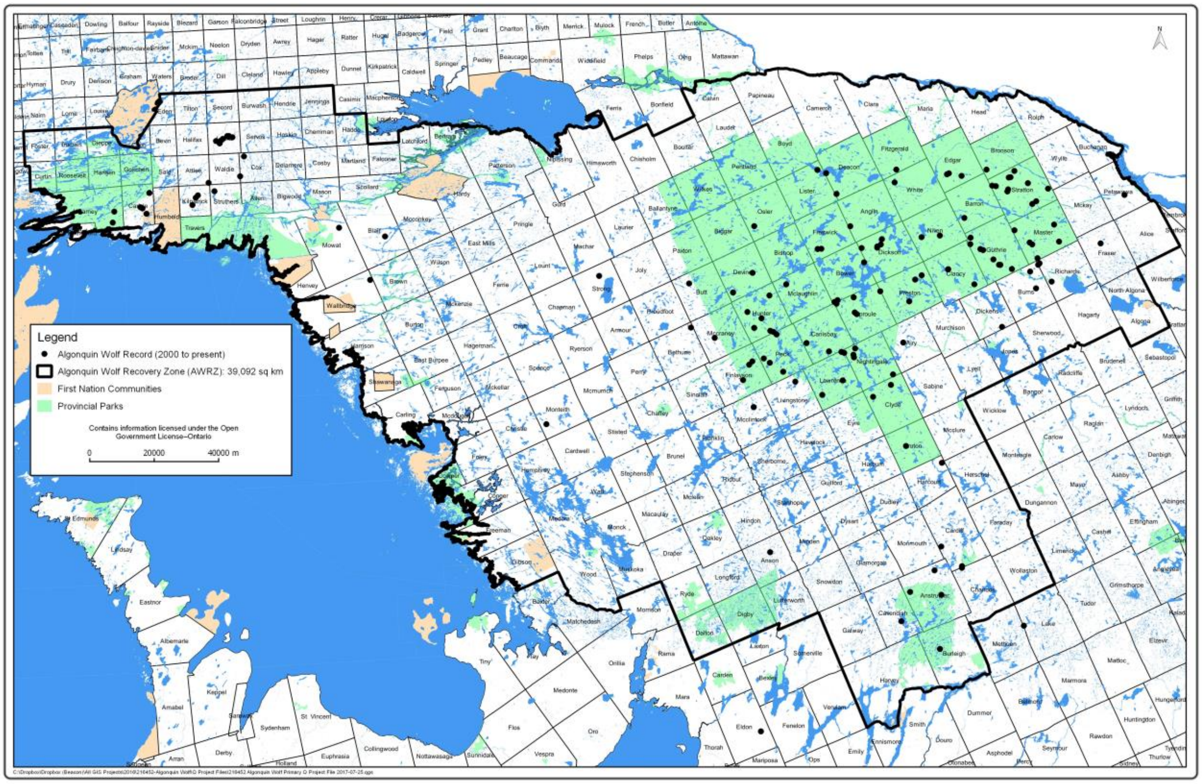

Figure 3. The Algonquin Wolf recovery zone (AWRZ) in Ontario, delineated using occurrence data for genetically confirmed Algonquin Wolves, including most of the known locations of the species in Ontario (Wheeldon 2009, Rutledge et al. 2010a, Benson et al. 2012, Wheeldon and Patterson 2012, Wheeldon et al. 2013, Rutledge et al. 2016).

Distribution Outside Ontario

The distribution of the Algonquin Wolf outside Ontario includes southern Quebec, north of the St. Lawrence River (COSEWIC 2015). Algonquin Wolves were once thought to have occurred across southern Ontario, southern Quebec and into the eastern United States (Wilson et al. 2000, Kyle et al. 2006, Rutledge et al. 2010d). Currently, the Algonquin Wolf is not believed to be present outside Canada (COSEWIC 2015). The Canadian extent of occurrence is estimated to be 126,573 km^2 (COSEWIC 2015).

Both mitochondrial and Y chromosome haplotypes associated with the Algonquin Wolf have been found as far as Saskatchewan and across the northeastern United States (COSSARO 2016). However, these occurrences likely represent historical hybridization events, and the descendants of these hybrids are not highly assigned Algonquin Wolves. Therefore, Algonquin Wolves are currently only known from Ontario and Quebec.

Abundance in Ontario

The population of Algonquin Wolves in Ontario has been estimated at between 250 and 1,000 individuals (COSSARO 2016). For context, the Eastern (Algonquin) Wolf national population size is estimated to be between 450 and 2,620 individuals or 205 to 1,203 mature animals (Environment Canada and Climate Change [ECCC] 2017).

The effective population size for the Algonquin Wolves in APP was estimated to be between 24 and 122 individuals, with a harmonic mean of 45.6 (Rutledge et al. 2016).

Population estimates for this species vary greatly based on the source and they have a high level of uncertainty.

Population Trends

There does not currently appear to be reliable population trend estimates either for Ontario or for the Canadian population.

However, research has been underway since 2001 to specifically examine the effects of the harvest ban in APP and the 40 surrounding Townships on Algonquin Wolves in APP. Theberge et al. (2006) obtained 11 consecutive years (1989 to 1999) of Algonquin Wolf population estimates from eastern APP. Wolf densities ranged from 1.4 to 3.4 wolves per 100 km^2 between 1988 and 1999, with the lowest density recorded in 1999 (Theberge et al. 2006) **(Figure 4).** During this period, human-caused mortality, including both shooting and trapping, accounted for 67% of the known annual mortality (Theberge et al. 2006). After the harvest ban was initiated in late December 2001, population densities ranged from 2.9 to 3.1 wolves per 100 km^2 (Rutledge et al. 2010c) (**Figure 4).** The Algonquin Wolf population in APP experienced a positive response to the hunting and trapping ban. A rate of increase in wolf density of 0.20 wolves per 100 km^2 was noted between 1999 and 2003. However, no further increases in density were noted between 2003 and 2007, despite a marked reduction in human-caused mortality from hunting and trapping: 42 human-caused deaths were noted pre-ban and five were noted post-ban (Rutledge et al. 2010c). This was due in part to the fact that natural causes replaced human causes as the leading causes for wolf mortality in APP (21 pre-ban and 26 post-ban (Rutledge et al. 2010c).

Despite the high rates of pup mortality in western APP, the Algonquin Wolf population is stable, with annual survival of 85 percent for adults and yearlings (Benson et al. 2014).

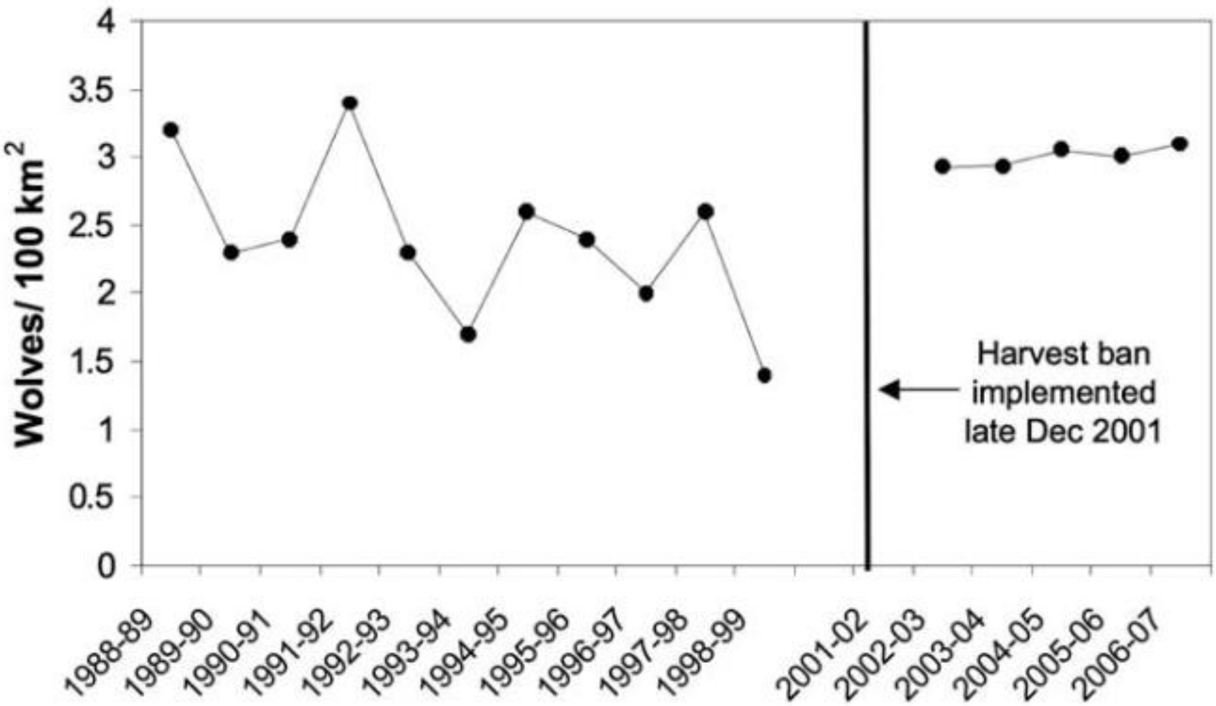

Figure 4. Wolf density in Algonquin Park, Canada. Pre-ban (1989–1999) data are from Theberge and Theberge (2004). Post-ban data was collected after a hunting and trapping ban was implemented in townships surrounding the park. From Rutledge et al. 2010c).

1.5 Habitat Needs

Algonquin Wolves are generally not restricted to a specific habitat type, and habitat is thought to be defined by a combination of competition, availability of vulnerable prey, den sites and rendezvous sites. Availability of prey and distance of the natal den from human disturbance also influence habitat use (COSEWIC 2015, Benson et al. 2015). Algonquin Wolves are typically associated with lower levels of human presence (e.g., roads and urban development) and higher densities of Moose than surrounding areas (Benson et al. 2012).

Territories

Territoriality is thought to ensure access to space and resources, particularly prey (Mech and Boitani 2003). Territory size is likely related to the abundance of vulnerable prey and size of a pack, while permanent land features (e.g., waterbodies, hills) do not seem to determine territory boundaries (Theberge and Theberge 2004).

Algonquin Wolves move within a defined territory to hunt and defend it from neighbouring packs (see Benson and Patterson 2013), and wolves in general use scent marking or howling to communicate the boundaries of their territory with neighbouring packs (Mech and Boitani 2003, Benson and Patterson 2013). Average pack territory size in APP is approximately 190 ± 88 km^2 (mean ± SD, *n*=12; Loveless 2010). Outside APP in the Papineau-Labelle Wildlife Reserve in Quebec, average territory size is approximately 199 km^2 (± SE 16, n=19) (Potvin 1988). Territories are most often exclusive, and very little overlap has been documented among Algonquin Wolves, Eastern Coyotes and other admixed canids (Benson and Patterson 2013). Factors including harvest regulation, fragmentation of habitat by roads, and genetic structure of the local canid populations do not appear to influence spatial overlap among territories (Benson and Patterson 2013).

Dens

Dens are an important habitat feature used by Algonquin Wolves from early April to early May for pup rearing. Protection of den sites for Eastern Wolf is described in the Forest Management Guidelines for Conserving Biodiversity at the Stand and Site scales (OMNR 2010a). In eastern APP, Algonquin Wolves have been documented establishing den sites more commonly in conifer forest (Benson et al. 2015), particularly in pine forests (Norris et al. 2002) and near water (Benson et al. 2015). Dens may also occur in wetlands, mixed forests, hardwood forests, and rock/grass habitats (Benson et al. 2015). The presence of dens next to water may be because females avoid leaving their pups unattended when lactating (Benson et al. 2015). Dens can be tunnels excavated into the ground, around tree roots or into banks (Benson et al. 2015). Rock dens, which include crevices between or under rocks and boulders, are also used in APP (Benson et al. 2015). Joslin (1967), Pimlott et al. (1969) and Voigt (1973) have documented use of large hollow logs as den sites. Pine forests offer well-drained sandy soils that are suitable for digging, and low elevations that are clear of understory to facilitate easy travel to and from the den. However, dens have been located in a wide range of soil and forest types in APP (COSEWIC 2015). Dens may be used in subsequent years (Pimlott et al. 1969, Argue et al. 2008, Benson et al. 2015,), although reuse is low in APP, indicating that den sites are not a limited habitat feature in APP (Benson et al. 2015).

Rendezvous Sites

Rendezvous sites are also an important habitat feature used by Algonquin Wolves. Protection of traditional rendezvous sites for Eastern Wolf is described in the Forest Management Guidelines for Conserving Biodiversity at the Stand and Site scales (OMNR 2010a). Wolves use rendezvous sites to provide a source of protection, water, food, and shelter for the pups. A series of rendezvous sites are used from early summer to fall (Joslin 1967, Voigt 1973, Argue et al. 2008, Mills et al. 2008), after the pack has left the denning site. Theberge and Theberge (2004) hypothesized that Algonquin Wolves tended to not have a habitat preference for rendezvous sites, and that the selection of rendezvous sites may relate more to the presence of ungulate kills or the mobility of pups. Joslin (1967), Pimlott et al. (1969), and Voigt (1973) found rendezvous sites from packs in eastern APP to be primarily beaver meadows (i.e., abandoned beaver floodplains) or similar areas with open play areas, nearby conifer and alder shade, appropriate hiding areas, and situated close to water (creeks or lakes). Recent research confirms that wolves in APP tend to select wetlands and conifer forests for rendezvous sites, and that rendezvous sites are most often located near water (Benson et al. 2015). A small number of rendezvous sites in APP may also be used year after year (Theberge and Theberge 2004).

Landscape Level Habitat Requirements

Algonquin Wolves are currently associated with areas with limited human presence or human activity and higher Moose densities than the surrounding areas (Benson et al. 2012). Although they may use a variety of habitat types, Algonquin Wolves are most often associated with extensive forested areas (COSEWIC 2015), that may include coniferous forests, hardwood forests, mixed forests, wetlands, and rock barrens.

1.6 Limiting Factors

Population Expansion from Algonquin Provincial Park

A significant limiting factor for Algonquin Wolves appears to be their inability to establish outside APP or other core areas. Expansion outside APP is limited by three main factors. These are:

(1) Increased susceptibility to human-caused mortality when compared to other canid types (Benson et al. 2014);

(2) The physical presence of territorial Eastern Coyotes and other admixed canids in the areas outside APP (Benson and Patterson 2013); and

(3) The limited number of Algonquin Wolves, and therefore conspecific mating opportunities for Algonquin Wolves outside APP (Benson et al. 2012), likely increases breeding events (i.e., hybridization) that do not contribute to Algonquin Wolf population growth (Benson et al. 2014).

Increased susceptibility to human-caused mortality, including hunting and trapping, appears to limit survival of dispersing Algonquin Wolves outside of the areas where they are protected from hunting and trapping (see **Threats to Survival and Recovery**). Benson et al. (2014) found that Algonquin Wolves were 2.1 (95% Confidence Interval: 1.3, 3.4) times more likely to die than other canid species when they travelled outside of APP. Algonquin Wolves were 3.5 (95% Confidence Interval: 1.5, 7.8) times more likely to be trapped or shot than other canid species. Further, transient or dispersing animals from all canid groups (including Algonquin Wolves) were 2.7 times more likely to die from harvest mortality relative to residents.

The presence of the Eastern Coyote and other admixed canids limits expansion outside APP, as most of the known habitat is occupied by territorial canid packs and territoriality exists regardless of ancestry of the individual pack members (Benson and Patterson 2013). Although the Algonquin Wolf is generally larger than the Eastern Coyote, a dispersing individual, most of which are solitary, younger animals, would be unlikely to displace a pack of resident Eastern Coyotes or other admixed canids and successfully establish a territory. Therefore, the presence of other canid types reduces the possibility for a single dispersing Algonquin Wolf to establish a territory outside APP.

Finally, if an Algonquin Wolf is able to establish a territory outside APP, the chance of finding a conspecific mate may be low. Benson et al. (2012) found that approximately 13 percent of the canids captured in central Ontario (outside APP) were Algonquin Wolf, compared to inside APP where 63 percent were Algonquin Wolf (Benson et al. 2012). For this reason, mating events among the Algonquin Wolf, the Eastern Coyote, the Great Lakes Wolf, and other hybrids also continues to occur outside APP (Rutledge et al. 2010a, Benson et al. 2014) (see **Threats to Survival and Recovery**). These mating events do not contribute to the population growth of the Algonquin Wolf.

Poor survival outside APP is likely a key limiting factor that further influences hybridization dynamics by keeping the density of Algonquin Wolves low, which limits mating opportunities among Algonquin Wolves (Benson et al. 2014).

The presence of the Great Lakes Wolf to the north of the Algonquin Wolf range is also considered a limiting factor; however, hybridization between the Algonquin Wolf and Great Lakes Wolf is considered to be a natural evolutionary process, given that the two species were living in sympatry prior to European settlement (Nowak 1995, Nowak 2002). Similarly, competition between Algonquin Wolf and Great Lakes Wolf is limited, as these species have different habitat and prey requirements (Kolenosky and Standfield 1975, Wheeldon 2009).

1.7 Threats to Survival and Recovery

The predominant threats to the Algonquin Wolf include: mortality from hunting, trapping and roads; hybridization with Eastern Coyote.

Human-caused mortality, including hunting, trapping, and, to a much lesser degree, vehicular collisions are known to be the major sources of mortality for Algonquin Wolves (Theberge et al. 2006, Rutledge et al. 2010a, Benson et al. 2014).

Rabies and mange have contributed to mortality in the past, but are not consistent threats to the Algonquin Wolf.

Hunting and Trapping

Hunting and trapping have been described as major causes of mortality for the Algonquin Wolf in Ontario (Theberge et al. 2006, Rutledge et al. 2010a, Benson et al. 2014). Annual survival for the Algonquin Wolf in APP (where hunting and trapping is not permitted) is 85 percent. Annual survival for Algonquin Wolves outside APP is 39 percent (Benson et al. 2014). Benson et al. (2014) found that for all canid types hunting and trapping was by far the major source of mortality in central Ontario. Between 2004 and 2010, 24.0 ± 3.9 percent (mean ± SE, n=29) of all canids outside of APP were killed by hunting and trapping, while 6.7 ± 2.5 percent (n=8) were killed by vehicles, 5.8 ± 2.1 percent (n=7) by natural causes and 4.7 ± 2.1 percent (n=5) by unknown causes. The study further found that Algonquin Wolves outside APP were more likely to die than other canids and more likely to be trapped or shot than other canids in the same area (see **Limiting Factors**).

Recent data indicate that many of the Algonquin Wolves found outside APP have dispersed from APP (Patterson et al. in review), and it is hypothesized that these animals may be naïve to mortality risk from humans and roads, which increases their susceptibility to mortality (Benson et al. 2014). Within APP and other provincial parks Algonquin Wolves may use roads to travel across rugged terrain and to capture prey without increased risk of mortality (Benson et al. 2014). Conversely, using roads when outside APP may increase their susceptibility both to harvest mortality and to road mortality.

The Algonquin Wolf is a fur-bearing mammal that is regulated in Ontario under the *Fish and Wildlife Conservation Act*, 1997. In Ontario, wolves and coyotes are hunted for sport and commercial purposes and shot or trapped for commercial purposes by licenced trappers. The current (2017) wolf and coyote hunting and trapping season is from September 15 to March 31 in the wolf core range (WMU 1A, 1C, 1D, 2-42, 46-50 and 53-58; Figure 3 for WMUs). South of the core range, hunting and trapping of wolves and coyotes can occur year round. Hunters require a small game licence, and an additional wolf/coyote game seal (with a limit of two per year) to hunt within the core range. Hunters (game seal holders) are also required to submit a completed Wolf/Coyote Mandatory Questionnaire even if a wolf/coyote was not killed.

The number of Algonquin Wolves killed by hunters is unknown, since wolves and coyotes are not distinguished in the mandatory questionnaire. A total of 4,922 hunters purchased a Wolf/Coyote seal in 2016 in all of Ontario. Of these, 413 purchased a second seal. The reply rate to the mandatory questionnaire was 52 percent. These data are reported by WMU (OMNRF pers. comm. 2017). An extrapolation from hunter replies showed 33 wolf/coyote kills in the WMUs that partially or totally overlap with the Algonquin Wolf range. However, given the low reply rate it is unknown if this relatively low number is biased in either direction.

Trapping harvest typically exceeds hunting harvest (ECCC 2017). For example, a mail-in survey undertaken in southern Quebec reported that 97 percent of wolves harvested were harvested by trapping (Jolicoeur et al. 2000). In Ontario, the number of Algonquin Wolves annually harvested through trapping is unknown due to difficulties distinguishing among Algonquin Wolf, Eastern Coyote, and other hybrids. During the 2014/2015 harvest season, the pelts of 628 wolves and 3,643 coyotes were sold at Ontario fur auctions (R. Horwath pers. comm. 2017). The number that can be ascribed to Algonquin Wolves is unknown due to the difficulty of visually distinguishing between species.

Since 2001, hunting and trapping of wolves has not been permitted in APP or in the 40 townships that surround APP with the prohibition on hunting and trapping Eastern Coyotes added in 2004. Wolves are also protected from hunting in most Ontario provincial parks, all Crown Game Preserves and Pukaskwa National Park (COSEWIC 2015). Under a trapping phase-out policy, trapping of wolves will be eliminated from one-third of the remaining Ontario provincial parks where it is currently permitted (COSEWIC 2015).

Under an interim approach, an amendment to Ontario Regulation 670/98 (September 2016) has closed the hunting and trapping season for wolves and coyotes in three additional core areas where Algonquin Wolf is known to occur. These are: Kawartha Highlands Signature Site Park, Queen Elizabeth II Wildlands Provincial Park, and Killarney Provincial Park and surrounding townships. The amendment closed the hunting and trapping season in 40 additional townships, including those townships that fall within the parks. Although many known Algonquin Wolf territories fall partially within areas where hunting and trapping is prohibited, there are many packs whose territory extends beyond the boundary of these areas, and remain susceptible to harvest mortality (B. Patterson pers. comm. 2017a).

Algonquin Wolves were studied extensively in APP between 1989 and 1999, and research has been underway since 2001 to examine the effects of the harvest ban on the Algonquin Wolf population in APP. Theberge et al. (2006) obtained 11 consecutive years (1989 to 1999) of Algonquin Wolf population estimates from eastern APP. Densities ranged from 1.4 to 3.4 wolves per 100 km^2, with the lowest density recorded in 1999 (Theberge et al. 2006) (Figure 2). During this period, human-caused mortality, including both shooting and trapping, accounted for 67 percent of the known annual mortality (Theberge et al. 2006).

After the harvest ban was initiated in late December 2001, population densities ranged from 2.9 to 3.1 wolves per 100 km^2 (Rutledge et al. 2010c) (Figure 2). The population in eastern APP apparently doubled between 1999 and 2003 (Figure 2 in Rutledge et al. 2010c), However, no further increases in density were noted between 2003 and 2007, despite a marked reduction in human-caused mortality from hunting and trapping; 42 human-caused deaths were noted pre-ban but only five were noted post-ban (Rutledge *et al*. 2010c).

Although the density of Algonquin Wolves did not increase significantly within APP after the harvest ban, density did stabilize after the ban was initiated (Figure 3). Annual survival was 95 percent in 2002/2003, 82 percent in 2003/2004, 84 percent in 2004/2005, 82 percent in 2005/2006, but 70 percent in 2006/ 2007 when 12% of wolves in the Park died of mange (B. Patterson pers. comm. 2017d). A 95 percent survival rate is unprecedented and highly unusual even for wolves in areas where they are protected from hunting and trapping. In subsequent years, natural causes replaced human-caused mortality as the leading causes of wolf mortality in APP (natural mortality accounted for 33% of all deaths pre-ban vs 84% post-ban [Rutledge et al. 2010c]).

The social structure of Algonquin Wolf packs in APP was also restored following the harvest ban (Rutledge et al. 2010c); post-ban packs were less likely to accept unrelated individuals. According to Rutledge et al. (2010c), the social restoration of pack structure is an important element of a naturally-functioning ecosystem. Restoring social structure among packs can have positive effects on fitness such as the ability to better detect and kill prey, increased pup survival, and preclude or limit hybridization with Eastern Coyote due to lower turnover of canids in APP (Rutledge et al. 2010c). In addition, a more normal age structure is restored.

Rutledge et al. (2011) found Algonquin Wolves had a restored nuclear genetic signature (i.e., genes characteristic of Algonquin Wolves with little Eastern Coyote introgression), after the reduction in harvest mortality in the townships around APP. They suggested that mating events with Eastern Coyotes had increased previously, at a time when mortality rates in APP were high.

Research is also underway to determine the effects of the interim approach on the Algonquin Wolf population in Ontario (B. Patterson pers. comm. 2017a, b).

Hybridization with Eastern Coyote

Western Coyote originally inhabited the prairies and grasslands of North America (Parker 1995). As wolf numbers were reduced in the east and the north, the Western Coyote expanded northward and eastward. During this expansion, Western Coyote mated with Eastern Wolf and produced an intermediate-sized canid, which is known today as Eastern Coyote (Parker 1995; see **History of Hybridization in Ontario**). The first record of a coyote in southeastern Ontario was documented in 1919 (Nowak 1979).

Today, the Eastern Coyote occupies most of southeastern and parts of central Ontario (Figure 1). Breeding opportunities between Algonquin Wolf and Eastern Coyote appear to be widespread in areas outside APP (Rutledge et al. 2010a, Benson et al. 2012). These mating events do not contribute to the growth of the Algonquin Wolf population (Benson et al. 2012) and represent a threat to the long-term maintenance of the Algonquin Wolf in Ontario. Continued hybridization among canids in Ontario could lead to further genetic homogeneity, and increase the genetic dilution among parental groups (Otis et al. 2017).

Although hybridization is recognized as a natural evolutionary process, it also may be exacerbated by environmental factors, particularly high rates of human-caused mortality

(Benson et al. 2012, Rutledge et al. 2012, Benson et al. 2014; see **Limiting Factors**). Human-caused mortality appears to be a main cause for hybridization between the Algonquin Wolf and the Eastern Coyote around APP (Rutledge et al. 2011). Hybridization may occur more often when a wolf population becomes more socially fragmented (Rutledge et al. 2010c) and when a lone Algonquin Wolf has no choice but to mate with an Eastern Coyote due to a lack of mate availability (Ewins et al. 2000; see **Limiting Factors**).

Hybridization between Algonquin Wolves and Eastern Coyotes occurs less frequently in APP, as well as in other provincial parks in central Ontario (Rutledge et al. 2011, Benson et al. 2012, Rutledge et al. 2016). This is likely due to protection from human-caused mortality, as well as suitable environmental conditions, including lower levels of human presence and higher densities of large ungulate prey (Benson et al. 2012). APP in particular may be difficult for Eastern Coyote to inhabit, as the availability of smaller prey, as well as White-tailed Deer, is limited year round (Benson et al. 2012).

Road Mortality

Direct mortality through vehicular collisions is also a source of mortality for the Algonquin Wolf. Within APP, 140 adult Algonquin Wolves and 78 pup Algonquin Wolves were radio-tracked from 2002 to 2007 (B. Patterson unpub. data). Vehicular collisions accounted for deaths to 2.7 percent ±1.0 percent (mean ± SE) of adults and 3.7 percent ± 2.0 percent of pups. From 2004 to 2010, Benson et al. (2014) recorded the deaths of 39 Algonquin Wolves in APP and adjacent protected areas and 15 Algonquin Wolves outside of APP; vehicular collisions accounted for 4.9 percent and 6.7 percent of deaths respectively. Outside APP, Algonquin Wolves tend to avoid primary roads, which is likely an adaptive response to minimizing vehicular collisions, as most mortality from vehicles occurs on primary roads (Benson 2013). However, they are susceptible to vehicle collisions in areas of high secondary road density (Benson et al. 2014).

Road densities of less than 0.3 to 0.7 km of roads per km^2 have been suggested as necessary to maintain wolf populations (Wydeven et al. 1998). In southern Ontario the road density is generally greater than 0.6 km/km^2 (Buss and deAlmeida 1997). The road density in southern Ontario may prevent recovery of Algonquin Wolf in its historical range (COSEWIC 2015), especially where other mortality factors remain high.

Areas of higher road density (and the associated increased human presence) also increases the likelihood of hybridization between Algonquin Wolves and Eastern Coyotes (Benson et al. 2012). Roads may provide increased interactions with humans and increase hunting and trapping mortality (Benson et al. 2014), which can further exacerbate hybridization with Eastern Coyotes (see **Limiting Factors**).

1.8 Knowledge Gaps

Recovery for the Algonquin Wolf will require an ongoing understanding of distribution and movement patterns, habitat requirements and availability across the landscape, threats and the effectiveness of managing these threats, as well as socio-economic barriers to recovery of the Algonquin Wolf in Ontario.

The Algonquin Wolf has been one of the most intensively researched wildlife species in Ontario in recent years. However, successful recovery of the Algonquin Wolf in Ontario will need to include a flexible and adaptive management framework so that recovery actions can be adjusted as new information becomes available. The following is a summary of knowledge gaps for this species.

Distribution and Population Trends

Distribution of the Algonquin Wolf (specifically breeding pairs) and movement in Ontario and to Quebec

- The Algonquin Wolf is currently known from five areas in the province of Ontario. Although genetic samples have been obtained from much of the Algonquin Wolf range (Figure 1) three additional high priority areas have been identified for targeted research, including: (1) Madawaska Highlands, (2) Bancroft area; and (3) French River to Killarney (B. Patterson pers. comm. 2017).

- More detail on Algonquin Wolf movement patterns between APP and the French River to Killarney Area is needed to better understand movement patterns and potential dispersal corridors.

- Collaboration with the Province of Quebec to evaluate dispersal from Zone 3 (see Section 2 Recovery) to Quebec to better understand potential dispersal or travel corridors between the two provinces.

Population Viability Analysis for the Algonquin Wolf

- A Population Viability Analysis (PVA) that considers the sex, age-structure, and genotype structure of the population, and models interactions among behaviour, demography, genotype, and landscape is needed. A PVA should provide a better understanding of the likelihood of extinction of this species under different management scenarios, and provide a well-supported management framework for this species. Although some PVA work has been undertaken for the species (Vucetich and Paquet 2000; Patterson and Murray 2008), neither study considered genetics in estimating population viability (Rutledge et al. 2016). These are the critical considerations that must be accounted for in future PVA, especially outside APP, so that population growth is estimated based on conspecific breeding and not on hybridization.

Summer Predation and Diet of the Algonquin Wolf

- Currently little is known about summer predation and diet of Algonquin Wolves. Summer food shortages and perhaps the difficulty of killing Moose during snow-free months may contribute to poor pup survival, but the rate at which wolves kill Moose and White-tailed Deer during summer is unknown.

- Kill rates on Moose and White-tailed Deer should be estimated by investigating clusters of GPS data, using similar methods employed by Benson et al. (2017) during winter months.

- Estimates of smaller prey use during summer would be useful to understand the full range of diet (e.g., using scat analysis and/or stable isotopes).

Distribution of Habitat at the Landscape, Stand and Site Scale

- The Algonquin Wolf is typically a habitat generalist that primarily occurs in contiguous forested habitat types in the Great Lakes-St. Lawrence landscape. The Algonquin Wolf can persist in areas with mature, late-succession forest types, and high densities of Moose relative to other prey types, such as western APP. Areas with these habitat characteristics which also provide protection from human-caused mortality allow wolves to have high survival and limit interaction with Eastern Coyote. An analysis of the distribution of this habitat type at the landscape scale will assist in identifying potential recovery habitat and travel corridors, as well as guide future research efforts.

- Information is lacking at the forest stand and site level to support a habitat protection and management recommendations although prescriptions for traditional rendezvous sites and dens are included in OMNR (2010a). Prescriptions for prey of the Algonquin Wolf (i.e., White-tailed Deer and Moose) are provided for landscape, stand and site levels in OMNR (2010a, b). Details regarding specific habitat needs would be useful for identifying the area to be considered for a habitat regulation, as well as for directing other resource management activities.

Mitigation of Threats to Survival and Recovery

- There is an immediate need to assess the response of Algonquin Wolves (e.g., density, social structure, genetic structure) to the interim harvest ban. Details regarding the response of Eastern Coyote (and other canids), as well as prey distribution and abundance, would also help direct future management strategies.

- Further research is required to evaluate and mitigate the threat of hybridization. Details regarding hybridization rates in areas where human-caused mortality is eliminated (outside APP) will also help direct future management.

- An assessment of the social shifts in the perception of wolves by humans in Ontario and an assessment for the potential to increase positive human perceptions of the intrinsic and ecological value of wolves would assist in directing recovery efforts in Ontario.

Indigenous Knowledge, Perspectives and Practices

- Traditional Knowledge from communities within the Algonquin Wolf range would increase the available knowledge base, and in particular contribute to the debate surrounding the origin of this species. The following would be of particular relevance to the recovery of the Algonquin Wolf in Ontario: (1) Traditional Knowledge related to the distribution of wolves in Ontario, prior to European settlement; (2) the cultural, spiritual, ecological significance of the Algonquin Wolf; and (3) Indigenous harvesting practices.

1.9 Recovery Actions Completed or Underway

The following actions have been completed or are currently underway to assist with the recovery of the Algonquin Wolf in Ontario.

Research

- The ecology, distribution, genetics and threats to Algonquin Wolves in APP have been studied since the early 1960s (Pimlott et al. 1969, Kolenosky and Stanfield 1975; Forbes and Theberge 1992, 1995, 1996; Theberge et al. 1994, 2006; Norris et al. 2002; Grewal et al. 2004; Patterson et al. 2004; Theberge and Theberge 2004; Mills 2006; Argue et al. 2008; Mills et al. 2008; Patterson and Murray 2008; Rutledge et al. 2010b, 2010c, 2011, 2015, 2016; Vucetich and Paquet 2010; Benson et al. 2012, 2013, 2014, 2015; Benson and Patterson 2013).

- Similarly, data regarding distribution, ecology and genetics have been collected for canids in Ontario outside APP. These data have contributed greatly to understanding the dynamics of hybridization among canids outside APP (Schmitz and Kolenosky 1985; Sears et al. 2003; Kyle et al. 2006; Wheeldon 2009; Wheeldon and White 2009; Wilson et al. 2009; Holloway 2009; Loveless 2010; Rutledge 2010a; Rutledge et al. 2010b; 2010d, 2016; Benson et al. 2012, 2013, 2014, 2015, 2017; Benson and Patterson 2013; Benson and Patterson 2015; Otis et al. 2017).

Legal Protection

- The Algonquin Wolf was first protected from hunting and trapping in APP in 1958 (Theberge and Theberge 2004), when the first major research program began there (Pimlott et al. 1969). Park Rangers were encouraged to kill wolves up until 1958. The majority of APP was closed to hunting and trapping, except for small numbers taken by Indigenous trappers in the eastern part of APP (until 1991), and by trappers in Bruton, Clyde and Eyre Townships, which are in APP (Theberge and Theberge 2004).

- In 1972, wolves were protected in Ontario under the *Game and Fish Act* (OMNR 2005).

- In 1993, a seasonal (winter) wolf hunting and trapping prohibition was implemented in three additional townships adjacent to APP (Hagarty, Richard and Burns Townships), including the area in which the Round Lake Deer Yard is located, southeast of APP.

- In 1998, the Algonquin Wolf Advisory Group (AWAG 2000) was formed. The objectives of AWAG were to assess the status of wolves in APP, identify the issues relevant to their management, and to provide the Minister of Natural Resources with recommendations to ensure the long-term conservation of these wolves.

- In 2001, a ban on the harvesting of wolves was enacted in 40 townships surrounding APP and in two townships located within the park.

- In 2004, a permanent ban on hunting and trapping wolves and coyotes in APP and the 40 surrounding townships was put in place (total area of 15,623 km^2), increasing the protection for Algonquin Wolf by 6,340 km^2. Eastern Coyote was included in the ban due to the difficulty in visually distinguishing Algonquin Wolf from Eastern Coyote in the area. Additionally, a science strategy was developed by the Ontario Ministry of Natural Resources and Forestry (MNRF) to enhance research and monitoring of wolves, habitat and their main prey species (OMNR 2005a and b, OMNR 2014).

- In June 2016, the Eastern Wolf (*Canis lupus lycaon* or *Canis* sp. *cf. lycaon*) in Ontario was renamed the Algonquin Wolf (*Canis* sp.) by COSSARO (Committee on the Status of Species at Risk in Ontario) and re-classified as a threatened species under Ontario's *Endangered Species Act*, *2007* (ESA).

- In 2016, an amendment to Ontario Regulation 670/98 resulted in the closure of the hunting and trapping season for wolves and coyotes in additional core areas where Algonquin Wolves are known to occur. These were: Kawartha Highlands Signature Site Park, Queen Elizabeth II Wildlands Provincial Park, and Killarney Provincial Park. Areas outside of the additional core areas described above were exempted from Section 9 of the *Endangered Species Act, 2007*. This allowed hunting and trapping to continue in the interim outside the core areas in accordance with the Act and its supporting regulations, while the MNRF conducted the recovery planning process for Algonquin Wolf.

- Under a trapping phase-out policy, trapping of wolves will be eliminated from one-third of the remaining Ontario provincial parks within the AWRZ where it is currently permitted (COSEWIC 2015).

- Despite the hunting and trapping prohibition that is in place within the core Algonquin Wolf areas, there is an exemption under the *Endangered Species Act* that allows for species at risk to be killed, harmed or harassed if there is an imminent health and safety risk. In these situations, the exemption allows for an Algonquin Wolf to be killed, harmed, or harassed in the protection of people, livestock or animals from imminent risk. In situations where the threat from an Algonquin Wolf is not imminent, the person is able to protect their property by entering into a protection of property agreement with the Minister under the ESA. These agreements do not allow for the killing of Algonquin Wolf, but do allow for the harassment or capture and transfer.

Management

- A Strategy for Wolf Conservation in Ontario was developed by MNRF in 2005, which included goals, objectives and key strategies for managing wolves in Ontario (OMNR 2005). The strategy included implementation of the following policies for northern and central Ontario: a closed season for hunting and trapping from April 1 to September 14, requirement for a wolf/coyote hunting game seal (in addition to a small game licence) with a limit of two seals per year, and mandatory reporting by hunters and persons that kill a wolf in protection of property.

- The document entitled *Forest Management: Conserving Biodiversity at the Site and Stand Scales Guide* (OMNR 2010) provides recommendations on undertaking forestry activities within the Algonquin Wolf range. The guide describes an Area of Occupancy as 200 m from the entrance of an occupied (known to have been occupied a least once in the past ten years) Algonquin Wolf den. This guide provides recommendations when working (i.e., forest management activity) near an occupied den, including distances for harvest and tending activities, timing restrictions, and other activities. These guidelines apply to dens known before, and found during, operations. There is also a prescription for traditional rendezvous sites of the Eastern Wolf.

Education

- Education about wolves has been ongoing in Ontario’s provincial parks since 1963. As of 2016, there have been 117 wolf howl events, with over 168,000 people attending (R. Stronks pers. comm. 2017). In addition, 15 to 25 wolf talks about the ecology of wolves in APP and other provincial parks are given each year, with over 2,000 people attending annually. The wolf howl program at APP has been identified as a “Canadian Signature Experience” by Destination Canada.

Compensation

- Compensation programs for livestock and poultry losses to predators have been in place in Ontario since 1972, when the provincial bounty was eliminated. During that year, the *Wolf Damage to Livestock Compensation Act*, and the *Dog Tax and Livestock Compensation Act* were enacted (OMNR 1997).

2.0 Recovery

2.1 Recovery Goal

The recovery goal is to ensure a self-sustaining population of the Algonquin Wolf within the AWRZ in Ontario (Figure 3).

An accurate estimate of the Algonquin Wolf population is currently not available, although, all evidence suggest it is less than 1,000 mature individuals and potentially much less. The absence of a population estimate precludes the development of a recovery goal that provides a specific population target. Therefore, an area-based recovery goal that focusses on a sustainable population and expanded occupancy across the AWRZ (Figure 3) in Ontario has been developed. This recovery strategy focusses on mitigating threats, and connecting existing populations (including the Quebec population) so Algonquin Wolves can establish territories, and find mates of the same species both in and outside APP that will contribute to the overall growth of the Algonquin Wolf population with reduced hybridization with Eastern Coyotes and Gray Wolves.

COSEWIC (2015) estimated that a generation time for the Algonquin Wolf is likely 3.5 years. Because as many as 15 generations may be required to achieve the recovery goal, the timeline is 50 years. Ultimately, however, a Population Viability Analysis that considers the sex, age-structure and genotype structure of the population, as well as models interactions among behaviour, demography, genotype and landscape will be required to determine the timeline.

2.2 Protection and Recovery Objectives

The protection and recovery objectives assist with attaining the recovery goal. They provide a set of distinct measurable objectives that are relevant in both the short-term (within five years) and the long-term (greater than five years).

Table 3. Protection and recovery objectives.

No.	Protection and Recovery Objective
1	Mitigate or eliminate known threats, particularly intentional human-caused mortality, to the species and its habitat through harvest regulation, education, and management.
2	Assess changes to the population size, genetic structure, occurrence, and mortality rates of the Algonquin Wolf in Ontario.
3	Establish a standardized approach for long-term monitoring of the Algonquin Wolf population in Ontario.
4	Fill key knowledge gaps to better understand: a) Population viability; b) Location and quality of Algonquin Wolf habitat in Ontario, including identification of areas more favourable to Algonquin Wolves than Eastern Coyotes; c) Changes in density and distribution of the Algonquin Wolf and other canid types, and prey species in response to harvest management; and d) Human perception of wolves in Ontario and the potential to increase positive human perceptions of their intrinsic and ecological value.
5	Establish an inter-jurisdictional working group for recovery of the Algonquin Wolf to monitor recovery efforts, ensure integration among governments, and address key stakeholder concerns.
6	Strengthen the engagement of stakeholders and Indigenous communities in the implementation of recovery approaches for the Algonquin Wolf.

Narrative to Support the Recovery Objectives

The currently known population of Algonquin Wolves in Ontario is distributed within two general geographic areas. These are: (1) APP and areas to the south and south-west, and (2) Killarney Provincial Park and areas to the east and south (Figure 5). Algonquin Wolf in APP and the surrounding area is the most studied population in Canada and is thought to represent the core of the Algonquin Wolf population in Ontario. Although Algonquin Wolves are found in Quebec, the Ontario population, particularly the APP population, is important to the maintenance of the national population. The Ontario population of Algonquin Wolf was listed as threatened because the estimated population of mature individuals is less than 1,000 (COSSARO 2016). While the APP population appears stable, this small population size puts the Algonquin Wolf at risk in the long-term. Therefore, this recovery strategy focusses on mitigating threats and connecting existing sub-populations such that the overall population can grow and recover.

The proposed AWRZ (Figure 5) defines the geographic area within which recovery approaches should be undertaken. The AWRZ includes areas that are currently occupied, as well as areas that provide connectivity among currently occupied sites. Providing connectivity among the currently occupied sites will be critical for establishing and maintaining packs outside APP.

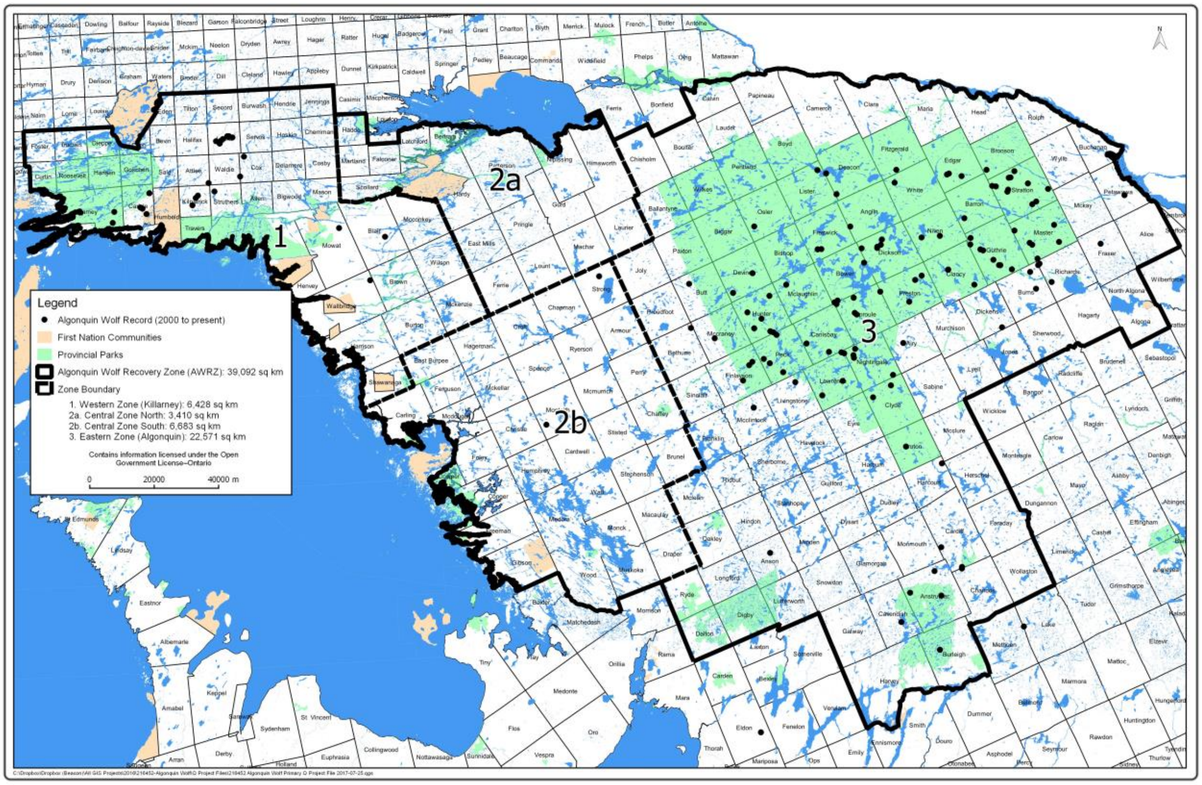

Figure 5. The Algonquin Wolf (*Canis* sp.) Recovery Zone (AWRZ) and three management zones (occurrence data from Rutledge et al. 2010a; Benson et al. 2012; Rutledge et al. 2016; OMNRF, unpub. data).

Three management zones have been delineated to guide recovery approaches (see **Algonquin Wolf Recovery Zone Delineation**). Population expansion and occupancy in Zones 1 and 3 will require east - west connectivity, through protection from hunting and trapping mortality. A higher susceptibility than other canids to harvest mortality makes it difficult for Algonquin Wolves to establish beyond currently occupied areas (Benson et al. 2013). Their potential to establish and persist in all of these areas would be greatly increased by minimizing harvest mortality.

It is currently unknown if the area between APP and Killarney (see Zone 2a in Figure 5) is used as a travel corridor or dispersal route by Algonquin Wolves to connect those two populations as few wolves have been radio-collared in northwestern APP.

The presence of other canids, especially Eastern Coyote, provides a significant barrier to recovery across the AWRZ. Despite the fact that resident Algonquin Wolves have been documented breeding in Zone 2b, there is a real possibility that even with protection from harvest, the presence of Eastern Coyote in this area will function as an insurmountable barrier to establishment of Algonquin Wolves. The presence of Eastern Coyotes on the landscape, including their ability to defend and hold a territory, and more importantly their ability to hybridize with Algonquin Wolves, remains a critical concern for the recovery of the species that may only be directly addressed through intense, costly and unjustifiable management that has a low likelihood of succeeding. The Eastern Coyote continues to present a threat to the recovery of several canid species including the species known as the Red Wolf (Wayne and Jenks 1991, Adams et al. 2003 from ECCC 2017), which is present in the southeastern United States.

Algonquin Wolves in APP have thrived with a relatively stable population and the least amount of Eastern Coyote hybridization, compared to other areas. APP is characterized by continuous forest cover, low human disturbance, protection from hunting and trapping, low road mortality, and high moose densities. These factors appear to have favoured survival of the Algonquin Wolf in APP over hybridization with the Eastern Coyote; strengthening the notion that recovery objectives and approaches outside APP need to focus on these factors.

The six protection and recovery objectives identified below address the need for: (1) mitigating threats; (2) assessing Algonquin Wolf status; (3) monitoring management actions; (4) filling knowledge gaps; and (5) coordination and engagement of various governments and non-government groups. While fulfilment of all objectives may be required for the overall recovery of the Algonquin Wolf population in Ontario, recovery outside of APP is not likely to occur without mitigating the current threats.

Algonquin Wolf Recovery Zone Delineation

Three zones were delineated within the AWRZ to direct recovery approaches (Figure 5). These approaches may differ among zones. The three zones identify areas that are differentiated in the following ways: (1) the presence of Algonquin Wolves and/or other canids; (2) types of habitat and prey for Algonquin Wolves; (3) potential for connectivity among currently occupied areas; and (4) types and degrees of threat.

The following information was used to delineate zones within the AWRZ:

1) Historic range of the Algonquin Wolf (Nowak 1995, Rutledge et al. 2010a);
2) Known occurrence of genetically confirmed Algonquin Wolves, Eastern Coyotes, Great Lakes Wolves and other admixed canids (Wheeldon 2009, Rutledge et al. 2010a, Benson et al. 2012, Wheeldon and Patterson 2012, Wheeldon et al. 2013, Rutledge et al. 2016; Figure 1);
3) Location and movement patterns of radio-collared Algonquin Wolves, including territory size (Benson et al. 2012, B. Patterson pers. comm. 2017b);
4) Forest cover type and condition (OMNRF pers. comm. 2017);

5) Human activity, including: urbanization (using ortho-rectified satellite imagery), livestock premises (unpub. data via OMAFRA pers. comm. 2017), and road density (Buss and de Almeida 1997); and
6) Current and historic populations of Moose and White-tailed Deer (OMNRF, pers. comm. 2017) and their habitats, primarily White-tailed Deer yards (OMNRF 2017).

The southern limit of the AWRZ was delineated based on the extent of fragmented landcover and areas heavily occupied by the Eastern Coyote. The northern limit of the AWRZ was delineated based on the presence of the Great Lakes Wolf.

A description of each zone follows.

Zone 1 - Western (Killarney/Magnetawan) Zone

This zone is approximately 6,428 km^2 and includes eight provincial parks and nature reserves. The five largest parks in terms of area are: French River Provincial Park (736 km^2), Killarney Provincial Park (494 km^2), Killarney Lakelands and Headwaters Provincial Park (154 km^2), Grundy Lake Provincial Park (36 km^2) and Magnetawan River Provincial Park (34 km^2) (Figure 5).This zone is primarily within WMU 42 and WMU 47, where Moose populations have been relatively high and stable. White-tailed Deer have thrived in WMU 47, which contains several deer yards. The Loring Deer Yard (Ontario's largest deer winter concentration area in the 1980s; Broadfoot et al. 1996), is situated within WMU 47. American Beaver densities were high in Zone 1 in the 1960s; however, American Beaver have presumably declined as forests have matured.

Zone 1 has large tracts of contiguous forest consisting of pine, tolerant hardwoods and intolerant hardwoods (OMNRF pers. comm. 2017). Fragmentation is low in this zone; there are few livestock operations, and urbanization is also limited. Although Highway 69 (a major highway) runs north/south through the zone, road density is low.

Zone 1 has genetically confirmed records of breeding, resident Algonquin Wolves throughout (Benson et al. 2012; Rutledge et al. 2016; Figure 5). Eastern Coyotes, Great Lakes Wolves and other admixed canids have also been documented (Figure 1).

Hunting and trapping occurs in Zone 1. In 2015/2016 seven wolves and 154 coyotes were reported as harvested through trapping from Parry Sound District. Similar rates were reported in 2014/2015 (six wolves and 108 coyotes). Zone 1 is partly within Parry Sound District.

Zone 2 - Central Zone

This zone is roughly 10,093 km^2 in area and is bounded by Zones 1 and 3. There are 13 provincial parks and nature reserves completely or partially within Zone 2. The five largest parks in terms of area are: French River Provincial Park (736 km^2), The

Massasauga Provincial Park (132 km^2), Restoule Provincial Park (26 km^2), Round Lake Provincial Nature Reserve (26 km^2) and Mashkinonje Provincial Park (21 km^2).

Zone 2 is primarily within WMUs 53a, 53b, 49, and 47. Deer harvests have been moderate, with success rates of 20 to 30 percent per hunter since 2000. There are small to medium-sized deer yards throughout Zone 2. Moose populations vary from 13.5 to 25.0 moose/100 km^2 in the WMUs within this zone (OMNRF pers. comm. 2017). While American Beaver occur throughout Zone 2, there are currently no population or trend estimates available for this area. When compared to the other two zones, Zone 2 has a greater level of human activity, including a fragmented landscape and more primary and secondary roads. Highway 11, a major highway, runs north south through this zone. Zone 2 (particularly WMU 49) has cleared land and fragmented second-growth forest that promotes the occurrence of small mammals and White-tailed Deer, as well as increased access for humans. There is also a higher density of livestock operations than in Zones 1 and 3, particularly along the Highway 11 corridor. Zone 2 has few occurrences of genetically confirmed Algonquin Wolf; although breeding has been confirmed in recent years. Zone 2 is also well within the dispersal range for Algonquin Wolves moving from APP. Zone 2, however, has a high density of Eastern Coyote and other admixed canids (Figure 1).

It remains unknown whether the northern portion of Zone 2 (Zone 2a, Figure 5) functions as a corridor for Algonquin Wolves moving between Zone 1 and Zone 3. Movement data are lacking for the Algonquin Wolves in northwest APP as few wolves were collared in the northwest portion of APP. It is plausible that Algonquin Wolves are moving from northwest APP to Zone 1, as Algonquin Wolves have been tracked further south moving from APP to WMU 49 (Benson et al. 2012). The movement from APP to Killarney is well within the known dispersal range for the species. In response to this potential for a movement corridor, Zone 2 has been divided into two zones. Zone 2a is the northern portion, with the potential to be a corridor between Zones 1 and 3. Zone 2b is the southern half, where a limited number of Algonquin Wolves occur in the presence of many admixed canids.

Hunting and trapping occurs in Zone 2. In 2015/2016 seven wolves and 154 coyotes were reported as harvested through trapping from Parry Sound District. Similar rates were reported in 2014/2015 (six wolves and 108 coyotes). Zone 2 is partly within Parry Sound District.

Zone 3 - Eastern (Algonquin) Zone

Zone 3 measures roughly 22,571 km^2 in area. It includes APP, where Algonquin Wolves have persisted with protection since the 1960s. The Algonquin Wolves in APP, including their movements and rates of survival, were well-studied during the 1960s, the 1980s and 1990s, and more intensively since 2004. The APP population is currently the largest known population of Algonquin Wolf in Ontario.

Including APP there are 27 provincial parks and nature reserves completely or partially within Zone 3. The five largest parks in terms of area are: APP (7,630 km^2), Kawartha Highlands Signature Site Park (375 km^2), Queen Elizabeth II Wildlands Provincial Park (335 km^2), Mattawa River Provincial Park (141 km^2) and Samuel de Champlain Provincial Park (25 km^2).

The three largest parks (APP, Kawartha Highlands Signature Site Park and Queen Elizabeth II Wildlands Provincial Park) have genetically confirmed Algonquin Wolves (Figure 5). Wolves in all three provincial parks move outside park boundaries, and pack territories often extend beyond the park boundaries.

There are persistent populations of Moose, White-tailed Deer and American Beaver throughout Zone 3. White-tailed Deer densities are moderate, with hunter success rates of 20 to 30 percent. White-tailed Deer are prevalent throughout the areas south of APP, although populations have fluctuated primarily in response to winter conditions and changes in carrying capacity as forests have matured. This zone has a relatively stable Moose population, with the highest density in the entire MNRF Southern Region. High densities of Moose occur in APP, WMU 48 (38.5 moose/100 km^2),) and WMU 54 (42 moose/100 km^2). American Beaver densities are low within APP in areas dominated by mature tolerant hardwood forests. Concern has been expressed about the impacts of the Algonquin Wolf on American Beaver densities in and around APP. However, thus far no investigations have examined this question.

Zone 3 provides the largest contiguous habitat for Algonquin Wolves in Ontario. The area within Zone 3 that includes APP, Kawartha Highlands Signature Site Provincial Park, Queen Elizabeth II Wildlands Provincial Park, and the lands connecting these areas provide the greatest short-term potential for population expansion of the Algonquin Wolf.

Hunting and trapping occur in parts of this zone. In 2015/2016, 24 wolves and 180 coyotes were reported as harvested through trapping from the Bancroft District. Similar rates were reported in 2014/2015 (eight wolves and 137 coyotes).

2.3 Approaches to Recovery

The approaches to recovery (Table 4) are implementable elements that address the specific objectives and in turn, support the recovery goal.

Table 4. Approaches to recovery of the Algonquin Wolf in Ontario.

Objective 1: Mitigate or eliminate known threats, particularly intentional human-caused mortality, to the species and its habitat through harvest regulation, education, and management.

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Critical (Zone 1, 2a, and 3) Necessary (Zone 2b)	Short-term	Protection Management	1.1 Use existing acts and regulations to reduce and/or eliminate the threat of hunting and trapping mortality within the AWRZ.	Threats: • Hunting and Trapping
Necessary (all zones)	Ongoing	Education Outreach	1.2 Promote the expansion of education programs (including within provincial parks) to increase awareness of the species, threats to the species, and co-existence with humans and other wildlife.	Knowledge gaps: • Assists in providing support for recovery actions
Beneficial (all zones)	Short-term	Education	1.3 Update communication materials and policy documents with current common and scientific name to reduce confusion among public concerning the Algonquin Wolf, Eastern Wolf and other canid names.	Knowledge gaps: • Assists in providing support for recovery actions
Necessary (all zones)	Long-term	Management	1.4 Promote conservation and management strategies that encourage maintenance of habitat within the AWRZ that favours the Algonquin Wolf over the Eastern Coyote (e.g., contiguous tracts of mature forests with abundant prey [especially Moose], and little human disturbance).	Threats: • Hunting and Trapping • Hybridization with Eastern Coyotes

Objective 2: Assess changes to the population size, genetic structure, occurrence, and mortality rates of the Algonquin Wolf in Ontario.

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed

Necessary (Zones 1, and 3) Beneficial (Zone 2)	Ongoing	Management
		
		Inventory and Monitoring
			2.1 Continue monitoring genetic status of Algonquin Wolves in currently occupied areas (including APP and Townships around APP, Killarney Provincial Park, Kawartha Highlands Signature Site Provincial Park, Queen Elizabeth II Wildlands Provincial Park, and WMU 47).
			• Monitor density of Algonquin Wolves inside and outside APP (wolves per 100 km^2).
			• Monitor genetic structure and change of Algonquin Wolf packs over time.
			• Ensure that a summary of the following is available to the inter-jurisdictional working group, relevant stakeholders, and Indigenous communities every two years:
			  ◦ Current and historical density of Algonquin Wolves;
			  ◦ Estimate of number of breeding pairs; and
			  ◦ Estimate of percent of canids with $Q \geq 0.8$.
				Threats:
				• Hybridization
				• Hunting and Trapping
				• Road mortality
				
				Knowledge Gaps:
				• Distribution and Population Trends
				• Mitigation of threats to survival and recovery

Objective 3: Establish a standardized approach for long-term monitoring of the Algonquin Wolf population in Ontario.

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Necessary (Zones 1 and 3) Beneficial (Zone 2)	Long-term	Management Inventory and Monitoring	3.1 Develop and implement a long-term, standardized monitoring program to evaluate status, ongoing threats, and spatial distribution of Algonquin Wolves across the AWRZ. • Develop non-invasive sampling to monitor the genetic ancestry of Algonquin Wolves and other canid packs in the recovery area. • Collaborate with Indigenous communities, stakeholders (including where appropriate the hunting and trapping community), and citizen science data collection programs that are well-organized and targeted in areas of known or potential occurrence.	Threats: • All threats Knowledge gaps: • Distribution and population trends • Mitigation of threats to survival and recovery
Necessary (Zones 1 and 3) Beneficial (Zone 2)	Long-term	Management Inventory and Monitoring	3.2 Establish, implement and maintain a monitoring program that assesses abundance and distribution of prey species (including White-tailed Deer, Moose and American Beaver).	Knowledge gaps: • Mitigation of threats to survival and recovery
Necessary (all zones)	Long-term	Management Inventory and Monitoring	3.3 Maintain a standardized database for all population data, including those data collected by government, research and non-government organizations, as appropriate.	Threats: • All threats

Objective 4: Fill key knowledge gaps to better understand:

a) Population viability;
b) Location and quality of Algonquin Wolf habitat in Ontario, including identification of areas more favourable to Algonquin Wolves than Eastern Coyotes;
c) Changes in density and distribution of the Algonquin Wolf and other canid types, and prey species in response to harvest management; and

Human perception of wolves in Ontario and the potential to increase positive human perceptions of their intrinsic and ecological value.

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Critical (all zones)	Long-term	Research Management	4.1 Assess habitats currently occupied by Algonquin Wolves to better understand habitat requirements at both the landscape and local level (including prey abundance).	Knowledge gaps: • Distribution of habitat at the landscape, stand and site scale
Critical (all zones)	Long-term	Research Management	4.2 Assess options to improve and manage habitats at the landscape and local levels to benefit Algonquin Wolves to the detriment of Eastern Coyotes.	Threats: • All threats Knowledge gaps: • Mitigation of threats to survival and recovery
Critical (all zones)	Long-term	Research Management	4.3 Investigate the distribution of currently unoccupied habitat for Algonquin Wolves in Ontario, and explore options to assist in establishing naturally colonizing packs in these areas.	Threats: • All threats Knowledge gaps: • Mitigation of threats to survival and recovery

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Critical (all zones)	Ongoing	Research Management	4.4 Investigate all mortality causes to determine the effects of human-caused mortality relative to natural causes including threats posed by parasites, diseases, fighting among wolves, and starvation.	Threats: • Hunting and Trapping • Road mortality Knowledge gaps: • Mitigation of threats to survival and recovery
Necessary (all zones)	Ongoing	Research Management	4.5 Investigate anthropogenic and environmental factors that may affect the rate of hybridization with other canids, and implement successful strategies where appropriate.	Threat • Hybridization Knowledge gaps: • Mitigation of threats to survival and recovery
Necessary (all zones)	Short-term	Research Management	4.6 Undertake a Population Viability Analysis (PVA) to understand the likelihood of extinction of Algonquin Wolves in Ontario under different management scenarios, and thus a well-supported management framework.	Knowledge gaps: • Distribution and population trends
Necessary (all zones)	Short-term	Research Management	4.7 Undertake a Minimum Viable Population analysis that takes into consideration the genetic structure and demographics of the population to determine the minimum population size required to maintain a viable population.	Knowledge gaps: • Distribution and population trends

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Beneficial (all zones)	Long-term	Research Management Education	4.8 Undertake a survey of residents within the AWRZ regarding attitudes about Algonquin Wolves and identify potential conflict with wolves, to help target education programs and identify areas of concern to address. • Identify tolerance levels of residents and areas of concern.	Threat • Negative public perception of wolves Knowledge gaps: • Mitigation of threats to survival and recovery
Necessary (all zones)	Short-term	Inventory and Monitoring Management	4.9 Support Indigenous communities in collecting, storing and managing local and traditional knowledge related to the Algonquin Wolf and its habitat.	Knowledge gaps: • Indigenous knowledge, perspective and practices

Objective 5: Establish an inter-jurisdictional working group for recovery of the Algonquin Wolf to monitor recovery efforts, ensure integration among governments, and address key stakeholder concerns.

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Necessary (all zones)	Ongoing	All recovery themes	5.1 Establish an inter-jurisdictional working group, including representatives from Ontario, Quebec, the federal government and Indigenous communities, for integrated recovery of the Algonquin Wolf.	Threat • All threats

Objective 6: Strengthen the engagement of stakeholders, and Indigenous communities in the implementation of recovery approaches for the Algonquin Wolf.

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Critical (all zones)	Short-term	Management Protection	6.1 Support the development of an Algonquin Wolf advisory group, which consists of stakeholders, Indigenous communities, and government members, to provide advice and recommendations for sustaining the Algonquin Wolf and its habitat.	Threats: • All threats
Necessary (all zones)	Short-term	Inventory and Monitoring Management	6.2 Assess the inclusion of hair samples for genetic testing as part of the mandatory reporting requirements under the protection of property provisions under the *Fish and Wildlife Conservation Act*, and the *Endangered Species Act*.	Knowledge gaps: • Distribution and population trends
Necessary (all zones)	Short-term	Inventory and Monitoring Management Education	6.3 Assess obtaining hair samples and morphometric data (e.g., length, weight, paw size) from hunters and trappers in the AWRZ to improve knowledge of where the Algonquin Wolf occurs in Ontario. • Ensure results are reported to those who contribute samples.	Knowledge gaps: • Distribution and population trends
Necessary (all zones)	Ongoing	Management Education Outreach	6.4 Regularly present findings of ongoing research to stakeholders and Indigenous communities.	Threats • Hunting and trapping • Negative public perception of wolves

Relative priority	Relative timeframe	Recovery theme	Approach to recovery	Threats or knowledge gaps addressed
Necessary (all zones)	Ongoing	Management Education	6.5 Support, through research, and funding, actions that reduce conflicts between livestock producers and the Algonquin Wolf within the AWRZ. • Develop “best practices” for living with wolves” education material for livestock producers that operate within the AWRZ. • Work with government agencies to minimize the cost of deterrents for livestock producers (e.g., materials, licences).	Threat • Hunting and Trapping • Negative public perception of wolves

Narrative to Support Approaches to Recovery

The Algonquin Wolf was identified as threatened in both Ontario and Canada by both COSEWIC and COSSARO, due to the small size of the current population. Therefore, a delay in implementation of recovery approaches while additional research is undertaken may jeopardize the long-term recovery of the Algonquin Wolf. Efforts to minimize or eliminate threats to the species must be addressed in the short-term until the population can recover to a self-sustaining population.

The two most important factors threatening the Ontario population of the Algonquin Wolf are human-caused mortality (i.e., trapping, shooting and to a much lesser degree road mortality) and hybridization, especially with the Eastern Coyote and to a lesser extent with the Gray Wolf.

Adult survival has been identified as the most important demographic parameter influencing the population growth of Algonquin Wolves (Patterson and Murray 2008); therefore, the loss of adults can have long-term repercussions for the population as a whole. At a minimum, it will be important to ensure that there is connectivity and high survival of populations within and between Zone 1 and Zone 3 so that dispersing individuals can establish territories and have access to conspecific mates. Increasing survival will be the single most important recovery approach for this species, and human-caused mortality can be addressed directly.

The delineated AWRZ is primarily south of the Great Lakes Wolf range. It is expected that hybridization and competition could limit any expansion northwards. A more challenging issue is the current presence of Eastern Coyote and other admixed canids especially in Zone 2. Competition for space and further hybridization will make recovery difficult in Zone 2. Beyond mitigating or eliminating human-caused mortality, management for habitats that favor Algonquin Wolf over Eastern Coyote is one of the few approaches that may assist in recovery.

Hybridization may only be managed by managing for habitat that benefits the Algonquin Wolf at the expense of the Eastern Coyote. Resident packs of Algonquin Wolves are currently only known from five locations in the province of Ontario. Each of these areas can be characterized as large tracts of forested habitat, with relatively high densities of Moose and limited interaction with Eastern Coyotes. Furthermore, four of these areas provide some protection for hunting and trapping mortality. Although habitat availability is not thought to be a limiting factor for Algonquin Wolves, there is sufficient evidence to conclude that protecting habitats where Algonquin Wolves can persist and thrive in the absence of Eastern Coyotes, and human-caused mortality, may be an effective indirect means to address the hybridization threat.

Given the importance of the APP population and low density and survival rates outside APP, it will be important to continue to monitor the genetic structure of canids and density (wolves per 100 km^2) of Algonquin Wolves within APP to ensure that they remain the dominant canid in the future. Ongoing monitoring will also be required to regularly assess the density and genetic structure of known Algonquin Wolf populations in occupied habitat outside APP (including the Townships surrounding APP, Killarney Provincial Park, Kawartha Highlands Signature Site Provincial Park, Queen Elizabeth II Wildlands Provincial Park, and WMU 47).

In addition, the development of a long-term monitoring program will be required to evaluate status, ongoing threats, spatial distribution, and the effectiveness of management strategies for the Algonquin Wolf in Ontario. Such a long-term program will also be important for also monitoring densities of prey species (i.e., White-tailed Deer, Moose and American Beaver), as well as other canid types.

Several key knowledge gaps exist related to population viability, landscape level and local habitat requirements; and perceptions of the intrinsic and ecological value of wolves in Ontario. There is an immediate need to understand the effect of the interim harvest ban on both Algonquin Wolves and Eastern Coyotes, as well as on prey species density and distribution. Filling these knowledge gaps will assist with refining recovery objectives and directing future recovery approaches for this species.

Since a large area will be required to maintain this species, recovery will require the integrated engagement of a variety of stakeholders including federal and provincial governments, Indigenous communities, non-government organizations (including but not limited to Beef Farmers of Ontario, Ontario Fur Managers Federation, Ontario Fur Harvesters, Ontario Federation of Agriculture, Wolves Ontario, Ontario Federation of Anglers and Hunters, Ontario Sheep), researchers, landowners and the general public. Further, additional communication, data sharing, and joint efforts to implement recovery approaches will be required at all levels of government. The recovery strategies for Algonquin Wolves in Ontario, Quebec and Canada should be strongly integrated.

The involvement and cooperation of the public, primarily residents and stakeholders who live and operate within the recovery area for the Algonquin Wolf, will be critical for implementing a successful recovery of this species.

2.4 Area for Consideration in Developing a Habitat Regulation

Under the ESA, a recovery strategy must include a recommendation to the Minister of Natural Resources and Forestry on the area that should be considered in developing a habitat regulation. A habitat regulation is a legal instrument that prescribes an area that will be protected as the habitat of the species. The recommendation provided below by the author will be one of many sources considered by the Minister when developing the habitat regulation for this species.

Habitat for the Algonquin Wolf is defined by competition, availability of prey, den and rendezvous sites, and distance of the natal den from human disturbance (COSEWIC 2015, Benson et al. 2015, Benson et al. 2017). Historically, the Algonquin Wolf thrived in many habitat types, including both late and early succession forest stages. Their preferred prey, White-tailed Deer, American Beaver and Moose, also thrived in these forest types. Today, the Algonquin Wolf is not generally limited by habitat type but within Ontario occurs most often in contiguous tracts of forested habitat; specifically areas with limited human presence, protection from hunting and trapping mortality, and higher Moose densities than the surrounding area (Benson et al. 2012). As previously discussed in this document, this habitat type appears to favour the Algonquin Wolf, to the detriment of the Eastern Coyote. The Eastern Coyote has thrived in fragmented forests or agricultural land. While Eastern Coyotes can prey on deer, they rarely prey on Moose, and they are primarily a predator of small prey species compared to wolves.

The following was considered when developing a recommendation for the area to be considered in developing a habitat regulation:

- Hybridization remains a major threat to the Algonquin Wolf. Today, the Algonquin Wolf most often occurs in Ontario in areas where forests are contiguous and often in late succession stages and where Moose are the primary prey item. These areas appear to be less favourable for Eastern Coyotes and therefore Algonquin Wolves may persist in these areas with less hybridization (Benson et al. 2012).

- Hybridization between Algonquin Wolves and Eastern Coyotes occurs less frequently in APP, and other provincial parks in central Ontario (Rutledge et al. 2011, Benson et al. 2012, Rutledge et al. 2016) due to historical abundance, strong territoriality, assortative mating and high survival due to protection from hunting and trapping (Benson et al. 2014).

- Average pack territory size (home range) in APP is approximately 190 ± 88 km^2 (mean ± SD; Loveless 2010), and 199 km^2 (± SE 16, n=19) in the Papineau-Labelle Wildlife Reserve in Quebec (Potvin 1988). Territory size is related to pack size and biomass of prey (Mech and Boitani 2003).

- Currently, Algonquin Wolves occur primarily in APP, most likely due to the availability of prey, the large area of the park itself, protection from harvest, and limited interaction with Eastern Coyotes and other admixed canids (Benson et al. 2012, COSEWIC 2015). Habitat conditions and the prey species available in western APP may preclude Eastern Coyotes from establishing.

- Within Ontario, Algonquin Wolves are almost all found in provincial parks, even though sampling has been undertaken over a wide range of park and non-park, areas (COSEWIC 2015). The number of genetic samples collected within the AWRZ has been extensive (Wheeldon 2009; Rutledge et al. 2010a; Benson et al. 2012; Wheeldon and Patterson 2012; Wheeldon et al. 2013; Rutledge et al. 2016; Figure 1 and Figure 5).

- Den sites are an important habitat feature that are used for pup rearing. Dens are commonly established in conifer forest (Benson et al. 2015), particularly in pine forests (Norris et al. 2002) and near water (Benson et al. 2015), although dens may also occur in wetlands, mixed forests, hardwood forests, and rock/grass habitats (Benson et al. 2015). Reuse over subsequent years within APP is low (Pimlott et al. 1969, Argue et al. 2008; Benson et al. 2015), suggesting that den sites are not a limited habitat feature within APP. Algonquin Wolves select den sites away from roads in areas where harvest is permitted (Benson et al. 2015). The availability of denning sites outside APP is unknown (J. Benson, pers. comm. 2017a).

- Within APP dens were located within conifer forests, wetlands, mixed forests, hardwood forests, water, and rock/grass habitats (Benson et al. 2015). The analysis of these data showed that when compared to rendezvous sites, dens were more often located near wetlands, water, tertiary roads, and on steeper slopes (Benson et al. 2015).

- Rendezvous sites are also an important feature and provide a source of protection, water, food, and shelter for the pups. Algonquin Wolves may chose rendezvous sites based on prey availability or mobility of pups (Theberge and Theberge 2004), and near a water source (Benson et al. 2015). A small number of rendezvous sites are used year after year, suggesting that they are not a limited habitat feature within APP (Theberge and Theberge 2004). The availability of rendezvous sites outside APP is unknown (J. Benson, pers. comm. 2017b).

The following currently occupied areas, as well as the areas that provide a connection between the currently occupied areas, should be considered in developing a habitat regulation for the Algonquin Wolf:

- APP (7,630 km^2) and the 40 surrounding townships including: Airy, Alice, Ballantyne, Boulter, Boyd, Bruton, Burns, Butt, Calvin, Cameron, Chisholm, Clancy, Clara, Clyde, Dickens, Dudley, Eyre, Finlayson, Franklin, Fraser, Hagarty, Harburn, Harcourt, Havelock, Head, Herschel, Lauder, Livingstone, Maria, McClintock, McClure, McCraney, McKay, Murchison, Papineau, Paxton, Petawawa, Richards, Rolph, Sabine, Sinclair, and Wylie. These areas continue to maintain the highest densities of the Algonquin Wolf with the least Eastern Coyote presence and least hybridization (Rutledge et al. 2010a). APP and the 40 surrounding townships represent a source population for areas outside APP (Figure 5).

- Currently occupied areas or likely occupied areas outside APP, including: Killarney Provincial Park (including the geographic townships of Allen, Attlee, Bevin, Burwash, Caen, Carlyle, Cox, Curtin, Dieppe, Eden, Foster, Goschen, Halifax, Hansen, Humboldt, Killarney, Kilpatrick, Laura, Roosevelt, Sale, Secord, Servos, Struthers, Tilton, Truman, and Waldie), Kawartha Highlands Signature

Site Park (including the geographic townships of Anstruther, Burleigh, Cardiff, Cavendish, Chandos, Harvey, and Monmouth), Queen Elizabeth II Wildlands (including the geographic townships of Anson, Dalton, Digby, Longford, Lutterworth, Minden, and Ryde), and, within WMU 47, the former geographic townships of Mowat, Blair, McConkey, Walbridge, Brown and Wilson (Figure 5).

- The areas that provide a connection between these occupied areas, particularly in Zone 1, Zone 2a, and Zone 3 (Figure 5).

The following features within the Great Lakes-St.Lawrence landscapes in the AWRZ should be managed for Algonquin Wolves using current forest management guidelines (OMNR 2010a, b):

- Forested landscapes with little fragmentation or agricultural clearing including contiguous forest stands of various ages and types (coniferous, hardwood and mixedwood forests);

- Natural habitats such as wetlands and rock barrens mixed with contiguous forest stands that provide for Algonquin Wolf prey populations. Forested areas with low human presence (e.g., roads and trails) and high Moose densities would be more beneficial to Algonquin Wolf than Eastern Coyote; and

- Natural habitats, including those listed above, that provide dispersal and travel corridors between occupied sites, as well as sites traditionally used for dens or rendezvous sites.

Urban areas, and areas with high human use such as urban centres, industrial areas and primary roads are little used by Algonquin Wolves and not considered important habitat for the species and are not recommended for inclusion in a habitat regulation.

Glossary

Admixture (hybridization): Genetic admixture occurs when two or more previously isolated populations begin interbreeding.

Assortative Mating: A term used to describe how animals can choose mates in a non-random pattern.

Canid: A member of the dog family (Canidae).

Carrying Capacity: Maximum number of individual organisms that the resources of a given area can support for an extended period of time.

Cf: Used in writing to refer the reader to other material to make a comparison with the topic being discussed. The abbreviation "sp. *cf*." in the scientific name means that the Eastern Wolf is recognized as a distinct species based on the best available data, while taking into account that the current taxonomic debate has yet to be completely resolved (COSEWIC 2015).

Committee on the Status of Endangered Wildlife in Canada (COSEWIC): The committee established under section 14 of the *Species at Risk Act* that is responsible for assessing and classifying species at risk in Canada.

Committee on the Status of Species at Risk in Ontario (COSSARO): The committee established under section 3 of the *Endangered Species Act*, *2007* that is responsible for assessing and classifying species at risk in Ontario.

Competition: Interaction among individuals that are competing for the same space or resources.

Conservation Status Rank: A rank assigned to a species or ecological community that primarily conveys the degree of rarity of the species or community at the global (G), national (N) or subnational (S) level. These ranks, termed G-rank, N-rank and S-rank, are not legal designations. Ranks are determined by NatureServe and, in the case of Ontario's S-rank, by Ontario's Natural Heritage Information Centre. The conservation status of a species or ecosystem is designated by a number from 1 to 5, preceded by the letter G, N or S reflecting the appropriate geographic scale of the assessment. The numbers mean the following:

1 = critically imperiled
2 = imperiled
3 = vulnerable
4 = apparently secure
5 = secure
NR = not yet ranked

Dispersal: Generalized movement of individuals within a population away from their original home range; non-directed movement in general.

Effective Population Size: The effective size of a real population is equal to the number of individuals in an ideal population (i.e., a population in which all individuals reproduce equally) that produces the rate of genetic drift seen in the real population.

Endangered Species Act, *2007* (ESA): The provincial legislation that provides protection to species at risk in Ontario.

Genetic Cluster: Clusters represent genetically distinct groups with differentiated ancestry.

Genetic Drift: Random fluctuations in gene frequencies that occur as a result of non-representative combinations of gametes during mating, especially in small populations.

Habitat: Place where an animal normally lives or where individuals of a population live.

Habitat Generalist: A species that can exploit a variety of habitats in a given geographic range.

Halotype: A is a group of genes within an organism that was inherited together from a single parent.

Harmonic Mean: A specific type of average that is used when dealing with averages of units. Using the harmonic mean is most appropriate when the set of numbers contains outliers that might skew the result. It is calculated by adding the reciprocals of the numbers in the data set, and dividing the number of items in the data set by the answer.

Home Range: An area over which an animal moves during normal daily activities.

Hybridization: The interbreeding of individuals from two populations, or groups of populations, which are distinguishable on the basis of one or more heritable characters.

Hybrid Zone: Areas where individuals from genetically distinct populations interbreed and produce offspring.

Hypothesis: A tentative answer to a question from which testable predictions can be generated.

Inferred ancestry coefficient (Q): Genetic correlation between relatives by determining the probability that two alleles are identical by descent or an exact copy of an ancestral allele.

Introgression: The permanent incorporation of genes from one set of differentiated populations into another, i.e., the incorporation of alien genes into a new, reproductively integrated population system.

Minimum Viable Population Analysis (MVPA): Analysis of the minimum population size at which a population is likely to persist over some defined period of time with a given probability of extinction.

Morphology: Study of the form and structure of living organisms.

Morphological: The size, shape and structure of an organism or of one of its parts.

Population Viability Analysis (PVA): The general term for the application of models that account for multiple threats (i.e., demographic, environmental, and genetic) facing the persistence of a population to access the likelihood of the persistence of the population over a given period of time.

Prey: Animal consumed by another.

Principal Components Analysis: A statistical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components.

Self-sustaining: A population that has a high (90%) probability of persistence and is capable of sustaining itself while under the influence of stressors.

Species at Risk Act (SARA): The federal legislation that provides protection to species at risk in Canada. This act establishes Schedule 1 as the legal list of wildlife species at risk. Schedules 2 and 3 contain lists of species that at the time the Act came into force needed to be reassessed. After species on Schedule 2 and 3 are reassessed and found to be at risk, they undergo the SARA listing process to be included in Schedule 1.

Species at Risk in Ontario (SARO) List: The regulation made under section 7 of the *Endangered Species Act, 2007* that provides the official status classification of species at risk in Ontario. This list was first published in 2004 as a policy and became a regulation in 2008.

STRUCTURE: A widely used population analysis tools that allows researchers to assess patterns of genetic structure in a set of samples.

Ungulate: Collective term used to designate hooved mammals.

Wolf Core Range: Wildlife Management Units 1A, 1C, 1D, 2-42, 46-50 and 53-58.

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List of abbreviations

APP: Algonquin Provincial Park

Cm: Centimetre

COSEWIC: Committee on the Status of Endangered Wildlife in Canada

COSSARO: Committee on the Status of Species at Risk in Ontario

EOO: Extent of Occurrence

ESA: Ontario's *Endangered Species Act, 2007*

ISBN: International Standard Book Number

Kg: Kilogram

Km^2: Square kilometres

OMNR: Ontario Ministry of Natural Resources

OMNRF: Ontario Ministry of Natural Resources and Forestry

PVA: Population Viability Analysis

SARA: Canada's Species at Risk Act

SARO: Species at Risk in Ontario

Sp.: Species

WMU: Wildlife Management Unit

Appendix A: Aboriginal Peoples' of Eastern Georgian Bay Resolution on the Algonquin Wolf

Aboriginal Peoples' of Eastern Georgian Bay Resolution on the Algonquin Wolf

The Aboriginal Peoples' of Eastern Georgian Bay Resolution on the Algonquin Wolf was drafted at the culmination of a workshop hosted by Magnetawan First Nation and Beacon Environmental, attended by First Nation community members from the Eastern Georgian Bay area including Magnetawan First Nation, Shawanaga First Nation and Nipissing First Nation. The purpose of the workshop was to discuss issues surrounding the conservation and recovery of the Algonquin Wolf, to provide feedback, and where applicable to gather Traditional Ecological Knowledge.

We recognize, that while extensive research on the Algonquin Wolf has been conducted in the Algonquin area, more research should occur in the Eastern Georgian Bay area.

It is important that when considering species protection, that protection be focused and directed on saving the species, and not associated with financial outcomes. The aboriginal perspective on preserving Turtle Island and the species we share it with, is built on respect (minaadendamowin) and love (zaagi'idiwin) for nature itself.

The Algonquin Wolf is a species that crosses many territorial boundaries during its life-time and will require cooperation and relationship building between a variety of stakeholders. Relationship building between Governmental bodies including First Nations is an important aspect of Algonquin Wolf recovery. We encourage partnerships between governmental bodies, Aboriginal communities, stakeholders and citizens of the Province of Ontario.

We believe that Traditional Ecological Knowledge along with scientific information must be understood, then utilized prior to and while addressing actions for recovery of the Algonquin Wolf. This resolution has been signed by the following on behalf of their respective communities.

Appendix B: Season Closures for Hunting and Trapping Wolf and Coyote

Ontario

Season Closures for Hunting and Trapping Wolf and Coyote

Provincial Park Boundary

Wildlife Management Unit Boundary

No Open Season for Hunting and Trapping Wolf and Coyote

This map is illustrative only. Do not rely on this map for legal administrative purposes. Do not rely on it as being a precise indicator of routes, locations of features, or as a guide to navigation. This map may contain cartographic errors or omissions.

Map data compiled from various sources.
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Datum: North American 1983

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