Eastern Wolf (*Canis lycaon*) Status Assessment Report

Covering East-Central North America

Richard P. Thiel
7167 Deuce Rd.
Tomah, WI 54660

and

Adrian P. Wydeven
Wisconsin Department of Natural Resources
Park Falls, WI 54552

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DISCLAIMER:

This document is a compilation of biological data and a description of past, present, and likely future threats to the *eastern wolf, Canis lycaon*. It does not represent a decision by the U.S. Fish and Wildlife Service (Service) on whether this taxon should be designated as a candidate species for listing as threatened or endangered under the Federal Endangered Species Act. That decision will be made by the Service after reviewing this document; other relevant biological and threat data not included herein; and all relevant laws, regulations, and policies.

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1. Common Name: Chambers et al. (submitted) identified Algonquin wolf, Great Lakes wolf and Eastern wolf as names associated with the small-sized wolf of the genus *Canis* in eastern North America.

In our review these various names were used by the following authors to describe a wolf-like canid that historically ranged throughout east-central North America:

A. Eastern wolf (Wilson et al. 2000, Wayne and Vila 2003, Grewal et al. 2004, Kyle et al. 2006, 2008, Koblmüller 2009, Fain et al. 2010, Rutledge et al. 2010b, Wheeldon et al. 2010a, Wilson et al. 2009, Chambers et al. submitted, Mech et al. In Prep).

B. Great Lakes wolf (Chambers et al. submitted, Koblmüller 2009, Schwartz and Vucetich 2009, vonHoldt et al. 2011).

C. Algonquin wolf (Chambers et al. submitted)

In this document we refer to this unique genetic assemblage of canids as eastern wolves, *Canis lycaon*.

2. Current Scientific Name:

Canis lycaon.

Wilson et al. (2000) first proposed the existence of a unique, small-sized wolf occurring in eastern North America, based on genetics study of wolves from Algonquin Provincial Park in southeastern Ontario, and referred to it as *Canis lycaon*.

Ronald Nowak (2009), a recognized authority on *Canis* morphologic taxonomy in North America, reviewed the historical sequence in assigning binomial nomenclature to wolves within eastern North America and states that if given species status the name, *Canis lycaon*, would take precedence (see also Brewster and Fritts 1995 and Goldman 1944).

Since 2000, when Wilson et al. (2000) proposed species designation, *Canis lycaon* has been used by Wayne and Vila (2003), Grewal et al. (2004), Kyle et al. (2006), Chambers et al. (submitted), Wilson et al. (2009), Rutledge et al. (2010a,b), and Mech et al (In Prep), among others.

3. Controversial or Unsettled Taxonomy

Background: Historically, mammalian taxonomy, the designation of species (binomial name given as genus and species), and their phylogenetic placement within a lineage of species, relied on pelage characteristics and measurements of various aspects of the skulls of specimens collected within the geographic range of a putative species. Various statistical tools were devised to separate within-species and between-species variations. A type specimen is named as a reference to describe a species. This type specimen is supposed to be broadly representative of the species being described, and is normally maintained in a recognized scientific museum for scientists to view and study. This method is referred to as morphological taxonomy and has been the standard methodology used in describing species for several centuries.

Around 1990 breakthroughs in molecular genetics created a second avenue in investigating taxonomic issues and have expanded greatly in utility since then. Genetics research has been used to identify individuals, identify relatedness of individuals, devise markers useful in distinguishing between species, and establishing the phylogenetic relatedness of individuals and populations. Genetics taxonomy is still undergoing rapid advances, and is replacing morphological taxonomy as the prime determinant in designating species. Although some laboratories have recently begun preserving samples that could serve as vouchers, genetic samples are not typically archived (as in the procedure followed by morphological taxonomists using voucher material) so that they may be used by other genetic researchers for critical cross-examination, especially as it relates to questions of species designation. Mech (2010) expresses caution about assigning species designation based on genetic analyses because genetics research has yet to bridge the association between genes and their morphological expressions.

As can be expected, differences in interpretation of species inevitably arise between the two methodological approaches to taxonomy. A proclivity towards interbreeding coupled with a nearly complete occupation of all North American biomes by members of the genus *Canis* species within North America has enlivened considerable debate between these two disciplines.

Definition of Species: Chambers et al. (submitted) and 76 FR, 26086 – 26145, May 5, 2011 provide several definitions for the term ***species***:

Biological species: The ability to breed and have gene flow between two populations indicates they belong to the same species (Mayr 1963).

Phylogenetic species: Species are identified by their genealogical (lineages) and phylogentic (evolutionary) relationships and diagnosability.

Wayne and Vila (2003) provide further clarity for the phylogenetic species definition, stipulating that once a barrier is removed, crossbreeding resumes between subspecies, but does not with members of different species.

In addition to these definitions, Rutledge et al. (2010a) provided a third definition for species,

Cohesion species: An inclusive population displaying phenotypic cohesion.

Problems of Definitions: Amongst the lay public and for many professionals within the field of biology, several key terms used by morphological taxonomists and geneticists in promoting various interpretations of their works suffer for lack of clarity. This was pointed out by Cronin and Mech (2009), who took issue with lack of clarity in various definitions used by geneticists, and specifically Koblmüller et al. (2006).They argue that mtDNA and "other molecular patterns can help understand current and historic processes, but do not necessarily reflect species and population status." They advise, "…it is important to use the terms 'hybridization and introgression' carefully." They suggest, for instance, that Great Lakes wolves be referred to as a wolf population "with mixed ancestry". Chambers et al. (Submitted), however, take issue with even this term as being too ambiguous. It is not within the scope of this report to settle such problems of definition, but until such time as all parties agree on technical parlance within the discipline, scientific inquiry into the precise phylogenetic ancestry and present-day diversity of *Canis* populations inhabiting portions of North America will remain contested.

Current Competing Genetic Hypotheses: Considerable controversy surrounds the placement of eastern wolves, *Canis lycaon*, within the suite of North American *Canis* species. Some of this controversy involves poor understanding of *Canis* species distribution over the geological time scale being represented (prehistoric, post European contact period through settlement at roughly 1900, and contemporary). Also contributing to this quandary are anthropogenic-caused shifts in habitat, prey diversity and population sizes, intense control campaigns causing severe reductions or annihilation of *Canis* populations over much of the area prior to or concomitant with the era of scientific inquiry, and invasion of *Canis latrans* over most of the eastern portion of North America in the 20th century.

Chambers et al. (submitted) are in general agreement with Kyle et al. (2006) in categorizing the literature of competing interpretations of eastern wolf (*Canis lycaon*) phylogenetic placement relative to other *Canis* presently existing in North America. These competing interpretations include:

(1) Considered eastern wolves to be a full species (Wilson et al. 2000, 2009, Baker et al. 2003, Grewal et al. 2004, Fain et al. 2010, Chambers et al. submitted, Wheeldon and White 2009, Wheeldon et al. 2010a, Rutledge et al. 2010a,b);

(2) a gray wolf subspecies, *Canis lupus lycaon* (Nowak 1979, 1983, 1995, 2002, 2003, 2009; Koblmüller et al. 2009, Leonard and Wayne 2009; vonHoldt et al. 2011);

(3) the same species as the red wolf, *C. rufus* (Wilson et al. 2000, Kyle et al. 2006, 2008; and

(4) a result of hybridization between *C. rufus* and *C. lupus* (Nowak 2002, 2003, 2009).

Phylogeny of North American Holocene Canids: Generally taxonomists and geneticists agree that gray wolves (*Canis lupus*)originated in Eurasia, while dire wolves (*Canis dirus*), red wolves (*Canis* rufus) and coyotes (*Canis latrans*) originated in the Americas (Nowak 1979, 2002, 2009; Wang and Telford 2008, Koblmüller et al. 2009, Leonard and Wayne 2007, Wayne and Vila 2003, Wheeldon and White 2009, among others).Wilson et al.(2000) speculate that an eastern wolf lineage differentiated from a *C. latrans* lineage about 150-300,000BP. Chambers et al. (submitted) allude to a much earlier divergence of eastern wolves from a common ancestor with coyotes (*viz.* 500,000 + BP), but provide no substantive evidence for this. Rutledge et al. (2010c) estimate divergences between

548,000 (ATPase) to 486,000BP (control region). By contrast Nowak (2002, 2009) states that a wolf was absent from the fossil record for roughly 1 ma until the end of the Pleistocene (15 – 10,000 BP). Around that time a wolf that differed morphologically from coyotes and western gray wolves reappeared in eastern North America (Nowak 2002, 2009). It is conceivable a wolf-sized canid evolved from a coyote-like clade, as geneticists claim (Wilson et al. 2000, Leonard and Wayne 2007). The progenitor of such a clade could have been *Canis armbrusteri* whom Nowak (2002: Figure 4) believes was the best candidate for the lineage based on fossilized morphological evidence.

Wang and Telford (2008) state that *Canis lupus* originated in Beringia around 800,000 BP but only invaded North America around 100,000 BP. Morphological taxonomists (principally Nowak) and geneticists (Wayne, Vila, Wilson among others) also agree that Pleistocene glaciation segregated wolf-like *Canis* into several geographically isolated regions or refugia (see Nowak 1983: Figure 7a, Wilson et al. 2000, Wayne and Vila 2003, Wheeldon and White 2009, Wheeldon et al. 2010a, Chambers et al. Submitted) on multiple occasions during the Pleistocene Era (~2 ma to 10,000 BP), and opportunistically invaded North America several times during interglacial intervals (Wilson et al. 2000, 2009; Wheeldon et al. 2010a; and Nowak 2002, 2009).

During the most recent glacial episode (~ 60 – 70 to 10,000 BP), *Canis* refugia were present in Beringia, and south of the ice sheets below 40^{o} N latitude in North America (Nowak 1983, 1995, 2002). These two canid groups likely existed in isolation from each other for perhaps 50,000 years. *Canis lupus* populations in Beringia were cold-adapted

(Wang and Telford 2008) while the *Canis* existing south of the ice sheets in eastern North America inhabited a number of biomes, including comparatively narrow bands of boreal, mixed conifer-hardwood, deciduous, and southern evergreen forests (Delcourt and Delcourt 2004). Subsequent to the retreat of the continental glaciers, the two *Canis* populations reunited; a process referred to as parapatry (see Hewitt 2000).

Stance as a Distinct Species: Wolves inhabiting regions north and south of the Ohio River valley have been assigned to two species by morphological taxonomists (Goldman 1944, Nowak 1983, 1995, 2002, 2003, 2009). Nowak (2002: Figure 1) placed *rufus* within the Ohio River Valley and south, and a gray wolf subspecies, *C. lupus lycaon*, in the region immediately north of the Ohio River basin through upper New York and Vermont and east along the St. Lawrence seaway. These specialists note that wolves in both geographic areas exhibited more gracile skull features, especially a slender rostrum that superficially resembled larger *Canis rufus* specimens (Goldman 1944). They were smaller than gray wolves west of the Mississippi River and north and west of the Great Lakes. However, individuals in the upper Great Lakes displayed characteristics intermediate between their western (larger form) and eastern (smaller form) counterparts (Goldman 1944, Nowak 2002, 2003, 2009).

Goldman's assignment of *C. lupus lycaon* was based on examination of 77 skulls of specimens taken throughout eastern North America (Goldman 1944). Nowak (1995, 2002, 2003, 2009) applied statistical weight to various skull measurements in assigning wolves north of the Ohio Valley as a gray wolf subspecies, using new material in addition to many of the same specimens examined by Goldman (1944). Nowak's most recent reworking of material continues to support *lycaon* as a subspecies of *Canis lupus* (Nowak 2009).

Roy et al. (1994), using microsatellite loci in their analysis of coyote, gray wolf and red wolf populations across North America, identified gray wolf X coyote hybrid zones in Minnesota and in southern Quebec. They observed that red wolves shared all their alleles with coyotes, interpreting that red wolves arose from hybridization between gray wolves and coyotes, a stance shared more recently by Leonard and Wayne (2007), Koblmüller et al. (2009), and vonHoldt et al. (2011).

Wilson et al. (2000) found unique haplotypes in eastern wolves similar to coyotes and ascertained these split off 150 – 300,000 BP during the late Pleistocene, from a phylogenetic clade shared with coyotes. Wilson et al. (2000) proposed that gray wolf evolutionary history differs from that of coyotes, red wolves and eastern wolves. Furthermore, Wilson et al. (2000) suggest that red wolves and eastern wolves are likely the same species, a stance supported by Kyle et al. (2006, 2008).

The Wilson et al. (2000) hypothesis provides an alternate explanation for the presence of coyote haplotypes observed by Roy et al. (1994), Koblmüller et al. (2009), and vonHoldt et al. (2011) in wolves in eastern North America. Since then, numerous researchers (Grewal 2004, Kyle et al. 2006, 2008, Chambers et al. submitted, Rutledge et al.2010a,b, Wheeldon et al. 2010a, Wilson et al. 2009, among others) affiliated with Wilson have supported and promoted elevation of eastern wolves to species status by recognizing it as a distinct species.

Wayne and Vila (2003), Koblmüller et al. (2009) and Nowak (2009) have accepted the possibility that eastern wolves may be unique, but not necessarily a different *Canis* species. Leonard and Wayne (2007) and Koblmüller (2009) recognized unique features of wolves in the Great Lakes that distinguished them from coyotes and western gray wolves, but considered them gray wolves X coyotes, the result of crosses after roughly 1915. Similarly, vonHoldt et al. (2011) describes wolves in the Great Lakes region as a highly admixed blending of gray wolf and coyote.

In their analysis of genetic material collected from Great Lakes region wolves and coyotes, Fain et al. (2010) affirmed the Wilson et al. (2000) position that *Canis lycaon* should be elevated to species standing. Chambers et al. (submitted), in reviewing the various genetics works published over the past 15 years, also conclude that the eastern wolf should be recognized as a separate species, *Canis lycaon*, but consider it a separate species from the red wolf, *Canis rufus*, though they speculate these two species share a common ancestor.

In summary, morphological taxonomists have long recognized that wolves in eastern North America differ from their northern and western North American counterparts by displaying more gracile characteristics, represented chiefly by differences in body mass, and in various skull measurements. Geneticists working with material primarily limited to the region within and surrounding Algonquin Provincial Park in east-central Ontario, have identified unique haplotypes that are also present in *Canis rufus* material, leading them to suspect that *rufus* and *lycaon* are the same species (Wilson et al. 2000, Grewal 2004, Kyle et al. 2006, 2008, Rutledge et al.2010a,b, Wheeldon et al. 2010a, Wilson et al. 2010, among others).The pooled paleontological, morphological and genetic evidence implies that a unique smaller-sized wolf occupies east-central North America. Its ancestry is not derived from gray wolves that evolved in Beringia and Eurasia, but can be traced to a North American Pleistocene ancestor that also gave rise to coyotes.

4. Physical Description of Taxon

Eastern wolves belong to the Class *Mammalia*, Order *Carnivora*, Family *Canidae,* and the Genus *Canis*.

Wild members of North American *Canis* are medium sized carnivores with coyotes (*Canis latrans*) being the smallest and gray wolves (*C. lupus*) the largest members in the genus. Height at the shoulder ranges from 50 (coyote) to 75 cm (gray wolf), and total length (head and body length, including tail) ranges from 85 (coyote) to 145 cm (gray wolves). Coyotes generally weigh 10-18 kg; gray wolves 24 – 60 kg. Eastern wolves from Algonquin Provincial Park, Canada, weighed an average of 24.5 kg (range:17 to 32 kg) among adult females, and 27.7 kg (19.5 to 36.7 kg) among adult males (Pimlott et al. 1969), and averaged 23.9 kg for females and 30.3 kg for males in the more recent study (Theberge and Theberge 2004).

Coat colors vary from black to white, but typically consist of a grizzled grayish brown, mixed with cinnamon, rufus or creamy along the sides and beneath the chest, and salt-and-pepper black and gray guard hairs along the nape, shoulder and tail region. Goldman reported a darker coat color amongst *lycaon* wolves and occurrences of black coat color among red wolves (Goldman 1944); a trait substantiated by Nowak (2009). Black coats are relative rare among eastern wolves, but relatively common among gray wolves (Kolenosky and Standfield 1975). Ear length for both eastern and gray wolves average about 12 cm, but do frequently approach and exceed 13 cm among eastern wolves (Mech 2011a).

Until recently it was accepted that four species within *Canis* occurred in post-Pleistocene North America: gray wolves, *C. lupus*, red wolves, *C. rufus*, coyotes, *C. latrans*, and dog, listed variably as either *C. familiaris* or *C. lupus familiaris* (Wong and Tedford 2008).

Both coyotes and gray wolves are widely distributed in North America. Body morphs, represented most often by mass, differ between geographic regions. Generally, coyotes are smallest in the southwest and increase in mass within the temperate lower Great Lakes region, reaching their greatest mass in the New England Maritime zone (Way 2007). Gray wolves are typically smallest in the Upper Great Lakes region and largest in northwestern North America (Alberta to interior Alaska).

5. Summary of Biology & Natural History

Habitat requirements: Algonquin Provincial Park in east-central Ontario is considered by most geneticists to be the geographic core of current *Canis lycaon* distribution in eastern North America (Sears et al., 2003; Grewal et al. 2004, Rutledge et al. 2010a). We relied on the works summarized by Pimlott et al. (1969) and Theberge and Theberge (2004) in Algonquin Provincial Park in the following discussion of the natural history of eastern wolves, because it represents and synthesizes much of what is presently known of eastern wolf ecology.

Reproduction: Pimlott et al. (1969) assessed productivity based on necrospies of 17 adult females. They found that 59 percent of these adults bore fresh scars, and average litter size was 4.9 pups (range: 3 to 7). Pimlott et al. (1969) accrued productivity data in13 pack-reproductive years and determined that in a minimum of 10 packs (77 percent) pups were detected during summer months (Table 16, page 80). Pups comprised 31 to 35 percent of wolves trapped within Algonquin Provincial Park between 1957-59 and 1964 and 1965 (Pimlott et al. 1969).

Mills et al. (2008) studied early pup survival in Algonquin Provincial Park between 2004 and 2006. They found high survival of pups (97 percent) between June and November. Mortality was fairly constant, and mostly due to natural causes. Mills et al. (2008) documented dispersal of pups at 15 weeks of age, the earliest age noted among wolves thus far (Mech and Boitani 2003). However, their use of inter-parenteral transmitters is the first successful glimpse of mortality in such young wolf pups. This observation may therefore be an artifact of the uniqueness of the study design and therefore not necessarily a trend unique to eastern wolves.

Recruitment: Theberge and Theberge (2004) noted that pup productivity was low, but did not give any figures and used the percent yearlings in the population as the measure of annual recruitment which averaged 20.5 percent (range 0.03 to 0.42). This was similar to an earlier era when Pimlott et al. (1969) reported that yearlings in the population ranged from 40 percent between 1957 -59, and 15 to 18 percent in 1964 and 1965. They felt differences may have been due to active removal efforts in the 1950's. Theberge and Theberge (2004) calculated that yearlings composed about 20 percent of their study population (range 10 to 42 percent; Table 3.1), a rate similar to that observed by Pimlott et al. (1969) following cessation of control activities.

Mortality: Theberge and Theberge (2004) reported an average of 32 percent annual mortality in Algonquin Provincial Park between 1988-89 and 1998-99, and 64 percent of the deaths of radio-collared wolves were caused by humans. For the period 1987 through 2001 when wolf harvesting was allowed in townships around Algonquin Provincial Park, 67% of wolf deaths were human-caused (Rutledge et al. 2010b). After wolf and coyote harvests were closed in townships surrounding the park between 2002 and 2007 only 16% of mortality were human-caused (Rutledge et al. 2010b). The cause of natural deaths included rabies, starvation and other wolves.

Diseases and Parasites: Serology tests were performed for Canine Parvovirus (CPV), Canine Distemper (CDV) and Canine Hepatitis. Serology tests for these diseases are the most commonly surveyed among gray wolves (Kreeger 2003). Positive values were obtained as follows: 82 percent CPV; 46 percent CDV; and 76 percent for hepatitis. These values suggest the wolf population studied by Theberge and Theberge (2004) had been recently exposed to these diseases. Although they did not provide statistics, Theberge and Theberge (2004) also reported an outbreak of rabies that killed at least five wolves, and incidences of mange amongst study animals.

Longevity: Very few studies on gray wolves have reported average life spans likely because of the difficulty in capturing wolves of known age and monitoring them to determine their life-fates. Nonetheless, it is felt that most wolves have an average life span of 4 or 5 years (Fuller et al. 2003). Theberge and Theberge (2004) reported similar mortality rates for both their radioed yearlings and adults (33 percent vs. 40 percent), so presumably the average life span of eastern wolves in Algonquin was around 3 to 4 years. One wolf in their study was aged at 15 years at the time of its death. This is a longevity record for both *C. lupus* and *C. lycaon*.

Territory Size: Kolenosky and Johnston (1967) recorded summer home ranges of Algonquin Provincial Park wolves, ranging between 18 and 70 km^2. Pimlott et al. (1969) reported winter territories ranging from 104 to 311 km^2, an average of 175 km^2 among 4 Algonquin Provincial Park wolf pack territories studied between 1958 and 1965.

Territory size during the Theberge and Theberge (2004) study period had a yearly average ranging from 110 to 185 km^2 and absolute ranges of 50 to 395 km^2.

Densities: Pimlott et al. (1969) recorded a density of 3.86 wolves per 100 km^2. Over the course of their 10-year study, Theberge and Theberge (2004: Table 3.1; Figure 3.1) observed variations in density ranging from 1.4 and 3.4 wolves per 100 km^2, and averaged 2.4 per 100 km^2. More recently Patterson and Murray (2004) and Rutledge et al. (2010b) report on more stable between-year wolf densities fluctuating from 3 to 3.4 wolves per 100 km^2 for the period ending in 2006-07.

6. Current and Historical Range

The reader is referred to Section 3. Controversial or Unsettled Taxonomy, including physical description useful to a biologist to appreciate the limitation in delineating the range of eastern wolves.

Good evidence exists for the long-term presence of contact or suture zones that extend along the periphery of eastern wolf range. Presently eastern wolves are sympatric with gray wolves to the north; sympatric with gray wolves and coyotes to the northwest (Western Great Lakes region); and to the southeast they are sympatric to (northeastern) coyotes, and in former times, red wolves.

Historical Range: Map 1 depicts changes in taxonomists' understanding of the probable historical (roughly ca. 1800) range of what they interpreted to be *Canis lupus lycaon*

(Nowak 1995, 2002, 2003, 2009) and is alternatively interpreted to be *Canis lycaon* by Wilson (2000). The most ancient putative eastern wolf remains from which DNA has been extracted came from two of four *Canis* specimens from a southeastern Ontario Iroquois Nation archeological site dated to around 4-5,000 BP (Rutledge et al. 2009). Coyote-like mitochondrial haplotypes were present, and these were interpreted as eastern wolf or a shared ancestry. However the authors could not rule out a *C. lupus* X *C. lycaon* hybrid. These specimens were near the core of the geographic range of *Canis lycaon* as presently understood.

Several genetic analyses of skulls have been performed on wolves from eastern North America taken during the period of roughly 1890 to 1915. Mitochondrial DNA (mtDNA) extracted from a wolf killed in Maine in the 1880s and the last wolf reportedly killed in New York State dating to the 1890's indicated these animals represented eastern wolves (Wilson et al. 2003). These specimens are significant as they were taken well before the expansion of western coyotes (*Canis latrans*) into the northeastern United States. From the northwestern suture zone Wheeldon and White (2009) determined that two Minnesota wolves and one Wisconsin wolf collected between 1899 and 1908 contained admixtures of both eastern and gray wolf haplotypes.

This contrasts with Leonard and Wayne (2007) and Koblmüller et al. (2009)who sampled specimens (US National Museum [USNM]) taken between about 1892 and 1912 primarily from the Great Lakes region. A majority of these samples were proximate to the northwestern suture zone within the states of Wisconsin and Michigan. They determined that historic wolf sequences were "basal to those of modern coyotes…" Their interpretations may be affected by a mistaken assumption that, “The historic GL [Great Lakes] wolves were all collected before coyotes became established in the region.” (Koblmüller et al. 2009; but also Leonard and Wayne 2007). Long before the specified time period, coyotes were sympatric to wolves from western Minnesota through south-central Wisconsin and into Illinois and likely west-central Indiana as well (Thiel 1993, See especially *Canis latrans* late Holocene map, Graham and Lundelius 1994, See Nowak 2002, Figure 1). Dispersal from these centers could place coyotes well within Upper Michigan and perhaps northwestern Ontario. Their observed presence of coyote haplotypes does not successfully vanquish the Wilson et al. (2000) hypothesis for a shared ancestry between eastern wolf and coyotes.

Some morphological evidence supports the possibility that eastern wolves occurred north of Lake Superior. Mech et al. (2011) found that pre-1950 northeast Minnesota wolf skulls were smaller than those of western wolves and resembled in size southeastern Ontario wolves. To the south of Lake Superior Nowak (2002: page 120) found that Upper Michigan wolves, collected between 1905 and 1965, showed statistical similarities to (were nearly as robust as) *Canis lupus* that occurred further west.

Contemporary Range / Recent Specimens: Map 2 shows the core range of eastern wolves today is centered in east-central Ontario in the vicinity of Algonquin Provincial Park (Grewal et al 2004, Wilson et al. 2009, Rutledge et al. 2010a, among others). It likely extends west towards the vicinity of Georgian Bay in Lake Huron, and east into Quebec (Grewal et al. 2004, Wilson et al. 2009, Rutledge et al. 2010a). Wilson et al. (2009)

suggest the genetically purest eastern wolf populations extend from northwestern and northeastern Ontario, through Algonquin Provincial Park Ontario, and into Quebec.

Present-Day Suture Zones: Two broad geographical areas of contact presently exist along the periphery of eastern wolf range (Map 3). To the north and northwest eastern wolves come in contact with gray wolves and admix with them; this admixtured population of gray wolf X eastern wolf rarely if ever breeds with coyotes (Wilson et al.2009, Mech 2010). To the south and southeast, eastern wolves contact northeastern coyotes and admix with these (Grewal et al. 2004, Rutledge et al. 2010a). Because eastern wolves seem to readily hybridize with these sympatric canid species, the two suture zones are described in more detail below.

An ill-defined but broad suture zone extends from southwestern Manitoba through central Minnesota (Nowak 2002, 2009, Mech 2010). Here eastern wolves are in varying contact with both coyotes and gray wolves. Mech et al. (2011a) analyzed Minnesota wolf skulls, segregated into various time periods, to ascertain whether differences occurred substantiating whether smaller variants attributable to *Canis lycaon* have ever occurred there. Pre-1950 Minnesota wolf skulls were similar in size to wolves from southeastern Ontario and smaller than western wolves. Skulls from 1970-1976 showed a shift to the larger, western form. Although Minnesota skull measurements after 1976 were unavailable, rostral ratios from 1969 through 1999 were in between the smaller eastern wolf and the larger western form, consistent with molecular data that suggest Minnesota wolves are an admixture of both eastern and western wolves. Using ear lengths as possible indicators of eastern wolf genetic influence, Mech (2011a) found ear lengths in accord with eastern wolves from Algonquin Provincial Park in 30 percent of his samples from extreme northeastern Minnesota. He interpreted this as supportive of morphological evidence for admixtures between gray and eastern wolves in that state.

Extending east from above Lake Superior through central Ontario, Quebec and Labrador to the Atlantic Ocean eastern wolves are primarily in contact with gray wolves, although coyotes are locally present (Nowak 2002, 2009, Kolenosky and Standfield 1975, Schmitz and Kolenosky 1985, Wheeldon et al. 2010a, Wilson et al. 2009 among others).Wolves within this broad and lengthy zone display larger, more robust morphological traits, gradually increasing in size geographically as they encroach on known gray wolf populations (Kolenosky and Standfield 1975, Schmitz and Kolenosky 1985). Wolves within this same suture zone feature genetic haplotypes representing admixtures primarily between eastern and gray wolves (Wilson et al. 2009, Wheeldon et al. 2010a). In sum, these two suture zones describe boundaries between *Canis lupus* (north and west) and *Canis lycaon* (south and east).

Immediately south of Algonquin Provincial Park in southeastern Ontario, extending across the lower Great Lakes and south of the St. Lawrence Seaway lies the suture zone between eastern wolves and coyotes (Kolenosky and Standfield 1975, Sears et al. 2003, Grewal et al. 2004, Kays et al. 2009, Way et al. 2010, Rutledge et al. 2010a). Within this zone eastern wolves admix with coyotes that began a west-to-east invasion of the region sometime following 1900 (Nowak 2002, Kays et al. 2008, 2009, Wilson et al. 2009, Wheeldon et al. 2010b). Here canid morphology trends towards smaller, more coyote-like morphological traits (Kolenosky and Standfield 1975, Schmitz and Kolenosky 1985, Sears et al. 2003, Way 2007, Kays et al. 2008, 2009). South of Algonquin Provincial Park, in an area referred to as the Frontenac Axis, the major genetic ancestry consists primarily of coyote admixed with eastern wolf (Wilson et al. 2009). This trend is observed east into New England and further south in western Pennsylvania, New York and Massachusetts (Kays et al. 2009, Way et al. 2010). Ohio coyotes do not display any eastern wolf haplotypes (Kays et al. 2010). Coyotes colonizing Ohio were assumed to have spread eastward south of the Great Lakes without coming into contact with eastern wolves, whereas coyotes spreading eastward across upper Michigan or across the top of the Great Lakes likely encountered eastern wolves in southern Ontario and Quebec as they spread to the east and southeast.

Morphologically, coyotes in the northeastern United States and southeastern Canada differ from their more western counterparts. Sears et al. (2003) investigated hybridization of *Canis* populations existing southeast of Algonquin Provincial Park. Frontenac canids were morphologically between Algonquin Provincial Park canids and coyotes in size. But Frontenac canids were larger in weight than reports of northeastern coyotes, with the exception of eastern coyotes from Vermont and New Hampshire. In the Cape area of Massachusetts, Way et al. (2010) report canid weights ranging from 13.6 to 18.2 kg, well above the weights of other North American coyote weights summarized by Way (2007). Kays et al. (2009) report that coyotes from this region display sexual dimorphism – a trait more prominent amongst wolves than western coyotes – and had larger skull characteristics. They noted these traits disappeared in coyotes in Ohio (Kays et al. 2009).

7. Current & Historical Productivity Trends –by State /Province

Eastern Canada:

New Brunswick: Although not overly abundant, wolves apparently did occur in the Maritime provinces until the late 1800s (Lohr et al. 1996). There did seem to be an increase in wolves into New Brunswick in the 1840s as white-tailed deer moved into the province. The pattern by wolves of following white-tailed deer as they expanded northward also occurred later in Quebec and Ontario, suggesting that these may have been eastern wolves because they are thought by some to be specialized as deer predators (Sears et al. 2003, Wheeldon et al. 2010a, vonHoldt et al. 2011). Unfortunately Lohr and Ballard (1996) were unable to locate any wolf specimens for the Maritimes to determine the species/subspecies of wolf that occurred there. Wolves apparently disappeared from New Brunswick by the late 1800s (Lohr et al. 1996). Apparently suitable habitat persists or has become re-established, and if wolves where to return to the area, Carroll (2003) estimated a potential wolf population of 486 wolves for New Brunswick for conditions that existed in 2000.

Nova Scotia: Historical accounts listed a small population of wolves in Nova Scotia, and pelts were shipped out of the province as late as 1921 (Lohr et al. 1996). But since that time wolves have been extirpated. Carroll (2003) estimated that in 2000 conditions were adequate to support as many 158 wolves in the province.

Ontario: Wolf Ecological Zone 5 in southern Ontario from Georgian Bay east to the Quebec border is considered to be occupied by eastern wolves, and in 2005 the population was estimated at 1620 wolves (Ontario MNR 2005). Areas north of Nipissing Lake were consider to be gray wolf –eastern wolf hybrids (2230 wolves) similar to the Western Great Lakes States, or gray wolves (5000) further to the north (Ontario MNR 2005). The general province wolf population is considered stable or increasing. Recently Maria de Almeida and Brent Patterson (009 – Appendix 1) suggest the overall province wolf population was about 7,710, but estimate the number of eastern wolves may be as low as 350-400, and best guess would be about 500 eastern wolves. They indicate most wolves in the province are a gray-eastern wolf hybrid. There is no indication that there has been a recent decline in eastern wolves; rather this refined estimate is a result of better genetic testing capabilities and increased sampling.

Quebec: Wolves defined as Algonquin wolves that lived in deciduous forest and hunted mainly white-tailed deer, were estimated in 2002 to consist of 434 to 707 wolves (mean 585) based on four methods of estimation of density (Jolicouer and Hénault 2002). The area occupied by these Algonquin or eastern wolves was 56,460 km^2. The classifications of wolves in Quebec were based on ecological classification of wolves (Theberge 1991) and not by genetics, but Carmichael et al. 2007 have determined that selection of habitat type and prey specializations may have strong genetic components in wolves. Currently biologists in Quebec recognize ecotypes of wolves, but do not accept eastern wolves as a separate species (Michel Hénault and Emmanuel Dalpé-Charron, personal communications). It is not clear how many of these Algonquin wolves in Quebec would qualify as relatively pure version of eastern wolves from a genetic perspective and preliminary genetic research indicate few would be considered eastern wolves (009, Appendix 1: Brent Patterson, pers. comm. 2011)

Currently breeding populations of wolves only occur north of the St Lawrence River in Quebec. In general the eastern wolf populations in Quebec appear to be relatively stable, although there are no large areas closed to public harvest and level of exploitation may reduce chance of wolves spreading south of the Saint Lawrence River and increase the likelihood of hybridization with northeastern coyotes (Wydeven et al. 1998, Carroll 2003, Rutledge et al. 2010b, Rutledge et al In Press).

Eastern Canada Summary: To summarize eastern wolf population and range in Canada (Map 2), Quebec estimates 585 wolves, Ontario estimates >500 wolves of high content *Canis lycaon* (Table 7.1).

Northeastern States:

Connecticut: Reports of wolves occurred in Connecticut into the early 1800s (Goldman 1944). Harrison and Chapin (1997) did not detect any suitable habitat for wolves in Connecticut. If wolves became established in the Northeast, individual wolves might occasionally travel through the state.

Maine: Wolves were extirpated from Maine by the end of the 1800s. A specimen killed in north central Maine in 1863 was considered a red wolf *(Canis rufus)* by Nowak (2002) based on skull characteristics. Wilson et al. (2003) indicate this specimen was actually an eastern wolf (*Canis lycaon)* based on genetic assessments. At least 2 wolf-like canids were killed in Maine in the last 20 years, including a young (yearling?) black female near Moosehead Lake on August 30, 1993, and an adult male east of Bangor on November 2, 1996 (002, Appendix 1; Glowa to Salazar). But stable isotopes analysis shows both these canids fed on diets high in corn as in dog food or having fed on domestic stock that was on a high corn diet, and would thus indicate the canids were probably of captive origin (Kays and Feranec 2011). Thus it appears wolves have been absent from Maine for most of the last 100 years and there is no evidence thus far of wolves successfully dispersing into the state. Recent dispersers found dead in nearby Quebec (Villemure and Jolicoeur 2004) and Vermont (Kays and Feranec 2011) indicate that there is at least some potential that wolves could eventually disperse into Maine.

Several recent GIS habitat assessment and spatial modeling studies suggest that Maine has large areas of suitable wolf habitat and could support a fairly large wolf population. Harrison and Chapin (1997, 1998) indicated Maine contained 44,196 km^2 (17,064 $mi.^2$) of potential core habitat and 4,589 km^2 (1772 mi^2) of dispersal habitat for wolves. They suggest that with contiguous habitat into New Hampshire the region could hold a minimum of 488 wolves. Mladenoff and Sickley (1998) estimated 47, 332 km^2 (18,255 mi^2) of favorable wolf habitat exists in Maine that could support about 900 wolves.

Carroll (2003) calculated that under conditions that existed in 2000, Maine could support as many as 1170 wolves.

Massachusetts: Wolves may have persisted in the western mountains of Massachusetts to the end of the 1800s (Goldman 1944). Only about 51 km^2 (20 mi^2) of potential core habitat exist in the state, and 103 km^2 (40 mi^2) of dispersal habitat occurs in the state (Harrison and Chapin 1997). Mladenoff and Sickley (1998) did not analyze potential wolf habitat in Massachusetts. Carroll (2003) only analyzed a small portion the state for potential for wolves in Massachusetts, and did not make an estimate of the potential for wolves in the state. It appears that an 85 - lb male wolf did travel into the state and was killed on October 13, 2007, near Shelburne, Massachusetts (002, Appendix 1: Glowa to Salazar). Genetically the wolf appeared to be an eastern wolf (*Canis lycaon* or *Canis lupus lycaon*). Massachusetts appears to have very little potential for a breeding wolf population, but wolves may occasionally travel through the state.

New Hampshire: Wolves probably disappeared from New Hampshire in the middle to late 1800s. Harrison and Chapin (1997) determined that the state contained about 4,591 km^2 (1773 mi^2) of core habitat and 1,222 km^2 (472 mi^2) of dispersal habitat. Core habitat was directly connect to a much larger area in Maine, and the two states contained about 48,787 km^2 (18,837 mi^2) of habitat, that potential could support at least 488 wolves (Harrison and Chapin 1997). Mladenoff and Sickley (1998) estimated 5,472 km^2 (2113 km^2) of favorable habitat that could potentially support about 150 wolves. Carroll

(2003) estimated that in 2000 New Hampshire could support about 110 wolves, but would likely decline to 68 by 2025.

New York: Wolves persisted in portions of northern New York until the late 1800s (Goldman 1944). Hunters referred to two wolves in the state according to Goldman (1944), one being a “deer wolf “, and the second a clumsy short-legged wolf that especially fed on livestock. The deer wolf likely was the eastern wolf, but the wolves that fed on livestock may have been wolf-dog hybrids based on the descriptions in Goldman (1944). Between 1871 and 1897, 98 wolves were submitted for bounty in New York, mainly in northern counties (Goldman 1944). The bounty ended in 1898, and wolves were considered extinct thereafter. A specimen collected in the Adirondacks prior to 1855 was considered to be an eastern wolf (*Canis lupus lycaon)* based on skull characteristics (Nowak 2002). Wilson et al. (2003) considered this same specimen an eastern wolf by genetic assessment, referring to it as *Canis lycaon*.

Sizeable areas of potential wolf habitat exists in the state, especially in the area of the Adirondacks. Harrison and Chapin (1997) estimated 14,618 km^2 (5644 mi^2) of core habitat and 4,589 km^2 (1772 mi^2) of dispersal habitat, and felt the state could hold about 146 wolves. Mladenoff and Sickley (1998) estimated New York contained 16,020 km^2 (6,185 mi^2) of favorable habitat for wolves, and potentially could hold about 200 wolves. Paquet et al. (1999) estimated that the Adirondacks contained 9,634 km^2 (3,720 mi^2) of highly suitable habitat, and 11,666 km^2 (4,505 km^2) of moderately suitable habitat, but felt conditions were not adequate for maintaining long-term viability of wolves in the region. Carroll (2003) calculated that New York could hold as many as 460 wolves under conditions that existed in 2000, and would still be able to support as many wolves as 338 in 2025. Carroll suggests higher numbers and viability for wolves in New York than estimated in earlier studies.

On December 19, 2001, an 85 --lb male wolf was killed in Day, New York (002, Appendix 1: Glowa to Salazar). Carbon isotope testing indicated this was a wild wolf (Kay and Feranec 2011).

Vermont: Wolves apparently disappeared from Vermont by the mid to late 1800s. Harrison and Chapin (1997) estimated about 2,470 km^2 (954 mi^2) of potential core wolf habitat, and 1,222 km^2 (472mi^2) of dispersal habitat. Mladenoff and Sickley estimated about 3,624 km^2 (1399 mi^2) of favorable wolf habitat in Vermont. Carroll (2003) indicated that under conditions in 2000, Vermont was capable of supporting as many as 168 wolves, but suggested that by 2025 the potential may drop to 50, suggesting declining conditions for wolves. Of three wolves detected in United States border states in recent years, two occurred in Vermont (Kays and Feranec 2011), despite have the lowest area of suitable habitat of these states. In November 1998, a 72 -- lb male was shot near Glover, Vermont (002, Appendix 1: Glowa to Salazar). On October 1, 2006, a -- 91 lb male wolf was shot near North Troy, Vermont (002, Appendix 1: Glowa to Salazar). It appears that Vermont may not have enough habitat to support viable wolf independently, but would be an important connector between New York and Maine, as well as with the Canadian wolf population.

Northeastern States Summary: Wolves are considered extirpated throughout the northeastern United States. Significant habitat is thought to exist in northeastern New York, and in Maine with good connectivity existing in both New Hampshire and Vermont between these two areas. Occasionally eastern wolf dispersers from Canada reach this area, based on retrieval of carcasses. Potential for natural recolonization in this region in the foreseeable future, however, appears slim.

Western Great Lakes Region:

Wolves in the Western Great Lakes states represent an admixture of both gray and eastern wolves (Fain et al. 2010, Wheeldon et al. 2010a, 006- Appendix 1: Fain to Wydeven) and should not be considered extant eastern wolves. This wolf population does contain eastern wolf genes (Wheeldon et al. 2010a), is considered predominantly gray wolf by Koblmüller et al. (2009), and in many ways behaves more like gray wolves – most notably by avoiding breeding with coyotes (Mech 2010, Mech 2011b, Wheeldon et al. 2010a). Wheeldon and White (2009) and Wheeldon et al. (2010a) believed Western Great Lakes wolves display genetic continuity. For these reasons they should not be considered and extension of the relatively pure versions of eastern wolves that occur in southern Ontario or southern Quebec. However, since this population contains genes of eastern wolves and perhaps occasional individuals of nearly pure eastern wolf stock via dispersals, we summarize wolf habitat area and population characteristics for this region.

Michigan: Michigan contains an admixed population of gray and eastern wolves that it shares with Wisconsin, Minnesota and northern Ontario. Wolves from Michigan over 100 years ago already displayed genetics of an admixed population (Wheeldon and White 2009).

Beyer et al. (2009) discussed the history of wolves in Michigan from loss of breeding packs in the1950s, to return of wolves dispersing from Minnesota and Wisconsin in the 1980s and 1990s. The population was estimated at 434 wolves in 2006 (Beyer et al. 2009) and 687 wolves in 2011 (Christopher Hoving, pers. comm. 2011). Suitable habitat was estimated at 41,419 km^2 (15,992 mi^2) for the Upper Peninsula of Michigan and potentially as much as 28,265 km^2 (10,913 mi^2) in the Lower Peninsula of Michigan (Mladenoff et al. 2009). Most of the Upper Peninsula's suitable habitat is occupied by wolves, while only a few dispersers have been found in the disjunct habitat of lower Michigan.

The Upper Michigan habitat is also nearly contiguous to 120,000 km^2 of suitable habitat in Wisconsin and Minnesota (Mladenoff et al. 2009). Gehring and Potter (2005) estimated only 4,231 km^2 (1,634 mi^2) of favorable habitat in Lower Michigan and estimated that area could hold 40 - 105 wolves. Gehring and Potter (2005) used criteria for assessing wolf habitat from Mladenoff et al (1995), and in their update Mladenoff et al. (2009) indicate their new methods based on Wisconsin wolf habitat may not be as predictive as the earlier system. Thus the estimates by Gehring and Potter (2005) probably are a more reasonable estimate of wolf potential in Lower Michigan. Wolves are doing well in Michigan and populations in the Upper Peninsula may be approaching potential carrying capacity.

Minnesota: Wolves were located throughout Minnesota at the time of European settlement and may have consisted of 4000 to 8000 wolves (Erb and DonCarlos 2009). From the mid 1800s through mid 1900s the population and distribution of wolves declined drastically and dropped down to as few as 400 wolves in the 1950s and 1960s, when wolves occurred only in extreme northeastern Minnesota, the last population of wolves in the continental United States (Erb and DonCarlos 2009). From the 1960s through early 2000s the population increased and was estimated at 3,020 in 2004 (Erb and DonCarlos 2009). The population seems to be stabilizing and in 2008 a total of 2,921 wolves were estimated in the state (Dan Stark, pers. comm. 2011). Mladenoff et al (2009) estimated 80,608 km^2 (31,123 mi^2) of suitable wolf habitat in Minnesota. Erb and DonCarlos (2009) estimated 88,325 km^2 (34,102 mi^2) of total wolf range and 67,852 km^2 (26,198 mi^2) of occupied range in 2004. Wolf range also seems to have stabilized since the late 1990s.

Wisconsin: In early 1800s the area of Wisconsin may have held as many as 3000 to 5000 wolves, but by 1960 had been extirpated from the state (Wydeven et al. 2009). Wolves returned to the state in about 1975, and winter counts, begun in 1979 and recording 25 wolves, had grown to 782 - 824 in winter 2010 - 11 (Wydeven et al. 2011). Mladenoff et al (2009) estimated about 42,017 km^2 (16,223 mi^2) suitable wolf habitat in Wisconsin. The wolf population grew at rate of 22 percent annually in the 1990s, and around 12 percent annually between 2000 and 2007 (Wydeven et al. 2009). Currently wolves appear to be reaching their equilibrium population in Wisconsin (Van Deelen 2009).

Western Great Lakes Summary: In summary, approximately 4,400 wolves, considered genetically an admixture of gray and eastern wolves, occupy roughly 254,200 km^2 of habitat in the three-state region as of the 2009.

Jurisdictional Surveys

In preparation for this report, we conducted an email survey of all jurisdictions within the historical range of *Canis lupus lycaon – Canis lycaon* (refer to Map 1; Nowak 2003 and Chambers et al. Submitted delineations) to evaluate whether these states and provinces are aware of *Canis lycaon*, and to determine what is known of population status and existing regulatory mechanisms affecting wolf management[1] .

Summary of Recent Evidence of Wolves' Presence in Northeastern United States and Eastern Canada: Table 7.2 and Map 4 summarize data on putative wolf specimens recovered in Canada and the United States south of the St. Lawrence River since 1990. At least eight specimens of large wolves have been recovered within this region in the past 20 years (Table 7.2) (002 – Appendix 1: Glowa to Salazar,Villemure and Jolicoeur 2004, Maine Wolf Coalition , http://mainewolfcoalition.org/wolves-in-the-northeast/, Kays and Feranec 2011). Kays et al. (2010) allude to the use of DNA samples from "…three large wolf-like canids from Vermont and New York…", citing USFWS

[1] We also included a query regarding the jurisdiction's position on restoration; while this is not germane to assessing the current status of eastern wolves, it could be useful if the Service were to list *Canis lycaon* under the ESA. Survey results are being retained by the Service in their files.

investigation reports dated to 2002, 2004 and 2007. These likely are the same individuals listed as *Sequence* 4, 6 and 7 in Table 7.2, assembled by Glowa (002, Appendix 1 - Glowa to Salazar). Kays and Feranec (2011) utilized isotopes to determine that three recent specimens tabulated by Glowa were wild in origin (Table 7.2). The strongest evidence comes from Villemure and Jolicoeur (2004) who reported that the Ste. Marguerite de Lingwick, Quebec specimen's DNA profile was that of an eastern wolf from Algonquin Provincial Park.

Although the origin of some of these specimens is suspected to have been from captive escapes, the region from which most have been found is within known dispersal distance of wolves inhabiting areas of Canada north of the St. Lawrence. Photographs of several of these specimens are available for viewing at: http://mainewolfcoalition.org/wolves-in-the-northeast/. Further, the recovery localities of some of these specimens lie within projected suitable wolf habitat (for further discussions of dispersal and habitat, see Sections 10 and 12, below). The documentation of specimens provided in Table 7.2 implies that eastern wolves are at least occasionally present in the Gaspe Peninsula of Quebec, and in the northeastern United States.

8. Threats:

A. Modification or Destruction of Habitat & Range

In the western Great Lakes region, road densities, human densities and percent forest cover appear to define suitable *lupus* x *lycaon* wolf habitat (Mladenoff et al. 1995, 2009). These parameters have been used to assess habitat availability in the northeast (Harrison and Chapin 1998, Mladenoff and Sickley 1998). Field studies conducted by Sears et al. (2003) identified road management as vital to conservation management of "Wolf-like canids or possibly Wolves", and they recommended road densities of <0.6km/km^2 to minimize or prevent hybridization with coyotes in southeastern Ontario. Similar relationships between larger and smaller canids have been observed in New York (Kays et al. 2008).

Large blocks of forested land containing low resident human densities and low road densities is essential to the restoration and maintenance of eastern wolves. Forest fragmentation is correlated with morphological size differences in northeastern American canids (Sears et al. 2003, Kays et al. 2008). Sears et al. (2003) documented hybridization between eastern wolves and coyotes in fragmented forested habitats. For more discussion, see Sections 3 and 6, below. Throughout their range, eastern wolves seem best adapted to regions of deciduous and mixed deciduous/conifer forest. Current distributions of eastern wolves are squeezed between the agricultural landscapes of extreme southern Ontario and Quebec, in a band of deciduous and mixed conifer forest to the south of the conifer boreal forests of central Ontario and Quebec.

Habitat and over-exploitation are considered by Sears et al. (2003) and Rutledge et al. (2010b, In Press) to be key components in preventing the creeping of coyote genes into eastern wolf range. Immediately south of Algonquin Provincial Park, Sears et al. (2003) studied the habitat use and diet of Frontenac canids. These canids are morphologically variable, being intermediate in size between coyotes and Algonquin wolves (Sears et al.

2003). Larger bodied canids morphologically similar to *C. lycaon* occupied landscapes that had fewer human influences and higher forest cover (Sears et al. 2003), while smaller sized canids morphologically similar to *C. latrans* were associated with disturbed landscapes having higher road densities and lower proportions of forests. Diet was much higher in large prey in heavily forested landscapes; smaller prey predominated in habitats with lower forested landscapes, especially in summer. Sears et al. (2003) suggested that habitats with heavily forested tracts and road densities <0.6km/km^2 are necessary to minimize or prevent hybridizing with coyotes, especially in areas where harvesting occurs.

Habitat areas in Ontario and Quebec appear fairly secure for eastern wolves in areas north of the St Lawrence River (Henault and Jolicoeur 2003, OMNR 2005). At least 5 reserves occur within apparent range of eastern wolves in Quebec and are mostly 800 to 1600 km^2 in size (Henault and Jolicoeur 2003), but only two areas exist where eastern wolves are completely protected: Parc national du Mont Tremblant (1,492 km^2) and Parc de la Maurice (536 km^2). Much of the region occupied by putative eastern wolves in Quebec is predominantly land open to sustainable forestry, and open to hunting and trapping. Ontario portions of the eastern wolf range include the 13,911 km^2 protected area of Algonquin Provincial Park and surrounding townships closed to wolf and coyote hunting and trapping. Most of the eastern wolf areas in Ontario, including Algonquin Park are open to various levels of logging. Logging, as long as it is done on a sustainable basis and does not result in high density of roads, is probably beneficial to wolves providing habitat to white-tailed deer and beaver, major prey for eastern wolves. Intense logging in the1800s may have been a factor that allowed eastern wolves to spread northward into Ontario and Quebec.

Considerable areas of potential wolf habitat exist south of the St Lawrence in southeast Canada and northeastern U.S. (Harrison and Chapin 1998, Mladenoff and Sickley 1998, Carroll 2003). Harrison and Chapin (1998) estimated at least 65,926 km^2 of potential core habitat in the U.S. portion of the region, and estimated the area could hold 564 to 2235 wolves. Mladenoff and Sickley (1998) estimated 72,448 km^2 of favorable wolf habitat in the U.S. portion of this region and estimate the area could support 1424 wolves. Carroll (2003) estimated that the U.S. portion of this region in 2000 could have supported 1908 wolves, and the adjacent portions of southeast Canadian another 1094 wolves. By 2025, Carroll expected wolf potential in the U.S. portions to decline to 1486, and Canadian portions to 594. Despite this amount of potential habitat, current potential for recolonization by dispersal seems low because, to date, wolves have not readily dispersed into these areas (Wydeven et al. 1998, Carroll 2003).

From a federal wolf conservation standpoint, the Northeast does suffer from the lack of public federal lands. Only 5.7 percent of Maine consists of public land, and federal lands included: national forest 402 km^2 (155 mi^2), national parks 280 km^2 (108 mi^2), and 307 km^2 (118 mi^2) of other federal lands such as national wildlife refuge and military lands (National Wilderness Institute). New Hampshire includes 18.0 percent public land and federal lands included: national forest 3339 km^2 (1289 mi^2), national parks 41 mi^2 (16mi^2), and 122 km^2 (47 mi^2) of other federal land (National Wilderness Institute).

Vermont includes 15.8 percent public land and federal lands include: national forest 3301 km^2 (1275 mi2), national parks 34 km^2 (13 mi^2), and 55 km^2 (21mi^2) of other federal lands (National Wilderness Institute). New York State does have low area of federal lands that include: national forest 54 km^2 (21 mi^2), national park service 147 km^2 (57 mi^2), and 325 km^2 (126 mi^2) other federal lands (National Wilderness Institute), but New York does have 18,782 km^2 (7,552 mi^2) of state land managed for conservation (2009 New York Statistical Yearbook: http://www.rockinst.org/nys_statistics/2009/O/).

B. Overutilization: Commercial, Recreational, Scientific, Educational.

Historically anthropogenic activities, ranging from habitat alterations to direct killings of wolves resulted in the eastern wolf's extirpation throughout the northeastern United States, New Brunswick, and severely reduced populations in southeastern Ontario (Young and Goldman 1944, Pimlott et al. 1969, among others.

Within Canada, eastern wolf range exploitation by humans led to increased hybridization with coyotes (Theberge and Theberge 2004). Rutledge et al. (2010b, In Press) report this threat was reduced in and immediately surrounding Algonquin Provincial Park following a harvest restriction within townships surrounding the Park that increased the protected zone by 45 percent. Along with 7571 km^2 within Algonquin Park, and surrounding areas, a total of 13,911 km^2 provides complete protection for wolves (Rutledge et al. 2010b), and this area supports as many as 365 eastern wolves (009 – Appendix 1: Brent Patterson, pers. comm. 2011). Human-caused mortality dropped from 67 to 16 percent and wolf density increased and stabilized over the pre-ban era. Using genetic data, Rutledge et al.

(2010b) determined that the structure of packs changed from where most packs consisted of unrelated wolves, to ones where a majority of wolves were closely related, returning the population to a more natural kin-based social structure. They showed the closely related structure with eastern wolf packs may also provide resistance to the prospect of hybridization with coyotes, a noted threat (Rutledge et al. 2012)(See Sections 3 & 6).

Wolves are presently harvested by trapping and hunting seasons in both Ontario and Quebec, and the seasons do not distinguish between gray and eastern wolves. In Ontario a sizeable area is closed to hunting and trapping of both coyotes and wolves in and around Algonquin Park to protect eastern wolves. Similar large protected area do not exist within the range of eastern wolves in Quebec, although it is not clear whether these eastern wolves are relatively pure version of the species (or subspecies) or if these represent eastern/gray wolf hybrids.

Hunting and trapping season last from September 15 through March 15 for wolves in Ontario, with bag limit of 2 wolves for hunters and no bag limit for trappers. In Ontario, among annual hunter harvest of 109 -170 wolves and coyote that were submitted to fur dealers in wolf range, only about 10-15 % (11 to 23 wolves) were actual wolves, and others were coyotes, although some of the coyotes harvested may have included eastern wolves (OMNR 2005). Additional 1000-1600 wolves/coyotes were harvested annually by hunters (OMNR 2005), and if similar ratios were actually wolves, a total of 100 to 240 additional wolves may have been killed by hunters. Thus total wolf harvest by hunters might be somewhere in the range of 110-260 wolves.

Annual wolf harvest by trappers in Ontario over a period from 1971-72 to 2002-03 ranged from 285 to 1,248 wolves, and averaged 337 wolves annually (OMNR 2005). Assuming a province wide harvest of 337 wolves by trapping and about 123 by hunters, a total of about 500 wolves were harvested annually out of a population of 8,850 wolves (2005 estimate), or about 6 percent of the population. During some years harvests might be as high as 1,500 wolves representing 17 percent of the provincial wolf population.

Creel and Rotella (2010) argue that most wolf population can only tolerate human offtake as high as 22 to 25 percent. Adams et al (2008) estimated that wolf populations could sustain human exploitation rates as high as 29 percent, and Fuller et al.(2003) believes a range of 29-35 percent human take can be sustained by wolf populations. On a province-wide basis, wolf harvests in Ontario appear well within range of sustainability, but harvest is probably not evenly distributed. Harvest is likely to be much higher in southern portions of wolf range where access is much higher, and wolves are closer to areas of dense human populations. Wolves in southern portions of wolf range are also more likely to be eastern wolves that are subjected to high levels of hybridization with coyotes due to over-exploitation (Rutledge et al. 2012).

In Quebec wolf trapping occurs from October 18 through March 1, and hunting from October 18 through March 31, but portions of the north have hunting seasons from October 11 through April 15. Annual harvest rate based on fur sold for hunted and trapped wolves in the late 1990s ranged from 2.9 to 26.7 percent of wolf populations across 9 regions of Quebec (Hénault and Jolicoeur 2003). Harvest rates were highest in the southern regions that contained Algonquin or eastern wolves, ranging from 9.0 to 26.7 percent and averaged 18.8 percent harvest for 6 regions in the south that contain eastern wolves (Hénault and Jolicoeur 2003). Two regions with highest harvest rates included Abitibi-Témiscamingue (26.7 percent) in southwest Quebec and Capitale-Nationale in south-central Quebec (Hénault and Jolicoeur 2003). Thus it appears that at least 2 regions sustain harvests near the maximum levels of sustainability. Only about 2028 km^2 (783 km^2) is closed to wolf harvest on two national parks, probably protecting only about 25 wolves.

While harvest levels in southern Quebec may not threaten overall wolf population viability, such harvest may heavily exploit the pool of dispersing wolves (Adams et al. 2008). Such exploitation may also influence the direction of dispersing away from the south where vacant habitat exists in the United States. Higher rates of harvest may subject wolves to greater incidences of hybridization with coyotes (Sears et al. 2003, Rutledge et al. 2010b, In Press), a factor viewed as perhaps the biggest threat facing the Quebec wolf population (Michel Hénault and Emmanuel Dalpé-Charron, personal communications).

Illegal killing is likely a problem for any wolves dispersing from Canada south into the northeastern United States with their liberal coyote seasons(002, Appendix 1 - Glowa to Salazar, Kays and Feranec 2011) (Table 8.2). Recovery of wolves was possible in the states of Minnesota, Michigan and Wisconsin despite very liberal public harvests on coyotes, where the only restrictions on coyote hunting occurred during firearm deer seasons (9 to 27 days) in both Wisconsin and Michigan. Unlike the Western Great Lakes, where wolves are comparatively larger and less likely to be confused with coyotes, purer versions of eastern wolves such as exist in southeastern Canada would present difficulties for northeastern United States trappers and hunters to identify especially since northeastern coyotes are larger than their counterparts in the Western Great Lakes states. Recall, as well, that a total closure of coyote hunting and trapping around Algonquin Provincial Park was necessary to adequately protect eastern wolves (Therberge and Theberge 2004, Rutledge et al. 2010b).

C. Disease, Parasites, Predation& Genetic Swamping

See also <u>Section 5: Diseases and Parasites</u>, above. Eastern wolves are subjected to a number of canine diseases that affect other members of the genus and there is no reason to assume the effects on them differ from other members of the genus. Although destructive to individuals, most of these diseases seldom cause significant, long-term changes in population (Fuller et al. 2003, Kreeger 2003). Sarcoptic mange, rabies and canine parvovirus have been reported to cause population declines (Kreeger 2003).

Diseases affecting wolves in the Western Great Lakes region are discussed in details the recent *Federal Register* on the proposed delisting of wolves in the Western Great Lakes region (Federal Register, May 5, 2011). Canine parvovirus was perhaps the most serious disease affecting wolves in the region. The disease was not recognized in the United States until 1977, and especially affected wild canid populations in the 1980s. Canine parvovirus apparently caused a population decline in Wisconsin (Wydeven et al. 2009), and on Isle Royale (Wilmers et al. 2006) during this time. Growth of the wolf population into the late 1980s may have been slowed by the disease in both locations. Mech and Goyal (2011) determined that canine parvovirus effects on northeast Minnesota wolf population were most intense in the late 1980s and early 1990s. Since that time the Minnesota wolf population seemed to have developed enough immunity to withstand the disease. The same could probably be said for the remainder of the Western Great Lakes wolf population, that despite high levels of prevalence of parvovirus among wolves within the region, the population has shown tremendous growth in recent years (Federal Register, May 5, 2011).

Sarcoptic mange was first detected in wolves in the Western Great Lakes region in 1991 (Wydeven et al. 1996). During the early and mid 1990s the disease may have reduced growth of the wolf population in Wisconsin and later in Michigan (Wydeven et al. 1996), but the effects on population growth were short lived. Jimenez et al. (2010) also found that sarcoptic mange was an important mortality factor for wolves in Montana and Wyoming, but impacts were mostly localized and impacts on the overall population were relatively minor.

OMNR (2005) reported signs of sarcoptic mange on 12-15 percent of yearling and adult wolves in Algonquin Park. It had been reported as common on wolves and coyotes in southern Ontario in the early 1990s, and was again common between 2003 and 2005

(OMNR 2005). It was not known at the time how much mange influenced the population dynamics of wolves in Ontario.

Other diseases detected in wolves in the Western Great Lakes included Lyme disease, dog louse (*Trichodectes canis)*, canine distemper virus, blastomycosis, canine heartworm, bacterial myocarditis, and other disease have been detected in Great Lakes wolves (Federal Register, May 5, 2011). While some of these diseases occasionally cause mortalities, there is no evidence these diseases are slowing the growth of wolf recovery in the Western Great Lakes region (Federal Register, May 5, 2011). Some diseases may become more important at higher wolf densities and as wolf populations reach carrying capacity, and could become important factors that regulate the long-term wolf population in the region, but by themselves the diseases are not likely to compromise viability of a wolf population in regions of suitable habitat.

Eastern wolves in Algonquin Provincial Park between 1989-1996 commonly tested positive for canine parvovirus (CPV-2) , with 38 of 46 testing positive (82 percent) for the disease, and similar numbers tested positive for canine hepatitis virus (35 of 46 or 76 percent) (OMNR 2005). Although it was suspected these diseases may play roles in the demographics of wolves, no specific measures of impact were given. Eastern wolves in Algonquin did contrast with gray wolves in the Greater Pukaskwa Ecosystem, where parvovirus and hepatitis were infrequent and canine distemper had not been detected (OMNR 2005).

Rabies has been detected in Ontario wolves and confirmed as a mortality factor in Algonquin Provincial Park (Theberge and Theberge 2004, OMNR 2005). Of 35,000 cases of rabies verified in Ontario from 1957 to 1993, only 224 were attributed to wolves (0.6 percent), compared to 68 percent in red fox (*Vulpes vulpes)* and 29 percent in striped skunk (*Mephitis mephitis).* Low occurrence of the disease is attributed to the territorial behavior of the large canid excluding foxes from their territories. Thus rabies appears to be a relatively infrequent mortality factor among wolves in Ontario and has not produced major declines in wolves as seen in other locations such as Alaska (Ballard and Krausman 1997).

Rabies had not been detected in wolves in Quebec until February 2002 when a female wolf killed three dogs and injured two others (Hénault and Jolicoeur 2003). Apparently the disease is relatively rare in Quebec. Other diseases such a canine parvovirus and sarcoptic mange have been detected at low levels. Some mange has been detected in wolves in Quebec, but overall prevalence is not known. In general disease problems do not appear to be major limiting or mortality factors for wolves in Quebec.

Predation on eastern wolves is likely a rare event, primarily because few other predators other than black bears (*Ursus americanus*) and other wolves have that capacity (Ballard et al. 2003). Joslin (1966) found an adult lactating female, eastern wolf laying dead next to her den after an apparent attack by a bear. In this case the pups inside the den would likely also die. This is the only case in North America where a black bear was known to have killed a wolf. Likely black bears that readily hunt for neonate ungulates, would readily kill wolf pups if detected without adults present, and perhaps in the case observed by Joslin, the bear was trying to get to the pups. But bear attacks on wolf pups have never been detected, although specific mortality factors on young wolf pups are poorly known. In general wolves are more likely to outcompete black bears in most encounters (Ballard et al. 2003) especially if in a pack. Besides humans, and other wolves, few animals are likely to prey on wolves in North America.

At present eastern wolves exist in a narrow band extending through east-central Ontario into west-central Quebec (Map 3). Its range is sympatric with gray wolves to the north and west, and with coyotes to the west, south and southeast. It readily admixes with both gray wolves and coyotes within these two respective suture zones (Grewal et al. 2004, Kyle et al. 2006, Wilson et al. 2009, Rutledge et al. 2010b). Genetic swamping is viewed as a serious threat to long-term survival of eastern wolves (Sears et al. 2003, Kyle et al. 2006, Rutledge et al. 2010b. (See also Section 3 and Section 6, *Present Day Suture Zones*, above, for information on phylogenetic relationships and cross-breeding between eastern wolves, gray wolves and coyotes.)

D. Inadequacy of Existing Regulatory Mechanisms

States and provinces believed that adequate regulatory protections were being provided for wolves with the sole exception of New Brunswick (Table 8.1). All jurisdictions contacted held trapping and hunting seasons on coyotes (Table 8.2).

Mistaken Identity: Although most states and provinces consider that sufficient regulatory mechanisms are in place to provide adequate protection for eastern wolves, a few authorities expressed concern that coyote hunters could and have mistakenly killed wolves. A wolf with genetic affinities similar to eastern wolves was trapped and killed south of the St. Lawrence River in southern Quebec in 2002 (Villemure and Jolicoeur 2004). In Ontario complete protection of eastern wolves was only possible by also protecting coyotes with in areas where eastern wolves are being protected (OMNR 2005). In Wisconsin and Michigan coyote hunting was closed during firearm deer hunting seasons (9 days to 3 weeks) during early recolonization in areas of suitable wolf range, but coyote hunting was other wise allowed year-round, and wolves were able to recolonize both states. Wolf range expansion in Minnesota was possible without any special restrictions on coyote hunting.

Harvesting coyotes could be considered a potential threat to wolf dispersers as they are sometimes killed as cases of mistaken identity in the Western Great Lakes region where wolves are larger and coyotes smaller than those occurring in the Northeast (Wydeven, unpublished data). Early in the wolf recovery phase Wisconsin enacted provisions protecting coyotes during their gun-deer season within the northern wolf range to protect wolves from killings. The Upper Peninsula of Michigan held a similar closure on coyote hunting during the regular firearm deer season for a period of 16 days, from the early 1994 through 2010, and a coyote closed season existed in the northern Lower Peninsula from 2005 through 2009 (007 & 008 – Appendix 1: Roell and Byers to

Wydeven, 2011). Minnesota, where wolves were never extirpated, has the most liberal controls on coyote hunting and trapping, with no closed seasons.

It appears that a coyote hunting and trapping season, as applied in the Western Great Lakes have not been an impediment to recovery of wolves, but the admixed gray wolf population in the region are larger than eastern wolves, and Western Great Lakes coyotes are smaller than northeastern coyotes. Here the two species have not been documented to hybridize (Mech 2010). In regions where coyotes and wolves are closer in size, and hybridization readily occurs, coyote seasons may have greater impacts on wolves.

Ontario has a fairly restricted hunting season for coyotes in wolf range. The hunting and for both coyotes and wolves runs from September 15 to March 31, and is limited to two game seals of wolf and/or coyotes. Trapping in wolf range is also held from September 15 to March 31, and although there is no bag limit, across mot wolf range trappers are restricted to over 2,800 registered trap-lines.

A large area in and around Algonquin Provincial Park and all other provincial parks are closed to wolf and coyote harvest. South of wolf range and outside of areas with suitable habitat for wolves, coyote and wolf hunting and trapping are open year-round. This is an area of mostly agricultural land and receives highest level of depredation by wild canids (mostly coyote), where it is desirable to keep coyote population in check and keep wolves out. This system is very reasonable, balancing wolf conservation in the north in areas of low conflict and highly suitable habitat, with intense controls in the south in areas of high levels of conflict and poor wolf habitat. However, this system inevitably discourages the dispersal of eastern wolves to areas of suitable habitat in the Northeastern United States; the wolf/coyote harvest system in extreme southern Ontario sets up gauntlet that would be difficult for dispersing eastern wolves to pass through.

As with Ontario, wolves and coyotes in Quebec are regulated together for the purpose of hunting and trapping seasons. Hunting seasons vary by 29 zones, and starting dates are October 18, 25 or November 8 with all ending on March 31. Two hunting season zones in the northeast run from October 11 through April 15. Some zones in the far north have no open hunting season. Trapping seasons vary by 96 furbearer management units with starting dates of October 18 or 25, and ending dates of March 1 or March 15.

There are no bag limits for either hunting or trapping seasons. In the far north trapping is reserved for native peoples and there is no public hunting season. In southern Quebec only les Parcs Nationaux are closed to harvest of wolves and coyotes. The structure of hunting and trapping seasons in southern Quebec results in intense harvest of wolves and coyotes, although at presumably sustainable levels, but in all likelihood reduces opportunities for wolves to disperse southward into areas of suitable habitat in the northeastern United States.

Coyote harvest season varied among the five Northeast States with potential wolf habitat. Massachusetts is the most restrictive with trapping using box traps only from November 1 through November 30. New Hampshire has the lengthiest trapping season that runs from October 15 through March 31. All states use traps and cable restraints from which wolves can be released with only minor injuries.

Hunting seasons range from 3 months in New Hampshire to year-round in Vermont and Maine. Only New Hampshire has a coyote hunting season that avoids ungulate hunting seasons. Probably the highest risk of wolves being mistakenly shot for coyotes occurs during ungulate hunting seasons, when highest numbers of hunters are on the landscape, and coyotes are more likely shot as targets of opportunity by hunters who normally do not hunt coyotes.

While there is some risk that wolves could be shot during coyote hunting seasons, this did not prevent wolves from recolonizing the Western Great Lakes region. However, in the Northeast with larger coyotes and smaller wolves, some restrictions may be needed to allow wolves to return to the area.

E. Other Natural or Manmade Factors Affecting Future

Argue et al. (2008) studied the effects of anthropogenic disturbances at summer wolf homesites in Algonquin Provincial Park. Packs tended to move pups following human intrusions into homesites, but were just as likely to reuse such sites in subsequent summers as packs in which no homesite disturbance was recorded. Although pup mortality at disturbed sites was slightly higher, no significant difference was detected. Argue et al. (2008) concluded that eastern wolves were resilient to disturbances.

The level of development along the St Lawrence River and portions of southern Quebec and southern Ontario seems to restrict wolves from readily traveling through the region. (Wydeven et al. 1998, Carroll 2003). Liberal harvest in developed areas of southern Ontario and Quebec reduces depredation problems by wolves but also makes it difficult for wolves to disperse through the area to large areas of suitable habitat to the south. Various combinations of habitat disturbances, developments, liberal harvest, and maintaining open channels for shipping commerce along the St. Lawrence River (Wydeven et al. 1998, Carroll 2003) allow few wolves to pass through the area.

An additional factor affecting wolves as discussed earlier under genetics, is the hybridization of the eastern wolf population by coyotes on the south edge of wolf range in southern Quebec and Ontario. Hybridization is the biggest threat facing *Canis* populations in Quebec (Michel Hénault and Emmanuel Dalpé-Charron, personal communications). Within the range considered occupied by eastern wolves, it is not clear whether this represents a relatively high content eastern wolf zone, a zone of eastern wolf –coyote hybridization, or gray wolf - eastern wolf hybrids. Hybridization with coyotes had been a problem with eastern wolves in Algonquin Provincial Park Grewal et al. (2004), and Kyle et al. (2006), but greater protection of this wolf population seems to have reduced the tendency to hybridize with coyotes (Rutledge et al. 2012).

Eastern wolves that are able to disperse through the St. Lawrence Valley into areas of suitable habitat in the Northeastern United States will encounter a landscape of large coyotes that already carry wolf genes in them (Kays et al. 2009, Way et al. 2010). Unless such a wolf encounters another wolf of the opposite sex soon after it arrives, it likely would breed with an eastern coyote and be absorbed into that population. Such hybrid swamping would make it difficult for wolves to establish a foot hold within the region. and would limit the ability of eastern wolves to spread and reestablish on the landscape despite huge areas of very suitable habitat.

9. Current Protective Status by State/Province/Tribal/Federal Laws

Wolves are protected in all 6 of the states that responded to our survey (Table 8.1). In Canada seasons exist on wolves in both Ontario and in Quebec, and are probably unprotected in New Brunswick (Table 8.1). In Ontario gray wolves are classified as a Furbearing Mammal while eastern wolves are classified as a Species of Special Concern (Table 9.1). Harvest seasons presently do not differentiate between the two (*See Section 8, Part D, above*).

10. Summary of Land Ownership and Existing Habitat for each Population.

For a synopsis of federal and public land ownership see Section 8, Part A, above. The Northeastern United States lacks extensive areas of federal lands. Ironically Maine, which has the largest area of suitable habitat, also has the least amount of public land of the four states with suitable wolf habitat in this region. Less than 6 percent of Maine is in public lands, and thus lands are at greater risk of becoming fragmented or developed. New Hampshire and Vermont are 16-18 percent public land, and contain some sizeable areas of national forest, but by themselves contain only small portion of the suitable wolf habitat within the region. New York has very little federal land, but has some sizeable areas of state lands, especially in and around the Adirondacks, but Paquet et al (1999) argue that by itself, the Adirondacks may not support a viable wolf population.

Mladenoff and Sickley (1998) conducted a GIS habitat suitability analysis of portions of New York, Vermont, New Hampshire and Maine based on methods used in the Upper Great Lakes states (Mladenoff et al. 1995). They estimated that approximately 72,500 km^2 of high potential wolf habitat exists in the region, with the largest concentration (53,700 km^2) extending from Maine through New Hampshire into Vermont. Mladenoff and Sickley (1998) estimated this region could support in excess of 1,000 wolves. Although they did not provide data on the relative amounts of land within various forms of land ownership, their model favored publicly owned and industrial forest complexes over privately owned land parcels.

Harrison and Chapin (1998) also performed a GIS analysis in this region and evaluated the potential dispersal capabilities and connectivity between habitats. They divided habitat into core and dispersal zones based on the relative levels of road and human densities, and the extent of forest cover. Their analysis revealed that the Maine – New Hampshire area contained over 54,600 km^2 of contiguous habitat, and the Adirondacks contained an additional 14, 618 km^2 of habitat. They estimated this region contained 78,723 km^2 of suitable habitat (84 percent core habitat and 16 percent dispersal), similar to the estimates of Mladenoff and Sickley (1998). Based on their GIS extrapolations, Harrison and Chapin estimated that the region could support between 564 to 2,235 wolves. They also determined that an additional 58,000 km^2 of dispersal habitat existed between occupied Canadian wolf range, and the core habitats in New York and Maine, which at one point they identified, is only a distance of 70 km, well within the dispersal capability of wolves. However, they also noted that higher human and road densities, more open, non-forested terrain and the potential for breeding with indigenous coyotes could serve as an impediment to colonization by dispersers.

Habitat presently exists for eastern wolves in 4 northeastern states New Hampshire, New York, Vermont, Maine) and in Ontario, Quebec and extreme western New Brunswick within the historic range of the species (Map 1, as delineated by Nowak 2003, Table 10.1 and Chambers et al. Submitted). Additional habitat exists in the western Great Lakes states of Michigan, Minnesota, Wisconsin, and on Isle Royale National Park, and northwestern Ontario (Map 3). However, this area already supports a wolf population believed to be an admixture of *lupus* x *lycaon* wolves (Koblmüller et al. 2009, Wheeldon and White 2009, Wheeldon et al. 2010a, Chambers et al. Submitted, Fain et al. 2010, vonHoldt et al. 2011, 006 – Appendix 1: Fain to Wydeven 2011).

11. Past & Current Conservation Activities of Benefit

Ontario has implemented a number of regulatory restrictions to enhance survival of eastern wolves, and has conducted meaningful research in evaluating the effects of such regulatory changes. Rutledge et al. (2010b) analyzed the effect of a geographical extension of a wolf protection zone surrounding Algonquin Provincial Park, where eastern wolves are already fully protected. Extended protection did not impact population size because human-caused mortality was off-set by natural causes. But this shift resulted in kin-driven pack structures that were less vulnerable to admixing with coyotes (Rutledge et al. 2012).

Sears et al. (2003) evaluated habitat parameters as it related to canid genetics in an area south of Algonquin Provincial Park and determined that larger blocks of contiguous forest cover were inhabited by larger, more *lycaon*-like canids, as opposed to fragmented terrain where a *lycaon* – *latrans* admixture predominated. The implications of this study suggest that preserving large blocks of forested landscapes with minimal human intrusions would favor maintenance of eastern wolves.

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Tables

Table 7.1

	Present now?		
State/ Province	***C. lupus***	***C. lycaon***	***C. latrans***
New Hampshire			Yes
New York			20,000-30,000
Maine			Yes
Massachusetts		1 in 2007	Yes
Michigan	<< 687>>		Yes
Minnesota	2,921 in 2008		Yes
Vermont			4,500 - 8,000
Wisconsin	800		~50,000
Isle Royale National Park	?	Yes	No
New Brunswick	No		Yes
Ontario	Yes	Yes	Yes
Quebec	Yes	Yes, but version of *C. lupus*	Yes

Table 7.2

Information from Glowa to Salazar; Appendix 1: 002									Kays and Feranec 2011	
Sequence	**Date**	**Locality**	**Age**	**Sex**	**Wt**	**DNA?**	**How Obtained**	**Source**	**Number**	**Wild?**
1	30-Aug-1993	Moosehead Lk, ME	Y	F	67	*C. lycaon*	shot			
2	2-Nov-1996	Bangor, ME		M	82	*C. lycaon*	trapped		ME-96	No
3	00-Nov-1998	Glover, VT		M	72	*C. l. lycaon*	shot		VT-98	Yes
4	19-Dec-2001	Day, NY		M	85	*C. lupus*	shot		NY-01	Yes
5	00-Jan - 2002	Ste. Marguerite de Lingwick, QE		F	64		trapped	Villemure and Jolicouer 2004		
6	12-Apr-2005	Sterling, NY		M	99	*C. lupus*	shot		NY-05	No
7	1-Oct-2006	North Troy, VT		M	91	*C. lupus*	shot		VT-06	Yes
8	13-Oct-2007	Shelburne, MA		M	85	*C. l. lycaon*	shot			

Table 8.1

			Potential to Increase Protections?	***Conserve Dispersers?***
	Jurisdictional Protection for?			
State/ Province	***C lupus***	***C. lycaon***		
New Hampshire	both state & federal		No	Likely
Maine	Yes		Yes?	Yes
Massachusetts	Yes	Yes	Not needed	Yes
Michigan	Yes		N/A	Yes
Minnesota	Yes		N/A	N/A
Wisconsin	Yes		Not needed	Yes
Isle Royale National Park	Yes	Yes	Yes	Yes
New Brunswick	No		Doubtful	Unknown
Ontario	Furbearer	Furbearer with Closed Area	NA	NA
Quebec	Furbearer	Same as C. lupus	NA	NA

Table 8.2

	Methods of Harvest				*season:*		
Jurisdiction	***trap***	***hunt***	***cable restr***	***control***	***bag limit***	***from***	***to***
New Hampshire	Oct 15-Mar 31	Jan 1-Mar 31	no	no	none	see trap / hunt	
Maine	Mid Oct - Dec 31	all year			none	see trap / hunt	
Massachusetts	Box traps Nov 1 - 30	Mid Oct.-Mar 8	no	no	none	see trap / hunt	
Michigan	Oct 15 - Mar 1	Jul 15-Apr. 15	Jan 1 - Mar 1		none	see trap/hunt/cable	
Minnesota	all year	all year			unprotected		
New York	N Oct.25-Dec. 10 S. Oct.25-Feb. 15	Oct. 1-Mar. 25		no	no		
Vermont	late Oct - Dec 31	all year					
Wisconsin	Mid Oct - Mid Feb	all year	Dec 1 - Feb 15	no	none	see trap/hunt/cable	
Isle Royale National Park	N/A						
New Brunswick				Yes			
Ontario	Sept. 15-Mar. 31	Sept. 15-Mar. 31	Yes	No	2 by Hunters		
Quebec	Oct.18-Mar. 1/15 Oct. 25-Mar 1	Oct 18-Mar.31	?	Yes	none		

Table 9.1

	Listing Status		***Is ____ recognized within jurisdiction?***		
State/ Province	***C lupus***	***C. Lycaon***	***C. lupus***	***C. lupus lycaon***	***C. lycaon***
New Hampshire	extirpated indigenous non-game			Yes	
New York	Endangered				
Maine	Extirpated		Yes		No Discussion
Massachusetts	Not listed	Not listed			Yes?
Michigan	State protected species per Chapter 9.3 Wildlife Conservation Order		Science unsettled. Managed as a population regardless of species		
Minnesota	State: Special Concern	Not Listed	Yes		
Vermont	Species of Greatest Conservation Need				
Wisconsin			Yes	Yes	No
Isle Royale National Park	Endangered	Not Listed	?	?	Yes ?
New Brunswick	Extirpated	N/A	Yes		
Ontario	Furbearing Mammal	Species of Concern	Yes	Yes	Yes
Quebec	Furbearer	Furbearer as subspecies of C. lupus	Yes	?	Not as distinct sp.

Table 10.1

	Population Status…						***Size of…***			
	Does habitat for breeding pop exist?			***Does habitat for viable pop exist?***			***C. lupus***		***C. lycaon***	
State/ Province	***C. lupus***	***C. Lycaon***	***C. latrans***	***C. lupus***	***C. Lycaon***	***C. latrans***	***habitat size***	***# wolves***	***habitat size***	***# wolves***
New Hampshire	No	No		No	No		2,000 mi^2		2,000 mi^2	
Maine	Yes			Yes			20,388 mi^2			
Massachusetts	No	No		No	No		N/A		N/A	
Michigan	Yes	Yes		Yes	Yes		687 (2010)			
Minnesota	Yes			Yes			35,000 mi^2	2,921 in 2008		
Wisconsin	Yes			Yes			16,200 mi^2	800 in 2010		
Isle Royale National Park	Yes	Yes		Yes	Yes		?	?	210 mi^2	24 (1959-2011)
New Brunswick	Yes	?		Yes	?					
Ontario	Yes	Yes		Yes	Yes		309,000 mi^2 & 7710 both, 400-1620 C. lycaon			
Quebec	Yes	Yes		Yes	Yes		518,000 mi^2	6,380	22,000 mi^2	~585

Maps

See separate attachments

Map 1. Interpreted historical range of *Canis lupus lycaon*; *Canis lycaon*.

Map 2. Possible current range of *Canis lycaon*.

Map 3. Distribution of *Canis lycaon* and admixtured suture zones, based on morphological and genetics studies.

Key:

G= genetics study

M = morphology study

1. Fain et al. 2010
2. Grewal et al. 2004
3. Kays et al. 2011
4. Kolenosky and Standfield 1975
5. Mech 2010
6. Mech et al. In Prep
7. Nowak 2003
8. Nowak 2009
9. Rutledge et al. 2010a
10. Schmitz and Kolenosky 1985

11. Sears et al. 2003.

12. Way et al. 2010

13. Wheeldon et al. 2010

14. Wilson et al. 2009

Map 4. Recent wolf specimens in relation to potential suitable habitat in northeastern United States (see Table 7.2 for numbering system). Suitable habitat based on Mladenoff and Sickley (1998).

Appendices

See separate attachments

***Appendix 1*. Contacts, emails, correspondence. Include phones/faxes/emails**

Summary / Recommendations

1. A genetically and morphologically unique large *Canis* species occupied much of east-central North America during the final stages of the Pleistocene up to present times. Its present range is restricted to a swath of east-central Ontario and southwestern Quebec in Canada. Scientists are increasingly referring to this canid as the eastern wolf, *Canis lycaon.*

2. Recent carcass recoveries reveal that individual eastern wolves are at least occasionally present in the Northeastern United States, but there is no evidence that any breeding occurs at the present time.

3. Wolves in the Western Great Lakes states lie within a naturally occurring suture zone where gray wolf and eastern wolf populations collided during and following the retreat of the continental glaciers. The wolf population in this geographic region is taxonomically distinct, an admixture of *Canis* lupus X *Canis lycaon*. It displays genetic continuity and is representative of the gene pool present prior to anthropogenic influences. There is good agreement that wolf populations in this region have since functionally and numerically recovered.

4. Geneticists, especially, use peer-reviewed scientific journals to advance their position that this unique wolf type, labeled the eastern wolf, *Canis lycaon*, is a distinct species. This posture is presently subject to robust and healthy scientific debate. The fact remains these large canids presently *lack official designation* as a species. We encourage those who promote eastern wolves as a distinct species petition an international authority such

as the International Commission of Zoological Nomenclature, the American Society of Mammalogists, etc., to resolve this issue so that conservation efforts may proceed.