
Colorado Lynx Recovery Project

2000 Progress Report to the U.S. Fish and Wildlife Service



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Executive Summary

This report on the Colorado's Division of Wildlife's (CDOW) effort to re-establish lynx (*Lynx canadensis*) is being submitted to the U.S. Fish and Wildlife Service as partial requirement for subpermit sp00-04.00. This report mainly highlights the activities of the reintroduction since the Canada lynx was listed on March 24, 2000. April 23, 2000 was the date the listing rule was published in the [Federal Register](#) and the date when a USFWS permit was required by the state to conduct this program (USFWS 2000).

Ninety-six animals have been released in Colorado since the first release on Feb. 3, 1999 under 5 release protocols, which were sequential adaptations that were successful in improving the survival of released animals. Twenty-eight of the 96 are known to have died: 7 starvation, 3 road-kill, 4 shooting, 1 bobcat predation, 2 sylvatic plague, 5 unknown but not starvation, 4 unknown, and 2 trauma. Another collar was located, separate from the animal, that may have slipped off the animal's neck. It was not possible to determine if this animal was dead or alive, and is currently presumed to be alive.

Sixty-one animals are being regularly tracked using VHF and/or satellite radiotelemetry collars. Collars on the remaining 6 individuals have not been regularly monitored for over 1.5 years (all males) are either no longer functioning, the animal has died and the collar destroyed or the animals have dispersed outside our monitoring area. Examples of movements of the animals which have been tracked are displayed in Figures 3 and 4. Some

lynx are still dispersing and may be trying to find habitat similar to their former ranges in Alaska and Canada. Some individuals have dispersed or wandered to areas of unsuitable habitat such as in the deserts of New Mexico and Utah, the SW corner of Nebraska and the middle of the San Luis Valley. Extreme movements by both females and males in March and April of 2000 may have been related to breeding behavior. While many of the monitoring data for the Colorado lynx have been collected and entered into databases, they have not yet been analyzed. The CDOW plans to begin analyzing these data during the spring of 2001 and to publish the first scientific report on the re-introduction project in the late spring of 2001.

Snow-tracking results indicate that the primary prey items of released lynx are snowshoe hares (*Lepus americanus*) and pine (red) squirrels (*Tamiasciurus hudsonicus*), with waterfowl and other mammals and birds forming a minor part of the winter diet. These results are similar to food habits for lynx in their northern range during lows of the snowshoe hare cycle. It should be noted, however, that snow-tracking data are biased towards larger prey because prey items that are eaten in their entirety (e.g., small mammals) cannot be quantified with this field technique. Summer food habits have not been documented.

Future plans for the next calendar year include continuing to monitor the reintroduced lynx, attempt to recapture and refit new VHF/satellite radio collars on lynx whose collars are designed to fail spring 2001 and those with faulty collars, initiate a state recovery plan process for Canada lynx and initiate a snowshoe hare ecology study.

I. INTRODUCTION

This report on the Colorado's Division of Wildlife's (CDOW) effort to re-establish lynx (*Lynx canadensis*) is being submitted to the U.S. Fish and Wildlife Service as partial requirement for subpermit sp00-04.00.

The first lynx were released on Feb. 3, 1999. A total of 96 lynx have been released in southwestern Colorado. It is still too early to tell if this effort will be successful in restoring this species as part of the state's biodiversity. This is only the second time in North America that a lynx reintroduction has been attempted. The first effort was in Adirondack Park in New York in the late 1980's (Brocke et al. 1990, Brocke et al. 1993). Apparently this effort failed to establish lynx; however, adequate post-release monitoring was never completed.

Caution must be used in interpreting preliminary monitoring data from this project. Some lynx are still dispersing and may be trying to find similar habitat to their former ranges in Alaska and Canada.

While much of the monitoring data for the Colorado lynx have been collected and entered into databases, they have not yet been analyzed. The CDOW plans to begin analyzing this data during the spring of 2001 and to publish the first scientific data on the re-introduction project in the late spring of 2001.

II. METHODS

A. Vet Inspection (Wild 1999) –

Source Site: To insure that all lynx were in good health and disease free, they were inspected by a local veterinarian and treated with certain drugs (flea powder [Carbaryl] Ivermectin and Praziquantel) prior to being shipped to Colorado to reduce the risks of introducing an internal or external parasite to the state. The veterinarian attempted to verify the age of each lynx, determined the sex, and inspected the feet to make sure they did not have more than one missing toe and had good teeth. All lynx were held a minimum of 5 days in the local holding pens prior to the veterinary inspection. This was done to allow a better inspection for freeze damage that sometimes may not become apparent until after the 5th day of captivity. Blood serum was collected from all lynx as a tool to monitor for diseases. All lynx from Canada were issued an International Health Certificate. Lynx from Alaska did not require the international health certificate since they did not travel through any foreign ports, as they were flown via direct flights from Fairbanks to Salt Lake City. Alaska lynx were issued a state health certificate.

Colorado: Several days after the lynx arrived at the Colorado holding facility, they were given another thorough veterinarian inspection. The lynx were placed in a specially designed squeeze chute and then immobilized with Telazol. The time of administration and their recovery was closely recorded. The inspection followed the same procedure as the source site inspection but was more thorough and included some other steps such as collecting hair and blood samples for DNA fingerprinting and for serological studies (EDTA & RTT). Two transponder tags were installed for future identification. One tag was placed in the chin and one between the shoulder blades. During the second year, it sometimes became necessary to pair lynx together in one pen. When this occurred, a unique colored pet collar was placed on them to readily determine their identity. The first year several lynx were also ear-tagged but this practice was deemed redundant and later dropped. Also, in 1999 all lynx faces were photographed.

Under normal circumstance, if there were no injuries, the lynx were processed a second and final time. The second inspection was usually 2-3 days prior to release. During this inspection vital statistics such as measurements and weight were again collected. The lynx were given a thorough vet inspection and the radio collar was fitted to the animal. Female lynx that were trapped after March 1 were radiographed to determine breeding status. Lynx with injuries had to be re-inspected on a more regular basis depending on the situation to monitoring healing.

B. Monitoring Protocol (Shenk 2000a, b, c) – CDOW researcher, Dr. Tanya Shenk, has been in charge of the lynx monitoring program. The post-release monitoring program has two primary goals. The first goal is to obtain regular locations of released lynx. From these locations we will be able to determine how many lynx remain in Colorado and their locations relative to each other. Given this information and knowing the sex of each individual we will be able to assess the feasibility of these lynx to form a breeding core from which a viable population might be established. Also from these data we can describe general movement patterns and habitats used. The second primary goal of the monitoring program is to estimate survival of the reintroduced lynx and, where possible, determine cause of mortality of reintroduced lynx.

Additional goals of the post-release monitoring program for lynx reintroduced to the southern Rocky Mountains include refining descriptions of habitat use and movement patterns, determining food habits, and obtaining information on reproduction. More emphasis will be placed on refining descriptions of movement patterns and habitat use in areas of repeated lynx use.

Objectives -

The initial post-release monitoring of reintroduced lynx will emphasize five primary objectives:

1. Assess and modify release protocols to ensure the highest probability of survival.
2. Obtain regular locations of released lynx to describe general movement patterns and habitats used by lynx.
3. Determine causes of mortality occurring in reintroduced lynx.
4. Estimate survival of lynx reintroduced to Colorado.
5. Estimate reproduction of reintroduced lynx.

Three additional objectives will run concurrently or become active after lynx become established in an area that encompasses their movements. These objectives include:

6. Better refine descriptions of habitats used by reintroduced lynx.
7. Better refine descriptions of daily and overall movement patterns of reintroduced lynx.
8. Describe food habits and prey of reintroduced lynx.

The data collected during the post-release monitoring will be analyzed to evaluate habitat use, movement patterns, reproduction and survival. These data will be used to further the knowledge about habitat requirements for this species in the southern Rocky Mountains. Thus, the final objective for the post-release monitoring plan is to:

9. Refine habitat protection recommendations and conservation strategies based on information collected from released lynx.

C. Monitoring Methods (Shenk 2000a, b, c) –

Assessment of Release Protocols: A total of 96 lynx were released at selected areas in the San Juan Mountains of southwestern Colorado. Prior to release, each lynx was examined and age, sex, and body condition determined. Each lynx was fitted with a VHF radio-collar (first year). During the second year, 51 of the 55 released lynx were fitted with a combination VHF/satellite collar. Specific release sites were selected based on land ownership and accessibility during times of release. Lynx were transported from the holding facility to the release site in individual cages and in some cases, 2 lynx per cage. Release site location was recorded in Universal Trans Mercator (UTM) coordinates and identification of all other lynx released at the same location, on the same day, was recorded. Behavior of the lynx on release and movement away from the release site were documented.

Monitoring of the survival and mortality factors (see below) of each lynx was used to modify release protocols. Release protocols were modified, as new information became available, in an attempt to release each lynx with the highest probability of survival.

Documenting Movement Patterns: To obtain regular locations of released lynx to determine general movement patterns and habitats used by reintroduced lynx, a combination of aerial and ground radio tracking was used. Locations and general habitat descriptions of each location were recorded and mapped.

Frequent flights (at least three times per week) were critical during initial post-release periods because of the greater likelihood of dispersal and mortality in reintroduced carnivores. This was especially true the first year when satellite collars were not used. Every effort was made to locate every lynx during each flight during this period.

When possible at least one observer flew with the pilot to become familiar with the terrain, to operate the radio telemetry receiver, and to record the global positioning system (GPS) locations of the lynx. Early in the project, systematic transects were flown in the release area and expanding in all four directions as lynx began to disperse. Generally, the pilot circled a strong telemetry signal and then bisected the circle activating the GPS unit when approaching the lynx directly overhead. The date and time of the beginning and ending of the flight, the time each lynx was located, the UTM coordinates for each animal located, general weather conditions, primary overstory vegetation type, and names of the personnel in the plane were recorded. All locations were entered into a database for analysis.

All 41 of the lynx released in the winter/spring of 1998-99 were equipped with a Telonics™ VHF radio-collar. Biologists can receive the signals from these collars either on the ground or in an airplane. In most cases, the

receiver can pick up the collar signal if the collar has a clear line of sight to the receiver. In some cases the signal can be picked up from over 30 miles away. The collars were all equipped with a mortality switch that will activate if the collar remains motionless for a period of 4 hours or more. Any mortality signals relocated on the ground as soon as possible to allow for the best chance of determining the cause of death of the lynx.

Fifty-one of the 55 lynx released in the spring 2000 were fitted with a Sirtrack™ dual satellite/VHF radio-collars. The other 4 lynx were fitted with VHF collars. These collars also have a mortality indicator switch that operates on both the satellite and VHF mode. This satellite location capability will greatly increase the number and regularity of locations we can obtain for each lynx. The satellite component of each collar is programmed to be active for 12 hours per week. The 12-hour active periods are staggered throughout the week, with approximately seven collars being active each day of the week. Signals from the collars allow for locations of the animals to be made via Argos, NASA, and NOAA satellites. The location information is processed by ServiceArgos and distributed daily to the Colorado Division of Wildlife through e-mail messages. Thus, each morning we have new locations for seven or eight lynx. With such frequency we will not only be able to locate lynx, but document large scale movement patterns for individual lynx.

Determining Causes of Mortality: To determine causes of mortality occurring in reintroduced lynx every effort was made to locate and retrieve carcasses of dead lynx as soon as possible. When a mortality signal (75 ppm vs. 50 ppm for the Telonics™ VHF transmitters, 20 bpm vs. 40 bpm for the Sirtrack™ VHF transmitters, 0 activity for Sirtrack™ PTT) was heard during either satellite, aerial or ground surveys, the location (UTM coordinates) was recorded. Ground crews located and retrieved the carcasses. The immediate area was searched for evidence of other predators and the carcass photographed in place before removal. Additionally, the mortality site was described, habitat associations, and exact location were recorded. Any scat found near the dead lynx that appeared to be from the lynx was collected.

All carcasses were transported immediately to the Colorado State University Veterinary Hospital for a post mortem exam. Lynx carcasses were not frozen but kept cool. If carcasses were already frozen due to field conditions, this was noted on the field form.

The objectives of the post-mortem examination were to 1) determine the cause of death and document with evidence, 2) collect samples for a variety of research projects, and 3) archive samples for future reference (research or forensic). The gross necropsy and histology were performed by, or under the lead and direct supervision of a board certified veterinary pathologist. At least one research personnel from the Colorado Division of Wildlife involved with the lynx program was also present. In general, the protocol followed standard procedures used for thorough post-mortem examination and sample collection for histopathology and diagnostic testing. Some additional data/samples were routinely collected for research, forensics, and archiving. Other data/samples were collected based on the circumstances of the death (e.g., photographs, video, radiographs, bullet recovery, samples for toxicology or other diagnostic tests, etc.). The CDOW retained all samples and carcass remains with the exception of tissues in formalin for histopathology, brain for rabies exam, feces for parasitology, external parasites for ID, and other diagnostic samples.

Estimating Survival: Survival rates of lynx reintroduced to Colorado will be estimated using the Kaplan-Meier method with staggered entries (Pollock et al. 1989).

Documenting Habitat Use and Hunting Behavior: More refined descriptions of habitats used by reintroduced lynx were obtained through snow-tracking of animals. Data were collected on habitats used; daybed and hunting bed locations, and travel corridors. Hunting and feeding behavior information was also collected by documenting prey taken, prey chases, relative abundance of prey (tracks and sightings), and use of carrion. Snow tracking was conducted during February-May, 1999 and again in November 1999 – May 2000. Locations from the aerial-tracking were used to help the ground crew locate lynx tracks in the snow. Snowmobiles, where permitted, were used to gain the closest possible access to the lynx tracks without disturbing the animal. From that point, snowshoes were used by the ground crew to reach the tracks. Once tracks were found, the ground crew backtracked the animal. Backtracking should avoid the possibility of disturbing the lynx by moving away from the animal rather than towards the animal. However, monitoring of the lynx through radio-telemetry was also used to assure that the ground crew stayed a sufficient distance away from the lynx in the event the lynx might double back on its tracks. If the lynx began to move in response to the observers, the observers retreated. If the lynx began to move and the movement did not appear to be a response to the observers, the ground crew attempted to follow and record locations, habitats used, and behavioral information for as long as possible.

Locations of the lynx tracks were recorded using a GPS and 7.5° topographic map. These data will be used for mapping and spatial analyses. Data will be analyzed to make inferences on how different habitats are used, frequency of use, daily movement patterns, hunting areas, daybed locations, den sites, and travel corridors. Data will also be used to document any changes in habitat use as animals begin to settle into areas of repeated use.

Through backtracking, habitats used by the lynx were recorded. Habitat descriptions included overstory and understory vegetation descriptions as well as any behavioral observations that could be interpreted from the tracks (e.g., chases, scent marking).

An attempt was made to locate tracks from all lynx. However, first priority was given to locating any animal that appeared to be consistently in the same location from aerial surveys. Such stationarity may indicate an injured, starving, or otherwise traumatized animal.

Data on hunting behavior were collected by location of kills, food caches, chases, and through scat analysis. Prey from attempted and successful hunting attempts was identified by either tracks or prey remains. Information from scat analysis also provided information on foods consumed. Scats were collected wherever found, recording location and individual lynx identification. Only part of the scat was collected, the remainder was left where found so as not to interfere with the possibility the scat was being used by the animal as a territory mark. Comparisons of food composition and percent occurrence will be made within and among individuals. Analyses of temporal, spatial, and individual differences will be conducted to provide information on feeding ecology of reintroduced lynx in the southern Rocky Mountains.

Estimating Reproduction: Reproductive status of all female lynx was determined prior to release through radiographs. All females known to be pregnant or thought to possibly be pregnant on release were monitored closely from their release through the following August to determine reproductive success. Females remaining within a limited area immediately after release through August were located and observed to look for accompanying kittens or a den site. Females that had been released in 1999 and were alive in spring 2000 were monitored for proximity to males during breeding season and for site fidelity to a given area during the denning period of May and June 2000. Each female lynx from the 1999 releases was directly observed in summer 2000 over 3-5 different visits to look for accompanying kittens or evidence of denning.

III. RESULTS

A. Results Comments - The CDOW has tried to capitalize on every opportunity to learn from this project. There isn't a blueprint to follow on how to conduct this project since a successful North American lynx reintroduction has never been accomplished. The CDOW had to develop techniques and procedures as needed to complete the reintroduction. This has necessitated the project proceed adaptively: a continuous process of applying a treatment or protocol, evaluating the effects, and making adjustments that seem reasonable and prudent.

B. Holding Facility Behavior - Several things were learned by observing the lynx in the holding pens:

- Lynx cache excess food in nest boxes and appear to be very protective of their food supply.
- Lynx are very vocal in early evening and morning hours starting at the beginning of their breeding season in early March.
- Lynx are tolerant of other lynx and it was possible to hold two lynx (male or female) together without problems.

C. Lynx Reintroduction Statistics - A total of 96 lynx have been released into the state (41 in the winter of 1998-99 and 55 in the winter of 1999-2000).

Table 1. Lynx received in the winter of 1998-99.

Source	Males	Females	Total	Comments
British Columbia	6	5	11	2 juveniles by mistake; shipped by truck
Yukon	7	4	11	1 juvenile female; 1 adult male euthanized in CO; 1 suspected pregnant
Alaska	7	13	20	6 pregnant & 1 suspected
	20	22	42	

Table 2. Lynx received in the winter of 1999-00.

Source	Males	Females	Total	Comments
British Columbia	9	10	19	1 adult female euthanized in CO
Yukon	7	20	27	1 juvenile male
Alaska	4	6	10	2 juvenile female; 1 pregnant & 3 suspected pregnant
	20	36	56	

D. **Assessment of Release Protocols** - A total of 41 lynx were released in Colorado in 1999 under five different release protocols (Table 3). The initial release protocol called for the immediate release of females once they passed veterinary inspection in Colorado. Males were to be held for a period of weeks until females established a territory, and then males were to be released near female territories. Four animals were released in early February 1999, however, three of these died of starvation within six weeks of their release and the fourth was recaptured and returned to the holding facility where she recovered and was later re-released (Table 4). Reevaluation on the condition of animals released under the first protocol suggested that these animals might not have been in optimal physical condition when released. Therefore, a second release protocol was initiated whereby lynx were held at the Colorado holding facility for a minimum of three weeks and fed high quality diets to encourage weight gain. Most lynx gained considerable body weight while in captivity (Wild 1999). Nine lynx were released under this second protocol (Table 4). Of these nine lynx, one juvenile female died of starvation seven weeks after release.

After the starvation death of the first lynx under the second protocol, a third release protocol was developed that called for releasing all subsequent lynx in the spring after a minimum stay in the holding facility of at least three weeks (Table 4). A spring release would assure the lynx were released when prey was most abundant (i.e., young of the year would be most abundant and hibernating and migratory prey would be available). Twenty lynx were released under this protocol (Table 4). Additionally, six females were released under this third protocol that were known to be pregnant (Protocol 3P) and two that were possibly pregnant (Protocol 3P?). No lynx reintroduced under Protocol 3 died of starvation within six months post-release (Table 4). However, two of the six lynx released when pregnant died of starvation within six months post-release.

An assessment of the fates of each lynx under all five release protocols used in 1999 led to release protocols for lynx released in 2000. Release protocols 2 and 3 resulted in the fewest post-release (up to six months after release date) starvation mortalities (Table 4). The common element in both protocols was increased captivity time in the Colorado holding facility. The single starvation mortality for lynx released under Protocol 2 in 1999 was also the only juvenile released under that protocol and the only animal released in February (the other 8 Protocol 2 lynx were released in March 1999). Thus, all lynx released in 2000 were released under either Protocol 2 or 3 but not before April 1. Because of the high percentage of starvation mortalities in females pregnant on release (Table 4), we also attempted to avoid reintroducing lynx that were known to be pregnant. This was best accomplished by trying to have animals captured for the reintroduction effort in Canada prior to their breeding season.

Table 3. Release protocols for lynx released in southwestern Colorado in 1999.

Protocol	Description
1	Release females as soon as they pass veterinary inspection in Colorado. Release males once females appear to have settled into an area.
2	Release males or females after they have been held in Colorado holding facility for a minimum of 3 weeks. During this holding period, the lynx were fed high quality diets to encourage weight gain, assuring each lynx would be released in optimal physical condition. Such a minimal holding period also provided an opportunity for the lynx to acclimate to the climate, elevation, and local

conditions of the environment they would be released into. Although most lynx were housed in individual pens, with a few sharing a pen with one other lynx, the holding facility allowed the lynx to hear and smell each other throughout this acclimation period. Such contact may also have provided time for social interactions to occur.

3 All lynx to be kept in the holding facility for not only the minimal three week period but until spring (April 1 or later). A spring release would assure the lynx were released when prey was most abundant (i.e., young of the year would be most abundant and hibernating prey would be available). Coupled with the minimum holding period of three weeks, these lynx would also be released when in optimal physical condition and after a period of acclimation to their new surroundings.

3P Pregnant females released under Protocol 3.

3P? Possibly pregnant females released under Protocol 3.

Table 4. Summary of number of lynx released under each release protocol and numbers of lynx mortalities six months post-release for lynx released into southwestern Colorado in 1999 and four months post-release for lynx released in 2000.

		1999				2000			
		Number released		Mortalities 6 months post-release (n, %)		Number released		Mortalities 6 months post-release (n, %)	
		Female	Male	Starvation	Other	Female	Male	Starvation	Other
Protocol									
	1	3	1	3, 75%	0, 0%	0	0	-	-
	2	3	6	1, 11%	0, 0%	25	16	1, 2%	3, 7%
	3	8	12	0, 0%	3, 15%	6	4	0, 0%	2, 10%
	3P	6	-	2, 33%	2, 33%	1	-	0, 0%	0, 0%
	3P?	2	-	0, 0%	0, 0%	3	-	0, 0%	0, 0%
Total		22	19	6, 14%	5, 12%	35	20	1, 2%	5, 9%

E. Movement Patterns - Through extensive aerial and satellite tracking, we continue to search and locate 61 of the 67 lynx with collars on and assumed to be alive. We have 3902 satellite locations for 49 of the 51 lynx fitted with dual collars (2 satellite collars never worked after the lynx were released) and 1506 aerial VHF locations for all 96 reintroduced lynx. Six males from the 1999 releases have not been found since at least 1 October 1999. Possible reasons for not locating these six males include (1) long distance dispersal, beyond the areas currently being searched, (2) radio failure, or (3) destruction of the radio (e.g., run over by car). We continue to search for all missing lynx during both aerial and ground searches. Last known locations for each of the 67

collared lynx are presented in Figure 1.

Initial dispersal movement patterns of the lynx released in 1999 were extremely variable. Dispersal habitat used by lynx released in 1999 has been highly variable, from high elevation Engelmann spruce/Subalpine fir to Nebraska agricultural lands. However, numerous travel corridors have been used repeatedly by more than one lynx, possibly suggesting route selection based on olfactory cues.

Dispersal movement patterns of lynx released in 2000 were much less than those observed by lynx released in 1999. Most of 2000 releases have remained within an area encompassed by 100-km radius from the release locations. Most movement away from this core area has been to the north. We have had at up to six lynx using areas near Interstate 70.

F. Survival and Mortality Factors - Of the 96 lynx released, 28 mortalities have been recorded to date (Table 4&5; Figure 2). From the 1999 releases (41 animals) we have had 22 known mortalities (6 from starvation, 8 unknown, 3 gunshot, 2 hit by car, 2 trauma, and 1 predation). We have six missing males. We are following 13 of the lynx from the 1999 releases on a regular basis. From the 2000 releases (55 animals) we have six known mortalities (1 shot, 1 hit by car, 2 disease, 1 starvation, and 1 unknown) and one animal that possibly slipped her collar. We are following the remaining 49 animals on a regular basis.

Of the total seven confirmed starvation deaths, three were associated with animals released in less than ideal body condition and two were lynx less than one year old. Percent mortality due to starvation decreased with each modification of release protocols (75% under Protocol 1, 11% under Protocol 2, 0% under Protocol 3).

Necropsy results for lynx BC00F3 and AK00F1, both females released on April 2, 2000 near Creede and on May22, respectively, indicate they died from pneumonic plague. Lynx BC00F3 was in fairly good condition, there was some abdominal fat, no muscle wasting, and the bone marrow had fat in it. The only gross lesion was an acute fibrinous pneumonia (i.e., lung infection of short duration). The lynx had probably only been sick a few days before it died. The carcass was recovered near her release site. Lynx AK00F1 was in poorer body condition when found. Plague was diagnosed by fluorescent antibody test and isolation of *Yersinia pestis* from lung and spleen samples.

Table 5. Cause of Mortality for lynx released into southwestern Colorado in 1999 and 2000.

Cause	1999 – Male	1999-Female	2000 - Male	2000-Female	Total
Starvation	1	5	1		7
Road-kill		2		1	3
Shot	2	1	1		4
Bobcat		1			1
Plague				2	2
Unknown	4				4
Unknown – not Starvation	1	3		1	5
Trauma		2			2
Total	8	14	2	4	28
No. Released	19	22	20	35	96
% Mortality	42%	64%	10%	11%	29%

Table 6. Release and mortality information for lynx released into southwestern Colorado in 1999 and 2000.

Release Information						Mortality Information	
Animal ID	Sex	Age	Date	Site	Protocol	Date	Cause of death
BC99M1	M	8mo	2/4/99	Goose Creek	1	2/24/99	starvation

BC99F9	F	2+	2/3/99	Goose Creek	1	2/26/99	starvation
BC99F7	F	3+	2/3/99	Goose Creek	1	3/16/99	starvation
BC99F8	F	9mo	2/20/99	Red Mt. Creek	2	4/10/99	starvation
AK99F4	F	1-2	5/7/99	Sand Bench	3p	6/13/99	starvation
AK99M23	M	1-2	5/14/99	Love Lake	3	6/18/99	shot
BC99F6	F	2+	2/4/99	Goose Creek	1	7/19/99	hit by car
AK99F17	F	2-3	5/10/99	First Fork	3p	7/22/99	hit by car
AK99F8	F	5+	5/10/99	First Fork	3p	7/30/99	starvation
AK99F18	F	1-2	5/14/99	Love Lake	3	8/25/99	trauma, emaciation
AK99F10	F	10mo	5/12/99	Lemon Res	3p	9/13/99	unknown, not starvation
BC99M2	M	4+	3/19/99	Red Mtn Creek	2	10/20/99	unknown, not starvation
AK99F27	F	10mo	5/14/99	Love Lake	3	10/31/99	shot
AK99M6	M	5	5/13/99	Vallecito Res	3	11/16/99	shot
AK99F15	F	2-3	5/14/99	Love Lake	3	11/24/99	blunt trauma
YK99F4	F	4-5	5/13/99	Vallecito Res	3	1/25/00	predation, emaciation
AK99M11	M	2-3	5/12/99	Lemon Res	3	1/29/00	unknown
BC00F3	F	1	4/2/00	Goose Creek	2	5/24/00	pneumonic plague
YK00M5	M	10mos	4/2/00	Beaver Meadows	2	5/25/00	starvation
YK99F3	F	2	5/10/99	First Fork	3	6/7/00	unknown, not starvation
YK99M6	M	3	5/13/99	Vallecito Res	3	6/19/00	unknown
AK99F13	F	10mo	5/12/99	Lemon Res	3	6/22/00	unknown
YK00F17	F	1	4/17/00	Rio Grande Res	2	7/29/00	unknown, not starvation
BC99M10	M	3-4	3/19/99	Red Mtn Creek	2	8/2/00	unknown
AK99F25	F	10mo	5/7/99	Sand Bench	3	8/10/00	unknown, not starvation
YK00F6	F	2	4/2/00	Rio Grande Res	2	8/17/00	hit by car
AK00F1	F	10mo	5/22/00	Rio Grande Res	2	9/14/00	plague
AK00M2	M	4	5/3/00	Rio Grande Res	2	8/30/00	shot

G. Recaptures - Three lynx have been recaptured and subsequently re-released since their initial release. Lynx BC99F6 was released in 1999 under Protocol 1. Her behavior and incidental sightings by the public suggested the lynx was in poor condition. We trapped her using a Tomahawk™ live trap baited with rabbit. She

was recaptured the first night (March 25, 1999) we set the trap. On capture, we found she was severely emaciated. We anesthetized her with Telezol (2 mg/kg) and returned her to the Colorado holding facility. She was rehabilitated through diet. The lynx gained weight steadily and was re-released on May 28, 1999. She was hit by a car on Interstate 70 on July 19, 1999. Necropsy results indicated she was in excellent body condition at her time of death.

Lynx AK99M9 was released on May 12, 1999 and recaptured on March 24, 2000. Field observations by the lynx monitoring crew suggested that the lynx was severely emaciated. Live-trapping the lynx failed, so the lynx was darted with Telazol (3 mg/kg) using a Dan-Inject CO₂ pistol. Physical examination revealed severe emaciation (6 kg). The lynx was returned to the Colorado holding facility and rehabilitated through diet. The lynx gained weight steadily and was re-released on May 3, 2000.

Lynx AK99F2 was released on May 7, 1999 and recaptured on April 18, 2000. Field observations by the lynx monitoring crew suggested that the lynx was emaciated. She was live-trapped with a Tomohawk™ live trap with one night's effort. On capture, we found she was emaciated. We anesthetized her with Telezol (2 mg/kg) and returned her to the Colorado holding facility. She was rehabilitated through diet. The lynx gained weight steadily and was re-released on May 22, 2000.

H. Habitat Use and Hunting Behavior-

February 1999-May 1999: Through snow-tracking, we were able to document habitat use, daily movement patterns, and hunting behavior of the earlier released lynx. Snow-tracking of lynx began shortly after the first release, Feb. 6, and continued until May 15, 1999. Although we tried to continue beyond May 15, efforts beyond this date did not yield any information because of either the lack of snow in the areas where the lynx were, or the snow conditions were too difficult to track in (hard, crusty, patchy). Because the majority (28) of the lynx were first released under Protocol 3, after May 6, the snow-tracking effort focused on the 13 lynx released prior to this date, under Release Protocols 1 and 2.

Approximately 114 km of lynx tracks were followed. These tracks were from 11 different lynx, with kilometers tracked for any individual varying from 1 to 31 kilometers. Two lynx (one female and one male) from Release Protocols 1 and 2 were never snow-tracked because we were either not able to locate the animals or because when we did locate them we could not readily access where they were. Daybeds and hunting beds were located for eight of the lynx.

Prey chases or kills were found for four lynx, scat samples were collected from five lynx, and possibly from a sixth. From the kills found and from initial examination of the scat samples, the lynx fed on snowshoe hare (*Lepus americanus*), pine (red) squirrel (*Tamiasciurus hudsonicus*), and waterfowl. All the snow-tracking effort was conducted on nine lynx released under Protocols 1 and 2. Any lynx released under Protocol 3 were released too late to track.

November 1999 - April 2000: Ground crews tracked 13 of the lynx released in 1999 during this period (Table 7). Two other lynx were being located during this time but were not in snow. A total of 139 kills or chases were located, 75% were snowshoe hare, 23% were pine (red) squirrel, and the remaining 2% were made up of other mammals and birds. We collected 115 scat samples that will be analyzed for content. Lynx released in 2000 were released too late to snow track.

Table 7. Hunting behavior as described by tracking period, number of lynx tracked, kills, beds, scats and the number of tracking day. Data presented here are for the 1999 and 1999-2000 snow-tracking field seasons.

Tracking Period	No. of lynx tracked	Kills	Beds	Scats	Tracking Days
Feb 99 - May 99	11	8	71	17	84
Nov 99 - Apr 00	13	139	300	115	137

I. Reproduction - Six lynx released under Protocol 3 in 1999 were known to be pregnant (Table 4, Release

Protocol 3P). Two other females may have been pregnant, the radiographs were suggestive but inconclusive (Table 4, Release Protocol 3P?). Three of the six lynx known to have been pregnant on release in 1999 died within two months after release. Two starved and one was killed on the road (Table 5). Long distance movements and lack of stationarity in the movement patterns of the other three lynx known to have been pregnant on release in 1999 suggests these females did not have young with them by July 1999. Of the two females that might have been pregnant, movement patterns were not suggestive of a female rearing young. It is not known if any other females bred and/or had young once released, however no females snow-tracked November 1999 through April 2000 had young with them.

From radiographs taken of the 35 females released in 2000, one female was known to be pregnant and three were possibly pregnant. Movement patterns suggest that none of these females have kittens with them as of July 2000.

There were seven females released in 1999 that were alive during the spring 2000 breeding season. All seven females were in close (< 5 km) proximity to a male during the breeding season and could have bred. The seven females were monitored closely for stationary movement patterns, indicative of denning, from May-July 2000. Ground trackers also walked in on all seven females for visual observations on a minimum of three occasions and two females were visited on five occasions. No kittens were observed. However, the question of whether they successfully bred or had kittens at some point in 2000 is unknown. One of these females has since died and three others have made movements of over 100 km. Although we are confident none of the six live females have kittens at this time, for further confirmation we will snow-track each of these females as soon as they are in areas with fresh snow to check for kitten tracks.

Beginning in March 2000 both male and female lynx began to exhibit extensive movements (>100 km) away from areas they had used throughout the winter. For example, female (AK99F3) moved from the area near Grizzly Gulch she used throughout the winter to the Wolf Creek Pass area, a straight-line distance of approximately 255-km (Figure 3). Male YK99M3 moved from the area near the Climax mine, which he had used throughout the winter to Taylor Mesa, a straight-line distance of approximately 270km (Figure 4). Such movements by both females and males put them in close (< 5 km) proximity to a lynx of the opposite sex. Two isolated males did not move during March or April and thus were not in close proximity to a known female during the breeding season. This was a male that had used the area in and adjacent to the northwest corner of Rocky Mountain National Park and a male that used the area around Cuchara, Colorado throughout the winter.

IV. DISCUSSION

Monitoring of lynx reintroduced to southwestern Colorado is crucial to evaluating the progress of the lynx reintroduction. Monitoring of these released lynx provides information and data necessary for improving release techniques to ensure the highest probability of survival for each individual lynx released in future years, and perhaps in other areas. Lynx are currently a species listed as threatened under the ESA. Information collected on the progress of the lynx reintroduction program, including habitats used, movement patterns, mortality factors, survival, and reproduction, could also be used to help develop recovery goals and conservation strategies for this species specific to its southern range.

Three primary release protocols were used in the reintroduction of lynx to Colorado in 1999. Release protocols were modified as new information became available from monitoring the released lynx through radio-telemetry and snow-tracking. Each modification of the release protocols decreased the percent of animals dying from starvation. The primary element in later, more successful release protocols was an increased time in captivity at the Colorado holding facility. Increasing the amount of time lynx were held in the Colorado holding facility provided each lynx with an opportunity to increase body weight and acclimate to the climate, elevation, and local conditions of the environment they would be released into. Although most lynx were housed in individual pens, with a few sharing a pen with one other lynx, the holding facility also allowed the lynx to hear and smell each other throughout this acclimation period. Such contact may have provided time for social interactions to occur. Such social interactions may improve the likelihood these animals could form a breeding population.

Post-release monitoring provided preliminary information on habitat use specific to Colorado that might later be used to refine habitat protection and management recommendations specific to Colorado. However, caution must be used in interpreting the information collected to date on habitats used by the introduced lynx. The aerial locations and snow-tracking results do provide some information but may also reflect behavior of displaced animals. General observations to note may be repeated use by multiple lynx of certain travel corridors and lack of use of tundra areas for any length of time. Both these habitat use characteristics have been noted for naturally

occurring lynx populations.

Preliminary data collected on kills suggests the reintroduced lynx are feeding on their preferred prey species, snowshoe hare and pine (red) squirrel in similar proportions as those reported for northern lynx during lows in the snowshoe hare cycle (Aubry et al., 1999). Caution must be used in interpreting the proportion of identified kills. Such a proportion ignores other food items that are consumed in their entirety. Through snow-tracking we have evidence that lynx are mousing and several of the fresh carcasses have yielded small mammals in the gut on necropsy. Nearly all the scat samples collected have been found through snow-tracking efforts and thus are representative of winter diet only. However, the summer diet of lynx has been documented to include less snowshoe hare and more alternative prey than in winter (Mowat et al., 1999).

The extreme movements observed by both females and males in March and April 2000 may have been related to breeding behavior. March and April are the natural breeding periods for northern lynx (Tumilson 1987). We do not know if any of the females bred or had kittens but we are fairly sure that no female has kittens at this time. With only seven females from the 1999 releases in the wild in spring 2000 it was not unexpected that there might not be successful reproduction in 2000. During the summer of 2000, some lynx that were released in 1999 and had been faithful to a given area have made large movements away from these areas. Extensive summer movements away from areas used throughout the rest of the year have been documented by native lynx in Wyoming and Montana (Squires and Laurion 1999).

Proposed monitoring and research include continued aerial radiotelemetry to document current locations and movement patterns, documentation of mortalities and causes of death, use of snow-tracking to document habitat use and hunting behavior, and further assessment of snowshoe hare densities in the state. The habitats used by the lynx will continue to be identified, mapped, and analyzed. These data will be used to further the knowledge about habitat requirements and preferences for this species in the southern Rocky Mountains. This information will be used to identify other blocks of potential habitat located throughout the Southern Rocky Mountains and evaluate conflicts that might jeopardize the recovery of lynx in Colorado. If conflicts are identified, such information can be used to develop conservation strategies and recommend land management strategies to mitigate them.

V. FUTURE PLANS

A. Monitoring and Recapture— During the calendar year 2001, the CDOW plans to continue to monitor the lynx for at least the next three years while some of the radio collars are still active. It may be possible to recapture some lynx to replace radio collars. Also, there may be an opportunity to capture and radio collar Colorado born lynx. These animals would not be radio collared until they are at least 6 months old.

B. Colorado Lynx Recovery Plan - The CDOW will start the process of developing a state recovery plan for lynx. Hopefully, the recovery team will involve federal agency personnel and the state plan and recovery team will evolve into the federal team and plan. The U. S. Fish and Wildlife Service estimates that the federal recovery plan will not start for 2-3 more years (G. Patton, personal Commun.) giving the state an opportunity to maintain the lead in the lynx recovery effort.

C. Snowshoe Hare Ecology Study - The CDOW will be developing a Request for Proposal (RFP) to conduct snowshoe ecology research. Results of this effort could reveal how hares are utilizing various habitat types and which habitats and parameters are most important to hare survival and productivity. From this research, management prescriptions could be designed to better manage forests for optimum hare populations. Maintaining abundant and widespread snowshoe hares populations are essential to recovering lynx in Colorado.

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