Lynx (*Lynx canadensis*) Use of the Wolf Creek Pass Area along Highway 160, Mineral County, Southwestern Colorado

Report for:
The Colorado Division of Wildlife

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INTRODUCTION

The Colorado Division of Wildlife (CDOW) conducted the following analysis in response to requests from the U.S.D.A. Forest Service (USFS) for information regarding Canada lynx (*Lynx canadensis*) use of the area around Wolf Creek Pass along Highway 160 in Mineral County, southwestern Colorado. The USFS requested this information for use in assessing the potential effects of the proposed Village at Wolf Creek Project (Figure 1) on lynx in the area. A detailed description of the proposed project is available in the Draft Environmental Impact Statement (USFS 2003). In particular, CDOW was asked to characterize general use of the project area by lynx and to provide information on where lynx have crossed Highway 160 near Wolf Creek Pass.

Due to the limitations of the available data, this report can provide only limited information on exact lynx highway crossings. The report does explain and demonstrate the limitations of existing data and then provides what data are available on lynx use of the area surrounding the proposed development. Finally, a brief description of a proposed study that could be conducted to provide more complete lynx highway crossing information is provided.

ANALYSIS AREA

The analysis area was determined as the nearest area of repeated use by multiple lynx north and south of Highway 160, the proposed development area and the stretch of Highway 160 between Pagosa Springs and the Colorado 149 junction.

METHODS

Datasets

Three types of lynx location data were used for this analysis. The first type of lynx location data are collected via satellite from the satellite transmitters on the lynx (hereafter satellite locations). Satellite transmitters were first used for lynx in April 2000 in combination with the VHF transmitters. The satellite transmitters are designed to provide locations on a weekly basis for 18 months. The second dataset of lynx locations includes all aerial locations obtained from daytime flights conducted to locate lynx by their VHF transmitters (hereafter aerial locations). VHF transmitters have been used on lynx since the first lynx were released in February 1999. The third lynx location dataset includes all locations collected by winter field crews with GPS units and recorded in Universal Transverse Mercator (UTM) coordinates while actually following lynx tracks in the snow (hereafter snow-tracking locations). GPS locations and general vegetation cover type were recorded for most activity sites including prey chases and kills, bedding sites, territorial marks, and road crossings.

It is assumed that lynx may not be exhibiting typical habitat selection behavior within the first few months after their release in Colorado. Therefore, the first six months of locations after release for each lynx were excluded from both the aerial and satellite location datasets. As a result, the aerial location dataset used for this analysis contains lynx locations from September 1999 through April 2004 while the satellite location dataset begins in October 2000 and also extends through April 2004.

Accuracy of both aerial and satellite locations vary with the environmental conditions at the time the location is obtained. Satellite location accuracy is also influenced by atmospheric conditions and

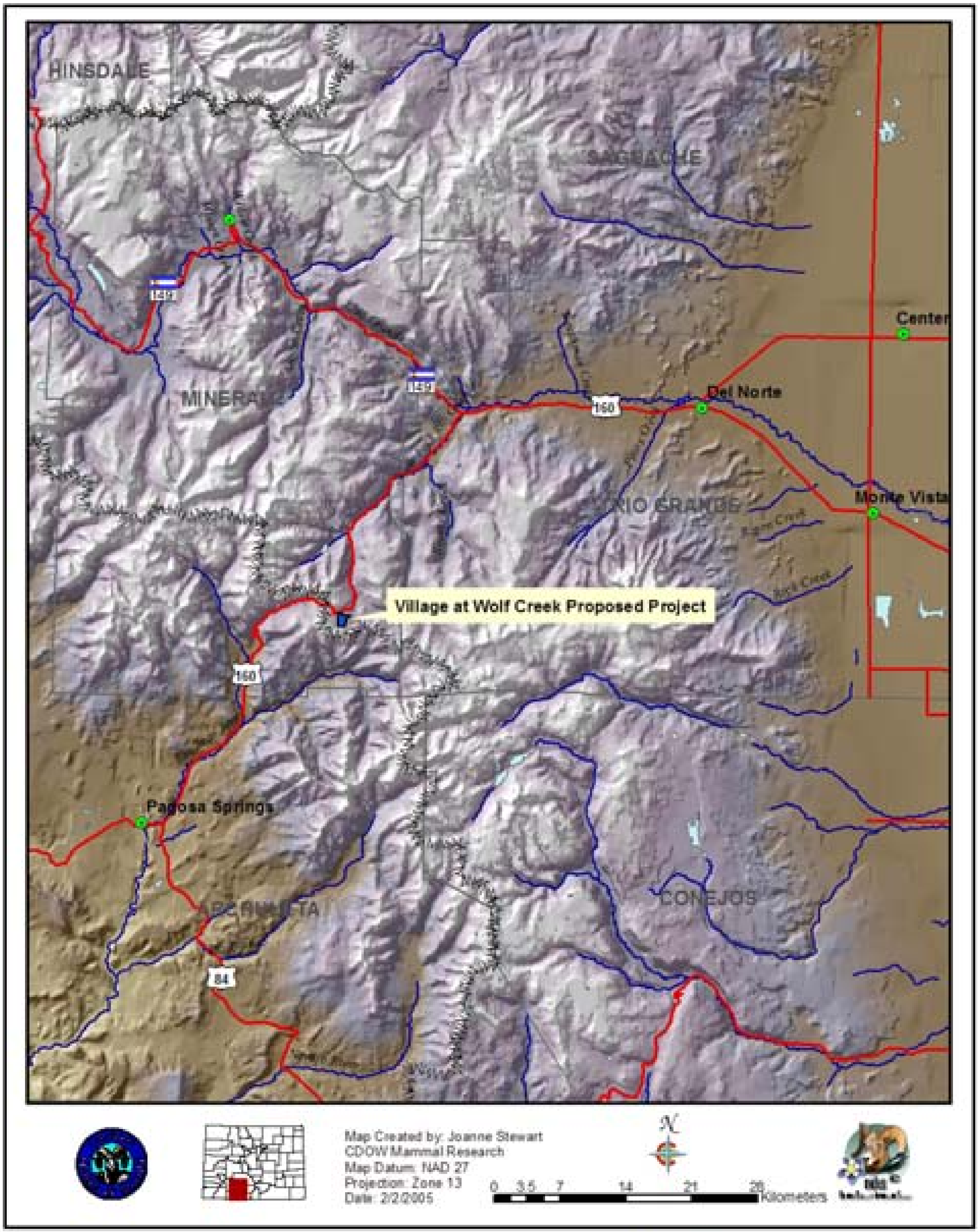

Figure 1. Location of the proposed Village at Wolf Creek in Mineral County, Colorado.

position of the satellites. Satellite location accuracy can range from 150 meters -10 km. Accuracy of aerial locations is influenced by weather with accuracy ranging from 50 - 500 meters. Snow-tracking locations are collected with the highest accuracy as lynx locations are obtained with Garmin 12 XL GPS units on lynx tracks with an accuracy of 15 meters (Garmin owners manual). Therefore, due to differences in accuracy among the datasets, satellite, aerial and snow-tracking data were analyzed separately.

Area Use
The above datasets were used to analyze proximity of lynx to the proposed project area. All lynx were released into Colorado north of Highway 160. Therefore, to estimate the number of lynx that most likely crossed Highway 160 near the proposed development, the number of lynx located at least once south of Highway 160 were summed. The area where lynx were counted was bounded by Highway 160 between Pagosa Springs and Alamosa, with a western boundary of Highway 84 south of Pagosa Springs and an eastern boundary of Highway 17 south of Alamosa.

Highway Movement Paths
Straight line movement paths for each lynx were created by linking temporally sequential location points using Hawth's Tools (Beyer 2004). Two separate sets of movement paths were created for each lynx; one using aerial locations and the other using satellite locations. To create a subset of these movement paths relevant to this analysis, paths that crossed Highway 160 between Pagosa Springs and the Colorado 149 junction were isolated using ArcGIS. To estimate the number of times lynx cross Highway 160, the isolated movement paths were totaled for each lynx documented south of the highway.

Because aerial and satellite locations were not typically obtained at short (daily) temporal intervals, these straight line movement paths do not represent exact or even approximate road crossing locations. In addition, all aerial locations were taken during daylight hours when lynx are least active. Thus, most aerial locations may under represent travel corridors. Despite these sources of error and bias, a dataset was generated which included only movement paths generated from location points taken within 2 weeks of each other. These movement paths were displayed on maps. This analysis was conducted only to determine if any patterns would emerge, not to imply exact road crossing locations.

Highway Crossing
Snow-tracking data were also plotted within the analysis area in an attempt to provide information on what activities lynx might engage in near highways and to document actual lynx highway crossings. Detailed snow-tracking data documenting lynx use of areas immediately adjacent to Hwy 160 were included.

RESULTS

Area Use
Lynx have used the area near Wolf Creek Pass consistently since 1999. Excluding all lynx locations collected in the first 6 months after release, aerial and satellite, a total of 27 individual lynx, 10 males and 17 females, were found south of the analysis segment of Highway 160 from September 1999 through April 2004 (Table 1). Satellite and aerial locations of lynx in the general area of the proposed project for each year since 1999 are displayed in Figures 2, 3, 4, 5, 6

and 7. The decrease in satellite locations documented in 2001 and 2002 is more likely due to few satellite collars functioning in those years rather than indicating less use of the area during that time. The satellite transmitters in the lynx collars are built to last approximately 18 months post-release. Thus, few were transmitting in 2001 and 2002 given no releases of new lynx in either of those years.

Table1. All individual lynx (n = 27) located south of Highway 160 to the Colorado/New Mexico border between Highway 84 and Highway 17 by year. Number of estimated lynx movement paths intersecting Highway 160 for both satellite and aerial data, regardless of temporal separation of sequential lynx locations, are shown for each lynx.

Lynx ID	Years Each Lynx Occurred South of Highway 160						Number of Movement Paths Crossing Highway 160	
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**Aerial Locations**	**Satellite Locations**
BC99M10	X						1	
YK00M4		X	X				3	21[a]
YK00M2		X	X	X	X	X	5	4
YK00F3		X	X					
BC99M4		X						
BC00F8		X	X	X	X	X	2	
YK99M2		X	X				2	
YK00F13		X	X					
YK99M3		X					2	
BC00M13			X				2	
YK00F2			X	X	X	X	4	
YK00M3			X	X	X	X	5	
BC00M11			X	X			4	
YK00F11				X	X		6	
BC00F14				X			2	6
YK00F5				X			2	
AK99F5				X	X		4	3
BC00M9				X			2	
YK00F10				X			2	
BC00F18					X			5
BC03F03					X	X	2	4
QU03F04					X			1
BC03F02					X	X		
QU03F01					X	X		
YK00F15					X		2	
QU03F03						X		1
YK00F17						X		
Totals	**1**	**8**	**10**	**10**	**12**	**9**	**52**	**45**

[a] This is an inflated estimate given the poor quality of satellite locations and the close proximity to the highway (see Figure 8).

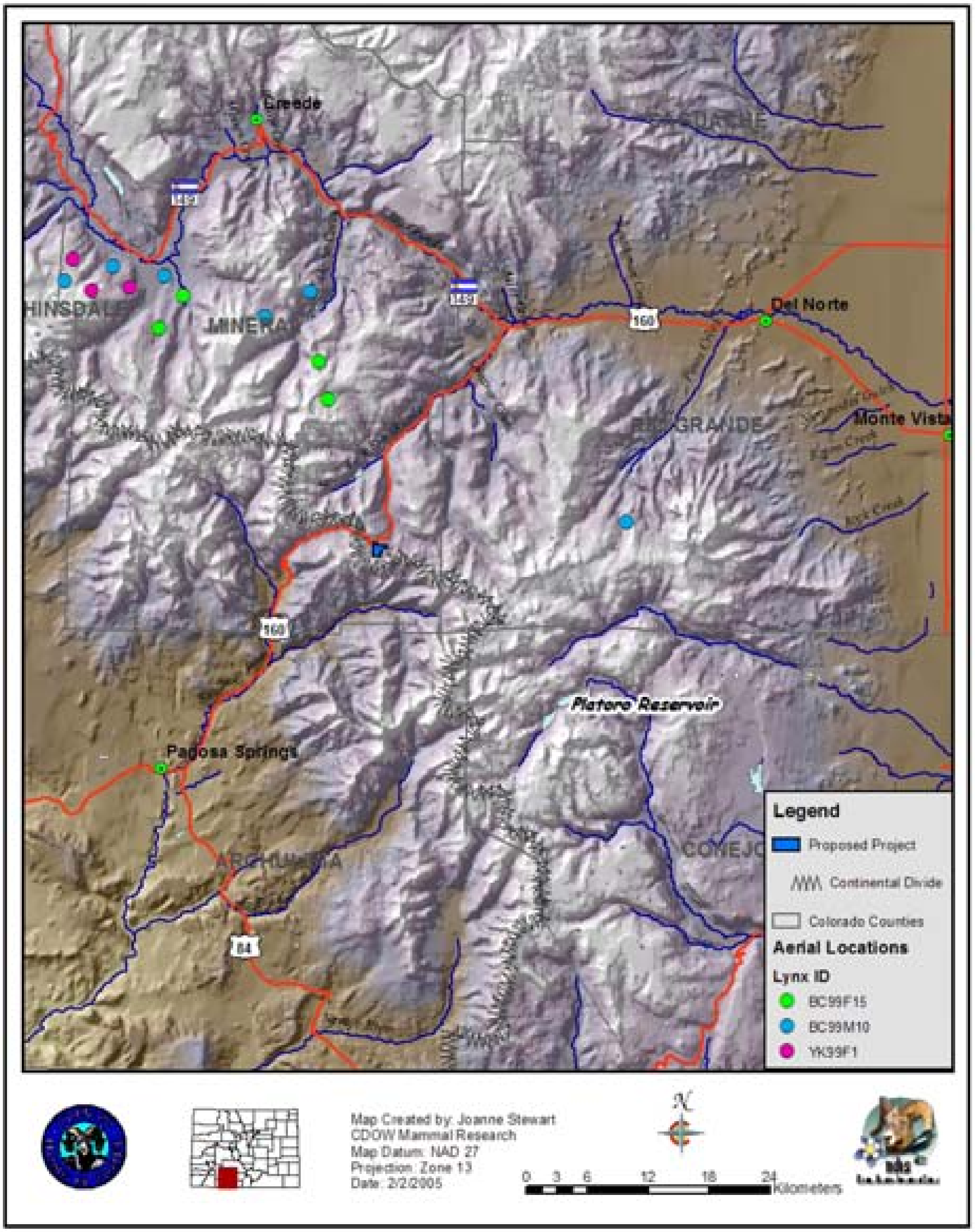

Figure 2. Lynx locations in 1999 near Wolf Creek Pass, Colorado.

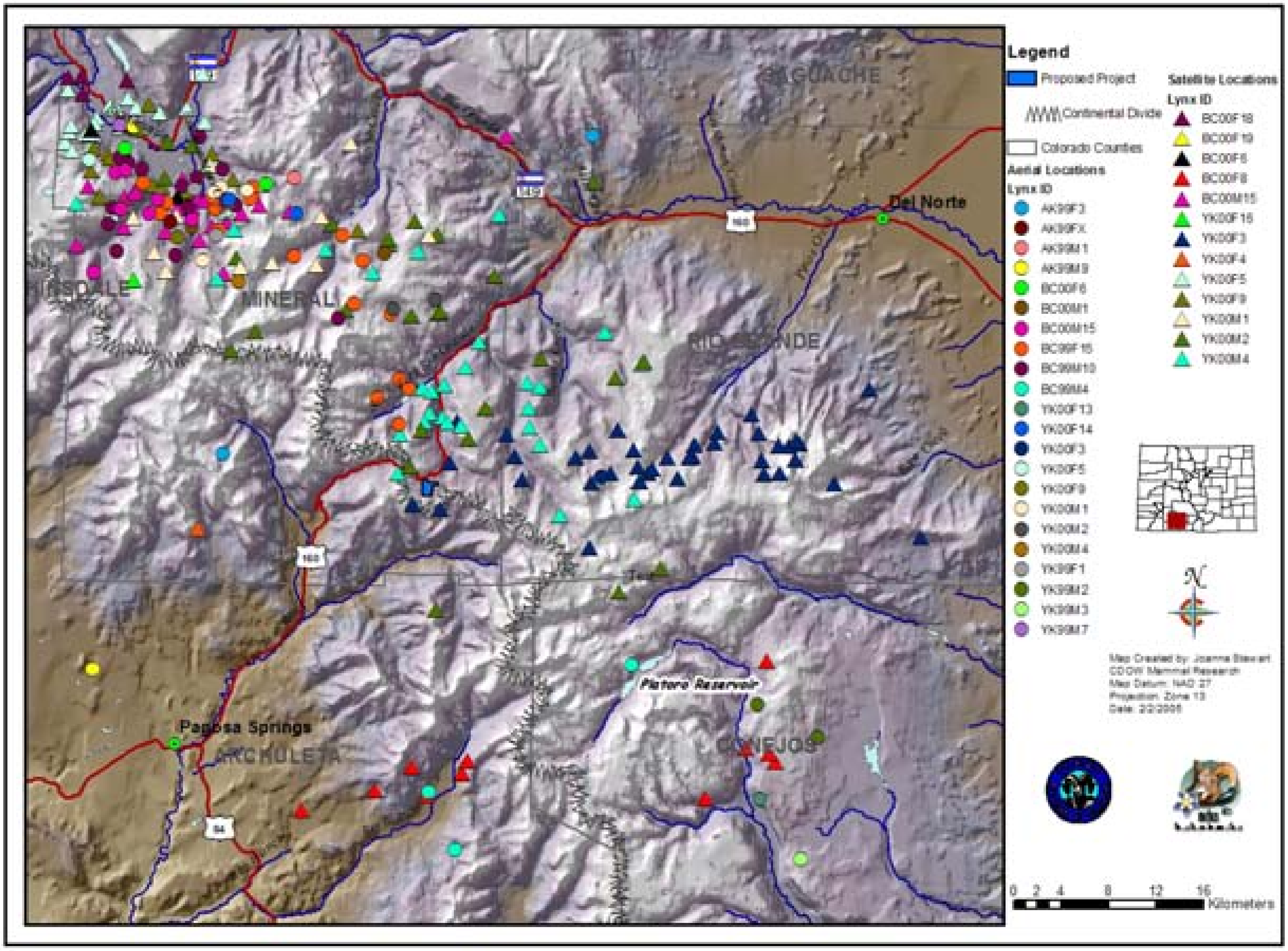

Figure 3. Lynx Locations in 2000 near Wolf Creek Pass, Colorado.

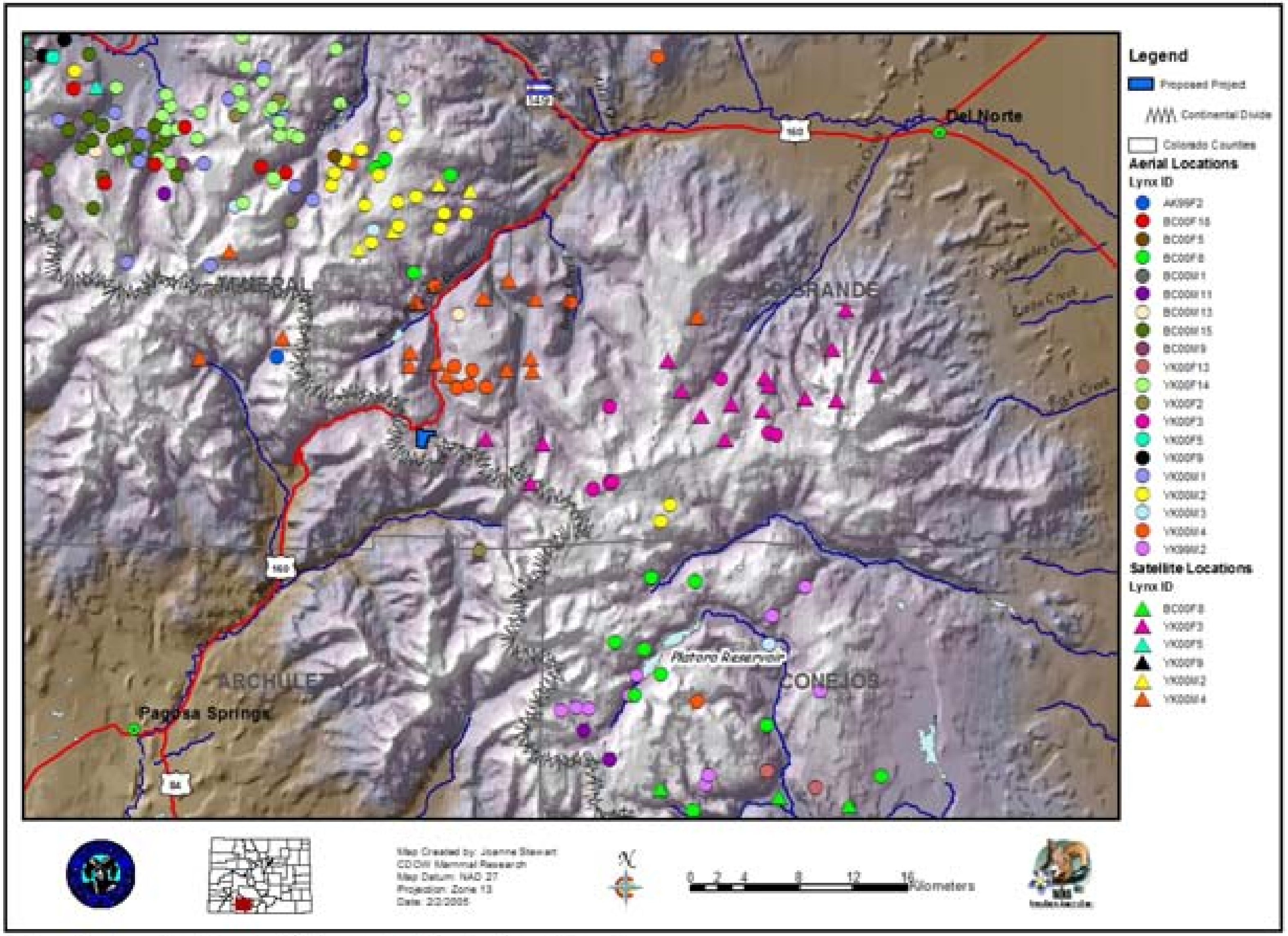

Figure 4. Lynx Locations in 2001 near Wolf Creek Pass, Colorado.

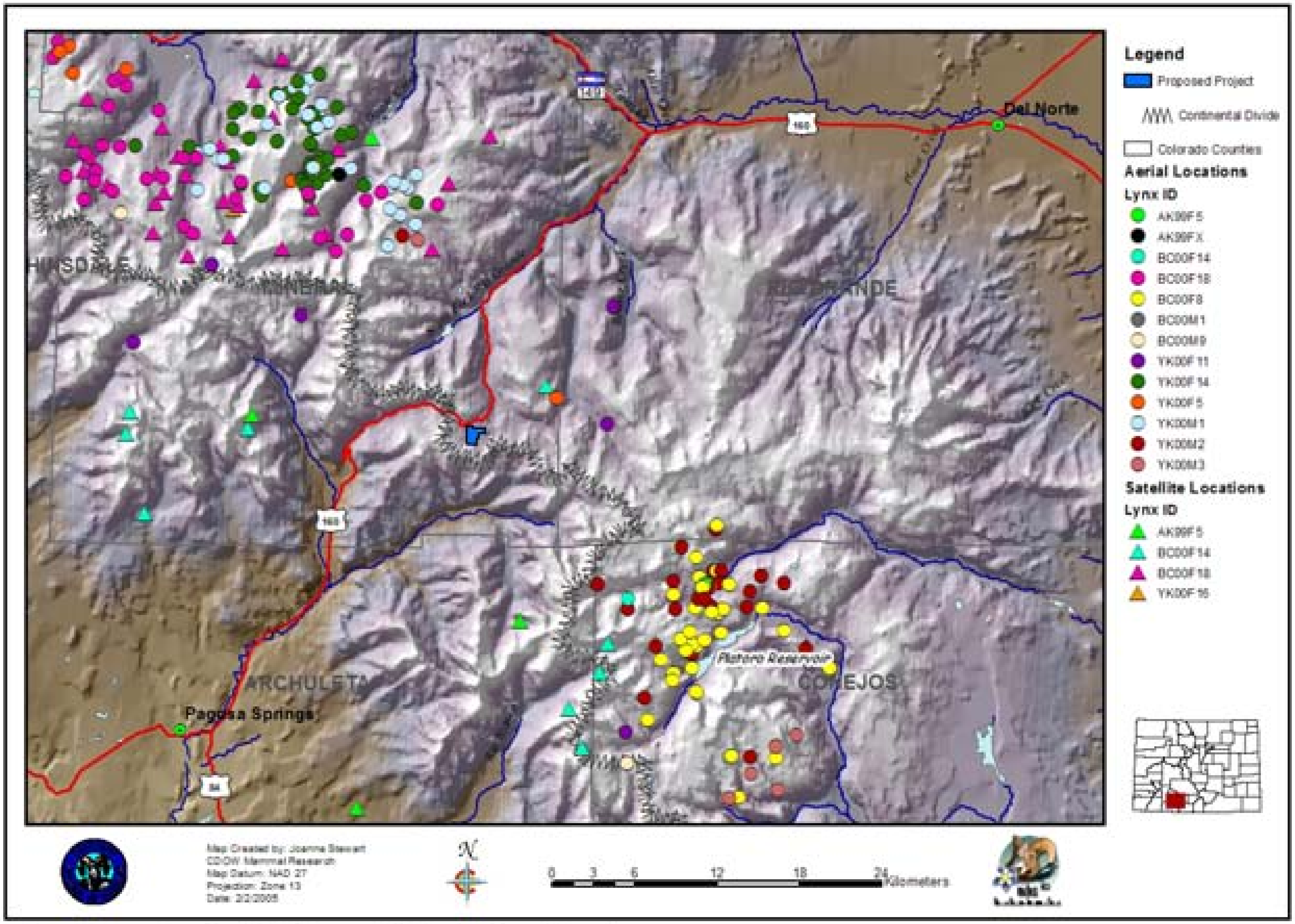

Figure 5. Lynx Locations in 2002 near Wolf Creek Pass, Colorado.

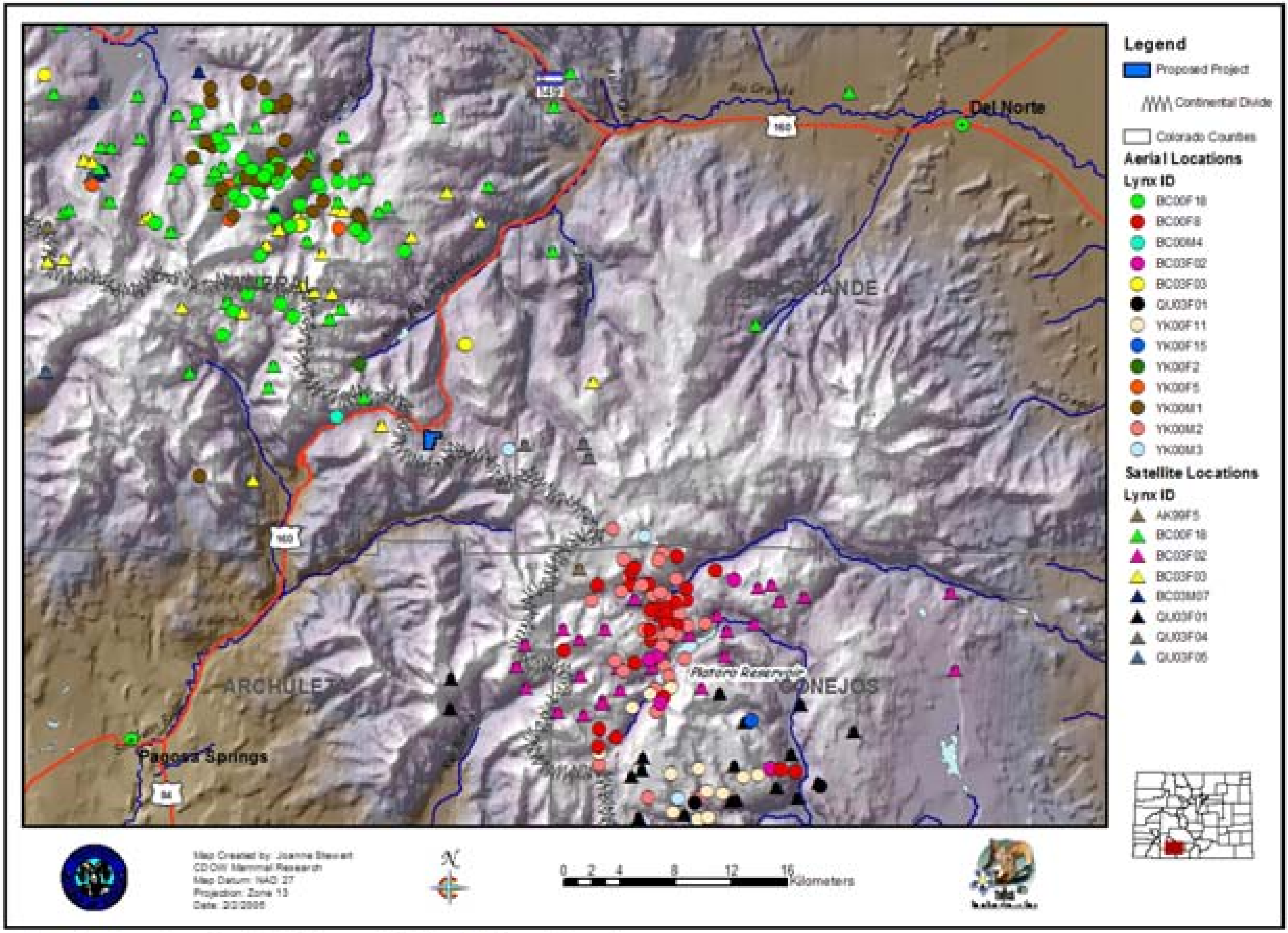

Figure 6. Lynx Locations in 2003 near Wolf Creek Pass, Colorado.

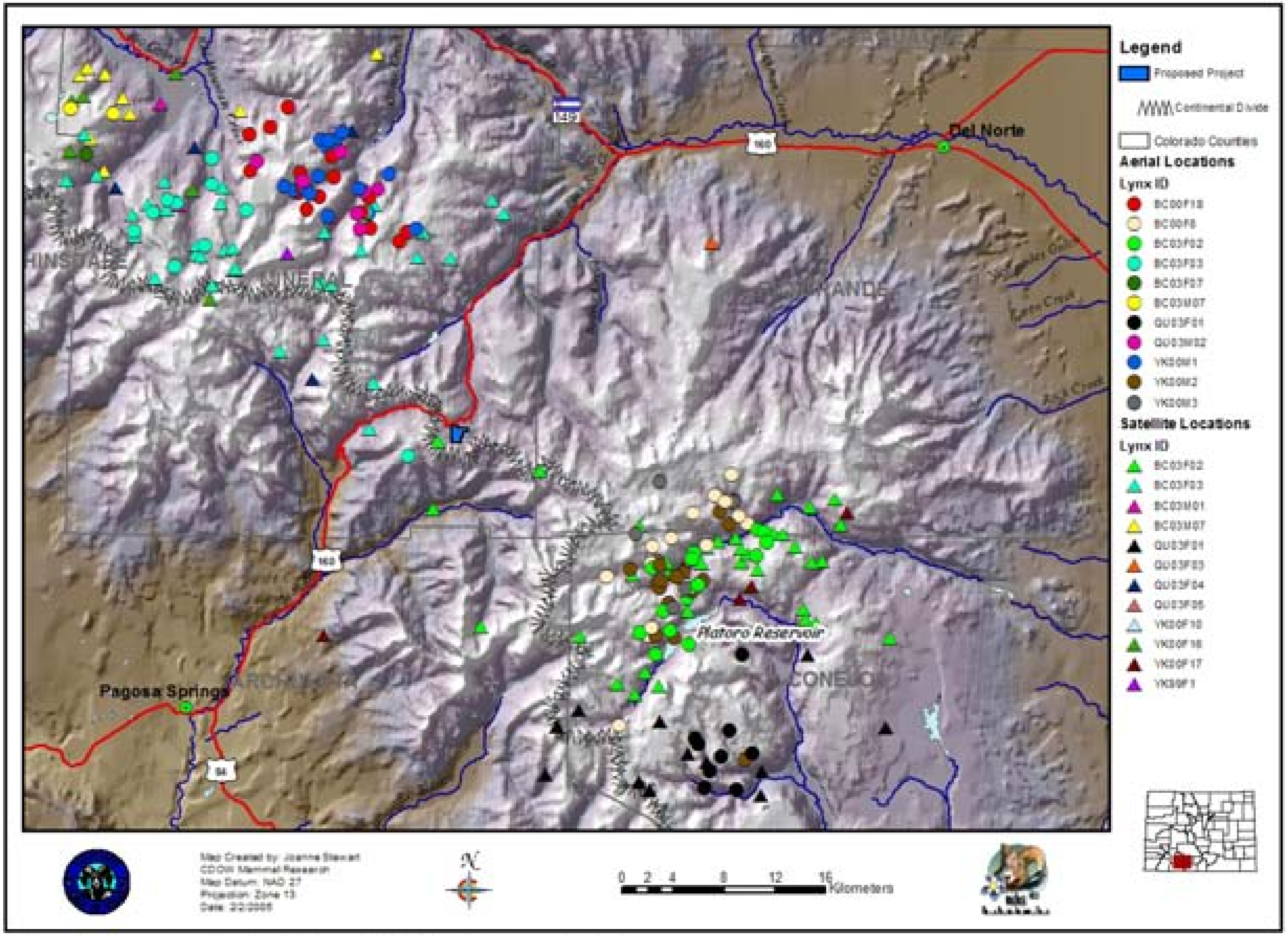

Figure 7. Lynx Locations in 2004 near Wolf Creek Pass, Colorado.

Highway Movement Paths
All straight line projections between a lynx's location and its next temporal location that intersected Highway 160 within the analysis area were summed (Table 1). However, only the straight line projections that resulted from sequential locations for an individual lynx that were temporally separated by < 14 days were used to map possible lynx highway crossings (Figures 8 and 9). Satellite data provided 38 projected crossings of Highway 160 by 8 individual lynx between Pagosa Springs and the Colorado 149 junction (Figure 8). Aerial location data projected 12 crossings of Highway 160 by 10 individual lynx (Figure 9).

Highway Crossing
Snow-tracking data were collected from 24 individual lynx within the analysis area (Figure 10). Only 2 highway crossings were documented through snow-tracking and both crossings were made by the same lynx, YK00M02, in an area approximately 5.6 – 6.4 km north of the proposed Village at Wolf Creek Project (Figure 11). One crossing occurred at UTM Easting 343531 meters and UTM Northing 4154004 meters (NAD 27, Zone 13). Habitat at this crossing location consisted of willow (Salix sp.) and alder (Alnustenuifolia sp.) mixed with Engelmann spruce (Picea engelm*anni*) on the northwest side of the highway and Engelmann spruce with subalpine fir (*Abies lasiocarpa*) on the southeast side of the highway. The second crossing occurred in an open area on a steep hill at UTM Easting 343570 meters and UTM Northing 4155203 meters (NAD 27, Zone 13).

Lynx YK00M02 was the only lynx snow-tracked adjacent to Highway 160 between Pagosa Springs and the Colorado 149 junction (Figure 12). In addition to the 2 road crossings, activity sites documented during the snow-tracking sessions included kills, chases, long-duration beds, short hunting beds, and territory marks (Figure12). Travel point locations and areas where scat was found are also identified (Figure 12).

DISCUSSION

Current data collection methods used on the Colorado lynx reintroduction program were not designed to address the objective of documenting exact lynx highway crossings or use of the Wolf Creek Pass area specifically. However, data collected to meet other objectives of the program have been used to provide as much information as possible to address the question of lynx use in the area of interest.

It is difficult to document lynx travel corridors with the existing aerial locations given the little time that lynx would likely spend in corridors and the length of time between aerial locations. The weekly satellite locations were better designed to document corridor use as the locations were obtained during evening and nighttime hours. However, the low accuracy of the satellite locations compromises the use of these locations to document exact highway crossings. Despite these limitations some patterns emerged from the existing datasets.

Lynx use of the area near the proposed Village at Wolf Creek appears to be more as a corridor than for residence. The corridor links two primary, year-round use areas - one centered near the release areas close to Creede, Colorado and a second area centered northwest of Platoro Reservoir. These 2 year-round, high use areas have both had lynx use since 1999, with the

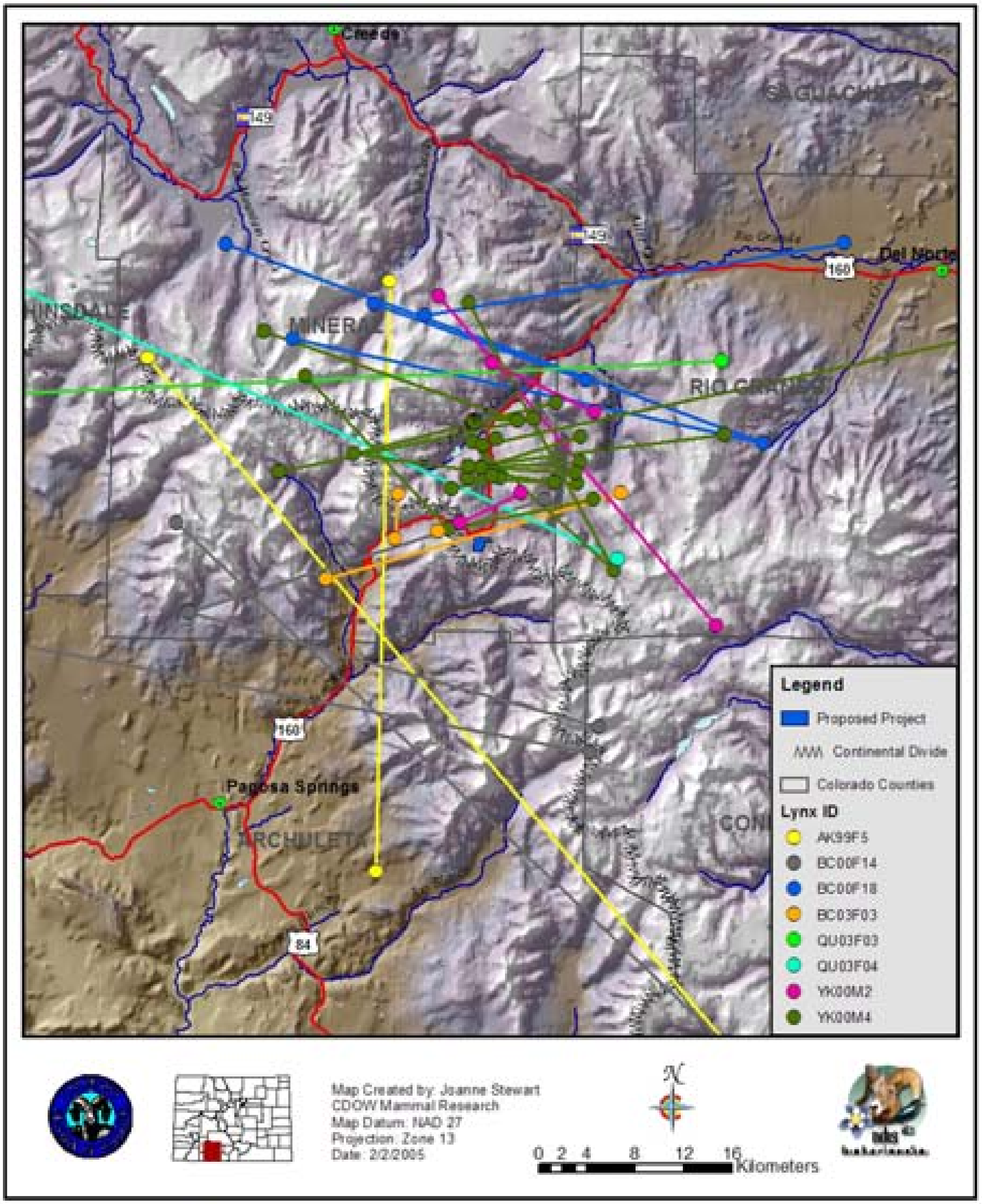

Figure 8. Straight line projection of highway crossings from satellite locations within two weeks of each other.

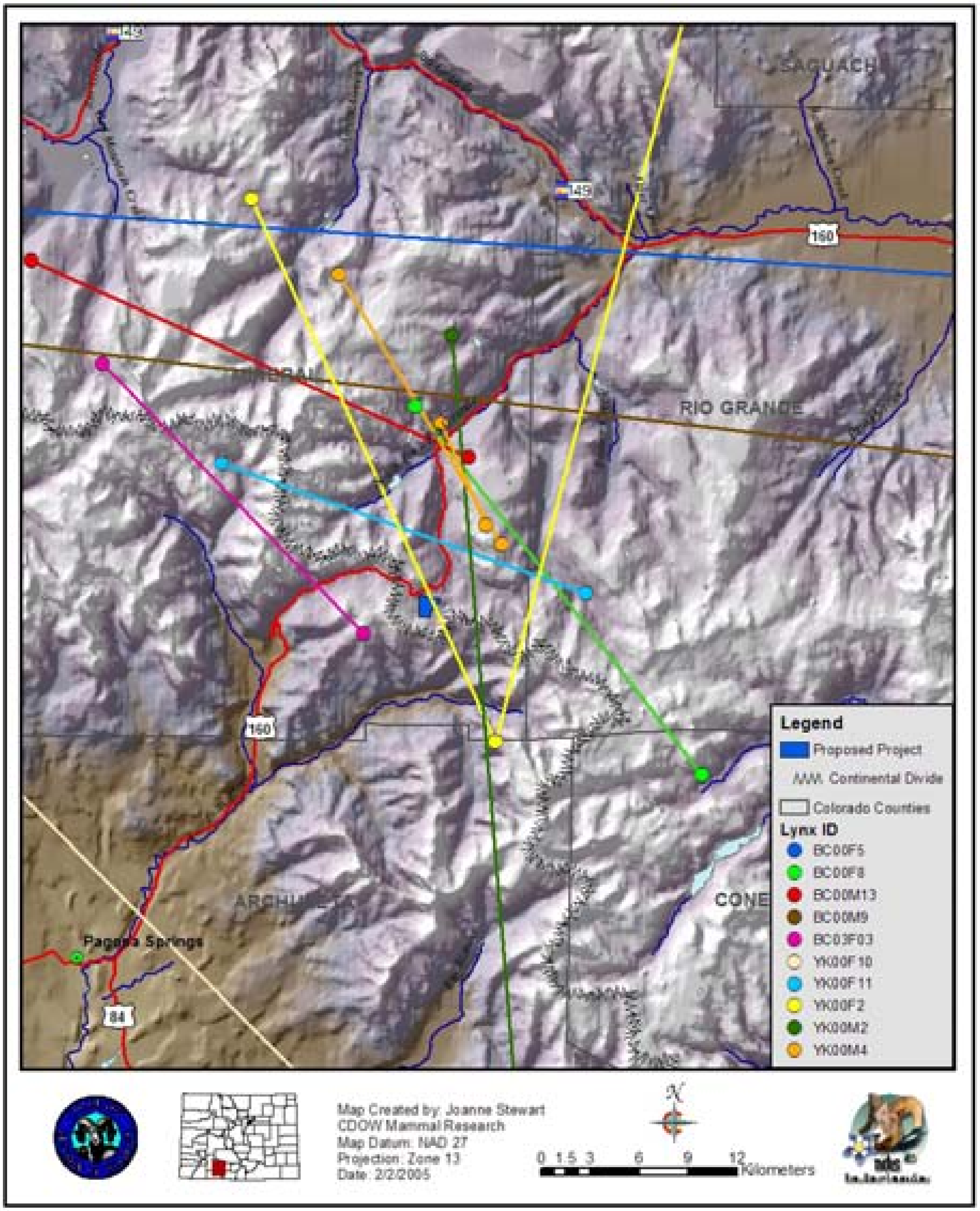

Figure 9. Straight line projection of highway crossings from aerial locations within two weeks of each other.

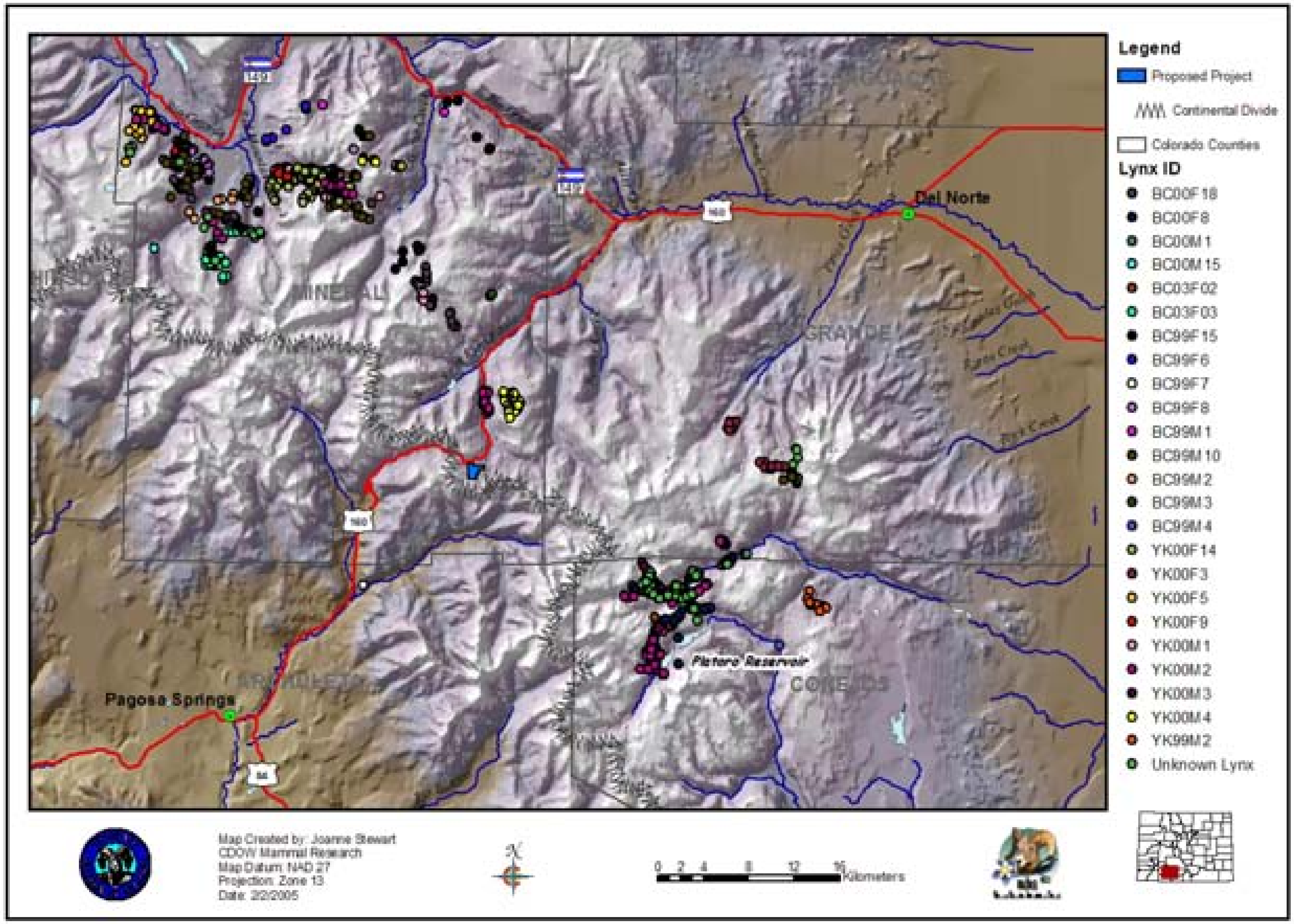

Figure 10. Lynx snow-tracking locations near Wolf Creek Pass, Colorado, from February 1999 through April 2004.

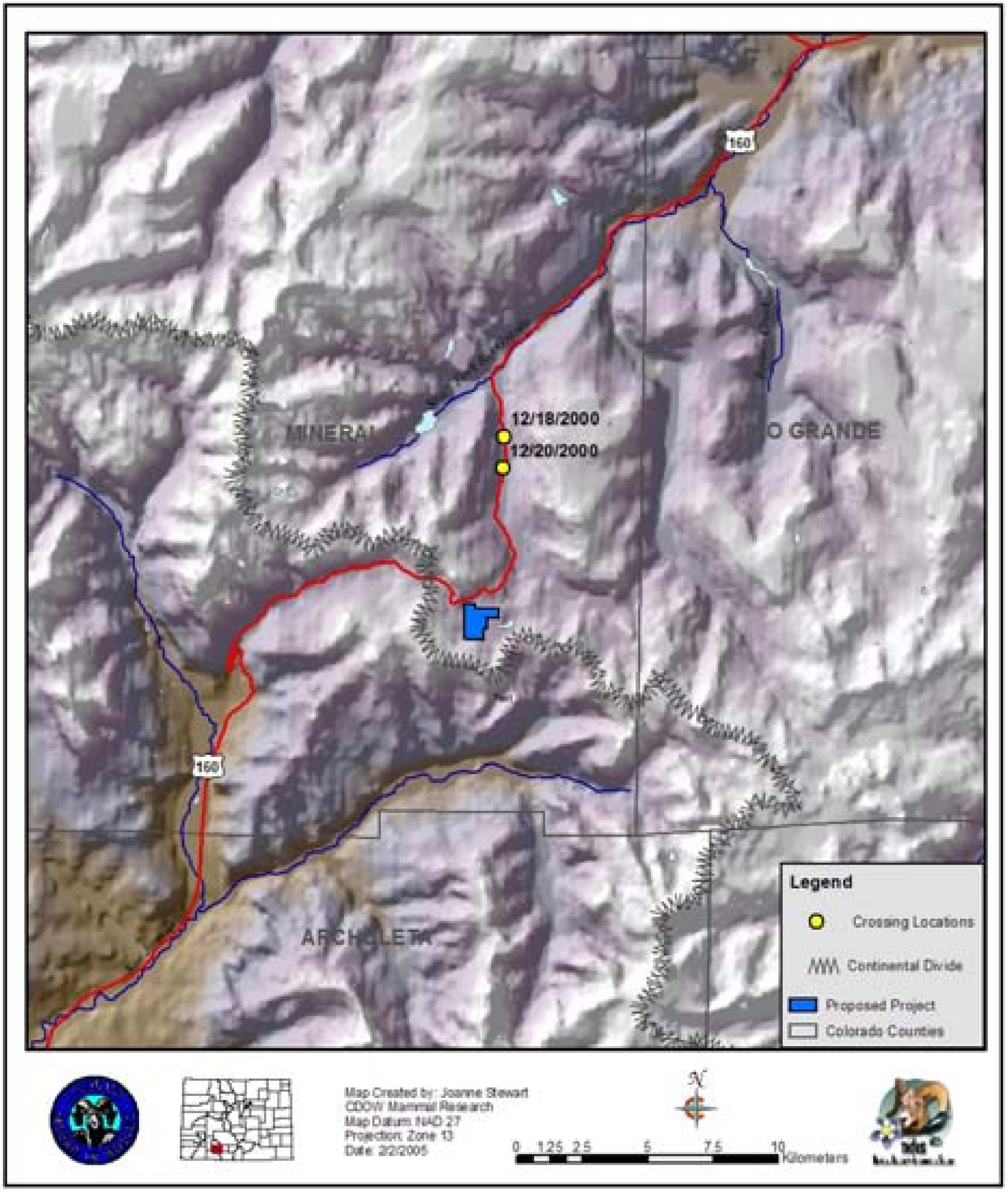

Figure 11. Locations of lynx YK00M2 crossing Highway 160 near Wolf Creek Pass obtained from snow tracking in December 2000.

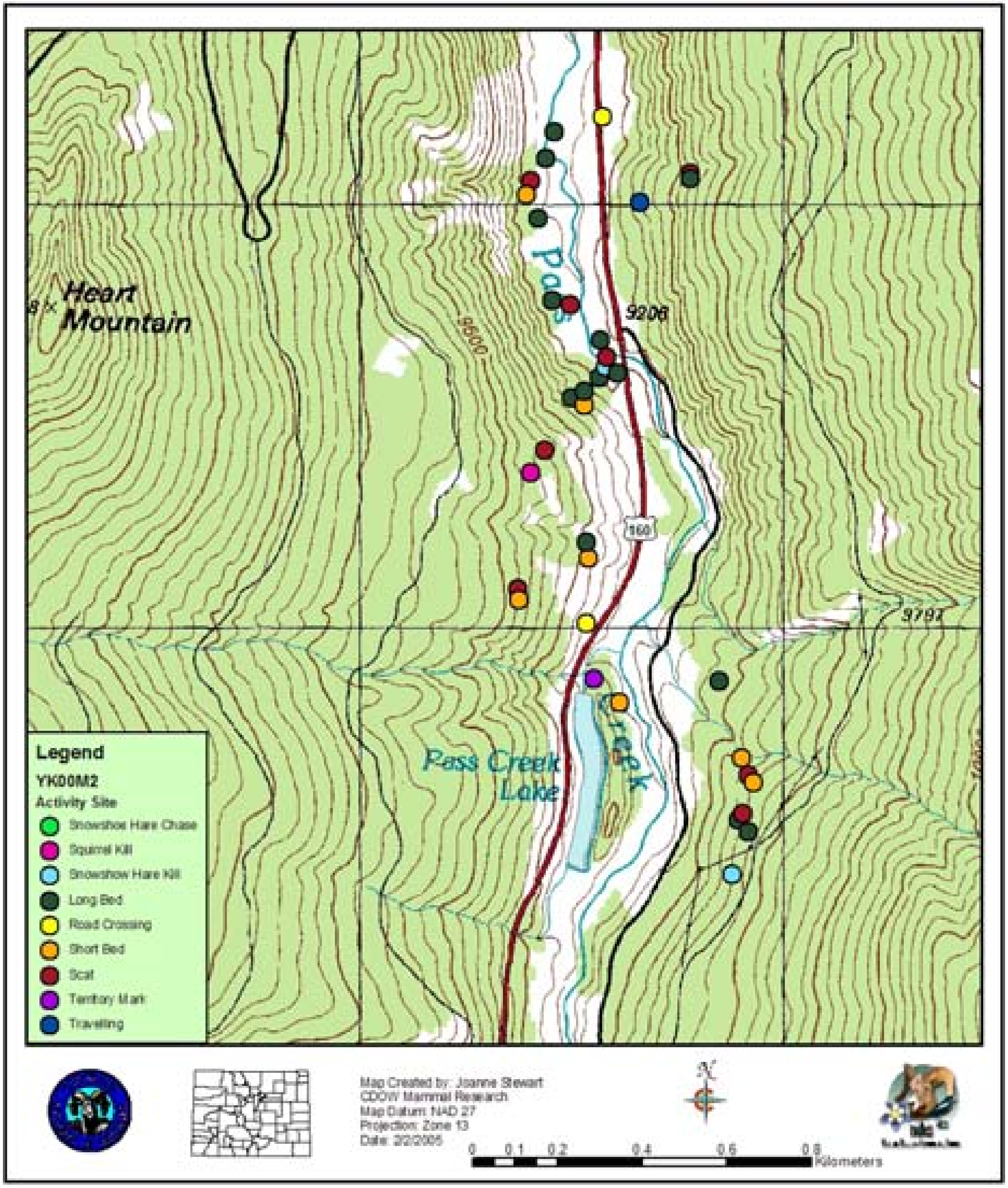

Figure 12. Snow-tracking data for lynx YK00M2 along Highway 160 in December 2000.

Platoro Reservoir area starting to show heavy use in 2001 and becoming well established by 2002.

Lynx dens have been documented both north and south of Highway 160 in these high use areas in 2003 and 2004. Surviving kittens from each year have also been documented in both subsequent winters. Thus, connectivity between these two areas of high use could provide a corridor for dispersal of these and future young.

Only 2 actual road crossing of Highway 160 by lynx have been documented through snow-tracking. Such a low sample size provides very little information about the frequency of lynx crossing highways or how lynx select sites for crossing highways. Because the snow-tracking data was of limited value, we estimated movement paths and number of highway crossings using the projections resulting from the straight line analyses of sequential lynx locations. Assuming straight line movements based on aerial locations, 18 individual lynx 'crossed' Highway 160 between Pagosa Springs and the Colorado 149 junction on 52 occasions, and based on satellite locations, 8 individual lynx 'crossed' the same portion of Highway 160 on 45 occasions. Limiting these estimated crossings to lynx locations that were obtained within 14 days of each other yielded 12 'crossings' based on aerial locations and 38 'crossings' based on satellite locations. Five individual lynx were estimated to have made crossings based on both aerial and satellite locations.

Caution must be used in inferring habitat use when making such simplistic assumptions and recognizing the error associated with both the aerial and satellite locations as used in the movement path analysis. However, the lynx movement path analysis still proved useful to document a few patterns of lynx movement in the area. The first pattern that emerges is that lynx use the forested area east of Wolf Creek Pass far more than the forested area west of the Pass (Figures 3-7). Second, within the forested area between Wolf Creek Pass and the Colorado 149 junction, there appears to be an area of higher use based upon the projected movement paths of lynx generated from the aerial locations (Figure 9). Lastly, lynx move back and forth across Highway 160 as evidenced by the 52 estimated crossings made by 27 individual lynx.

The patterns that emerged from the existing data are not sufficient to determine where lynx cross Highway 160. To adequately address this question would require the use of GPS collars on lynx. GPS collars have the capability of providing continuous 24-hour data with accuracy in the locations necessary to document actual road crossings. From such accurate road crossing locations, data could be collected on vegetation and topographic features as well as lynx behavior while using areas near highways. Hopefully, patterns would emerge from data collection at a sufficient number of road crossings. This information would then be used to provide site specific data for the stretch of highway where the study was conducted. Extrapolating these patterns to other highways could only be made by assuming lynx would exhibit similar behavior in other areas. Such an assumption may or may not be true.

The most efficient study (i.e., maximum sample size obtained within the shortest period of time) that could be conducted using GPS collars to obtain lynx road crossing locations should be conducted in areas where specific lynx are known to cross highways on a regular basis. This would allow lynx known to cross the highways in these areas to be targeted for re-collaring with

GPS collars and monitored regularly to document exact highway crossings. Two areas currently exist where lynx are known to regularly cross highways. The first area includes highway 550 between Coal Bank Pass and Red Mountain Pass. Another area includes Highway 145 between Rico and Telluride.

LITERATURE CITED

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