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Ontario Species at Risk Evaluation Report for

Eastern Wolf (Canis sp.)

Committee on the Status of Species at Risk in Ontario
(COSSARO)

Assessed by COSSARO as Threatened

March 2022

Final

Executive summary

Eastern Wolf was previously referred to as the Algonquin Wolf (*Canis lycaon*) by COSSARO. The name change was adopted in the November 18, 2021, virtual meeting. The final assessment and voting were deferred to the March 31/April 1, 2022, COSSARO meeting.

Eastern Wolf is an intermediate-sized canid that lives in family-based packs and feeds on prey that includes Beaver, White-tailed Deer, and Moose. The Eastern Wolf in Ontario is largely restricted in Ontario to Algonquin Provincial Park plus surrounding areas, some of which are protected. These include an area from Killarney Provincial Park south to Kawartha Highlands Signature Site. More distant records are relatively infrequent and likely attributable to occasional long-distance dispersal events, The total number of canids in this genetic group likely numbers between 350 and 1,000 (maximum) mature individuals, and populations at this time seem relatively stable.

Although some authors have postulated that the eastern wolf lineage originated from hybridization between gray wolf and coyote, numerous studies present evidence that the eastern wolf represents a distinct evolutionary unit (lineage) that diverged from a common ancestor with either gray wolf or coyote. Historic and contemporary hybridization appear to have contributed to allele sharing observed between Eastern Wolf and coyote. However, the two species are significantly differentiated at DNA markers, suggesting that they remain largely reproductively isolated. In addition, morphological data identify Eastern Wolf as being generally larger than *C. latrans*-type canids, and smaller than *C. lupus*-type canids, although reliable identification requires genotypic data.

1. Eligibility for Ontario status assessment

1.1. Eligibility conditions

1.1.1. Taxonomic distinctness

The Eastern Wolf population found predominant in and around Algonquin Park and surrounding townships in Ontario was previously identified as Algonquin Wolf by COSSARO. Here we revert back to Eastern Wolf, consistent with other taxonomic classifications (Rutledge et al. 2010a; Benson et al. 2012; COSEWIC 2015), which in turn has been identified as either *Canis lycaon* (Rutledge et al. 2010a; Benson et al. 2012), *Canis sp. cf. lycaon* (COSEWIC 2015), or *Canis lupus lycaon* (Van Zyll de Jong and Carbyn 1999). Much of the debate about the taxonomy of *Canis* is associated with the arrival of the Coyote (*Canis latrans*) into eastern North America. In a continental-scale invasion, Coyotes from the Prairie region of North America expanded northward and eastward; the first record in southeastern Ontario was in 1919 (Nowak 1979). These small *Canis* (e.g., adult male averages of 13 - 14 kg in different parts of the central Prairies [Parker 1995]) bred with a larger Canis in the Great Lakes region and produced an intermediate-sized animal (e.g., adult male averages of 14.6 - 21 kg in different parts of northeastern North America [Parker 1995; Villemure and Jolicoeur 2004]). The new animal, named the Eastern Coyote, then established itself across eastern Canada, reaching Québec in 1944, Nova Scotia in the 1970s, and Newfoundland in 1985 (Parker 1995; Naughton 2012).

There is general consensus that the historical and continued sympatric distributions of *C. lycaon*, *C. lupus*, and *C. latrans* has led to widespread and longstanding hybridization, backcrossing, advanced-generation hybridization, and introgression among these three taxa in eastern North America (Grewal et al. 2004; Rutledge et al. 2010a; Way et al. 2010; Wheeldon et al. 2010b; Wilson et al. 2012; Benson et al. 2012; Rutledge et al. 2012), and this introgression may also have involved genes from domestic dogs (C. lupus familiaris) (Wilson et al. 2012; Wheeldon et al. 2013; Monson et al. 2014). This explains some of the confusion regarding the identity and distribution of Eastern Wolves (see Section 1.3).

Morphological data provide a potential method for identifying putative Eastern Wolves, as there are numerous records of canids in Ontario that are intermediate in size to Gray Wolves and Coyotes (e.g. Kolenosy and Standfield 1975; Theberge and Theberge 2004; Rutledge et al. 2010b; Benson et al. 2012). The Eastern Wolf phenotype is a continuum of sizes that are generally intermediate to C. lupus and C. latrans (Benson et al. 2012), and this intermediate size range has been attributed to hybridization between Gray Wolves and Coyotes (Nowak 1979, 1995), or a response to changes in prey size (Young and Goldman 1944; Kolenosky and Standfield 1975; Schmitz and Kolenosky 1985; Brewster and Fritts 1995; Nowak 1995). The hybrid wolves of APP are overall intermediate in size to C. lupus-like canids and C. latrans-like canids, typically weighing < 30 kg (Theberge and Theberge 2004). Based on data collected in Algonquin Park

from 2002 - 2007, female average yearling weight is 18.1 kg and female average adult weight is 24.2 kg, whereas male average yearling weight is 23.5 kg and average adult weight is 29.3 kg (COSEWIC, 2015). Average adult shoulder height for Eastern Wolves in Ontario is 63.8 cm for females and 70.0 cm for males (Brent Patterson pers. comm. cited in COSEWIC [2015]). However, size ranges do have some overlap between Algonquin Wolves, C. latrans-like canids, and C. lupus-like canids (B. Patterson, pers. comm. 2015), and therefore size is not a completely reliable identifier.

To date, the most definitive assignments of individuals to the Eastern Wolf population have been based on population genetic data. Researchers have used these data, typically microsatellite allele and genotype frequencies, combined with programs such as Structure (Pritchard et al. 2000; Falush et al., 2003; Hubisz et al. 2009), to first identify the most plausible number of genetic clusters within any given data set; in this context, clusters represent groups of potentially interbreeding individuals that each conform to parameters such as Hardy-Weinberg equilibrium and linkage equilibrium. Once such clusters have been identified, membership to each cluster can be estimated by inferred ancestry to each cluster. COSEWIC (2015) used an inferred ancestry coefficient (Q) of 0.8 or higher as the threshold for identifying animals as Eastern Wolves. There is no known 'pure' Eastern Wolf individual or population that can be used as a genetic reference, and it is therefore most accurate to say that the Q value of 0.8 or higher can be used to identify wolves with a high level of inferred ancestry to the Ontario population. Indeed, the COSEWIC report (2015) acknowledges that '…we lack enough specimens that have been collected before Coyotes were present to characterize a pure Eastern Wolf'. This lack of reference material, combined with a well-documented pattern of hybridization, admixture, and introgression among Ontario canids (see above), means that the Eastern Wolf in Ontario is most appropriately described as a hybrid group that collectively represents a genetically discrete cluster with distinct morphological characteristics.

More recently, Heppenheimer et al (2018) assessed the genetic variation among 281 canids in central Ontario, the first single nucleotide polymorphism (SNP) dataset with substantial representation of its kind for this taxonomic group. The reported eastern wolf dispersal outside the boundaries of Algonquin Provincial Park (APP), with eastern wolf genetic variation decreasing with distance from the park. For this assessment, we therefore considered individuals with an inferred ancestry of 0.8 or higher (following Structure analyses) to the APP wolves to belong to the genetic cluster that largely inhabits APP.

Geneclass (Piry et al. 2004) assignment tests supplemented the Structure analyses by using the Algonquin reference population of 88 canids with Q>0.8 (based on Structure; Rutledge et al. [2010]) to determine whether or not canids from an additional 105 individuals sampled from outside APP were assigned to the APP population. Nineteen individuals from outside the park were assigned to the APP population by Geneclass, whereas 33 individuals from the same group were identified by Structure as having an inferred ancestry of 0.8 or greater with the APP population (T. Wheeldon, L. Rutledge, B. Patterson, unpublished data). This discrepancy had a negligible impact on both the extent and the area of occurrence of Eastern Wolves, and although it did reduce by 14

the number of wolves outside APP identified as having high ancestry with the Eastern Wolf, the uncertainty in total population size associated with incomplete sampling outside APP means that the difference in inferred numbers of Eastern Wolves outside the park based on the two methods of analysis (Structure versus Geneclass) is unlikely to have an appreciable impact on estimates of total population size. Because both methods (Structure and Geneclass) are model-based, both carry sets of assumptions, and should be viewed as complementary analytical approaches. In this case, the outcomes from each type of model were of sufficient similarity to strengthen our overall conclusions regarding distribution and population size.

Finally, an unpublished study found that some alleles in the major-histocompatibility complex (MHC), a group of genes involved in immune response, were found in Eastern Wolves but not in either Eastern Coyotes or Grey Wolves. Although preliminary, these data further reinforce the conclusion that the Eastern Wolf comprises an evolutionarily distinct unit.

Collectively, the data outlined above support the premise that the Eastern Wolf conforms to the broad definition of species defined by Endangered Species Act, 2007 (ESA), which states that “species” means a 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”. Following this definition, the genetic distinctness of the Eastern Wolf, combined with its native status, makes it suitable for Ontario status assessment.

1.1.2. Designatable Units

The Eastern Wolf (Canis Lycaon, Ontario population) comprises a single genetic cluster to which the majority of APP canids are assigned at an inferred ancestry of 0.8 or higher.

1.1.3. Native status

The Eastern Wolf (Canis sp.) has been postulated to share ancestry with C. lycaon, which is native to Ontario, with records dating back to the 1700s (COSEWIC 2015). The long-term presence of an intermediate-sized canid in eastern Canada is also confirmed by Aboriginal Traditional Knowledge. Gray Wolves are also considered native to Ontario, and Eastern Coyotes have been in Ontario for at least 100 years. Therefore, all of the taxa within this hybrid complex are native to Ontario and Canada and Ontario.

1.1.4. Occurrence

The Eastern Wolf (Canis sp.) is known to occur in Ontario. The current Ontario distribution of the Eastern Wolf is in central Ontario, with core concentrations in APP and surrounding townships (Figure 1). The Eastern Wolf also occurs in and around Killarney Provincial Park, Kawartha Highlands Signature Site, Queen Elizabeth II Wildlands, and the Magnetawan area (Rutledge et al. 2010a; Benson et al. 2012; Wilson et al. 2009; B. Patterson, pers. comm.). In addition, there are a few records from

Manitoulin Island and the area around Sault Ste. Marie. This distribution is based on genetic analysis (Structure) of 154 individuals as mapped in COSEWIC (2015) and six additional analyzed records from the Natural Heritage Information Centre.

1.2. Eligibility results

The Eastern Wolf (Canis sp.) is eligible for status assessment in Ontario.

2. Background information

2.1. Current designations

- GRANK: G2, Imperiled, Eastern Wolf (Canis lupus lycaon)
- IUCN: NSR, Eastern Wolf (Canis lupus lycaon)
- NRANK Canada: N2N3, Eastern Wolf (Canis lupus lycaon)
- COSEWIC: Threatened, Eastern Wolf (Canis lupus lycaon)
- SARA: Special Concern (under consideration for status change)
- ESA 2007: Threatened
- SRANK: S4, Eastern Wolf (Canis lupus lycaon)

2.2. Distribution in Ontario

The Eastern Wolf is discontinuously distributed in the mixed Great Lakes-St. Lawrence Forest of central Ontario and is concentrated in various protected areas (Figures 1 and 2). It occurs from Killarney Provincial Park east to Algonquin Provincial Parkand the Ottawa Valley, south to Fenelon Falls and Buckhorn, with rare records west to the Sault Ste. Marie area.

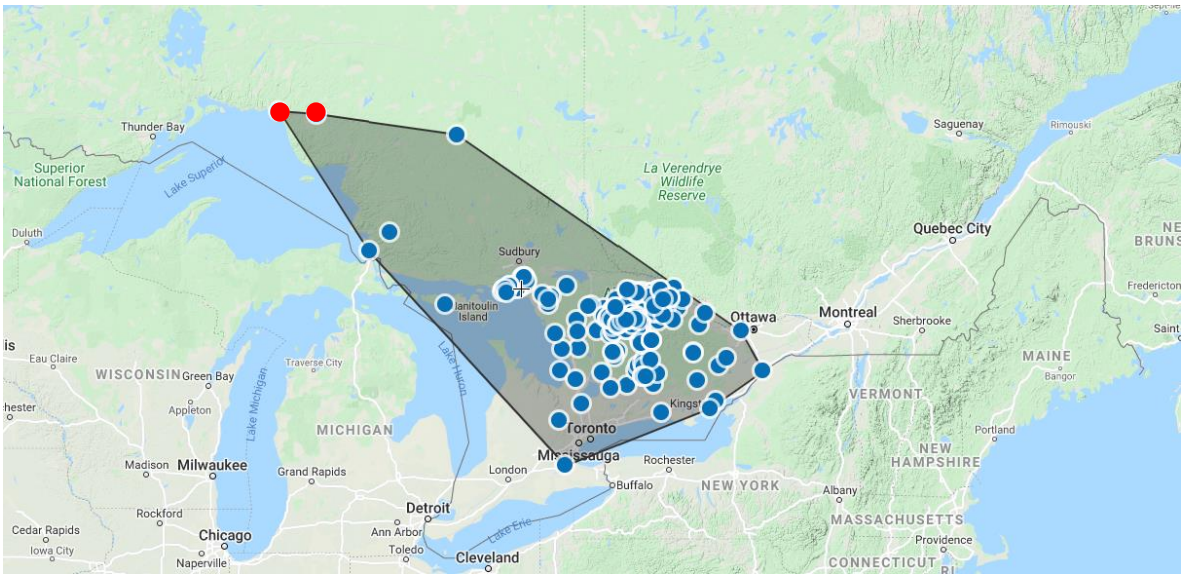

Figure 1: Distribution map of Eastern Wolf occurrences in Canada. EOO (228,784.6 km2) and IAO (>1,232 km2) estimated from GeoCat from 1994 to 2020. The individuals from north of Lake Superior (in red) are considered either gray wolf or eastern wolf, depending on the study, and their ancestry with the Eastern Wolf cluster has not been verified.

2.3. Distribution, status and the broader biologically relevant geographic range outside Ontario

Outside of Ontario the Eastern Wolf (identified on the basis of 80% or higher inferred ancestry with wolves in Algonquin Provincial Park; see Section 2) occurs primarily in southern Quebec north of the St. Lawrence River (COSEWIC 2015). Researchers have identified a taxon as Eastern Wolf (Canis lycaon) in the western Great Lakes region of the USA (Mech 2010; Fain et al. 2010), but these populations are thought to be primarily hybrids between Canis lupus and C. lycaon (aka C. lupus lycaon) (Wheeldon and White, 2009; Wheeldon et al. 2010a; Fain et al. 2010; Rutledge et al. 2015), and population genetic comparisons between Eastern and Great Lakes Wolves do not suggest that the two groups share high recent ancestry (Rutledge et al. 2015; although see vonHoldt et al. 2011; Rutledge et al. 2012; Monzon et al. 2014; Rutledge et al. 2015 for some of the complexities surrounding this issue). Mitochondrial and Y chromosome haplotypes that have been associated with C. lycaon have been found as far west as Saskatchewan, as far east as Quebec, and across broad regions of the northeastern United States (Wilson et al. 2000; Grewal et al. 2004; Koblmüller et al. 2009; Fain et al. 2010; Stronen et al. 2010, 2012; Way et al. 2010), but these likely represent historical hybridization events, and the descendants of these hybrids are not closely related to the Eastern Wolves.

Table 1. Condition of the Species in Adjacent Jurisdictions and Broader Biologically Relevant Geographic Range

Adjacent Jurisdictions	Biologically Relevant to Ontario (n/a, yes, no)	Condition	Notes & Sources
Quebec	Yes	SNR	Natureserve 2021

2.4. Ontario conservation responsibility

Ontario represents the majority of the global range of Eastern Wolf, with approximately 63% of the extent of occurrence (EOO) in Ontario. Ontario represents approximately 65% of the population of mature individuals estimated by COSEWIC (Table 2; 2015).

2.5. Direct threats

Although human-caused mortality is identified as a significant threat, a reduction in

hunting and trapping mortality from 67% to 16% resulting from a ban in townships in and adjacent to Algonquin Park in 2001 was followed by a comparable increase in natural mortality rates (COSEWIC 2015). Coyotes may be hunted in northern Ontario (north of wildlife management unit 42) which may put broader dispersed individuals at risk (Rutledge et al 2016), but not in or south of wildlife management unit 42 (Killarny-Sudbury-North Bay). There are areas in southern and central Ontario which currently house some Eastern Wolves and where neither wolves nor coyotes are protected from hunting, but that has been the case for more than a decade, and in these areas hunting and trapping remain a significant threat. However, although there is a threat from hunting and trapping to Eastern Wolves in some areas this threat is not increasing, other than for those few animals north of the continuous distribution in areas like Sault Ste. Marie (B. Patterson, pers. comm., 2021). Rabies and mange have been significant mortality factors on occasion but are not consistent threats.

A recent analysis by Meröndun et al (2021) suggests that competitive imbalances between the Eastern Wolf (Canis lycaon), coyote (Canis latrans) and gray wolf (Canis lupus) may result in losses to Eastern Wolf, particularly with coyote like canids dominating throughout much of the Eastern Wolf range. As such, competitive disadvantages may limit the species' recovery potential.

The Threats Calculator in COSEWIC (2015) indicated that high threats are hunting and trapping, associated with high road densities that facilitate human access. Medium threats include road-related mortality. Residential housing development is considered a low threat, related more to a potential increase in human-related mortality than to quantitative habitat loss (COSEWIC 2015).

2.6. Specialized life history or habitat use characteristics

The Eastern Wolf is not restricted to any specific habitat type, although it is most abundant in areas with abundant prey such as Moose (Alces alces), White-tailed Deer (Odocoileus virgianus) and Beaver (Castor canadensis), and low levels of human-caused mortality (COSEWIC 2015). Den and rendezvous sites are typically located in conifer-dominated landscapes near a permanent water source with suitable soil such as sand for excavation (COSEWIC 2015).

3. Ontario status assessment

3.1. Application of endangered/threatened status in Ontario

3.1.1. Criterion A – Decline in total number of mature individuals

Does not apply/insufficient information. The Eastern Wolf population appears to be stable (COSEWIC 2015).

3.1.2. Criterion B – Small distribution range and decline or fluctuation

Does not apply. Exceeds thresholds for EOO (228,784.6 km2); The IAO (>1,232 km2)

meets the threshold for threatened, but it is not severely fragmented, there is no observed, inferred or projected continuing decline in IAO, and there are no extreme fluctuations in IAO.

3.1.3. Criterion C – Small and declining number of mature individuals

Does not apply. While the total number of mature individuals meets the criteria for endangered, there is no evidence of a population decline.

3.1.4. Criterion D – Very small or restricted total population

Meets the criteria D1 for threatened, with the total number of mature individuals estimated to be less than 1000 mature individuals.

3.1.5. Criterion E – Quantitative analysis

Does not apply/inconclusive. Reanalysis of a PVA which predicted extirpation of APP wolves (Theberge et al. 2006) concluded that wolves in APP are unlikely to decline significantly over the next 20 years (Patterson and Murray, 2008).

3.2. Application of Special Concern in Ontario

Not applicable.

3.3. Status Category Modifiers

3.3.1. Ontario’s conservation responsibility

Ontario’s conservation responsibility is relatively high, with what is likely the majority of the breeding population occurring here.

3.3.2. Status modification based on rescue effect or level of risk in broader biologically relevant range

Rescue effect is unlikely because individuals from geographically distant locations are unlikely to genetically cluster with APP wolves. Some rescue effect from Quebec populations may be feasible, although risks of human-caused mortality and hybridization with coyotes increase outside of protected areas. The level of risk for this species in the broader biologically relevant range is unknown and does not influence the risk status in Ontario.

3.4. Other status categories

3.4.1. Data deficient

Not applicable.

3.4.2. Extinct or extirpated

Not applicable.

3.4.3. Not at risk

Not applicable.

4. Summary of Ontario status

The Eastern Wolf, *C. lupus*, is classified as Threatened in Ontario under criterion D1.

This status of this species is consistent with the definition of Threatened under the Endangered Species Act, 2007.

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Appendix 1: Technical summary for Ontario

Species: Eastern Wolf (*Canis* sp.)

Demographic information

Demographic attribute	Value
Generation time. Based on average age of breeding adult: age at first breeding = X year; average life span = Y years.	3.5 years
Is there an observed, inferred, or projected continuing decline in number of mature individuals?	Possibly, but uncertain
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations.	unknown
Observed, estimated, inferred, or suspected percent reduction or increase in total number of mature individuals over the last 10 years or 3 generations.	unknown
Projected or suspected percent reduction or increase in total number of mature individuals over the next 10 years or 3 generations.	Unknown
Observed, estimated, inferred, or suspected percent reduction or increase in total number of mature individuals over any 10 years, or 3 generations, over a time period including both the past and the future.	unknown
Are the causes of the decline (a) clearly reversible, and (b) understood, and (c) ceased?	a. Unknown b. Yes c. Possibly
Are there extreme fluctuations in number of mature individuals?	No

Extent and occupancy information in Ontario

Extent and occupancy attributes	Value
Estimated extent of occurrence (EOO). *If value in COSEWIC status report is not applicable, then use geocat.kew.org. State source of estimate.*	228,784.6 km^2 Based on GeoCat estimate.
Index of area of occupancy (IAO). *If value in COSEWIC status report is not applicable, then use geocat.kew.org. State source of estimate.*	>1,232 km2 km^2 Based on GeoCat estimate.
Is the total population severely fragmented? i.e., is >50% of its total area of occupancy is in habitat patches that are: (a) smaller than would be required to support a viable population, and (b) separated from other habitat patches by a distance larger than the species can be expected to disperse?	a. No b. No
Number of locations. *See Definitions and Abbreviations on COSEWIC and IUCN websites for more information on the term "location". Use plausible range to reflect uncertainty if appropriate.*	Population exists mainly in eight sites (plus numerous townships around Algonquin Park) in Ontario

Extent and occupancy attributes	Value
Number of NHIC Element Occurrences *Request data from MNRF.*	58
Is there an observed, inferred, or projected continuing decline in extent of occurrence?	Unknown
Is there an observed, inferred, or projected continuing decline in index of area of occupancy?	Unknown
Is there an observed, inferred, or projected continuing decline in number of sub-populations or EOs?	Unknown
Is there an observed, inferred, or projected continuing decline in number of locations?	Unknown
Is there an observed, inferred, or projected continuing decline in [area, extent and/or quality] of habitat?	Unknown
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of mature individuals in each sub-population or total population (if known)

Sub-population (or total population)	Number of mature individuals
Ontario	Likely 350 – 1000 (maximum)

Quantitative analysis (population viability analysis conducted)

The most recent PVA suggests that the population will be stable in the near-future (Patterson and Murray, 2008).

Threats

Key threats (based on COSEWIC 2020) were identified as:

I. Livestock farming and ranching (IUCN 2.3), primarily on the wintering grounds – medium threat impact
II. Logging and wood harvesting (IUCN 5.3), primarily on the wintering grounds, but also to a lesser extent on the breeding grounds – medium threat impact
III. Climate change and severe weather (IUCN 11), especially drought on the wintering grounds – low to medium threat impact
IV. Residential and commercial development (IUCN 1), notably collisions with tall – low threat impact
V. Annual and perennial non-timber products (IUCN 2.1), primarily on the wintering grounds – low threat impact
VI. Energy production and mining (IUCN 3) – low threat impact

VII. Utility and service lines (IUCN 4.2), especially collisions with communication towers – low threat impact
VIII. Other ecosystem modifications (IUCN 7.3) – low threat impact.

Rescue effect

Rescue effect attribute	Value
Does the broader biologically relevant geographic range for this species extend beyond Ontario?	Yes
Status of outside population(s) most likely to provide immigrants to Ontario	SNR (Quebec)
Is immigration of individuals and/or propagules between Ontario and outside populations known or possible?	Unknown
Would immigrants be adapted to survive in Ontario?	Yes
Is there sufficient suitable habitat for immigrants in Ontario?	No
Are conditions deteriorating in Ontario?	Unknown
Is the species of conservation concern in bordering jurisdictions?	Yes
Is the Ontario population considered to be a sink?	Unknown
Is rescue from outside populations likely?	Unknown

Sensitive species

No.

Template last updated: Oct 14, 2020.

Acronyms

APP: Algonquin Provincial Park
COSEWIC: Committee on the Status of Endangered Wildlife in Canada
COSSARO: Committee on the Status of Species at Risk in Ontario
ESA: Endangered Species Act
EO: Element occurrence (as defined by NHIC)
EOO: extent of occurrence
GRANK: global conservation status assessments
IAO: index of area of occupancy
IUCN: International Union for Conservation of Nature and Natural Resources
MNRF: Ministry of Natural Resources and Forestry
NHIC: Natural Heritage Information Centre
NNR: Unranked
NRANK: National conservation status assessment
SARA: Species at Risk Act
SNR: unranked
SRANK: subnational conservation status assessment
S1: Critically Imperiled
S2: Imperiled
S3: Vulnerable
S4: Apparently Secure
S5: Secure
IUCN: International Union for Conservation of Nature and Natural Resources
CDSEPO: Le Comité de détermination du statut des espèces en péril en Ontario