Research Studies Related to Snowmobiling Impacts

WILDLIFE – Lynx

Mammals / Lynx

1. **Southern Rockies Lynx Management Direction – Record of Decision**. USDA Forest Service (2008) National Forests in Colorado and southern Wyoming
http://www.fs.fed.us/r2/projects/lynx/documents/record_of_decision.pdf

Summary of the decision: The Forest Service is charged with managing various renewable resources so that they are utilized in the combination that will best meet the needs of the American people, with due consideration given to the relative values of the resources, and without impairment of the productivity of the land (Multiple Use Sustained Yield Act of 1960). Under the Endangered Species Act, the agency is required to use its authorities to conserve threatened and endangered species and the ecosystems upon which they depend. In this decision, I consider how to amend Land and Resource Management Plans (Plans) to add consistent management direction that will conserve the Canada lynx (*Lynx canadensis*), a species listed as threatened under the Endangered Species Act, while at the same time allowing management and use of other natural resources in the Southern Rocky Mountains.

I have selected Alternative F-modified (Attachment 1). With this decision, the eight Land and Resource Management Plans (Plans) listed above are amended to incorporate the goal, objectives, standards and guidelines, and monitoring requirements of Alternative F-modified. My decision provides management direction that contributes to conservation of the lynx in the Southern Rocky Mountains, meets the Purpose and Need, responds to public concerns, and incorporates the terms and conditions contained in the U.S. Fish and Wildlife Service's Biological Opinion. My decision is consistent with applicable law, regulation and policy.

This decision supersedes the 2006 Lynx Conservation Agreement in the Southern Rockies Lynx Amendment area. The White River and Medicine Bow National Forests previously completed revisions of their Plans (in 2002 and 2004, respectively) and incorporated management direction for lynx. By amending all eight Plans in the Southern Rockies, this decision assures consistent management direction. The U.S. Fish and Wildlife Service's 2008 Biological Opinion for this amendment supersedes previous Biological Opinions for lynx that were issued for the White River Revised Plan, Medicine Bow Revised Plan, and Rio Grande MIS Amendment.

Over-the-snow winter recreation (p 13-14): Lynx have very large feet relative to their body size, providing them with a competitive advantage over other carnivores in deep snow. The LCAS recommended two objectives and two standards relating to winter dispersed recreation, which are reflected under Alternative B as Objectives *HU O1 and HU O3*, and Standards *HU S1 and HU S3*. All alternatives contain Objectives *HU O1* and *HU O3* that discourage expansion of snowcompacting human activities. All alternatives would allow existing special use permits and agreements to continue.

In comments on the Draft EIS, some people said they thought allowing no net increase in groomed or designated routes was insufficient, and asked that no dispersed over-the snow use be allowed off groomed or designated trails. Some recommended that the management direction be in the form of a standard, not a guideline.

Other people said standards related to over-the-snow use should be removed. They said there is no evidence to show that coyotes and other predators use packed snow trails to compete with lynx for prey, and the amount of compaction created by snowmobiles is insignificant compared to the compaction created naturally by the weather. They were concerned that if such language was introduced into Plans, it could be difficult to change and would restrict the places where snowmobiling is allowed. Others wanted an allowance made to increase snowmobile use.

Multi-species predator and prey relationships in the boreal forest are complex. The degree to which lynx and coyotes compete for snowshoe hares in the western United States is unknown. In some regions and studies, coyotes were found to use supportive snow conditions more than expected. For example, Bunnell et al. (2006) reported that the presence of snowmobile trails was a highly significant predictor of coyote activity in deep snow areas, and suggested that coyotes may use compacted routes to access lynx habitat and compete with lynx for snowshoe hare prey. On the other hand, Kolbe et al. (2007) found that compacted snow routes did not appear to enhance coyotes' access to lynx and hare habitat, and that there was little evidence that compacted snowmobile trails increased competition between coyotes and lynx during winter in Montana. In their final listing rule (2000b) and remanded rule (2003), FWS concluded there is no evidence that competition exists that may exert a population-level impact on lynx, although adverse effects on individual lynx are possible depending on the situation (USDI Fish and Wildlife Service 2008).

Current research indicates that prohibiting snow-compacting activities or reducing dispersed recreation use would be unwarranted. At the same time, an alternative to drop all direction limiting snow compaction was not developed in detail, because snow compaction may affect individual lynx.

I decided to include guideline *HU G10* in Alternative F-modified, which says that designated over-the-snow routes or play areas should not expand outside of the baseline areas of consistent snow compaction, unless it serves to consolidate use and improve lynx habitat. There may be some cases where expansion of over-the-snow routes would be warranted and acceptable, or where research indicates there would be no harm to lynx, and this guideline provides the flexibility to accommodate those situations. Guideline *HU G12* limits access for non-recreation uses to designated routes.

The U.S. Fish and Wildlife Service concluded the Objectives *HU O1* and *O3* and Guidelines *HU G10* and *G12* would maintain habitat effectiveness for lynx by limiting the expansion of compacted snow routes. This conclusion will be tested through monitoring required as part of this decision.

2. **Northern Rockies Lynx Management Direction – Record of Decision**. USDA Forest Service (2007) National Forests in Montana and parts of Idaho, Wyoming, and Utah
http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5277399.pdf

Summary of the decision: We have selected Alternative F, Scenario 2 as described in the Northern Rockies Lynx Management Direction Final Environmental Impact Statement (FEIS) (pp. 35 to 40), with modifications. We modified Alternative F, Scenario 2 and incorporated the U.S. Fish and Wildlife Service (FWS) Terms and Conditions (USDI FWS 2007), where applicable, into the management direction – see Attachment 1- hereafter called the *selected alternative*. We determined the selected alternative provides direction that contributes to conservation and recovery of Canada lynx in the Northern Rockies ecosystem, meets the Purpose and Need, responds to public concerns, and is consistent with applicable laws and policies. In the FEIS we analyzed six alternatives in detail and two scenarios for Alternative F. Of those, we determined Alternative F Scenario 2 is the best choice. With this decision, we are incorporating the goal, objectives, standards, and guidelines of the selected alternative into the existing plans of all National Forests in the Northern Rockies Lynx Planning Area – see Figure 1-1, FEIS, Vol. 1 Tables 1-1 and 1-2.

The direction applies to mapped lynx habitat on National Forest System land presently **occupied** by Canada lynx, as defined by the *Amended Lynx Conservation Agreement between the Forest Service and the FWS* (USDA FS and USDI FWS 2006). When National Forests are designing management actions in **unoccupied** mapped lynx habitat they should consider the lynx direction, especially the direction regarding linkage habitat. If and when those National Forest System lands become occupied, based upon criteria and evidence described in the Conservation Agreement, the direction shall then be applied to those forests. If a conflict exists between this management direction and an existing plan, the more restrictive direction will apply.

The detailed rationale for our decision, found further in this document, explains how the selected alternative best meets our decision criteria. Those decision criteria are: 1) meeting the Purpose and Need to provide management direction that conserves and promotes the recovery of Canada lynx while preserving the overall multiple use direction in existing plans; 2) responding to the issues; and 3) responding to public concerns.

Management direction related to human uses: Over-the-snow winter recreation (pp. 22-25)
Lynx have very large feet in relation to their body mass, providing them a competitive advantage over other carnivores in deep snow. Various reports and observations have documented coyotes using high elevation, deep snow areas (Buskirk et al. 2000). Coyotes use open areas because the snow is more compacted there, according to research conducted in central Alberta (Todd et al. 1981). In another study in Alberta, coyotes selected hard or shallow snow more often than lynx did (Murray et al. 1994).

The LCAS recommended two objectives and two standards relating to winter dispersed recreation. These are reflected in Alternative B, Objectives HU O1 and HU O3, and Standards HU S1 and HU S3. In Alternative B, Standard HU S1 would maintain the existing level of groomed and designated routes. All action alternatives contain Objectives HU O1 and HU O3 that discourage expanding snow-compacting human activities. Alternatives B, C, and D contain Standard HU S1 that would allow existing over-the-snow areas to continue but not expand into new, un-compacted areas. Alternative E, the DEIS preferred alternative, contains Guideline HU G11 that discourages the expansion of designated over-the-snow routes and play areas into uncompacted areas. All alternatives would allow existing special use permits and agreements to continue.

In comments on the DEIS some people asked that no dispersed over-the-snow use be allowed off groomed or designated trails and areas, saying the no net increase in groomed or designated routes did not go far enough. Others said the management direction should be in the form of a standard, not a guideline.

Some people said standards related to over-the-snow use should be removed. They said there is no evidence to show that coyotes and other predators use packed snow trails to compete with lynx for prey, and the amount of compaction created by snowmobiles is insignificant compared to the compaction created naturally by the weather. They were particularly concerned that if such language was introduced into plans, it could be difficult to change, incrementally restricting the places where snowmobiling is allowed. Others wanted an allowance made to increase use. These comments were considered for management direction – see FEIS Vol. 1 pp. 90-93.

In their comments on the DEIS the FWS agreed it is prudent to maintain the status quo and restrict expansion of over-the-snow routes until more information is available because of the possibility that, over time, unregulated expansion could impair further conservation efforts. They also said current, ongoing research in Montana may shed some information on the effects of snow compaction on lynx. They suggested careful consideration of the most recent information and the reality of possible impairment of options for the future. They suggested considering language that could provide more guidance on conditions where the expansion of over-the-snow routes would be warranted and acceptable.

We reviewed the results of research conducted since the DEIS was released. In northwestern Montana (within the northern lynx core area) Kolbe et al. (in press) concluded there was "little evidence that compacted snowmobile trails increased exploitation competition between coyotes and lynx during winter on our study area." Kolbe et al. (in press) suggested that compacted snow routes did not appear to enhance coyotes' access to lynx and hare habitat, and so would not significantly affect competition for snowshoe hare. They found that coyotes used compacted snow routes for less than 8 percent of travel, suggesting normal winter snow conditions allowed access by coyotes, regardless of the presence or absence of compacted snow routes. Kolbe was able to directly measure relationships between coyotes, compacted snow routes and snowshoe hare in an area that also supports a lynx population (USDI FWS
2007). In this study coyotes primarily scavenged ungulate carrion that were readily available while snowshoe hare kills comprised only three percent of coyote feeding sites (Kolbe et al. in press).

In the Uinta Mountains of northeastern Utah and three comparative study areas (Bear River range in Utah and Idaho, Targhee NF in Idaho, Bighorn NF in Wyoming) Bunnell (2006) found that the presence of snowmobile trails was a highly significant predictor of coyote activity in deep snow areas.
From track surveys it was determined the vast majority of coyotes (90 percent) stayed within 350 meters of a compacted trail and snow depth and prey density estimates (snowshoe hares and red squirrels) were the most significant variable in determining whether a coyote returned to a snowmobile trail (Bunnell 2006). Of the four study areas recent lynx presence has only been documented on the Targhee NF. Bunnell indicated that "circumstantial evidence" suggested the existence of competition.

To date, research has confirmed lynx and coyote populations coexist, despite dietary overlap and competition for snowshoe hare, the primary prey of lynx, and alternate prey species. In some regions and studies, coyotes were found to use supportive snow conditions more than expected, but none confirm a resulting adverse impact on lynx populations in the area. The best scientific information (Kolbe's study) is from an occupied core area within our planning area. Radio-collared lynx and coyotes were monitored in this study, unlike the Bunnell study. This area is occupied by both lynx and coyotes and the study concludes coyotes did not require compacted snow routes to access winter snowshoe hare habitat.
Based on this information, we reevaluated management direction related to over-the-snow activities. An alternative to prohibit all snow-compacting activities or to limit dispersed use was evaluated, but not considered in detail because current research indicates this level of management direction is unwarranted (USDI FWS 2000a; FEIS, Vol. 1, Appendices O and P).

An alternative to drop all direction limiting snow compaction was not developed in detail because there is evidence competing predators use packed trails, suggesting a potential effect on individual lynx. We decided it was prudent to maintain status quo and not let over-the-snow routes expand. However, we also decided it was reasonable to retain the direction as a guideline in the selected alternative which can be used in project design. The intent is to follow management direction in guidelines. However, there may be some cases where expansion of over-the-snow routes would be warranted and acceptable, or where research indicates there would be no harm to lynx. Guidelines are better suited to adaptive management.

There is also no basis to establish any particular threshold of allowable increases. However, the selected alternative allows expanding winter recreation in some places where heavy public use existed in 1998, 1999, or 2000 – see Guideline HU G11.

The FWS concluded the Objectives HU O1 and O3, and Guideline HU G11 would be sufficient to maintain habitat effectiveness for lynx by limiting the expansion of compacted snow routes and this conclusion would be tested through monitoring required in this decision. The best information available has not indicated compacted snow routes increase competition from other species to levels that adversely affect lynx populations, and under the selected alternative the amount of areas affected by snow compacted routes would not substantially increase (USDI FWS 2007).

3. **Canada Lynx in the Great Lakes Region 2005 Annual Report.** Moen, R., Niemi, G., & Burdett, C.L. (2006) Report to the U.S.D.A. Forest Service, Minnesota Cooperative Fish and Wildlife Research Unit, and Minnesota Department of Natural Resources
http://www.nrri.umn.edu/lynx/publications/2005_MN_LynxReport_v2.pdf

Executive Summary: We summarize the third year of a project on Canada lynx ecology in the Great Lakes region. The project is designed to address four major questions about this population of Canada lynx: distribution, habitat use, abundance, and persistence. In the first 33 months of this project we captured and deployed radiotelemetry collars on 32 Canada lynx. Each animal was located approximately biweekly after being collared when logistically feasible.

GPS collars have been deployed on 12 of the lynx in this project. Over 12,000 locations were obtained from GPS collars at the end of 2005. GPS collar locations will be fundamental to understanding movements and

habitat use of Canada lynx. Ambient temperature and animal activity level is recorded by the collars indicating daily patterns in activity, and also shows how active an animal was when each GPS location was obtained.

Radiocollared females have had kittens in 2004 and 2005, and at least 5 of the 12 kittens known from den visits in 2005 survived until December 2005. Of the 2004 litters, 1 and possibly 2 of the known offspring were alive at the end of 2005. Of the 32 lynx radiocollared by December 31, 2005, 2 died in 2003 and no animals were recovered dead in 2004. We recorded the deaths of 14 radiocollared animals in 2005, one of which had died in 2004.

We finished the third year of surveys for snowshoe hare, the major prey species of Canada lynx. Permanent pellet plots were established throughout the SNF for snowshoe hare. Plots were distributed based on stratified random, systematic, and selective site selection strategies. Many stratified random plots had few or no pellets. The highest pellet density over two years of pellet surveys occurred in young red pine and young upland black spruce cover types. A mark-recapture experiment will make it possible to estimate density of snowshoe hares from pellet plots.

We continue to use the project website (www.nrri.umn.edu/lynx) to provide information to biologists and the general public. The website gets over 1,000 page requests per day. This website is a historical record of the project, lists project goals and accomplishments, and gives information and pictures of each lynx. The annual reports and other publications on the project are or will be available for download. Trail camera images were added to the website in 2005.

We begin the report with a brief chronological summary of Canada Lynx ecology in the Great Lakes region. The project has been supported by several agencies with some common deliverables and some deliverables that varied among agencies. To produce a cohesive, logically organized annual report, we describe the project in its entirety, and we indicate specific deliverables in Appendix 1. We first describe Canada lynx trapping and the deployment of radiotelemetry collars. The radiotelemetry program is very important because each of the major deliverables depends on telemetry data. Next, we address progress made on each of the major questions: 1) distribution, 2) habitat use, 3) abundance, and 4) persistence. Prey species surveys and other aspects of the project are also summarized.

We conclude main sections with the current status and future plans for each topic. Some of the questions will require several years of data collection which was built into the project master plan. With the number of Canada lynx now radiocollared and the number of locations available, data collected on this project were used to assist in management decisions in 2005.

4. **National Interagency Canada Lynx Detection Survey in Minnesota, Wisconsin, and Michigan.** Burdett, C., Lindquist, E., Moen, R., Niemi, J., & Route, B. (2006) Center for Water and Environment Natural Resources Research Institute – University of Minnesota, U.S.D.A. Forest Service – Superior National Forest, and Department of Interior National Park Service – Great Lakes Monitoring Network. http://www.nrri.umn.edu/lynx/publications/NRRI_TR-2006-29.pdf

Summary: A variety of non-invasive techniques including hair snagging, snow-tracking, and remote cameras can be used to monitor mammalian carnivores. The National Interagency Canada Lynx Detection Survey (NLDS) was a survey designed to detect lynx with a hair-snagging protocol applied throughout the conterminous U.S. range of lynx. Hare-snagging stations consisted of a scent lure, a carpet piece with nails to snag hair, and a pie tin to attract the cat's attention. We applied NLDS protocol in Superior and Chippewa National Forests in Minnesota, the Chequamegon and Nicolet National Forests in Wisconsin, and the Ottawa National Forest in Michigan. Mammalian species detected included black bears (*Ursus americanus*), bobcats (*Lynx rufus*), coyotes (*Canis latrans*), ungulates, and other canids. The NLDS did not detect lynx in the Great Lakes Geographic Area (GLGA) despite their likely presence on some of the Minnesota NLDS grids. We also opportunistically set up hair snagging stations in areas in Minnesota where we knew lynx were present to further test the efficacy of hair-snagging stations. We had limited success using hair snares to selectively sample lynx despite placing snares in areas regularly used by lynx. We suspect the detection probability for lynx hair-

snagging surveys in the GLGA may be low and other survey techniques may prove more useful, particularly for localized selective sampling for lynx presence.

5. **Lynx Habitat Management Plan for DNR-Managed Lands.** Quade, C. & Minkova, T. (2006) Washington State Department of Natural Resources
http://www.dnr.wa.gov/Publications/lm_ess_lynx_plan_final.pdf

Introduction: The Washington State Department of Natural Resources (DNR) manages more than 5 million acres of state land. Some of those lands are uplands within the range of the Canada lynx (Lynx canadensis) (Figure 1), a native cat that is listed as threatened with extinction—both in the state of Washington and under the federal Endangered Species Act.

Lynx habitat is forested, and most DNR-managed forests are managed using sustainable forest management practices to provide income for various state trust beneficiaries, including public schools, state universities, counties, and other public institutions. Forest management activities in Washington State are regulated by the state's Forest Practices rules, and DNR's forest management must comply with those rules.

This modified Lynx Habitat Management Plan (the 2006 Lynx Plan) was developed in response to the federal listing of the species (USFWS 2000). It revises the 1996 DNR Lynx Habitat Management Plan (WDNR 1996a), which had been developed in response to the state listing. This plan guides DNR's forest management activities to facilitate the creation and preservation of quality lynx habitat. It allows DNR to meet state and federal requirements for protecting lynx, while at the same time providing revenue through timber production and meeting its other land management obligations (i.e. recreation).

This chapter provides historical and management context and basic information about the Canada lynx natural history and distribution. The following chapters define categories of lynx habitat, outline DNR's implementation of the plan, and provide specific guidelines and provisions for monitoring and evaluation. A report on the implementation monitoring conducted for the period 1996-2004, in accordance with the 1996 Lynx Plan commitment, is presented in Appendix 1, and a report on the effectiveness monitoring conducted from 1997 through 2002 is presented in Appendix 2.

6. **Lynx and Other Carnivore Surveys in Wisconsin in Winter 2003-2004.** Wydeven, A.P., Wiedenhoeft, J.E., Schultz, R.N., & Boles. S. (2004) Wisconsin DNR and U.S. Fish and Wildlife Services – Region 3 Endangered Species Grant Program.
http://www.dnr.state.wi.us/org/land/er/publications/reports/pdfs/LynxandOtherCarnivoreSurveysinWisconsininwinter2003-2004.pdf

Introduction: The Wisconsin DNR listed the Canada lynx (*Lynx canadensis*) as a state endangered species in 1973, but removed lynx from the list in 1997, due to lack of evidence of any potential for a breeding population within the state. The U.S. Fish and Wildlife Service listed the lynx as a threatened species within the contiguous Unites States on 24 April 2000. States that were thought to have lynx included Wisconsin, Michigan, Minnesota and 10 other states. There has not been any evidence of a breeding population of lynx in Wisconsin in the 1900's (Thiel 1987, Wydeven 1998). Lynx are occasionally observed in the state, and up to 1% of bobcat hunters and trappers reported lynx sign in Wisconsin (Wydeven 1998). Therefore there is a need to determine more precisely if lynx are occurring in Wisconsin, and if so, determine distribution and breeding status of lynx in the state.

The Wisconsin DNR has cooperated with the U.S. Fish and Wildlife Service to search for gray wolves (*Canis lupus*) using snow track surveys since 1979 (Wydeven et al 1995). These surveys have detected lynx in the past (Wydeven 1998, Wydeven et al 1995). Therefore these snow track surveys are being used to search for evidence of lynx in the state.

Results: A total of 3696.5 miles of track surveys were conducted by DNR trackers in 80 survey blocks in northern Wisconsin (Table1, Figure 1). Two sets of lynx tracks were detected in survey block 82, in Vilas County. The most abundant carnivores were fisher (*Martes pennanti)* which was detected at a rate of 16.0 per

100 miles of survey. The 4 canids were the next most abundant carnivores including coyotes (*Canis latrans* 14.1 / 100 miles), gray wolf (*Canis lupus* 9.4 / 100 miles), fox (*Vulpes vulpes & Urocyon cinereoargenteus* 8.8 /100 miles), and dog (*Canis familiaris* 8.0 / 100 miles). Rates of track detection were lower than 2003 for most carnivores, except wolves had increased, otter were similar, and the first observation of lynx tracks in 5 years.

Two probable lynx tracks were detected by Ron Schultz on 22 March 2004 in NW SW Section 36, T42N, R10E in Vilas County (Latitude 46. 0753 / Longitude 89.1981). It appeared that 2 lynx were traveling together. Schultz followed the tracks for about 2.1 miles. Snow conditions allowed only one good measurement, consisting of a minimum outline of 6.5 cm length and 7.1 cm width. Measurement of variable outline was 9 cm long by 10.2 cm wide. Urine samples were collected from snow, but could not be verified as lynx. Attempts were made for follow-up surveys and consideration was given to attempt trapping, but snow melted soon afterwards. It could not be determined if these 2 represented a female and her kitten or a male following a female; in either case this may represent the possibility of breeding lynx.
Felid track observations included 97 bobcat (*Lynx rufus*) or 2.6/ 100 miles, 5 cats (*Felis catus)* at 0.1 / 100 miles, and 2 Canada lynx 0.1/ 100 miles. No cougar (*Puma concolor*) tracks were found and none have been detected during any previous years. Bobcat detection rate was less than 2003 (4.6 / 100 miles), but similar to 2002 (3.0/ 100 miles). Bobcat were detected in 41 survey blocks (51.2%).

More intense efforts to search for lynx were made in the Nicolet National Forest where lynx had been detected between 1993 and 1997 (Wydeven 1998). Two lynx were detected along 572.2 miles of survey route at a rate of 0.3 lynx per 100 miles (Table 2). This was the first detection of lynx in the Nicolet since 20 January 1997 (Wydeven 1998). Bobcats were detected at a rate of 6.1 bobcat / 100 miles, slightly higher than 2003, when 5.5 bobcat / 100 miles were found. Ratio of lynx:bobcat detection was 1:17.5.

Discussion: The 2 lynx found this year in northeast Vilas County were the first lynx detected since 1999 (Figure 2), when one was detected in western Douglas County along the Minnesota border (Wydeven et al. 1999). Four observations were detected in the Nicolet National Forest between 1993-1997 including: 17 February 1993, 28 January 1995, 1 March 1996, and 20 January 1997 (Wydeven 1998). All these observations were tracks of single animals, and close to Alvin in Forest County. The lynx track observation in 2004 was just to the west of the Nicolet Forest, and about 20 miles west of the sightings near Alvin.

The presence of 2 lynx together might indicate possibility of breeding activity. Normally only adult females and their offspring travel together, or adult males and females travel together during breeding season, but sometimes adult lynx hunt together (Mowat et al. 2000). The detection in late winter did not allow many follow-up surveys. Additional surveys will be done in the area next winter, and if lynx continue to be found in the area, livetrapping and radiocollaring will be attempted.

7. **Washington state recovery plan for the lynx.** Stinson, D.W. (2001) Washington Department of Fish and Wildlife, Olympia, Washington. http://wdfw.wa.gov/wlm/diversty/soc/recovery/lynx/finallynx.pdf

Executive Summary: The lynx (*Lynx canadensis*) is the rarest of three cat species native to Washington probably numbering fewer than 100 individuals in the state. Lynx have large feet and long legs that give them a competitive advantage in deep snow over other carnivores that might otherwise compete for habitat and prey. Lynx are largely dependent upon a single prey species, the snowshoe hare, but they also eat red squirrels, small mammals, birds, and carrion. Lynx are primarily associated with subalpine and boreal forest types in the mountains of north-central and northeastern Washington, and formerly occurred in the southern Cascades. Topographic relief gives these forests a patchy distribution which in turn affects their potential to support lynx.

Across most of their range in northern boreal forests, lynx undergo cyclic changes in abundance that lag 1 year behind snowshoe hare population cycles. This 10-year cycle in snowshoe hare abundance may occur in Washington with a reduced amplitude, but it has not yet been clearly demonstrated. The lynx's response to the hare cycle produces pulses of dispersing individuals that may travel long distances in search of suitable habitat. At these times, some lynx may immigrate to Washington from larger populations in British Columbia and

Alberta. Immigration from northern populations, and dispersal between subpopulations in Washington may be essential to the long-term viability of Washington's lynx population.

Prior to 1947, lynx in Washington were classified a "predatory animal" with a bounty of $5. Lynx were trapped or hunted until 1991 when a decline was readily apparent. It now seems clear that the lynx population in Washington could not sustain perennial exploitation due to the fragmented nature of subalpine-boreal habitats, low density of snowshoe hares, and variable quality of habitat through time.
The lynx was listed as a state threatened species in 1993, and became a Threatened species under the federal Endangered Species Act (ESA) in April 2000.

The major factors affecting habitat and the lynx population include forest management, fire and fire suppression, insect epidemics, and management of lynx harvest and habitats in southern British Columbia. Lynx are relatively tolerant of human activity, but recreational developments and roads with high traffic volumes may affect lynx movements. Anecdotal observations have fueled speculation that snow compaction on forest roads and trails may affect the degree to which lynx must compete with coyotes and other carnivores, but few data exist from which to draw conclusions about the affect on lynx. Most of the lynx habitat in six Lynx Management Zones is on federal lands (92%), and almost 40% is in wilderness, parks and other reserves. Petitions to list the lynx under the ESA, and the subsequent listing increased attention on lynx. The large proportion of habitat in national forests provides the opportunity for the U. S. Forest Service to manage for lynx at the ecosystem scale. The understanding of lynx harvest management has improved in recent years, providing British Columbia and Alberta the ability to prevent overharvests that could reduce the frequency of immigration to Washington. These factors may improve the prospects for the recovery of lynx populations in Washington.

Meaningful population based recovery objectives are not possible to formulate at this time due to the rudimentary knowledge of lynx population dynamics in southern boreal forests. Interim objectives to down-list the lynx to Sensitive involve consistent occupancy of most of the habitat (>75% of lynx analysis units) capable of supporting reproductive populations. Recovery objectives and maps will be revised as new information becomes available about the habitat and populations of lynx and hare in Washington.

8. **Canada Lynx Conservation Assessment and Strategy.** Ruediger, B., Claar J., Gniadek, S., Holt, B., Lewis, L., Mighton, S., Naney, B., Patton, G., Rinaldi, T., Trick, J., Vandehey, A., Wahl, F., Warren, N., Wenger, D., and Williamson, A. (2000) USDA Forest Service, USDI Fish & Wildlife Service, USDI Bureau of Land Management, and USDI National Park Service. Missoula, MT. http://www.fs.fed.us/r1/clearwater/terra_org/wildlife_07/t_e/canada_lynx/conservation_assessment_strategy%20.pdf

Executive Summary: **Purpose of this Document -** The Lynx Conservation Assessment and Strategy was developed to provide a consistent and effective approach to conserve Canada lynx on federal lands in the conterminous United States. The USDA Forest Service, USDI Bureau of Land Management, and USDI Fish and Wildlife Service initiated the Lynx Conservation Strategy Action Plan in spring of 1998.

The lynx was proposed for listing as a threatened species under the Endangered Species Act on July 8, 1998 (Federal Register Volume 63, No. 130). The final rule listing the contiguous United States Distinct Population Segment (DPS) was published on March 24, 2000 (Federal Register Volume 65, No. 58). In the final rule, the U.S. Fish and Wildlife Service concluded that the factor threatening the contiguous U.S. DPS of lynx is the inadequacy of existing regulatory mechanisms, specifically the lack of guidance for conservation of lynx in the National Forest Land and Resource Management Plans and the BLM Land Use Plans. This lack of guidance may allow or direct actions that cumulatively adversely affect the lynx.

Under provisions of the Endangered Species Act, federal agencies shall use their authorities to carry out programs for the conservation of listed species, and shall insure that any action authorized, funded, or carried

out by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or result in the destruction or adverse modification of critical habitat (16 USC 1536).
The conservation measures presented in this document were developed to be used as a tool for conferencing and consultation, as a basis for evaluating the adequacy of current programmatic plans, and for analyzing effects of planned and on-going projects on lynx and lynx habitat.

Guiding Principles: The conservation strategy must provide guidance that retains future options, provides management consistency, offers necessary flexibility, and ultimately will accomplish the objective of conserving the lynx. In the face of a high degree of scientific uncertainty, we relied on five guiding principles:

- *Use the best scientific information available about lynx*. We relied on information from research throughout the range of the species, recognizing that behavior and habitat use may be different in the southern portion of its range. We also incorporated information about the ecology of the primary lynx prey species, snowshoe hare, and an important secondary prey species, red squirrel. Where no information exists, we made assumptions or inferences, based on the collective experience and professional judgment of team members and other scientists.
- *Until more conclusive information concerning lynx management is developed, retain future options.* In some cases, this led us to recommend no increase in certain types of development within lynx habitat, even though the effects of current levels may be unknown. A conservative approach is prudent to avoid irrevocably committing resources that may ultimately prove to be important to the survival and/or conservation of lynx.
- *Integrate a consideration of natural ecological processes and landscape patterns, and explicitly consider multiple spatial scales*. A blending of the ecological process and species-centered approaches is more likely to maintain diversity, species viability, and sustainability.
- *Consider the habitat requirements of other wildlife species, including other forest carnivores*. A management plan that integrates recommendations for a variety of species is more likely to be feasible and to be successfully implemented.
- *Develop a useful, proactive plan to conserve lynx on federal lands.* Although analysis may consider all ownerships to provide context, conservation measures apply only to federal lands.

How the Document is Organized: Part I of the document provides an assessment of lynx status and risk. An overview of lynx ecology is presented first, followed by identification and description of risk factors. Lynx population status, habitat, and relevant risk factors are assessed for four spatial scales: range-wide, each of 5 geographic areas (Cascade Mountains, Northern Rocky Mountains, Southern Rocky Mountains, Great Lakes, and Northeast), planning unit, and home range. The assessment lays the conceptual and scientific foundation for Part II, the conservation strategy.

Part II contains recommended conservation measures that address each of the risk factors. The conservation measures are sorted into programmatic and project level objectives and standards. Additional sections provide guidance for analysis of effects and project conferencing and consultation, inventory and monitoring, and management priorities.

Lynx Habitat: Lynx occur in mesic coniferous forests that have cold, snowy winters and provide a prey base of snowshoe hare (Quinn and Parker 1987, Koehler and Brittell 1990, Koehler 1990, Koehler and Aubry 1994, Mowat et. al. 2000, McKelvey et. al. 2000*b*, Ruggiero et al. 2000*b*). In North America, the distribution of lynx is nearly coincident with that of snowshoe hares (McCord and Cardoza 1982, Bittner and Rongstad 1982). Lynx are uncommon or absent from the wet coastal forests of Canada and Alaska (Mowat et al. 2000).

Both snow conditions and vegetation type are important factors to consider in defining lynx habitat.
Across the northern boreal forests of Canada, snow depths are relatively uniform and only moderately deep (100-127 cm or 39-50 inches) (Kelsall et al. 1977). Snow conditions are very cold and dry. In contrast, in the southern portion of the range of the lynx, snow depths generally increase, with deepest snows in the mountains of southern Colorado. Snow in southern lynx habitats also may be subjected to more freezing and thawing than in the taiga (Buskirk et al. 2000*b*). Crusting of snow may reduce the competitive advantage that lynx have in soft snow, with their long legs and low foot loadings (Buskirk et al. 2000*a*).

Vegetation types and elevations that provide lynx habitat include:

- Northeastern U.S.: Most lynx occurrences (88%) fell within Mixed Forest-Coniferous Forest-Tundra province; 77% of occurrences were associated with elevations of 250-500 m (820-2,460 ft) (McKelvey et al. 2000*b*). Lynx habitat includes coniferous and mixed coniferous/deciduous vegetation types dominated by spruce, balsam fir, pine, northern white cedar, hemlock, aspen, and paper birch.
- Great Lakes states: Most lynx occurrences (88%) fell within the Mixed Deciduous/Conifer Forest province (McKelvey et al 2000*b*). Lynx habitat includes boreal, coniferous, and mixed coniferous/deciduous vegetation types dominated by pine, balsam fir, black and white spruce, northern white cedar, tamarack, aspen, paper birch, conifer bogs and shrub swamps.
- Western U.S.: Most lynx occurrences (83%) were associated with Rocky Mountain Conifer Forest, and most (77%) were within the 1,500-2,000 m (4,920-6,560 ft) elevation zone (McKelvey et al. 2000*b*). There is a gradient in the elevational distribution of lynx habitat from the northern to the southern Rocky Mountains, with lynx habitat occurring at 2,440-3,500 m (8,000-11,500 ft) in the southern Rockies. Primary vegetation that contributes to lynx habitat is lodgepole pine, subalpine fir, and Engelmann spruce (Aubry et al. 2000). In extreme northern Idaho, northeastern Washington, and northwestern Montana, cedar-hemlock habitat types may also be considered primary vegetation. In central Idaho, Douglas-fir on moist sites at higher elevations may also be considered primary vegetation. Secondary vegetation that, when interspersed within subalpine forests, may also contribute to lynx habitat, includes cool, moist Douglas-fir, grand fir, western larch, and aspen forests. Dry forest types (e.g., ponderosa pine, climax lodgepole pine) do not provide lynx habitat.

Landscapes are more heterogeneous in terms of topography, climate, and vegetation in the southern portion of its range, as compared to the northern taiga, (Buskirk et al. 2000*b*). In the southern portion of its range, lynx populations exhibit large home range sizes, high kitten mortality due to starvation, and greater reliance on alternate prey, especially red squirrels, which is similar to characteristics of populations in the taiga during the declining or low phase of the snowshoe hare cycle (Koehler 1990, Apps 2000). This suggests the importance of designing management practices to maintain or enhance habitat for snowshoe hare and alternate prey such as red squirrel.

Snowshoe hares are the primary prey of lynx, comprising 35-97% of the diet throughout the range of the lynx (Koehler and Aubry 1994). Red squirrels have been shown to be an important alternate prey species, especially during snowshoe hare population lows (Koehler 1990, O'Donoughue 1997). Summer food habits of lynx have been poorly defined, but McCord and Cardoza (1982) indicated that the diet might include other species such as mice, squirrels and grouse. Lynx at the southern periphery of the range may prey on a wider diversity of prey because of differences in small mammal communities and lower average hare densities, as compared with northern taiga.

The common component of natal den sites appears to be large woody debris, either down logs or root wads (Koehler 1990, Mowat et al. 2000, Squires and Laurion 2000). These den sites may be located within older regenerating stands (>20 years since disturbance) or in mature conifer or mixed coniferdeciduous (typically spruce/fir or spruce/birch) forests (Koehler 1990, Slough *in press* cited in Mowat et al. 2000). Stand structure appears to be of more importance than forest cover type (Mowat et al. 2000).

Risk Factors: The lynx assessment includes a list of potential risk factors (Table 1). This is a thorough list of programs, practices, and activities that may influence lynx or lynx habitat, and may need to be addressed during conferencing or consultation. The risk factors are limited to those within the authority and jurisdiction of the federal land management agencies.

Risk factors were not ranked by priority of effects to lynx or lynx habitat. Risk factors may interact, and their relative importance may vary in different areas. Lynx population distribution, habitat components, and risk factors are described for four spatial scales: range-wide; geographic areas (Cascade Mountains, Northern Rocky Mountains, Southern Rocky Mountains, Great Lakes, and Northeast); planning area; and home range.

Conservation Measures: Part II of the document is the conservation measures. These were developed to address each risk factor, in order to conserve the lynx and to avoid or reduce adverse effects from the spectrum of management activities on federal lands.

Plans that incorporate the conservation measures, and projects that implement them, are generally not expected to have adverse effects on lynx, and implementation of these measures across the range of the lynx is expected to lead to conservation of the species. However, because it is impossible to provide standards and guidelines that will address all possible actions, in all locations across the broad range of the lynx, project specific analysis and design also must be completed.

The conservation measures will likely be implemented through two scales of decision-making: programmatic and project planning. Programmatic plans provide broad direction for management activities by establishing goals, objectives, desired future condition statements, standards, guidelines, and land allocations. Project planning implements the broad programmatic direction, by accomplishing procedural requirements and designing activities that tailor substantive management direction to the unique conditions and circumstances of a particular site.

Conservation measures address a variety of programs and activities that occur on federal lands, or are authorized or funded by federal agencies.

9. **Effects of Winter Recreation on Lynx.** (1999) Effects of Winter Recreation on Wildlife of the Greater Yellowstone Area: A Literature Review and Assessment. Olliff, T., Legg, K. & Kaeding, B. Greater Yellowstone Coordinating Committee, Yellowstone National Park. pp. 49-63. http://www.nps.gov/yell/parkmgmt/upload/wildlifewint.pdf

Potential Effects: Because of the secretive nature of lynx and their habit of using deep-forest habitats, few ecological studies of lynx exist, let alone research on the effects of winter recreation. However, the paucity of data should not be construed as evidence that winter recreation has no adverse effects on this species.

Snowmobiling may be particularly adverse to lynx because: 1) this activity occurs when animals are frequently in poor condition due to the stresses of winter; 2) this activity may be dispersed on the landscape (i.e., not confined to roads) on national forest lands outside of wilderness areas; 3) it may occur at night when lynx are usually active; 4) it is frequently accompanied by human disturbance and habitat loss associated with recreational infrastructure; and 5) this activity may alter the density and distribution of snowshoe hares, a favored prey item.

Disturbance, however, does not necessarily lead to a continued reduction in habitat effectiveness for lynx.

Surprisingly, disturbance by people may have a greater negative effect than motorized vehicles on established roadways because mammals habituate more quickly to mechanical noise than to noise from humans. Laughing and yelling can arouse responses of mammals at greater distances than snowmobile noise (Bowles 1995).

Management Guidelines: Snowmobile traffic may reduce the effectiveness of lynx habitats that are peripheral to groomed snowmobile routes. Lynx and hares that use habitats in the vicinity of roads may be adversely stressed by disturbance. Night use of roads may be more detrimental than day use because lynx are nocturnal and crepuscular. However, lynx may show some habituation to snowmobile activity where it is temporally and spatially consistent. Restrictions on quantity and timing of snowmobile travel could reduce adverse effects on lynx. Snowmobiles are frequently used in the backcountry at high elevations, often within or near lynx habitat. Because this activity is highly obtrusive and usually dispersed on the landscape, it has a strong potential to displace lynx from their winter haunts, increase stress levels, and reduce the fitness and viability of lynx populations (Cole and Landres 1995).