Eastern puma (=cougar) *(Puma concolor couguar)*

5-YEAR REVIEW:
Summary and Evaluation

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5-YEAR REVIEW

Species reviewed: Eastern puma (=cougar) *(Puma concolor couguar)*

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1.0 GENERAL INFORMATION

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1.2 Methodology Used to Complete the Review

This review was based on information obtained from reports, surveys, peer-reviewed and published scientific literature, books, Web sites, and other scientific and management information. This information was augmented by conversations with and comments from biologists and other experts familiar with the species. Information was also obtained from a survey (Appendix A) distributed to the fish and wildlife agencies in 21 States and Washington, D.C. within the historic range of the eastern puma, as mapped in the recovery plan (U.S. Fish and Wildlife Service (USFWS) 1982). Although we did not send surveys to eastern Canadian Provinces, we reviewed other sources of information for this portion of the historic range. From the survey, we received responses from 14 States (Connecticut, Indiana, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New York, North Carolina, South Carolina, Rhode Island, Vermont, Virginia, and West Virginia) and Washington, D.C. We also created an eastern puma website (http://www.fws.gov/northeast/ECougar/) to collect reports from the public of sightings of pumas. We received approximately 573 written and electronic mail responses from the public as follows: Connecticut =6, Delaware=1, Illinois=1, Maine=17, Maryland=17, Massachusetts=6, Michigan=18,

Minnesota=1, Montana=1, New Brunswick=1, New Hampshire=17, New Jersey=5, New York=46, North Carolina=73, Ohio=3, Pennsylvania=270, South Carolina=15, Rhode Island=2, Tennessee=5, Vermont=10, Virginia=25, West Virginia=4, and miscellaneous=29. We received no public comments from eastern Canada or Washington, D.C. There are thousands of unconfirmed reports of pumas in the 21-State region in State wildlife agency files. We received photographs and video of alleged pumas, puma-killed animals, scat, tracks, and other signs, some of which were possibly evidence of pumas but could not be verified. We relied primarily on published scientific information and information provided by State wildlife agencies. We used the methodology of The Cougar Network (http://www.cougarnet.org/, Appendix B) to classify reports and observations.

The review, conducted by Mark McCollough, Ph.D., USFWS Maine Field Office, consisted of an evaluation of the recovery objectives and criteria in the Eastern Cougar Recovery Plan (USFWS 1982). All recommendations resulting from this review are a result of a thorough review of all available published information on the eastern cougar (=puma). We did not have the means to collect all unpublished information, including the thousands of unpublished reports of puma occurrences in State and private organization files.

Comments on this review were received from USFWS Regions 3, 4, and 5. No part of this review was contracted to an outside party. After USFWS' review, we received additional information concerning pumas in Quebec and Ontario, which were incorporated into Appendix B. This information did not change the conclusions or recommendations of this status review.

1.3 Background

1.3.1 Federal Register (FR) Notice announcing initiation of this review: January 29, 2007 (72 FR 4018-4019): Initiation of a 5-year Review of 10 Listed Northeastern Species.

1.3.2 Listing history:

Original listing

FR Notice:	37 FR 14678 Amendments to List of Endangered Fish and Wildlife
Date listed:	June 4, 1973
Entity listed:	Subspecies, *Felis (=Puma) concolor couguar*, Eastern cougar (=puma).
Classification:	Endangered in eastern North America.

1.3.3 Associated rulemakings/actions: None. Critical habitat has not been designated for this species.

1.3.4 Review history: A comprehensive review of the status of the puma in North America, including the eastern puma, was completed by the USFWS in 1976 (Nowak 1976). Robert L. Downing (newsletters from 1979 to 1982) did the last review of the eastern puma for the USFWS in 1978. He distributed surveys to 30 eastern State wildlife agencies and three Canadian Provinces. All three Canadian Provinces and Tennessee, North Carolina, Virginia, West Virginia, Connecticut, Massachusetts and New York responded that they believed they had wild pumas. States and Provinces had no estimates of population size, except for Florida documenting 10 to 15 animals. Six States responded with knowledge of captive pumas escaping or being released, but none believed these contributed to self-sustaining populations. New Brunswick, all seven "Florida panther States," and four other States thought that pumas had been present long enough to possibly represent native, not introduced, animals.

Since then, the eastern puma was included in three cursory 5-year reviews. The following list of previous 5-year reviews in which the eastern puma was included was generated from a search of the Hein-Online database of FR notices, and from other notices found in files.

> **May 21, 1979** (44 FR 29566) – review of all species (foreign and domestic listings) listed prior to 1975. Three FR notices refer to results of the 1979 review: 45 FR 40958, June 16, 1980 (completion notice for three kangaroos); 29 FR 10520, March 20, 1984 (Arctic peregrine reclassified); and 50 FR 4938, February 4, 1985 (eastern brown pelican DPS delisted).
>
> **July 22, 1985** (50 FR 29901) – all species listed before 1976, and in 1979 to 80 (foreign and domestic listings). Resulted in 52 FR 25522 (July 7, 1987) notice of completion with no changes.
>
> **November 6, 1991** (56 FR 56882) – all species (foreign and domestic listings) listed before 1991.

No formal 5-year reviews have heretofore been conducted specifically for the eastern puma. Nowak (1976) did a review of the status of pumas in North America for the USFWS. The recovery plan (USFWS 1982) also included a status assessment.

1.3.5 Species' Recovery Priority Number at start of 5-year review: 18 (TESS database). This recovery priority number has been based on a presumption of extinction.

1.3.6 Recovery plan: Eastern Cougar Recovery Plan (USFWS 1982), prepared by Robert L. Downing, USFWS, Clemson, South Carolina
Date issued: August 2, 1982

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) Policy

2.1.1 Is the species under review a vertebrate? Yes.

2.1.2 Is the species under review listed as a DPS? No.

2.1.3 Is there relevant new information for this species regarding the application of the DPS policy? No. See sections 2.2 and 2.3 below.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable recovery criteria? A recovery plan was approved in 1982. Recovery objectives for reclassifying the Eastern puma from endangered to threatened (i.e., downlisting) will be achieved when one population containing at least 50 breeding adults is found or established. Delisting (= recovery) will occur when at least three self-sustaining populations (each containing >50 breeding adults) are found or established. This recovery plan is among the first written and does not contain measurable

recovery criteria. There are no recovery objectives or criteria for habitat, distribution of populations, or other listing factors.

2.2.2 Adequacy of recovery criteria:

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat? No. The recovery plan is 27 years old, and considerable new information is available. The plan lacks recent published and unpublished scientific information on the eastern puma and its habitat.

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria? No. The five listing factors are not mentioned in the plan. The plan does not contain a threats section. Overhunting in the colonial era, past declines in prey (deer), habitat loss, and problems associated with increasing human population are alluded to in the recovery plan, and few literature references are provided.

2.2.3 List the recovery criteria as they appear in the recovery plan and describe how each criterion has or has not been met citing information.

Recovery Criterion 1: A population containing at least 50 breeding adults was found or established.

Recent reviews of the status of the eastern puma (Parker 1998, Cardoza and Langlois, 2002, Bolgiano and Roberts 2005) provide no evidence of a persistent, breeding population of pumas in the historical range of the subspecies. Individual pumas have been verified by specimens, genetic samples, and well-documented photographs and tracks (Appendix B). Evidence of reproduction (e.g., kittens killed in Kentucky and New York, Appendix B) is likely from released or escaped pets. Thus, the downlisting criterion has not been met.

2.3 Updated Information and Current Species Status

2.3.1 Biology and habitat: The information in this review updates our understanding of the status of the eastern puma. Such a review has not occurred since the recovery plan was written in 1982. Because time and resource constraints limited our ability to fully investigate the enormous volume of unpublished records, historical information, museum records, information compiled by puma organizations, and reports in State wildlife agency files, this 5-year review cannot be considered a comprehensive review of the subspecies' status. However, we relied heavily on accessible published literature and several recently published reviews of the status of the eastern puma (Parker 1998, Cordoza and Langlois 2002, Bolgiano and Roberts 2005) that we believe reflect the most recent status of the biology and habitat of the eastern puma. The following sections summarize the biological status of the eastern puma and analyze threats to this subspecies based on information collected subsequent to the 1982 recovery plan.

2.3.1.1 New information on the species' biology and life history: The eastern puma (*Felis=Puma concolor couguar*) was considered a subspecies of the puma, which is known by many common names: cougar, catamount, mountain lion, panther, painter, Indian devil, mountain screamer, wildcat and other names (Seton 1929). This taxonomy was recently revised because of new genetic information (see Taxonomy section below). The puma is the most widely distributed land mammal in the New World (Nowak 1976) and is one of the most adaptable mammals in the Northern

Hemisphere (Sunquist and Sunquist 2002). It has the greatest latitudinal range (about 110°) of any non-migratory terrestrial vertebrate except humans (Iriarte et al. 1990). It occupies an altitudinal range from sea level to 4,500 mi. (mi.) and a climatic range from dry desert to wet lowland tropical rain forest (Nowak 1991). At the time of European contact, it occurred throughout most of North, Central, and South America. The puma occurred throughout eastern North America, but did not extend far into the boreal forest zone (Young and Goldman 1946, Peterson 1966, Hall 1981, Scott 1998). Breeding populations still occupy about one-third of their historical range in North America and are absent from historical range in central and eastern North America, except Florida. Although there are many historic references to the presence of pumas in eastern North America (Tinsley 1987), little was recorded about their natural history. Allen (1876) said they occurred in eastern North America as far north as northern New England. Audubon and Bachman (1851) reported that the puma was "sparsely distributed" over North America up to about 45° north latitude, which roughly equates with the colonial-era range of their primary ungulate prey, white-tailed deer. The puma occurred in a variety of habitats from swamps and everglades in the South to temperate forests in the Northeast.

George Buffon described the eastern puma in 1766 in the publication *Cougar de Pennsylvanie* (as quoted in Shoemaker 1917): "It was low on its legs, has a longer tail than the Western puma, it is described as 5 feet 6 inches in length, tail 2 feet 6 inches; height before, 1 foot 9 inches; behind 1 foot 10 inches." Kerr (1792) described the eastern puma as a small reddish or yellow race with a dark dorsal stripe and a small head. Audubon and Bachman (1851) provided one of the few scientific descriptions of the subspecies. Their description of morphology and pelage provide no unique coloration or adaptations distinguishable from pumas elsewhere in North America. Audubon and Bachman (1851) believed after examining many specimens from North and South America that they were "one in the same species, and cannot even be regarded as varieties." C. Hart Merriam (1882) said that the head of the Adirondack puma was proportionately small, but George G. Hastings (in Shoemaker 1917) said that the pumas he killed in Pennsylvania had heads "like bulldogs." Young and Goldman (1946) described the eastern puma based on DeKay's (1842) description; "Body and legs of a uniform fulvous or tawny hue. Ears light colored within, blackish behind. Belly pale reddish or reddish-white. Face sometimes with a uniform lighter tint than the general hue of the body." Lazell (1981) described the skull as broad with inflated nasals. Emmons (1840 in Young and Goldman 1946) described the length of a male specimen from New York as 9 feet.

Belden (1986) described unique characteristics of the Florida panther *Felis concolor coryi,* including a ridge or whorl of hairs in the mid-dorsal region of the back, a 90-degree crook in the end of the tail, and white flecks of hair in the neck and shoulder pelage. These and other unique attributes (heart abnormalities, lower sperm viability), are believe to be attributed to the isolation and inbreeding of that subspecies (Roelke et al. 1993, Seal 1994, Pimm et al. 2006). These characteristics have largely disappeared from the population since the introduction of 8 female pumas from Texas (Land et al. 2004, Pimm et al. 2006). *Felis. c. coryi* was also described as being more rufous or reddish brown in pelage and having longer legs and smaller feet than *F. c. couguar* (Young and Goldman 1946).

There is much conjecture about the existence of "black panthers" in eastern North America. Buffon (1761) described a "black couguar" from America. Kerr (1792) named a species, *Felis discolor*, which was likely a description of the black color phase of the American jaguar (*Panthera onca*). He described the hair of the animal as short, very smooth, and of a brownish color, "but sometimes marked with spots of a full black colour." In large felids, melanism (dark pigmentation of skin or hair) occurs uncommonly, but consistently only in leopards (*Panthera pardus*) and jaguars (Robinson 1978). In 2002 a leopard skull and bones were found in Manchester, New Hampshire, and released/escaped pet black leopards have been documented in Great Britain (Lankalis 2006). A few melanistic pumas have been documented in Brazil (Thompson 1896) and Central America (Cabrera

and Yepes 1940, Tinsley 1987), but no melanistic specimens have been authenticated from North America (Young 1946, Tinsley 1987) despite many alleged eyewitness reports to the contrary. Scott (1998) could find no records of a melanistic puma being born in captivity. Nevertheless, a high proportion of sighting reports in eastern North America (up to 30 percent in some jurisdictions) are of black pumas. Wright (1972) listed 20 reports of black pumas in New Brunswick between 1951 and 1970, but believed that puma hides may darken if soaked in water. Coleman (1994) debunked the oft-quoted hypothesis of black pumas originating from circus train wrecks. Reports of black pumas provide further evidence that many sightings are mistaken identity of other animals (e.g., fishers, black bears, Labrador retrievers, house cats, other captive exotic cats) and should be discounted until there is unambiguous verification.

Given our current knowledge of North American pumas, there is little reason to believe that eastern pumas had significantly different ecology than pumas elsewhere on the continent. The first organized field studies of pumas using radio-telemetry started in the mid-1960s in Idaho (Hornocker 1970, Seidensticker et al. 1973) and were followed by studies in Arizona (Shaw 1977, 1980), Wyoming (Logan and Irwin 1985), Utah (Laing 1988), California (Beier and Barret 1993), British Columbia (Spalding and Lesowski 1971), and in Florida (Belden et al. 1988). Today telemetry studies continue in Florida and many western States and Provinces expanding knowledge of home range, movements, and populations, diet, mortality, and natality.

Adult male pumas in North America typically weigh 116 to 147 pounds (52.6 to 66.7 kg) and are about 1.4 times larger than adult females, which weigh 75 to 105 pounds (34.0 to 47.6 kg) (Anderson 1983, Lindzey 1987). A puma killed in New Hampshire in 1853 was 100 inches (254 cm) long and weighed 198 pounds (89.8 kg), and a Vermont male taken in 1875 was 87 inches (221 cm) long and weighed 110 pounds (49.9 kg) (Silver 1957). Total body length ranges from 80 to 108 inches (203 to 274 cm) and 72 to 79 inches (183 to 201 cm), for males and females respectively (Lindzey 1987). The pelage is uniformly tawny (thus its species name *concolor* – "cat of one color"). Pumas adapt to a wide range of habitats and prey, making it one of the most adaptable and generalist mammalian carnivores (Iriarte et al. 1990). Pumas prey primarily on native ungulates, but regularly kill smaller prey such as rabbits, porcupines and beavers. Deer are the puma's primary prey – white-tailed deer in eastern North America and mule deer and elk in the West (Dixon 1982, Anderson 1983, Iriarte et al. 1990). White-tailed deer and porcupines were reportedly the primary foods of eastern pumas (Merriam 1882, Wright 1959). Porcupines are a preferred food item throughout North America (Dixon 1982, Anderson 1983). In British Columbia, 27 percent of puma diet was snowshoe hare at peak hare abundance (Spalding and Lesowski 1971). Medium- and small-sized prey (large rodents, medium-sized carnivores, lagomorphs, and armadillos) comprised 2.5 to 30.5 percent of the diet of North American pumas (Irairte et al. 1990). In western Canada, moose contributed a significant portion of the diet (Spalding and Lesowski 1971, Ross and Jalkotsky 1996). In Florida, pumas feed on white-tailed deer, wild hogs, raccoons and armadillos (Maehr et al. 1990). The estimated frequency of kills ranges widely from one deer per 10 to 14 days (Hornocker 1970 for single adults) to one deer per 2 to 3 days for females with kittens (Ackerman et al. 1984). Captive pumas eat 5 to 12 pounds (2.3 to 5.4 kg) of meat per day (Lindzey 1987). Washington pumas killed an average of one deer every 6.7 days (Cooley et al. 2008). Ackerman (1982) estimated an adult male needed to kill 44 deer per year, an adult female 22 deer/year, and a female with 2 or 3 yearling cubs about 113 deer annually. Energetic studies estimate kill rates of 19.4 deer/year for males and 39.6 deer/year for females with kittens (Laundre 2005). In southern California, an adult puma killed about 48 large and 58 small mammals per year and fed for an average of 2.9 days on a kill (Beier et al. 1995).

Male and female pumas are typically sexually mature at 24 to 36 months (Eaton and Velander 1977, Maehr et al. 1991a). Male Florida panthers are reproductively active possibly as early as 17 months (Belden and Schulz 2007). Female Florida panthers have bred as young as 18 months old (Maehr et

al. 1989) and as old as 11 years (Belden and Schulz 2007), but average age at first reproduction is 2.2 years (Belden and Schulz 2007). Females are promiscuous and may breed with multiple males (Seidensticker et al. 1973). Pumas are believed to be induced ovulators (Bonney et al. 1981), and breeding can occur year-round (Lechleitner 1969). Females breed at an interval of every 2 to 3 years after their young have dispersed. Breeding activity of Florida panthers peaks from December to March (Shindle et al. 2003). Gestation is 82 to 96 days (Hansen 1992). Mean litter size is 2.6 (range 1 to 6) (Anderson 1983). Seventy percent of Florida panthers have litters of 2 or 3 kittens (Belden and Schulz 2007). Young are born year-round, but most births occur between April and September (Robinette et al. 1961, Anderson 1983, Lindzey 1987). Sixty percent of Florida panther births are between March and June (Jansen et al. 2005, Lotz et al. 2005). Eastern puma kittens were historically documented in the spring in the North and sometimes in the autumn in the South, reportedly were weaned when about half-grown, and stayed with their mother until she produced young again (Audubon and Bachman 1851). Birth sites are in caves, under uprooted trees or dense thickets (Young and Goldman 1946). Young stay at the birth site until weaned and visit kill sites with their mother at about 6 weeks of age (Grinnel et al. 1937). In rare instances, an independent young puma 6 to 10 months of age may be able to survive by killing deer (Shaw 1980) or domestic livestock (McBride 1976).

Kittens stay with their mother until they become independent at 12 to 24 months of age (Robinette et al.1961, Hornocker 1970, Beier 1995). Subadult females disperse short distances and often stay near or within the home range of their mother or another female. Transient males usually disperse and occupy a series of small home ranges until they find an area to occupy as a permanent territory (Beier 1995). Average dispersal distance is 31 to 100 mi. (49.9 to 160.9 km) for males (Ashman et al. 1983, Hornocker 1970) and 18 mi. (29.0 km) for females (Ashman et al. 1983). Florida panther dispersal is less than western populations: 42.5 mi. (68.4 kilometer (km.)) for males and 12.6 mi. (20.3 km.) for females (Maehr et al. 2002b). All female Florida panthers were successful at establishing home ranges, whereas males were successful 58 percent of the time. Pumas have been known to disperse up to 600 to 1,000 mi. (965 to 1609 km) from their birthplace (Parfit 1985, Logan and Sweanor 2000, Thompson and Jenks 2005). Successful male recruitment seems dependent on either the death or relocation of a resident adult male or dispersal to unoccupied habitat (Maehr et al. 1991).

Pumas are polygamous, and the large home range of a male typically encompasses several smaller female home ranges. Home ranges vary widely in size depending on local vegetation, prey density and distribution, and time of year. Male home ranges are typically 78 to 195 mi.^{2} (202 to 505 km.^{2}) (but up to 500 mi.^{2}, 1295 km.^{2}) (Anderson 1983, Lindzey 1987, Hansen 1992, Logan and Sweanor 2000, 2001) and sometimes overlap with other males. Female home ranges (8 to 400 mi.^{2}, 21 to 1036 km.^{2}) (Anderson 1983, Lindzey 1987, Hansen 1992) overlap broadly. Male Florida panther home ranges averaged 296 mi.^{2} (768 km.$^{2)}$ and females 94 mi.^{2} (244 km.^{2}) (Thatcher et al. 2003). Females require higher quality habitat (higher prey densities) to raise young. In the West, pumas sometimes migrate from summer to winter range following their ungulate prey and may cover 315 mi.^{2} (817 km.^{2}) in a year (Pierce et al. 1999). Perhaps some eastern pumas shifted their home ranges to deer wintering areas or followed woodland bison or eastern elk herds (both are now extinct) (Maehr 2001). Adult pumas sometimes leave their home ranges in search of a new home range.

Puma densities and home range sizes are determined by the abundance and availability of ungulate prey (Iriarte et al. 1990). Population densities are difficult to measure for a solitary, highly mobile predator like pumas (Lindzey 1987), but have been estimated to range from 0.5 to 0.8 adult pumas per 100 mi.^{2} in southern Utah (Hemker et al. 1984) to 3 to 7 adults per 100 mi.^{2} in southern Alberta (Pall et al. 1988) and California (Hopkins 1989).

Mortalities of Florida panthers were from intraspecific aggression (42 percent), vehicle collision (19 percent), and unknown causes (24 percent) (Jansen et al. 2005, Lotz et al. 2005). Most intraspecific aggression occurs between males. Mean annual survival of radio-tagged Florida panthers was 90 percent for females and 78 percent for males (Lotz et al. 2005). The annual survival rate in an unhunted population in Utah was 74 percent (Lindzey et al. 1989). Maximum longevity of wild pumas is not well documented but may be 10 to 11 years (Anderson 1983).

Pumas use a variety of habitats occupied by ungulate prey. Stalking and escape cover are usually present. Puma habitat is the same as that of their primary prey – mule deer in the West and white-tailed deer in the East (Dixon 1982). Historic habitat in eastern North America was open oak stands, marshes and swamps, and small prairies with an abundance of edge (Severinghouse and Cheatum 1956). Early reports of puma habitat in the East included watercourses and swamps, particularly native bamboo or canebreaks and mountainous areas with ledges (Nuttall 1821, Audubon and Bachman 1851, Wailes 1854, and Hallock 1877). Puma populations were once widespread through Midwest prairie (Sunquist and Sunquist 2002, Pierce and Bleich 2003) and they still thrive in grassland-dominated landscapes in South America (Iriarte et al. 1990). Typical habitat in western North America is open woodland, and they prefer rocky ledges that provide cover. Hunting occurs along edges between habitats. For example Florida panthers make frequent use of ecotones between dense slash pine/palmetto cover and open hardwood hammocks (Maehr 1997). Puma prefer to use habitat away from paved roads (Van Dyke et al. 1986, Sweanor et al. 2000, Dickson and Beier 2002). The best puma habitats seem to be forested areas that include good deer forage and cover, a diversity of terrain, and stalking cover. Pumas are generally thought to be nocturnal. Florida panthers were most active at sunrise and sunset (Maehr et al. 1990). California pumas hunted from dusk to midnight (Beier et al. 1995). Male pumas traveled 6.6 mi. (10.6 km) while covering a net distance of 3.0 mi. (4.8 km) during daily nocturnal periods in California (Beier et al. 1995). Seidensticker et al. (1973) estimated daily distance traveled of 1 to 8 mi. (0.6 to 12.9 km) before a kill and 1 to 4 mi. (0.6 to 6.4 km) after a kill.

Space and landscape requirements for pumas have been described by various authors. Habitat is described as large blocks of contiguous forest having moderate deer populations (Sweanor 1990). Beier and Loe (1992) and Beier and Barret (1993) suggested that 425 $mi.^2$ to 850 $mi.^2$ (1,100 to 2,200 $km.^2$) of high quality habitat is needed to support a long-term persistence of 15 to 20 pumas in the absence of immigration. If a wildlife movement corridor is available to allow immigration of up to 3 males and 1 female per decade, an area as small as 231 $mi.^2$ to 618 $mi.^2$ (600 to 1,600 $km.^2$) may be adequate. Logan et al. (1994) and Thatcher et al. (2006) indicated that Florida panthers needed areas >1,000 $mi.^2$ (2,590 $km.^2$) to attain population viability. A population of about 80 to 100 pumas currently occupies 3,398 $mi.^2$ (8,800 $km.^2$) of habitat in Florida (Maehr et al. 2001). Fecske et al. (2006) estimated a minimum of 2,037 $mi.^2$ (5,277 $km.^2$) of high quality habitat was necessary to maintain a puma population in South Dakota for >100 years. Shaw et al. (2007) estimated the minimum space requirement for a population of 50 pumas (high prey density, optimum habitat conditions) would be 900 $mi.^2$ (2,330 $km.^2$). LaRue (2007) modeled potential puma habitat in the Midwest using blocks of 965 $mi.^2$ (2,500 $km.^2$) of contiguous habitat. An analysis of the recovery requirements for the Florida panther estimated that a reserve network for short-term population viability (100 to 200 animals) would require 10,781 $mi.^2$ to 21,562 $mi.^2$ (27,922-55,845 $km.^2$) (Noss 1991), which would occupy much of the State of Florida. It is uncertain whether this much land is needed, and whether areas this large are likely to be available for pumas anywhere in North America (Noss and Cooperider 1994).

2.3.1.2 Abundance, population trends, demographic features, demographic trends: At the time of European contact, the puma occurred throughout North, Central, and South America. In eastern North America they ranged from Florida to southern Quebec (Seton 1929). Pumas were abundant

through much of eastern North America during the colonial era, but declined throughout the 1800s. As a competitor for game and occasional predator of livestock, pumas were greatly feared and persecuted; anecdotes of puma attacks and persecution are abundant in the historic literature.

Eastern North America populations (with the exception of Florida and perhaps the Smoky Mountains) had been largely extirpated by the 1870s (see individual State report below) and by 1900 in the Midwest (Young and Goldman 1946). Seton (1929) in *Lives of Game Animals* concurred that the species was extinct in the East: "In the eastern States, [the puma] is virtually extinct. If there is a pair of cougars in the Green Mountains of Vermont, now, it is the highest possible number. If there are six pairs in the mountains between the Catskills and Georgia, I should be agreeably surprised." The last remnant population of pumas in the East persisted in central and southern Florida (Lotz et al. 2005). Since 1967 the Florida panther has been listed as a federally endangered subspecies (*Puma concolor coryi*). Young and Goldman (1946), who identified *Felis concolor couguar* as a unique subspecies, also believed "they became extinct many years ago." Late puma records in New Brunswick (1932) and Maine (1938) suggest that a population may have persisted in northern New England and eastern Canada. In 1976 Ron Nowak, a USFWS biologist, in his status review *"The Cougar in the United States and Canada"* believed that the preponderance of unverified sightings of pumas from the public was evidence that certain other populations also survived or became re-established in the central and eastern parts of the continent and may have increased in number since the 1940s. Danz (1999) estimated that there were at least 30,000 pumas remaining in the western United States and another 5,000 in Canada.

The following summarizes the history and current status of the eastern puma in the States and Provinces of its historical range. Recent records (post-1900) of pumas with a higher level of validity are summarized in Appendix B.

Eastern Canada Federal status – The first status review of the eastern puma by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assigned endangered status to the taxon *Puma concolor couguar* based on sightings of pumas throughout Ontario, Quebec, and the Maritime Provinces (van Zyll de Jong and van Ingen 1978). At that time, there was no physical evidence of pumas in eastern Canada. The authors assumed that there was at least a possibility that some of the hundreds of sightings represented remnant survivors of the original population. Escaped or released captive animals were not mentioned. The authors concluded that numbers were very low and prey availability and human activities were limiting factors. Federal and Provincial wildlife agencies continued to maintain records of puma reports in eastern Canada and acknowledged the increasing number of pumas in captivity. In the most recent review of the status of the eastern puma in Canada, Scott (1998) acknowledged that escaped captive pumas are "at least the major, if not the only, source of wild sightings." Genetic techniques have been used to determine that several recent puma occurrences in eastern Canada were of South American origin (thus captive origin); however, several were of North American origin (uncertain whether captive or wild origin)(Appendix B). Scott (1998) concluded "that there is no objective evidence (actual cougar specimens or other unequivocal confirmation) for the *continuous* presence of cougars since the last century anywhere in eastern Canada or the eastern United States outside of Florida," and that, "there is circumstantial evidence for virtual or complete extirpation" from central Ontario eastward. He stated that there was no consensus on the survival or extinction of the original eastern puma. He viewed the likelihood of survival as lowest in the eastern United States and possibly to the north and western part of its range (i.e., extreme northwestern Ontario). Scott surmised from unverified sighting reports that animals encountered in eastern Canada are of captive origin, that some animals are surviving, and that breeding is occurring. Based on Scott's (1998) review, the eastern puma was relisted on the Canadian Federal list from Endangered to the Data Deficient or Indeterminate category for Ontario, Quebec, New Brunswick, and Nova Scotia. Scott (1998) maintained that Manitoba is the easternmost part of

Canada for which there is objective evidence of the uninterrupted survival of a puma population from European settlement to the present. Scott (1998) believed that genetically, the Manitoba population must have been closely related to, if not identical with, eastern pumas that existed in western Ontario.

Starting in 2001, scratching posts with pheromones were installed at localities that coincided with puma sightings in Quebec, New Brunswick, and Nova Scotia (Lang 2007, Gauthier 2010). Lang (2007) examined 322 samples from animals identified as pumas. Of the 322 samples gathered, 10 were confirmed as pumas, 8 in Quebec and 2 in New Brunswick (Lang 2007, Appendix B). Genetic analysis documented four of the puma samples were of possible North American origin, four of Central or South American origin, and two of unknown origin (Lang 2007). Gauthier (2010) identified three other puma specimens in southern Quebec (Appendix B).

New Brunswick – Krohn and Hoving (2010) compiled historic references of pumas in New Brunswick and adjacent Maine. Allen (1894) and Boardman (1903) believed that the existence of the puma in the Province was well authenticated, whereas Ganong (1903) could find no authenticated records and questioned whether it ever existed. Gesner (1847) said the puma was present, but very rare, with a single skin showing up from time to time in the fur market in St. John. In 1894 Allen said it possibly occurred, but there was "no satisfactory evidence" (in Parker 1998). Both Squires (1946) and Morris (1948) believed the puma's existence in earlier times was probable, though in very small numbers. As in Maine, pumas may have been very rare (Hardy 1901) because of low deer populations and harsh snow conditions. Young and Goldman (1946) could find only one reference to a puma in New Brunswick in the historical literature – an 1873 reference to an attack on a man near Fredericton that occurred in 1841. Peterson (1966) stated the puma disappeared from eastern Canada about 1860. Wright (1948, 1953, 1959, 1963, 1971, 1972) championed the notion that the eastern puma was never extirpated and survived in wild areas of New Brunswick long after it was gone from elsewhere in eastern North America. He reported 19 pumas trapped, shot, or wounded in the Province since 1900, but most of these reports lack verification and evidence. The best documentation is an animal shot and photographed in 1932 (Appendix B). Banfield (1974) believed the puma to be recently extinct in eastern Canada except for a few in New Brunswick. Dilworth (1984) believed the puma's existence unlikely. Parker (1998) investigated puma reports from 1976 to 1984 for the Canadian Wildlife Service but found no clear evidence of pumas being present. Stocek (1995) further reviewed about 600 public reports of pumas collected in New Brunswick and Nova Scotia by the Canadian Wildlife Service and concluded that a small number of pumas could be present, but origin and taxonomy were unknown. Van Zyll de Jong and van Ingen (1978) reviewed the data on the eastern subspecies of puma in the eastern Canadian Provinces and concluded that no reliable estimates of the number of pumas could be made.

The puma has been listed as an endangered species under the Provincial Endangered Species Act (ESA) since 1976. However, lack of evidence of a viable population has made it difficult to validate its status as endangered (Cumberland and Demsey 1994). Large undeveloped forested landscapes occur throughout the northern portion of the Province, but deer densities are low (4 to 10 deer/mi.^{2}).

Newfoundland – Pumas were not native to the Province. In 1960, a New York businessman illegally introduced three pumas imported from Idaho (Parker 1998). There were 8 or 9 puma sightings in Newfoundland since 1960, and these are believed to be from the animals released, or possibly their descendants (Parker 1998, Scott 1998).

Nova Scotia – There are no historical records of pumas in the Province (Pulsifer 1992, Parker 1998). Wright (1972) cites few colonial-era records and believed the eastern puma extended its range into the Province coincident with the expansion of the deer population in the early 1900s. He lists 25 reports from the Province (most since 1950), but none verified. Cameron (1958) and Squires (1968)

believed the puma still occurred throughout the Province, including Cape Breton Island. Banfield (1974) listed the puma as extinct in Nova Scotia. Stocek (1995) believed that a small number could occur, but the origin and taxonomy were unknown.

The puma is not listed on the Provincial list of endangered species, but is protected by Provincial regulations. Scott (1998) compiled and mapped recent sightings.

Prince Edward Island – There are no known historic records of pumas on this island.

Quebec – The puma was believed to be common south of the St. Lawrence River (Anderson 1938, Young and Goldman 1946, Parker 1998). Lett (1887) believed they were once common in the Ottawa Valley and found in all parts of Quebec and Ontario in 1777. There is a newspaper account of a panther killed about 25 mi. from Montreal in 1836 (Young and Goldman 1946). The last records for the Province include one killed near Sherbrooke about 1840 and another near Sorel in 1863 (Seton 1929, Anderson 1938, Young and Goldman 1946). A mounted specimen of a puma killed in Russeltown was presented to the Montreal Natural History Society Museum in 1859 (Parker 1998). Wright (1972) searched early written records, which ended about 1880. He provided unverified sighting records to the early 1900s and also cited that the Dominion Bureau of Statistics reported eight pumas taken and skins sold in 1919 to 1920.

Van Zyll de Jong and Van Ingen (1978) classify the puma as not currently protected in the Province. Tardif et al. (2005) classify the puma as "likely to be designated" on the Provincial endangered and threatened list. Recent sighting reports were summarized by Tardif (1997), Scott (1998), and Jolicoeur et al. (2006). White-tailed deer are at the northern edge of their range in the Province and are found primarily south of the St. Lawrence River. Although deer populations in this region are sparse (2 to 10 deer/mi.^{2}), moose are abundant and small herds of woodland caribou occur, particularly north of the St. Lawrence River, providing prey that could potentially support a puma population.

Ontario – Nash (1908) believed pumas were uncommon in southern Ontario during the early period of colonization, but others believed them to be common and widespread (Doel 1894). Clark (1969) documented a puma specimen killed in Scarborough in 1820. Orr (1909) reported a puma attack on a woman near Fingal and puma occurrences in Lambeth about 1848 and Wentworth County about 1831. The last puma believed killed in Ontario was taken by T. W. White of Creemore in 1884 (Clark 1969). A mounted specimen in the New York State Museum, Albany, is labeled as a female collected in Ontario in 1908, but no other details are available (Parker 1998). Pumas disappeared from the southeastern region of the Province by the early 1900s, but unverified reports persisted to the 1950s from western and northern regions (Dear 1955, Nowak 1976). Dawson (1997 in Scott 1998) compiled and mapped recent sightings. Nash (1908) reported the puma was extirpated at the time of writing his book and was never very abundant. The Ontario Ministry of Natural Resources investigated 318 puma sightings from 1935 to 1983 and none were confirmed by positively identified tracks or other sign (Gerson 1988).

Ontario lists the puma as extirpated, and it is not protected under the Ontario ESA (Scott 1998). Because white-tailed deer (estimated population of 550,000) occur in the southern portion of the Province (moose, caribou, and snowshoe hare occur in the north), and there are large blocks of forested habitat, potential puma habitat exists in Ontario. As a result, the Ontario Puma Foundation developed a puma recovery strategy and management plan (Kenn and Helferty 2002).

Manitoba – Young and Goldman (1946) provided no occurrence records for the Province, however, Hutlet (2005) cites historic accounts that indicate pumas likely occurred throughout much of

Manitoba during the 1700s. Seton (1929) published early records, particularly of animals from the southwestern portion of the Province. Pumas were never thought to be extirpated in Manitoba (Hutlet 2005). Pumas carcasses were documented in every decade except the 1940s (Nero 1974, Nero and Wrigley 1977, Wrigley and Nero 1982), and there have been at least 14 sightings of adults with kittens (Wrigley and Nero 1982). From 1879 to 1950 there were only 16 reports of pumas in Manitoba. From 1951 to 1971 there were about 68 reports including five pumas that were shot (Nero 1974). A cougar was shot and killed on December 25, 1973, about 35 mi. northeast of Winnipeg. Pumas seemed to have increased in number since 1960, correlating well with an increased white-tailed deer populations in Manitoba during that time period. Nero and Wrigley (1977) estimated a population of up to 50 animals existed in the Province. A breeding population of 20 to 100 pumas existed to the west in Saskatchewan (Anderson 1983, W. Runge *in* Tischendorf and Henderson 1994). Sightings records were compiled by Norris-Elye (1951) and Sutton (1960). In 1972, Robert Nero (Manitoba Wildlife Branch) and Bob Wrigley (Assinboine Park Zoo) began a program to document the presence of pumas in the Province (Nero 1974, Nero and Wrigley 1977, Wrigley and Nero 1982).

In response to the shooting of two pumas of wild origin (adult male and female killed near Riding Mountain National Park in 2004) (Watkins 2005), the Province passed legislation protecting pumas. Pumas are not listed as endangered on the Provincial endangered species list because there is not enough evidence to document their status, but they are considered a protected Species of Special Concern. The Province has a white-tailed and mule deer herd of approximately 150,000 and populations of elk and moose. Large blocks of forested habitat are abundant throughout the Province and are sufficient to support puma populations, but snow depth may limit populations (Hutlet 2005).

Connecticut – Allen (1942) reported bounties paid on pumas from 1694 to 1769. Some towns responded to surveys between 1800 and 1832 and indicated that pumas were present (Bickford 2003). Linsley (1842) saw a specimen killed in the northern part of the State in Mix's Museum "some years since." Goodwin (1935) believed that the puma was common in the State's early history, but believed pumas no longer occurred east of the Mississippi River. Godin (1977) described the species as extirpated in Connecticut.

The puma is currently listed by the State as a species of special concern – believed extirpated. Pumas are protected under State law because there is no open season. Private possession is prohibited. Regulations only allow for municipal parks, zoos, nature centers, museums, laboratories and research centers to possess wild felines and forbid private ownership or any feline breeding farms. Sometime around 1985, a puma briefly escaped from captivity and was recaptured (Paul Rego, letter to USFWS). The State maintains a sighting database, and approximately 200 sightings have been recorded since 2002. Over 100 sightings have been investigated in winter (tracks in snow), and all proved to be misidentifications. Potential habitat in Connecticut is limited. Deer densities range from 3 to 29/mi.^{2} throughout the State, however, the largest unfragmented forest habitat is only about 56 mi.^{2} (145 km.^{2}) (Paul Rego, Connecticut Fish and Wildlife, pers. comm.).

Delaware – The puma disappeared from the State in the 1700s, and Nowak (1976) listed no recent reports. Several well reported puma occurrences were documented in the 1990s (Appendix B), but these were believed to be released pets and the animals have not persisted in the wild.

The puma is currently listed by the State as extirpated. Possession of captive pumas is permitted by the State Department of Agriculture and requires owners to acquire a special carnivore permit to possess animals not native to the State. The State issues carnivore licenses to firms, dealers, pet shop operators, research centers, municipal zoos and traveling circuses. The State also issues individual lifetime permits for private possession of wildlife for pet purposes. Stringent terms and conditions follow issued permits, and it must be determined that the animal will not pose a threat or nuisance to

the public before a permit is issued. Delaware Fish and Wildlife is unaware of any pumas in private possession within the State (Ken Reynolds, Delaware Department of Fish and Wildlife, pers. comm.).

Illinois – The western boundary of the range of the eastern puma is uncertain because of a lack of reference specimens (USFWS 1982). Young and Goldman (1946) included all of Illinois within the range of *P. c. couguar*, whereas Hall (1981) included only part of the State (and the remainder within the range of *P. c. schorgeri*) (see taxonomy section below). The last resident pumas were extirpated from Illinois prior to 1860 (Danz 1999, Heist et al. 2001). Hoffmeister (1989) researched early records of pumas in the State and believed pumas were extirpated before 1870. He cites historical records of panthers shot in 1817 and 1818, but no later. Cory (1912 *in* Nowak 1976) believed that a puma had been killed about 1862 in Alexander County, and that there was an unverified sighting in Pope County in 1905.

The puma is currently listed by the State as extirpated. Pumas have no State endangered species status but have some level of protection under State law because there is no open season. Leopards, jaguars, tigers, lions, cheetahs, mountain lions, snow leopards, ocelots, bobcat, jaguarundi and margay are considered by the State as "Dangerous Animals" and require permit approval by the Director of Natural Resources. Private possession of these wild felines is not allowed by State statute and permits are only issued to U.S. Department of Agriculture (USDA) licensed exhibitions, zoos, for scientific or research purposes, or to animal refuges by the Director of Natural Resources. The number of captive animals is unknown. An estimated 100 to 500 captive pumas are in captivity in neighboring Iowa. A sighting database can be found at Illinoiscougarwatch.com. This website mentions recent instances of escaped captive pumas being killed in the State. It also mentions the likelihood that pumas dispersing from western populations may migrate into the State of Illinois, as may have occurred in 2000 and 2009 (Heist et al. 2001, Appendix B).

Nielsen (2006) used the bobcat (*Lynx rufus*) as a surrogate species to model potential restoration of pumas in Illinois. They determined the nearest source populations of pumas would most likely come from Colorado, Texas, or the Dakotas. Several dispersal corridors were identified between Illinois and the Colorado/Texas populations, including the Platte and Missouri Rivers (LaRue and Nielsen 2008). Potential puma habitat in Illinois is located in the extreme southern portion of the State, dominated by the Shawnee National Forest. This is the only contiguous patch of highly suitable habitat, >386 mi.^{2} (1,000 km.^{2}) in Illinois. Deer are abundant throughout southern Illinois, with county-wide density estimates of >30 deer/km.^{2} (Roseberry and Woolf 1998), which is greater than areas in the West where viable populations of puma still occur (Becker et al. 2003).

Indiana – References to pumas are rare in Indiana's early history. Lyon (1936) believed them to be gone from southwestern part of the State by 1832 to 1833, although a few may have occurred in the north for a few more years. Young and Goldman (1946), Mumford (1969), and Mumford and Whitaker (1982) believed they had been extirpated from the State by 1851. Butler (1895) reported puma occurrence in Davies and Knox Counties in 1830 and 1833, and that "none have been reported for 30 years or more." There was a Brown County record in 1836. At Brookville (Franklin Co.) two young were captured in 1838, but few animals had been seen there since 1835 (Evermann and Butler 1894 *in* Mumford 1969). The latest records are from Paragon (Morgan County) and Marion County in 1851. Hahn (1909) believed pumas to be exceedingly rare in the early 1830s and had "practically disappeared" by the 1850s. The only known specimen consists of bones from an archeological site (Adams 1950 in Mumford 1969).

The puma is currently listed by the State as extirpated, and pumas receive no legal protection under State regulation, rules, or laws. Private possession of pumas is allowed by State permit, but new State laws prohibiting possession were considered in 2007. The State issues Wild Animal Possession

Permits that are for 1 year only and must be renewed annually. Persons licensed by the USDA as commercial exhibitors, zoos or dealers are exempted from this State permit and its requirements. In addition to six pumas licensed by the Department of Natural Resources (DNR), approximately 30 people have exotic cats under USDA permits in the State of Indiana. Indiana records show only one confirmed case of a captive puma escaped into the wild in Clay County in early 2007 (Scott Johnson, Indiana DNR, pers. comm.) and may have been resighted in 2009 (Appendix B). The State maintained a database of puma sightings since 1992. Based on investigations of these database reports, Indiana DNR believes there is no evidence that wild pumas have bred in the State, and most reported sightings are of misidentified wildlife. Deer density/population information is not available for the State.

Kentucky – The puma was widely distributed throughout the State. Imlay (1793) and Warden (1819) listed it among the mammals of the State. Funkhouser (1925) quoting Garman in a statement made in 1894, that "the species existed in the State within the past fifty years." According to True (1889), the last puma was killed in 1863 near Lexington. Barbour and Davis (1974) state pumas were once common but there have been no valid records since about 1900. They attribute recent reports to released pets or misidentification.

The puma is considered extirpated on the State threatened and endangered species list. Effective in 2005, a ban on private possession of pumas and other dangerous wildlife was enacted in Kentucky. This is one of the most comprehensive restrictions on the keeping of exotic animals as "pets" in the United States. The regulation also prohibits previously permitted pumas from being bred.

Potential habitat occurs in Kentucky. The Statewide deer population is estimated to be 690,000. Elk re-introduced in the late 1990s have quickly grown to a herd >6,500. The combined deer and elk population provides ample prey to support a puma population. Daniel Boone National Forest (1,103 mi.^{2} [2,857 km.^{2}]), Big South Fork National River and Recreation area (195 mi.^{2} [506 km.^{2}]), and the Land Between the Lakes National Recreation Area (266 mi.^{2} [688 km.^{2}]).) provide potential habitat for pumas.

Maine – A thorough review of historic literature related to the eastern puma in Maine was completed by Krohn and Hoving (2010). Historic literature contains many stories of the "Indian Devil" (local name for pumas), particularly in southern and western Maine where there were white-tailed deer populations. However, writings of many naturalists suggest that irrefutable evidence of pumas was sparse in Maine and neighboring New Brunswick throughout the 1700s and 1800s. According to Palmer (1937) and Young and Goldman (1946), the puma was probably always of rare occurrence throughout the State. Manly Hardy, a late 1800s fur dealer and naturalist, believed pumas to be present, but rare. He and his father were Maine's primary fur dealer for 70 years in the 1800s and never handled a specimen or knew of one taken (Hardy 1901). Norton (1930) also believed that the puma had been rare in the State and probably was never more than a straggler. Ezekiel Holmes listed the puma as occurring in the State (State of Maine 1861). One puma was reported killed around 1845 in Sebago (Cram 1901, Norton 1930, Krohn and Hoving 2010) and another in 1891 near Andover (Norton 1930, Goodwin 1936, Young and Goldman 1946). Seton (1929) lists several unsubstantiated reports up to 1907 as did Goodwin (1936), however Ames (1901) questioned the veracity of reports. Jackson (1922) mentions a puma killed in 1906 near Mount Kineo on Moosehead Lake (Appendix B). Wright (1948, 1971, 1972) lists a number of more recent records, including pumas killed in LaGrange in 1915 and on the Little St. John Lake in 1938. The 1938 specimen was photographed (see Wright 1972) and is in the New Brunswick Museum. This is believed to be the last documented wild eastern puma taken before extirpation in the State of Maine and possibly in the eastern United States.

The puma is State-listed as extirpated, and there is a perpetual closed season on the puma. The State allows pumas to be held in captivity with a permit that must be renewed every 2 years. No permanent marking of captive animals is required, although this is being considered. Personal possession requires an Import Permit and Propagator Permit. The State currently permits 11 captive pumas and has anecdotal reports of pumas escaping captivity. Although numerous reports of pumas are received annually, the State is not aware of any wild pumas residing in the State. The State maintains a database of sightings. Recent records in Cape Elizabeth (1995) and Monmouth (2000) are of uncertain origin (Appendix B).

Potential puma habitat occurs in the State. Deer densities range from 2 to 22 deer/mi.^{2} in wildlife management districts. Large blocks of uninhabited, forested habitat occur throughout the State. Harrison and Chapin (1998) identified an area of 17,064 mi.^{2} (44,196 km.^{2}) of land as suitable (low human and road density) habitat for wolves, which would likely also be suitable habitat for pumas. Carroll (2003) used a spatially explicit population and habitat viability model that confirmed the aforementioned predictions that habitat and prey were available to support viable populations of wolves in Maine if they could successfully disperse from Quebec.

Maryland – Scott (1807) and Audubon and Bachman (1851) include the puma among the mammals of the State, and it once occurred Statewide (Paradiso 1969). Meshach Browning (1928), a noted trapper, estimated that he killed more than 50 pumas between 1790 and 1836. There is no information on the last occurrence in the State, but Paradiso (1969) believed pumas persisted until the late 1800s. Parker (1998) believed it more likely they disappeared before 1800, especially in settled areas near the coast. Walsh (1956) claimed the last was killed in 1851, but no references are provided.

The State lists the puma as endangered-extirpated, and is protected from take under the State ESA. Pumas may be held in captivity with a State permit, however, no permits have been issued. The Criminal Code was recently amended to prohibit possession of big cats, and there is no personal possession permit. Denial of personal possession is based on the rabies concern and a lack of an USDA approved rabies vaccination for wild felines. A public zoo, park, museum, educational institution, or a person holding a valid State or Federal permit for educational, medical, scientific or exhibition purposes may possess, trade, barter, import or sell wild felines. The only facilities authorized to hold captive pumas are USDA-permitted zoos. More than a 160 reports have been filed since 2000 according to the State maintained database of sightings (Therres 2007). None of the reports provide conclusive evidence of free-roaming pumas in the State.

Taverna et al. (1999) employed a geographic information system (GIS) landscape analysis to evaluate habitat suitability for supporting a population of pumas in West Virginia, Pennsylvania, western Maryland, southeast Ohio, eastern Kentucky, and western Virginia. Forest land cover, human density, road density, and deer density were used to model potential habitat. Although there are no large (>200 mi.^{2}) blocks of unfragmented forest in the State of Maryland, they documented potential puma habitat in western Maryland in the Appalachian Mountains bordering areas of potential habitat in West Virginia and Pennsylvania. Dense deer populations occur throughout the State.

Massachusetts – The puma formerly occurred throughout the State (Young and Goldman 1946), but was nearly extirpated by the early 1800s (Nowak 1976). Massachusetts initiated a 40-shilling bounty on pumas in 1742, which was increased to four pounds in 1753 (Allen 1942). Wright (1959) believed the last "normal" puma abundance was about 1820. Emmons (1840) believed the puma extirpated by 1840. DeKay (1842) reported that a few were occasionally observed prior to 1842. The last known record of the eastern puma in Massachusetts was from Hampshire County about 1858 (Stoner 1950, Massachusetts Dept. of Fisheries and Wildlife 2000 *in* Bolgiano and Roberts 2005). The mounted

specimen, possibly of this animal, was originally in the Natural History Museum of Amherst College and was transferred to Arcadia Wildlife Refuge in Easthampton (Cardoza *in* Parker 1998). Young and Goldman (1946) believed the puma extinct in the State by the mid-1800s. Crane (1931) mentioned a puma report in 1926 near Huntingdon, Hampshire County, and a puma was killed and photographed in Shutesbury in 1927 (Downing 1984, Appendix B). Wright (1972) cites various unverified reports from the 1940s to 1971, including an unverified road kill along the Massachusetts Turnpike in 1960. Nowak (1976) reports sightings in 1968 and 1969 on the Quabbin Reservation by professional wildlife biologists.

The puma is not on the Massachusetts list of endangered, threatened, and special concern species. However, by statute, the State list must include all species found on the Federal list. Thus, the eastern puma is incorporated in the Massachusetts list by it Federal designation. It is protected under State law by virtue of a closed season and as being on the State endangered species list. The State maintains a database of puma sightings (~500 since colonial times), many of which have proven to be misidentifications of other species by investigating biologists and conservation officers. There is no evidence of a breeding population since the early 1800s. Since the 1970s, it has been unlawful to possess most wild mammals as pets. Some species (not pumas) may be kept under permit for scientific or educational use. No permits are issued for breeding unless in compliance with the Association of Zoos and Aquariums, the International Union for Conservation of Nature (IUCN), or the State of Massachusetts or the United States, and in the opinion of the Massachusetts Fish and Wildlife Department will make a meaningful contribution to the survival and recovery of the species. No personal possession permits for the purpose of pet ownership are issued. Authentic and legitimate educational use certified by zoological or biological officials will be issued permits. Commercial businesses where the animal is in conjunction with the applicant's primary existing occupation or livelihood will be granted a permit. There were no pumas lawfully kept under State permit in 2009. There were six captive pumas lawfully held within the State in 2007 – all in zoos. There have been at least four illegal pet or exhibit pumas seized since the early 1970s. During the same period other free-ranging, exotic cats have been documented in the State.

There is not adequate habitat to support a population of pumas in Massachusetts. Although white-tailed deer densities vary from 8 to 55 deer/mi.^{2}, the largest unroaded habitat block is only about 13 mi.^{2}.

Michigan – The puma once occurred throughout much of the State (Burt 1946, Young and Goldman 1946, Baker 1983), but became rare by the 1830s and was believed extirpated (Goodrich 1940). Pumas were believed to be plentiful in eastern Oakland County in the mid-1820s (Hoyt 1889 *History of the Town of Commerce in* Vaselenak 2007). Wood (1914) accounted for their presence in the southeast portion of the State from 1835 to 1870, when he believed them extirpated from that region. Late 1800s records included a report of a puma killed in 1875 at Pleasant Lake in Ingham County and another treed by dogs near Stanton in Montcalm County in 1885 (Wood and Dice 1924). Schorger (1942) believed the last valid records of pumas were in 1850, but others believed they persisted until the early 1900s (Manville 1948, Baker1983, Johnson 2002). In a 1922 inventory of mammals of Washtenaw County, Norman A. Wood recorded pumas around Manchester in 1835 with the last one seen in 1870. In another inventory, Wood recorded a puma killed at Pleasant Lake in Ingham County in 1875 and another treed near Stanton in Montcalm County in 1885 (Vaselenak 2007). Burt (1946) believed pumas survived longer on the Upper Peninsula. The last recorded puma killed in Michigan was in the Upper Peninsula in December 1906 near Tahquamenon River in Luce County (Seton 1953, Zuidema 1999, Johnson 2002,Vaselenak 2007). Mammalogist Norman A. Wood (1914) inventoried mammals of the State and categorized pumas as extirpated from the State. Manville (1948) lists a "documented record" from the Huron Mountains of Marquette County in 1937. As elsewhere, there are many recent unverified reports from various parts of the State (Nowak 1976, LaPointe 1978,

Richey 1981, Evers 1994, Rusz 2001, 2006a, b, c). The only specimen of a Michigan puma is from an archaeological excavation north of the Flint River (Foster and Hagge 1975). Zuidema (1999) and Yoder (2003) compiled and analyzed recent sighting reports. Despite recent sightings (Appendix B), Michigan DNR believes the puma to be extirpated from Michigan, but that pumas from other populations (esp. the Dakotas) have the potential to disperse long distances into portions of the State (W. Moritz, Michigan DNR letter to USFWS 3/30/2007). In 2006, the Michigan DNR established a response procedure and protocol for puma reports and uses evidence standards established by the Eastern Cougar Network. There have been several recent occurrences having higher levels of confirmation (Appendix B).

A genetic analysis was done on 297 scats collected by the Michigan Wildlife Conservancy between 2001 to 2003 (Swanson and Rusz 2005). The authors amplified deoxyribonucleic acid (DNA) from only 12 scats, 10 of which they claimed were confirmed as puma, possibly representing eight different animals. The authors found the DNA was genetically similar to the Flint River archeological specimen. Kurta et al. (2007) challenged these results because of problems in methodology, unreasonable conclusions, and speculative results in light of no other evidence in the scientific literature suggesting the existence of a population of pumas in Michigan. Rusz (2006c) provided other occurrence records of pumas (tracks, kills, photographs, videos) that have not been confirmed. Butz (2005) chronicled the controversy about pumas in Michigan. The puma has been classified as endangered on the State list since 1987. It is protected from take under the State endangered species regulations. The Michigan DNR maintains a sightings database. Private ownership of pumas in the State was prohibited with the passage of the Large Carnivore Act of 2001. The Large Carnivore Act requires owners to have a permit to hold wildlife of native species. Pumas and lynx are State-endangered species and cannot be privately owned for pets. However, puma owners having permits were allowed to renew permits for the life of the animal. In 2007 the State had records of only one animal remaining in private ownership, but more may be held illegally. At least two illegal pumas have been confiscated in recent years. Other smaller exotic cats can still be kept in captivity, and their escape or release could be the source of some puma reports.

Evers (1994) believed that several areas, including northern Michigan, may support small self-sustaining populations. The Upper Peninsula of Michigan has 11,331 mi.^{2} (29,348 km.^{2}) of potential wolf habitat (Mladenoff et al. 1995), which would likely be suitable for pumas. Gehring and Potter (2005) applied the Mladenoff et al. (1995, 1999) wolf model (road density as primary variable) to the northern Lower Peninsula area of Michigan and conservatively estimated that 1,634 mi.^{2} (4,231 km.^{2}) of favorable habitat existed. Deer densities of up to 25 to 30 deer/mi.^{2} throughout the Upper Peninsula region are generally greater than prey densities in similar favorable habitat in the Northeast (Mladenoff and Sickley 1998). The Michigan DNR believes there is sufficient habitat in the Upper Peninsula and Northern Lower Peninsula to support pumas with several large unroaded or lightly roaded areas present (W. Moritz, Michigan DNR letter to USFWS 3/30/2007). Excessive snow depth in the Lake Superior watershed in the Upper Peninsula may limit establishment of a puma population in this region. The Statewide deer population is estimated to be 1.7 million animals. There are also localized populations of elk, moose, and small game that could support pumas.

Missouri – The western boundary of the range of the eastern puma is uncertain because of a lack of reference specimens (USFWS 1982). Young and Goldman (1946) did not include Missouri within the range of *P. c. couguar*, whereas Hall (1981) included a small portion of the southeastern portion of the State (and the remainder within the range of *P. c. schorgeri*) (see taxonomy section below). The puma was common in Missouri prior to European settlement. The last puma taken in Missouri was in 1927 (Swartz and Swartz 1959). There were observations of pumas in the State by reputable observers in 1955 (Robb 1955) and 1966 (Lewis 1969). Many recent confirmed sightings are summarized in Appendix B. Missouri had its first modern occurrence of a puma in 1994 when an

adult female was treed and shot in Carter County. Since 1994, 10 free-living pumas have been confirmed in Missouri, but there is no evidence of a reproducing population (Missouri Department of Conservation website, Hamilton 2006, CougarNet, Appendix B). In 1996 the Missouri Department of Conservation established a Mountain Lion Response Team with specially trained staff to investigate reports and evidence of pumas. Most Missouri pumas are believed to be dispersing animals and perhaps released or escaped pets. The closest source populations of pumas include Texas, Colorado, Wyoming, and the Dakotas.

Pumas are classified as extirpated in Missouri, but are protected under provisions of the Wildlife Code. They may be killed if attacking or killing livestock or domestic animals or threatening human safety. About 25 captive pumas are permitted, and an unknown number are held illegally. Captive pumas are common in neighboring States (Missouri Department of Conservation website) and sometimes escape or are released.

LaRue and Nielsen (2008) modeled potential puma habitat and dispersal corridors in the Midwest, including Missouri. Large blocks of highly suitable habitat to facilitate dispersal and sufficient in size to support populations were identified in the Ozark regions of southeastern Missouri and Arkansas. Missouri has ample prey populations with a statewide population of over 1.3 million and densities range from 13-33 deer/mi.^{2} (Missouri Department of Conservation data).

New Hampshire – Silver (1957) provides information on the puma in the State, but provided no specimen records since 1853 (the "Chapman" puma killed in Lee (Dearborn 1927)), and the mounted specimen in the Annie E. Woodman Institute, Dover (Parker 1998)). Silver (1957) reviewed many historic documents and surmised pumas were always rare in the State, but animals were killed throughout the State's history until the puma disappeared in the late 1800s. Jackson (1922) said that pumas had been killed in 1870 in Epping and in 1885 in the White Mountains, and that a pair still was present along the east side of the Androscoggin River. Seton (1929) provides documentation of a puma shot about 1865 in the White Mountains, the skin of which was in the First Methodist Church in Exeter. This was believed by C. F. Jackson to be the last record for the State. Goodwin (1936) believed a "few remained in northern Vermont and New Hampshire until about 1888." Seton (1929) provides an unsubstantiated record of a puma shot as late as 1894. Stone and Cram (1905) believed the puma disappeared from the northeastern part of the State about 1852, refer to the last puma being shot in about 1865 and state, "but there are still rumors from time to time of them having been seen in the northern part of the State, especially since deer have become more common." Jackson (1922) believed a pair of pumas existed into the 1920s along the upper Androscoggin River.

New Hampshire Fish and Game Department keeps an electronic file of puma sightings from the 1950s. Siegler (1971) reported that the State received so many reports from the public in the 1960s that the State passed a bill in 1967 protecting the animals from shooting or trapping, except in self-defense. In doing so, New Hampshire became the first State in the range of the eastern cougar (=puma) to protect pumas (Florida gave the puma complete legal protection in 1958). The puma continues to be a protected species in the State and is considered extirpated. It is illegal to possess wildlife in the State except for educational purposes. New Hampshire only allows possession of wild felines by USDA licensed exhibitors. There are four captive pumas in the State at educational facilities. The white-tailed deer population is estimated to be ~85,000 and the moose population ~6,000. There are a few large, forested, unroaded areas in White Mountain National Forest and northern New Hampshire, that could support pumas.

New Jersey – Smith (1765) said the puma was common. Early accounts suggest pumas occurred throughout the State at the time of European contact (Rhoads 1903, Parker 1998). Seton (1929) did not give an extirpation date, but believed they became extinct in the early 1800s. Warden (1819)

listed the puma as a mammal that had nearly disappeared from the State by the early 1800s. Rhoads (1903) and Goodwin (1936) suggested that the last pumas were killed between 1830 and 1840. Backus (1956) considered unverified reports in the vicinity of Lebanon, Hunterdon County in the 1950s.

The puma is not on the State endangered species list and is considered extirpated. The State does not issue permits for potentially dangerous species (all felids) for pet or hobby purposes. Possession of potentially dangerous species must be for scientific holding, animal exhibitor, zoological holding or animal dealer. The number of pumas permitted and in captivity is unknown. The deer population numbers ~140,000 and occurs at densities of 13 to 77/mi.^{2}. Large, unroaded areas that could support pumas are not present in the State.

New York – Prior to colonization, the puma occurred throughout the State, although the Adirondacks and Catskills were considered its primary strongholds (Manville 1951). Pierce (1823) said pumas occur in the Catskills, but are "not so numerous as in the middle region" of the State. Young and Goldman (1946) describe the puma as "formerly abundant" throughout the State, particularly in the Adirondacks. Young and Goldman (1946) provide an 1842 report from a Connecticut naturalist (Dr. Emmons) who said pumas were still found in St. Lawrence County where one man killed five with his dog not many years previous. Bounties of $20 were initiated in 1871, and from 1871 to 1882 a total of 46 were killed for bounty payments (Young and Goldman 1946). Seton (1929) reported that pumas were "practically exterminated" and "odd ones were still reported" in the Adirondack Mountains – the last stronghold for the puma. He said that J. R. Simms recorded that Thomas Meacham, a trapper who died about 1849 killed 77 pumas in the Adirondacks. C. Hart Merriam (1882) reported that E. L. Shepherd had killed 28 pumas by 1883. Seton believed the last puma was killed in New York in 1890, and documents a bounty paid in 1889 from the Adirondacks and a mounted specimen killed in 1897. A total of 107 were bountied from 1879 to 1890 (Nowak 1976). The last bounty was paid in 1894 for an animal taken in Herkimer County (Reilly 1964). Manville (1951) claims a bounty was paid in 1897, but the documentation is uncertain (Reilly 1964). Goodwin (1936) also concurred that the last record was in 1894. Miller (1899) stated that the puma had been eliminated in all but the wilder portions of the Adirondacks. A State Game Commission report published about 1904 said the puma was extirpated (Reilly 1964). A puma was reportedly killed near Elk Lake in 1908 (Young and Goldman 1948). Various unsubstantiated reports were discussed by Manville (1951), Seagears (1956), Reilly (1964), and Wright (1972).

The State Department of Environmental Protection considers the species to be extirpated, but it is protected by the State ESA. A few recent specimens are believed to be released or escaped captives (Appendix B). In 2005 a new law specifically prohibits the possession, sale, barter, and importing of big cats. The State issues permits for possession, sale and breeding, scientific or exhibition purposes, and collection. Native felines may not be kept as pets. In 2004, there were 23 active permits to possess one or more pumas, and it is believed there are others that possess pumas illegally.

Large areas of lightly-roaded, forested habitat occur in the Adirondack Preserve and other portions of the State. Attributes of landscapes suitable for wolves and pumas are similar (adequate ungulate prey base, suitable forested habitat, low road density, and low human influences) (Ruth et al. 2005). Harrison and Chapin (1998) completed a landscape analysis to document potential wolf habitat in the Northeast and Maritime provinces. Based on road density, human density, and habitat characteristics, they concluded that extensive areas of contiguous, suitable habitat existed in the Adirondacks and other areas. Mladenoff and Sickley (1998) used road density as a primary variable to predict wolf habitat in the Northeast. They estimated >29,903 mi.^{2} (77,448 km.^{2}) of suitable habitat existed from upstate New York to Maine including 4,633 mi.^{2} (12,000 km.^{2}) in the Adirondacks where prey is lowest (<3 deer/km.^{2}). Brocke (1994) assessed the potential for restoring pumas in the Adirondack

Mountains and predicted that puma survival in the Northeast "is virtually impossible for any period long enough to contribute to reproduction and population increase." Because the State's relatively high road density and human population would lead to human-induced mortality rates greater than a puma population could support. New York's deer population is ~800,000 and large areas of potential habitat occur, especially in the Adirondack area that could possibly support a puma population if human-related mortality was not excessive.

North Carolina – Lawson (1718) said the puma was quite common in the State in the early 1700s. Schoepf (1911) included the puma among the mammals found in the State in the late 1700s. Brimley (1946) documented a few early reports of pumas shot in early 1860s to 1886. Young and Goldman (1946) indicate that the puma had largely disappeared by the late 1800s. Last records for the puma include animals killed in Gaston County in 1868, Wrightsville in 1878 (Parker 1998), and Craven County about 1886 (Young and Goldman 1946, Brimley 1946). After a journey through the Great Smoky Mountains during the summer of 1887, Merriam (1888) reported the puma was "unknown." Brimley (1939) recorded a specimen taken in Craven County about 1886. There are reports that two pumas were killed about 1899 – one near Smokemont and the other in the Greenbrier area (Linzey unpub. report). Hamnett and Thornton (1953) stated that "it is now believed to be extinct…last positive records for the State were from the coastal region…in the early 1900s." Lindzey (1988) believed the puma to occupy the Great Smoky Mountains until about 1930s. Culbertson (1976) documented the last puma killed in the Great Smoky Mountains National Park was in 1920 near Fontana Village, North Carolina (Appendix B). Based on scant sightings (12 sightings from 1908 to 1965) Culbertson (1976) surmised that the puma may have never gone extinct in the Great Smoky Mountains. She estimated three to six animals existed in the Park in 1975, with other animals nearby. David Lee, the curator of birds and mammals at the North Carolina State Museum, completed a formal review of 300+ puma reports in the State. He found no conclusive evidence of pumas being present (Lee 1977). Downing (1984) did collaborative field investigations (1978 to 1983) for the USFWS, National Park Service (NPS), and U.S. Forest Service (USFS) and found no evidence of pumas present in the State and the Great Smoky Mountain region.

The puma is protected as an endangered species in the State, which has no open season. The State has developed a standard puma reporting form and maintains a database, but it is not implemented Statewide. Hundreds of reports have been investigated by biologists, but to date no credible evidence has been revealed to confirm sightings. Approximately 50 percent of reports are of black panthers. Track, hair, and scat investigated have been those of black bears, dogs, coyotes, bobcats, deer, or house cats. Great Smoky National Park also keeps a log of puma sightings.

In the State of North Carolina, no captive license may be issued for pumas except to zoos, education or research institutions or individuals who owned the puma on June 29, 1977. The North Carolina Wildlife Resources Commission believes there are fewer than 20 captive pumas in the State, including seven in zoos. The Commission cites at least nine instances of confiscating illegally held pumas.

Thatcher et al. (2003, 2006) developed a GIS habitat model for potential Florida panther reintroduction sites in the Southeast. They identified areas in eastern North Carolina (1,036 mi.^{2}, 2,682 km.^{2}) and Great Smoky National Park region (1,500 mi.^{2}, 3,884 km.^{2}) as potential habitat where pumas could be restored. The North Carolina Wildlife Resources Commission did an assessment of suitable puma habitat (large blocks of forested habitat) and identified relatively unfragmented, suitable habitat primarily in the western (Great Smoky Mountains National Park, Pisgah and Nantahala National Forests) and southeastern coastal (Croatan National Forest) portions of the State. White-tailed deer densities vary from 4 to 52 deer/mi.^{2}, and the deer population numbers about 1 million animals.

Ohio – Puma remains have been documented in Ohio archaeological sites (Young and Goldman 1946). Trautman (1939) said pumas were in vicinity of Buckeye Lake in 1805 "and Great and Bloody Run Swamps for several years thereafter." Kirtland (1838) recorded the presence of pumas, but believed they had disappeared by the early 1800s. Brayton (1882) stated the puma had been long extirpated in the State. Trautman (1977) summarized historic records and believed the puma was uncommon as early as 1800 and extirpated by 1850. Walsh (1956) claimed the last puma was killed in 1838, but no references are provided.

The puma is not on the State endangered species list and is considered extirpated (Reichling 2006). There is no State regulation for exotic felines.

The Ohio deer population was ~675,000 in 2006. Deer densities are greatest (~35 deer/mi.^{2}) in the east central and southeast portions of the State and lowest (5-10/mi.^{2}) in the agricultural lands in the western part of the State. There are no large, relatively unfragmented forest lands in the State. Thus, there is little likelihood of supporting a puma population.

Pennsylvania – Shoemaker (1917) provides a thorough documentation of the puma in Pennsylvania. They were a common resident throughout the State (Rhoads 1903), but were believed to be more numerous in the Allegheny Mountains (Young and Goldman 1946). Shoemaker (1917) described organized "circle hunts." Forty-one pumas were allegedly killed on a 1760 hunt. Phillip Tome estimated he saw about 30 between 1789 and 1823 (Tome 1854). Bounties were paid on hundreds of pumas. A bounty of $8/individual was instituted in 1805, increased to $12 in 1819, and to $14 in 1840 (Walker 1960). Between 1808 and 1820, bounties were paid for 200 in Luzerne County alone. Sam Askey of Snow Shoe, Centre Co. killed 64 between 1820 and 1845. Shoemaker (1917) estimated that, during these same years, 600 were killed in Centre County. Hundreds were killed in Susquehanna, Wyoming, Lycoming, Sullivan, Clearfield counties – the most mountainous area of the State. Shoemaker documented a 1914 visit with Aaron Hall "Lion Hunter of the Juniata" who claimed to slay 50 pumas between 1845 and 1880. Remains of at least 11 animals still existed in 1914. Rhoads (1903) and Doutt (1969) stated the last puma was killed in 1871 in Clinton County. However, there seem to be later records. The last known in the northeastern region of the State was in Susquehanna County in 1874 (Stephen et al. 1985). The last bounty was paid on an animal killed by John Lucas in the Moshannon region of Centre County in 1886 (Shoemaker 1943), but Rhoads (1903) could not verify its reliability. Shoemaker (1917) provided additional records. By 1880 he claimed Clearfield, Centre, and Mifflin Counties contained the only remaining populations. By 1895 the range was limited to two valleys in Mifflin Co. "when the last native race of panthers disappeared." Shoemaker (1917) provides a list of confirmed cougar kills. He documents cougars shot in 1905 (Clearfield Co.) and 1893 (Centre Co.), which may have been the last shot in the State. Two sets of kittens were collected in 1892 and 1893 in Mifflin Co. Shoemaker (1943) documents additional unconfirmed sightings and tracks into the 1940s. Young (1954) maintained the puma was extirpated but accepted a report from the 1930s. A puma of captive origin was killed in Crawford County in 1967 (Appendix B, Doutt 1969, McGinnis 1982). McGinnis (1994) compiled 325 plausible sighting reports collected from district game protectors and other sources that occurred between 1890 and 1981. Many unconfirmed sightings continue to be reported (G. Odato, 2007 unpublished report provided to the USFWS).

The Pennsylvania Game Commission lists the puma as extirpated. It is protected in the wild by virtue of no open season. The State requires an Exotic Wildlife Possession Permit or Exotic Wildlife Dealer Permit to allow lawful possession of puma. Both permits prohibit breeding and sale of puma. A Wildlife Menagerie Permit allows possession of cats as well as many other species, but to qualify, the facility must be open to the public and charge a fee. An Exotic Wildlife Permit allows the importation and possession of wildlife, but a separate permit must be obtained for each animal. New

regulations passed in April 2003 include a 2-year experience requirement for each felid species permit application. Illegally held pumas have been confiscated in recent years.

Taverna et al. (1999) employed GIS landscape analysis in West Virginia, Pennsylvania, western Maryland, southeast Ohio, eastern Kentucky, and western Virginia to evaluate habitat suitability for pumas. Forest land cover, human density, road density, and deer density were used to model potential habitat. They found suitable puma habitat was extensive and widespread along the Appalachian Mountains. In Pennsylvania, potential habitat existed in Warren and Forest Counties in the northern Allegheny Plateau (including the Allegheny National Forest) and north-central Pennsylvania (Susquehanna, Sproul, Moshannon, and Tioga State Forests). Davis (1994) assessed puma habitat in the Allegheny National Forest in north-central Pennsylvania and concluded there was potential habitat in the national forest and adjacent state forests. The deer population in 2004 was ~1.6 million. Game Commission aerial surveys in 2006 showed densities averaged 8 to 18 deer/mi.^{2}, but was >120/mi.^{2} in some areas, densities high enough to support a puma population. However, the Pennsylvania Game Commission does not believe that there are areas remote enough where large predators could be reintroduced without creating conflicts with the public or other wildlife valued by people (Pennsylvania Game Commission news release #023-07). The Game Commission is opposed to any initiative, public or private, to reintroduce pumas into the Commonwealth.

Rhode Island – Early records are scant, but the puma was undoubtedly present during early colonial times (Young and Goldman 1946). It had largely been eliminated from the State by the early 1800s (Nowak 1976). Mearns (1900) listed the puma as a species that once inhabited the State. Seton (1929) reports a mounted specimen from Rhode Island is in the Boston Society of Natural History Museum. This was the last known record of a specimen and was taken in 1847 or 1848 in West Greenwich (Allen 1942, Young and Goldman 1946, Cronan and Brooks 1968). The mounted specimen and skull now resides at the Harvard Museum of Comparative Zoology (MCZ 42598) (Parker 1998).

The puma is classified as extirpated in the State. The State does maintain a database of unconfirmed large cat sightings. To date, the Division of Fish and Wildlife has no conclusive evidence to suggest that pumas currently exist in the State. State laws require a permit from the State Department of Environment, Department of Agriculture to import, possess or receive any native wildlife or hybrid thereof. Criteria for legal possession of pumas except by a zoo or scientific institution would be extremely difficult for an individual to meet. There are no known pumas in captivity in the State.

Although there are sufficient deer population densities on mainland Rhode Island (15 - 30/mi.^{2}), there are no large unfragmented forest areas in the State to support a puma population.

South Carolina – Schoepf (1911) lists the puma among the early mammals occurring in the State. Audubon and Bachman (1851) believed the puma present in South Carolina as late as 1851. Warden (1819) believed it extirpated east of the Appalachian Mountains by that time. True (1883) listed the puma as "probably extinct," but Golley (1966) reported a kill in the Camden area in 1916 (Appendix B). Nowak (1976) cites several recent unverified reports.

The puma is classified as a State-endangered species and individuals are protected from take under the State ESA. The DNR has no confirmed evidence of pumas and believes that a wild, native population does not occur in the State. The State does not keep a puma sighting database. The State of South Carolina does not provide license, permit, registry, or standards for the care of captive pumas, therefore prohibiting ownership of pumas in captivity within the State. Despite this, the DNR believes there may be 25 to 50 pumas in captivity, but a Clemson University forestry professor is aware of >100.

Thatcher et al. (2003, 2005) developed a GIS habitat model for potential Florida panther reintroduction sites in the Southeast, but did not identify sites in South Carolina. Jordan (1993, 1994) identified an area in coastal South Carolina that could support pumas, but did not meet the Thatcher et al. (2003) minimum area criteria. The DNR identified two areas of potential puma habitat in the northwest part of the State (Sumpter National Forest and adjacent areas and lower Savannah River). Deer densities of >30 deer/mi.^{2} occur throughout most of the State, and the statewide population is about 800,000.

Tennessee – Williams (1930) recorded the puma in the early history of the State. Warden (1819) mentions its occurrence in the State. Young and Goldman (1946) said that historically it was common in the western portion of the State. Hallock (1880) noted that it still occurred in the cane bottoms below Memphis. Rhoads (1896) believed a few still existed in the "impassable brakes and harricanes" in Lauderdale County. Pumas were probably extirpated prior to 1900 (Parker 1998). However, Culbertson (1976) documented the last puma killed in the Great Smoky Mountains National Park was in 1920 near Fontana Village, North Carolina. Ganier (1928) reported the panther was "extinct" in Tennessee "save possibly a half dozen individuals in the Great Smokies." Downing (1984) believed there was evidence that pumas survived as late as 1930 in the Park. Culbertson (1976) concluded "the number of mountain lion sightings through the years suggest that the mountain lion may never have actually been extirpated in the great Smoky Mountains area. The puma may have been able to maintain itself in small number in the more inaccessible mountainous regions in or around the park…while a conservative population estimate for 1975 would be three animals, the estimate could be as high as five or six." Downing (1984) was unable to confirm their existence after a 5-year survey.

The puma is considered extirpated in the State. Possession of dangerous animals requires commercial activity and USDA license.

Thatcher et al. (2003, 2006) developed a GIS habitat model for potential Florida panther reintroduction sites in the Southeast. They identified areas in the Great Smoky National Park region (1,500 mi.^{2}, 3,884 km.^{2}) and central Tennessee (1,025 mi.^{2}, 2,655 km.^{2}) as potential habitat where pumas could be restored. State forests in the State include 162,000 acres (253 mi.^{2}, 656 km.^{2}), the largest being Natchez Trace (32,000 acres, 130 km.^{2}). The 640,000 acre (2,590 km.^{2}) Cherokee National Forest straddles the Appalachian Mountains north and south of the Great Smoky National Park (which comprises 521,000 acres (2,108 km.^{2}) in Tennessee and North Carolina). Collectively, these large blocks of relatively unfragmented forestland provide potential habitat for pumas. The Tennessee deer herd numbers about 900,000 animals.

Vermont – Altherr (1994) provided a thorough documentation of the puma in Vermont. Pumas were often hunted and killed prior to the Revolutionary War (Allen 1942). John W. Titcomb in his account of animals of Vermont said "it has never been abundant" (p. 56 in Seton). However, Seton (1929) provides many records. Davis and Foote (1944) cite an early naturalist who in 1853 commented that pumas had previously been much more common. Warden (1819) included the puma in the State list of mammals. Pumas were bountied as early as 1779 with an 8 pound bounty for adults and four pounds for kittens (Altherr 1994). The bounty remained at $20 through the 1800s (Parker 1998). Foote (1944) believed that pumas had been nearly extirpated by 1850, but acknowledged that the last bounty was paid in 1896. He believed that a few animals still existed in the 1940s in the Green Mountains. Thompson (1853) commented that pumas had been much more common prior to the mid-1800s. Puma reports began to diminish in the 1840s. An 1850 article in the *Burlington Free Press* stated that not more than 6 had been killed in the State in the last 40 years (Altherr 1994). An 1867 specimen from Weathersfield was well-documented and photographed (the mounted specimen

at the Weathersfield Historical Society (Altherr 1994, Parker 1998)). Another puma killed in Johnson in 1867 was displayed in the Montpelier State House rotunda (Altherr 1994). An 1875 specimen (one of two killed at Wardsboro) is in the Museum of the Boston Society of Natural History (Parker 1998). The Vermont Historical Society Museum in Montpelier has a specimen that was killed in Barnard in 1881 that weighed 182 pounds, which is believed to be the last puma shot in the State (Spargo 1950, Altherr 1994, Parker 1998). This specimen is now on display at the Pavilion Museum in Montpelier. Henshaw (1904) declared the puma "almost extirpated" and listed 1894 as the last record for Vermont. In 1904 the State repealed the bounty on wolves and pumas, believing both historic predators were extinct. Kirk (1916) listed the puma as "probably extinct." Osgood (1938) considered pumas to be extirpated by the late 1930s. A local newspaper in the 1930s offered a $1000 reward for a Vermont puma dead or alive, but the reward was never collected. Wright (1972) lists several unverified recent reports, but the State considers the species no longer present (Nowak 1976). Hitchcock (1986, 1989) reviewed some recent, unconfirmed sighting reports.

The eastern puma has been listed as endangered since 1972 and is protected under the State ESA. Vermont Department of Fish and Wildlife maintains a database of puma sightings dating back to 1942. Based on 542 reports, the State lacks any substantive tangible field evidence resulting from these sightings other than the 1994 sighting from Craftsbury (Appendix B). Highly credible sightings are likely escaped or released captives. The Department of Fish and Wildlife maintains "there is no evidence, in any form, to indicate a wild lion population exists in Vermont." Possession of big cats requires an importation and possession permits, which are rarely, if ever issued. The State does not issue permits if wild felines are desired for pets, breeding stock, or private collection. With sufficient documentation, they would allow the importation for scientific research, education, or exhibition purposes.

Vermont's deer population is approximately 110,000 to 130,000 animals at a density of about 15/mi.^{2}. Vermont is 85 percent forested and likely has large forested blocks suitable for supporting an average home range for pumas.

Virginia – English colonists encountered pumas in the coastal lowlands and wherever they penetrated the Virginia wilderness (Handley 1979). Hallock (1880) listed the puma as still plentiful in the Dismal Swamp. Handley and Patton (1947) said the puma had a statewide distribution and was still hunted in the western mountains in the 1880s, but apparently disappeared soon afterward. The last known puma killed was in 1882 in Washington County (Handley 1979). No bounties were claimed in Virginia after the 1880s although they were still offered. Bailey (1946) stated that the puma was formerly found in the Allegheny Mountains, but was no longer known to occur anywhere in the Commonwealth. Linzey (1979) believed the puma disappeared in the 1880s and reappeared in Virginia beginning in the 1960s after about a 75-year hiatus. Sighting reports became more frequent in the 1970s and have been compiled by Linzey (1998). Sightings reports have been compiled by Donald Linzey (pers. comm., March 28, 2007 letter to USFWS) and Cougar Quest – Virginia (B. Chaplin, pers. comm.. March 12, 2007 letter to USFWS). The Virginia Department of Game and Inland Fisheries also maintains a database and GIS coverage of reports received through the Virginia Department of Game web page or directly to staff. The Virginia Department of Game believes most reports are of misidentified wildlife or observations of pumas that were released or escaped from captivity. The Virginia Department of Game and Inland Fisheries is not aware of confirmed records of wild pumas in Virginia since the 1880s (R. Fernald, March 27, 2007 letter to USFWS).

The puma is listed as endangered and is protected by the State ESA. The State requires an import permit before wild felines can enter this State. The Virginia Department of Game is aware of three individuals who are permitted to have pumas in Virginia.

Deer are numerous throughout the State with moderate to highest densities in the western mountainous portions of the State. Large tracts of sparsely settled, forested lands capable of supporting pumas likely exist in the western mountainous portions of the State.

Washington, D.C. – Philp (1861) lists the puma as a mammal native to the area. Shoemaker (1917) and Seton (1929) report the killing of a panther in November, 1913 several mi. north of Washington, D.C. The puma was not included in a 1923 list of mammals of the district.

The puma is considered extirpated in this area. Private possession is prohibited, and none are known to be held in captivity.

West Virginia – Pumas were common in the State, particularly the Allegheny Mountains, during early settlement of the region (Young and Goldman 1946). Between 1852 and 1859, bounties were paid on 73 pumas from Randolph County alone. Pursley (in Nowak 1976) said that the last puma killed was in Pocahontas County in 1887, but that there have been "definite" records since then. Shoemaker (1917) observed the hide of an adult female killed on the Greenbrier River, Pocohontas County in 1901. Porter (1903) provides a record of a puma entering a logging camp in Tucker County in 1893. Young and Goldman (1946) said that the puma had once been common in the State and that a few may have survived as late as 1910. Brooks (1910) claimed that a "few still exist in our more secluded forests." Kellogg (1937) claimed to have seen track on Kennison Mountain in Pocahontas County in 1936.

The puma is on the State list of threatened and endangered species and is protected by the State ESA. The State maintains a hard copy file of reported puma sightings. Game farm permits from the West Virginia DNR are required to hold native or exotic felines. The animal must be legally obtained from commercial dealer, and the director must be satisfied that animals are properly provided for and the public is protected. Permits allow the buying, selling, and breeding of pumas. Importation permits are required for pumas brought into the State. The West Virginia DNR estimated fewer than 15 permits are currently issued to hold captive pumas and that there are pumas being held illegally. The Coopers Rock cougar rehabilitation facility harbors an additional six animals.

Taverna et al. (1999) employed GIS landscape analysis in the mid-Atlantic region to evaluate habitat suitability for supporting a population of pumas. Forest land cover, human density, road density, and deer density were used to model potential habitat. They found suitable puma habitat was extensive and widespread along the Appalachian Mountains in northeast and central West Virginia. The largest area of potential suitable habitat was in Ritchie, Gilmer, Tyler, Doddridge, and Wirt Counties in West Virginia, constituting an area of 1,471 mi.^{2} (3,810 km.^{2}) of predominantly private forestland. Deer density in West Virginia averages 34 deer/mi.^{2}. Much of the State is sparsely settled, and the Monongahela National Forest and other large tracts of forestland may provide potential puma habitat.

Wisconsin – The western boundary of the range of the eastern puma is uncertain because of a lack of reference specimens (USFWS 1982). Young and Goldman (1946) included all of Wisconsin within the range of *P. c. couguar*, whereas Hall (1981) included the State entirely within the range of the "Wisconsin cougar" *P. c. schorgeri*)(see taxonomy section below). Prior to European settlement the puma was likely common and widespread throughout the State as it was throughout the Great Lakes region (DeVos 1964), but may have been particularly abundant in the forested valleys of the Mississippi and Fox Rivers and their tributaries (Cory 1912, Schorger 1942, Jackson 1961). Earliest references to pumas date back to 1673 and there were many well-documented records throughout the 1800s (Scott 1939, Schorger 1942) and summarized by Jackson (1961). The type specimen of *P. c. schorgeri* was shot near Appleton in 1857 (Schorger 1938, Jackson 1955). One was killed in Douglas county about 1905 and two seen in Marinette County in 1909, which are thought to be the last wild

animals that occurred in the State (Jackson 1961, Anderson et al. 2003). A puma observed several times in 1945 was believed to be a released or escaped captive as were any subsequent records (Jackson 1961).

Confirmed records of pumas have increased since 1994 and are summarized in Appendix B. State biologists first documented tracks on snow in 1988. Wisconsin DNR began collecting information on cougar observations in 1991, and 345 unconfirmed records were catalogued 1994 to 2003, of which 9 percent were "probable" occurrences.

In 1997, 12 Wisconsin Department of Natural Resource field personnel were aware of pumas being illegally released (Anderson et al. 2003).

Puma habitat has not been assessed or modeled in Wisconsin; however, Anderson et al. (2003) commented that there were likely several areas of the State having adequate forested habitat and deer densities to support pumas.

Surveys in the eastern United States and Canada

Although single, transient pumas are difficult to detect, documenting the presence of a cougar population can be accomplished with a reasonable amount of effort. Brocke and Van Dyke (1985) estimated a 95 percent confidence of finding tracks of a resident female by searching 19 mi. (31.6 km) of dirt road or snow under good tracking conditions or 47.1 mi. (78.5 km) on average for all tracking conditions. They documented these distances can be covered in one day by a team of two in a slow-moving vehicle (or snowmobile in the north). By contrast, the equivalent value to detect transient pumas was 113 mi. (188.4 km). Similar track and sign surveys have been used for Florida panthers (Roof and Maehr 1988). Motion-sensing trail cameras placed at 1.2 to 1.8 mi. (2 - 3 km) intervals for 30 to 90 days have been effective at identifying individual pumas and estimating populations in Belize, Argentina, and Bolivia (Kelly and Camblos 1996, Kelly et al. 2008). Cameras were used to assess Florida panther populations (Lotz and Land 2003), but were not successful in a similar monitoring project in South Dakota (Kintigh 2003).

The following surveys were conducted by wildlife biologists in remote areas within the historical range of the eastern puma. Some surveys targeted pumas and others targeted other species (e.g., wolves, lynx). Nearly all of the following surveys failed to detect sign or evidence of eastern pumas.

Georgia, South Carolina, North Carolina, Tennessee, and Virginia 1978 to 1983 – Environmental groups threatened litigation against the USFS in 1977 concerning logging in the Nantahala National Forest in western North Carolina where pumas have been reported (Downing 1984). The USFS, NPS, and USFWS jointly sponsored a study to determine if pumas still existed in the region. Robert Downing, USFWS biologist and author of the eastern cougar recovery plan, coordinated the survey from 1978 to 1983. He conducted tracking surveys, and distributed questionnaires and other information to State and Federal biologists. Over 800 natural resource agency personnel were trained to recognize sign and collect information. State biologists in Tennessee and Virginia employed hundreds of sanded track plots at scent stations. After 5 years of effort, he was unable to document a reliable track, scrape, or scat (Downing 1984). However, Downing admitted it was difficult finding suitable tracking conditions in this region and may have covered no more than 20 mi. in bare ground conditions (Downing 1994b).

Kentucky (2005 to 2008) – Brown (2005) completed seven 0.6 to 1.8 mi. (1 - 3 km) track transects and placed motion-sensing cameras baited with puma urine at the location of "reputable" puma

sightings in the Westvaco Wildlife Management area, Hickman County near Columbus and Obion Creek Wildlife Management area. No pumas were detected (Eastern Cougar Foundation).

The Eastern Cougar Foundation (ECF) conducted a remote camera project at the Land Between the Lakes National Recreation Area (USFS, 170,000 acres in western Kentucky and Tennessee). The project ran from December 2006 to March 2008. The cameras were placed on game trails and abandoned logging roads. They also used cougar urine, estrous cougar urine and Canine call. In addition, to the remote cameras, pheromone scent and hair trap posts (using techniques of Marc Gauthier) were also set. The cameras or scent posts did not capture any pictures or hair samples of pumas.

Massachusetts, Quabbin and Berkshire Regions (1972 to 1985) – Virginia Fifield founded the Eastern Cougar Survey funded by the Worcester Science Center. She did extensive searches of the Quabbin and a few places in the Berkshire Mountains in western Massachusetts. Fifield found several possible puma tracks and a possible cache, but nothing that she could definitively pronounce as an indication that a puma had been present at any of those locations (Tougias 1992, 1997, 2006).

Michigan 1996 to 2007 – Between 1996 and 2007, Federal and State biologists have conducted annual snow track surveys throughout the State of Michigan to locate and census wolf packs. Surveyors are also trained to detect, identify and report puma tracks during survey efforts. For each year, about 2,000 person hours are expended to survey all Upper Peninsula counties. As an example of the level of effort that is typically employed, surveyors tracked 8,298 mi. (13,354 km) of snow covered roads and trails in 2004 (Beyer et al. 2004). Although 360 wolves were counted during that effort, no puma tracks were found. No puma tracks have been observed in similar surveys efforts conducted annually from 1996 to the present.

Michigan 2001 to 2003 – Searches for track and sign were conducted by the Michigan Wildlife Conservancy in the Upper and Lower Peninsulas including intensive searches of the 33-mile (53 km) dune and beach system at Seul Choix Point. These searches allegedly resulted in the documentation of at least nine different pumas (from DNA in scats), tracks, and two sightings of pumas in both the Upper and Lower Peninsulas (Swanson and Rusz 2006, Rusz 2006*a*). The results of these surveys have been contested and the methodology questioned. Kurta et al. (2007) challenged the methodology used to analyze scats and believed that only one of the samples may be puma. Carney (2006) questioned the methods, conclusion and validity of the evidence and likened the survey and reporting results to the public as "voodoo science" (Park 2000). The Michigan Chapter of The Wildlife Society offered to conduct a formal review of the methodology, but the Michigan Wildlife Conservancy declined to participate (Roloff 2003, Carney 2006). The Michigan Wildlife Conservancy responded to claims of improper scientific methods (Rusz 2006*b*).

Michigan, Sleeping Bear Dunes National Lakeshore 2004 to 2005 – In response to many reports of pumas, the NPS conducted extensive field surveys using track surveys, remote cameras, and investigation of puma reports (Belant et al. 2006a,b). No evidence of pumas was found. The Grand Traverse Band of Ottawa and Chippewa Indians has been doing furbearer track surveys in the Sleeping Bear Dunes area for a number of years (B. Fessell, furbearer biologist, pers. comm. in Carney 2006). These surveys did not produce evidence of the presence of pumas.

Maine – Maine Department of Inland Fisheries and Wildlife conducted 415 mi. (668 km) of snow tracking surveys in 1996 and 559 mi. (900 km) in 1997 for wolves, lynx, and other carnivores in remote areas of northwestern Maine. No evidence of pumas was detected. From 2003 to 2007 Maine Department of Inland Fisheries and Wildlife conducted snow track surveys for Canada lynx and other large carnivores in 70 townships throughout western, northwestern, and eastern Maine. The surveys

covered over 4,000 mi. (6,666 km) of logging roads. These surveys did not provide any tracks or sign of pumas.

Clayton Lake, Maine – Thirty-six infrared motion sensing cameras were established for 4 months (July to October, 2005) on a 36 mi.^{2} (100 km.^{2}) study area. Canada lynx were detected but no pumas (Nielsen and McCollough 2007).

Appalachian Trail 2007 – Smithsonian Institution researchers attached 50 motion-sensitive cameras along the Appalachian Trail in Virginia, West Virginia, and Maryland. No pumas were detected.

Maryland – Maryland DNR employed a statewide hair snare program to estimate bear populations and has placed trail timer cameras in Allegany County. Both efforts did not obtain evidence of pumas.

Jefferson National Forest, Virginia – Fifteen infrared motion sensing cameras were established for 72 days (August to October, 2005) on a 11.6 mi.^{2} (30 km.^{2}) study area. No evidence of pumas was obtained (Kelly and Holub 2005).

Great Smoky Mountain National Park – For 12 months rubbing pads were maintained near the Sugarlands Visitor Center. Approximately 70 rubbing pads were maintained for 18 months from Davenport Gap on the eastern edge of the Park to Cades Cover on the western edge. Several infrared motions sensing cameras were deployed. They collected hair and photographs from black bears, coyotes, bobcats, gray foxes, red foxes, and wild boars, but not pumas (D. Linzey, March 28, 2007 letter to USFWS).

Monongahela National Forest, West Virginia – Todd Lester from the Eastern Cougar Foundation placed 20 remote cameras in the national forest from 2003 to 2004. Cameras photographed deer, bears, coyotes, bobcats, and other wildlife, but no pumas (Bolgiano 2006, McGinnis 2007).

Land Between the Lakes Kentucky, south-central Pennsylvania, Dolly Sods-Roaring Plains – Members of the Eastern Cougar Foundation placed infrared motion sensing cameras in these areas from 2006 to 2007. Many species of wildlife were photographed, but no pumas (Eastern Cougar Foundation).

Virginia – In 2005, Kelly and Holub (2008) deployed 16 trail cameras in a 10.4 mi.^{2} (27 km.^{2}) study area for 72 days in Jefferson National Forest. Many carnivores were photographed, but no pumas.

Trail cameras – Several recent occurrences of pumas in the Midwest have been documented by the use of trail cameras (Cougar Network 2008). As many as 300,000 trail cameras are being sold annually in the United States and are commonly used by hunters and nature enthusiasts. Their use in scientific projects has increased dramatically. Pumas in eastern North America, if present, would be photographed with increasing regularity. Pumas have been recorded on trail cameras set by hunters and outdoor recreationists in the Midwest (CougarNet), but not in eastern North America.

Wisconsin – Adrian Wydeven, a mammalian ecologist with the Wisconsin DNR, has been conducting road surveys for wolves and pumas since 1979. Trained field technicians and biologists have surveyed over 3,000 mi. (4,828 km) of snow-covered roads and, since 1995, volunteers have surveyed an additional 3,000 mi. (4,828 km) of roads. Pumas have not been detected in these surveys (Carney 2006). A puma was observed, tracked (on several occasions) and verified from DNA (blood collected in tracks) in January 2008. The same animal was shot in Chicago, Illinois, in April 2008

(Appendix B). Another puma was treed and photographed on several occasions in Spooner, Wisconsin in March, 2009. Attempts to tranquilize the animal for tagging failed.

The following surveys were conducted by wildlife biologists in eastern Canada. All surveys targeted pumas.

Southern New Brunswick and Fundy National Park 1992 – Friends of the Panther and Mountain Lion Foundation cosponsored a 2-week puma survey in March 1992 (in Hansen 1992). Wright (1972) believed this area to be the breeding area of the eastern puma. There was no documentation of pumas.

New Brunswick (1994, 1995) – New Brunswick furbearer program did snowtrack surveys on 60 mi. (100 km) of transects in 1994 and 186 mi. (300 km) in 1995, and no puma tracks were encountered (R. Cumberland, 1997 letter to F. Scott).

Fundy, Kouchibouguac, Cape Breton Highlands National Parks, New Brunswick (2003) – Bertrand et al. (2006) investigated tracks and kill sites and collected hair and scat samples in these National Parks. Eight scent lure stations and associated motion-sensing cameras were established using the techniques of Marc Gauthier (Envirotel Inc.). Results have not been reported at the time of writing this review.

Maritime Provinces of eastern Canada (2001 to 2005) – Gauthier et al. (2005) set up >50 scratching posts baited with a puma pheromone lure in Quebec, New Brunswick, and Nova Scotia including Mont-Tremblant and Gaspesie Provincial Parks, La Mauricie, Forillon, Kouchibouguac, Fundy National Park and the Ruiter Valley ecological reserve. Posts were monitored for 3 to 36 months. Hairs were collected and sent for analysis at the University of Montreal. Six samples were confirmed as puma (Appendix B). No information was provided to confirm whether motion-sensing cameras were used to ensure that intentional hoaxes were not perpetrated at these sites. Several of the genotypes identified were of South American origin, indicating released or escaped captive pumas may be present. Others were of North American origin, but it could not be determined if they were of captive or wild origin.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation: Genetic evidence suggests pumas originated in the Brazilian Highlands about 230,000 to 300,000 years ago (Culver et al. 2000). Pumas quickly spread thereafter throughout North and South America. A possible extirpation and recolonization in North America by pumas occurred approximately 9,000 to 12,000 years ago during the Pleistocene extinctions. Thus, the North American populations had little time to develop variation between geographic regions. Subsequently, at least three population bottleneck events occurred in the North American population (Culver et al. 2008). The Florida event was the most severe, and this population was monomorphic at multiple, highly polymorphic microsatellite loci. Genetic bottlenecks and inbreeding depression are threats to recovery for the Florida panther (Pimm et al. 2006, Culver et al. 2008).

2.3.1.4 Taxonomic classification or changes in nomenclature: The North American puma was described by many early American explorers and naturalists (Tinsley 1987, Parker 1998, Bolgiano and Roberts 2005). In 1766 the French naturalist George Louis Compte de Buffon published an article on *Le Couguar de Pennsylvanie*, which was translated into English in 1771, the same year that Linnaeus gave the puma its scientific name *Felis concolor*, "cat of one color." The type specimen came from Elk County, Pennsylvania and is in the U.S. National Museum. Shortly thereafter Robert Kerr (1792) of the Royal Physical Society and Royal Society of Surgeons assigned the name *Felis couguar* to the race that inhabited eastern North America north of Florida. The animal was described

as “having a remarkably thin and long body, reddish tawny above and whitish on the underparts.” Subsequently, from the late 1700s through the 1800s many subspecies of puma were described based on geographical variations in pelage and color, size, and cranial and dental measurements. True (1884) reassigned the puma to *Felis concolor*. Nelson and Goldman (1929) first assigned the eastern puma to the subspecies *Felis concolor couguar*. The Florida panther, *Felis concolor floridana*, was first described by American ornithologist Charles B. Cory who killed several pumas in Florida in 1895 (Cory 1896). He described them as “having small feet, long tail, and bright yellowish bay color.”

The puma was originally assigned to the genus *Felis* by Linnaeus in 1771, but in 1834 Jardine renamed the genus *Puma* (Wozencraft 1993). Later, taxonomists lumped many smaller cat species, including *Puma*, into subgenera under the genus *Felis* (Nowak and Paradiso 1983). Ewer (1973) proposed *Puma* as a separate genus. The puma was placed in the monotypic genus *Puma* Jardine 1834 by at least four authors revising the family Felidae (Wilson and Reeder 1993, Nowell and Jackson 1996). The American Society of Mammologists adopted this change in 1993. Thus, the current taxonomy is to refer to the species as *Puma concolor* (Linnaeus 1771).

The first comprehensive revision of the pumas was by Clinton Hart Merriam (1901) who listed 11 forms of pumas under 6 species. Nelson and Goldman (1929) completed the next major taxonomic revision listing 19 geographic races or subspecies and assigned all of them to the nominal species, *Felis concolor*. Based on examination of 764 specimens, Young and Goldman (1946) acknowledged the subgenus *Puma*, which included one species *Felis concolor* and 15 subspecies in North America and 15 subspecies in South America; more subspecies than for any other carnivore species in the world. Two subspecies were named in eastern North America; the eastern cougar *Felis concolor couguar* and the Florida panther *F. c. coryi*. These subspecies descriptions were based on several morphological features (pelage, skull and skeletal measurements).

Young and Goldman (1946) described the eastern puma *F. c. couguar* from skull measurements from just 8 specimens (sex of specimens unknown) from imprecise locations in New York (n=6), Pennsylvania (n=1), and West Virginia (n=1) (Figure 1). From this scant evidence collected from a small geographic area, Young and Goldman (1946) described the range of the *F. c. couguar* as eastern Ontario, southern Quebec and New Brunswick and a region bounded from Maine to Michigan, Illinois, Kentucky, and South Carolina in the eastern United States. The USFWS’ endangered listing of the subspecies coincides largely with the range of the eastern cougar proposed by Young and Goldman (1946). There are about 26 historic specimens of eastern pumas (12 mounts, 1 partial mount, 11 skulls, and 2 skins) in museums or other collections representing 7 eastern States and one Canadian Province within the historical range of the eastern puma (J. Cardoza, Massachusetts Department of Fish and Wildlife *in* Bolgiano and Roberts 2005).

Jackson (1955) described a new subspecies, the Wisconsin puma (*P. c. schorgeri*), from a small sample of skulls (n=3) from the Midwest. He mapped *schorgeri’s* range as Minnesota, Wisconsin, Upper Peninsula Michigan, Iowa, Illinois, Missouri, and eastern Kansas. Johnson (1961) believed the puma in the Upper Peninsula of Michigan to be more closely allied with *F. c. schorgeri.* In the Lower Peninsula of Michigan Burt (1946) identified the puma as *F. c. couguar*. Hall and Kelson (1959) revised the taxonomy of the Central and North American subspecies.

Hall (1981) next revised the genus *Felis* and recognized 32 subspecies (15 in North America) (Figure 2). He deleted *F. c. olympus* and added *F. c. schorgeri*, the Wisconsis puma, with a range that included the eastern portion of *F. c. hippolestes* and the western extreme of the eastern puma *F. c. couguar*. Hall (1981) extended the range of the eastern puma into Nova Scotia and mapped the Florida panther’s (*F. c. coryi*) range as far north as South Carolina and southwestern Tennessee.

Figure 1. Distribution originally assigned to *Puma concolor couguar*, from Young and Goldman (1946) and the localities of specimens on which they based their description (from Scott 1998).

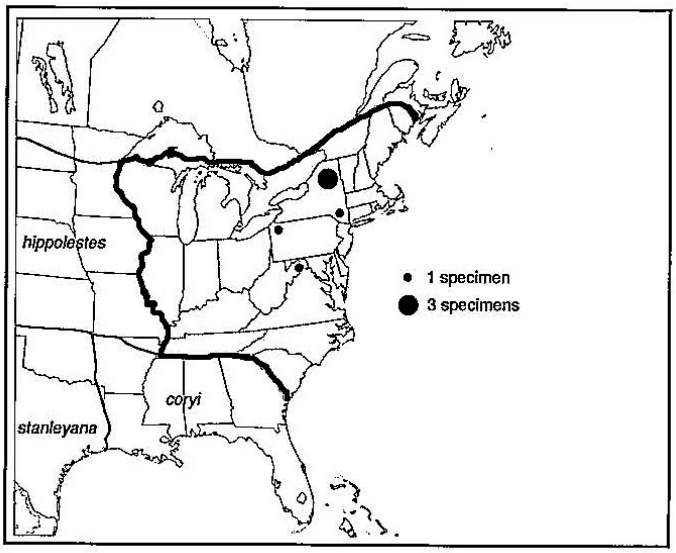


Figure 2. Distribution of North American subspecies of *Puma concolor* recognized by Hall (1981), (from Scott 1998).

Lazell (1981) examined 215 North American cougar specimens belonging to all subspecies, including 17 eastern cougar specimens, and could find no discontinuous variation in morphological traits. He concluded that the western subspecies represented no more than clinal variation, and he could assign skulls to subspecies with <75 percent accuracy. He could usually separate the eastern cougar and Florida panther from western populations based on skull measurements, but there was still overlap. He found the Manitoba specimens (*P. c. missoulensis*) and Wisconsin specimens (*P. c. schorgeri*) more similar to the eastern cougar than western populations. Jones (1964) and Bowles (1975) also disputed the validity of *P. c. schorgeri* based on the small sample size (n=3) used to describe the subspecies. Lazell (1981) believed that all of the proposed mid-continent subspecies (*schorgeri, stanleyana* and eastern *missoulensis* and *hippolestes*) were not valid and were misidentified *couguar, coryi* or western animals or their intergrades.

There is no universally accepted definition for subspecies within or across taxa (Haig et al. 2006). Mayr (1963) described subspecies as "geographically defined aggregates of local populations which differ taxonomically from other such subdivisions of the species." Frankham et al. (2002) said subspecies were "populations partway through the evolutionary process of divergence toward full speciation." O'Brien and Mayr (1991) proposed that members of a subspecies would share: (a) A unique geographic range, (b) close similarity in size, shape, and color, (c) genetic similarity, and (d) obvious habitat-related differences relative to other subspecies. Haig et al. (2006) proposed unified subspecies criteria that would reduce ambiguity and facilitate consistent application of ESA policy and uniform implementation across all taxa. Valid subspecies should be discrete populations and have biological significance in relation to the remainder of the species to which it belongs. These criteria are somewhat similar to the USFWS' Distinct Population Segment criteria.

S. N. Rhoads, an early Philadelphia naturalist, considered all North American cougars to be races of a single species (in Seton 1929). Young and Goldman's (1946) taxonomy of pumas was inadequate, even by the standards of their time. Their results were based on very small sample sizes, the samples were from an extremely small portion of the alleged eastern puma's range (samples from Vermont and Quebec were available, but not examined), their work was not peer reviewed, their taxonomy lacked statistical analysis, and their work would likely be rejected under standards for modern scientific journals.

By the 1980s and 1990s, increasing knowledge of the extensive movements by pumas, their broad, contiguous distribution, few geographic barriers to gene flow, and relatively minor, if any, phenotypic variability provided further evidence to doubt the validity of so many subspecies of pumas in North America. Culver et al. (2000) examined genetic markers (3 mitochondrial DNA genes and 10 nuclear microsatellite DNA loci) and diversity in puma population throughout North and South America. She collected tissue samples from 315 pumas throughout North and South America (261 from contemporary individuals and 54 from museum specimens, including 6 eastern puma *P. c. couguar* specimens). She documented 14 unique maternal types, and only two of these types occurred north of Nicaragua. Phylogenetic trees lumped the genotypes into just 6 groupings – North America, Central America, northern South America, central South America, eastern South America, and southern South America (Figure 3).

South American pumas have higher levels of mitochondrial DNA diversity and microsatellite satellite markers. In contrast, North and Central American populations have no mitochondrial DNA variation (except in the Olympic Peninsula) and moderate levels of microsatellite DNA variation. These patterns of genetic diversity formed the basis for Culver's recommendation to revise the taxonomy to just six subspecies – five in South America and all North American (north of Nicaraugua) as a single subspecies *Puma concolor couguar* named after the oldest named subspecies by Kerr in 1792 (Culver et al. 2000).

For North America, the accepted taxonomic list of mammals is the *Revised Checklist of North American Mammals North of Mexico* which is published in the Occasional Papers series of the Museum of Texas Tech University. The most recent list (Baker et al. 2003) is the eighth version but is due for revision. The checklist is at the species level only and lists *Puma concolor*.

On a global basis, *Mammal Species of the World* (Wilson and Reeder 2005) is widely accepted as the leading global authority on mammalian taxonomy (Haig et al. 2006). This publication lists species and subspecies. Mammal taxonomy is revised and published about every 5 years. With each revision, proposed changes from the scientific literature are reviewed, and some are accepted while others rejected. A checklist committee established by the American Society of Mammalogists Board of Directors and Association of Systematics Collections oversees this periodic review of world mammalian taxonomy. In the early 2000s, editors Wilson and Reeder assigned Dr. W. Chris Wozencraft of Bethel University, Indiana, as the sole reviewer of worldwide Order Carnivora taxonomy (including the puma). Citing only Culver et al. (2000) Dr. Wozencraft revised the taxonomy of the genus *Puma* in *Mammal Species of the World* (Wilson and Reeder 2005) to a single North American subspecies based on Culver's recommendations.

Figure 3. The geographic ranges of six revised subspecies of pumas as define by mtDNA and microsatellite analysis. Dotted lines demarcate former subspecies ranges. Squares around haplotype letter indicates a museum sample. From Culver et al. (2000).

Dr. Judith Eger, Royal Ontario Museum, Toronto, Ontario, chair of the American Society of Mammalogists checklist committee, was consulted for this review to clarify the conclusions concerning revisions to *Puma* taxonomy. Dr. Wozencraft died in 2007 and left no notes about criteria or considerations for how *Puma* taxonomy decisions were made. Puma biologists were not consulted, some of whom accept the revised taxonomy and some of whom do not (C. Belden, USFWS pers. comm. 2008). Dr. Eger advised that genetic information should be evaluated with morphological, ecological, and behavioral considerations when making subspecies determinations. She further advised that Culver et al, (2000) was not a proper a proper taxonomic revision, as it

offered no evaluation of the existing subspecies of the puma. Culver et al. (2000) presents a different dataset that adds information but does not refute Young and Goldman's (1946) analyses and conclusions. Young and Goldman's (1946) conclusions may be wrong, but Culver et al. (2000) do not provide the necessary analysis and evaluation to show such. Nonetheless, Culver et al. (2000) provides valuable genetic insights into the historical context, origin, and genetic relationship between the North American puma populations.

Subsequent genetic studies at the population level have demonstrated large areas occupied by pumas (e.g., Colorado and Utah) having little or no genetic variation (McRae 2004; Sinclair et al. 2001) and other areas having significant population-level differentiation within a single State such as California (Ernest et al. 2003) and Idaho (Loxterman 2001). Culver (2006) summarized the implications of recent population-level genetic studies of North American *Puma:*

1) McRae (2004) studied 36 populations in Arizona, Utah, New Mexico, and Colorado. There was almost no population differentiation in northern Arizona, New Mexico and Utah and Colorado. Greatest population fragmentation and differentiation occurred in the "sky island" populations in southern Arizona and New Mexico.
2) Walker et al. (2000) found significant genetic variation between populations in western and southern Texas separated by >350 mi. of desert/scrub habitat.
3) Anderson et al. (2004) found little genetic variation between Wyoming and South Dakota populations.
4) Ernest et al. (2003) studied 12 California populations separated by deserts and other landscape features and found significant subdivisions between most of them.
5) Loxterman (2001) examined several Idaho puma populations and found differences between populations north and south of the Snake River, especially where populations were fragmented by landscape features.

The USFWS has determined that the best available information supports maintaining the Young and Goldman (1946) taxonomy of the puma, as described above. While more recent genetic information introduces significant ambiguities, a full taxonomic analysis is necessary to conclude that a revision to the Young and Goldman (1946) taxonomy is warranted.

Three subspecies of puma are federally listed:
- Eastern cougar (*Puma concolor couguar*) (listed 1973, 38 FR 14678)
- Florida panther (*P. c. coryi*) (listed 1967, 32 FR 4001)
- Costa Rican puma (*P. c. costaricensis*) (listed 1976, 41 FR 24062-24067)

Two other subspecies were formerly listed as Category 2 candidates:
- Yuma puma (*P. c. browni*)
- Wisconsin puma (*P. c. shorgeri*)

The eastern cougar is listed as endangered in the IUCN Mammal Red Data Book (http://www.iucnredlist.org/). The eastern cougar is classified as an Appendix I animal by the Convention on International Trade in Endangered Species, which provides protection from international trade (http://www.cites.org/).

NatureServe classifies the eastern puma (*P. c. couguar*) as follows:

Global Status: G5 (species secure, widespread, abundant) THQ **(**Taxonomy/Subspecies, Historical, Questionable)

Global Status Last Reviewed and changed: 10 December 2003
Rounded Global Status: TH - Possibly Extinct
Nation: United States
National Status: NH (Historic from United States)
Nation: Canada
National Status: NH (Historic from United States)

United States: Connecticut (SX), Delaware (SX), District of Columbia (SX), Georgia (SH), Indiana (SX), Kentucky (SX), Maine (SH), Maryland (SH), Massachusetts (SX), Michigan (SX), Missouri (SX), New Hampshire (SH), New Jersey (SX), New York (SX), North Carolina (SH), Ohio (SX), Pennsylvania (SX), Rhode Island (SH), South Carolina (SH), Vermont (SH), Virginia (SX), West Virginia (SH)

Canada: Manitoba (S2S3), New Brunswick (SH), Nova Scotia (SU), Ontario (SH), Quebec (SNR)

SH: NatureServe Subnational Conservation Status Rank - Possibly Extirpated (Historical) - Species occurred historically in the State or Province and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20 to 40 years. A species could become SH without such a 20- to 40-year delay if the only known occurrences in a nation were destroyed or if it had been extensively and unsuccessfully looked for. The SH rank is reserved for species or communities for which some effort has been made to relocate occurrences, rather than simply using this status for all species or communities not known from verified extant occurrences.

SX: NatureServe Subnational Conservation Status Rank - Presumed Extirpated - Species is believed to be extirpated from the State or Province. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.

2.3.1.5 Spatial distribution, trends in spatial distribution, or historic range: Young and Goldman (1946) believed the eastern puma to be extinct as did other authors (Paradiso 1972, Burt and Grossenheider 1976, Maehr 2005). Hall (1981) did not regard the eastern puma *F. c. couguar* as extinct and included records (veracity unknown) from Indiana, Illinois Ontario, New Brunswick, Nova Scotia, Tennessee, and South Carolina. Currier (in Russell 1978) based a map of puma distribution on Nowak's (1976) published accounts of reliable puma sightings, which included reports (veracity unknown) from Maine, Massachusetts, North Carolina, South Carolina, Tennessee, and Quebec. Deems and Pursley (1978) conducted a 1976 furbearer survey of States and Provinces, including questions concerning the existence of the puma. They produced a range map based on records (veracity unknown) including western Ontario, eastern West Virginia/western Virginia, North Carolina, and Tennessee. Nowak (1976) concluded after his review: "On the basis of available data, it can not be said with certainty whether any cougars currently living in the wild in these areas (Northeast and Midwest) represent the originally present subspecies, wanderers from the range of other subspecies, or introduction by human agency. The sum evidence suggests that native cougar populations have maintained themselves in southeastern Canada, within the former range of *P. c. couguar…*" Anderson (1983) consolidated available literature (1950 to 1980) for a range map that included annotated records from southern Quebec, Massachusetts, West Virginia, North and South Carolina, and Tennessee.

Recent evidence for pumas in the East

There are few puma reports in eastern North America from the time of extirpation (late-1800s) until the 1940s and 1950s (Appendix B). McGinnis (1994) recorded plausible puma sightings in Pennsylvania from 1900 to 1950. Eastern puma reports increased in the 1950s coincident with

coverage in the popular press (Sass 1954) and when biologists (especially Bruce Wright from New Brunswick) and other writers asserted that there was sufficient evidence to believe that the eastern puma still existed (Thornton 1954, Robb 1955, Backus 1956, Wright 1953, 1959, Larson 1966, Sealander and Gipson 1973). Increasing puma reports in eastern North America in the 1950s also coincided with a growing number of pumas in the North American pet trade.

A noticeable increase in reports followed in the 1960s and 1970s (Bolgiano 1995a, b, c) and was coincident with the popular publications and books by Bruce Wright. Wright was a wildlife biologist from New Brunswick and former student of Aldo Leopold who made a case for a breeding population of cougars persisting in eastern Canada and northern New England (Wright 1960, 1961, 1971, 1973). Wright believed a population of pumas that survived in the northeastern United States and eastern Canada was repopulating eastern North America. Wright's passion for the survival of the eastern puma stirred the public imagination that this vestige of our colonial past had not disappeared entirely. Many, including other wildlife biologists, accepted Wright's hypothesis without critical scientific review. Most of Wright's evidence for a breeding population was unconfirmed sightings, track photos and plaster casts (some of which seem to be lynx or canids), and photographs of pumas killed in New Brunswick (1932) and Maine (1938) (Appendix B). Some authors (e.g., Godin 1977, Rezendez 1999) still describe New Brunswick or northern New England as the location of a breeding population.

Starting in the 1950s, States, Provinces, and puma organizations began to collect and investigate records of pumas and maintain databases of these records. Numerous authors have compiled these reports in eastern North America (e.g., Gerson 1988 for Ontario, Stocek 1995 for eastern Canada, Lutz and Lutz 1996 for the mid-Atlantic region) citing the volume of anecdotal reports as evidence for the continued existence of pumas. Growing puma reports in the 1960s lead to the listing of the eastern couga (= puma) as endangered under the Endangered Species Act in 1973 even though no populations were known. The USFWS funded a 3-year investigation of puma reports in the Southeast (Downing 1981a,b, 1984, 1994a, 1994b) and the Northeast (Brocke 1994) and completed a recovery plan (USFWS 1982).

By the 1970s groups formed to record, investigate, and advocate for puma recovery. Nearly every State had at least one group actively collecting cougar sighting records and investigating reports. The Eastern Puma Research Network collected over 3,000 sightings in Pennsylvania, Maryland, and West Virginia (Lutz and Lutz 1996). The Friends of the Eastern Panther (founder Ted Reed), Eastern Cougar Survey 1972-1985 (Ginny Fifield), and Stuart Mitchell (Conncecticut) collected, investigated and compiled sightings in New England. The New England Panther Research Alliance was formed in Brandon, Vermont. Helen McGinnis (1994) compiled Pennsylvania sightings. William Reichling (2006) investigated Ohio sightings with the R&R Animal Trackers Puma Research Project. Bill Betty searched for pumas in Rhode Island and gave talks throughout New England. Todd Lester formed the Eastern Cougar Foundation to advocate for restoration of pumas in the East. The Eastern Cougar Foundation maintains a website and recently sponsored surveys in the southern Appalachian region (Bolgiano 2006). The Michigan Wildlife Conservancy compiled Michigan sightings, conducted surveys, and advocated for restoration (Rusz 2001, 2006c). The Cougar Network (Nielsen et al. 2006) maintained a web site with information about the eastern puma, mapped confirmed puma occurrences, published *Wild Cat News*, and provided a valuable educational approach to the eastern puma phenomenon. The Eastern Puma Research Network compiled a summary of sighting reports throughout eastern North America (2,255 "good" reports from 1983 to 1993 from 25 States and another 3,900 inconclusive) (Greenwell 1994). The Ontario Puma Foundation compiled over 500 sighting reports (Kenn 2006). Jolicoeur et al. (2007) compiled and presented 1,062 reports provided to the Province of Quebec. Many of these groups are still active and continue to collect sighting records. Many are convinced of the existence of pumas in eastern North America including breeding

populations throughout the region. Some believe that State and Federal governments have conspired to hide data or have been involved in covert reintroduction programs. Some advocate for puma recovery in the East whether the animals are of captive, migratory, or remnant populations.

Since the 1960s, thousands (perhaps 10,000s) of reports of pumas have been collected by State, Federal, and Provincial wildlife agencies and puma organizations. There are hundreds of puma sightings by credible witnesses, including wildlife biologists, conservation officers (and even a former Director of the USFWS), where physical evidence was not available. We document 60 reports that have some likelihood of validity from verified identification of tracks, photographs, genetic, hair, or scat samples or carcasses (Appendix B).

Many alleged puma observations lack concrete physical evidence and could be classified as "eyewitness" accounts. Eyewitness accounts make compelling courtroom testimony, yet psychological research shows this form of evidence can be unreliable. Up to 20 percent of convictions based on eyewitness testimony are incorrect (Cutler and Penrod 1995). Huff (1987) estimated that eyewitness error was involved in nearly 60 percent of 500 cases of erroneous conviction. A meta-analysis of >100 field studies that evaluated eyewitness reporting of simulated crimes averaged 35.8 percent false identification leading Cutler and Penrod (1995) to conclude that "identification of persons seen briefly in nonstressful conditions, and attempted after brief delays, are frequently inaccurate." Psychologists have identified multiple factors that influence the reliability of eyewitness accounts (Stern and Dunning 1994):

- ***Time of day.*** Wildlife is more difficult to identify at night than during the day.
- ***Duration of time an event was witnessed.*** An animal glimpsed running for a few seconds is much more difficult to identify than an animal standing in unobstructed view for several minutes.
- ***Duration of time since the event that witnesses are queried.*** Many puma sightings are not relayed to wildlife officials for days, weeks, or months after the event by which time the details of the observation are forgotten.
- ***Experience level and confidence in their ability to correctly identify individuals (wildlife) and accurately recall events.*** Nearly all puma reporters recount their high level of outdoor experience. In reality, wildlife identification experience varies widely, and much of the public lacks wildlife identification experience and skills.
- ***Memory capabilities***. Some people have better attention to detail and have better short-term memories than others.
- ***Memory contamination by information acquired since an event was witnessed.*** Many people reporting pumas admit studying puma photos in a book or on the internet after their encounter.
- ***Experiential context.*** Was the animal observed under ideal conditions, or did weather, lighting, or activity affect accuracy?
- ***The nature of questions asked by an interviewer.*** "Did the animal have a long tail? Was it tawny in color? These questions may lead the witness.
- ***Trustworthiness.*** Unfortunately, honesty is sometimes an issue.

Certain memory processes, including perception, encoding, storage and retrieval influence the accuracy of identifying an object. Psychologists have documented that humans often use inference to fill in missing details in their recollections (Lindsay 1994). Often the system of retrieval and memory of what was witnessed and inference about what was missed when viewing an event is accurate, but the same mechanisms can corrupt memory leading to erroneous conclusions. For example, visual closure is the ability of the human visual system to identify an object from incomplete or partial viewing conditions (Foley et al. 1997). Incomplete visual closure may occur when an observer has a fleeting glimpse of an animal run across the road or through brush. Human visual and memory

processes attempt to fill in the missing pieces and identify the object. When an unfamiliar object is viewed for the first time, errors in identification are more likely to be made (Doninger et al. 2001). What a person actually saw and what they *believe* they saw may be substantially different.

Experience has shown that 90 to 95 percent of alleged puma sighting reports from the public are not valid (Brocke 1981, Downing 1984, Hamilton 2006) and involve instances of misidentification (pumas are most frequently confused with house cats, domestic dogs, bobcats, Canada lynx, foxes, coyotes, fishers, deer, and other wildlife) or even deliberate hoaxes. Reports of unusual vocalization thought to be pumas are suspect. Most are likely misidentification of other animals (owls, raccoons, porcupines) as few members of the public (and biologists) have experience with puma vocalizations. The public (and many wildlife professionals) lack the tracking skills to distinguish puma from domestic dogs and cats, wild canids and felids, fishers, and other wildlife. Photographs of a single, large track are often submitted for consideration. Under certain conditions a single canid track may lack toenail marks or seem to have asymmetrical toe pads. Trackers know that viewing a series of track is far preferred to confirm identification (Rezendez 1999, Elbroch 2003). Many reports come from hunters who may have more field identification skills than the public. Many sightings come from motorists who experience a fleeting glimpse of an unidentified animal in the headlights.

Western States and Provinces rarely use alleged puma sightings to document puma persistence or range (Bolgiano 1995b). However, there may be some validity of recording sightings by the public in areas where pumas are uncommon. In South Dakota where a small population of pumas occurs, approximately 55 percent of sightings from the public were either verified by biologists (17.5 percent) or very likely pumas (37.7 percent) (South Dakota Fish, Wildlife and Parks 2005). South Dakota Fish, Wildlife and Parks (2005) has a sophisticated program for puma sighting protocol and analysis, which is an important component of their puma management program. Van Dyke and Brocke (1987b) recommended a protocol for experienced biologists to investigate sightings. Sightings databases have been used as a means to track populations and distribution and are an effective means of responsibly addressing public inquiry and concern about pumas (Hamilton 2006).

Van Dyke and Brocke (1987a) and McKelvey et al. (2008) concluded that compilations of unconfirmed sighting reports produce a large volume of convincing but misleading information and constitute an unreliable method of assessing the distribution and abundance of pumas. McKelvey et al. (2008) identified problems associated with the use of anecdotal sighting or occurrence data as empirical evidence of rare or elusive species like the eastern puma and argued that policy must be based only on verifiable physical evidence. Whereas detailed eyewitness reports are often accepted as testimony in a court proceeding, it is difficult for the public to accept that hundreds of seemingly reliable sighting reports of a rare, elusive, or extinct species (perhaps even by wildlife professionals) are met with skepticism by wildlife professionals. Compounding the problem, anecdotal observations are sometimes accompanied by inconclusive physical evidence such as an indistinct photograph or plaster cast of a track, out-of-focus videos and photographs of an alleged puma, or carcasses of animals allegedly killed by pumas. McKelvey et al. (2008) argued that serious errors of omission (e.g., underestimating the presence of pumas because of a lack of verifiable evidence) and commission (e.g., overestimating the presence of pumas by the inappropriate use of unverified reports) can result from inappropriate use of anecdotal records. As a species becomes rarer, the proportion of false positives will increase. Even the most tangible evidence of a pumas (e.g., a carcass in hand) must be followed by secondary and tertiary levels of inquiry (i.e., the genetic origin of the animal - subspecies and population markers, evidence of being in captivity – tattoos, declawed, vaccine titers, carbon isotope analysis of diet, disease and parasite history) to ensure that it is a truly wild puma. Conservation policy must be made solely on verifiable records and sound science.

Over the last 50 years there have been thousands of investigations of puma sightings by State and Federal wildlife professionals at substantial public expense. There have also been thousands of investigations by private individuals interested in documenting the eastern puma at substantial private expense. Only a small percentage of investigations resulted in collection of a track, scat, or hair that could be interpreted or further analyzed, and a small percentage of those provide irrefutable evidence of a puma. When the public is informed that they saw a domestic dog or cat or another species of wildlife, they often respond negatively. They *know* they saw a puma. The degree to which sighting data is rejected or accepted is primarily a matter of belief, not reason (McKelvey et al. 2008).

State and Federal wildlife officials with reduced budgets, high workloads, and higher priorities often do not respond to puma sightings. Sometimes the inquiring public is met with ridicule and rude responses from wildlife agencies. This results in poor public relations and credibility for wildlife agencies, especially when these circumstances are reported by the local media. Hamilton (2006) warns State and Federal agencies that a cavalier, condescending attitude risks alienating the public and leads to resentment, mistrust, and damaging the credibility of agencies. Puma stories are prominent in the media, whether correct or not. Interpretation of alleged puma signs or sightings is often left to the observer who may have received poor response from agencies. As a result, agencies are often not part of the media report or are dismissed. Lacking agency response, the public go to self-appointed puma experts. Concern for public safety, belief in black pumas, and stories of covert puma reintroductions create public hysteria and paranoia (Hamilton 2006). Missouri and other States have developed puma response teams to enhance agency credibility, improve investigative skills of agency personnel, and increase public knowledge about the possible existence of pumas. Similar programs have been ongoing for years in western States and Provinces where puma populations exist.

Weidensaul (2002) discussed the phenomenon of why so many people claim to see eastern pumas and why there has been so much public interest in their possible return to eastern North America: "The idea [of pumas being present] is incredibly seductive – the notion that these gentle mountains, long settled and so badly misused by people for centuries, could have reclaimed such a potent symbol of wilderness as the mountain lion. Sometimes, I think, we need to believe such things even when the evidence (or its absence) suggests we are deluding ourselves. Deep down in our overcivilized hearts, we need the world to be bigger, and more mysterious, and more exciting than it appears to be in the cold light of day – especially in this age, when the planet shrinks daily and no place seems truly remote or unknown. We're unwilling to accept that there isn't more to the world than what we can see." Butz (2005) espoused that the multitude of puma sightings represented "wishful thinking, or that peculiar human desire to bear witness to something nobody else has seen before."

Both Weidensaul (2002) and Butz (2005) hypothesized that humans by nature are a hopeful, optimistic species and that the belief that pumas still haunt the East "adds luster to an ever-dimmer planet." At the heart of the eastern puma controversy and debate is hope – hope that past environmental transgressions did not eliminate the puma, and if it is gone, hope that against odds it is making a comeback to its former habitats in eastern North America. "The more dramatic, colorful, or formidable an animals is – the longer shadow it casts upon its environment and the bigger psychic hole left by its absence – the less likely we are to accept its loss, and the more apt we are to keep hunting and hoping, even when the evidence is pretty grim" (Weidensaul 2002). Bass (1995) said (of grizzlies in Colorado, but it applies equally well to pumas in the East), "there is a place in our hearts for them, and so it is possible to believe they still exist, if only because that space of longing exists." "The eastern cougar is less a concrete, biological organism than it is a talisman, a totem of wilderness to which people can pin a lot of their dreams… of all the lost species that may haunt the globe, few have the evocative power of these ghost cats. More than for almost any other extinct animal, people want to believe – maybe even need to believe – that big cats still linger on the wild margins of their urbanized world" (Weidensaul 2002).

A number of species thought to be extinct have been rediscovered (Weidensaul 2002), and some species, like the gray wolf and black bear have reclaimed historic habitat in eastern North America. This raises hope that the puma can do the same (Tischendorf and Johnson 2006). For example, the possible rediscovery of the ivory-billed woodpecker (*Campephilus principalus*) captured the imaginations of the public, media, and the USFWS. Jackson (2006) characterized the many who claim to have observed ivory-billed woodpeckers, "We do not question the sincerity, integrity and passion of these observers. We simply cannot know what they saw. We all want there to be ivory-billed woodpeckers out there. We all have hope."

On occasion, the search for the eastern cougar has taken on the status of a mythic quest, has become the matter of intense controversy, and sometimes has involved charlatanism and hoaxes (Hamilton 2006). Articles on the eastern cougar regularly appeared in the now-defunct journal Cryptozooloogy, devoted to the study of animals undescribed by science (e.g., bigfoot, Loch Ness monster, sea serpents). Verified puma occurrences (of released or escaped pets) have occurred with enough frequency in eastern North America to encourage the hope of believers that a cryptic population persists. It has been widely reported that government agencies have secretly reintroduced pumas or conspired to hide information about their existence. On the other extreme, skeptics discount even the most credible of public reports unless a carcass is produced. Given the number of confirmed puma occurrences in recent years (Appendix B), many people have really seen pumas in eastern North America. The media feeds on the controversy, and volumes of newspaper and magazine articles, television shows, and internet dialogue have been devoted to the speculation and debate.

The eastern cougar phenomenon has too often lacked a basis of scientific inquiry. Shermer (1997) points out some of the pitfalls of a non-scientific approach that characterize much of the eastern puma controversy:

- ***Anecdotes, unverified stories recounted in support of a claim, do not make science.*** Corroborative/supportive evidence from other sources, physical proof, or controlled experiments are needed to support the hypothesis that a population of eastern pumas still exists.
- ***Rumors do not equal reality.*** The number of alleged puma photographs and emails circulating the internet do not prove that a populations exists (most have been proven hoaxes).
- ***Scientific language does not make a science.*** Papers written in scientific format, but based on unconfirmed puma occurrences or poor methodology do not prove the existence of pumas in eastern North America.
- ***Bold statements do not make claims true.*** The more extraordinary the claim, the more extraordinarily well-tested the evidence must be.
- ***Burden of proof.*** The person making the extraordinary claim has the burden of proving to the experts and to the community at large that his or her belief has more validity than almost everyone else accepts. The burden of proof is on those claiming that a puma population still exists in eastern North America to provide solid scientific evidence in support of their claims.
- ***Failures are rationalized.*** In science, negative findings are just as important as positive findings. If a population of pumas exists, there should be ample evidence (tracks, scat, animals killed, trapped). Surveys have failed to produce this evidence.
- ***Representativeness.*** Aristotle said, "The sum of the coincidences equals certainty." Our tendency is to remember promising evidence (e.g., a puma kitten was killed in Kentucky), but ignore the details (the kitten had South American genes).
- ***Ad ignorantiam.*** The argument that if you cannot prove something does not exist, then it must exist. In science, belief should come from positive evidence in support of a claim, not lack of evidence for or against the claim.

- ***Hasty generalization.*** Conclusions are drawn before the facts warrant it. A puma killed in Pennsylvania in 1967 does not prove that a remnant population exists.
- ***Credo consolans.*** People maintain unrealistic ideas because these ideas maintain a sense of mystery in an increasingly industrialized, predictable, scientific world. The existence of a puma population provides hope that nature can heal itself from our past transgressions.
- ***Communal reinforcement.*** When claims become beliefs through repeated assertions by members of a community or when the media provide tacit support for untested and unsupported claims by providing no skepticism about even the most outlandish claims (Carroll 2008).

Evidence expected of a breeding puma population (vs. non-breeding individuals)

Breeding populations of pumas, even small populations, are not difficult to detect. Pumas are killed by motor vehicles, even where they are not common. When present, pumas are encountered by bobcat and bear hunters who use dogs and are easily treed (as recently occurred in Wisconsin). Hunters who use remote controlled cameras photograph them (as has occurred in Minnesota). Pumas are readily trapped. In North Dakota (puma population <100) three pumas were trapped or snared in 2007 and four in 2006. Pumas in the Dakotas were shot illegally, trapped, found drowned in reservoirs, and die from other miscellaneous causes (South Dakota Game Fish and Parks 2006). Given the frequency of these incidences, one would expect similar indications of a breeding Eastern cougar population.

Hamilton (2006) indicates that even in jurisdictions having small puma populations (<200 animals) and low road densities, pumas are killed on roads nearly every month of the year. Twenty-two were killed on roads in California between 1971 and 1976 (Sitton 1977). In Florida (population 80 to 100 animals), 19 pumas were killed on roads prior to 1976 (McCauley 1977) and 67 were killed between 1972 and 2000 (Land et al. 2001). Vehicle mortality represented >50 percent of total mortality of the Florida population (Maehr et al. 1991b, Lotz and Land 2007). Vehicle mortality has increased in Florida in recent years as the puma population has grown. From 1997 to 2007, 67 vehicle mortalities were recorded (Lotz and Land 2007). In 2007, 15 were killed on highways alone. Many others have been found dead from intraspecific aggression, disease, and unknown causes (Florida Fish and Wildlife Commission 2006). In South Dakota, where there is a well documented puma population (185 to 210 animals), 121 cougar carcasses were recovered from 2004 to 2006. Fifty-six mortalities were documented in 2006 (9 vehicle collisions, 7 incidentally trapped, 16 problem animals removed, 16 hunter harvest, and 8 accidents and other causes) (South Dakota Game Fish and Parks 2006).

The documented occurrence of road-killed pumas has been posited as necessary to prove their existence in the East outside of Florida (Guynn et al. 1985). There has been evidence of possible vehicle collisions or road mortalities documented in the region in recent years (South Carolina 1942 to 1943, 1952; Ohio 1960s, Kentucky 1997, Nova Scotia 1985, Quebec 1996, 2002, Michigan 2004), but these are likely of captive origin (Appendix B). Based on road mortality rates for the Florida panther, a small population of pumas (35 animals) would experience traffic mortality once every 2 to 3 years (Leberg et al. 2004). The absence of regular road mortalities in the East would argue against a viable, remnant population (Downing 1994a).

Given their extensive daily movements, pumas are usually not difficult to detect from their tracks. Tracks should not be difficult to locate in the snow in the northern part of their range. Cougar track survey protocols are used throughout their range to detect and estimate populations of rare carnivores (Van Dyke 1983, Van Dyke and Brocke 1987a,b, Roof and Maehr 1988, Van Sickle and Lindzey 1992, Smallwood and Fitzhugh 1995; Beier and Cunningham 1996). In good tracking conditions Brocke (1996) estimated a 95 percent probability of detecting the presence of a resident female cougar if 19.6 mi. (31.6 km) of dirt road in the animal's range is searched. Van Dyke et al. (1986)

found that 31.8 mi. (51.1 km) of road searched was needed to detect resident females in Utah and Arizona. They found track surveys detected 78 percent of transients and 58 percent of kittens. They recommended track surveys along 224 mi. (360 km) per 193 mi.^{2} (500 km.^{2}) should be sufficient to detect pumas in least favorable conditions and <56 mi. (90 km) should be sufficient under ideal tracking conditions. Vehicle traffic does not deter pumas from crossing unpaved roads, but can obliterate tracks before they can be located by searchers (Beier and Cunningham 1996). Downing (1981, 1984) noted the lack of good conditions for track searches throughout much of the Southeast where snow events were rare and hard soils were not conducive to tracking. Track surveys for large carnivores in eastern North America have failed to detect pumas (see pages 28 to 30 of this review).

Areas that support native puma populations typically have a long and persistent record of verified occurrences. For example, in Manitoba puma carcasses have been recovered in all but two decades between 1870 and 1977 (Nero and Wrigley 1977, Watkins 2005). The absence of carcasses found from 1940 to 1959 (but there were 31 sightings), was explained by fewer hunters and trappers in the woods during World War II and the Korean War. Two pumas were killed in Manitoba in 2004 (Hutlet 2005). The population is estimated to be about 50 animals in the 1970s (Nero and Wrigley 1977). Similarly, there is a long and continuous record of cougar specimens from Florida documenting the presence of the Florida panther (Belden 1977). There are no regions in eastern North America (other than Florida) that have such a long, persistent record of verified puma occurrences.

LaRue and Nielsen (2008) recommended monitoring programs (track surveys and camera traps) in identified dispersal corridors near source populations. These surveys may provide information on frequency of dispersal and use of corridors by dispersing pumas. Similar methods could be used to periodically monitor the occurrence of pumas in areas having persistent reports and in areas having large, unoccupied habitat blocks that could support pumas. Similar methods have been effective for monitoring small populations of large, elusive felids such as jaguars (*Panthera onca*) (Wallace et al. 2003, Silver et al. 2004) and tigers (*Panthera tigris*) (Karanth 1995, Karanth and Nichols 1998).

Origin of pumas currently observed in eastern North America

On occasion pumas are found in the wild in eastern North America. Approximately 15 puma carcasses have been documented in eastern North America (north of Florida) since 1950 (Appendix B). Possibilities for origin of these animals include: (1) A relic population that has survived within the region (2) released or escaped captives, and (3) dispersal from source populations outside of the region (Dowling 1984, McGinnis 1994, Bolgiano 2005). We examined the evidence of eastern pumas in light of these three hypotheses:

1) A relic population of pumas survived in eastern North America.

Some hypothesize that the eastern puma survived in eastern North America since colonial times. Many groups and individuals have made extensive efforts to collect evidence to support this hypothesis and there have been several symposia dedicated to the possibility (Tischendorf and Ropski 1996, McGinnis et al. 2006). Hypothetical refugia include New Brunswick and Maine (Wright 1948, 1959, 1972, Bolgiano et al. 2000), western Massachusetts (Tischendorf 2003), the Adirondacks (Tischendorf 2003), Pennsylvania (McGinnis 1994), Tennessee-Kentucky-West Virginia (Tischendorf 2003), Michigan and Great Lakes Region (Rusz 2001, Johnson 2002), the southern Appalachians including the Great Smoky Mountain National Park (Cahalane 1948, Culbertson 1976, Linzey 1979, Bolgiano et al. 2000), and the Missouri-Arkansas-Oklahoma area (Tischendorf 2003).

Based on a compilation of unconfirmed sightings, Wright (1972) presumed there were 25 to 50 pumas in New Brunswick and fewer than 100 in all of eastern North America. Wright's numerous publications and books on eastern pumas, the Federal listing of the eastern puma, and subsequent recovery plan (USFWS 1982) was the basis for many other authors to espouse the likelihood that puma populations persisted in eastern North America (Cahalane 1964, Burt and Grossenheider 1976, Deems and Pursley 1978, Russell 1978, Hall 1981, Anderson 1983). A USFWS status review of the puma (Nowak 1976) concluded: "The sum of evidence suggests that native cougar populations have maintained themselves in southeastern Canada, within the former range of *F. c. couguar*, and in the Ozark Plateau and adjoining forests of Arkansas, southern Missouri, eastern Oklahoma, and northern Louisiana."

The hypothesis that pumas survived extirpation in eastern North America has scant support from the historical record, the history of white-tailed deer, and our current understanding of the species' ecology (Van Dyke and Brocke 1987b). Habitat for the puma and their primary prey, the white-tailed deer changed dramatically with the settlement of North America. At the time of European contact, the range of the white-tailed deer extended north to the coast of Maine and New Brunswick (there were no deer in Nova Scotia), and the Great Lakes States and southern Ontario. Northern New England, the Maritime Provinces and the Great Lakes States were predominantly moose-caribou-wolf ecosystems, especially during the end of the "Little Ice Age" era in the late 1700s. Higher snow depths and boreal ecosystems were likely poor habitat for pumas (Parker 1998).

As the human population grew and expanded westward after the Revolutionary War, the vast interior forests were quickly cleared for agriculture, firewood, and lumber. By 1800 the wave of westward expansion reached the Midwest. Agricultural land use in eastern North America peaked between 1820 and 1850 when up to 80 percent of the region was cleared of forest. Large tracts of forested habitat that could support a puma population were gone, and deer were almost nonexistent.

Land use changes and dramatic population growth in the mid- to late 1800s had profound effects on white-tailed deer population and other wildlife. Eastern elk and bison, likely important prey for pumas, were extirpated from the East by 1800. Deer populations increased briefly in eastern North America in response to early successional habitat created by farming and small human populations. However, there were no game laws, and the burgeoning human population exploited deer for subsistence and market hunting. Throughout much of the mid-Atlantic and Southeast regions there was a brisk trade in deer hides, and deer were nearly hunted to extinction. By 1830, hunters were receiving $1 per deer (origin of the expression of "buck" for a dollar), and venison sold for 2 to 3 cents per pound. In New England, deer were intentionally killed as a means of eliminating wolves from the landscape (Siegler 1968). Widespread poisoning was also used to eliminate wolves, which would have indiscriminately killed pumas as well. In the late 1800s, railroads extended into the northwoods regions, which enabled market hunters to promptly get deer to markets in the Eastern cities.

By the mid to late 1800s, unrestricted harvest and habitat loss led to the near extirpation of deer from eastern North America. In Maine and New Brunswick, deer were eliminated from coastal regions (Banasiak 1961). Deer were scarce or absent from Nova Scotia until the late 1800s when populations dispersed from New Brunswick and they were introduced into various parts of the Province (Benson and Dodds 1977). By 1840 deer were extremely scarce in Vermont and existed only in a few pockets near Mt. Mansfield and Essex County (Foote 1945). In 1842 there was only a single record of a deer killed in Connecticut. In Massachusetts deer were nearly gone, remaining only in the rugged areas of the northern Berkshires, on Cape Cod, and a few pockets elsewhere (Parker 1998 citing James Cardoza). By 1880 deer were extirpated from most of New York except in the central Adirondacks (Severinghaus and Brown 1956). Deer did not reappear in western New York until 1910. Deer all

but disappeared from Pennsylvania by 1900 (Forbes et al. 1971). Small pockets of deer remained in the Pocono and South Mountain region and other small enclaves in 30 counties. In New Jersey there were only stragglers (Rhoads 1903). Local scarcities of deer were reported in West Virginia as early as 1841. They disappeared from most of the State coincident with extensive timber harvest between 1880 and 1910. By 1910 fewer than 1,000 remained in fewer than a dozen small enclaves. Deer were extirpated from most of Virginia by the 1880s and persisted in small populations in the Tidewater region (Handley 1979, Linzey 1979). They disappeared from all but a few mountain counties where they remained in some forested enclaves (Handley and Patton 1947). Deer hunting was prohibited in Maryland in 1902 with only small populations persisting in the Appalachians. Deer were nearly extirpated in Kentucky and Tennessee by 1915. They were so few (~2,000 animals) in Kentucky that hunting did not resume until 1946 (Maehr et al. 2001). By 1900 deer populations in North and South Carolina were limited to a few remote mountain and coastal locales. Deer were mostly gone from southern Michigan by 1870 and numbered about 45,000 in 1914 (Butz 2005). They were extirpated from Iowa by 1898 and did not return until 1953 (Fisher and Clark 1997). Deer populations dwindled to just 400 animals in Missouri in the early 1900s (Missouri Department of Conservation website). In the absence of conservation programs and game laws, deer numbers dwindled rapidly in North America and reached a low point by l900 (McCabe and McCabe 1984). T. S. Palmer of the U.S. Bureau of Biological Survey estimated that only 300,000 white-tailed deer remained in the United States from 1890 to 1920 (Trefethan 1970).

An exception to these trends was in the northern regions of the puma and white-tailed deer range. Deer expanded their range northward from the 1820s to the 1860s in northern Maine, northern New England, Great Lakes States and southern Canada in response to habitat created by logging and fires, the elimination of wolves, moose and woodland caribou from much of this region, and an ameliorating climate (Banasiak 1961, Dahberg and Guettinger 1956). Michigan's deer herd on the northern peninsula grew to 1 million deer in the 1880s, but dropped to 45,000 (Statewide) in the absence of game laws. Starting about 1890 (later in the South and Midwest), deer from the North began to recolonize former agricultural areas as farms reverted to woodland and game laws restricted deer harvest. Deer from Michigan, Maine, and other northern States were translocated to many areas in the East to restore populations (McDonald and Miller 1993). Deer reintroductions began as early as the 1870s in Vermont and were common in almost all the eastern States until the 1950s. Deer translocations continue in some States (e.g., Tennessee and Kentucky). By the 1930s and 1940s deer populations rebounded and their geographic range expanded in response to conservation efforts and habitat changes throughout eastern North America. Recent estimates of the white-tailed deer population in North America are about 30 to 40 million, substantially more than at the time of European contact (Rooney 2001).

The last records of pumas in most of the eastern States and Provinces (1790-1890) coincided with the demise of deer populations and habitat loss throughout much of the region. Pumas likely persisted longest in the Appalachians (Pennsylvania 1893, West Virginia 1901), the Great Smoky Mountains (Tennessee 1900, North Carolina 1920), and at the northern periphery of their range (New York 1897, Minnesota 1897, Wisconsin 1905, Michigan 1906, New Brunwick 1932, and Maine 1938) where the last large tracts of forest existed and deer were never totally extirpated. Prior to their extirpation, the range of the puma may have shifted northward with the expanding range of the white-tailed deer in the late 1800s, which may account for late specimens from Maine and New Brunswick. A similar phenomenon has been recently noted in Manitoba (Nero and Wrigley 1977). To survive elsewhere throughout their range in the East, pumas would have had to persist for decades with low or absent populations of their primary prey, the white-tailed deer.

It is doubtful that pumas could have survived throughout most of their former range in eastern North America for a period of 50 to 75 years when deer were absent or found only in extremely small,

isolated populations. Even in northern regions, deer populations were small and snow depths would have limited pumas (Hutlet 2005). Had pumas survived, they should have been easy to detect. Much of the region was cleared for agriculture and animals would have had to cross open country from woodlot to woodlot. In the absence of their primary prey, white-tailed deer, pumas would have had to forage over large ranges to survive on small prey (porcupines, rabbits, small mammals and birds). Nowhere in North America are pumas known to persist exclusively on small prey. It is unlikely that a population could persist feeding only on small prey for many generations. Pumas most certainly would have killed livestock - the only large prey available. Yet there is almost complete absence of records relating to livestock depredation in the early 1900s. Surviving pumas should have been evident as there were frequent records leading up to their demise in the late 1800s. Some authors document a near-absence of puma records between the late 1800s and 1950 (Handley and Patton 1947, Handley 1979, Parker 1998), although there are some exceptions (Shoemaker 1917, 1943).

What is the likelihood that very small populations of pumas can persist? Brocke (1981) modeled cougar populations of 20 to 100 animals and found extinction to occur in 16 years with a 25 percent decline in survivorship. However, subsequent Florida panther models (Maehr et al. 2002) showed a >99 percent probability of persistence for populations of 50 to 70 animals (demographics in high quality habitat) over 100 years, but only a 7 percent probability for a population of 6 animals (demographics in the Everglades subpopulation). Genetic studies of the Florida panther suggest that this population may have survived for two generations with a small effective population size of as few as six animals (Culver et al. 2008). Similarly, a population viability model for a small population of pumas (15 to 20 animals) in the Santa Ana Mountains of California in 850 mi.^{2} (2200 km.^{2}) of habitat had a >98 percent probability of persistence over 100 years (Beier 1996). When habitat was reduced to 386 mi.^{2} (1000 km.^{2}), the population of 15 to 20 animals still retained a 98 percent probability of persistence, but only under the most optimistic estimates of biological parameters. Genetic and inbreeding effects would increase extinction risk at low numbers. These results also bracket the minimum area needed for a small population of pumas to persist. These studies suggest that a small cougar population could persist in a 386 to 772 mi.^{2} (1000-2000 km.^{2}) area of high quality habitat (i.e., pumas experience favorable demographic parameters) over a period of 100+ years. LaRue and Nielsen (2008) considered contiguous, forested areas of >965 mi.^{2} (2,500 km.^{2}) as suitable for supporting puma populations in the Midwest.

Results from population viability analyses must be considered cautiously because of inadequate data, imprecise estimates of natality, mortality and recruitment, failure to incorporate density dependence, and over-simplified analytical approaches (Patterson and Murray 2008). Such problems are possible for rare species, like pumas, for which there are few long-term population studies, sample sizes are small, and there may be considerable geographic differences in population demographics.

For the last half century, the existence or extirpation of the eastern puma has been prominently debated among North American wildlife professionals and the public. In the absence of a range-wide research effort to rigorously test the hypothesis that the subspecies is extirpated, biologists and the public have relied on historical and anecdotal evidence to "prove" their positions. Although wildlife biologists strive to employ the scientific method (hypothesis, experimentation, statistical analysis) (Romesburg 1981), results from experimental studies are generally not available for extinction of a species and most management decisions are made on the basis of incomplete information from disparate sources (Murphy and Noon 1991).

The aforementioned evidence supports the USFWS' conclusion that the eastern puma subspecies (*P. c. couguar*) is extinct in eastern North America. There is no evidence to suggest that a population of eastern pumas survived intense human exploitation and persecution, habitat changes, and near eradication of their primary prey, white-tailed deer, in eastern North America.

2) Pumas occurring in eastern North America are released or escaped pets.

Until the 1970s, Wright (1948, 1961, 1972) and others championed the idea that pumas found in eastern North America were evidence of populations that had survived extirpation. Wright (1953) first suggested that released or escaped captives could explain at least some of the sightings and specimens in eastern North America, a sentiment that was later espoused by Nowak (1976). Since then, there has been speculation that perhaps all of the puma sightings in the East (outside of Florida) are escaped or released captive animals (Lazell 1981, Downing 1986).

Many of the recent cougar specimens from eastern North America are known to be escaped or released animals of captive origin (Downing 1994a, Parker 1998, Cardoza and Langlois 2002, Appendix B). Genetic techniques can now document whether specimens (including scat or hair collected as evidence) are North American origin or are one of six South American genotypes (Culver et al. 2000). Captive puma enthusiasts apparently favor Central and South American animals because of their smaller size, and many are present in the North American pet trade (Bolgiano and Roberts 2005). Thus, pumas found in eastern North America with South American DNA are without doubt released or escaped captives or descendants of captives. Specimens with North American DNA cannot be differentiated between captive and wild origin by genetic information alone. Other evidence (parasites, vaccine titers, declawing, tattoos, isotopes present in tissue) can also help determine whether a puma was of captive origin. Some States (e.g., Missouri) are considering requiring that genetic samples be submitted of all pumas in captivity to better document the origin of pumas encountered in the wild (Hamilton 2006).

Apparently live pumas were popular in roadside and traveling menageries and circuses dating back to the late 1700s (Cram 1901, Altherr 1994). Coleman (1994) examined the popular belief that circus train wrecks were the source of some pumas in the wild, but found this unlikely. The frequency of reports of pumas in the eastern United States and Canada seems to coincide with the increasing private ownership, trade, and breeding of pumas in captivity in the 1940s and 1950s. Van Zyll de Jong and Van Ingen (1978) reviewed puma reports for eastern Canada. Reported sightings in eastern Canada were at a low level from 1900 to 1940 (average of one record per year) followed by a marked increase in the late 1940s. This could be explained by heightened public interest from Bruce Wright's (1948, 1953, 1959) publications on the eastern puma, the increased popularity of pumas in captivity after World War II, or both. Cheap air transportation, increasing wealth, and almost complete lack of regulation promoted a flourishing trade in exotic felines, including pumas (Rhyiner and Mannix 1959). Irresponsible breeding in small zoos and roadside menageries likely flooded the market with pumas. Zoos in the United States once sold or gave pumas to individuals or disreputable dealers, but the practice is strictly prohibited today. There currently is a ban on breeding pumas in zoos (Schireman 2000). In Great Britain 115 puma kittens were reported produced in captivity between 1962 and 1970 (Street-Perrott et al. 2006). It is likely that many times more pumas were produced in private North American facilities. As road-side menageries went out of business, animal collections were sold cheaply to inexperienced and often eccentric owners (Reichenbach 2002). Young (1946) documented that captive pumas were becoming popular immediately after World War II but were so untrustworthy that they were killed or given to zoos. Despite Wright's hypothesis that a native puma population had survived in New Brunswick, he did admit that "it is possible that small travelling animal shows may have turned loose specimens in this region when they have become bankrupt and could no longer afford to feed them" (Wright 1953). Brocke (1979) and East (1979) cited the State pathologist for New York who claimed that 5 to 10 pumas escaped from menageries, zoos, and private individuals annually in that State alone. Many were not reported because the pumas were being held illegally. With the advent of the internet in the 1990s, sales of exotic cats have flourished, and it is easy to find captive pumas for sale.

Several distinct subcultures appear to be involved in keeping pumas in North America and Britain. Some zoos, circuses and pet shops have continued to sell cats illegally to private owners such as drug dealers, who seek to demonstrate their machismo by keeping dangerous pets (Street-Perrott et al 2006). Unscrupulous and incompetent dealers and private breeders sell pumas to inexperienced, ill-equipped, and irresponsible private owners. Some States have lax licensing, holding or facility inspection requirements, and many do not know the number and disposition of captive pumas in their state. As a result, captive pumas are held in barns, bars, backyard menageries, and private residences throughout the eastern United States,

There may be thousands of captive pumas in the eastern United States (Bolgiano 1995, Downing 1994a). The States of Missouri and Arkansas each estimate a minimum of 100 captives (Sasse 2001), while estimates in Florida range from 300 to 500 (Sasse 2001) to 1000 to 2000 (Brocke and Van Dyke 1985, Parker 1998, Bolgiano and Roberts 2005). Parker (1998) estimated there were fewer than 12 pumas in captivity and registered in New Brunswick and Nova Scotia. Scott (1998) cites Alan Shoemaker of the Riverbanks Zoological Park in Columbia, South Carolina, as turning down "several hundred cougar cubs" over a 25-year period. McGinnis (1994) reported that there were at least 31 pumas in captivity in Pennsylvania, mostly in private ownership, and at least four people in and immediately outside the State bred and sold pumas. McGinnis (1994) reported Pennsylvania game protectors knew of at least four or five pumas that escaped from captivity, and she heard about escapes or deliberate releases of an additional 12 pumas. In 1997, there were about 200 licensed private cougar owners in Pennsylvania, an increase of at least 640 percent in 18 years (J. Seidensticker pers. comm. in Scott 1998). In Preble County, Ohio wildlife officials know of at least three residents who have four or more captive pumas. Many more captive pumas are believed to exist throughout Ohio (Craig Springer, USFWS unpublished article). According to a recently completed census, there are only 137 pumas in about 60 accredited North American zoos (Schireman 2000), but this is "dwarfed by the number in private hands" (D. Wildt, pers. comm. in Scott 1998).

Released or escaped captive pumas are not unusual (Animal Protection Institute 2008), and animals are frequently confiscated (Captive Wild Animal Protection Coalition 2008). For example, from 1966 to 1967, two pumas escaped from the farm of a former circus performer near Pierpoint, Ohio (possible of origin of 1967 Edinboro, Pennsylvania puma) (Appendix B, McGinnis 1994). Parker (1998) summarized records of nine pumas that had escaped or had been released and were recovered or shot in Massachusetts, Connecticut, Rhode Island, Virginia, and North and South Carolina since 1980. McGinnis (1994) reported two possible instances of deliberate release of captive animals to reintroduce a population. A Connecticut resident allegedly confessed to illegally importing pumas from Colorado to establish a breeding population in the western portion of the State for hunting (Sampson 2004, Tougias 2006). Media mogul Ted Turner released two western pumas on his property near Capps, Florida, in 1988 (Fergus 1996, Butz 2005). The male was killed 6 months later near Tallahassee with an armadillo in its stomach. The female was never found. Turner was fined $1,500. In one survey, 12 Wisconsin wildlife field personnel were aware of captive cougars being illegally released in the past 5 to 10 years (Anderson et al. 2006). Wildlife officers estimated at least 100 to 150 captive pumas in 20 Arkansas counties (50 to 100 in Benton County alone!) (Sasse 2001). Escapes or intentional releases are not uncommon; in Arkansas alone there was at least one incident annually from 1997 to 1999, three in 2000, and two in the first 3 months of 2001 (Sasse 2001). Scott (1998) could not determine numbers of captive pumas in eastern Canada. According to B. Valliere (cited in Gerson 1988) captive pumas are "fairly common" in southern Ontario. Scott (1998) surmised that captives are presumably concentrated in the most populous parts or Ontario and Quebec. In 2007 a puma escaped a facility in Center Point, Indiana, and is still at large. In 2006 two pumas escaped a facility in Gulf Breeze, Florida, and had to be located with heat sensing devices from a helicopter. In 2001 a cougar was killed in McGregor, Minnesota, and two African lion cubs were found in the same area the next morning. In 1999 a puma escaped captivity in Oneida, Ohio,

killed a neighbor's dog, and was shot by police. An escaped puma was shot by police in Fort Wayne, Indiana, in 2004. In 1998 a pet cougar was found wandering in Cincinnati, Ohio, after being stolen from its enclosure.

Mark Jenkins, Director of Cooper's Rock Mountain Lion Sanctuary (www.cougarsanctuary.org) in Bruceton Mills, West Virginia, started accepting captive pumas in 1998. Since then he has accepted six pumas from private owners and turned down over 75 (he receives approximately 12 requests per year) (Bolgiano and Roberts 2005). The Elijay Sanctuary (http://www.wildliferehabsanctuary.org) in Georgia (near Chattanooga, Tennessee) houses five "eastern cougars" and functions as a captive breeding and research center "working toward repopulating this species in appropriate wilderness areas throughout the East."

Experience in Great Britain corroborates the hypothesis that released or escaped exotic cats explain many recent puma occurrences (Weidensaul 2002). Great Britain has had no native, large felids since the Ice Age, yet there have been thousands of alleged sightings of pumas and black panthers since 1970 (Street-Perrott et al. 2006). All of these animals are released captive pumas and other felids (Greenwell 1994). Passage of the Dangerous Wild Animals Act in 1976, which required the licensing of exotic species, may have resulted in many owners releasing exotic cats into the wild. Allegedly, hundreds of captive, large, exotic cats were turned down by zoos after passage of this act (Street-Perrott et al. 2006). At least 5 puma occurrences with a high level of confirmation (specimen, photograph, genetic analysis) have been verified in the British countryside, as well as leopards, lynx (*Lynx lynx*), jungle cats (*Felis chaus*), leopard cats (*Prionailurus bengalensis*), snow leopard (*Uncia uncia*), and serval (*Serval serval*) (Street-Perrott et al. 2006). In 1997, the supply of captive lynxes in Ulster/Northern Ireland was reported to be "plentiful" and pumas were even less expensive, fetching around UK£300 to 400 (about US $500 to $667) each (Street-Perrott et al. 2006). The number of sightings of pumas, black panthers, and other large felids has increased substantially since 2000 in Great Britain (Smith et al. 2006), suggesting a "national psychosis" (Buller 2004), small breeding population of feral exotic cats, or illegal release on a significant scale (Street-Perrott et al. 2006). Some estimate more than 100 exotic large cats are currently loose in rural areas of Great Britain, but most scientific observers believe the number to be much smaller (Buller 2004).

There were many reports of pumas in western Australia in the 1970s, supposedly released by U.S. military personnel or from a circus (Long 1988). These theories received much attention in 1979, including numerous media mentions, and a debate on the issue in parliament. That year, the Agricultural Protection Board of Western Australia declared that a 2-year investigation had failed to find any evidence to suggest that pumas had ever been introduced into southwest Australia. Nonetheless, in 1981 a $20,000 reward was offered for the capture of a puma in Western Australia, dead or alive. The reward was never claimed.

Released or escaped captives can become successfully established in the wild. Non-dependent captive bred pumas translocated to northern Florida began making kills of large prey within a few days of release (Belden and McCown 1996). A subpopulation of Florida panthers has South American DNA and was established from released animals into Everglades National Park from a roadside menagerie in the area in the 1960s (O'Brian et al. 1990, Parker 1998). These animals are interbreeding with native pumas and are protected under the Endangered Species Act under a Similarity of Appearance designation (Alvarez 1993). Roy McBride, a puma tracker and houndsman, has documented feral declawed pumas surviving in Florida (Bolgiano 2006). Pumas raised or held in captivity readily adapted to wild conditions and had survival rates similar to wild pumas (Belden and McCown 1996). Exotic cats released in Great Britain may be surviving and even reproducing (Buller 2004).

If released or escaped captives initially avoid recapture or death, it is likely that they become wandering transients (Brocke and Van Dyke 1985). Seidensticker et al. (1973) postulated that transient pumas fail to recolonize new areas unless there is an adjacent resident population of pumas. Although transient pumas may leave scrapes, kills, and tracks, they are extremely difficult to detect because they cover such a broad range (e.g., as much as 600 mi.^{2} in Florida) (R.C. Belden, USFWS, in litt. 2010). Belden and McCown (1996) monitored radio-tagged captive bred, newly wild caught, and wild caught/captive-held pumas released in northern Florida. The captive bred pumas were most likely to be seen by people, preyed on livestock significantly more, experienced significantly lower mortality, established home ranges more quickly, and appeared to be more social than the wild caught pumas. In southern California, nine radio-tagged dispersing juvenile pumas all came within 100 mi. of urban areas and high-use recreation areas for several hours to several weeks at a time, though only five sightings, involving three animals, were reported (Beier 1995). Thus, it may be possible for captive pumas to transition into a wild existence, establish home ranges, and persist with minimal detection by humans.

We queried the 21 States where the eastern cougar is federally listed concerning laws and regulations pertaining to keeping captive pumas and the number of pumas that are known to be in captivity (see summary of laws and regulations in State accounts, pages 12 to 28). Fourteen of 21 States responded to the survey and provided the following estimates of pumas in captivity: Connecticut none – prohibited; Delaware – none known, Washington D.C. – none known; Indiana – 6 permits; Maine – 11 permits; Maryland – in zoos only; Massachusetts - 6 in zoos; Michigan – 1 in permit in private possession, otherwise zoos only; New Hampshire - 4 in zoos; New York – 23 permitted; North Carolina – <20, – 7 in zoos; South Carolina – 25 to 50 (although some estimate >100); Rhode Island – none; Vermont – 2 permits; Virginia – 3 permits; and West Virginia – <15. There are 110 to 135 pumas legally permitted in captivity in these 15 States. Of the States not responding**:**

- Kentucky has a complete ban as of 2005 (but some animals may be grandfathered);
- Tennessee – allows possession with permits
- Illinois – allows possession with permits only for zoos
- New Jersey – no possession permits are issued for dangerous animals (including pumas)
- Ohio – allows possession, no regulation of exotic felines
- Pennsylvania – allows possession with permits

Currently 20 States, including Connecticut, Illinois, Kentucky, Maryland, Massachusetts, Michigan, New Hampshire, and Vermont, prohibit the private possession of pumas and other big cats in captivity (Bolgiano and Roberts 2005). Sixteen States, including Delaware, Indiana, Maine, New Jersey, New York, Pennsylvania, Rhode Island, and Virginia, have a partial ban on possession of big cats or require permits for their possession. Fifteen States, including North Carolina, Ohio, South Carolina, and West Virginia, do not address the issue of private ownership of big cats. New Federal laws (2007, Federal Register 72(158):45938-45947) make it illegal to import, export, transport, sell, receive, acquire, or purchase, in interstate or foreign commerce pumas and other large cats (with certain exceptions). These new laws should limit the number of pumas in captivity.

Can captive pumas establish breeding populations? Feral pumas released in 1946 survived in southern Florida. Their persistence was likely enhanced by interbreeding with the small, but extant population of the native Florida panther (Maehr 1997). It is not unusual for puma reports to persist in an area for several months (but not years). There are often multiple reports from the public of pumas in a geographic location over a period of months (but not years). Repeated reports could be actual observations of escaped captive puma(s) or public hysteria-social collective behavior (Turner and Killian 1993). Captive pumas may be able to capture small prey for a period of time after release

(much the same as a feral house cat), but declawed, defanged animals would have little chance of long-term survival.

Although there are many sighting reports of pumas with kittens in eastern North America, few have been verified with substantial evidence. An emaciated puma kitten shot in New York in 1993 and a kitten killed on a highway in Kentucky in 1997 both had South American parentage (Appendix B). Breeding may have occurred in Newfoundland from the time of the illegal release of two females and a male in 1960 to an unconfirmed report of an animal killed on a highway in 1986 (Parker 1998), but this is unlikely.

Pumas found in eastern North America and having South American genes (Culver et al. 2000) are of captive origin (or progeny of captive animals). South American ancestry is evident in the Florida panther populations because released animals of South American origin interbred with native animals (Maehr 1997). Genetic tests may soon become available to determine the population of origin of pumas with North American genetic ancestry. There may be other techniques to distinguish captive verses wild pumas. Aside from obvious physical evidence (declawed or defanged, collar wear marks, tattoos, microchips, stomach contents, evidence of surgical procedures), other technologies may be available. For example, carbon isotopes in tissue offer a diagnostic signal of a captive history by detecting the high carbon isotope signature of pet foods (Kays and Reranec 2008). Missouri is contemplating legislation to require a blood sample from every captive cougar to be able to aid in genetic fingerprinting of captive pumas that may escape into the wild.

Since the early 1990s, there are 24 puma genetic samples collected within the historic range of the eastern puma that have been tested using a variety of techniques (Appendix B). Of these, about one third are of Central or South American origin, one third North American origin (two that are believed truly wild from Illinois and Wisconsin), and one third that were identified as puma but of unknown origin.

We conclude that the evidence supports the hypothesis that pumas recently found in eastern North America are released or escaped captive animals, with the exception of some animals in Illinois, Wisconsin, and other Midwestern States that are dispersing from populations in the West. We also acknowledge that a few pumas may be dispersing into the Midwest and Southeast from populations in eastern Texas and Florida (see discussion below). Genetic and isotope techniques are improving, which will help distinguish whether pumas of North American ancestry are of wild or captive origin.

3) Cougars in eastern North America are dispersers from breeding populations in Florida and the western United States and Canada.

The closest known breeding puma populations in proximity to eastern North America occur in Florida (Maehr 1997), Manitoba (Nero and Wrigley 1977, Scott 1998, Watkins 2005, Hutlet 2005), North and South Dakota (Johnson 2000a,b, Kintigh 2005), east Texas (Russ 1995, Harveson et al. 2003), and possibly Nebraska and Oklahoma (Cougar Network). The Florida panther population increased from 30 to 50 individuals in the 1980s to 70 to 100 individuals currently (Lotz et al. 2005). The population currently occupies most of the suitable habitat and may be close to reaching carrying capacity. Although occasional vagrants from Florida infrequently occur in Georgia and Louisiana (Golley 1962, Lowery 1974), until recently there was little evidence that the Florida panther population is expanding northward (Maehr et al. 2003). Since 1998, four radio-tagged male panthers and several unmarked animals have dispersed north across the Cahoosalatchee River, previously thought to be a barrier for northward expansion of the population (Lotz et al. 2005). Natural colonization of central Florida has been frustrated by lack of females, fragmented habitat, and the potential for increased human interactions (Belden and McBride 2005). DNA testing documented that an adult male puma

killed in Georgia in 2008 originated in Florida. Given substantial barriers to dispersal, it is highly unlikely that Florida panthers are dispersing with enough frequency out of Florida to establish populations in the Southeast (USFWS 2008); however, prey and habitat are available in Georgia to support a population (Belden and McCown 1996).

The situation in the West and Midwest is different. In all western States and Provinces, bounties were removed and big game status was granted to pumas over a 15-year period beginning in 1958 in British Columbia and concluding in Wyoming in 1973 (Christensen and Fischer 1976, Dixon 1982). Texas is the only State that has a year-round, unlimited harvest of pumas. Puma populations are growing in most western States and are believed to be at historically high levels (Pierce and Bleich 2003, Nadeau 2005). Elimination of bounties, discontinuing poisoning and government-sponsored eradication programs, designation as a game species with restrictive hunting regulations, preservation of large tracts of public land, and increasing ungulate populations are the most frequently cited reasons (Nowak 1976, Logan and Sweanor 2000, Nadeau 2005). Since 1970, breeding populations of pumas have expanded their ranges into eastern Montana (Desimone et al. 2005), eastern Wyoming (Moody et al. 2005), eastern Colorado, eastern New Mexico, eastern Texas, and western North and South Dakota (Fecske et al. 2006).

Transient pumas originating from established populations in the Bighorn Mountains and throughout Wyoming re-established breeding populations in the Black Hills of South Dakota and the Badlands region of North Dakota (Berg et al. 1983, Fecske 2006, Fecske et al. 2006). After South Dakota removed a bounty and instituted State protection as a threatened species in 1978, pumas reestablished a viable population in the State. The Black Hills region of South Dakota contains about 6,700 km.^{2} of high quality habitat (Fecske et al. 2006) and currently supports an increasing population of pumas. The South Dakota population, estimated at 185 to 210 animals (Thompson and Jenks 2007), is likely above carrying capacity, which is estimated to be 152 animals (Fecske et al. 2006). The population continues to increase (Kintigh 2005) and pumas are dispersing out of the State (Fecske 2003). Since the 1990s, pumas have been regularly documented dispersing from the Black Hills to central and eastern portions of South Dakota and North Dakota, southern Manitoba, western Minnesota (South Dakota Game, Fish and Parks 2005, Fecske 2006, Fescke et al. 2006), the panhandle area of Nebraska (Johnson 2000, Bischoff and Morrison 2000, CougarNet), and beyond. At least 8 radio-tagged juvenile males and one juvenile female have dispersed from the Black Hills area since 2002 (LaRue 2007). Radio-tagged pumas from South Dakota have made movements >660 mi. over relatively short periods of time (Thompson and Jenks 2005) and have been documented in all adjacent States except Iowa (Thompson and Jenks 2007). A radio-tagged puma from the Black Hills of South Dakota moved to eastern North Dakota and into Minnesota (Fecske 2006). DNA collected from a puma observed in Wisconsin in January, 2008 and shot in Chicago in April 2008, suggests a South Dakota origin. Pumas were documented with increasing regularity in North Dakota since the early 1990s and established a breeding population in the Badlands region. A hunting season was established in 2005 (Fecske 2006).

Since 1990, transients and dispersing pumas have increased throughout the Midwest, primarily west of the Mississippi River and possibly the Great Lakes Region (Pike 1999, Tischendorf 2003, Hamilton 2006, Cougar Network, Nielsen et al. 2006, Rusz 2001, 2006, Tischendorf and Johnson 2006). Verified occurrences have been increasing since 1990 (Cougar Network, Tischendorf 2003, Nielsen et al. 2005, Tischendorf and Johnson 2006). These records confirm that eastward dispersal from breeding populations is occurring, especially from North and South Dakota (Maehr in Bolgiano and Roberts 2005, Tischendorf and Johnson 2006, LaRue and Nielsen 2008). There is similar evidence of eastward dispersing pumas (*P. c. stanleyana*) from eastern Texas where populations have also been increasing (Russ 1995, Harveson et al. 2003, Leberg et al. 2004). Evidence from transient animals is difficult to obtain because the animals wander and do not leave a critical amount of

verifiable sign (Brock and Van Dyke 1985). Nevertheless, in recent years there have been >130 confirmed puma records (specimens, photographs, genetic samples) documented in the Midwest region, including Wisconsin, Illinois, Nebraska, Kansas, Minnesota, Missouri, and Iowa (Figure 4) (Hamilton 2006, Cougar Network, Tischendorf and Henderson 1994, Tischendorf and Johnson 2006, LaRue and Neilsen 2008).

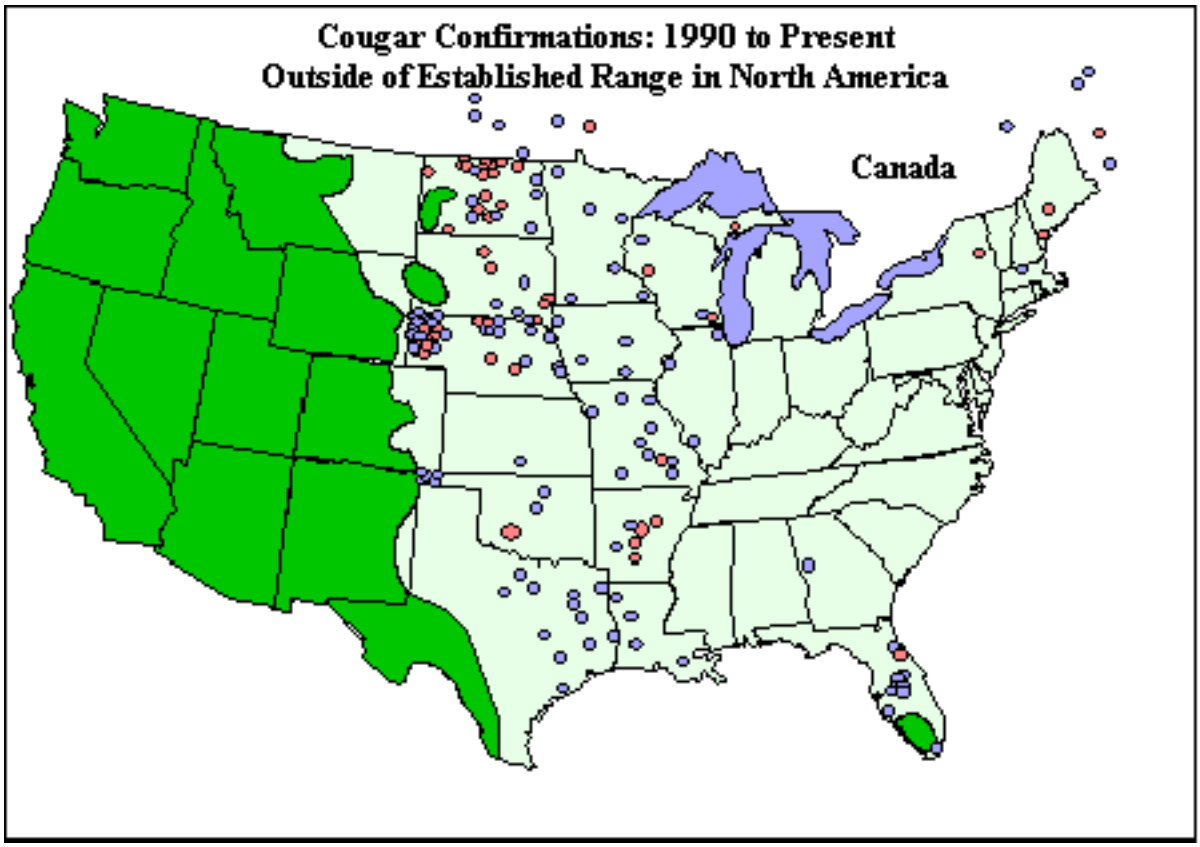
Confirmed records of wild-origin pumas exist in many States and Provinces bordering the historical range of the eastern puma. Pumas have been confirmed in Oklahoma, Arkansas, Kansas, Missouri and Louisiana since the late 1940s, although breeding populations have not been confirmed (Robb 1955, Goertz and Abegg 1966, Lewis 1969, CougarNet, Tischendorf and Henderson 2004, Hamilton 2006). A female kitten recovered in western Nebraska in 2007 may indicate breeding in that State (Cougar Network). Similarly, individuals from breeding populations in Colorado, New Mexico, and Texas are likely the source of the increasing number of pumas confirmed in Oklahoma in recent years (Pike et al. 1997). The Oklahoma Department of Fish and Wildlife believes it likely that breeding occurs in western portions of the State (Cougar Network). By 2002 Iowa DNR estimated as many as 10 pumas had moved into the State (Mahaffy 2005). Pumas of wild origin have been verified in Minnesota and Wisconsin (Wydevin 1993, Tischendorf and Henderson 1994, Cougar Network) and Georgia (Cougar Network).

Most of the Midwest States acknowledge the presence of pumas (Tischendorf and Henderson 1994; Johnson 1998, 2000a,b). The same is true for the eastern portions of Montana, Wyoming, Colorado, and Texas, where, in some cases, sporadic puma occurrences have been documented for years but are clearly increasing (Boddicker 1980; Berg et al. 1983; Johnson 1998, 2000a; Riley 1991; Roop 1971; Russ 1997).

Large populations of white-tailed deer, adequate to support pumas, occur throughout the Midwest and Great Lakes regions and suitable habitat exists in some areas (LaRue and Nielsen 2008). Persistent puma records have been documented in a few areas (Missouri, Iowa, Minnesota, Nebraska), suggesting that individual pumas are successfully surviving in the wild and may have established home ranges. The range of the white-tailed deer is expanding northward (Geist 1995) and with it the range of the puma. Puma sightings are increasing in the Yukon Territory (Weddle 1965), and in 1989 the first puma was taken in Alaska (Wrangell Island) (C. Land *in* Tischendorf and Henderson 1994).

Just how far east pumas can, or will, expand their range is a matter of conjecture. Recent developments in the Midwest have prompted predictions from two prominent puma biologists. Dr. Maurice Hornocker, quoted in the May 2003 issue of *Outside* magazine, proposed that: "Lions will hit the Mississippi in the next decade. The East and Midwest is beautiful cat country, full of deer and cover." Dr. Paul Beier, a biologist with extensive cougar experience, stated in a *New York Times* article (8 November 2002) that "they (pumas) will eventually get to New Jersey, or at least close" (Nielsen et al. 2006).

Figure 4. The map below shows puma occurrences with a high level of validity as documented by The Cougar Network (as of November, 2009). Class 1 confirmations**: t**he body of a dead cougar, or a live captured animal, photographs (including video), DNA evidence (hair, scat, etc.). Class 2 confirmations: track sets verified by a qualified professional, other tangible, physical evidence verified by a qualified professional (i.e., prey carcasses, microscopic hair recognition, thin-layer chromatography of scat). DNA evidence alone should be interpreted with caution. Confirmation from two independent laboratories and/or photographs from remote cameras at predetermined DNA collection sites will enhance confidence in cougar activity. Green=established populations. Blue=Class 1 confirmations. Red=Class 2 confirmations.



Maximum dispersal distances for western pumas (males) are approximately 100 to 300 mi. (Anderson et al. 1992, Ashman et al. 1983, Parfit 1985, Logan and Sweanor 2000). Maximum known dispersal of the Florida panther is just 18 mi. (29 km) for females, versus 144 mi. (232 km) for males (Maehr et al. 2002b). A radio-tagged subadult male dispersed 290 mi. (467 km) from the Bighorn Mountains of Wyoming to Denver, Colorado (Logan and Sweanor 2000). A radio-tagged subadult male puma traveled 640 mi. (1,030 km) from the Black Hills of South Dakota to northern Oklahoma where it was killed by a train (Thompson and Jenks 2005). In April 2008 a puma killed in Chicago was of South Dakota origin and determined to be in Wisconsin 3 months previously. This individual likely dispersed >1,000 mi. (1,609 km). Extreme movements of pumas from breeding populations in the West or Florida to the Atlantic seaboard States and Provinces in North America seem improbable, especially given physical barriers and hazardous encounters with humans (McGinnis 1994).

Pumas have a limited ability to expand their range. Pumas can temporarily occupy habitats influenced by extensive human development, but likely cannot persist in these areas for long periods of time (Cramer and Portier 2000). Maehr et al. (2002b) described dispersal of Florida panthers as "circular, frustrated, and of insufficient length to ameliorate inbreeding." Male dispersal averaged only 42.5 mi (68.4 km). In New Mexico male dispersal averaged 67 mi (108 km).

One of the greatest challenges to puma range expansion is female dispersal (Maehr et al. 2003). Female pumas often stay within the range of their mother (philopatry), and if they do disperse do not move far from their natal area. Female pumas in the western United States dispersed an average of 13.5 km (Sweanor et al. 2000), whereas Florida panthers dispersed an average of only 20.3 km (Maehr et al. 2002b). However, a dispersing female cougar of western origin was recorded traveling >1,300 km (Cougar Network, LaRue and Nielsen 2008).

Male pumas compete directly for access to females. Young males are generally not tolerated in adult male home ranges and are most apt to disperse until they can locate vacant space to claim as their own. Females readily establish home ranges in matriarchal groups or near their natal area. Dispersing (or released/escaped) female pumas typically select the first unoccupied area they encounter having suitable food and cover. Dispersing (or released/escaped) males also search for adequate food and cover (generally not limiting), and for an area occupied by one or more resident females. Thus, range expansion is unlikely unless females disperse (or are moved/released) into new habitats. Home ranges of seven Texas pumas translocated to the Florida-Georgia border varied from 21 to 9,136 km.^{2} after 17 to 144 days after release (Belden and Hagedorn 1993).

As would be expected, most recent Midwest specimens have been males. About 30 percent of the 130 puma carcasses retrieved in the Midwest since 1990 have been juvenile males (LaRue and Nielsen 2008); however, a few female specimens have been documented. Few confirmed records of pumas have been found east of the Mississippi River within the 21-State region where the eastern cougar is listed (Appendix B, Figure 4). To date, there has been little evidence of pumas breeding east of the Dakotas or western Nebraska and Oklahoma. However, if pumas continue to disperse from the Colorado, Wyoming, North and South Dakota, Texas, and possibly Florida populations, then range expansion is likely, especially into the Midwest.

LaRue and Nielson (2008) identified numerous dispersal corridors leading to highly suitable habitat areas in the Midwest that were within feasible dispersal distances for pumas. Dispersing pumas frequently travel along riparian habitats (Beier and Barrett 1993, Dickson and Beier 2002, Dickson et al. 2005), use habitats that provide cover (Beier 1995, Dickson et al. 2005, Kautz et al. 2006), and generally avoid human dominated landscapes (Beier 1995, Murphy et al. 1999, Dickson and Beier 2002). However, pumas will disperse across large expanses of inhospitable habitat (Anderson et al. 2004) and unusual habitats such as golf courses and housing developments (Beier 1995, Dickson and Beier 2002). In such areas, suitable habitat patches are used in a stepping-stone fashion (Sweanor et al. 2000). Contact with roads and developments increases the risk of mortality to dispersing pumas (Logan et al. 1986, Maehr et al. 1991b, Murphy et al. 1999).

Major rivers and associated deer-rich riparian areas such as the Platte, Missouri, and Arkansas Rivers that extend from current cougar range into the heart of the Midwest may provide adequate dispersal corridors (Tischendorf 2003, Nielsen 2006, LaRue 2007). Additionally, the documentation of puma deaths along railroad tracks in Nebraska and Illinois suggests the possibility that railroad rights-of-way and associated brush belts may also be effective pathways for pumas (Clark et al. 2002, Tischendorf 2003).

Potential puma dispersal corridors in the northern States and Canada have not been as well documented. The upper Midwest region (Minnesota, Wisconsin, Michigan) is the most favorable corridor for cougars repopulating the East (CougarNet). This would be the most likely route for pumas dispersing from the Dakotas. Manitoba's puma population may be a potential source for animals observed in Ontario, northern Minnesota, Wisconsin, and Michigan (Tischendorf 2003, Tischendorf and Henderson 1994, Watkins 2005, Hutlet 2005). This area has regions of sparse population, heavy forest cover, and a high prey population of deer, wild turkey, beaver, and moose. Whitetail deer numbers in the region are at historic highs and they occur in areas where they were historically absent prior to the early 1900s. Wolves, another top predator, were never extirpated from the region indicating a historic supply of prey and a habitat that was suitable. There is no large river barrier such as the Mississippi, which is present further south, to inhibit migration. However, the Great Lakes would be expected to influence movements.

Natural recolonization of predominantly male pumas assisted by strategic translocation of females can facilitate range expansion of pumas (Maehr et al. 2003a). Similar recolonization of former habitat has occurred by other large carnivore populations, such as wolves (*Canis lupis*) in Wisconsin and Michigan (Mech et al. 1995, Gehring and Potter 2005).

Given evidence of growing puma populations in the West, increased dispersal, and adequate dispersal corridors and prey in the Midwest, we believe that wild-origin pumas (primarily males) will continue to disperse into the mid-western States and into the historical range of the eastern puma. If wild females are successful at dispersing (or feral females of captive origin are present), the breeding range could expand eastward.

2.3.2 Five-factor analysis: Because we have determined that the population of pumas described as the eastern puma *P. c. couguar* has been extirpated (see section 2.3.1 above), a five-factor analysis is not called for.

2.4 Synthesis

For decades, many individuals and organizations have hypothesized that highly cryptic, broadly dispersed, widely roaming, breeding populations of pumas occur in eastern North Americas (as summarized in Tischendorf 2003). This review of the status of the eastern puma revealed no convincing evidence that a wild, breeding population of pumas survived within the historic range of the eastern puma. Widespread persecution (poisoning, trapping, hunting, and bounties), decline of forested habitat, and near extirpation of deer populations during the 1800s led to the extirpation of most puma populations by 1900. Although individual pumas were taken as late as 1932 in New Brunswick and 1938 in Maine, there is no convincing scientific data to support Wright's (1972) hypothesis that a small, cryptic population continued to persist in northern New England and eastern Canada. Thus, we conclude that pumas that occupied eastern North America were extirpated. Although there have been thousands of sightings, most are of mistaken identity. After conducting a similar status review, the Canadian Wildlife Service (Scott 1998) reached the conclusion "that there is no objective evidence (actual cougar specimens or other unequivocal confirmation) for the *continuous* presence of cougars since the last century anywhere in eastern Canada or the eastern United States outside of Florida." The Florida panther recovery plan (USFWS 2008) concludes that no reproducing population of panthers have been found outside of south Florida for at least 30 years despite intensive searches to document them (Belden et al. 1991, McBride et al. 1993, Clark et al. 2002). We conclude that the subspecies *Puma concolor couguar* or eastern cougar=puma, as originally listed in 1978 under the U.S. ESP is extinct.

We acknowledge that a small number of pumas are occasionally encountered in the wild in eastern North America in the historical range of the listed eastern puma. Based on the best available scientific evidence, we believe these are released or escaped captive animals. Breeding, if it occurs, seems to be extremely rare, and there is no evidence of a persisting population established from released captive animals. It is improbable that pumas can disperse regularly out of Florida. Puma range expansion may be occurring in the Midwest where an increasing number of individual pumas (>130 occurrences since 1990) are dispersing from populations in North and South Dakota, eastern Texas, and possibly other areas in the West. Some of the Midwestern pumas are undoubtedly feral released and escaped pets, but the expansion of native puma populations in the West is scientifically well-documented. In the Midwest within the historical range of the eastern cougar, several wild-origin pumas have been confirmed and are likely dispersers from populations to the west. Outside, but in proximity to, the historical range of the eastern puma, wild-origin pumas have been documented in Nebraska, Kansas, Oklahoma, Iowa, Missouri, Minnesota, Wisconsin, Georgia, and Louisiana. At this time, breeding within this area has been documented only in North and South Dakota, Nebraska, and possibly Oklahoma. Habitat models suggest expansion of populations into the Midwest is possible. Dispersal into the Midwest will likely increase in frequency as long as puma populations continue to grow in the West, North and South Dakota and Texas. Some biologists believe that if trends continue and pumas are adequately protected, they may expand their range to occupy some of their former habitat in eastern North America. The most likely dispersal corridor is through the Great Lakes States and southern Ontario.

Based on recent genetic analysis (Culver et al. 2000), the federally endangered eastern cougar=puma *Felis=Puma concolor couguar* subspecies may no longer be a valid taxonomic entity (according to Wilson and Reeder 2005 the nomenclature *P. c. couguar* now applies to all North American pumas). However, Culver et al (2000) was not a complete analysis of the subspecies status of North American pumas, as it offered no evaluation of the morphological, ecological, and behavioral considerations used when making subspecies determinations. Young and Goldman's (1946) and Hall's (1981) conclusions concerning the taxonomy of the eastern puma may be wrong, but Culver et al (2000) do not provide the necessary analysis and evaluation to demonstrate such. Nonetheless, Culver et al. (2000) provides valuable genetic insights into the historical context, origin, and genetic relationship between the North American puma populations.

3.0 RESULTS

3.1 Recommended Classification: Delist based upon extinction

3.2 New Recovery Priority Number: Retain as 18, recognizing that no recovery actions are being implemented for this subspecies, because it is presumed extinct.

Brief Rationale – The eastern puma currently has a recovery priority number of 18, the lowest priority for recovery planning and implementation. In view of the findings of this 5-year review, a recovery priority number may not be applicable for this subspecies; however, given the policy direction to document the recovery priority of all listed species, the ranking of 18 should be retained until the eastern puma is delisted.

3.3 Listing and Reclassification Priority Number: 6

Brief Rationale – A delisting priority number of 6 reflects the low management burden incurred by the current listed status of the eastern puma, as well as the absence of a petition to delist.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

The only action recommended pursuant to this review is to prepare a proposed rule to delist the eastern cougar.

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U.S. FISH AND WILDLIFE SERVICE 5-YEAR REVIEW of eastern puma
Puma concolor couguar

Current Classification: endangered

Recommendation resulting from the 5-Year Review:
____ Downlist to Threatened
____ Uplist to Endangered
__X__ Delist
____ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: N/A

Review Conducted By: Mark McCollough, Ph.D., Maine Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve Lori H. Nordstrom Date 3/2/2010

The lead Field Office must ensure that other offices within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. The lead field office should document this coordination in the agency record.

REGIONAL OFFICE APPROVAL:

The Regional Director or the Assistant Regional Director, if authority has been delegated to the Assistant Regional Director, must sign all 5-year reviews.

Lead Regional Director, Fish and Wildlife Service

Approve Kyle J. Haste Date 1-28-11
Acting Regional Director

The Lead Region must ensure that other regions within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. Written concurrence from other regions is required.

ES Assistant
Cooperating Regional Director, Fish and Wildlife Service, Midwest Region

__X__ *Concur* ____ *Do Not Concur*

Signature Lynn M. Lewis Date 6/14/10

Cooperating Regional Director, Fish and Wildlife Service

__✓__ *Concur* ____ *Do Not Concur*

Signature Jacqueline B. Pons Date JUL 08 2010

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Craig Stihler, Wildlife Resources Section, West Virginia Division of Natural Resources
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Appendix A. Survey sent to state fish and wildlife agencies in March, 2007.

2007 INFORMATION REQUEST ON THE STATUS OF THE EASTERN COUGAR

Background

On January 29, 2007, the USFWS published a notice in the FR announcing its intent to conduct a 5-year review of the endangered eastern cougar (*Puma concolor couguar*) ESA. This section requires that a review of each listed species be conducted at least once every 5 years. A 5-year review is a status assessment based on scientific and commercial data that have become available since the species' original listing or previous 5-year review. The eastern cougar was one of the first species listed under the ESA in 1973, and there has been no formal review of the status since a recovery plan was completed in 1982.

Our review of the eastern cougar will assess: (a) whether new information suggests that the species' population is extirpated, increasing, declining, or stable; (b) whether existing threats are increasing, the same, or abated; (c) if there are any new threats; and (d) if new information or analysis calls into question any of the conclusions in the original listing determination as to the species' status.

The information obtained in this review will be evaluated to determine if a change in the listing status of the eastern cougar may be warranted, based on the listing five factors described in the ESA.

We request your participation in providing information to the USFWS on the status of the eastern cougar. Please submit responses to Mark McCollough, Ph.D., Endangered Species Biologist, Maine Field Office, U.S. Fish and Wildlife Service, 17 Godfrey Drive, Suite #2, Orono, ME 04473 phone 207 866-3344 x115; email: mark_mccollough@fws.gov. Please contact Mark if you need further clarification of the questions below.

Information Request

1) Please provide the USFWS with published reports, articles, or other information that summarize historic records of the eastern cougar in your State, Province, or on tribal lands. Reprints of articles from State wildlife magazines, books, fact sheets, historic records, NatureServe records, conservation or recovery plans, or other pertinent information from your state will be helpful. Please make sure sources/citations are appended so we can cite these literature sources.

2) Please provide information on the State listing status for the eastern cougar in your State or Province.

3) The USFWS would like to summarize confirmed records of cougars in the wild in the States where the eastern cougar is listed and eastern Provinces. Please employ the methodology used by the Cougar Network (http://www.cougarnet.org), which is enumerated below, to classify records by indicating the nature of evidence collected and level of confirmation associated with each record submitted. Please provide information on the origin of the animal, if known (i.e. genetic analysis showed animal was of South American origin and animal was declawed, thus we conclude the animal was of captive origin, or "origin unknown" the animal was acting in a wild, free-ranging manner).

Class 1 Confirmation:

1. The body of a dead cougar, or a live captured animal
2. Photographs (including video)
3. DNA evidence (hair, scat, etc.)

Class 2 Confirmation:

1. Tracks verified by a qualified professional
2. Other tangible, physical evidence verified by a qualified professional (i.e. prey carcasses, microscopic hair recognition, thin-layer chromatography of scat.

4. Many States maintain a database of unconfirmed cougar sightings. Please indicate whether your State maintains a central cougar sighting database. Provide summaries of cougar sighting information, your interpretations of unconfirmed cougar reports from your State, or other information that will help the USFWS to determine the status of the eastern cougar. Are there areas of your State that have persistent cougar reports? Is there evidence to believe that cougars have bred in your State? Do you believe there is (or was) evidence of a breeding population of wild, native eastern cougars breeding in your State since 1940? In your best professional judgment, do you believe that cougars observed in the wild in your State are of misidentification of other domestic animals and wildlife, captive cougars that have escaped or been released, dispersing animals from the West, Florida, or Canada, a small, persistent native breeding population, or a combination of these sources?

5. The USFWS would like to compile information on the status of cougars in captivity for the States where the eastern cougar is federally listed and eastern Canadian Provinces. Please provide information on State and Provincial rules and regulations pertaining to keeping cougars in captivity in your State. Do you restrict private possession of cougars? Do you implement standards for housing captive cougars? Do you require marking captive cougars (PIT tags, tattoo). Please provide the exact number or your best estimate of the cougars, pumas, etc. in captivity in your State or Province. Please provide information about known instances of escaped captive cougars. Does your State or Province have means of accounting for tracking the status of captive cougars?

6. Please provide on information on State, Provincial, or tribal rules and regulations pertaining to protecting wild cougars in your jurisdiction (e.g. state and Provincial endangered species statutes, closed season regulations, or there is no protection, etc.)

7. White-tailed deer are a preferred prey of cougars. Please provide information on deer densities in your jurisdiction (by county, wildlife management districts, etc.).

8. Cougars have large home ranges, and even a small breeding population would require a large, relatively unfragmented block of forested habitat with an adequate prey base. Please provide information on landscape analyses that document large (>200 $mi.^2$) blocks of relatively unfragmented, forested habitat that could provide cougar habitat in your jurisdiction.

We are aware of one non-peer reviewed models of eastern cougar habitat suitability. Your comments on these habitat suitability analyses would be welcomed.

Taverna, K., J. E. Halbert, and D. M. Hines. 1999. Eastern cougar (*Puma concolor couguar*) a habitat suitability analysis for the central Appalachians. Charlottesville, Virginia: Appalachian Restoration Campaign. 23 pp. which can be found at www.heartwood.org/arc.

9. Please provide a name and contact information for the person compiling this information.

Thank you for your cooperation. The USFWS will provide copies of our 5-year status review to all States, Tribes, organizations, and individuals who responded to this questionnaire.

Appendix B. Published records of pumas since 1900 in the historical range of the eastern cougar. Reports of tracks confirmed by biologists, specimens, photographs, and genetic samples are included. The thousands of sightings without supportive evidence are not included. Most of the following reports came from Young and Goldman (1946); Jim Cardoza, Massachusetts Division of Wildlife (unpublished report); Allen Anderson, Colorado Division of Wildlife (1983); Helen McGinnis, The Eastern Cougar Foundation (website), Robert Downing, USFWS (1984); and The Cougar Network (website). The veracity of many of these sighting has not been confirmed.

Location and date	Comments	Observer	Citation
New Brunswick, fall 1904	One cub trapped in Millville	J. Gullison	Wright 1972:36 to 37 *in* Cardoza
New Brunswick, 1908	A puma shot on Porter Brook, a tributary of the Miramichi River.		Wright (1953)
New Brunswick, 1910	One adult male trapped	B. Good	Wright 1972:37 to 38 *in* Cardoza
New Brunswick, 1914	Forest ranger reports two trapped in the Miramichi area	P. Vanderbeck	Wright 1972:65 *in* Cardoza
New Brunswick, 22 November 1923	One shot, 4 foot long, Sevogle River area	C. Fraser	Wright 1972:65 to 66 *in* Cardoza
New Brunswick, March 1932	One shot near Mundleville; 7 feet; skinned; skin photographed	R. Grant H. Robertson	Wright (1953); Wright (1972:69) *in* Cardoza; cited in Cumberland and Demsey (1994); Tischendorf 2003
New Brunswick, 1963	Specimen from Fundy Hills		Wright 1972 *in* Nowak 1976, Anderson 1983
New Brunswick, June 1990	Poor quality video taken of alleged puma near Waasis. Reviewed by New Brunswick DNR and Energy biologists and Jay Tishendorf. They concluded the animal to be a young puma, although not all biologists shared this conclusion.	Donna and Roger Noble	Tischendorf (1990); Cumberland and Demsey (1994)
New Brunswick, November 1992	Provincial biologist Rod Cumberland documented tracks and collected a scat near Deersdale-McKiel Lake. Scat was analyzed by the Canadian Museum of Nature in Ottawa and found to contain snowshoe hare bones and foot and leg hairs of cougar.	Tom O'Blenis, Rod Cumberland	Cumberland and Demsey (1994); Bolgiano (1995c); Scott (1998); Bolgiano et al. 2000; Tischendorf (2003); Bolgiano and Roberts (2005); Bertrand et al. 2006; CougarNet
New Brunswick, 22 June/July 2003	Envirotel collected hair from a hair snare device in Fundy National Park. Genetic analysis documented South or Central American origin (released captive).	Marc Gauthier, University of Sherbrooke	Cougar Net; pers. comm.. from Marc Gauthier, Sherbrook University; Wissink (2005); Bertrand et al. 2006, Lang (2007)

New Brunswick, 22 October 2003	Envirotel collected hair from a hair snare device in Fundy National Park. (~ 10 km from 22 July, 2003 location). Genetic analysis documented North American origin.	Marc Gauthier, University of Sherbrooke	Cougar Net; pers. comm.. from Marc Gauthier, Sherbrooke University; Wissink (2005); Bertrand et al. 2006; CougarNet
Nova Scotia, 1985	Puma struck and killed by automobile.		Bruce Johnson, Canadian Wildlife Service *in* Hansen (1992) p. 100; Scott 1998 p. 14
Ontario, 1908	Mounted specimen of a female collected in Ontario in 1908 is in the New York State Museum in Albany.	Unknown	Stoner 1950:10 to 11, Busch 1996:99 *in* Cardoza; Parker (1998)
Ontario, 1999	Provincial biologist Lil Anderson tracked a puma and collected a scat, which was sent to the Alberta Natural Resources Service forensics lab in Edmonton. Thin layer chromatography found to be puma.	Lil Anderson	Bolgiano et al. 2000, Bolgiano and Roberts (2005) CougarNet
Ontario, March 2004	Scat found in Wainfleet Bog near Port Colborne. Genetic analysis of scat by Dr. Bradley White, Trent University, Peterborough tested positive for puma.	Stuart Kenn, Anne Yagi	Helen McGinnis pers. comm. 6/1/2007 email from Stuart Kenn
Quebec, 21 November 1909	Puma shot on Mt. Royal, Montreal, and mounted by House of Learo. Specimen still in existence.	Unknown	Wright 1972:91 *in* Cardoza, H. McGinnis pers. Comm. 2010 email.
Quebec, 1919 to 1920	8 reported shot and trapped in unknown areas of Quebec	Report of the Bureau of Statistics	Wright 1972:163 *in* Cardoza
Quebec, 1959	Tracks found in outskirts of Montreal. Redpath Museum, McGill University made plaster casts confirmed as cougar.	Unknown	Wright 1960 *in* Tinsley (1987)
Quebec, 27 May 1992	One shot in front yard of a house in St. Lambert-de-Desmoloizes near Abitibi Lake; 90 pound young adult male; Investigation by Quebec Wildlife and Canadian Museum of Nature. No external signs of captivity. Genetic analysis by M. Culver showed animal was of South American (Chilean) ancestry.	Unknown	Outdoor Nova Scotia Website Sept. 30, 1998 *in* Cardoza; Parker (1998); Scott (1998); Tischendorf (2003), Lang (2007)
Quebec, April 1996	Puma killed by a truck in Estrie near East-Hereford near New Hampshire state line. DNA analysis by Dr. Natalie Tessier, Labarotoire		Marc Gauthier, Sherbrooke Univ., pers. comm.; Helen McGinnis pers. comm. 6/5/2007 email

	d'ecologie Moleculaire et Evolution showed animal was of North American subspecies. Poor chain of custody. Pelt in existence, but may have come from elsewhere.		
Quebec, 10 September 2001	Hair sample collected from Envirotel's hair snare on Montagne Blanche, near Pellegrin. Genetic analysis by Dr. Natalie Tessier, Labarotoire d'ecologie Molectulaire et Evolution showed puma was a North American subspecies.		Marc Gauthier, Sherbrooke Univ., pers. comm., Lang (2007)
Quebec, 30 January and 6 March 2002	Hair sample collected from Envirotel's hair snare in Estrie, Ruiter Valley Ecological Reserve, Eastern Townships. Genetic analysis by Dr. Natalie Tessier, Labarotoire d'ecologie Moleculaire et Evolution showed March puma sample was a South or Central American subspecies.		Marc Gauthier, Sherbrooke Univ., pers. comm., Lang (2007), Gauthier (2010)
Quebec, 27 September 2002	Puma hit by car on Rt. 175 near the Laurentide Wilderness Reserve. DNA collected from damaged car by Bishops University and University of Montreal was cougar, but not enough to determine subspecies.		Marc Gauthier, Sherbrooke Univ., pers. comm.; Bolgiano and Roberts (2005); February 1, 2005 press release Quebec Ministry of Natural Resources, Fauna and Parks
Quebec, 31 October 2002	Hair sample collected from Envirotel's hair snare deployed by Quebec Ministry of Natural Resources, Fauna and Parks in Valins Mountains (zec Martins-Valins in the Saguenay-Lac-St. Jean region). Genetic analysis by Dr. Francois-Joseph Lapointe and Natalie Tessier, Labarotoire d'ecologie Moleculaire et Evolution, University of Montreal showed puma was a South or Central American subspecies.	Quebec Ministry of Natural Resources, Fauna and Parks	Marc Gauthier, Sherbrooke Univ., pers. comm.; February 1, 2005 press release Quebec Ministry of Natural Resources, Fauna and Parks, Lang (2007)
Quebec, 26 May 2009	Hair sample collected from Envirotel's hair snare in Sutton Mountain region of southern Quebec. Genetic analysis ongoing at University of Montreal. Subspecies determination has not been completed.		Bolgiano and Roberts (2005); CougaNet

Quebec, 25 August 2004	Hair sample collected from Envirotel's hair snare in Forillon National Park. Genetic analysis by Dr. Natalie Tessier, Labarotoire d'ecologie Moleculaire et Evolution shows that puma was a North American subspecies.		Bolgiano and Roberts (2005); CougaNet, Lang (2007)
Delaware, 1995 to 2002	Robert Hutchins, DE Division of Fish and Wildlife Law Enforcement cites 24 "confirmed" sightings in 2002, 20 in 2001, 13 in 2000, 12 in 1999, and back to 1995. One or two captive animals likely survived in the wild for a short period of time. No evidence of reproduction or persistence. No confirmed reports since about 2003.	Delaware Division of Fish and Wildlife	Bolgiano and Roberts (2005); Ken Reynolds, Wildlife Director, Delaware Division of Wildlife, pers. comm.
Illinois, July 15 (22?), 2000	One male hit by a train in western Randolph Co. near the Mississippi River and Shawnee National Forest; submitted to Southern Illinois University Cooperative Wildlife Unit (Alan Woolf) for examination; 4 to 6 year old adult, no evidence of captivity, deer remains in stomach, animal in good condition, genetic analysis demonstrate animal was of North American genotype.	Unknown	Illinois Dept. of Natural Resources News release July 17, 2000; Bolgiano et al. 2000; Heist et al. (2001), Bolgiano and Roberts (2005); Nielsen 2006; Cougar Network; Butz (2005)
Illinois, December, 2004	One shot and killed by an arrow near New Boston/Rock Island. Investigated by conservation officers. Disposition of animal and genetic testing unknown. Not declawed.		http://www.dnr.state.il.us/Law3/report/04/Dec04.htm; Cougar Network
Illinois, 14 April 2008	One 2 to 3 year-old male shot and killed in the Roscoe Village neighborhood on Chicago's North Side. Genetics analysis by USFS Rocky Mountain Research lab in Missoula, MT showed that this was the same puma observed and tracked in Wisconsin in January, 2008. Related to Black Hills, South Dakota population.		www.wbbm780.com/cougar-shot-in-Roscoe-Village/2001618; www.chicagotribune.com/news/local/chi-cougar-dna-wisconsin-web-may01,0,10686.st; Cougar Network
Indiana, 10 October 2009	Puma photographed by hunter near Brazil, Indiana with cell phone camera. An unsprayed female named Donner escaped from the Exotic	Paul Harbor	Brazil Times October 13, 2009

	Feline Rescue Center in central Indiana on January 5, 2007 approximately 7 mi. from this location. No further sightings have been confirmed.		
Indiana, 1 May 2010	After finding tracks and deer carcass, puma photographed in Highland Township near Bloomfield, Greene County by Indiand DNR with trail camera. Confirmed by Indiana DNR.	Scott Johnson	Helen McGinnis pers. Comm.., Cougar Net, Indiana DNR
Kentucky, ca. 1960	One reported killed near Central City; probable escape from a roadside zoo.	Unknown	Jenkins (1971) *in* Cardoza; Downing (1981, 1984); Nowak (1976)
Kentucky, June 1997	One female kitten killed by a car on Rt. 850 near Hippo in western Floyd Co. Was allegedly with a larger cat and another kitten. Genetic analysis by Melanie Culver, National Institutes of Health/National Cancer Institute and Holly Ernst, Univ. of California. Genetics showed mother was South American and father North American. Likely of captive origin.		Helen McGinnis; Bogiano and Roberts (2005); Tischendorf (2003); Butz (2005)
Maine, 1907	One puma shot and wounded near Sourdnahunk Lake. Animal escaped.	Charles H. Daisy	Seton (1929), Wright (1953)
Maine, 1915	Puma killed near south Lagrange. Confirmation unknown. Specimen unknown.	Unknown	Wright (1971); Downing (1981b)
Maine, January 1938	Trapped east of Little St. John Lake by Quebec trapper Rosarie Morin of St. Zacharie. Measured 7 ft. 1 inch and estimated to weigh 100 pounds. Purchased by Bruce Wright and donated to the New Brunswick Museum.	Rosarie Morin	Wright (1961), Wright (1972); Downing (1981b); Parker (1998); Tishcendorf (2003)
Maine, 1949	Skull of one killed on this date submitted to the Safari Club International	Unknown	Downing (1984)
Maine, 11 March 1995	Puma sighted in Cape Elizabeth. Hair collected by conservation officers and confirmed at the USFWS National Forensics Laboratory as puma (by hair morphology).	Rosemary Townsend	Maine Department of Inland Fisheries and Wildlife; CougarNet
Maine, 1994	Two Maine game wardens investigate tracks of three cats near the St. John River. Possibly lynx.?		Bolgiano et al. 2000 *in* Bolgiano and Roberts (2005)

Maine, 7 September 2000	Female and cub observed by Roddy Glover in Monmouth. Investigated by state fish and wildlife biologist and warden. Casts were taken of several of the 100s of tracks present in the mud		Maine Department of Inland Fisheries and Wildlife; CougarNet
Maryland, 1920s	One kitten reported killed, photographs exist – David Lee files. Specimen at the National Museum	Unknown	Downing (1981b); Downing (1984); Linzey (1998)
Maryland, early 1990s	A home video was obtained in the western mountains and verified by Leslie Johnston, District Wildlife Manager of the Maryland Dept. of Natural Resources, who made it available to Maryland public television where it was shown many times.	Unknown	Bolgiano et al. 2000
Massachusetts, 1927	One allegedly killed in Shutesbury (sometimes New Salem) and photographed. No features in the photo or accompanying written data to verify the provenance. Not referred in any mammal faunas of the period. Unconfirmed and suspect.	Unknown	Downing (1981, 1984); same as reported by Crane (1931) in Nowak (1976:139)? J. Cardoza, Massachusetts Division of Fish and Wildlife, letter to USFWS March 26, 2007
Massachusetts, 1981	Plaster cast of track taken in Goshen (Hampshire County) by loggers. Identified as puma by Robert "Chris" Belden from Florida panther project. Cast is in the Northeastern University Vertebrate Collections, Boston.	Virginia Fifield, Massachusetts Eastern Cougar Survey Team	J. Cardoza, Massachusetts Division of Fish and Wildlife, letter to USFWS March 26, 2007
Massachusetts, April 1997	Scat collected near Quabbin Reservoir by John McCarter, staff member of the Paul Rezendez Tracking School; genetic analysis by George Amato, Wildlife Conservation Society in New York and Melanie Culver, Virginia Polythechnic Institute and State University. Genetic analysis found the specimen was of North American genotype.	John McCarter	Helen McGinnis, Cardoza and Langlois (2002), Bolgiano et al. 2000, Bolgiano and Roberts (2005); Tougias 2006; CougarNet
Massachusetts, November, 2002	Parts of a puma skeleton collected on west side of Quabbin Reservoir east of Rt. 202 near gates 8 and 9. Skull characteristics indicative of North American origin. No genetic analysis has been	Richard and Susan O'Malley found the skull and bones. Thomas Abruzese later collected	Harvard Museum of Comparative Zoology specimen #63599 and 63600 on loan to the Smithsonian; J. Cardoza, Massachusetts Division of Fish and Wildlife, letter to USFWS March 26, 2007; email correspondence between J.

	done to date. Leg bones may be from a second puma. Animal was shot at close range with a small caliber firearm and the teeth show cage wear. Believed to be a hoax or someone killed a captive puma.	leg bones. The O'Malleys and Abruzese donated specimens to Harvard in 2003.	Cardoza and H. McGinnis in 2006; J. A. Lankalis unpub. Report; Chupasko et al. (2004); Tougias 2006 ; Chupasko 2006
Michigan, 3 January 1907	Puma caught in a trap near the Tahquamenon River, Chippewa County.	Chase Osborne and Ted Labonte	Seton (1953), Zuidema (1999) in Johnson (2002). Vaselenak (2007)
Michigan, 1966	Two DNR conservation officers saw puma crossing road near Cornell in Delta County and made plaster cast of tracks. Cast verified as puma by University of Michigan Zoologists. Location of plaster cast is unknown.	Francis Opolka	Veselenak (2007): Michigan Wildlife Conservancy
Michigan, 11 November 1984	Hunter reported shooting and wounding a puma in Menominee County west of Escanaba. Electrophoresis analysis of bone and tissue fragments conducted by Michigan State University and Colorado Fish and Game showed "a positive identity to mountain lion." Michigan DNR questions validity of electrophoresis techniques.	Dick Aartilla (hunter?)	W. Moritz, Michigan DNR letter to USFWS March 30, 2007; Michigan State University Necropsy Record
Michigan, 1997	Motorist saw puma crossing road and photographed in Alcona County. Michigan DNR questions validity of photograph – may have been a mounted specimen.	Jim Deutsch of Curran, Michigan on the property of Larry Lippert.	Veselenak (2007); Michigan Wildlife Conservancy web site; Butz (2005); Rusz 2006*c*
Michigan, 6 July 1998	Puma observed by DNR wildlife biologist in Alcona County (northern Lower Peninsula) and confirmed by photographs of tracks. (10 mi. from previous record.)	Lawrence Robinson	W. Moritz, Michigan DNR letter to USFWS March 30, 2007; Lawrence Robinson, Michigan DNR July 5, 1998 memo. Rusz 2006*c*, Butz (2005)
Michigan, fall 2001	Scat recovered in Delta County. Genetic analysis confirmed as puma. This is the only sample of 10 alleged puma scat samples reported by Swanson and Rusz (2005) that was accepted by Kurta et al. (2007). Geographic origin of puma not determined. Chain of custody of sample is unknown. Collection details not reported.		Swanson and Rusz (2005); Kurta et al. 2007; Carney 2006

Michigan, 2004	Puma skull found by wood cutters in Chippewa County. University of Michigan evaluation of skull noted lack of tooth wear and that the skull was likely of captive origin. The skull originated from a taxidermy shop owned by Randy Desormeau came from an 11-year old female captive animal of western origin named "Sasha" owned by a man on Neebish Island in the St. Mary River.		Eastern Cougar Network website citing 2001 letters from the Rose Lake Wildlife Disease laboratory, University of Michigan Museum of Zoology that believe the skull came from a captive animal. Carney (2006); Butz (2005)
Michigan, 2 November 2004	Evidence of a possible vehicle collision with a puma in southern Menominee County. Hair collected from vehicle submitted for genetic analysis at Central Michigan University was most likely from a puma.		W. Moritz, Michigan DNR letter to USFWS March 30, 2007; February 3, 2005 Michigan DNR press release
Michigan, 9 June 2008	Confirmed tracks were found in Delta County, Upper Peninsula. Tracks were found and confirmed by a USFS researcher doing Kirtland Warbler (a rare bird) surveys and also confirmed by the Michigan DNR. Track photographed by DNR Wildlife biologist Bill Rollo.	Janet Ekstrum, USFS	http://www.cougarnet.org/uppermidwest.html, http://www.michigan.gov/dnr/0,1607,7-153-10371_10402-194342--,00.html
Missouri, December 1994	A small adult female was treed and shot by two raccoon hunters near Peck Ranch in Carter County. The carcass was never recovered, but a photo was obtained of the animal on a truck tailgate. Each hunter was fined $2,000. In Nov. 1998 a deer hunter fount the skinned pelt of a small adult, female puma near a remote Texas County road. Evidence suggests this was the same animal killed in Carter County.		Missouri Department of Conservation http://mdc.mo.gov/nathis/mammals/mlion/sightings.htm
Missouri, November 1996	A video was taken by a conservation agent of a puma and deer carcass in Reynolds County.		Missouri Department of Conservation http://mdc.mo.gov/nathis/mammals/mlion/sightings.htm
Missouri, January 1997	A video was taken by a property owner in Christian County. Animal's behavior suggest that it had once been held in captivity.		Missouri Department of Conservation http://mdc.mo.gov/nathis/mammals/mlion/sightings.htm
Missouri, January 1999	An adult puma was treed by a rabbit hunter's		Missouri Department of Conservation

	dogs in Texas County. Tracks in the snow (photos taken) and two deer carcasses characteristic of puma kills were found nearby.		http://mdc.mo.gov/nathis/mammals/mlion/sightings.htm
Missouri, December 2000	Video taken by a deer hunter from a tree stand in Lewis County.		Missouri Department of Conservation http://mdc.mo.gov/nathis/mammals/mlion/sightings.htm CougarNet
Missouri, December 2001	Photograph taken by a game camera in Pulaski County. Likely a small, subadult puma.		Missouri Department of Conservation http://mdc.mo.gov/nathis/mammals/mlion/sightings.htm CougarNet
Missouri, October 2002	A 2- to 3-year-old male killed on I-35 in Clay County. 2- to 3-year old. DNA analysis revealed North American origin. No indication of being held in captivity.		Missouri Department of Conservation http://mdc.mo.gov/nathis/mammals/mlion/sightings.htm CougarNet
Missouri, August 2003	An approximately 1-year old male killed on road in Callaway County. DNA analysis revealed North American origin. No other obvious sighs that it was formerly a captive animal.		Missouri Department of Conservation http://mdc.mo.gov/nathis/mammals/mlion/sightings.htm CougarNet
Missouri, November 2006	Tracks and deer carcass characteristic of a puma kill were found in Shannon County.		Missouri Department of Conservation http://mdc.mo.gov/nathis/mammals/mlion/sightings.htm CougarNet
Missouri, December 2006	Photograph of a probably sub-adult taken by a game camera in Livingston County.		Missouri Department of Conservation http://mdc.mo.gov/nathis/mammals/mlion/sightings.htm CougarNet
New York, 1975	Puma shot by State Police in Catskills; escaped from zoo		Brocke 1981 *in* Cardoza
New York, ca. 1975	Puma escaped from Animal Land in Lake George; shot by sheriff		Brocke 1981 *in* Cardoza
New York, ca. 1975	Puma escaped in Northway; shot by police?		Brocke 1981 *in* Cardoza
New York, 31 December 1993	Kitten shot by a hunter near Sacandaga Reservoir in Saratoga County; 7.5 pounds emaciated; South American genetic origin	Unknown	NYDEC Pathology Unit Annual Report 1995 to 96 *in* Cardoza; Peter Nye, NYDEC pers. comm.; Kahn (1994)
North Carolina, 1900	Puma reported trapped in a pocosin in Craven Co.	Unknown from David Lee's files (North Carolina State Museum)	Downing 1981b *in* Cardoza; Downing (1984)
North Carolina, 1908 to	Rev. Conrad reported an adult and two kittens	Unknown	Culbertson (1977), Downing (1981, 1984)

09	killed near Tines Creek, Big Cataloochee area of Great Smoky Mountains National Park		
North Carolina, 1913	Newspaper column by Andy Huchinson in Asheville Citizen Times relates how R J. Williams killed a puma on Little Pisgah near Fairview. Good description.	R. J. Williams	Hutchinson (1979) *in* Downing (1984); Downing 1981b.
North Carolina, 1920	One reported killed, Fontana Village, Great Smoky Mountain National Park	W. Orr	Lindzey and Lindzey 1971, Culbertson 1976, Downing (1981b), Cardoza
North Carolina, 1930	One reported killed near Bryson City. Mr. and Mrs. McCall told Downing they saw one alive repeatedly and was killed on Waterrock Knob near Addie in Jackson Co. Good description. Close to possibly be Bryson City specimen.	Unknown	Downing (1981b)
North Carolina, 1959	One 79 pound male reported killed on Horse Face Mountain, Cherokee Co.	Unknown	Eaton 1973, Downing (1981,1984); Cardoza
North Carolina, 1975	Great Smokies National Park, L. Badin and L. Norman, verified hair samples	Unknown	Nowak 1976, Anderson 1983
North Carolina, 4 February 1981	B. Freeze and neighbor saw and weighed a 169 pound puma (male) killed February 4 by a truck near Ellerbe in Richmond Co. Location of specimen unknown.	Bill Freeze	Downing (1981b)
North Carolina, late 1980s	Two killed in Tyrell County while feeding at a dumpster; one eating catfood. Carcasses examined by David Rowe, state biologist, who found tattoes inside the mouth of both animals.	Unknown	Linzey 1998 *in* Cardoza; Parker (1998); Clark (1987)
North Carolina 1990s?	One immature (7 lb.) puma captured alive near a home in Rutherford County. Tame behavior suggested captive origin.		Parker (1998)
Ohio, 29 October 1966	One tame 1 ½ year old puma shot the day after it escaped	Unknown	Helen McGinnis *in* Downing (1984), McGinnis (1994)
Ohio, 1960s	Young puma killed by car near West Virginia line	Unknown	East (1979), Downing (1981b); Helen McGinnis *in* Downing (1984)
Pennsylvania 1901 to 1903	Three pumas killed in separate incidents. Confirmation uncertain.	Unknown	Shoemaker (1943); Wright (1971); Downing (1981b)
Pennsylvania, 1940s	Captive puma escaped near Kane and shot by	Unknown	Downing (1984)

	state patrolman several mi. away		
Pennsylvania, 1960s	Conservation officer encountered a puma in Forest County. He gave it a sandwich and it jumped in his car. It had been defanged and declawed, and escaped captive.		Pennsylvania Game Commission biologist Arnold Hayden *in* Parker (1998)
Pennsylvania, 1967	Young female puma (48 pounds) killed by squirrel hunter J. D. Gallant 1.5 mi. SE of Edinboro, Crawford County. Allegedly with a larger puma. (believed to be escaped animal from Ohio game farm according to correspondence between the Ohio and Pennsylvania Game Commissions in 1973). Likely of South America (captive) origin because of small size, color and possible rickets in leg bones. Specimen in Carnegie Museum #30438.	J. D. Gallant	Nowak 1976 *in* Anderson 1983; Doutt 1969, Nowak 1974, Doutt et al. 1977 *in* Cardoza; McGinnis (1982, 1994); H. McGinnis pers. comm.; Tischendorf (2003)
South Carolina, ca. 1916	One killed in the Camden area	T. Ancrum and W. Russell	Golley 1966 *in* Cardoza; Nowak (1976); Downing (1981, 1984)
South Carolina, 1942 to 43	One allegedly hit by a truck in Georgetown Co.; large; long tail. No specimen exists.	Alan G. Broun, Jr.	Sass (1954); Downing (1981, 1984)
South Carolina, 1952	One mangled in road. Animal described as large and difficult to drag by its large tail. No specimen exists.	Benajamin M. Badger of Charleston, South Carolina	Sass (1954); Downing (1981, 1984)
South Carolina, early 1960s	Downing (1984) interviewed a man who allegedly killed a puma (good description) that was catching chickens in his yard near Seneca.	Unknown	Downing (1981, 1984)
South Carolina, 1961	Beauford newspaper reports one killed	Unknown	Downing (1984)
South Carolina, mid-December, 1988	One shot on porch in Townsville; 75 pounds female; good condition; starch granules in stomach	Unknown	South Carolina Wildlife Division Service Briefs 4(4):4 January 1989 *in* Cardoza
South Carolina, early 1990s	Puma, believed to be an escaped captive shot in the back yard of a home in Anderson County.		Parker (1998)
Tennesse, 1920	One reported killed near the Fontana Village area.		Linzey and Linzey (1971); Tischendorf (2003)
Tennessee, 1929	One reported killed in Holston Mountains, Johnson County.		Kellogg (1939), Allen (1942) in Downing (1981b)

Tennessee, 1971	150 pound male killed by a deer hunter near Pikeville (north of Crossville), Bledsoe County. Specimen preserved, photographed and published in the Winchester, Tennessee Herald Chronicle (December 9, 1971). Specimen mounted. Toenails not visible in mount, so may be former captive.	Mr. Buckner of Decherd, Tennessee	Nowak (1976), Downing (1981b); Tischendorf (2003)
Tennessee, mid-1980s	One puma shot and killed while stalking a child. Animal was declawed, indicating former captive.	Wildlife officer George Gregory of Hickman County.	Parker (1998)
Vermont, 2 April 1994	Three pumas observed on the snow near Lake Eligo near Craftsbury. Tracks were video taped and a fresh scat was collected. Scat was analyzed by USFWS forensics lab in Ashland Oregon. Sample contained hair from front paw of puma. Conflicting DNA results from subsequent analyses by Holly Ernst, University of California, Davis, in 2004 caused Vermont Department of Fish and Wildlife to state the sighting are equivocal and therefore unconfirmed.	Mark Walker, Wayne and Cedric Alexander	Parker (1998); Bolgiano et al. 2000; Ronald Regan, Vermont Fish and Wildlife, March 13, 2007 letter to USFWS; Tougias 2006; Tischendorf (2003)
Virginia, 1990	Donald Lindzey collected photos and cement casts of tracks that he confirmed as puma.	Donald Lindzey	Bolgiano et al. 2000
West Virginia, October 1976	One young male shot in Jacox-Lobelia or Droop area in Pocahontas County; killing sheep; former captive?	Kessler Pritt	Frome (1979), Eastern Cougar Website *in* Cardoza; Bolgiano et al. (2000); Bolgiano and Roberts (2005)
West Virginia, October 1976	One female captured on Buffy's Creek near the animal above; taken alive to the West Virginia Dept. of Natural Resources French Creek Game Farm near Buckhannon,. Former captive. Died of feline distemper at West Virginia wildlife center or sold to a zoo in Pennsylvania.	West Virginia Dept. of Natural Resources	Eastern Cougar Website *in* Cardoza; Bolgiano et al. (2000); Bolgiano and Roberts (2005); Taverna et al. (1999)
West Virginia, 1980	Two escapes; roadside zoo; one shot		Brocke 1981 *in* Cardoza
West Virginia, 1996	Todd Lester made plaster casts of tracks in Wyoming County in southern West Virginia. Confirmed as puma by Lee Fitzhugh of the	Todd Lester	Bolgiano et al. 2000; Taverna et al. 1999

	Extension Wildlife Service and University of California, Davis and by David Maehr.		
West Virginia, 1998	Todd Lester made a plaster cast of a puma track in Mingo County, West Virginia. Confirmation unknown.	Todd Lester	Taverna et al. 1999
Wisconsin, 7 March 1988	Tracks found on winter snow track survey by state wildlife biologist in Section 27, T39N, R15E along Forest Road 2158 near Halsey Lake, Florence County (including tail drag marks).	Bill Creed, Wisconsin DNR	Winsconsin DNR Memorandum #8100
Wisconsin, 4 January to 14 April 2008	Animal observed and hair collected from puma near Milton. Subsequent confirmed observations through southeast Wisconsin. Animal shot in Chicago, IL (see record above). DNA testing revealed animal of North American origin and similar to South Dakota pumas.	Adrien Wydevin, Wisconsin DNR	CougarNet; http://dnr.wi.gov/org/land/er/mammals/cougar/sightings.htm
Wisconsin, 7 March 2008	Tracks observed near Elkhorn and confirmed by Wisconsin DNR. Other sets of tracks observed after in Rock County. This animal may be the same as January 2008 and same killed in Chicago, Illinois.	Jason Roberts and Adrian Wydeven, Wisconsin DNR	CougarNet http://dnr.wi.gov/org/land/er/mammals/cougar/sightings.htm
Wisconsin, 3 to 4 March 2009	Puma treed by hounds, photographed, and attempted capture by WI DNR near Spooner, Burnett County. DNA samples collected, but results not available.	Ken Jonas, Wisconsin DNR	CougarNet; http://dnr.wi.gov/org/land/er/mammals/cougar/sightings.htm
Wisconsin, June 2009	Tracks photographed in mud near Durand in Pepin County and confirmed by Wisconsin DNR.	Marty Weiss, Adrian Wydeven Wisconsin DNR	CougarNet http://dnr.wi.gov/org/land/er/mammals/cougar/sightings.htm
Wisconsin, December 2009	Puma tracked in Spring Valley, St. Croix County and later photographed on game camera in Dunn County (may have been June 2009 animal) and nearby deer kill.		CougarNet; http://dnr.wi.gov/org/land/er/mammals/cougar/sightings.htm