

Putative Canada Lynx (*Lynx canadensis*) Movements across Hwy 50 near Monarch Ski Area



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INTRODUCTION

Monarch Mountain Ski Resort is located near Monarch Pass in central Colorado. As such, it lies within the Poncha Linkage Zone (USDA Forest Service 2008) that supposedly provides an important travel corridor for Canada lynx (*Lynx Canadensis*) moving across Highway 50 between the San Juan Mountains of southwest Colorado and the Sawatch Range in the central part of the state. During an interagency coordination meeting in October 2010, biologists from Pike-San Isabel National Forest requested that the Colorado Division of Wildlife (CDOW) provide data and maps depicting lynx movements through these linkage zones to aid in their review of the Monarch Mountain Ski Area Master Development Plan. Here I summarize the methods, results, and deficiencies of a simple, preliminary analysis conducted to fulfill this request.

METHODS

Data

CDOW collected location data from reintroduced and Colorado-born lynx from 1999-2010 using both traditional VHF telemetry and the Argos satellite system. VHF locations were obtained from daytime flights using fixed-winged aircraft. The mean interval between consecutive VHF locations was 20.6 days, although about half of intervals were ≤ 7 days. The positional error of VHF is assumed to be ± 400 m.

Dual-transmitter satellite/VHF collars were first deployed on Colorado lynx in April, 2000. Satellite transmitters were designed to transmit 1 day per week, but it was possible to obtain several locations on that day. The Argos system computes locations when transmissions from a satellite collar are received and time-stamped by a single

Argos satellite orbiting from pole to pole. After 4 successive transmissions have been received, a location is calculated based on the Doppler Effect (CLS America 2008). This system differs markedly from the satellite system that produces GPS locations. In the latter, signals from multiple satellites are received by a GPS collar (rather than the collar transmitting to a single satellite). The time stamps of the signals and orbital information from each satellite are then used by the processor in the collar to “triangulate” its position (Garmin 2011). Because of these important differences, the error distributions associated with the 2 systems are substantially different. Whereas the error associated with GPS locations is often <15m (Garmin 2011), accuracy of Argos locations is often several hundred to >1000m. Specifically, Argos lists the standard deviation of the error distribution of its locations as 250m, 250-500m, 500-1500m, and >1500m for class 3, 2, 1, and 0 locations, respectively (CLS America 2008). Therefore if a transmitter remains stationary while an Argos satellite passes over multiple times, computing numerous class 3 location estimates, 68% of the resultant estimates can be expected to fall within 250m of the true location of the transmitter; 95% will fall within 2 SD (500m) of the true location. Similarly, 95% of class 1 locations can be expected to fall within 3000m (1.9 miles) of the true location. Argos systems also produce location estimates of class A, B, and Z, but these locations do not have associated error estimates. I only used class 1-3 Argos locations, in addition to VHF locations, for this analysis.

Analysis

For each lynx, I excluded VHF and Argos data collected within 6 months after its release, assuming that movements during that period were atypical. Additionally, I excluded Argos locations that fell outside of Colorado as well as locations of class 0, A, B, and Z (i.e., ignoring locations with no or extremely poor error estimates). I then imported these data into ArcGIS 10 (ESRI, Redlands, CA) and sorted them by Lynx ID and date. Next, I bisected the state along Highway 50 (incorporating a few segments of I-70 and I-25) and identified the subset of lynx that had been located both north and south of the highway. I used the “Points to Lines” Tool within ArcGIS to construct polylines connecting successive locations from each individual. I then plotted the segments with endpoints separated by ≤ 7 days that crossed Hwy 50. These segments were intended to identify broad areas along the length of Hwy 50 where lynx tended to cross. They in no way represent actual locations where lynx traversed Hwy 50. I also plotted only those segments with endpoints separated by ≤ 1 day in order to more closely identify road segments where crossings occurred.

RESULTS

I identified 19 segments from 12 lynx (individuals crossed 1-3 times) that represented crossings of Hwy 50 known to have occurred within a 7-day period (Fig. 1). Seven (37%) of these segments occurred within a 43-km stretch of Hwy 50 spanning the timbered areas east and west of Monarch Pass (from approximately Hicks Gulch to McClure Creek). An additional 4 segments (21%) crossed Hwy 50 in the 13km of road immediately west of the timbered area. Thus, over 50% of segments intersected Hwy 50 in the vicinity of Monarch Pass (Fig. 1,2). Note, however, that segments do not

indicate actual or even approximate location of lynx crossings because locations that form the endpoints of the segments are imprecise and separated by up to one week.

Only 2 segments with endpoints separated by ≤ 1 day occurred within the vicinity of Monarch Pass (Fig 3). One individual apparently crossed about 4km NE of Monarch Mountain Ski Area, the other farther east.

DISCUSSION

Due to the poor precision of location estimates and the amount of time elapsed between locations, the straight line movement paths depicted in this analysis **DO NOT** represent exact or even approximate locations where lynx crossed the highway. Additionally, VHF locations were obtained during daylight hours when lynx were least likely to be moving. Given these sources of bias, inference from this analysis is limited to identification of broad areas likely used by lynx to travel from the San Juan Mountains to ranges north of Hwy 50. Based on lynx ecology, biologists from various state and federal agencies have postulated that the forested bottleneck at Monarch Pass likely provides a corridor for lynx making north-south movements in Colorado (USDA Forest Service 2008). The analysis presented here is consistent with that hypothesis.

The location data used to conduct this analysis were not collected for the purpose of analyzing lynx movement or habitat use. The relatively high degree of error inherent in the locations, combined with the long period of time between consecutive points, makes such an analysis difficult. However, methods exist that may enable stronger inference from these data. By treating the locations, as well as the putative tracks between them, in a probabilistic fashion, it may be possible to develop a density surface that depicts probable travel routes across broad areas within the state. CDOW will collaborate with faculty at Colorado State University this calendar year to determine whether such approaches are feasible given these data.

LITERATURE CITED

CLS America. 2008. Argos User's Manual. <http://www.argos-system.org>.

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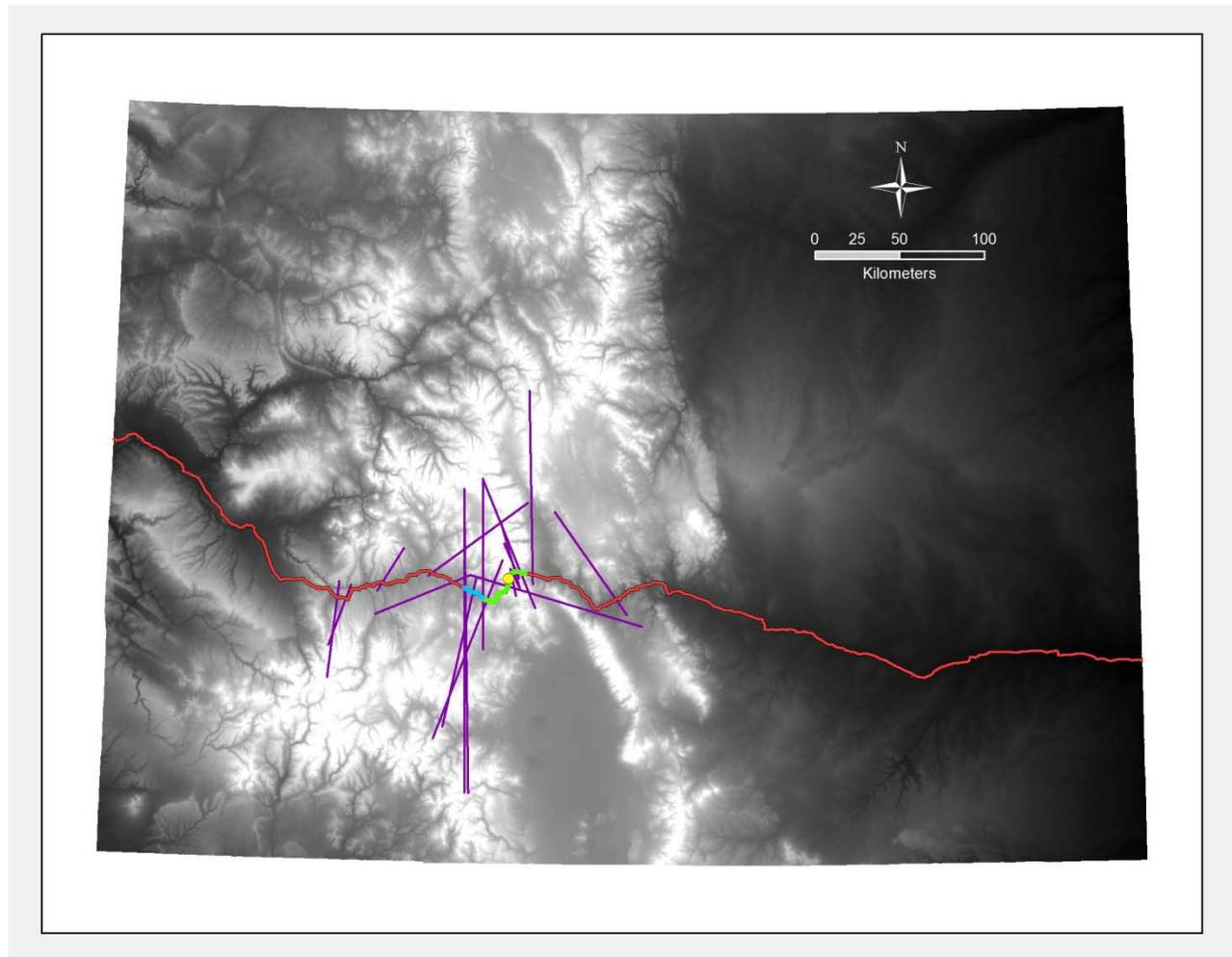


Figure 1. Line segments connecting consecutive lynx locations separated by ≤ 7 days that crossed Highway 50 (red), south-central Colorado, 1999-2010. Yellow circle is Monarch Mountain Ski Area. Green line is 43-km stretch of Hwy 50 that passes through a timbered landscape. Blue line is an additional 13-km stretch of Hwy 50 that included a large number of lynx segments. Note that segments do not indicate actual or even approximate location of lynx crossings because locations are imprecise and separated by up to one week.

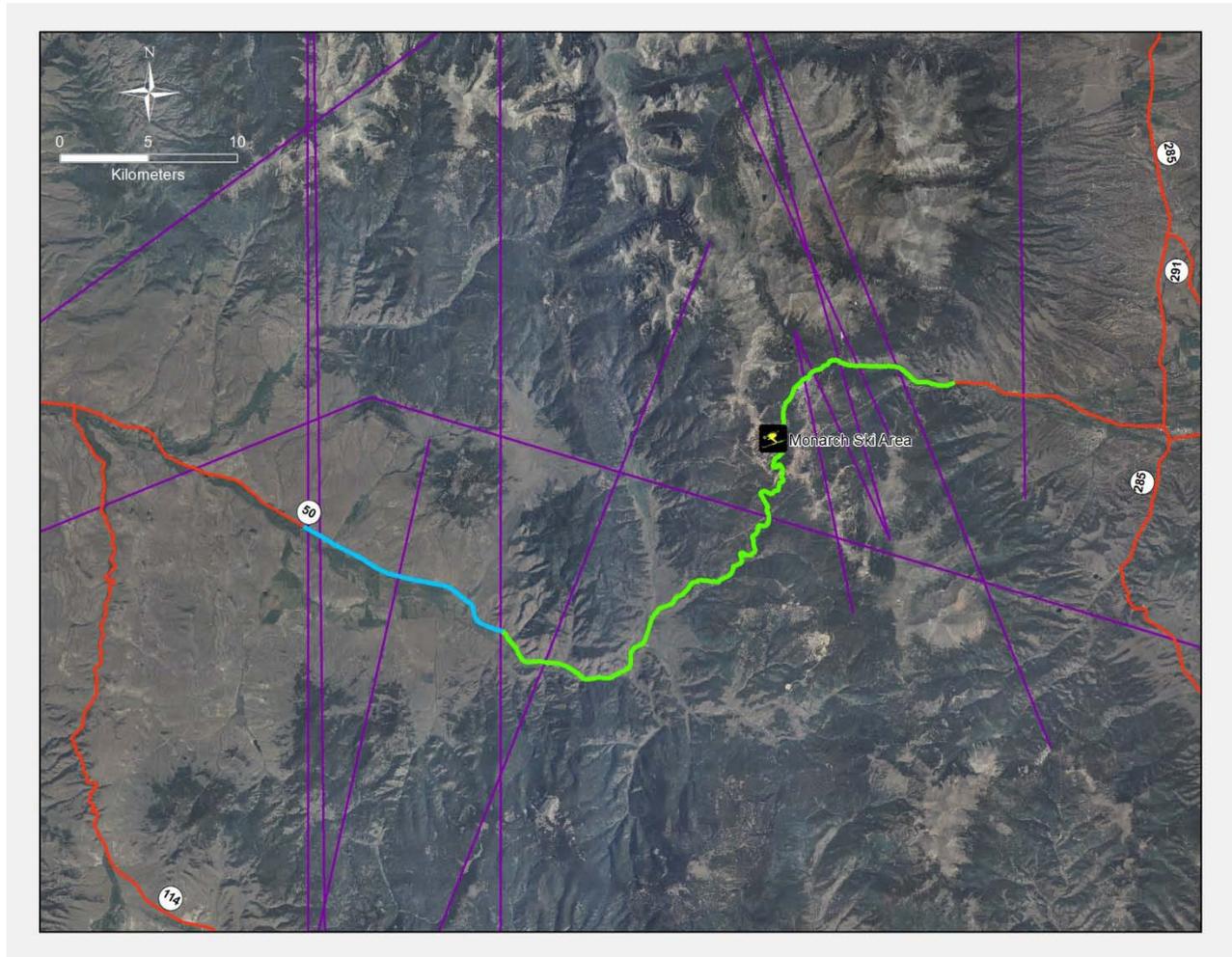


Figure 2. Line segments connecting consecutive lynx locations separated by ≤ 7 days that crossed Highway 50, south-central Colorado, 1999–2010. Green line is a 43-km stretch of Hwy 50 that passes through a timbered landscape. Blue line is an additional 13-km stretch of Hwy 50 that included a large number of lynx segments. Note that segments do not indicate actual or even approximate location of lynx crossings because locations are imprecise and separated by up to one week.

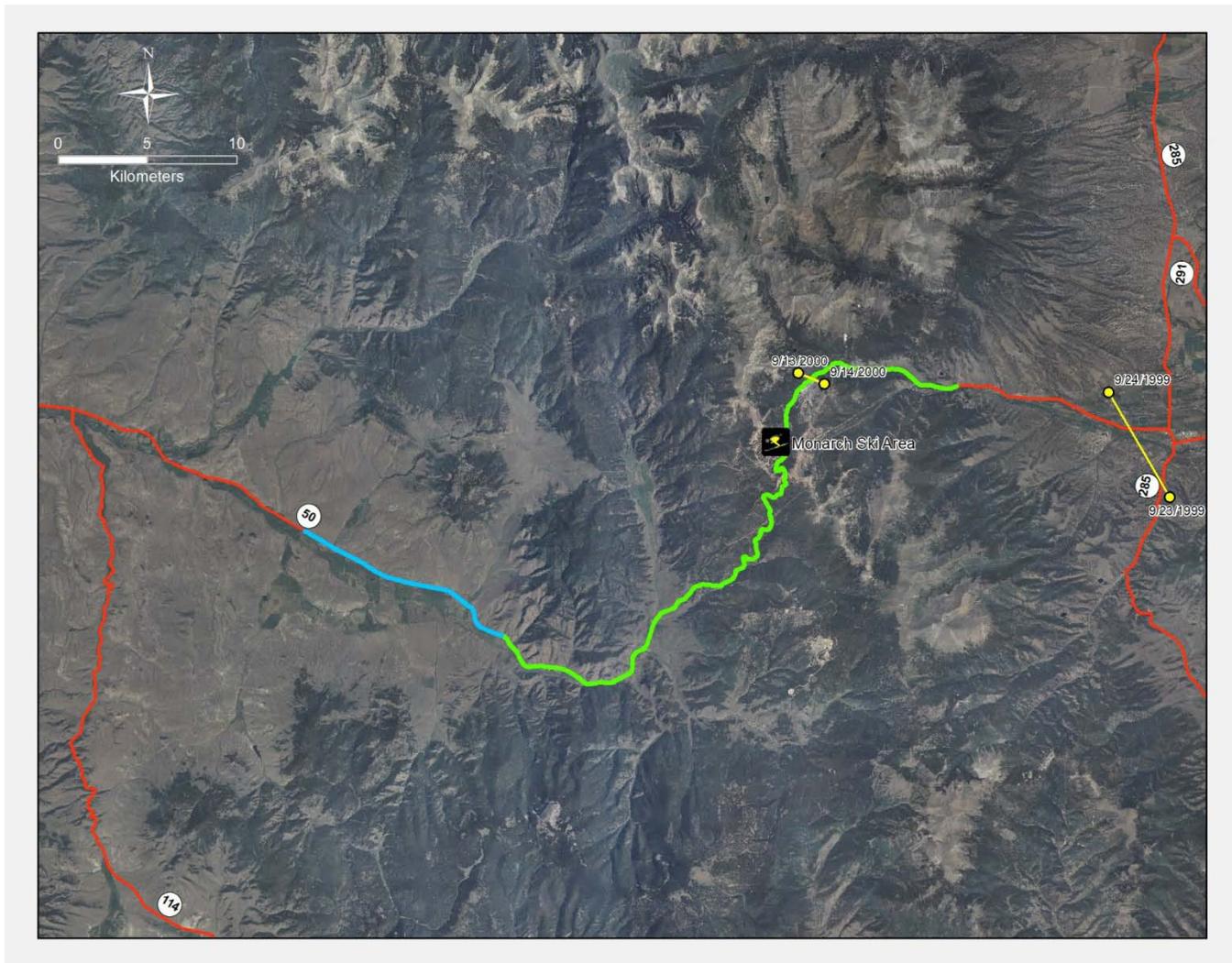


Figure 3. Line segments connecting consecutive lynx locations separated by ≤ 1 day that crossed Highway 50, south-central Colorado, 1999-2010. Note that segments do not indicate actual location of lynx crossings because locations are imprecise and separated by up to 24 hrs.