Putative Canada Lynx (*Lynx canadensis*) Movements across I-70 in Colorado

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INTRODUCTION

Interstate 70 (I-70) bisects Colorado and contains some of the most heavily traveled segments of highway in the state. As such, it may impede Canada lynx (*Lynx Canadensis*) movements between the Mosquito Range of central Colorado and the Front Range in the northern part of the state. Identifying where lynx have successfully crossed I-70 will inform decision makers tasked with siting overpasses/underpasses for wildlife use, managing adjacent lands for lynx and other wildlife, and reviewing projects that may impact corridors of movement. Here I summarize the methods, results, and deficiencies of a simple, preliminary analysis conducted to begin filling this information gap.

METHODS

Data

Colorado Parks and Wildlife (CPW) 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 ±400m.

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. For 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 250 m of the true location of the transmitter; 95% will fall within 2 SD (500 m) 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.

In addition to location data collected via telemetry, CPW also expended considerable effort snow tracking 144 reintroduced and Colorado-born individuals across the state. Among the data collected, trackers used GPS to record precise locations where lynx crossed a road or trail (n = 374 crossings across the state). I queried the CPW database to extract and plot locations where lynx tracks crossed I-70. Finally, I also extracted locations where lynx were struck by vehicles while crossing I-70.

Analysis of Telemetry Data

For each lynx, I excluded VHF and Argos data collected within 6 months after its initial 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 ordered them by Lynx ID and date. Next, I divided the state into 2 pieces using I-70 as the dividing line (Fig. 1). I identified the subset of lynx that were located both south and north of this dividing line and used the "Points to Lines" Tool within ArcGIS to construct polylines connecting successive locations for each individual. I then plotted the segments that a) crossed I-70, and b) had endpoint locations separated by ≤14 days. These segments were intended to identify broad areas lynx have used to make their way from the central to northern parts of the state and vice-versa. They in no way represent actual locations where lynx traversed the highway comprising the dividing line. Based on lynx movement patterns (Theobald and Shenk, unpublished data), I defined "winter" as the period of time when animals generally stay within their established home range (November through March) and "summer" as periods typified by larger movements, (April through October). Lines are color-coded to reflect the season during which the crossing occurred.

RESULTS

I identified 80 segments from 29 lynx ($\bar{x} = 2.8$ segments per individual; min= 1, max = 13) that crossed I-70 and had endpoints separated by ≤14 days (Fig. 1). These crossings were equally split among males and females (13 males, 16 females) and at least one crossing was documented each year from 1999-2010 ($\bar{x} = 7.7$ crossings per year; min = 1, max = 21). Thirty-one (39%) of these segments crossed I-70 within a 10-km stretch spanning the east entrance of Eisenhower Tunnel to Bakerville. Thirteen (16%) additional segments crossed from the east entrance of the tunnel through the Loveland Pass Linkage Zone, and 12 more (15%) passed through the Vail Pass Linkage Zone. Most crossings (64%) identified via telemetry occurred during summer months.

All but one of the 52 crossings of I-70 documented via snow tracking occurred within the "east entrance to Bakerville" stretch. These 52 snow tracking data points came from 6 individuals, 5 of which were part of the 29 individuals that contributed telemetry data, 1 of which was an unknown individual.

DISCUSSION

Due to the poor precision of telemetry 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 I-70. Additionally, VHF locations were obtained during daylight hours when lynx were least likely to be moving, and were biased toward winter months when field work was most intense. Given these sources of bias, inference from this analysis is limited to identification of broad areas likely used by lynx to travel from the central mountains of Colorado to ranges north of I-70. Also, note that the Herman Gulch Linkage Area (between Bakerville and Eisenhower Tunnel) was sampled more heavily for snowtracking purposes than other sections of I-70, and putative high use of that area is at least partly reflective of this sampling scheme.

Based on lynx ecology, biologists from various state and federal agencies have postulated that the high elevation bottlenecks at Dowd Junction (west of Vail Pass, not pictured), Vail Pass, Officer's Gulch, Loveland Pass, and Herman Gulch likely provide a corridors for lynx making make north-south movements in Colorado (USDA Forest Service 2008). Despite the biases noted above, the analysis presented here is generally consistent with that hypothesis and especially highlights high use at Herman Gulch and to a lesser extent, Vail Pass. Most of the crossings identified via telemetry occurred during the summer months. Given that few known lynx became residents in the northern portion of the state during the reintroduction, this result is sensible as lynx often make large exploratory movements during summer.

The snowtracking data shown here represent precise locations where lynx crossed I-70, but the telemetry 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 telemetry 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 segments 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. CPW 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.

USDA Forest Service. 2008. Final Environmental Impact Statement: Southern Rockies Lynx Management Direction, Volume 1. http://www.fs.fed.us/r2/projects/lynx/.

Garmin. 2011. What is GPS? http://www8.garmin.com/aboutGPS/.

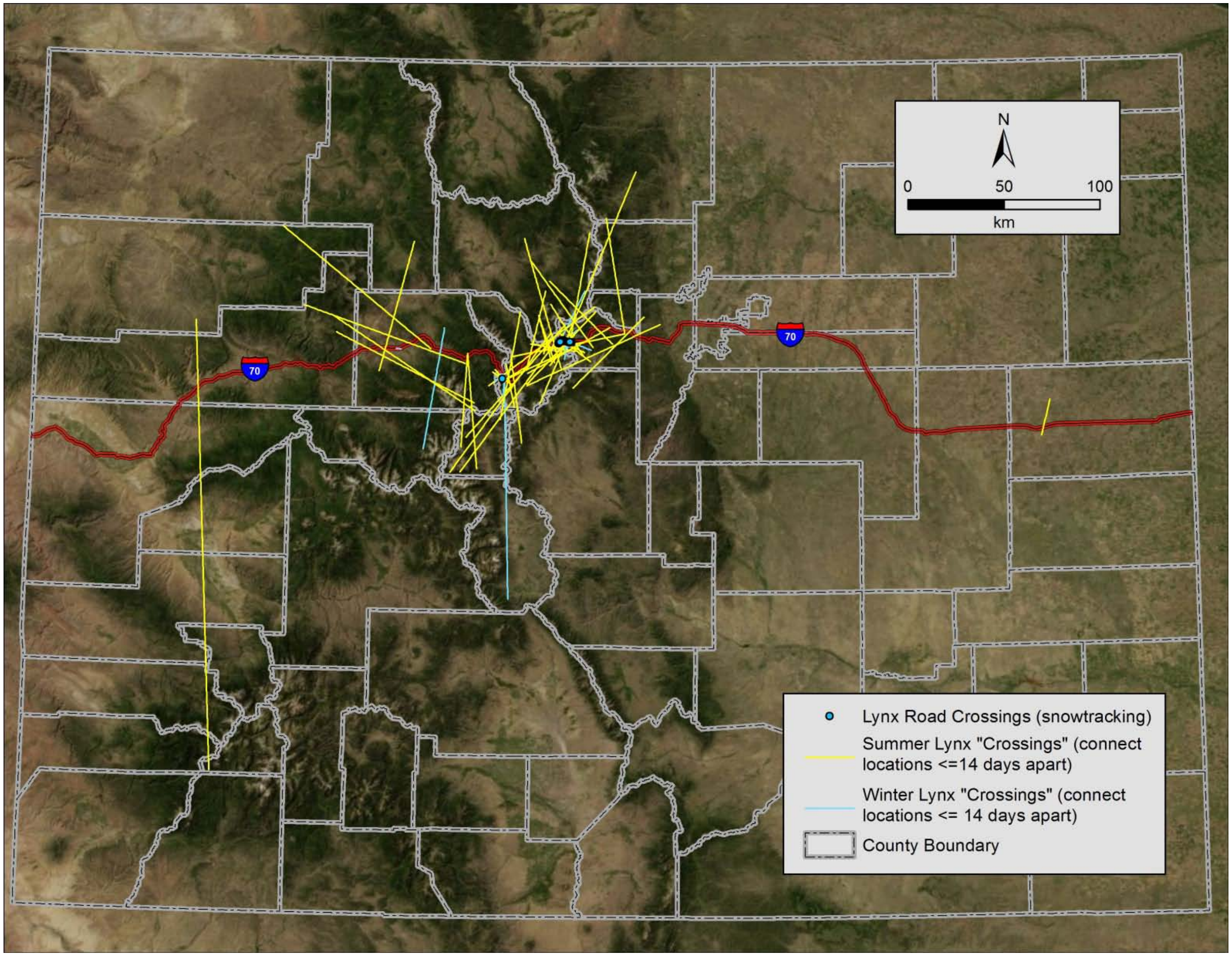

Figure 1. Road crossings documented by snow tracking line segments that a) crossed I-70, and b) had endpoint telemetry locations separated by ≤14 days, 1999-2010. Note that segments do not indicate actual or even approximate location of lynx crossings because locations are imprecise and separated by up to 2 weeks.

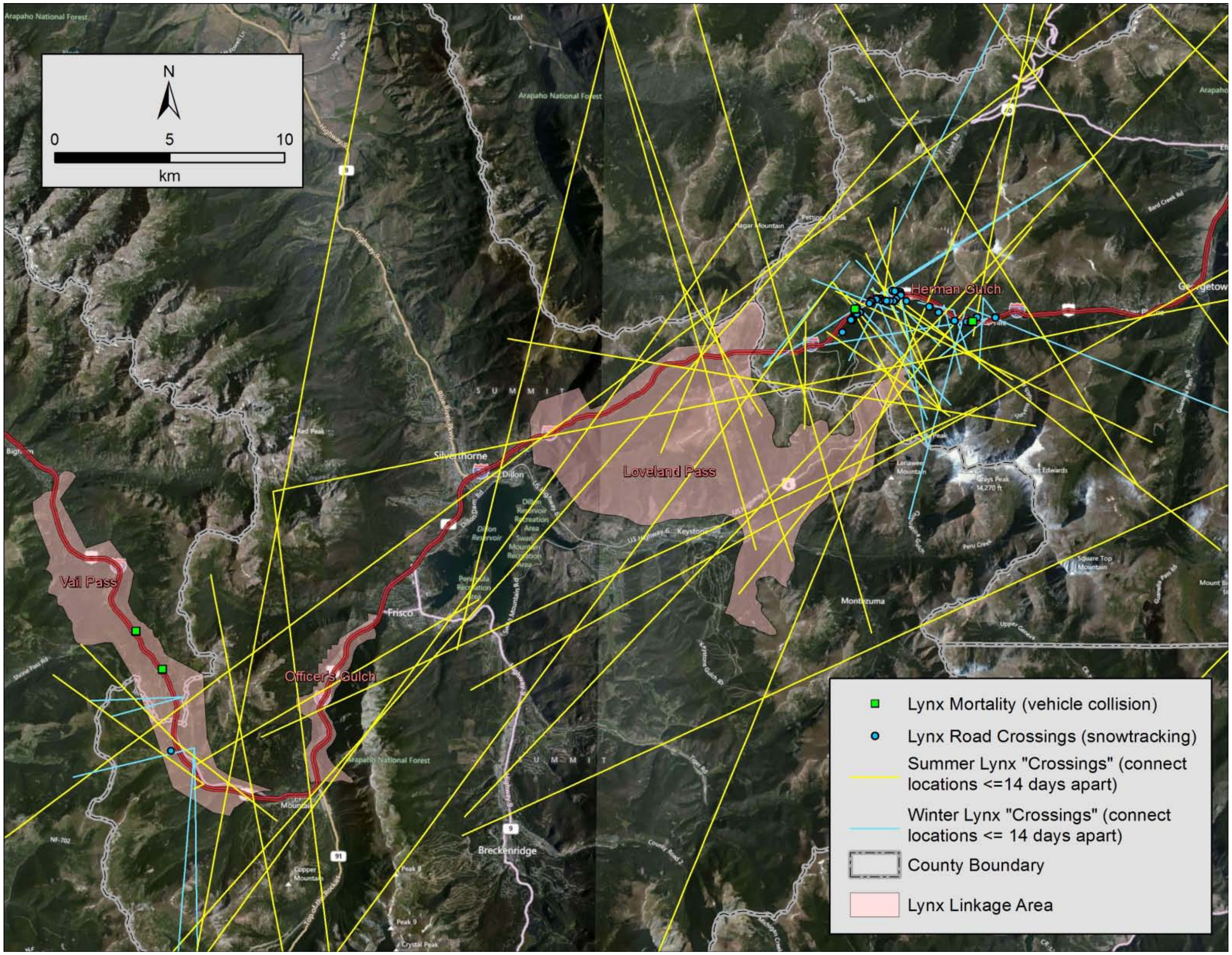

Figure 2. Road crossings documented by snow tracking and line segments that a) crossed I-70, and b) had endpoint telemetry locations separated by ≤14 days, 1999-2010. Colored polygons depict the Lynx Linkage Areas that intersect I-70. Note that segments do not indicate actual or even approximate location of lynx crossings because locations are imprecise and separated by up to 2 weeks.