SPECIES ASSESSMENT FOR CANADA LYNX (*LYNX CANADENSIS*) IN WYOMING

prepared by

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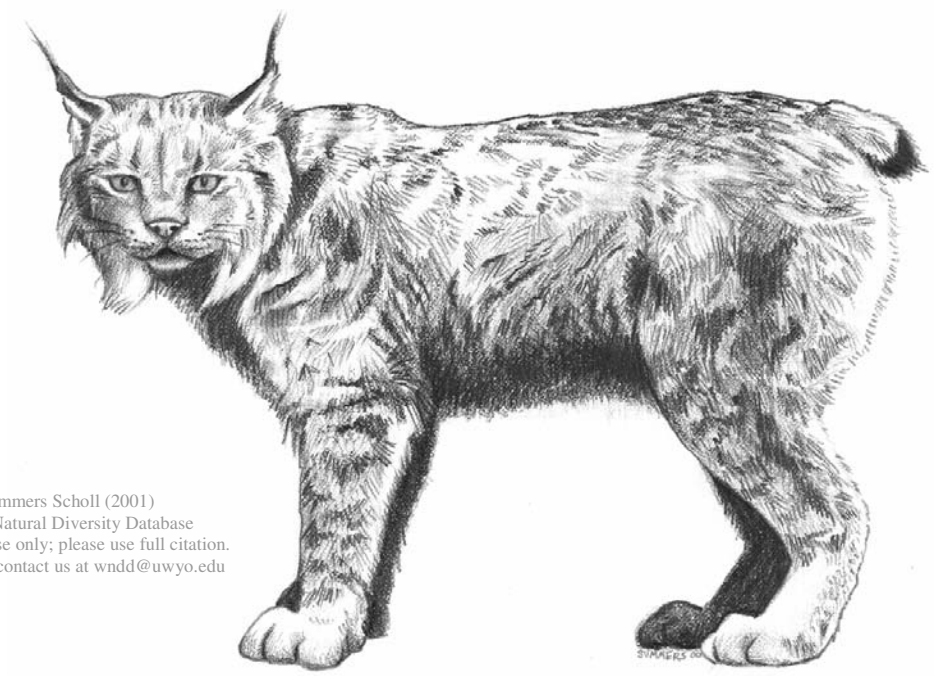

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Introduction

The Canada lynx (*Lynx canadensis*) reaches its southern range limit in the mountains of Colorado and southern Wyoming. In the continuous boreal forests of Canada and Alaska lynx populations are widespread and stable (Quinn and Parker 1987). Boreal forests attenuate in the Central and Southern Rocky Mountains, where they occur only on discrete mountain ranges separated by dry shrub- and grass-dominated basins. Populations of boreo-alpine vertebrates like lynx are similarly fragmented in this region (Beauvais 2000). There is concern that populations of lynx in the contiguous United States are vulnerable to habitat limitations and lack of regulatory mechanisms to protect them. Consequently the USDI Fish and Wildlife Service (USFWS) issued a final rule listing the contiguous United States Distinct Populations Segment (DPS) of Canada lynx as threatened under the Endangered Species Act (ESA) in 2000 (Federal Register Volume 63, No. 130).

Canada lynx depend strongly on snowshoe hares (*Lepus americanus*) as a food source, especially in northern portions of lynx range where both species are well-studied. The ecology of lynx in the southern portion of their range is rather poorly-known, but appears to be rather different. Differences center on the use of alternative prey; the effect of habitat patchiness on movements, reproduction, and survival; and the effects of predators and competitors (Aubry et al. 2000).

This assessment will focus on information available for the southern portion of lynx range, and is part of the Species Conservation Assessment Project for the Wyoming Office of the USDI Bureau of Land Management (BLM). It addresses the biology, ecology, and conservation status of the lynx through its current range in Wyoming and North America. Our goal is to provide a

current summary of published information and expert interpretation of this information that can be used to develop management plans.

Natural History

Morphological Description

The lynx is a medium-sized, short-bodied cat with long legs and stocky build (Clark and Stromberg 1987). Paws are very large and well-furred (an adaptation for flotation while moving across deep snow), ears tufted, tail blunt and short, and the head has a flared facial ruff. Winter coloring is typically grizzled brownish-gray mixed with buff or pale brown on the top and grayish-white or buff-white on the underside (Koehler and Aubry 1994). In summer, the pelage is more reddish to gray-brown. The tail is black-tipped all the way around. Total length is 67-85 cm and weight 8-10.5 kg; males are slightly larger than females (Clark and Stromberg 1987, Koehler and Aubry 1994).

The lynx differs from the similar-appearing bobcat (*Lynx rufus*) by having paws twice as large as those of bobcats (Quinn and Parker 1987); a completely black-tipped tail, in contrast to the bobcat tail which is black only dorsally and white ventrally; a less spotted coat; longer legs; and a more distinct facial ruff (Tumlison 1987). Reconstructing the historic range of lynx in southern portions of its range is complicated by the fact that old trapping records may refer to the pale mountain subspecies of the bobcat (*L. r. pallescens*) as lynx (Armstrong 1972), and also because the term "lynx cat" was often used for bobcats in good winter pelage (Reeve et al. 1986).

Taxonomy and Distribution

Taxonomy

There has been much debate in recent years over the taxonomy of lynx. The type specimen of the lynx in North America, described in 1792 from eastern Canada, was listed as *Lynx canadensis*

(Tumlison 1987). Van Gelder (1977) assigned all lynx to the genus *Felis*, and thus the Canada lynx became *Felis lynx*. This taxonomy placed the European and Canada lynx in the same species (Tumlison 1987), with subspecific recognition. Subsequent work reversed that taxonomy, reinvoking the generic name *Lynx* and recognizing three species: *L. lynx*, the European lynx; *L. canadensis*, the Canada lynx; and *L. pardina*, the Iberian lynx (Werdelin 1981, Wozencraft 1993). This latter approach is most commonly followed (Baker et al. 2003). In North America, two subspecies are recognized: *L. canadensis canadensis* for the entire range in Alaska, Canada, and the United States; and *L. c. subsolanus* from Newfoundland (Hall 1981).

The Canada lynx and bobcat are thought to descend from the Eurasian lynx that came across the Bering land bridge during two separate colonization events (Quinn and Parker 1987, Koehler and Aubry 1994, Anderson and Lovallo 2003). The bobcat's progenitors came across in the late Pliocene (2.6 million years ago) and evolved into a carnivorous generalist, whereas the ancestors of the Canada lynx came across during the Pleistocene, about 200,000 years ago. Competitive exclusion by the bobcat may have prevented any southward expansion of the lynx.

Distribution

The Canada lynx occupies the boreal forests of North America (Figure 1). Its range extends from Alaska to Newfoundland, descending into the lower 48 states in northern New England, the Western Great Lakes region, the Pacific Northwest, and the Rocky Mountains (Colorado, Idaho, Montana, Wyoming) (McCord and Cardoza 1982).

Lynx occupied Wyoming prehistorically (Kurten and Anderson 1980), as well as historically and into the present (Reeve et al. 1986). The distribution of lynx in North America has probably not changed much in historic times except at the southern boundary of their distribution (Quinn and Parker 1987). The best contiguous lynx habitat in Wyoming is in the northwestern and

western portion of the state. The remainder is highly fragmented, widely dispersed, and typically isolated by large expanses of arid shrubland (Ehle and Keinath 2002). The distribution of documented lynx specimens and observations in Wyoming indicate that they most consistently occupy the Salt River, Wyoming, Teton, Wind River, Gros Ventre, and Absaroka mountain ranges (Reeve et al. 1986). Lynx are recorded less frequently in the Uinta and Bighorn ranges, and very sporadically in eastern Wyoming (Wyoming Game and Fish Department 1999, Beauvais et al. 2001, Murphy et al. 2004; Wyoming Natural Diversity Database, unpublished data; Figure 2).

There are nine museum specimens of lynx from Colorado, but it is thought that lynx have always been rather rare in that state (Halfpenny and Miller 1981). By extension, lynx were probably never very numerous in the mountains of southern Wyoming. Indeed, consistent lynx occupation of the Central and Southern Rocky Mountains may have depended more on occasional dispersal of individuals from northern population centers than on intrinsic reproduction within the region itself. However, the current reintroduction effort by the Colorado Division of Wildlife has been successful, with reproduction occurring in the Southern Rocky Mountains of Colorado and additional releases planned. Four of the lynx reintroduced into Colorado ranged into the Medicine Bow, Sierra Madre, and Laramie mountains of southern Wyoming in 2003-2004. At least one female successfully established a den and produced kittens in southern Wyoming during this time (Colorado Division of Wildlife, unpublished data).

Habitat Requirements

General

Lynx generally require cool and moist coniferous forests with cold, snowy winters and abundant snowshoe hares. Primary vegetation in lynx habitat is lodgepole pine (*Pinus contorta*), subalpine fir (*Abies lasiocarpa*), and Engelmann spruce (*Picea engelmannii*) (Aubry et al. 2000,

Ruggiero et al. 2000). Secondary habitat includes cool, moist Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), western larch (*Larix occidentalis*), and aspen (*Populus tremuloides*). Drier types such as ponderosa pine (*Pinus ponderosa*) and pinyon-juniper woodlands are not considered suitable for lynx (Ruediger et al. 2000). It is important to recognize that lynx are extremely mobile and will occasionally move across and be recorded in unsuitable habitats, even including shrublands and true grasslands. However, they will not consistently occupy nor reproduce in such environments.

In northern boreal forests winters are consistently cold with deep snow, which favors the long-legged and large-footed lynx over other carnivores. In contrast, winters in southern boreal forests are more variable in temperature and snow depth. Shallow and crusted snow probably reduces the advantages of lynx and places them in direct competition with more generalist carnivores such as bobcats, coyotes (*Canis latrans*), and mountain lions (*Puma concolor*) (Buskirk 2000, Buskirk et al. 2000).

In summer, lynx in Washington selected strongly for northeast aspects and avoided Douglas-fir. This selection of wetter, cooler conditions in summer may have a thermoregulatory element (McKelvey et al. 2000b). In winter, they selected lodgepole pine and showed an increase in use of Douglas-fir compared to summer. There also was a seasonal shift in elevation. In winter lynx decreased their use of higher elevations (2,000 – 2,150m) and increased use of lower elevations (1,400 – 1,550m) (Koehler 1990, McKelvey et al. 2000b).

Lynx home ranges typically encompass a mosaic of forest types, with particular activities occurring preferentially in different types. Snowshoe hares are usually hunted in stands with high stem densities and shrubby coniferous growth forms. Dens are placed in late-seral stands with large woody debris in the form of downed logs and root wads (Koehler 1990, Ruediger et al. 2000,

Squires and Laurion 2000). Hunting and denning may both occur in older and mixed-age stands with well-developed midstories, large downed logs, and abundant red squirrels (*Tamiasciurus hudsonicus*) as well as snowshoe hares (Buskirk et al. 2000).

Foraging areas for lynx are largely determined by snowshoe hare habitat and density. In northern boreal forests hares are most abundant in early seral stands with dense, multi-layered under- and mid-stories. Hare cover and browse needs to extend up to ca. 4.5 m (15 ft) to be available above snow in winter (Ruediger et al. 2000). In north central Washington, lynx primarily used lodgepole pine and Engelmann spruce-subalpine fir habitats, and preferentially hunted in 20-year old lodgepole stands where hares were most abundant (Koehler 1990). In the Yukon lynx similarly preferred regenerating stands over mature forests (Mowat and Slough 2003). In these northern forests these young, shrubby stands are produced by disturbances such as fire, insect infestations, catastrophic wind events, disease outbreaks, and timber harvest (Agee 2000, Ruediger et al. 2000). They are also rather ephemeral; the consistently wet conditions that promote the dense growth of shrubs and tree seedlings/ saplings also causes the trees to quickly transition to the stem exclusion phase wherein hare browse and cover is quickly shaded out.

Some sites in the Central and Southern Rocky Mountains may be wet enough to produce the shrubby early-seral stands that serve as good snowshoe hare (and thus lynx foraging) habitat. However, most of the region is relatively dry, and as a result regenerating stands often lack a significant shrub stage. The best snowshoe hare (and thus lynx foraging) habitat here may more generally occur in late-seral and climax stands that contain canopy openings with dense patches of saplings, abundant coarse woody debris for snowshoe hare and lynx cover, and Engelmann spruce and subalpine fir stems with live branches 0 - 4.5 m above the ground (Buskirk et al. 2000). Such stands also typically support many red squirrels, which are a crucial alternative prey for lynx in its

southern range. Because such stands are at or near climax, they are more naturally stable; however, they are subject to occasional fire and, more recently, timber harvesting and associated road building.

In the western U.S. 70% of lynx occurrences were at elevations of 1,500 – 2,000 m (4,920 – 6,560 ft.). In Wyoming the elevational range for all lynx occurrences is 1,500 – 3,500 m (4,920 – 11,480 ft.) (McKelvey et al. 2000b). This reflects the general association of lynx with boreal forests and deep snow. Some information suggests lynx prefer flat topography over more rugged landscapes, possibly because the energetic cost of traveling through deep snow is so high that lynx cannot bear the additional costs of steep terrain. Flat forests have been disproportionately disturbed by timber harvesting in the Central and Southern Rocky Mountains, because of the relative ease of road building and timber extraction in flat sites.

Denning

Dens require the large downed timber more typically found in mature forests or recently burned stands. Coarse woody debris protects kittens from predators and provides thermal cover. Multiple natal dens are typically used, each typically positioned near good foraging habitat so the female can efficiently feed kittens (Ruediger et al. 2000).

In the Yukon dens (n=39) were located most frequently under deadfalls in recovering burns. Mature subalpine firs, shrubs, and willow thickets were also used as den sites in both burned and unburned areas (Slough 1999). Dens were not re-used, but could be as close as 300 m to neighboring female den sites. Females occasionally moved their kits to another den, even when seemingly undisturbed.

In the Central and Southern Rocky Mountains lynx dens are usually positioned in mature forest stands at least 1 ha in size in areas of minimal human disturbance (Koehler and Aubry

1994). Two lynx were captured and outfitted with radio-telemetry collars in the Wyoming Range in 1996 and 1997, and were followed for three years. In 1998 the collared female established a den in a mature stand of subalpine fir, with a minor component of lodgepole pine. The den was located in a west-facing, cave-like tree well, on a 36% slope. Canopy closure was 48% and coarse woody debris (downed logs) was abundant, as were subalpine fir saplings (3,600 stems/ ha). The female subsequently moved her kittens 200m to a maternal den located in a depression beside a fallen tree. Canopy closure there was 54%, and coarse woody debris and saplings (5,800 stems/ha) were abundant (Squires and Laurion 2000).

All six dens currently known from lynx recently reintroduced to southwestern Colorado were located in mixed stands of Engelmann spruce and subalpine fir with extensive amounts of deadfall (Colorado Division of Wildlife 2004). Dens ranged in elevation from 10,600 ft. – 11,700 ft.

Movement Habitat

In contrast to more northern populations that occupy large, continuous forests, lynx in southern forests occupy archipelagos of suitable mountain ranges within a matrix of unsuitable lowlands. In Wyoming these lowlands are typically dry, shrub-dominated semi-deserts. Individual lynx are periodically required to traverse these lowlands to find adequate prey, mates, and new home ranges (Aubry et al. 2000). When doing so they tend to travel along forested ridges and riparian corridors, and avoid large vegetation openings, whenever possible. Travel corridors that extend across otherwise harsh environments may play a critical role in regional persistence and metapopulation dynamics of lynx in Wyoming and Colorado (McKelvey et al. 2000a).

In Idaho lynx have been documented in shrub-steppe within 40 km (25 miles) of forested habitat during jackrabbit irruptions. It is possible that the unusually high availability of such alternate prey attracts lynx (Ruediger et al. 2000). White-tailed jackrabbits (*Lepus townsendii*)

may be a critical prey for lynx moving across shrub-dominated basins. Unfortunately, white-tailed jackrabbits appear to be declining, as attested by their disappearance from Jackson Hole since 1979 (J. Berger, personal communication) and other areas in western North America (Chapman and Flux 1990).

In Nova Scotia lynx used open, mature conifer forest with low hare densities rather than the mature, mixed conifer-hardwood forests with higher hare densities (Parker 1981, as cited in Aubry et al. 2000). The author suggested that lynx used the more open forests for travel. In Washington, lynx also used forest stands with sparse understories for travel (Koehler and Brittell 1990). Lynx generally avoid open areas, but thinned stands (420-640 trees/ ha) probably provide sufficient cover for travel.

Area Requirements

Individual lynx require large areas, and home range size varies widely with prey availability (but see Brand et al. 1976 for an exception in Alberta). Tumlison (1987) describes typical home ranges as 11 – 50 km^2. Home ranges are larger in southern populations, as is the case in Minnesota where they were 51 – 243 km^2 (Mech 1980), and in Montana where they averaged 238 km^2 and 115 km^2 for males and females, respectively (Squires and Laurion 2000). Home ranges of radio-collared lynx in Wyoming over a three year period were 110 km^2 and 90 km^2 for a male and female, respectively. Winter home ranges were 63 km^2 and 50 km^2, and in the summers they were 81 km^2 and 57 km^2 (Squires and Laurion 2000).

In Minnesota home ranges of females overlapped with each other; those of males did not. Female and male home ranges were generally adjacent and overlapped only minimally.

Movement and Activity Patterns

Dispersal

Lynx are very mobile (McKelvey 2000a). In northern populations there are two types of lynx dispersal recognized: innate dispersal of young from their natal home range, and environmental dispersal of all cohorts as a consequence of low prey density (Anderson and Lovallo 2003). The latter can involve movements of up to 1,000 km (600 miles) (Ruediger 2000).

Radio-collared lynx from Montana and Wyoming appear to have two different types of movement: daily movements of 2-4 km, typically within the home range, and exploratory and dispersal movements of 7-39 km that take the animal outside of its home range (Squires and Laurion 2000). The patchiness of southern lynx habitat may lead to more traveling between suitable foraging and denning sites within a given home range (Koehler and Brittell 1990).

Movements between mountain islands of conifer forest in southern populations is poorly understood, but exploratory movements during the summer by adult lynx have been documented in Wyoming and Montana (Apps 2000, Squires and Laurion 2000). Exploratory movements have also been documented in reintroduced lynx in Colorado. Two collared animals moved from south-central Colorado to the Medicine Bow National Forest in Wyoming during summer 2003, which required traversing some open environments (T. Shenk., Colorado Division of Wildlife, personal communication).

Migration

Lynx are considered non-migratory, but individuals do undertake regular altitudinal shifts in habitat use and travel over rather large areas. Lynx will occasionally abandon established home ranges and become nomadic when prey is extremely scarce.

Daily Activity

Lynx daily movements range 2.7 - 5.4 km, with greater movements during low hare densities (Ward and Krebs 1985). In addition, lynx move greater daily distances in summer than in winter on Cape Briton Island (Parker et al. 1983).

Daily travel distances were 2.2 km to 4.1 km for the two lynx in Wyoming. Exploratory movements of at least 30 km were also recorded (Squires and Laurion 2000).

Reproduction and Survivorship

Breeding and Social Behavior

Lynx are solitary carnivores with the ability to modulate reproductive output in accordance with variable, and sometimes cyclical, food availability. Adult lynx are social only during the breeding season when they form breeding pairs. They are polygamous and seasonally polyestrous; females cycle continuously until bred during the breeding season. Females typically give birth to 1-5 kittens (mean = 3.7 kittens) (McCord and Cardoza 1982).

Young remain with their mother until 8-10 months of age, and sometimes longer when adult females do not breed in response to low hare density. This long period of attachment allows females to develop strong social bonds with their young. Cooperative hunting by family groups has been observed (Tumlison 1987).

Breeding occurs in early spring (March and April). Kittens are born into a den after a gestation of 63-70 days (Anderson and Lovallo 2003). Females commonly move young to different dens during early development. Newborns open their eyes at 10-17 days of age, and begin to walk at 24-30 days (Tumlison 1987). Kittens nurse for six months, and take solid food at 30 days of age.

Fecundity and Survivorship

Yearling females typically breed infrequently; when they do, they consistently produce smaller litters than older adults (Anderson and Lovallo 2003, Brand and Keith 1979, Koehler and Aubry 1994). Males begin breeding in their second year. Adults are reproductive throughout their adult life.

Recruitment of kittens, yearling reproductive rate, and litter sizes for all age classes are strongly influenced by snowshoe hare abundance (Brand and Keith 1979, Koehler and Aubry 1994). Starvation of kittens and failure to reproduce are the two primary causes of lynx declines during period of hare scarcity (Anderson and Lovallo 2003). In Alberta, recruitment of kittens declined to zero when hare densities fell below 1.4 hares/ ha (Brand et al. 1976). Also in Alberta, 73% of females conceived in years of abundant snowshoe hares, but only 33% conceived in years when hares were rare (Brand and Keith 1979). Hare densities in the Wyoming Range were 0.8 hares/ ha in 1997 and 1.4 hares/ ha in 1998, when no kittens were known to survive (Squires and Laurion 2000).

Low hare abundance can lead to low lynx reproductive success by many avenues, most generally being functions of poor body condition of the mother: pre-implantation embryo losses, intrauterine embryo loss, and kitten mortality (Koehler 1990, Koehler and Aubry 1994). Lynx mated during periods of low hare density in the Yukon, but failed to raise any kittens; pre-natal and early post-natal loss of kittens was suspected. Lynx also have the ability to produce large litters, up to 8 kittens, during periods of high hare density (Mowat and Slough 1998).

Lynx rarely survive past 15 years in the wild. Primary sources of mortality are starvation as a result of prey scarcity, which affects kittens and yearling the most, and human-caused mortality (Tumlison 1987). Half of 14 radio-tagged lynxes that emigrated from Canada to northeastern

Minnesota suffered human-caused mortality, with no natural mortality observed (Mech 1980). Of 51 mortalities of reintroduced lynx in Colorado, 9 died of starvation, 6 were hit by a vehicle, 7 were shot, 4 were probably shot, 1 was human-caused but unknown, 1 died of probable predation, 4 died of plague, 2 were probably hit by a vehicle, and 17 were unknown (Colorado Division of Wildlife 2004). The starvation mortalities may have been due in large part to early release protocols that were subsequently changed. In all, 20 of 51 deaths (39%) were human-caused.

Survival rates are lower for kittens than for adults. There was a 65-95% mortality rate for kittens in Alberta during a three-year period of low hare abundance, presumably due to starvation (Brand and Keith 1979). Of four kittens born in Wyoming in 1998, none survived to the following winter (Squires and Laurion 2000). In Colorado in 2003, a study population of 55 reintroduced lynx produced 6 dens and 16 kittens; as of April 2004 6 of the kittens were confirmed alive, 7 were confirmed dead, and 3 were probably dead (Colorado Division of Wildlife 2003, 2004). An additional 7 kittens were found in May 2004.

Population Demographics

Canada lynx population dynamics in the northern taiga are closely tied to the population dynamics of snowshoe hares, and fluctuate in synchrony across huge areas. This well-known relationship was discovered by studying fur harvest records of the Hudson's Bay Company (Elton and Nicholson 1942). Northern snowshoe hare populations are cyclical, with a peak about once every ten years; lynx numbers follow with a one- to two-year time lag. Experimental results suggest that predation is a causal factor in snowshoe hare population cycles (O'Donoghue et al. 1998).

Two hypotheses have been put forward in recent times to explain the large-scale spatial synchrony of northern lynx population dynamics. Time-series data suggest that lynx population

dynamics are affected by three climatic regimes: Pacific-maritime, Continental, and Atlantic-maritime, with a possible link to the North Atlantic Oscillation (Stenseth et al. 1999). However, another hypothesis proposes that dispersal out from the core area of lynx distribution is the driving component, supported by the observation that gene flow apparently extends across distances greater than 3,100 km (Schwartz et al. 2002). These authors suggest that immediately after the peak of the lynx cycle in the center of their range, large numbers of animals disperse long distances, creating a wave of immigrants that drive cycle-like synchrony in distant population centers.

Snowshoe hare and lynx populations in the Central and Southern Rocky Mountains do not cycle strongly, and lynx populations are probably not synchronized on a regional scale. Lynx populations in north-central Washington, Montana, and Wyoming have demographic parameters comparable to northern populations during troughs in hare abundance, and do not exhibit the obvious cycles characteristic of northern populations (Aubry et al. 2000, Koehler and Aubry 1994). Typical demographic parameters for southern populations are: in-utero litter size 3.25-3.6; yearling pregnancy rate 27-44%; yearling litter size 1.75-3.2; kitten mortality rate 88%; generally low kitten production and low lynx density overall (Aubry et al. 2000).

Recent analyses suggest only mild cycles in southern hare populations, with peaks 8-11 years apart. Even during a peak, hare abundance is much lower in the south (1-2 hares/ ha) than in the north (4-6 hares/ ha) (Hodges 2000b).

Limiting Factors

Lynx in Wyoming and surrounding states experience different ecological pressures than do their counterparts to the north, and are thus subjected to different limiting factors. The main limit on southern lynx populations is the rarity and fragmented nature of suitable habitat (Beauvais

2000). Conifer forest in general is restricted to discontinuous mountain ranges, and late-seral forest, which provides the best habitat for hares, red squirrels, and lynx in southern mountains, is more rare and isolated still. Furthermore, timber harvesting and associated disturbances like road building have preferentially targeted the flat, late-seral stands preferred by lynx. This has further fragmented suitable lynx habitat, and roads and snow-machine trails have increased the ability of generalist carnivores (e.g., bobcats, coyotes, mountain lions) to prey upon and compete with lynx in formerly snowbound areas in the winter.

Some studies suggest that densities of 1.1 – 1.8 hares/ ha are necessary for lynx population persistence (Steury and Murray 2004), and such densities are exceedingly rare in the contiguous U.S. Field observations of lynx in the Central and Southern Rocky Mountains suggest an unusually heavy reliance on alternative prey such as red squirrels, ground squirrels (*Spermophilus* spp.), and blue grouse (*Dendrogapus obscurus*).

In general, human-caused mortality and disturbance is a major limiting factor on population expansion of most large mammalian carnivores in the Rocky Mountains (e.g., Beck 1991, Anderson et al. 1992, Wieglus et al. 1994, Mace et al. 1996; see also Noss et al. 1996). Given the rather high rates of human-caused mortality recorded in southern lynx populations, it is reasonable to assume that lynx are no exception to this generalization.

Metapopulation Dynamics

A number of factors suggest that southern lynx populations are arranged as metapopulations: habitat that is fragmented on both regional and local scales, with suitable patches embedded in a matrix of unsuitable-but-traversable environments, and a species with very high mobility (McKelvey et al. 2000a). Persistence of lynx in the contiguous U.S. may depend rather heavily on regular importation of individuals dispersing out of larger populations to the north, and as such the

maintenance of connectivity between northern and southern populations is of critical management importance (Schwartz et al. 2002). For Wyoming and Colorado, this translates into maintaining connectivity between populations in those two states, and also between lynx populations in Canada and Montana, and Montana and Wyoming.

Genetic Concerns

Peripheral populations of lynx have less genetic variation than core populations, as measured by fewer mean numbers of alleles per population and lower expected heterozygosity (Schwartz et al. 2003). Although surprising because of the lynx's ability to move long distances, these results can be explained by the fact that peripheral populations often have smaller population sizes and limited opportunities for genetic exchange. This further suggests that connectivity between northern (core) and southern (peripheral) lynx populations is important in maintaining genetic diversity, and therefore increasing the viability, of southern populations.

There is some indication that lynx and bobcat can hybridize; three putative lynx from Minnesota contained DNA from both bobcats and lynx, and samples from Maine and New Brunswick show similar blending. All suspected hybrids had lynx mothers (Pilgrim and Schwartz 2004).

Food Habits

Food Items

Primary lynx prey is the snowshoe hare. In Canada, Alaska, and Washington snowshoe hares comprised 35-97% of lynx diet (Koehler and Aubry 1994). Secondary prey includes red squirrels, ground squirrels, grouse, porcupine (*Erethizon dorsatum*), beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), deer mice (*Peromyscus* spp.), voles (*Microtus* spp.), shrews (*Sorex* spp.), and even some fish. Deer (*Odocoileus* spp.) and moose (*Alces alces*) occasionally appear in lynx

diets, mostly as carrion (Tumlison 1987, Ruediger et al. 2000). In Washington, the only state in the contiguous U.S. for which such data are available, the annual lynx diet was 79% hares, 24% tree squirrels, 3% ungulates, and 3% grouse (Koehler 1990). In northern populations red squirrels, voles, and other small mammals are a larger component of summer and fall diets, whereas snowshoe hares clearly dominate the winter diet (Anderson and Lovallo 2003).

The relative rarity of hares in southern mountains requires lynx to rely more heavily on other prey there (Hodges 2000b). Red squirrels are an especially important prey in the south, as they are in the north during troughs in the hare population cycle. Lynx appear to use non-hare prey to a greater degree in summer than in winter in both northern and southern forests, although data are scarce (Aubry et al. 2000, Mowat et al. 2000). In areas of patchy lynx habitat lynx are more opportunistic and may feed occasionally on white-tailed jackrabbits, black-tailed jackrabbits (*L. californicus*), sage grouse (*Centrocercus urophasianus*), and Columbian sharp-tailed grouse (*Tympanichus phasianellus columbianus*) (Quinn and Parker 1987, Ruediger et al. 2000).

Foraging Strategy

Lynx are most active between dawn and dusk, although they can seek prey any time of day. Their primary strategy is stalk-and-pounce; sometimes they will ambush from a branch or other high perch (Tumlison 1987). The chase typically covers a distance of 20 – 50 m. Family groups (female and kittens) occasionally forage cooperatively, with the young flanking the adult by 15 to 40 paces in heavily wooded sites. The young rejoin the female and follow in her tracks when crossing clearings. Lynx often rest in day beds near centers of hare activity.

Foraging Variation

In northern populations diet composition and foraging behavior varies in a rather straightforward manner with hare abundance. Both lynx and coyotes fed on hares in the Yukon

during cyclical highs and showed a clear functional response to changes in hare density (Mowat et al. 2000). After the hare decline, lynx increasingly foraged for squirrels. Relative frequency of red squirrels in lynx scats was 25 – 36%, and other small mammals was 23 – 25%, during hare lows. Hares showed up in scats in these years at a frequency of 38 – 60%, compared with 85 – 94% frequency during cyclical high hare populations. Kill rates varied from 0.3 to 1.2 hares per day. Hunting success for lynx preying on hares declined past the point when hares started increasing, and hunting success continued to increase for lynx hunting red squirrels, suggesting that lynx became skilled at killing red squirrels during hare lows (O'Donoghue et al. 1998). This has implications for lynx in southern populations: individuals may learn and become skilled at foraging on alternate prey.

Lynx have broader diets and use a wider range of habitats in summer than winter in northern populations. Summer diets there contain less snowshoe hare and more alternative prey, including red squirrels, small mammals, ground squirrels, ducks, passerines and other birds, ungulates, and carrion (Mowat et al. 2000). Riparian willow stands were used more in winter, but no other changes were observed between winter and snow-free times in the Yukon (Mowat and Slough 2003).

Community Ecology

Predation

The predatory relationship between the lynx and the snowshoe hare is well-known and well-studied in northern populations. The tightly linked cycles of the 2 species were first illustrated by fur harvest records of the Hudson's Bay Company in the 1800s (Elton and Nicholson 1942). Lynx densities at peak cycle can be 15-times higher than in the cycle trough, an amplitude much greater than is known for any other predator (Bulmer 1974). The generally accepted explanation for the

cycles is that high hare densities reduce winter forage, which reduces hare reproductive success and initiates a hare decline. Predation on hares by lynx and other predators accelerates the decline until hares become extremely rare. Lynx numbers trail those of hares, and bottom-out a year or 2 following the hare crash in response to low hare abundance. This allows winter hare forage to recover, which slowly results in increasing hare density. Climate may also play a driving role in the cycles, including a possible link with the North Atlantic Oscillation (Stenseth et al. 1999).

Whereas hares in northern populations may fluctuate 10 to 25 fold, in southern populations their fluctuations are typically much weaker (Hodges 2000a, 2000b).

Competition

Competition with lynx from other predators takes two forms, exploitation and interference (Buskirk et al. 2000). Exploitation competition involves potential competitors for food, especially snowshoe hares, such as coyotes and raptors. Interference competition involves direct aggression and may include attacking and killing. Coyotes, mountain lions, and bobcats are all exploitative and interference competitors with lynx. All 3 of these carnivores are also more widespread and abundant than they were 50 years ago in the southern portion of lynx range (Buskirk et al. 2000). Mountain lions are known to kill lynx in Montana (Squires and Laurion 2000). Bobcats are typically larger and more aggressive than lynx; on Cape Breton Island bobcats are the suspected cause of lynx disappearing from lower elevations (Parker et al. 1983).

Coyotes may be particularly important competitors in southern mountains (O'Donoghue et al. 1998, Buskirk et al. 2000). Coyote use of lynx habitat is likely increasing as snowmobiles and other agents extend compacted trails into areas where deep snow formerly prevented coyote travel (Koehler and Aubry 1994, Buskirk 2000, Buskirk et al. 2000, Bunnell et al. 2004; but see also Kolbe et al. 2004). This effect likely extends to other generalist predators as well.

Parasites and Disease

Ectoparasites and endoparasites have been described for lynx but do not appear to pose a management problem (Tumlison 1987). A number of diseases, including panleucopenia, rabies, coccidiosis, and mycoplasmosis, are known to infect lynx at rather low levels. Serological surveys of 215 lynx from six sites in western North America revealed low disease prevalence, suggesting rare contact between free-ranging lynx and common feline pathogens (Biek et al. 2002). All six sites did show serologic evidence for feline parvovirus, and it was more common in southern populations. Plague was the cause of death of four of the Colorado lynx (Colorado Division of Wildlife 2004).

Symbiotic and Mutualistic Interactions

There is no information to suggest important symbioses involving lynx.

Conservation Concerns

In northern populations there has not yet been a substantial amount of habitat alteration, and lynx populations are rather stable and under no great degree of conservation concern (Quinn and Parker 1987). In Canada the species is endangered only in New Brunswick, and has been extirpated from Prince Edward Island and mainland Nova Scotia. Fur trapping can be the single largest mortality source, and thus is a critical management factor, in northern populations (Ruggiero et al. 2000).

Knowledge of historic lynx distribution in the southern portion of their range is poor (Fitzgerald et al. 1994), but they appear to have regularly bred in the Central Rocky Mountains and regularly occurred, with possibly sporadic breeding, in the Southern Rocky Mountains. It is generally accepted that lynx have declined in these areas over the past 50 - 100 years as their already naturally-fragmented habitat was further fragmented by anthropogenic forces, most

notably timber harvesting, road building, and increased shooting and trapping pressure (Reeve et al. 1986, Quinn and Parker 1987). Most states allowed harvest of lynx up until the 1970s, but this has largely been abandoned as lynx numbers declined. In contrast to northern lynx populations fur trapping is probably not a major pressure in the south, although the effects of accidental capture of lynx in traps set for bobcats, coyotes, and other southern furbearers should be analyzed more closely.

Lynx in the southern portion of their range are ecologically distinct from lynx in the north. Naturally-fragmented habitat, more habitat disturbance, higher dependence on non-hare prey, and substantially more interactions with generalist carnivores all challenge the management and conservation of southern populations. The below discussion will focus on these southern dynamics, with only occasional and brief reference to northern populations.

Conservation Status

USDI Fish and Wildlife Service

The Canada lynx was proposed for listing as threatened under the ESA on 8 July 1998 (Federal Register Volume 63, No. 130). On 24 March 2000 the final rule listing the contiguous United States Distinct Population Segment (DPS; Colorado, Idaho, Maine, Michigan, Minnesota, Montana, New Hampshire, New York, Oregon, Utah, Vermont, Washington, Wisconsin, and Wyoming) was issued (Federal Register Volume 65, No. 58) (USDI Fish and Wildlife Service 2000). The main factor noted as threatening this DPS was the inadequacy of existing regulatory mechanisms. In 2002 the U.S. District Court for the District of Columbia remanded for further consideration the determination that the Northeast, Great Lakes, and Southern Rockies do not constitute a significant portion of the range of the DPS. The remand notice found that the lynx is

not endangered throughout a significant portion of its ranges, and does not warrant reclassification to "endangered" (USDI Fish and Wildlife Service 2003).

The USFWS plans to establish a Recovery Team and develop a Canada lynx Recovery Plan (http://www.r6.fws.gov/endspp/lynx/recovery.htm). No timeline is provided at this time. USFWS can propose delisting of a species when it determines that a listed population has recovered and there are reasonable assurances that it will not be threatened again when ESA protections are removed (16 U.S.C. §1533(a)). The USFWS is also currently developing critical habitat designations.

Reintroductions of lynx have occurred in New York in the late 1970s and in Colorado starting with releases in the late 1990s and continuing to present. The New York effort failed (McKelvey 2000). The Colorado project has been successful to date, with six dens found and 16 kittens born in 2003, and another seven kittens found in 2004 (Colorado Division of Wildlife 2004). As noted earlier, individuals from the Colorado reintroduction have colonized mountains of southern Wyoming, with successful reproduction documented in winter 2003-2004 in the state.

USDI Bureau of Land Management

The lynx does not appear on the Sensitive Species List of the BLM - Wyoming State Office because this list explicitly excludes species already designated by the USFWS as endangered or threatened.

USDA Forest Service

Similar to the situation with the BLM, the Sensitive Species lists of the USDA Forest Service explicitly exclude species already designated by the USFWS as endangered or threatened.

State Wildlife Agencies

The Wyoming Game and Fish Department (WGFD) classifies the lynx as a furbearer with no harvest allowed; i.e., it is a protected species. In their Native Species Status system the WGFD ranks the lynx as NSS1, which indicates populations are greatly restricted or declining with extirpation possible and/ or ongoing significant loss of habitat.

State Natural Heritage Programs

The Wyoming Natural Diversity Database (WYNDD; University of Wyoming) ranks the lynx as **G5 / S1** with a Wyoming Contribution Rank of **Low**. The "G5" indicates that the species is demonstrably secure at the continental scale; "S1" indicates a very high probability of extinction from the state. The Wyoming Contribution Rank indicates that because Wyoming forms a rather small part of the lynx's continental range Wyoming populations contribute little to the persistence of the species as a whole in North America (Keinath et al. 2003).

Biological Conservation Issues

Abundance

Lynx are so cryptic and occur at such low densities in Wyoming and surrounding states that it is difficult to assess their abundance. Reliable trapping data are available for only four U.S. states (Minnesota, Montana, New Hampshire, and Washington), with fairly large numbers of lynx reported from Minnesota and Montana (McKelvey 2000). For other states, including Wyoming, available data can be used only to infer some degree of presence.

Most of the historic and recent Wyoming lynx records are from the northwestern and western mountains (Reeve et al. 1986; WYNDD, unpublished data). Recent field data suggest that lynx currently occupy these ranges (Squires and Laurion 2000, Murphy et al. 2004; WYNDD, unpublished data), and lynx from the recent Colorado reintroduction have colonized portions of

the Medicine Bow and Sierra Madre ranges in southern Wyoming. The USFWS (USDI Fish and Wildlife Service 2003) believes that most lynx in Wyoming are dispersers from source populations to the north (and now south, assuming continued success in Colorado), with little reproduction occurring within the state itself.

Throughout most of the species' range the local abundance of Canada lynx clearly varies with snowshoe hare density. It is thought that this occurs in a rather dampened fashion in Wyoming and surrounding states, such that the highest possible densities in southern populations may be comparable to some of the lowest recorded densities in northern populations.

Trends

Abundance Trends

Quantitative estimates of lynx abundance trends in Wyoming are unavailable due to lack of data, but it is generally accepted that lynx numbers here have declined as anthropogenic impacts on boreal forests have increased. The persistence of southern populations may always have depended on regular importation of individuals from the north; this dependence may be greater now as habitat quality in the south has declined. In general, population peaks in northern populations can generate waves of dispersers that can supplement southern populations in following years, but the dynamics of such dispersal are not well-understood (Mech 1980, McKelvey 2000). Extremely low hare densities to the north can also send dispersers southward, as individual lynx abandon formerly adequate home ranges in search of more prey (McKelvey 2000).

The recent lynx reintroduction in Colorado has provided a new regional lynx source, and individuals from Colorado have colonized mountain ranges in southern Wyoming. The extent to which Colorado continues to serve as a lynx source is a major management question.

Population Extent and Connectivity Trends

Based on limited trend information and a general knowledge of lynx natural history it is reasonable to assume that human development of lynx habitat has decreased and fragmented the species' distribution relative to historic levels in Wyoming and surrounding states. The recent reintroduction in Colorado has clearly countered this trend and, as stated above, the extent to which Colorado continues to serve as a lynx source is a major management question.

Because Wyoming populations may depend highly on importation of dispersers from outside of the state, regional connectivity of lynx habitat is a key issue for Wyoming managers. Lynx can traverse low-elevation environments during dispersal, especially if timbered ridges and forested riparian corridors are available. However, such environments are heavily disturbed throughout the region; in fact, in general low-elevation environments are more disturbed than true lynx habitat at higher elevations.

Habitat Trends

The distribution of lynx in the U.S. is clearly tied to the distribution of boreal forest, and such habitat is naturally fragmented across Wyoming and surrounding states. Timber harvesting, road building, mining, and urbanization have further fragmented suitable lynx habitat here, especially considering that the late-seral stands preferentially targeted for timber harvest probably provide the best lynx habitat in the region. Loss and fragmentation of lynx habitat is expected to continue as human populations and development increase.

Range Context

Lynx populations in Wyoming and Colorado are at the southern end of the species' current and historic range. From a conservation standpoint this is a vulnerable position; in the long term, persistence in these areas may depend mostly on natural or human-mediated dispersal of individuals from outside population centers.

Extrinsic Threats and Reasons for Decline

Anthropogenic Impacts

High-impact anthropogenic features such as urban centers, surface mines, interstate highways, and reservoirs have had obvious negative impacts on lynx populations in the region and will not be discussed further.

Forest management actions that degrade habitat for snowshoe hares and/or red squirrels will negatively affect lynx. In southern mountains, where late-seral stands probably provide the best habitat for hares, squirrels, and lynx, timber harvesting may have the greatest impact in this context. Clearcut harvesting directly removes lynx habitat; other harvest types such as shelterwood cutting, seed tree cutting, and diameter-limited prescriptions probably have less dramatic impacts. Any harvest system that removes a significant number of large live trees, standing snags, and downed woody debris reduces the quality of current and future lynx habitat at that site (Koehler 1990, Koehler and Brittell 1990, Ruediger et al. 2000). The preferential siting of timber harvests in flat landscapes may be especially harmful, because lynx appear to seek out flat forests in winter to minimize the energetic cost of travel. Stand-replacing fires have the potential to degrade lynx habitat as well, although it is recognized that wildfire typically removes fine woody debris and leaves coarse woody debris, a situation opposite to that produced by timber harvesting.

The increase in road density that accompanies timber harvesting, mineral development, and other management actions also poses a threat to lynx by increasing den disturbance, incidental harvest, poaching, access during winter for competing carnivores, and mortality from vehicles (Koehler and Brittell 1990, Aubry et al. 2000, Buskirk 2000). Lynx are known to follow road edges for considerable distances, and commonly use roads as home range boundaries (Ruggiero et al. 2000, Apps 2000). Seven of the lynx translocated to Colorado between 1999 and 2003 were

illegally shot (Colorado Division of Wildlife 2004), accounting for 14% of the 51 mortalities; 6 Colorado lynx (12%) were killed by cars. Lynx in New York had 50% mortality from vehicle collisions. Two highway mortalities of native, wild lynx were documented recently in Wisconsin and Minnesota (Ruggiero et al. 2000).

Exceptionally heavy livestock grazing in high-elevation forests could affect lynx populations by reducing forage and cover for snowshoe hare and other lynx prey species, especially if such grazing takes place in productive aspen stands or riparian willow communities encompassed by late-seral conifer forest.

Because Wyoming lynx populations likely require continual supplementation of individuals from outside of the state anthropogenic development of low elevation environments not normally considered as lynx habitat could have profound impacts. Actions that reduce the likelihood of lynx moving across low elevation basins could "strand" Wyoming populations. In this region the largest disturbance to low-elevation travel habitat is probably mineral exploration and extraction, along with accompanying roads and increased human presence.

Invasive Species

There is no information to suggest that exotic species are currently affecting lynx in the Central or Southern Rocky Mountains.

Natural Predation

Lynx are vulnerable to predation by bobcats, mountain lions, coyotes, and possibly also wolves (*Canis lupus*). In general, anthropogenic development of lynx habitat increases the abundance and distribution of many generalist carnivores, probably to the detriment of lynx.

Intrinsic Vulnerability

Habitat Specificity and Fidelity

Current knowledge indicates that lynx are habitat specialists in the Central and Southern Rocky Mountains: they preferentially occupy large expanses of boreal forest, which are rare and fragmented at a regional scale, and have a finer-scale requirement for increasingly rare late-seral conifer stands within those forests. As such lynx are especially vulnerable to habitat disturbances.

Area Requirements

Individual lynx require rather large areas, on the order of 100 - 200 km^2 (10,000 - 20, 000 ha) for home ranges in Wyoming and surrounding states. The Lynx Conservation Assessment Strategy (LCAS) defined a lynx analysis unit (LAU) as the smallest scale for evaluation and monitoring of the effects of management actions on lynx (Ruggiero et al. 2000). An LAU approximates the size of one animal's home range, and includes the area required by a female to raise her young. The size of an LAU is described as 6,500 – 10,000 ha (16,000 – 25,000 acres or 25 – 50 square miles) of primarily boreal forest, with small amounts of other environmental types such as lakes, alpine tundra, and montane forest.

By any standard such land units are rare in Wyoming, and thus the likelihood of a viable population residing completely within state borders is rather low. As mentioned previously this suggests that managers should focus as much effort on maintaining connectivity to lynx populations in Montana (and, by extension, Canada) and Colorado as they do on maintaining and improving the quality of lynx habitat in Wyoming. Lynx dispersal into Wyoming from Idaho and Utah is probably rather low compared that from Montana and Colorado.

Susceptibility to Disease and Parasites

Although lynx can be infected by a number of pathogens, there is no information to suggest that parasites and diseases are major limits to lynx populations.

Dispersal Capability

Lynx can disperse over very long distances, with documented movements of northern animals reaching 1,000 km (Mech 1980, Slough and Mowat 1996, Poole 1997). During such dispersal animals travel about 1.7 – 8.3 km per day, similar to the daily movements of resident lynx (Mech 1980).

Lynx transplanted from the Yukon to southwestern Colorado have moved several hundred kilometers. One such lynx eventually died in western Nebraska, a linear distance of about 800km from its release site. At least 4 others have ranged into southern Wyoming, 400-600 km from their release sites (Colorado Division of Wildlife, unpublished data).

Reproductive Capacity

Lynx vary reproductive output in response to prey density. In Alberta 73% of females conceived in years of abundant snowshoe hares; this dropped to 33% when hares were rare (Brand and Keith 1979). Lynx also produce large litters (up to 8 kittens) when prey is abundant (Mowat and Slough 1998). Because prey densities appear to be chronically low (from a lynx perspective) in southern forests, it is assumed that lynx reproductive output will also be chronically low here. Of a litter of 4 kittens produced in western Wyoming in 1998, none survived (Squires and Laurion 2000). Of 16 kittens produced in Colorado in 2003, only 6 survived into their second year (Colorado Division of Wildlife 2003, 2004).

Sensitivity to Disturbance

Lynx can tolerate moderate levels of human disturbance (Aubry et al. 2000), although it is generally accepted that disturbance to active dens may result in abandonment.

Genetic Factors

Lynx and bobcats have hybridized in Minnesota, Maine, and New Brunswick. Pilgrim and Schwartz (2004) suggest that hybridization may hinder lynx recovery. Human modification of

native environments has allowed bobcats to occupy a larger area of North America than historically, which may increase the potential for hybridization across lynx range.

Small and peripheral populations of lynx have less genetic variation than core populations (Schwartz et al. 2003). At first glance this suggests that that Wyoming lynx may be somewhat threatened by detrimental genetic processes. However, continual dispersal of lynx into the state from northern population centers and from Colorado (lynx released in Colorado were originally captured in the Yukon) should alleviate these processes to some degree.

Protected Areas

Lynx themselves are protected across Wyoming by their federal listing under ESA and their non-harvest status within the WGFD. Much lynx habitat in the state falls within USDI National Park Service units and USDA Forest Service Designated Wilderness. However, the area of most consistent lynx occupation in Wyoming (the Wyoming and Salt River ranges of west central Wyoming) is managed as a multiple use landscape, as is most of the low elevation habitat that lynx must cross to access other mountain ranges and lynx population centers in the region.

Population Viability Analyses (PVAs)

At this time there are no population viability analyses for lynx in the literature. Dr. J. Squires (USDA Forest Service) is reportedly working on such an analysis for lynx in northwestern Montana.

Conservation Actions

The federal listing of the Canada lynx under the ESA in 2000 (USDI Fish and Wildlife Service 2000), further supported by the remand notice of 2003 (USDI Fish and Wildlife Service 2003), has stimulated broad conservation action in the contiguous U.S. As directed by ESA and court orders,

the USFWS is presently developing a lynx Recovery Plan and establishing lynx critical habitat in the contiguous U.S.

The LCAS (Ruggiero et al. 2000) grew out of the listing efforts, and puts forth relatively detailed criteria for allowable management actions and conservation. All USDA National Forests with designated LAUs are in the process of amending Forest Service plans to incorporate the conservation measures from the LCAS. The BLM is currently preparing a statewide programmatic Biological Assessment for their Resource Management Plans on lynx, and is considering adopting the LCAS conservation measures in this document.

The reintroduction of lynx into Colorado, and their subsequent dispersal into southern Wyoming, is the most aggressive conservation action to date for the species in the contiguous U.S. The success of this effort, still in question, will have a major impact on lynx management and recovery in the U.S. in general, and in Colorado and Wyoming in particular.

Conservation Elements

Inventory and Monitoring

There are no organized inventories or monitoring efforts for lynx being conducted in Wyoming. Biologists in federal land management agencies and WGFD commonly record observations of lynx and lynx tracks on an opportunistic basis, as do other biologists and some laypersons. Radio-collared lynx that range into southern Wyoming from Colorado are monitored by the Colorado Division of Wildlife.

Techniques for inventory and monitoring include track surveys in winter, scent stations with hair snags and track plates, and capture/ radio telemetry. Remotely-triggered cameras are being used in Colorado to evaluate use of highway underpasses. Further details on inventory and

monitoring techniques can be found in Ruggiero et al. (1994), with special attention to Koehler and Aubry (1994) and the subsequent publication of Zielinski and Kucera (1995).

Habitat Preservation and Restoration

If implemented, the recommendations within the LCAS will promote habitat protection and enhancement for lynx. In general, minimizing disturbance to late-seral boreal forest, and mid-seral forest that will soon convert to late-seral stages, will benefit lynx populations in Wyoming. Managers seeking to promote lynx occupancy and survival should pay special attention to protecting late-seral stands in flat landscapes, retaining large live trees and existing coarse woody debris in all stands, and minimizing the density of roads, especially packed roads and trails in winter. To the extent possible, management actions that benefit prey populations, especially snowshoe hare and red squirrel, will benefit lynx.

Because long-term lynx presence in Wyoming is likely very dependent on regular importation of individuals from population centers to the north and south, land managers should focus on maintaining regional permeability to dispersing lynx. This necessarily requires minimizing disturbance in key low-elevation environments that connect major mountain ranges. The Green River Canyon area in northwest Colorado, the Bear Lake area in northern Utah and southeast Idaho, the Snake River headwaters north of Rexburg, Idaho, the Prior Mountains of south-central Montana, the Crooks - Green - Ferris - Seminoe - Shirley mountain chain in central Wyoming, and the Owl Creek - Bridger mountain chain in central Wyoming are obvious sites in this context. Fine-scale mapping of these sites to identify and plan management of potential lynx movement paths, such as timbered ridges and riparian corridors, is recommended.

Augmentation and Reintroduction

There are no plans to reintroduce lynx in Wyoming. The Colorado Division of Wildlife has released 167 lynx into central and southern Colorado from 1999 to 2004, and plans to release 50 lynx in 2005 and 15 each in 2006 and 2007. Individuals from past Colorado releases have already colonized mountains in southern Wyoming, and more are expected to do so in the future.

Information Needs

Rangewide Needs

Much information on lynx ecology comes from northern populations, which are stable in a conservation sense and quite different from southern populations. More research into northern populations is certainly warranted, but it is not as high a priority as basic field research on southern lynx populations.

Wyoming Needs

Basic field studies of lynx in the Central and Southern Rocky Mountains are lacking. In general, radio-telemetry studies that take an explicitly spatial focus to elucidate population dynamics and viability in the patchy forests of the Central and Southern Rocky Mountains are most needed. Good information on home range and habitat selection, especially by reproducing females, as well as mortality sources and dispersal dynamics would greatly inform management. Similarly, scat analyses and snow trailing studies that estimate diet and prey selection in southern forests are needed.

Interactions between lynx and generalist carnivores could be studied in a variety of ways, including snow tracking and radio telemetry. Such interactions are likely very important to lynx in this region, and the probability of such interactions likely varies with road density and other

landscape metrics. Studies that estimate these relationships could provide valuable information to land and wildlife managers.

It is assumed that the telemetry monitoring of lynx recently released into Colorado will generate much of the information outlined above. Continued support for this research is crucial, as it will provide the largest and most important body of information for lynx management in Wyoming. The Colorado work will probably also provide some insight into the low-elevation environments used by lynx traveling between the Southern and Central Rocky Mountains. However, new studies will be needed to provide the same information for lynx dispersing between the Central and Northern Rocky Mountains.

Figures

Figure 1. Range of the Canada lynx (*Lynx canadensis*) in North America. Brown indicates areas of consistent occupation; blue lines encompass the region where lynx occasionally occur as they disperse from more permanent population centers in the vicinity of Wyoming. Note that lynx have recently been reintroduced into the Southern Rocky Mountains of Colorado. Modified from Patterson et al. (2003).

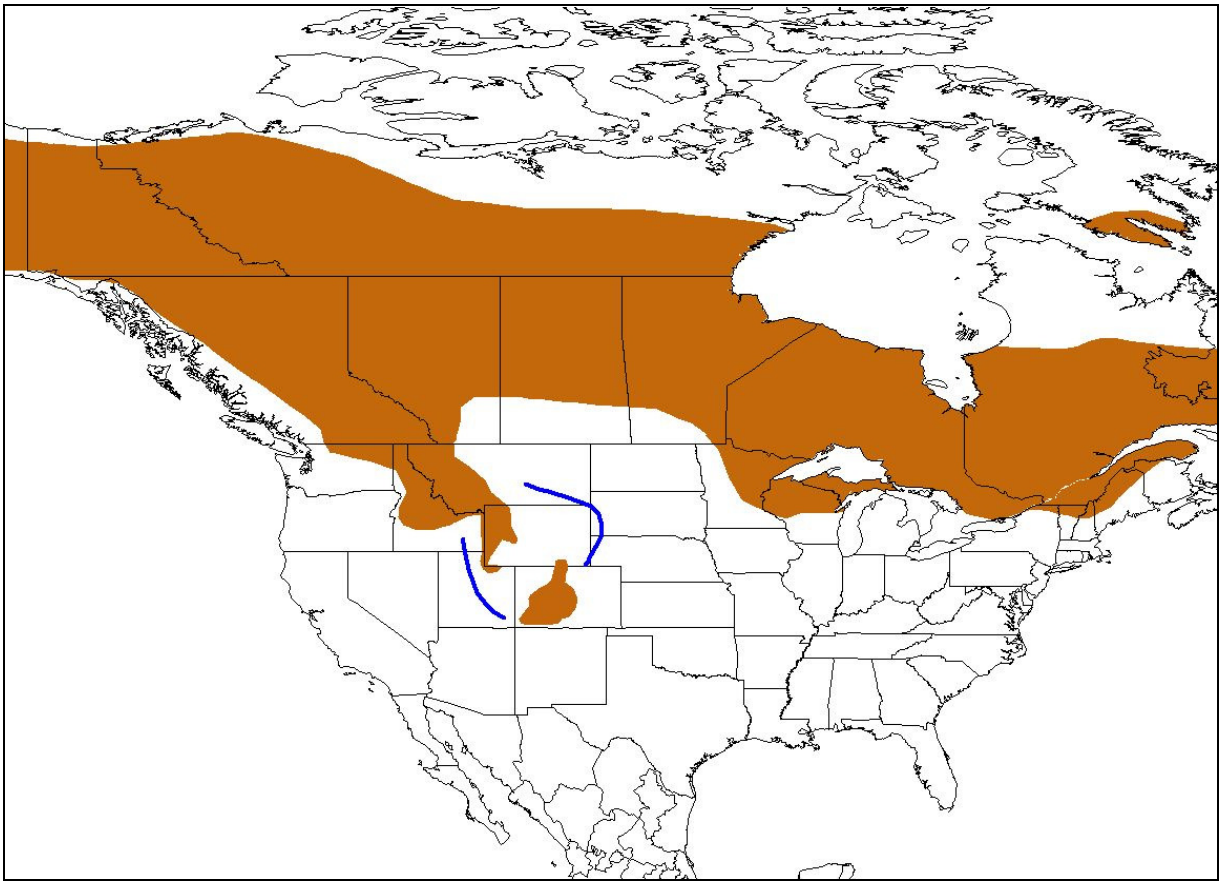
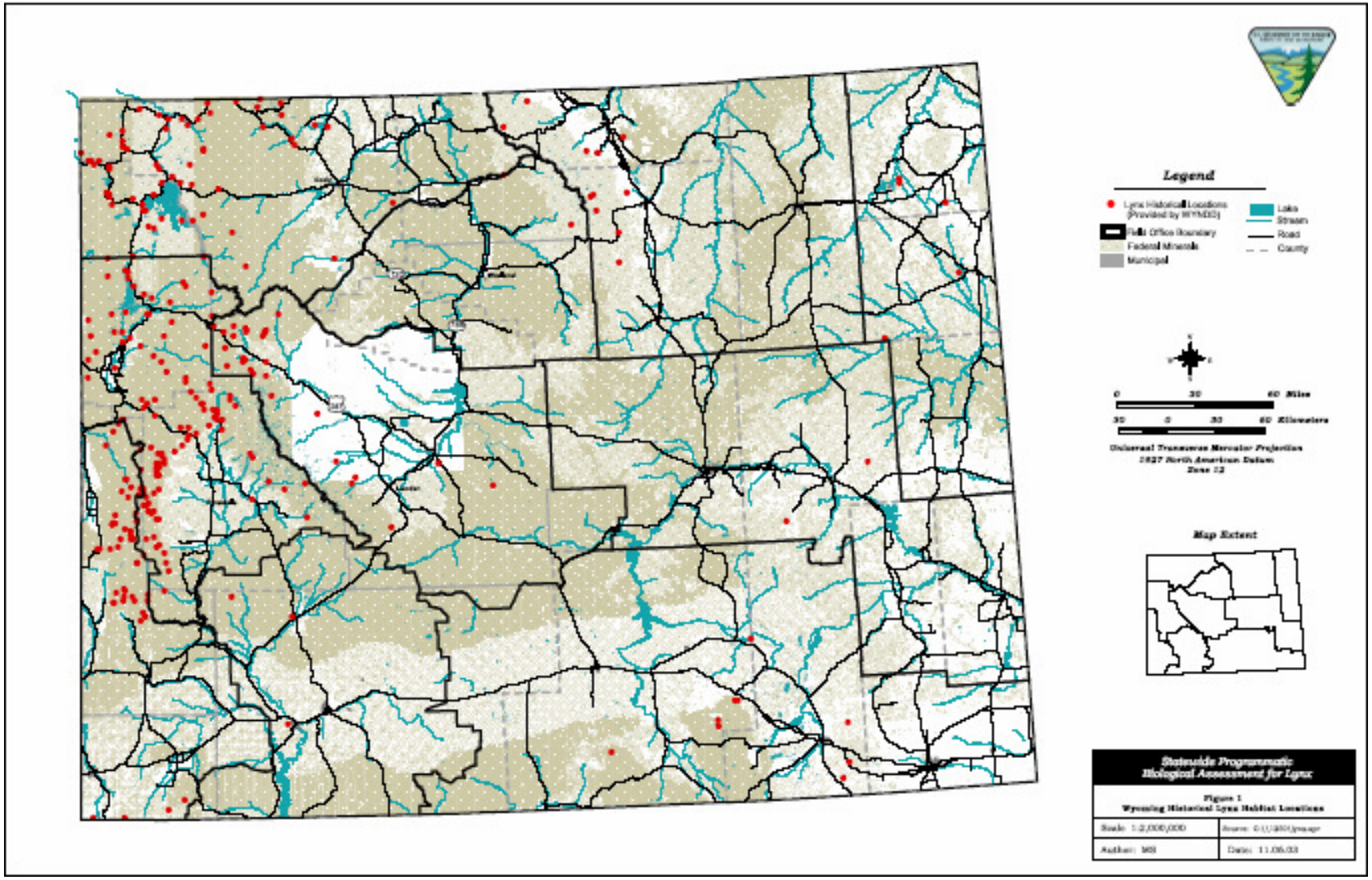


Figure 2. Documented observations of Canada lynx (*Lynx canadensis*) in Wyoming (red dots). Data on file at the Wyoming Natural Diversity Database, University of Wyoming (Laramie, Wyoming, USA).



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