Conservation status and needs of the lynx (*Lynx canadensis*)
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Abstract: This document presents a status review of the lynx in the US and recommendations on science-based policies needed to protect and restore the lynx and its habitat. Forest practices, fire, trapping, livestock grazing and other developments, habitat fragmentation, and the need for a cumulative effect analysis are recognized as the main issues affecting lynx conservation and recovery. A summary of scientific literature addressing each issue is presented together with the standards adopted by the US Forest Service on each component.

Saving a Place for America's Predators

Predator Conservation Alliance's Literature Summary —
Draft — May 4, 2001 — Draft
Conservation Status and Needs of the Lynx (*Lynx canadensis*)

Part I. Conservation status of the lynx

A. Current and historic lynx distribution and numbers nationwide (Sources: McKelvey et al. 2000, Koehler and Aubry 1994)

Lynx historically occupied the northern forests of the lower-48 states in the Northwest, Rocky Mountains, Lake States and Northeast. Today they are reduced to small, fragmented populations in the following areas: (1) the Northwest and northern Rockies, (2) the southern Rockies, thanks to a reintroduction project now underway, (3) the Lake States, where there are regular but unconfirmed sightings, and (4) the Northeast (a breeding population was recently confirmed in Maine). There are few estimates of lynx numbers in the published literature, but extrapolating from the best available information indicates an estimated population of fewer than 1000 lynx nationwide, including an estimated 500-750 in the northern Rocky Mountains, 100-200 in the

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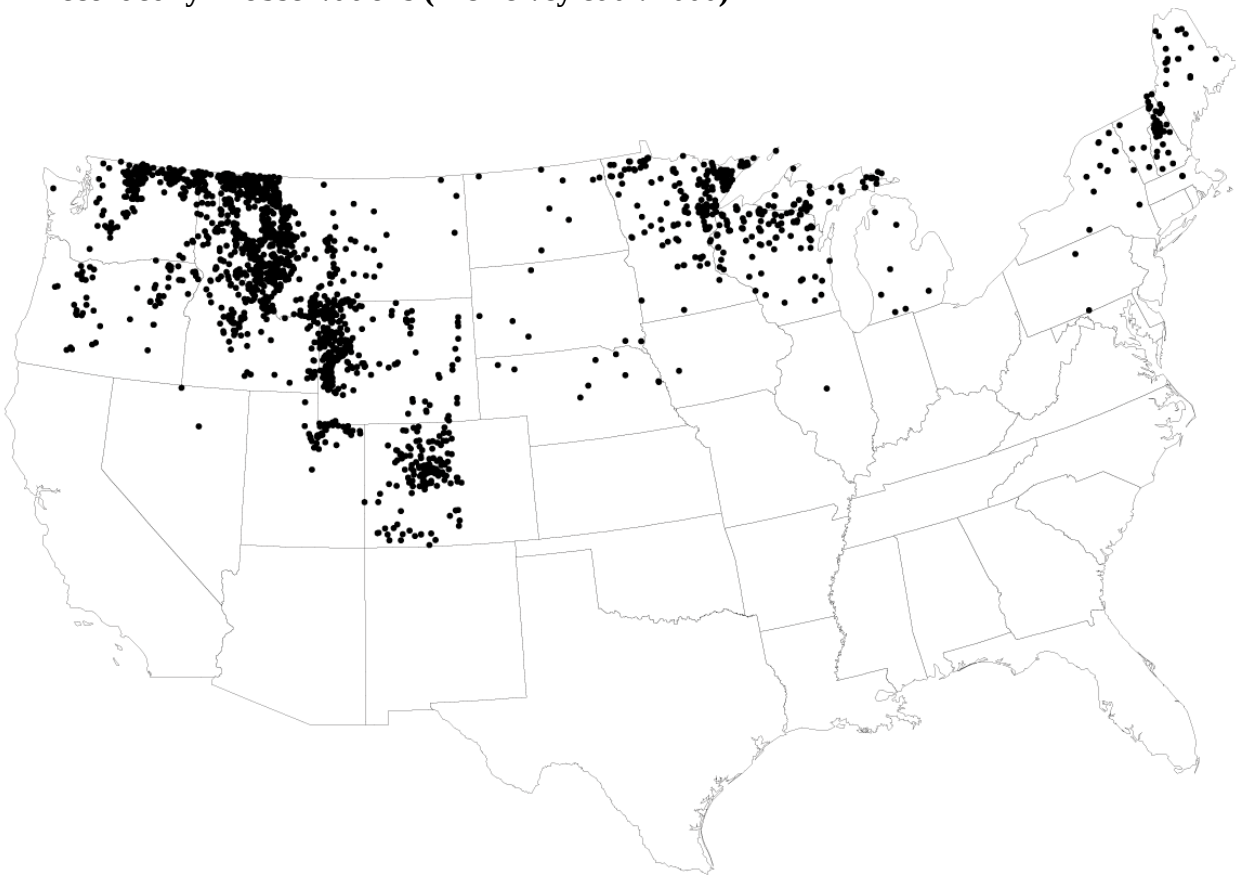
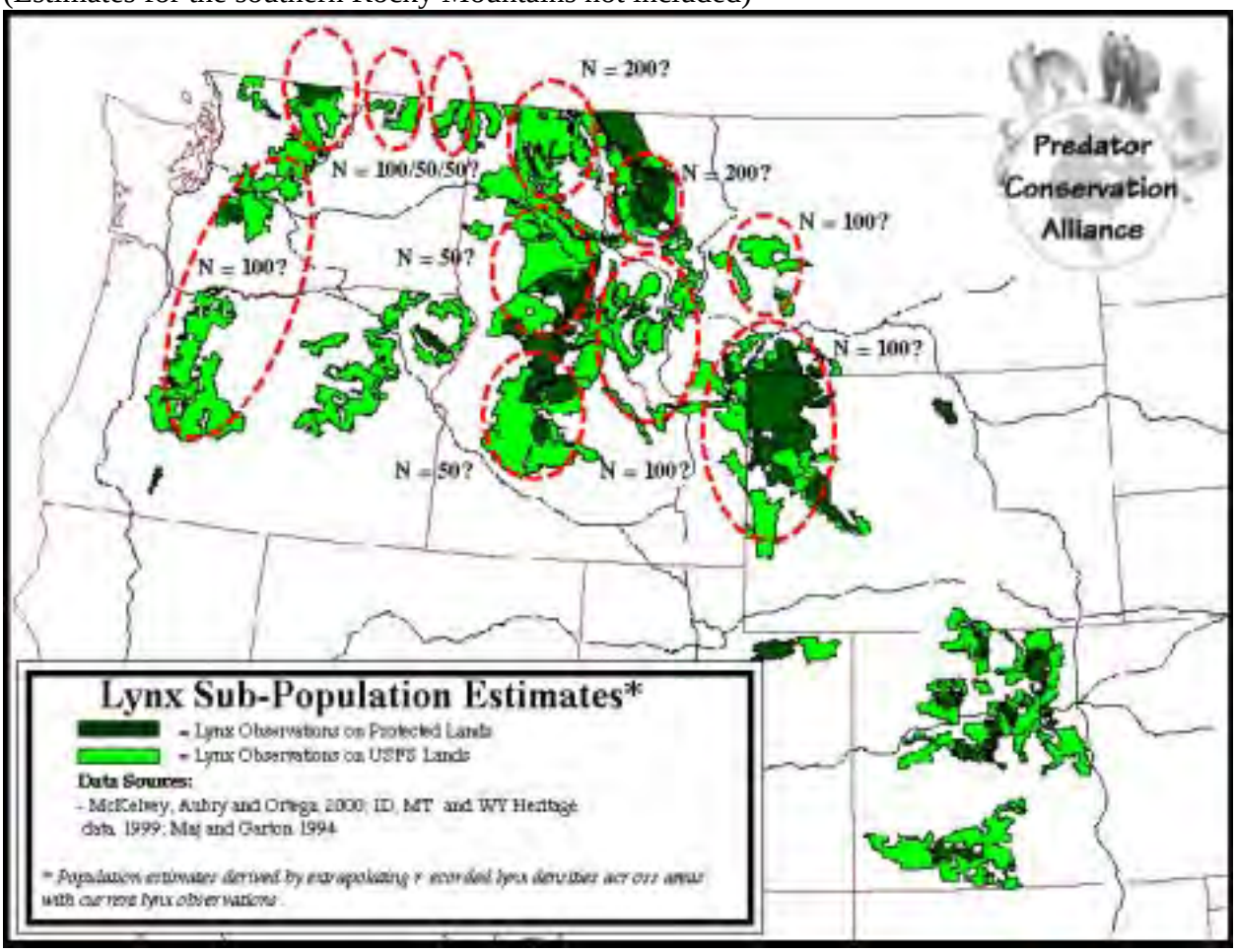
Northwest, 50-75 in the southern Rockies due to the reintroduction effort, and an estimated 50 animals or fewer in the Lake States and Northeastern United States.

All recorded lynx observations (McKelvey et al. 2000)



Predator Conservation Alliance's estimated lynx numbers in the western U.S.
(Estimates for the southern Rocky Mountains not included)



1. Northern Rockies

Montana is the remaining population "stronghold" for lynx in the lower-48 states, and even here lynx range has shrunk to a scattering of small and increasingly isolated populations in the state's western mountain ranges. Trapping data indicates that lynx populations crashed just decades ago: several hundred lynx were trapped annually in Montana as recently as the early 1970's (McKelvey et al. 2000) and just two lynx were trapped annually in recent years prior to the state moratorium on lynx trapping in 1999. There are no current published estimates of lynx numbers in Montana or elsewhere in the northern Rockies, other than the fact that they are imperiled (e.g., USFWS 1998, p. 36999):

> "After 1985, lynx populations in Montana were believed to be at or near their lowest levels in the past several decades (Hash 1990). Brainerd (1985) documented evidence of Canada lynx reproduction; however, more recent evidence of recruitment into the population has not been documented."

Nothing has changed since 1985 to indicate any significant improvement in lynx numbers in Montana. On the contrary, the number of factors contributing to lynx decline are still ongoing,

and this has probably led to further declines in the Montana population since their critically low levels in the 1980's (Hash 1990). Research is currently underway to better estimate lynx status and trends in some areas of occupied habitat in western Montana and Wyoming (Squires and Laurion 2000).

Lynx have not been confirmed in Idaho in recent years, though there is ample evidence of their presence there historically (Lewis and Wenger 1998, and USDI 1997). Very few lynx are known to occur in Wyoming, but breeding was documented in 1998 and 1999 (Squires and Laurion 2000).

As indicated in the figure above, unpublished estimates by Predator Conservation Alliance (based on approximate densities within currently occupied habitat) indicate perhaps 400-600 lynx in Montana, 100 lynx in Idaho, and 50 lynx in Wyoming, for a total of 500-750 lynx throughout the northern Rockies region.

2. Northwest

Besides Montana, Washington has the most lynx still surviving in the lower 48. The Washington Department of Wildlife recently estimated that fewer than 96 to 191 individuals still survive in Washington scattered among five "fingers" of habitat extending south from Canada (WDW 1993). There are periodic sightings throughout the Cascades, and a 1999 Forest Service survey indicated lynx presence in western Oregon (K. McKelvey, USFS Rocky Mountain Experiment Station, Missoula, Montana, pers comm).

3. Southern Rockies

There are numerous historical records of lynx in Colorado and Utah; the last confirmed lynx in Colorado was in 1974, and a lynx was trapped in Cache County, Utah in 1991 (McKelvey 2000, McKay 1991, Halfpenny et al. 1982). A lynx reintroduction project is now underway in Colorado, and 96 lynx have been imported since 1999 from British Columbia, Alaska, and the Yukon (CDOW 1998, T. Shenk, Colorado Division of Wildlife, pers comm).

4. Lake States

Despite hundreds of lynx trapped annually in Minnesota, Wisconsin, and Michigan, there have been no confirmed lynx observations in this area in recent years (McKelvey et al. 2000).

5. Northeast

Lynx records are scarce for the Northeast, but a female lynx was captured and radio-collared in Maine in 1999, and was accompanied by two kittens (McKelvey et al. 2000). A project to reintroduce the lynx to the Adirondack Mountains of New York was tried in the 1980's, but there is no evidence that lynx continue to survive in the area (Brocke et al. 1991, Brocke et al. 1990).

B. Protected status of the lynx

1. Federal protections

The U.S. Fish and Wildlife Service listed the lynx as Threatened throughout its range in the contiguous United States under the Endangered Species Act, effective April 24, 2000 (USDI 2000).

2. State protections

Colorado	State-listed Endangered, 1976
Idaho	Species of Special Concern, Trapping Closed in 1997
Maine	Species of Special Concern, 1997
Michigan	State-listed Endangered, 1987
Minnesota	Trapping Closed in 1967
Montana	Trapping Closed in 1999
New Hampshire	State-listed Endangered, 1980
New York	Trapping Closed, 1967
Oregon	State Denies that the Lynx is a Resident
Utah	State-listed Sensitive
Vermont	State-listed Endangered, 1980
Washington	State-listed Threatened, 1993
Wisconsin	Protect Wild Animal, 1998
Wyoming	Species of Special Concern

Source: U.S. Fish and Wildlife Service Biological Opinion, October 25, 2000, Helena, Montana

Part II. Science-based policies needed to protect and restore the lynx and its habitat throughout the U.S. lower-48 states

A. Forest practices

1. Overall objectives

> Our challenge, from the perspective of maintaining lynx and their prey in the context of ecosystem management, is to design management strategies that result in dynamic, sustainable landscapes that approximate the composition of natural systems. (Ruggiero et al. 2000, XV, 10).*

The Forest Service has adopted the following standards to help protect lynx habitat from logging (USDA 2000):

> … limit disturbance within each [Lynx Analysis Unit] as follows: if more than 30 percent of lynx habitat within a LAU is currently in unsuitable condition, no further reduction of suitable conditions shall occur as a result of vegetation management activities by federal agencies. (77)

> Management actions (e.g., timber sales, salvage sales) shall not change more than 15 percent of lynx habitat within a LAU to an unsuitable condition within a 10-year period. (79)

> Following a disturbance such as blowdown, fire, insects, and disease that could contribute to lynx denning habitat, do not salvage harvest when the affected area is smaller than 5 acres; exceptions would include areas such as developed campgrounds. Where larger areas are affected, retain a minimum of 10% of the affected area per LAU in patches of at least 5 acres to provide future denning habitat. In such areas, defer or modify management activities that would prevent development or maintenance of lynx foraging habitat. (79)

> In aspen stands within lynx habitat in the Cascade Mountains, Northern Rocky Mountains and Southern Rocky Mountains Geographic Areas, apply harvest prescriptions that favor regeneration of aspen. (79)

2. Protect from logging mature and old growth stands suitable for denning

Mature and old growth forest has declined significantly in the northern Rockies and Northwest, to the extent that this may be a primary factor limiting lynx survival and recovery. Any logging proposed in the name of improving habitat for lynx must avoid these areas.

The Forest Service has adopted the following standard to protect denning habitat for lynx (USDA 2000):

> Within a [Lynx Analysis Unit], maintain denning habitat in patches generally larger than 5 acres, on at least 10 percent of the area that is capable of producing stands with these characteristics. Where less than 10 percent of the forested lynx habitat within a LAU provides denning habitat, defer those management actions that would delay achievement of denning habitat structure. (78)

Several key aspects that define denning habitat and that must be protected are noted by FWS:

* Here and throughout this document, references to Ruggiero et al. 2000 include the chapter and page numbers, respectively. In this case, Chapter 15, Page 10.

> "Canada lynx utilize late successional forests with large woody debris, such as downed logs and windfalls, to provide denning sites with security and thermal cover for kittens...
>
> In Washington, lynx used lodgepole pine, spruce, and subalpine fir forests older than 200 years for denning...
>
> ... sites selected for denning must provide for minimal disturbance by humans and proximity to foraging habitat (early successional forests), with denning stands at least 1 hectare (ha) in size."
> (USFWS 1998, p. 36995)

A review of the literature provides some additional guidance:

- All known den sites in southern [boreal forest] regions were located in mature forest stands with large woody debris. (Ruggiero et al. 2000, XIII, 2)

- Elimination of mature subalpine fir and Englemann spruce stands also may impact lynx... they are an important component of lynx habitat, especially during inclement winter weather, drought, or denning periods (Brittel et al. 1989)

- Maintain downfall in densities greater than 40 logs/150 feet lying 1-4 feet above the ground (Koehler and Brittell, 1990; Brittel et al. 1989)

- Maintain more than 10% of suitable lynx habitat as denning habitat (WDNR 1996a; USFS 1994)

- Maintain at least two denning sites per square mile (WDNR 1996a)

- Denning habitat must receive minimal human disturbance (Koehler and Brittell, 1990; Brittel et al. 1989)

3. Coarse woody debris should be left in place; Regeneration of tall shrubs and saplings should be encouraged to provide browse and cover for hares (e.g. No herbiciding where it will affect forage for snowshoe hares)

FWS explains the important traits to promote snowshoe hares:

> "Snowshoe hare prefer diverse, early successional forests with stands of conifers and shrubby understories that provide for feeding and cover to escape from predators and protection during extreme weather."
> (USFWS 1998, p. 36995)

The literature provides some additional direction:

- Other prescriptions such as "seed tree harvests" open forest dramatically and are typically followed by slash burning. Functionally, such sites may differ little from clearcuts for fauna that depend on coarse woody debris. (Tanimoto and Garton 1993)

- More than 200,000 acres are burned anually in Oregon and Washington for silvicultural puposes (Kauffman 1990). This action results in reduced structural heterogeneity at and near ground level in managed forests (Tanimoto and Garton 1993).

- Current tree harvesting techniques remove or burn slash; slash is vital part of lynx habitat (Koehler and Brittell 1990, Brittel et al. 1989; USFS 1997)

- Forestry practices using fertilizers, herbicides, and thinning reduces the time that it is productive to lynx (Brittel et al. 1989)

- Maintain high stem densities (>2,000 stems/acre), 6 feet in height, Maintain 50% or more of large stands unthinned to encourage high densities of snowshoe hare (USFS 1994)

4. Thinning should be done before hares recolonize an area, or preferably after hare production has sharply declined (aged more than 50 years). Thinned stands should maintain 180 stems/acre to function as travel corridor. To function as foraging habitat, stands must be dense to provide security and thermal cover (> 3000 stems/acre, 4690-13440 stems/acre).

(USDA 2000)

> In lynx habitat, pre-commercial thinning will be allowed only when stands no longer provide snowshoe hare habitat (e.g., self-pruning processes have eliminated snowshoe hare cover and forage availability during winter conditions with average snowpack). (79)

Thinning generally adversely impacts hares and therefore lynx. Though these impacts can be somewhat lessened if the thinning is done early before hare recolonize the site, it is best delayed until after its productivity has declined. Quite simply, thinning reduces the density of young trees and shrubs that provide essential cover and browse for snowshoe hares.

> Snowshoe hares generally occur in areas of dense forest cover, including shrubs and “doghair” thickets of small trees (Chapters 6 and 7). These structures are common in naturally regenerating areas after fire, but do not result from standard, even-aged forestry practices (Daniel et al.1979). Thus, we believe that natural regeneration and stand development will likely benefit hares and, ultimately, lynx. (Ruggiero et al. 2000, XV, 14-15)

> "... early thinning to maximize tree-growth potential can be compatible with snowshoe hare and lynx habitat needs provided that stands are thinned before snowshoe hares recolonize the area (Koehler and Aubry 1994)..." (USFWS 1998, p. 37001)

Koehler and Brittel (1990) provide additional guidance:

- thinned stands should maintain at least 180 stems/acre for lynx to travel through them;
- "thin before hares recolonize an area, or thinning should be considered when stands are older than 30-40 years and little used by hares;
- stands must be dense to provide security and thermal cover (> 3000 stems/acre, 4690-13440 stems/acre);
- maintain trees and shrubs 6-8 ft. tall, browse must be <0.4 inch dia.

Brittel et al. (1989) concurs:

- a brushy understory is the "common denominator" of snowshoe hare habitat
- in Washington State, densely stocked stands of lodgepole pine provide winter food for hares
- forage, hiding, thermal cover for hares should be in close proximity
- key characteristics include trees and shrubs at least 6 ft. tall, densely stocked stands, down material

Thinning guidelines are already in place on the Kootenai National Forest. Though any monitoring of the effectiveness of these standards are not yet conclusive, they represent an important start and should be immediately initiated elsewhere. The guidelines include the following stipulations regarding thinning in potential lynx foraging habitat (USFS 1997, Appendix IX):

- 30% of each stand will be retained in an unthinned condition
- the remaining 70% will be thinned to no less than 1100 trees per acre, such that managers
    - leave 600-800 trees per acre that are greater than 6 feet in height
    - leave an additional 300-500 trees per acre that are 2 to 6 feet in height, favoring lodgepole pine, spruce, and subalpine fir
    - ensure that brush cutting will be limited
    - ensure that trees left than 2 feet may be removed or left in place.

5. Clearcuts should not exceed 40 acres

FWS explains the major reasons for limiting opening sizes in lynx habitat:

> Intensive tree harvesting (e.g., large-scale clearcutting) can eliminate the mosaic of habitats necessary for Canada lynx survival, including late successional denning and early successional prey habitat. Specifically, these activities can result in reduced cover, unusable forest openings, and monotypic stands with a sparse understory that are unfavorable for Canada lynx and/or their prey." (USFWS 1998, p. 37001)

> "Canada lynx avoid openings such as clearcuts, unforested areas, and grasslands (Koehler et al. 1979; Koehler and Brittell 1990, Murray et al. 1994) and snowshoe hares are also unlikely to use such areas because of the lack of cover (Koehler et al. 1979; H. Golden, Alaska Department of Fish and Game, pers. comm. 1994; Koehler and Aubry 1994)." (USFWS 1998, pp. 37001-37002)

Additional literature concurs that lynx avoid open areas (Halfpenny and Biesiot 1986, cited in WDNR 1996a) for thermoregulatory reasons, to avoid predation, and to increase contact with prey (Poole 1994, Murray et al. 1984, Parker et al. 1983, Koehler et al. 1979; as cited in WDNR 1996a). The "40 acres" limit appears in the literature cited above (Koehler and Brittell 1990, Brittell et al. 1989). Incidentally, maximum opening sizes of 40 acres is also recommended for protecting grizzly bear habitat (IGBC 1986).

6. Openings should be irregularly shaped such that they do not exceed 300 feet across

Research has shown that lynx typically do not cross openings greater than 300 feet across (Koehler and Brittell 1990), and therefore clearcuts larger than this may detriment lynx not only by the loss of that area to lynx, but also by serving as an obstacle to lynx movements. Washington Department of Natural Resources recommends against creating openings in lynx travel corridors greater than 330 feet across (WDNR 1996a).

7. Cutting units should be laid out in a manner that preserves travel corridors across the landscape, especially along ridges, saddles and riparian areas; travel corridors must be greater than 300 feet wide

FWS explains the importance of spatial considerations when managing habitat for lynx:

> "Lynx require adequate travel cover (frequently intermediate successional forest stages) to provide connectivity within a forest landscape for security, movement within home ranges, and access between den sites and foraging areas." (USFWS 1998, p. 36995)

Brittel et al. (1989) and the USFS (1997, 1994) provide evidence to justify the 300-foot standard and some more specific recommendations for mitigating the effects of cutting units described above:

- cutting units must be contiguous with travel cover (Brittell *et al*. 1989);
- to function as travel cover, requires coniferous or deciduous vegetation greater than 6 feet in height (Brittell *et al*. 1989, USFS 1997);
- 40-60% of suitable habitat should function as travel cover (USFS 1997, USFS 1994);

- To function as travel cover, canopy cover should exceed 30% (USFS 1994);

- To function as travel cover, stem density should be at least 200 stems per acre (USFS 1994).

8. Logging roads

Logging roads should be minimized and kept as primitive as possible and should be closed and obliterated immediately after use (WDW 1993, Koehler and Brittel 1990).

B. Fire

Fire suppression should be considered a negative impact on lynx. Logging is not necessarily an effective substitute for fire, and opportunities to use fire to create and maintain foraging areas should be encouraged.

The Forest Service has adopted the following standards to promote the use of fire to maintain and restore lynx habitat (USDA 2000).

> Project planning - standards. [p. 80]
> 1. In the event of a large wildfire, conduct a post-disturbance assessment prior to salvage harvest, particularly in stands that were formerly in late successional stages, to evaluate potential for lynx denning and foraging habitat.
> 2. Design burn prescriptions to regenerate or create snowshoe hare habitat (e.g., regeneration of aspen and lodgepole pine).
>
> Project planning - guidelines. [p. 81]
> 1. Design burn prescriptions to promote response by shrub and tree species that are favored by snowshoe hare.
> 2. Design burn prescriptions to retain or encourage tree species composition and structure that will provide habitat for red squirrels or other alternate prey species.
> 3. Consider the need for pre-treatment of fuels before conducting management ignitions.
> 4. Avoid constructing permanent firebreaks on ridges or saddles in lynx habitat.
> 5. Minimize construction of temporary roads and machine fire lines to the extent possible during fire suppression activities.
> 6. Design burn prescriptions and, where feasible, conduct fire suppression actions in a manner that maintains adequate lynx denning habitat (10% of lynx habitat per LAU).

Wildfire was the disturbance mechanism that created and maintained lynx foraging areas historically, so it is likely to be our best tool to restore these areas today. Only where fire is not an option due to other management constraints may logging be appropriate as the next-best alternative to create similar conditions, provided it is carefully designed to do so (Brittel et al. 1989). Research has shown that there are significant differences between fires and clearcuts that

imitate logging, mostly concerning the time required before the areas are productive foraging habitat:

- hares reoccupy severely burned areas within 15 months (Keith and Surrendi 1971, cited in Brittel et al. 1989), yet
- small mammal populations are "drastically reduced immediately following clear cut operations" (Brittel et al. 1989), such that
- hares may not recolonize clearcuts until 6-7 years after cutting, and may not reach high densities for 20-25 years (Koehler and Brittell 1990, summarized by Butts 1992)

These differences may be driven by discrepancies in vegetative production between areas cleared by logging and those cleared by burning:

- harvested areas provide less forage than naturally burned areas: regrowth of fewer than 250 lbs/acre versus fewer than 500 lbs/acre (Freedman and Habeck 1984, cited in WDW 1993)

Thus, fire appears to be significantly preferable to logging in creating foraging habitat for lynx. More recent lynx literature affirms this as well:

> For the boreal forest, there are several general principles that must be addressed in landscape management plans if harvesting or fire disturbance is to be incorporated:
>
> 1. The habitat will be a product of the cumulative effect of all disturbances. The substitution of logging for fire, for example, is only meaningful if fire can be successfully removed from the environment, and even then, logging will not totally mimic fire as a disturbance process because of roading and coarse woody debris differences.
>
> 2. Typical models used for fire history studies suggest that fire selected a range of stand ages to burn. Harvesting only the oldest ages will decrease the average stand age of the landscape and will remove the complex boreal stand structure that may be critical for lynx denning. Young and old stands need to be part of any landscape disturbance plan.
>
> 3. Size and juxtaposition of stands is critical. Most fires are small. Most of the landscape, however, is affected by larger fire patches, with unburned areas inside the fire perimeter (stringers, islands, fire skips). (Ruggiero et al. 2000, III, 34)

> "Fire has played an important role in forest ecology in western mountain ranges of the United States. Forest fires naturally maintained mosaics of early successional forest stands, unburnt bogs and swamps, and late-successional conifer forest forming ideal snowshoe hare and Canada lynx habitat (Todd 1985; Fischer and Bradley 1987; Quinn and Parker 1987). During the early twentieth century, Federal and State agencies in the contiguous United States enacted a policy of suppressing forest fires. The lack of adequate hare habitat in southern latitudes may be partially a result of fire suppression during the past 50 years (Koehler 1990). Suppression of forest fires in the West has allowed forests to mature, thereby reducing habitat suitability for snowshoe hares and Canada lynx (Brittell et al. 1989; Fox 1978; Koehler 1990; Washington Department of Wildlife 1993; T. Bailey, U.S. Fish and Wildlife Service, in litt. 1994; H. Golden, pers. comm. 1994). Fire suppression is most likely affecting lynx habitat in areas where historical frequency of fires is shorter than the length of time fires have been suppressed in the Region (P. Stickney, U.S. Forest Service, pers. comm. 1994)." (USFWS 1998, p. 37003)

C. Access and recreation

The Forest Service has adopted the following standards to protect lynx from forest roads and trails (USDA 2000).

> "Plowed roads and groomed over-the-snow routes may allow competing carnivores such as coyotes and mountain lions to access lynx habitat in the winter, increasing competition for prey (Buskirk et al. 2000). However, plowed or created snow roads may be necessary to accomplish winter logging, which may be desirable to meet a variety of resource management objectives.
>
> "Preliminary information suggests that lynx may not avoid roads, except at high traffic volumes. Therefore, at this time, there is no compelling evidence to recommend management of road density to conserve lynx. However, new road construction continues to occur in many watersheds within lynx habitat, many of which are already highly roaded, and the effects on lynx are largely unknown. Further research directed at elucidating the effects of road density on lynx is needed.
>
> Programmatic planning - standards. [p. 83]
> 1. On federal lands in lynx habitat, allow no net increase in groomed or designated over-the-snow routes and snowmobile play areas by LAU. Winter logging activity is not subject to this restriction.
>
> Programmatic planning - guidelines. [p. 83]
> 1. Determine where high total road densities (>2 miles per square mile) coincide with lynx habitat, and prioritize roads for seasonal restrictions or reclamation in those areas.
> 2. Minimize roadside brushing in order to provide snowshoe hare habitat.
> 3. Locate trails and roads away from forested stringers.
> 4. Limit public use on temporary roads constructed for timber sales. Design new roads, especially the entrance, for effective closure upon completion of sale activities.
> 5. Minimize building of roads directly on ridgetops or areas identified as important for lynx habitat connectivity.

1. Road density standards should be implemented and enforced to protect lynx habitat security.

A current study underway in southcentral British Columbia is finding that roads affect lynx movements and suggests a mechanism for why the effects of roads on lynx may be more significant than movement data may suggest:

> The likelihood of highway crossings by resident lynx can be expected to vary among home ranges according to proximal habitat conditions, width of road allowance and traffic volume, and perhaps by the animal's sex and reproductive status. Although my analysis did not account for these factors, all lynx crossed highways less than random expectation within their 95% UD home ranges, suggesting that highways influenced lynx movements. Although my analysis only considered the influence of highways within home ranges, they may also influence home range selection just as dominant natural features can (Koehler and Aubry 1994), and this would decrease the substantive influence apparent within home ranges. (Ruggiero et al. 2000, XII, 9)

The same researcher cites a relevant study in Wisconsin where bobcats avoided roads:

> ... bobcats in Wisconsin selected home ranges with lower densities of secondary roads and crossed paved highways less than expected, a function of vehicle traffic levels and juxtaposition of preferred habitat to roads (Lovallo and Anderson 1996). (Ruggiero et al. 2000, XII, 9)

The Lynx Science Report mentions less-direct effects of roads, including the fact that increased access into lynx habitat for both people and competitors would likely result in increased lynx mortalities.

> As in the taiga, we found little evidence that roads represented a significant disturbance or mortality factor for lynx. Roads into lynx habitat may, however, provide access to generalist competitors, such as coyotes and bobcats. (Ruggiero et al. 2000, XIII, 2)

> Roads into areas occupied by lynx may pose a threat to lynx from incidental harvest or poaching (Koehler and Brittell 1990), increased access during winter for competing carnivores, especially coyotes (Chapter 4), disturbance or mortality from vehicles, and loss of habitat. (Ruggiero et al. 2000, XIII, 19)

In its proposed rule to list the lynx, FWS does a commendable job of describing the problems of increased human access into lynx habitat, primarily due to roads:

> "The likelihood of lynx encountering people has dramatically increased over the last few decades as a result of elevated levels of human access into lynx habitat. Roads and trails, snowmobiles, offroad vehicles, and ski area developments enable human access into historically remote forests, thereby increasing the likelihood of lynx being displaced from otherwise suitable habitats and increasing the vulnerability of lynx to human-induced mortality." (USFWS 1998, p. 37008)

> Elevated levels of human access into forests are a significant threat to Canada lynx because they increase the likelihood of lynx encountering people, which may result in displacement of lynx from their habitats and/or possible injuries or deaths by intentional or unintentional shooting, trapping, and vehicle accidents (Hatler 1988; Thiel 1987; Brittell et al. 1989; Koehler and Brittell 1990; Brocke et al. 1991; Andrew 1992; Washington Department of Wildlife 1993; Brocke et al. 1993; M. Hunter, University of Maine, pers. comm. 1994). Human access into Canada lynx habitat in many areas has increased over the last several decades because of increasing human populations and increased construction of roads and trails and the growing popularity of snowmobiles and offroad vehicles. In the interior Columbia River basin of Washington, Oregon, Idaho, and Montana, increased human access has decreased the availability of areas with low human activities, which are important to large forest carnivores, including lynx (U.S. Forest Service and Bureau of Land Management 1997)." (USFWS 1998, p. 37005)

Although roads in and of themselves may not harm lynx — in fact, lynx may use them as for easy travel routes, and even benefit from foraging habitat along the roadsides — the associated human access typically overrides any positive or neutral aspects of roads into lynx habitat. FWS explains:

> "Lynx will use some types of roads for hunting and travel (Koehler and Aubry 1994). Koehler and Aubry (1994) concluded road construction and maintenance are important components of lynx habitat management because they both destroy and create prey habitat, but also make lynx more vulnerable to human-caused mortalities...
>
> Even roads that are considered “closed" will continue to be accessible to snowmobiles, thereby allowing access to higher elevation lynx habitat by humans and lynx competitors." (USFWS 1998, p. 37005)

FWS also relates the significant negative effects of roads that receive higher traffic, primarily due to direct mortalities and fragmenting lynx habitat:

> "Blocks of suitable habitat, both public and private, are often dissected by extensive networks of paved roads. Traffic on highways has been shown to pose a considerable mortality risk to Canada lynx (Brocke et al. 1991; B. Ruediger, U.S. Forest Service, pers. comm. 1997). Highway densities are a contributing factor in the decline of carnivores, including the lynx, in the contiguous United States (Ruediger 1996). Dispersing or transient lynx are more vulnerable to traffic deaths than resident lynx because their movements over large areas increase their exposure to roads. In the Great Lakes States, recent records of lynx are from mortalities due to vehicle collisions, which could limit the potential for reestablishment of populations in Wisconsin or Michigan." (USFWS 1998, p. 37005-37006)

Finally, FWS demonstrates the negative indirect effects of roads on legal and illegal hunting and trapping of lynx in both the U.S. and Canada:

> "Increasing human access into Canada lynx habitat has increased the vulnerability of Canada lynx to both legal and illegal harvest in areas that, historically, were relatively isolated from humans (Todd 1985; McKay 1991; Washington Department of Wildlife 1993; M. Hunter, pers. comm. 1994). In the Uinta Mountains of Utah, most of the documented Canada lynx specimens were shot during deer hunting season in an area easily accessed by hunters (McKay 1991). In Washington, there is concern that human access may reduce the number of Canada lynx emigrating from British Columbia, further increasing the vulnerability of the remaining small population (Washington Department of Wildlife 1993). The high degree of access into Alberta's forests created by petroleum development and logging was suggested as an explanation for why Alberta produced a large proportion of the total Canadian lynx harvest in the 1970's and 1980's (Todd 1985)." (USFWS 1998, p. 37006)

A review of other literature further supports these findings and argues for implementing standards to reduce roaded access into lynx habitat.

The impacts of roads include:

- roads increase access for hunters and trappers, destroy habitat for prey, and disrupt lynx travel and hunting patterns (Koehler and Brittell, 1990)

- direct loss of habitat
- indirect loss of habitat by avoidance of human activity areas

- greater accessibility to the legal trapper or hunter
- greater vulnerability to poaching... opportunities for illegal take will increase
- impacts from traffic include snowmobile use in the winter (Brittel et al. 1989)

Washington Department of Natural Resources is already implementing the following directions regarding road management (WDNR 1996a):

- minimize road width
- encourage vegetation on both sides
- reduce sight distance
- avoid loop roads
- close roads as soon as possible

Additional recommended standards include the following:

- [logging] roads should be kept to a minimum
- less than 50 ft. rights-of-way
- roads should be closed once timber harvest is complete, physical barriers (Koehler and Brittell 1990, summarized by Butts 1993; Brittel et al. 1989)

Though lynx research has not yet defined a specific "threshold" road density for lynx habitat, it is clear that the fewer roads into lynx habitat the better. Where lynx habitat overlaps with grizzly bear habitat or important habitat for elk, FWS should urge hasty progress toward ensuring that road density standards to protect those species is made.

Road density analysis is an important component of determining habitat security with Lynx Management Units on the Kootenai National Forest (see below). The Kootenai Forest uses a Risk Index whereby open road densities of less than 1 mile per square mile rate a "low" risk, 1-2 miles per square mile rate "medium," and greater than 2 miles per square mile rate "high" risk of mortality (USFS at 6-3). These proposed thresholds are preliminary, but represent an important first step toward quantifying the adverse effects of roads on lynx habitat, toward highlighting problem areas. Again, such analysis is very much consistent and should be coordinated with efforts to maintain and enhance habitat security for grizzly bears, elk, and other species.

Another preliminary attempt toward establishing road density standards recommends a standard of 1 mile per square mile in "primary" lynx conservation areas, and not to exceed 2 miles per square mile in "secondary" lynx conservation areas (USFS 1994). Though it is not clear if these standards are adequate to promote the survival and recovery of lynx, they should be instituted on an experimental basis and lynx effects should be monitored to see if they are adequate or need to be strengthened.

2. Snowmobiles should be restricted in areas where they pose a threat to lynx due to disturbance and/or allowing competitors access into lynx habitat.

The Forest Service has adopted the following standards to protect lynx from snowmobiles and other forms of winter recreation (USDA 2000).

Programmatic planning - standards. [p. 82]

1. On federal lands in lynx habitat, allow no net increase in groomed or designated over-the-snow routes and snowmobile play areas by LAU. This is intended to apply to dispersed recreation, rather than existing ski areas.
2. Map and monitor the location and intensity of snow compacting activities (for example, snowmobiling, snowshoeing, cross-country skiing, dog sledding, etc.) that coincide with lynx habitat, to facilitate future evaluation of effects on lynx as information becomes available.

Programmatic planning - guidelines. [p. 82]

1. Provide a landscape with interconnected blocks of foraging habitat where snowmobile, cross-country skiing, snowshoeing, or other snow compacting activities are minimized or discouraged.
2. As information becomes available on the impact of snow-compacting activities and disturbance on lynx, limit or discourage this use in areas where it is shown to compromise lynx habitat. Such actions should be undertaken on a priority basis considering habitat function and importance.

Project planning - standards. [p. 82]

Developed Recreation:

1. In lynx habitat, ensure that federal actions do not degrade or compromise landscape connectivity when planning and operating new or expanded recreation developments.
2. Design trails, roads, and lift termini to direct winter use away from diurnal security habitat.

Dispersed Recreation:

1. To protect the integrity of lynx habitat, evaluate (as new information becomes available) and amend as needed, winter recreational special use permits (outside of permitted ski areas) that promote snow compacting activities in lynx habitat.

Project planning - guidelines. [pp. 82-83]

Developed Recreation:

1. Identify and protect potential security habitats in and around proposed developments or expansions.
2. When designing ski area expansions, provide adequately sized coniferous inter-trail islands, including the retention of coarse woody material, to maintain snowshoe hare habitat.
3. Evaluate, and adjust as necessary, ski operations in expanded or newly developed areas to provide nocturnal foraging opportunities for lynx in a manner consistent with operational needs, especially in landscapes where lynx habitat occurs as narrow bands of coniferous forest across the mountain slopes.

The adverse effects of recreation is a subset of the adverse effects of roads in general, but snowmobiles present a unique concern: packed snowmobile trails may enable coyotes and bobcats to access lynx habitat in winter.

FWS explains:

> "Bobcats are able to outcompete lynx except in habitats with excessive snow depths. Roads and packed snow trails have allowed bobcats and coyotes to access the winter habitats for which lynx are highly specialized." (USFWS 1998, p. 37008)

FWS further explains the unique threat to lynx posed by snowmobiling:

> "Competition during late winter, a time when lynx are already nutritionally stressed, may be especially detrimental to lynx (Koehler and Aubry 1994). Snowmobile trails and roads that are maintained for winter recreation and forest management activities enable coyotes and bobcats to access lynx winter habitat (Koehler and Aubry 1994)...
>
> Snowmobile use in the Great Lakes and Rocky Mountain/Cascades regions has resulted in an increase in both human presence and the prevalence of packed snow corridors in lynx habitat. The increased snowmobile use and the increased area in which snowmobiles are used likely diminishes habitat quality for lynx, and also decreases the lynx's competitive advantage in deep snow. This results in an increased threat posed by competitors, as a result of the increase in hard-packed snow trails." (USFWS 1998, p. 37006)

D. Trapping

The areas of overlap between lynx and other species trapped for commercial or recreational purposes should be defined. Wherever the risks of incidental capture of lynx are significant, trapping regulations should be changed accordingly. Examples might include restricting the sizes of traps to discriminate between target species and lynx, use of padded leghold traps in lynx habitat, mandatory checking of those traps every 24 hours, and outright banning of trapping in areas where risks posed to lynx are highest.

> Although legal harvest is no longer a conservation concern, human-caused mortality is believed to be additive in the low-density lynx populations characteristic of southern boreal forests (Koehler 1990; Table 13.3). If so, illegal or incidental harvest could significantly reduce population numbers of lynx in southern regions. (Ruggiero et al. 2000, XIII, 19)

In its proposed rule, FWS acknowledges the threat to lynx posed by trapping: "Human induced mortality is the most important mortality factor for Canada lynx populations" (USFWS 1998, p. 37003).

Trapping mortalities have declined significantly since seasons have been closed in all states except Montana, where it is now under a temporary moratorium. Yet, trapping for animals other than lynx may result in incidental taking of lynx and thereby jeopardize recovery efforts in some areas. This would include both trapping of furbearers for commercial and recreational purposes, and trapping as a means to control livestock depredations by government trappers and private individuals.

E. Livestock grazing, and other developments (Oil and Gas Drilling, Mining, Reservoirs, Agriculture, Resort Developments)

The Forest Service has adopted the following standards to protect lynx from livestock grazing and other developments (USDA 2000).

Livestock Grazing

Project planning - standards. [p. 84]

1. Do not allow livestock use in openings created by fire or timber harvest that would delay successful regeneration of the shrub and tree components. Delay livestock use in post-fire and post-harvest created openings until successful regeneration of the shrub and tree components occurs.
2. Manage grazing in aspen stands to ensure sprouting and sprout survival sufficient to perpetuate the long-term viability of the clones.
3. Within the elevational ranges that encompass forested lynx habitat, shrub-steppe habitats should be considered as integral to the lynx habitat matrix and should be managed to maintain or achieve mid seral or higher condition.
4. Within lynx habitat, manage livestock grazing in riparian areas and willow carrs to maintain or achieve mid seral or higher condition to provide cover and forage for prey species.

Predator Control

Programmatic planning - standards. [p. 86]

1. Predator control activities, including trapping or poisoning on domestic livestock allotments on federal lands within lynx habitat, will be conducted by Wildlife Services personnel in accordance with FWS recommendations established through a formal Section 7 consultation process.

Other Developments (Oil and Gas Drilling, Mining, Reservoirs, Agriculture)

Project planning - standards. [p. 85]

1. On projects where over-snow access is required, restrict use to designated routes.

Project planning - guidelines. [p. 85]

1. If activities are proposed in lynx habitat, develop stipulations for limitations on the timing of activities and surface use and occupancy at the leasing stage.

2. Minimize snow compaction when authorizing and monitoring developments. Encourage remote monitoring of sites that are located in lynx habitat, so that they do not have to be visited daily.
3. Develop a reclamation plan (e.g., road reclamation and vegetation rehabilitation) for abandoned well sites and closed mines to restore suitable habitat for lynx.
4. Close newly constructed roads (built to access mines or leases) in lynx habitat to public access during project activities. Upon project completion, reclaim or obliterate these roads.

Ski Areas/ Large Resorts

Programmatic planning - standards: [pp. 89-90]
1. Within identified key linkage areas, provide for landscape connectivity.

Project planning - standards: [p. 90]
1. When planning new or expanding recreational developments, ensure that key linkage areas are protected.

Project planning - guidelines: [p. 90]
1. Plan recreational development, and manage recreational and operational uses to provide for lynx movement and to maintain effectiveness of lynx habitat.

F. Connectivity vs. fragmentation

The Forest Service has adopted the following standards to maintain and restore connections between lynx populations (USDA 2000).

General Connectivity

Programmatic planning - standards. [pp. 87-88]
1. Identify key linkage areas that may be important in providing landscape connectivity within and between geographic areas, across all ownerships.
2. Develop and implement a plan to protect key linkage areas on federal lands from activities that would create barriers to movement. Barriers could result from an accumulation of incremental projects, as opposed to any one project.
3. Evaluate the potential importance of shrub-steppe habitats in providing landscape connectivity between blocks of primary lynx habitat. Livestock grazing within shrub-steppe habitats in such areas should be managed to maintain or achieve mid seral or higher condition, to maximize cover and prey availability. Such areas that are currently in late seral condition should not be degraded.

Programmatic planning - guidelines. [p. 88]
B. Where feasible, maintain or enhance native plant communities and patterns, and habitat for potential lynx prey, within identified key linkage areas. Pursue opportunities for cooperative management with other landowners.

Highways

Programmatic planning - standards. [p. 87]
1. Within lynx habitat, identify key linkage areas and potential highway crossing areas.

Programmatic planning - guidelines. [p. 87]
1. Where needed, develop measures such as wildlife fencing and associated underpasses or overpasses to reduce mortality risk.

Programmatic planning - standards. [p. 88]
1. Federal land management agencies will work cooperatively with the Federal Highway Administration and State Departments of Transportation to address the following within lynx geographic areas:
a) Identify land corridors necessary to maintain connectivity of lynx habitat.
b) Map the location of "key linkage areas" where highway crossings may be needed to provide habitat connectivity and reduce mortality of lynx (and other wildlife).

Programmatic planning - guidelines. [p. 88]
1. Evaluate whether land ownership and management practices are compatible with maintaining lynx highway crossings in key linkage areas. On public lands, management practices will be compatible with providing habitat connectivity. On private lands, agencies will strive to work with landowners to develop conservation easements, exchanges, or other solutions.

Project planning - standards. [p. 88]
1. Identify, map, and prioritize site-specific locations, using topographic and vegetation features, to determine where highway crossings are needed to reduce highway impacts on lynx.
2. Within the range of lynx, complete a biological assessment for all proposed highway projects on federal lands. A land management agency biologist will review and coordinate with highway departments on development of the biological assessment.

Project planning - guidelines. [pp. 88-89]
1. Dirt and gravel roads traversing lynx habitat (particularly those that could become highways) should not be paved or otherwise upgraded (e.g., straightening of curves, widening of roadway, etc.) in a manner that is likely to lead to significant increases in traffic volumes, traffic speeds, increased width of the cleared ROW, or would foreseeably contribute to development or increases in human activity in lynx habitat. Such projects may increase habitat fragmentation, create a barrier to movements, increase mortality risks due to vehicle collisions, and generate secondary adverse effects by inducing, facilitating, or exacerbating development and human activity in lynx habitat. Whenever rural dirt and gravel roads traversing lynx habitat are proposed for such upgrades, a thorough analysis should be conducted on the potential direct and indirect effects to lynx and lynx habitat.

Land Ownership

Programmatic planning - standards: [p. 89]
1. Identify key linkage areas by management jurisdiction(s) in management plans and prescriptions.

Programmatic planning - guidelines: [p. 89]

1. In land adjustment programs, identify key linkage areas. Work towards unified management direction via habitat conservation plans, conservation easements or agreements, and land acquisition.

Project planning - standards: [p. 89]

1. Develop and implement specific management prescriptions to protect/ enhance key linkage areas.
2. Evaluate proposed land exchanges, land sales, and special use permits for effects on key linkage areas.

1. US/Canada connectivity

Because of the interdependence between lynx populations in southern Canda and the U.S, U.S. land and wildlife officials should: (1) approach Canadian officials toward maintaining contiguous lynx habitat, and (2) direct even more precautionary management of U.S. habitat given the threat to this connectivity.

The importance of this to recovery in the U.S. is appropriately highlighted in publications by the Forest Service and Fish and Wildlife Service:

> We cannot assume that lynx populations in the contiguous United States will be maintained by dispersal of lynx from Canada, nor that connectivity with larger habitat areas in Canada will be maintained in perpetuity. Although cooperative conservation efforts with Canadian land management agencies should be explored in all areas of adjacent lynx habitat, we believe that lynx conservation efforts in the contiguous United States should be addressed at geographic scales that will provide for the persistence of resident populations of lynx, regardless of periodic augmentations that may occur from other areas. Clearly, ecoprovince-wide planning is necessary to provide the broad-scale information necessary for effective conservation of lynx. (Ruggiero et al. 2000, XV, 9)

> "... dispersal of Canada lynx into the contiguous United States may now be necessary to replenish lynx numbers because of the current status of lynx in the contiguous United States." (USFWS 1998, p. 36996)

FWS notes that lynx populations in Washington are particularly vulnerable:

> "Recolonization of suitable lynx habitat within the State of Washington eventually may be precluded by the fragmentation of habitat and potential isolation from the lynx population in Canada (Washington Department of Wildlife 1993)." (USFWS 1998, p. 37003)

Efforts to persuade Canada to conserve lynx habitat should include trapping restrictions as well as forest practices. FWS notes some problems with current management in Canada:

> "In Canada, management of forest lands and conservation of wildlife habitat varies depending on Provincial regulations. In Alberta, there is no law regulating forest practices and the status of Canada lynx in Alberta is of concern because of habitat-related threats as a result of logging (B. Triechel, Alberta

Environmental Protection, pers. comm. 1997). There is no overarching forest practices legislation in Canada, such as the United States' National Forest Management Act, governing management of national lands and/or providing for consideration of wildlife habitat requirements. Additionally, in Canada, lynx harvest regulations vary, being regulated by individual Province or, in some cases, individual trapping district." (USFWS 1998, p. 37007)

2. Connectivity within the U.S.

Actions are needed to reduce the threat to lynx due to fragmentation at the regional and local levels within the U.S.

a. Connectivity between populations

FWS does a nice job of summarizing the threats to lynx due to its fragmented status in the lower-48 states:

> "Loss of suitable habitat for Canada lynx reduces the potential for population growth or recolonization of the lynx and further confines lynx to smaller, more isolated habitat units (Weaver 1993). Isolation increases the susceptibility of the lynx to human-caused threats, natural stochastic events, and effects of genetic bottlenecks (Andrews 1992; Weaver 1993). In the Rocky Mountain/Cascades Region much of lynx habitat is naturally disjunct and habitat connectivity is required across large geographic areas to facilitate dispersal and genetic exchange (Roloff 1995). The increased fragmentation of forest lands and loss of connectivity within and among blocks of habitat in the interior Columbia River basin of Washington, Oregon, Idaho, and Montana has reduced the ability of some wildlife populations to move across the landscape, resulting in long-term loss of genetic interchange (U.S. Forest Service and Bureau of Land Management 1997)." (USFWS 1998, p. 37005)

The FWS' own research demonstrates the especially vulnerable status of lynx populations in the Northeast, Lake states, and the southern Rockies due to their isolation from other lynx populations. Thus, these populations merit the highest level of protection:

> "Within the contiguous United States, the lynx population is divided regionally by ecological barriers consisting of unsuitable lynx habitat. These regions are the Northeast, the Great Lakes, and the Rocky Mountains/Cascades." (USFWS 1998, p. 36996)

b. Connectivity within populations

Within populations as well, barriers to lynx movement must be considered because they may represent a major obstacle to lynx survival and recovery. FWS offers Maine as an example:

> "Although localized habitat conditions have improved [in Maine], reoccupation of these areas may be impeded by barriers to lynx immigration, such as paved roads with high-volume traffic, non-forested agricultural habitats, or other intervening areas of suitable habitat." (USFWS 1998, p. 36996)

The USFS has already responded to this problem on the Kootenai National Forest, where lynx locations were mapped, and then identified ten "areas of concern for lynx movement across the forest." Management activities within these areas are reviewed for their effects on maintaining connectivity for lynx across the Kootenai Forest (USFS 1997 at 6).

G. Cumulative effects analysis

Because of the diversity of threats facing lynx survival and recovery across the landscape, a process of cumulative effects analysis is needed to assess the combined magnitude of these threats and implications for future management. Cumulative effects analysis can also provide a means to monitor the habitat quality of an area: that is, its ability to provide the security and various other components for denning, foraging, travel, and other lynx needs.

The Lynx Conservation Assessment and Strategy (USDA 2000) provides direction for cumulative effects analysis.

> Programmatic planning – standards. [p. 77]
> 1. Conservation measures will generally apply only to lynx habitat on federal lands within LAUs [Lynx Analysis Units].
> 2. To facilitate project planning, delineate LAUs. To allow for assessment of the potential effects of the project on an individual lynx, LAUs should be at least the size of area used by a resident lynx and contain sufficient year-round habitat.
> 3. To be effective for the intended purposes of planning and monitoring, LAU boundaries will not be adjusted for individual projects, but must remain constant.
> 4. Lynx habitat will be mapped using criteria appropriate to each geographic area.
> 5. Prepare a broad-scale assessment of landscape patterns that compares historical and current ecological processes and vegetation patterns, such as age-class distributions and patch size characteristics. In the absence of guidance developed from such an assessment, limit disturbance within each LAU as follows: if more than 30 percent of lynx habitat within a LAU is currently in unsuitable condition, no further reduction of suitable conditions shall occur as a result of vegetation management activities by federal agencies.
>
> Programmatic planning - guidelines.
> 1. The size of LAUs should generally be 6,500- 10,000 ha (16,000 – 25,000 acres or 25-50 square miles) in contiguous habitat, and likely should be larger in less contiguous, poorer quality, or naturally fragmented habitat. Larger units should be identified in the southern portions of the Northern Rocky Mountains Geographic Area (in Idaho from the Salmon River south, Oregon, Wyoming, and Utah) and in the Southern Rocky Mountains Geographic Area.
>
> In the west, we recommend using watersheds (e.g., 6th code hydrologic unit codes (HUCs) in more northerly portions of geographic areas, and 5th code HUCs in more southerly portions). In the east, terrestrial ecological units that have been delineated at the landtype association or subsection level (e.g., LTAs or whatever scale most closely approximates the size of

a lynx home range) may be an appropriate context for analysis. Coordinate delineation of LAUs with adjacent administrative units and state wildlife management agencies, where appropriate.

2. After LAUs are identified, their spatial arrangement should be evaluated. Determine the number and arrangement of contiguous LAUs needed to maintain lynx habitat well distributed across the planning area. LAUs with only insignificant amounts of lynx habitat may be discarded, or portions of the unit combined with or divided among neighboring LAUs to provide a meaningful unit for analysis.

Project planning - standards. [p. 78]

1. Within each LAU, map lynx habitat. Identify potential denning habitat and foraging habitat (primarily snowshoe hare habitat, but also habitat for important alternate prey such as red squirrels), and topographic features that may be important for lynx movement (primary ridge systems, prominent saddles, and riparian corridors). Also identify non-forest vegetation (meadows, shrub-grassland communities, etc.) adjacent to and intermixed with forested lynx habitat that may provide habitat for alternate lynx prey species.
2. Within a LAU, maintain denning habitat in patches generally larger than 5 acres, on at least 10 percent of the area that is capable of producing stands with these characteristics. Where less than 10 percent of the forested lynx habitat within a LAU provides denning habitat, defer those management actions that would delay achievement of denning habitat structure.
3. Maintain habitat connectivity within and between LAUs.

We also commend the Kootenai National Forest for its precedence-setting work on this, and urge that FWS work to ensure that it is applied throughout all areas of lynx habitat. The Kootenai Forest's Lynx Management Unit (LMU) areas correspond to the estimated home range sizes of female lynx in the area. Other considerations in delineating their LMU's are described in a USFS memo on the subject (1997):

- Areas need to be small enough to show effects of projects
- Areas need to contain all habitat components necessary to support female lynx (existing or potential)
- Areas need to be aggregated up to a larger scale for cumulative effects
- Planning sub-units make efficient analysis areas, as do compartments on some districts

"Blocks" of suitable habitat within each LMU were evaluated based on their area and proximity to other blocks of habitat, such that small blocks that were at the limits of daily movements of lynx (2-5 miles away) were not considered suitable. The LMU process is still in its preliminary stages on the Kootenai, but forest officials claim that the system will ensure that they fulfill their viability objectives for lynx as directed in the National Forest Management Act: "With this strategy, it is the Kootenai National Forest biologists consensus opinion that lynx persistence on the Kootenai National Forest is assured" (USFS 1997, p. 6-1).

Other lynx science "summary" documents:

- U.S. Forest Service Lynx Science Report (Ruggiero et al. 2000);
- U.S. Forest Service Lynx Conservation Assessment and Strategy (USDA 2000);
- U.S. Fish and Wildlife Service Lynx Listing Rules, Proposed and Final (USDI 2000, USDI, 1998);
- Lynx management assessment and comment to USFWS (Tanimoto 1998);
- "Lynx" *in* Scientific Basis for Conserving Forest Carnivores (Koehler and Aubry 1994);
- Lynx Biology and Management, a literature review and annotated bibliography (Butts 1992).

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