Putative Canada Lynx (*Lynx canadensis*) Movements across Hwy 114 near North Pass, Colorado

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INTRODUCTION

North Pass is located is located along State Highway 114 mid-way between State Highway 50 and Saguache. As such, it lies within the North Pass Linkage Zone (USDA Forest Service 2008) that supposedly provides an important travel corridor for Canada lynx (*Lynx Canadensis*) moving between the San Juan Mountains of southwest Colorado and the Sawatch Range in the central part of the state. U.S. Forest Service District Wildlife Biologists requested that the Colorado Division of Wildlife (CDOW) provide data and maps depicting lynx movements through this linkage zone to aid in their review of proposed projects in the vicinity as well as to assess the general importance of the area. 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 ±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. 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 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 sorted them by Lynx ID and date. Next, I divided the state into 2 pieces using State Highways 50, 114, and 285 as the dividing line (Fig. 1; note the dividing line depicted also includes small segments of I-70 and State Highway 160). I identified the subset of lynx that were located both southwest and northeast of this dividing line (hereafter referred to as "Hwy 50/114/285") and used the "Points to Lines" Tool within ArcGIS to construct polylines connecting successive locations from each individual. I then plotted the segments that a) crossed Hwy 50/114/285, and b) had endpoint locations separated by ≤7 days. These segments were intended to identify broad areas lynx have used to make their way from the San Juan Mountains to the Sawatch Range and vice-versa. They in no way represent actual locations where lynx traversed any of the highways comprising the dividing line.

RESULTS

I identified 40segments from 28 lynx (18 females, 10 males) that crossed Hwy 50/114/285 and had endpoints separated by <7 days (Fig. 1). Thirteen (32.5%) of these segments occurred within a 17-km stretch of Hwy 114 spanning the timbered areas east and west of North Pass. Many of these segments pass through the North Pass Linkage area and/or the USFS Cochetopa Analysis unit. 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.

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 Hwy 50/114/285. 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 northeast of Hwy 50/114/285. Based on lynx ecology, biologists from various state and federal agencies have postulated that the forested bottleneck at North Pass likely provides a corridor for lynx making make 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

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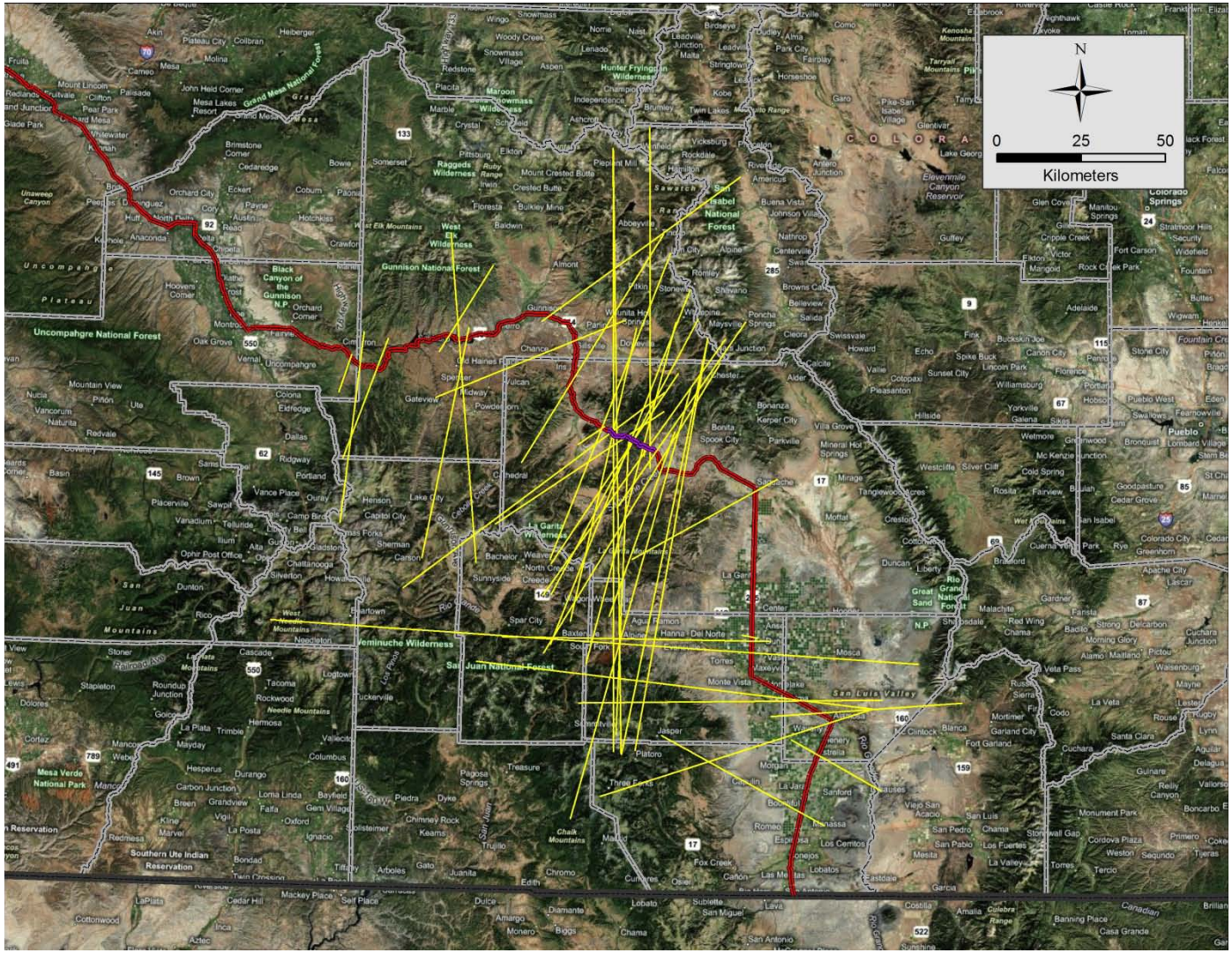

Figure 1. Line segments that a) crossed Hwy 50/114/285 (red), and b) had endpoint locations separated by ≤7 days, south-central Colorado, 1999-2010. Purple line is a 17-km stretch of Hwy 114 that passes through a timbered landscape near North Pass. Note that segments do not indicate actual or even approximate location of lynx crossings because locations are imprecise and separated by up to one week.

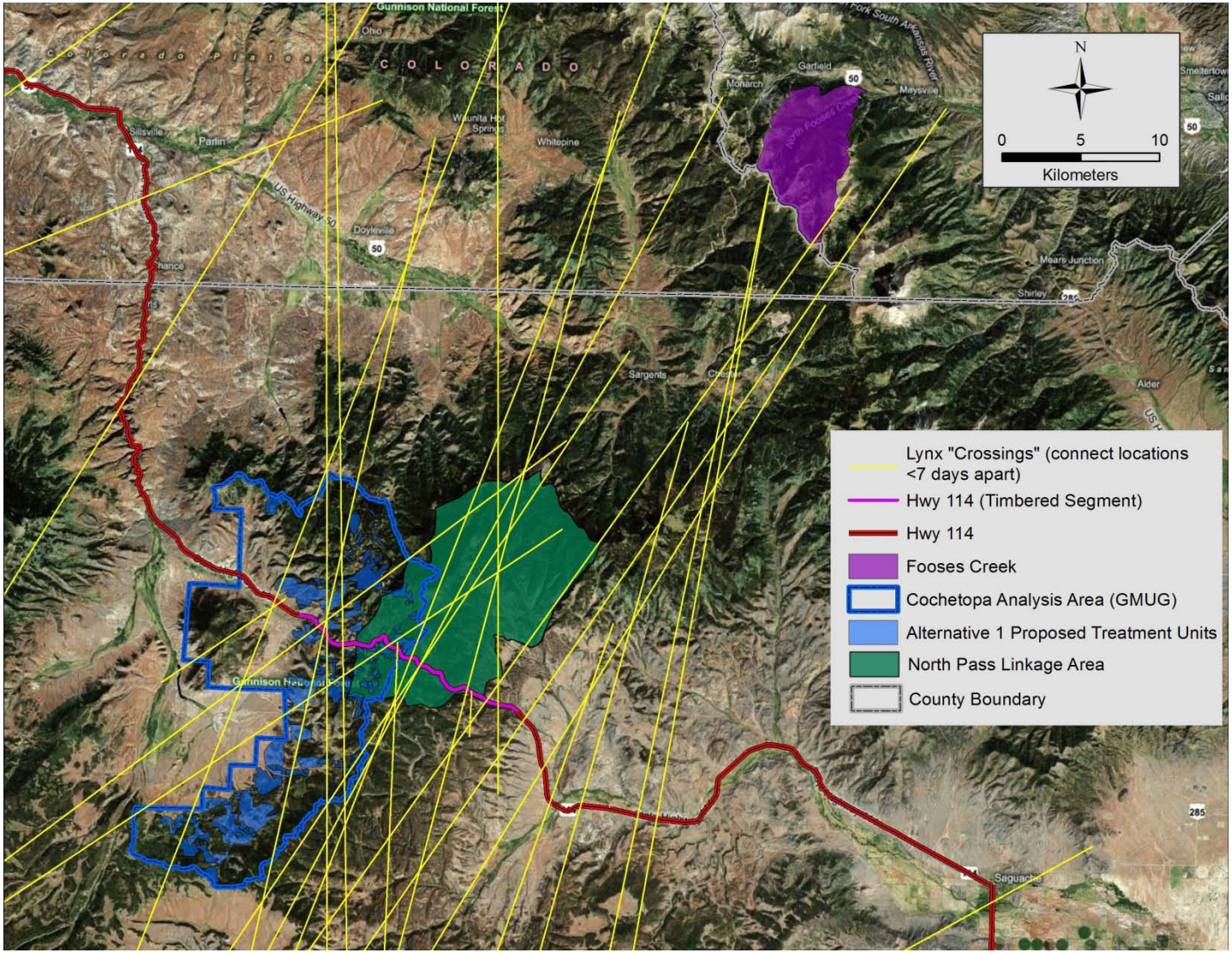

Figure 2. Line segments that a) crossed Hwy 114, and b) had endpoint locations separated by ≤7 days, 1999-2010. Colored polygons depict the North Pass Linkage Area or USFS project areas of interest. Note that segments do not indicate actual or even approximate location of lynx crossings because locations are imprecise and separated by up to one week.