Seasonal Ranges, Migration, and Habitat Use of the Platte Valley Mule Deer Herd

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INTRODUCTION

Mule deer in the Platte Valley Herd Unit are facing considerable stresses and information gaps that complicate their management by the Wyoming Game and Fish Department (WGFD). Changes in winter and summer habitat, predators, residential development, migration barriers, competition from other ungulates, and diseases are all factors that potentially influence this herd. Some combination of these factors have contributed to a large population decline over the last several decades, and solutions to recovering the herd to a sustainable level are actively being sought. Similar declines in mule deer herds have been reported throughout much of the West (deVos et al. 2003), likely a result of drought and habitat alteration, among other factors (Bishop et al. 2009, Monteith et al. 2014). Habitat enhancement and harvest management are two key strategies that can help enhance and regulate mule deer populations, and both benefit from detailed information of year-round habitat use.

The Platte Valley herd is mostly migratory. Mule deer are thought to migrate out of the Platte Valley in all directions: north across I-80, west into the high Sierra Madres, east to the Snowy Range, and south to summer ranges that extend around North Park, Colorado. Seasonal migrations complicate the management of mule deer herds. Winter ranges are relatively easy to delineate due to the large number of animals that congregate on them. Mule deer also show strong fidelity to migration routes (Sawyer et al. 2009), but delineating long-distance routes has only recently become possible, due to improved GPS technology. Spatial location data collected at fine spatial and temporal scales can now be used to estimate migration routes. Individual routes can also be combined to determine which route segments are used by the most individuals, and to identify stopover sites along migration routes that animals use for foraging and resting (Sawyer et al. 2009). Stopovers appear especially important because they allow animals to seek young nutritious forage in the spring when they are recovering body-fat stores lost over winter. Some mule deer populations spend up to 95% of the migration period in stopovers (Sawyer and Kauffman 2011). Winter range has traditionally been viewed as the most limiting habit for mule deer populations, but that notion has begun to shift in recent years as the importance of migration and summer nutrition are being better understood (Cook et al. 2004, Tollefson et al. 2010, Sawyer and Kauffman 2011, Monteith et al. 2014).

A primary objective of this collaring study was to evaluate detailed movement data to enhance our understanding of the threats to Platte Valley mule deer migrations, and to advance management of seasonal ranges and stopover habitat. This study was based primarily on capture and collaring efforts (Figs. 1 & 2). In 2011, 50 adult female mule deer were captured on winter range in the Platte Valley and instrumented with GPS collars that collected a location every 3 hours, 2011 through 2013. Additionally, 5 does and 15 mule deer bucks were captured and fitted with VHF collars that were monitored occasionally with ground and air telemetry. In 2012, 14 GPS and 5 VHF collars were redeployed due to mortalities in 2011.

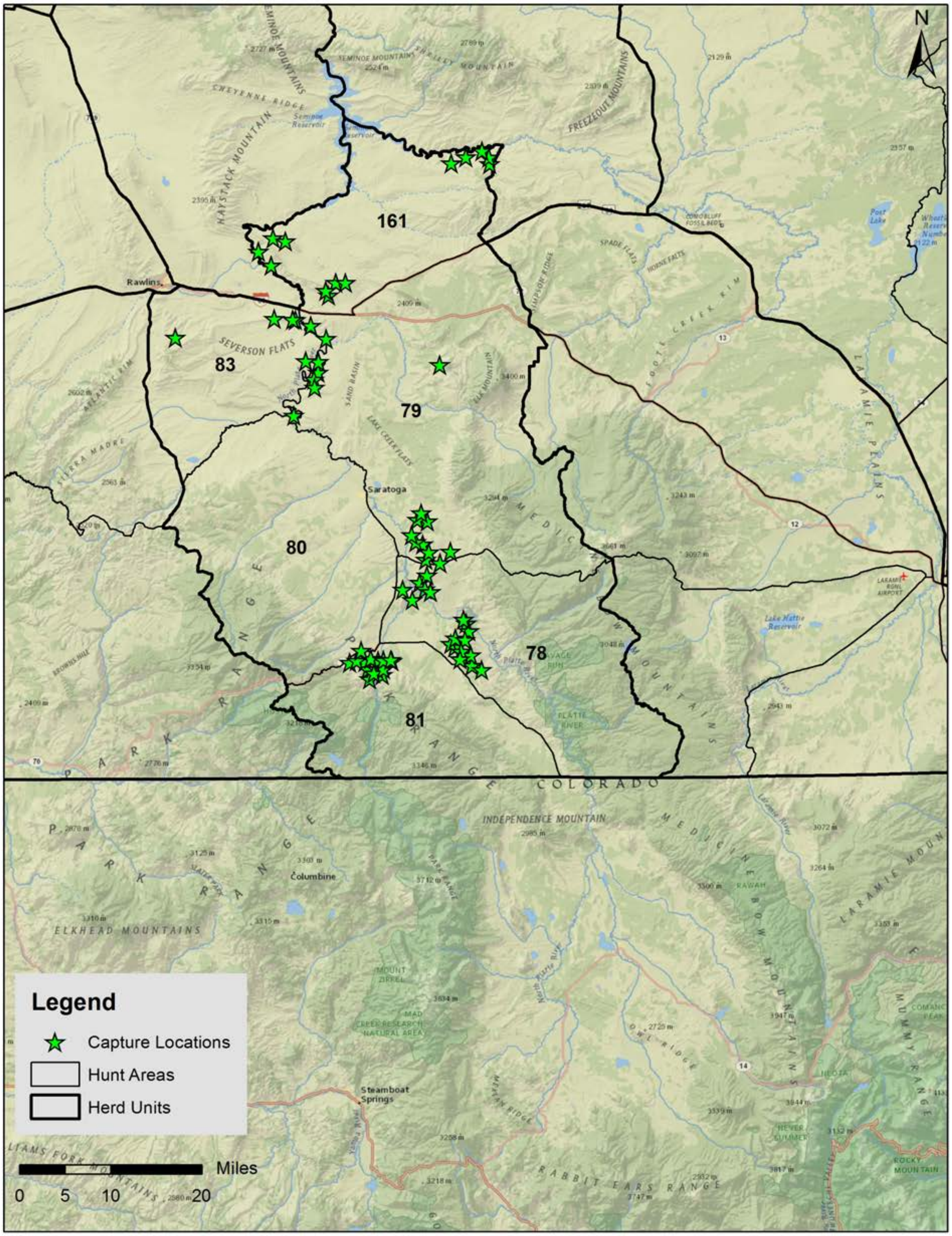

Figure 1. Mule deer (n=50) were captured and GPS-collared in January 2011 in the Platte Valley Herd Unit and associated hunt areas.

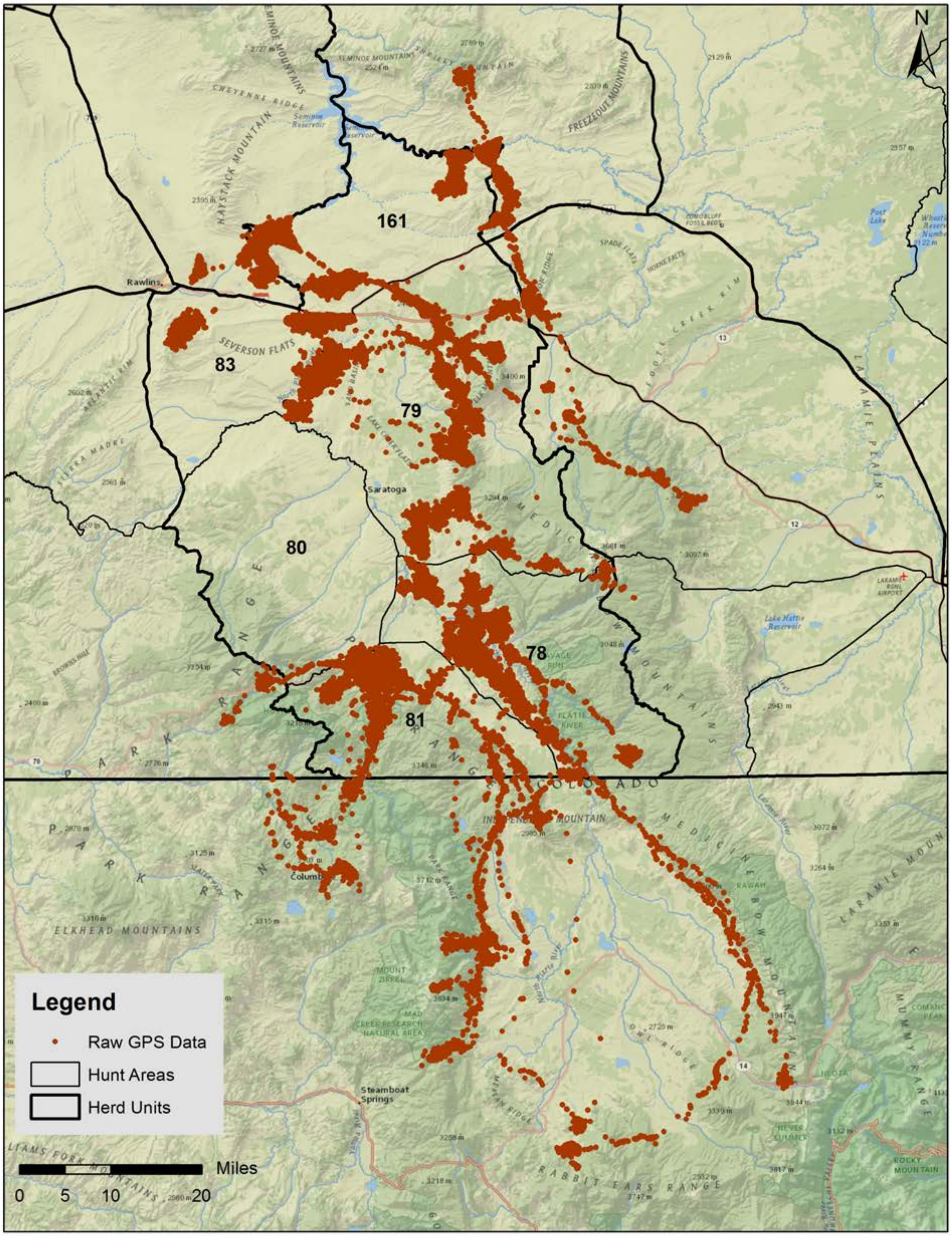

Figure 2. Distribution of 224,240 locations collected from GPS-collared mule deer, 2011-2013.

ANALYSES

1. Seasonal Ranges

Seasonal home ranges (winter and summer) were estimated for all GPS-collared mule deer. Winter was defined as the time between the end of fall migration and the beginning of the subsequent spring migration. Summer was defined as the time between the end of spring migration and the beginning of the subsequent fall migration. In the event that fall/spring migratory data were unavailable (e.g. the animal died after a fall migration but before a spring migration) home ranges were constructed using the available data. We used a kernel density estimator (KDE; Worton 1989) to derive a utilization distribution (UD) for seasonal relocation points. We used the 90th quantile of the UD to delineate a seasonal range polygon for each individual across each year and season. For animals that lived through the entire study period, we were able to estimate 2 winter range and 2 summers for each individual.

2. Migration Patterns

Population-level migration routes: We used the Brownian bridge movement model (BBMM; Horne et al. 2007) to estimate individual and population-level migration routes from GPS data. The BBMM estimates a UD for a sequence of animal locations. Migration sequences for the spring and fall migration of each animal were identified manually, as locations between distinct winter and summer ranges, including the 12-hr period prior to and following migration (Sawyer et al. 2009). Once migration sequences were extracted from GPS data, we used the "BBMM" package in R (Nielson et al. 2012) to estimate UDs for individual routes. Individual UDs were then averaged to estimate a population-level migration route (Sawyer et al. 2009, White et al. 2010) for each hunt area (HA). Assuming a representative sample of animals, the population-level migration route reflects both the spatial extent of a migratory population, as well as the intensity of use within the migration route.

Stopover sites: A key advantage of the BBMM approach is that it allows route segments used as stopover sites (i.e., foraging and resting habitat) to be discerned from those used primarily for movement. Stopovers are important to migratory mule deer because they allow animals to maximize energy intake by migrating in concert with plant phenology (Sawyer and Kauffman 2011). We identified stopover sites from the population-level migration route as the top 10% of UD values.

High-use routes: Another benefit of the BBMM approach is that when multiple migration routes radiate from a common winter range, as is often the case with mule deer, we can identify which of those routes are more heavily used than others. By overlaying the 99% contour of each animal's migration route, we calculated the proportion of marked animals that used each migration segment within each HA. This step is especially helpful for agencies, industry, and other stakeholders to prioritize which routes are most critical or important. Based on the proportion of the sampled population (<10%, 10 to 20%, or >20%) that used each route segment, we categorized route segments into low, moderate, and high-use areas. In this application, the level of use simply reflects the proportion of sampled animals that used each route or corridor (Sawyer et al. 2009).

3. Parturition

Parturition in mule deer typically occurs between June 1 – June 23 (Freeman et al. 2014), peaking around June 10. Because we were unable to determine date of parturition from GPS collar data, we sought to show the widespread nature of parturition time period relocations. Parturition locations vary widely and can occur on winter or summer range as well as throughout the entire migratory range of mule deer. Parturition locations were delineated separately for each year.

4. Buck Movements

As bucks only carried VHF collars, we sought to relocate them by fixed wing telemetry on an occasional basis. Approximately 16 mule deer bucks were available for relocation following capture. Particularly useful were summer relocations, which provided a clear indication of the direction of their migrations out of the Platte Valley winter range. We mapped paired capture and summer relocations to visualize buck migrations and provide a comparison to the migrations of the GPS-collared does.

RESULTS

1. Seasonal Ranges

Seasonal ranges were typical in size and distribution to mule deer elsewhere in Wyoming. The sample of collars roughly indicated four winter concentrations, loosely aligned with hunt areas 78 (Beaver Hills), 81 (south of Encampment), 79 (east of Saratoga) and 161 (north of I-80) (Fig. 2). Most winter range concentrations were relatively stable across years, with the exception of mule deer that wintered along the foothills of Elk Mountain, east of Saratoga. These deer wintered along the foothills in 2012 (Fig. 4), but not 2011. In 2011, these deer were pushed to lower elevations by heavy snowfall causing them to winter down along the North Platte River (Fig. 3).

Mule deer summered in several mountain ranges outside the Platte Valley (Fig. 6). Most of these deer summered in the foothills surrounding North Park, CO, including the Rawahs, Rabbit Ears Pass, and the Zirkel Range. A small portion also summered in the Sierra Madres and Park Range to the south. To the north of Platte Valley, a small number of deer summered on the slopes of Elk Mountain and the high country of the Snowy Range. One animal summered in the Shirley Mountains. We note that deer summer ranges are small and our delineation of summer range was constrained to 72 collared deer, i.e. other summer ranges exists that were not used by collared deer. In general, summer ranges were more stable than winter ranges due to high individual fidelity (Fig. 7).

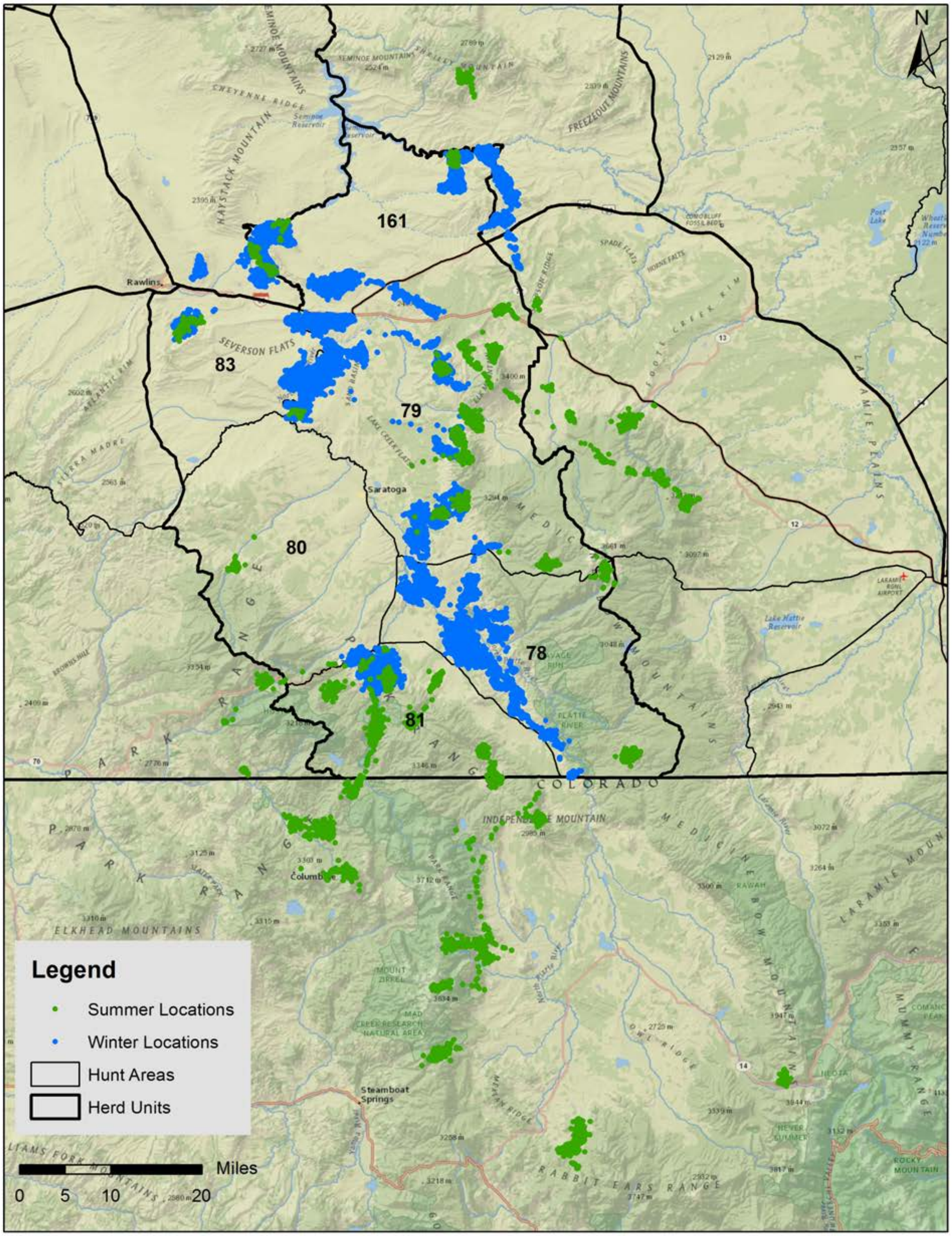

Figure 3. General distribution of summer and winter locations across the study area.

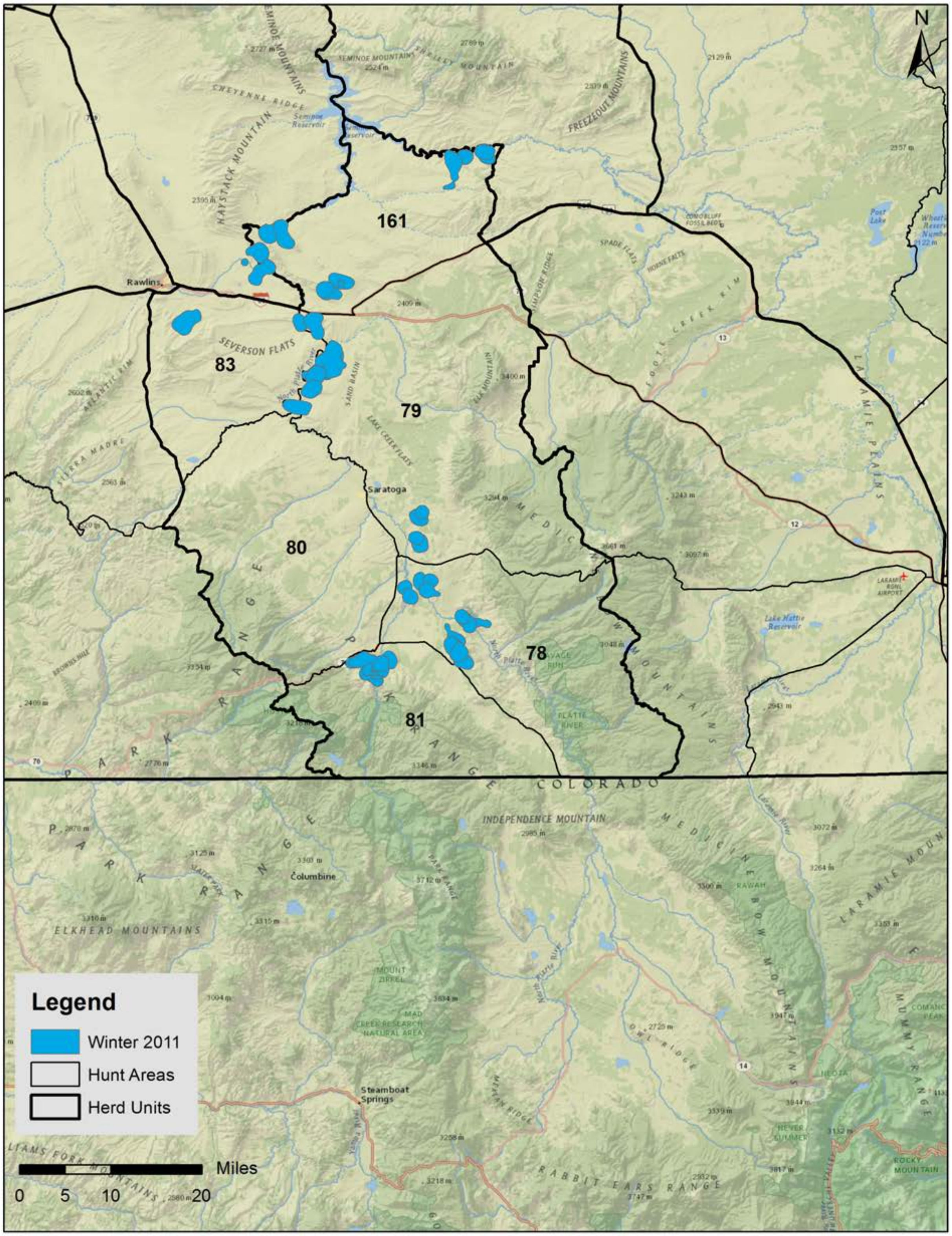

Figure 4. Winter range polygons of individual mule deer, 2011. The record-breaking snowfall of 2011 pushed deer out of the foothills on the western side of Elk Mountain, where they wintered in 2012.

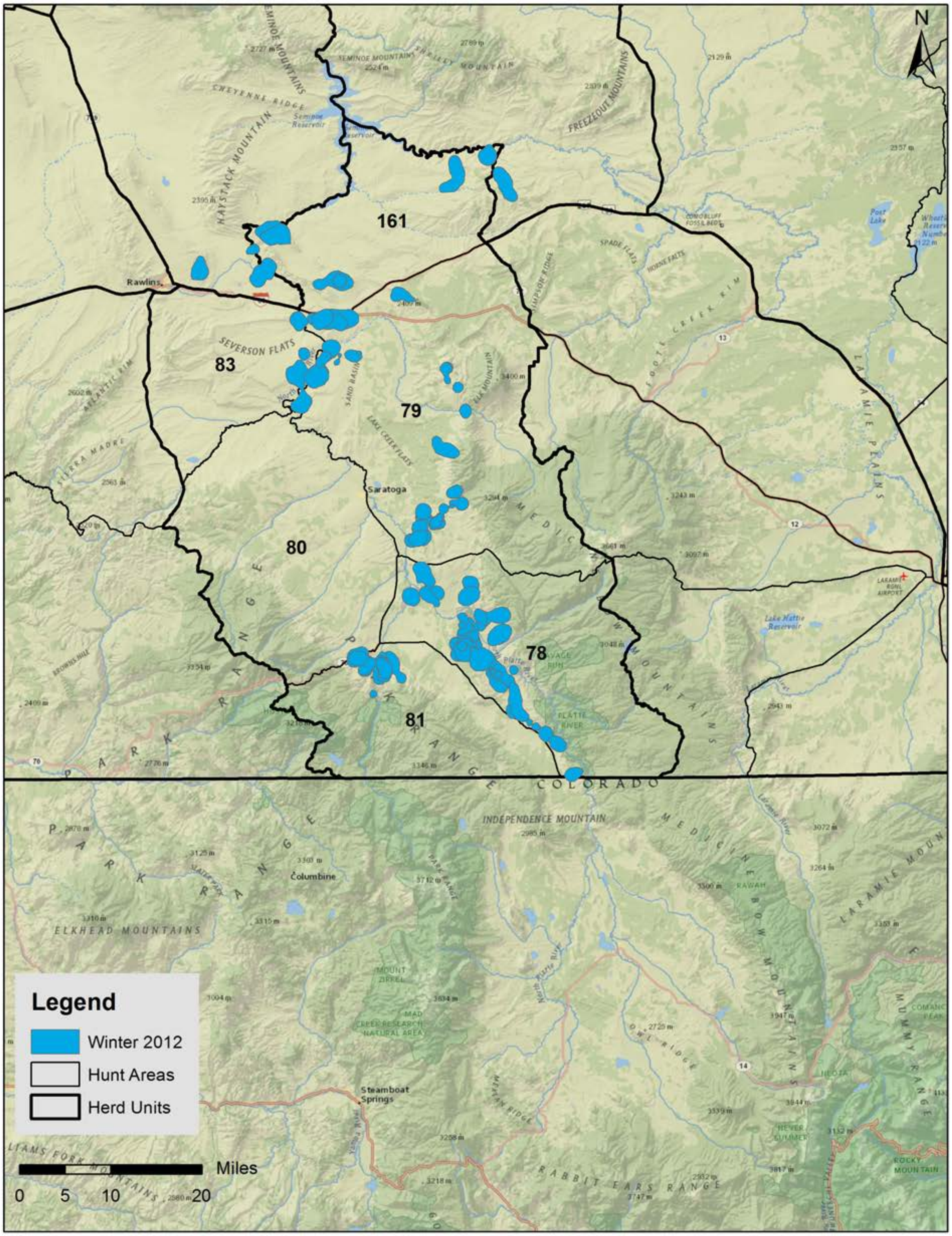

Figure 5. Winter range polygons of individual mule deer, 2012.

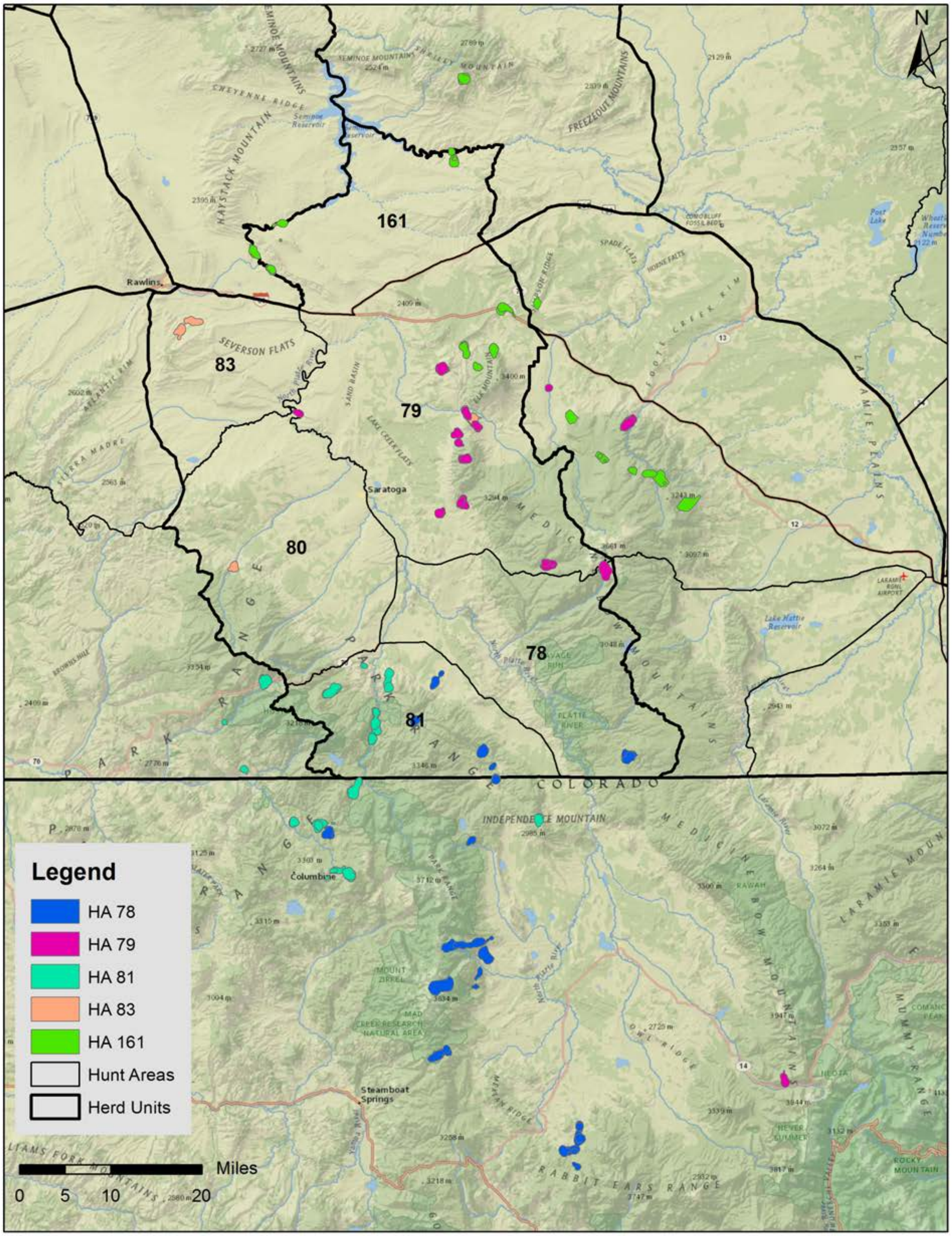

Figure 6. Summer ranges of mule deer captured in Platte Valley hunt areas.

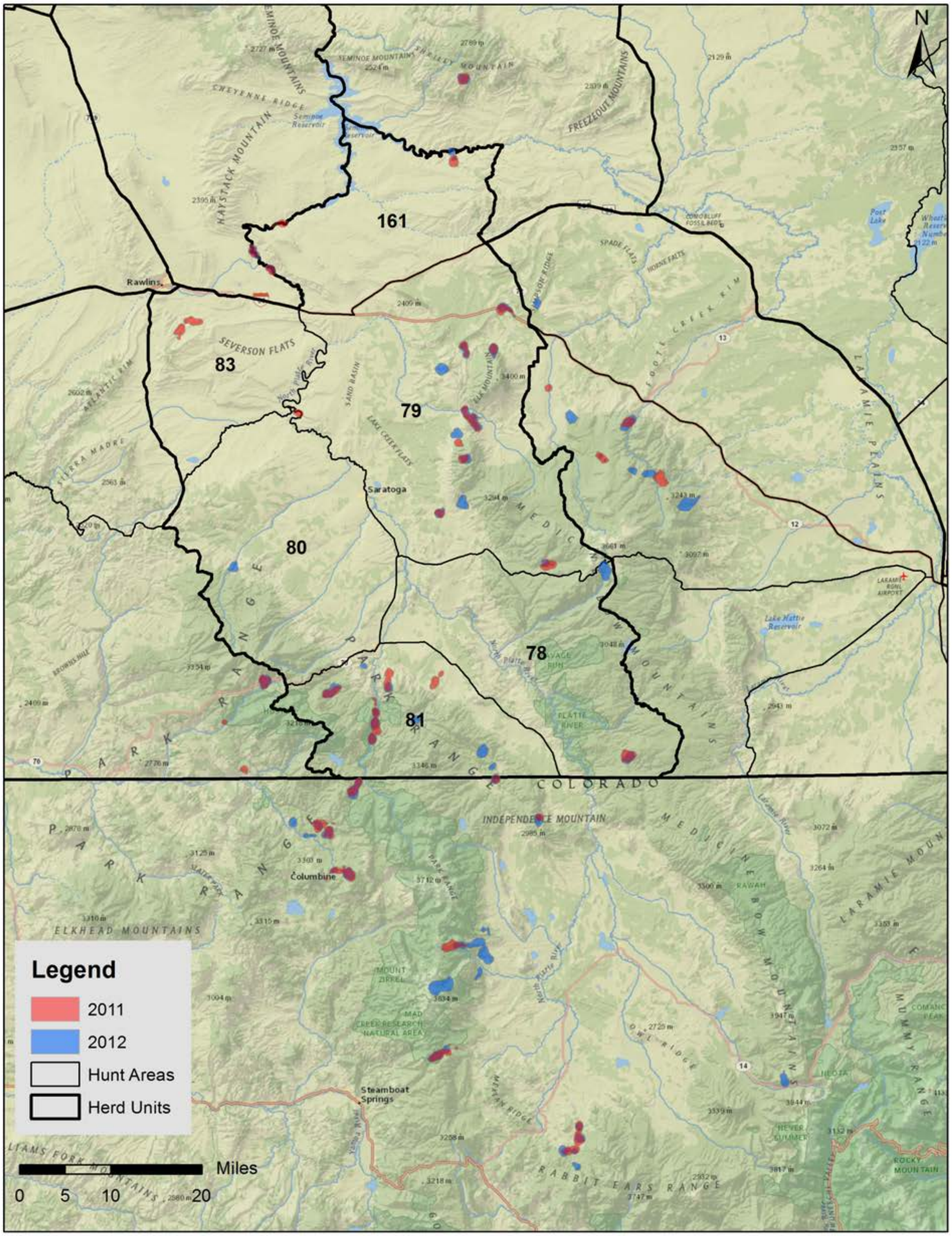

Figure 7. Summer ranges of Platte Valley deer in 2011 and 2012. Summer ranges lacking overlap between years were either deer that died or were newly collared.

2. Migration Patterns

Population-level migration route: We estimated population-level migration routes for HA 78, 79, 81, and 161 (Figs. 8 & 9). The route for HA 78 was estimated from 38 migration sequences (20 spring, 18 fall) collected from 13 individual deer between 2011 and 2013. The route for HA 79 was estimated from 36 migration sequences (22 spring, 14 fall) collected from 16 individual deer. The population-level migration route for HA 81 was estimated from 28 migration sequences (13 spring, 15 fall) collected from 8 individual deer. The population-level migration route for HA 161 was estimated from 18 migration sequences (9 spring, 9 fall) collected from 5 individual deer. The 3-hr GPS intervals resulted in Brownian motion variances (BMV; mean = 2,843, SD = 2,251) that were comparable to other mule deer studies where GPS fix intervals were 2.5-hr (mean = 2,679, SD = 280; Sawyer et al. 2009), however the variation among BMVs was considerably higher. The BMVs reported for Platte Valley were lower than those estimated in Oregon where GPS intervals were 4-hr (mean = 5,622, SD = 4558; Coe et al. In preparation) and higher than Nevada where GPS intervals were 1-hr (mean = 1,363, SD = 723; Sawyer and Brittell 2014). The BMV is important because the width of the estimated migration route decreases as BMV decreases. Migration sequences with BMV >10,000 were excluded from our analysis, including 3 sequences from HA 78, 7 from HA 79, 1 from HA 81, and 1 from HA 161.

The timing of migration varied among hunt areas, with the spring migration starting as early as February and as late as May (Fig. 11). Fall migrations were equally variable, ranging from September to December, depending on the year (Fig. 11). Platte Valley mule deer migrated in spring similar to mule deer elsewhere in the state, with considerable annual variability (high snow in 2011 lead to a late spring migration; Fig. 12).

Stopover sites: The population-level routes of each HA contained distinct stopover areas where mule deer spent the majority of their time during migration (Fig. 10).

High-use routes: Based on the proportional level of use, we identified low, moderate, and high-use route segments for each hunt area (Fig. 10). The moderate and high-use areas represent the most heavily used segments. High-use routes in HA 78 ran along the east edge of Platte Valley, from Bennett Peak south to Overlook Hill. Another route ran from Beaver Hills south to the North Platte and Big Creek. From Big Creek, one route crossed Wyoming Highway 230 and veered west towards Bear Mountain. The other route continued south in the foothills between Wyoming Highway 230 and the North Platte River. One high-use route led mule deer into Colorado and extended along the east side of the Zirkel Range, from Independence Mountain south to Red Canyon. High-use routes through HA 81 extended along the Encampment River, from Miner Creek south to Colorado state line. Further north in HA 79, several high-use routes connected the Pennock/Coad/Elk Mountain summer ranges with winter ranges west across Wyoming Highway 130. The high-use route from HA 161 extended southeast from Saint Mary's Ridge to Dana Ridge, underneath Interstate 80 (via machinery underpass; I-80 milepost 244) and down to Halleck Ridge and Elk Mountain.

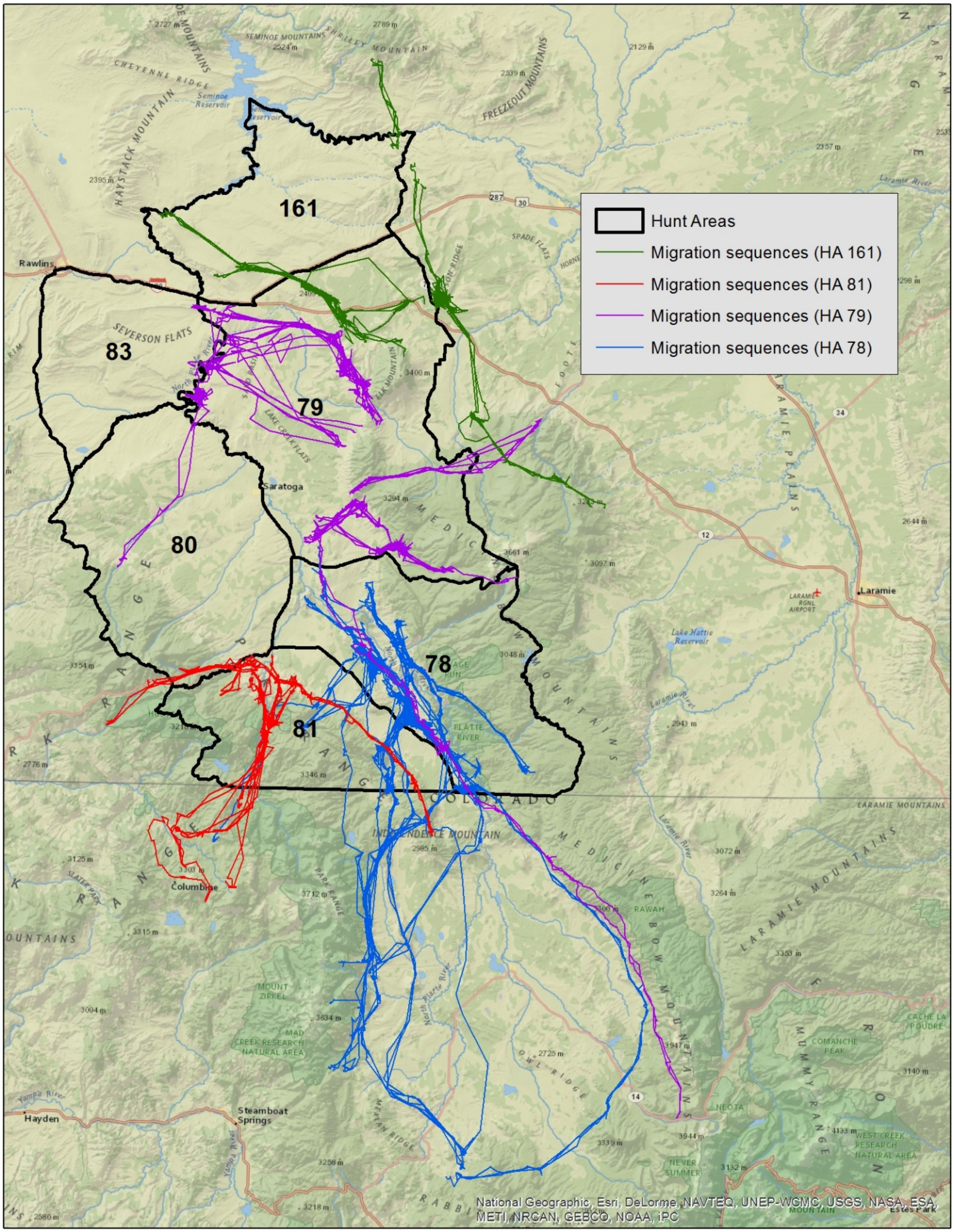

Figure 8. Migration sequences (n=120) collected from 42 individual mule deer across Platte Valley hunt areas between 2011 and 2013.

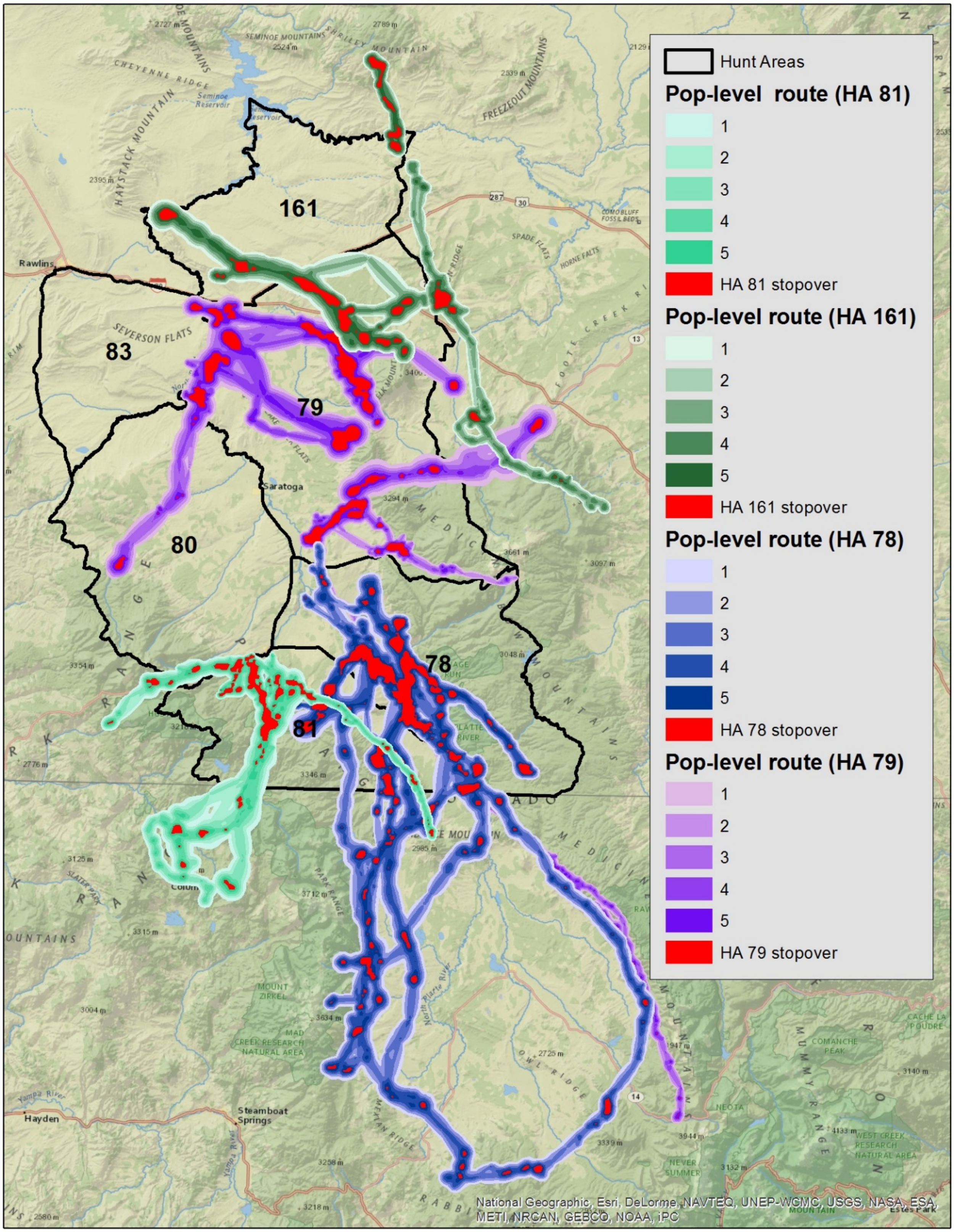

Figure 9. Population-level migration routes and stopover sites estimated for hunt areas (HA) 78, 79, 81, and 161.

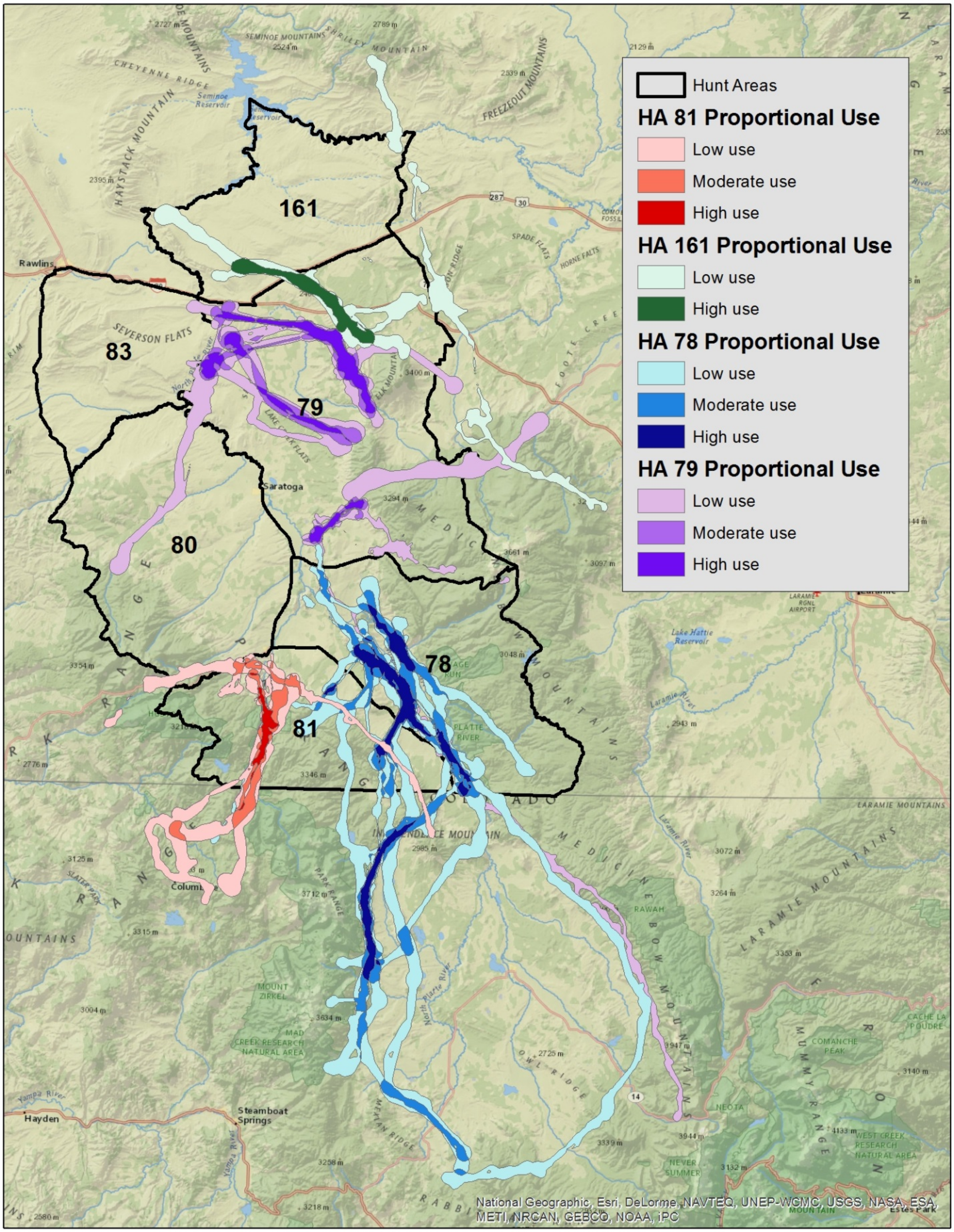

Figure 10. Low, moderate, and high-use segments within the population-level migration routes of hunt areas (HA) 78, 79, 81, and 161.

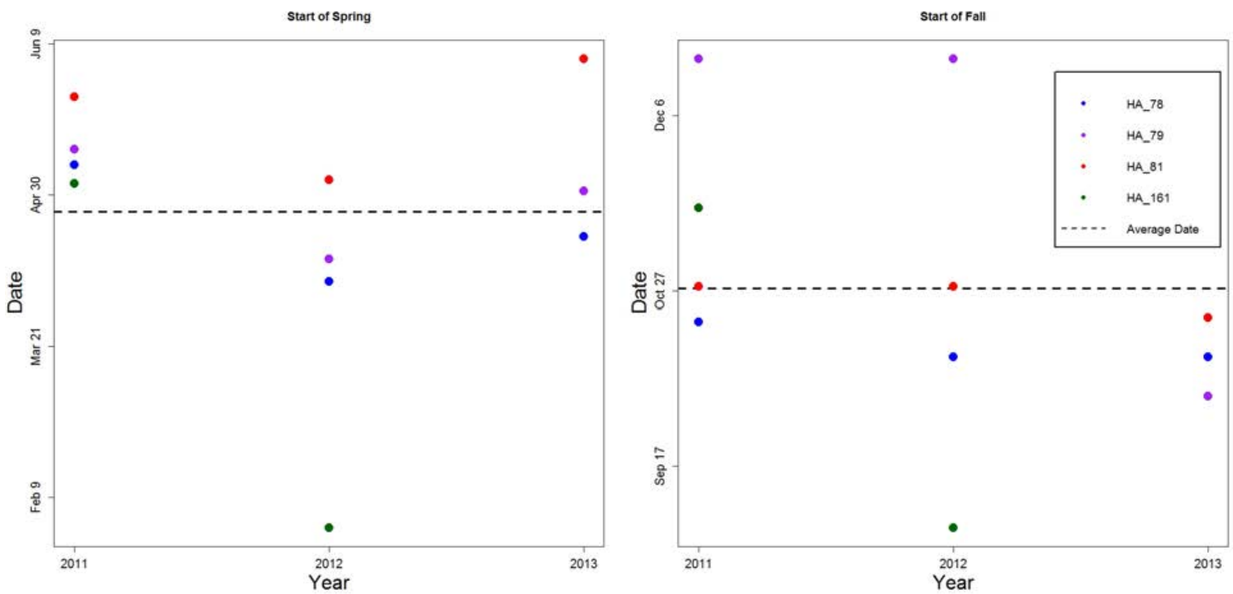

Figure 11. Timing of spring and fall migrations of Platte Valley deer. Deer showed considerable variability in the timing of spring and fall migrations. Notably, the spring migrations followed a consistent pattern wherein migration began first in HA 161, followed by HA 78, 79, and 81, across all years.

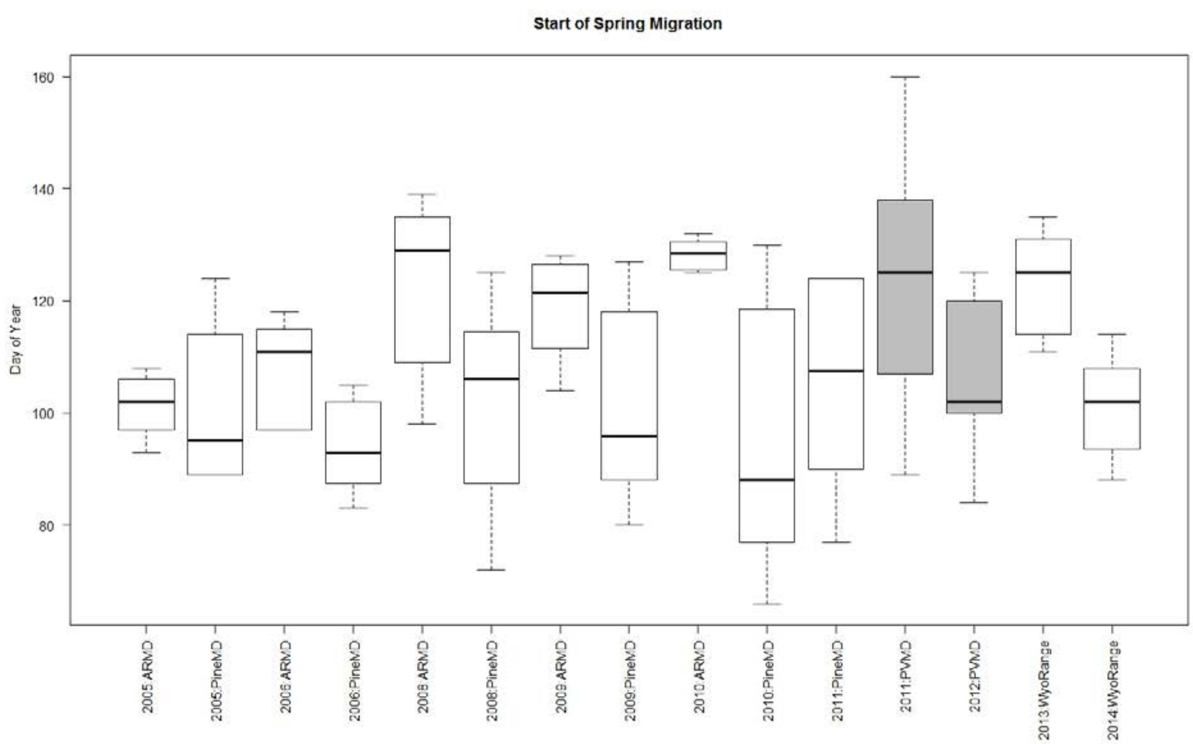

Figure 12. The timing of spring migration across Wyoming mule deer herds based on a standardized movement model. The timing of spring migration in Platte Valley deer is typical, but strongly influenced by winter/spring conditions. ARMD = Atlantic Rim; Pine = Pinedale; PV = Platte Valley; WyoRange = Wyoming Range.

3. Parturition

Parturition areas were widely spread between winter and summer ranges. Most parturition areas were close to summer range, or on summer range, within forest habitat. Mule deer have high fidelity to their migration routes and summer ranges, but the timing of migration varies annually. Thus, the variation in parturition areas from year to year (Fig. 13), is a function of early versus late migrations. Identifiable parturition habitat was not evident from the collar data.

4. Buck Movements

Based on a limited number of telemetry locations, mule deer bucks appear to have migratory patterns similar to does (Fig. 14). Collared bucks wintered in the south, which could simply be a function of initial capture bias. In general, these bucks migrated south into the North Park foothills of Colorado. Bucks that wintered in the Encampment area however, did not summer with the does they wintered with; instead, they migrated to summer ranges further south and east of the summer ranges of does. Relocation flights were not frequent enough to estimate timing of migrations.

Table 1. Proportion of migratory versus resident mule deer across Platte Valley hunt areas.

Hunt Area	Non-Migratory	Migratory	Total Animals
78	0	17	17
79	2	18	20
81	1	10	11
83	1	3	4
161	4	11	15

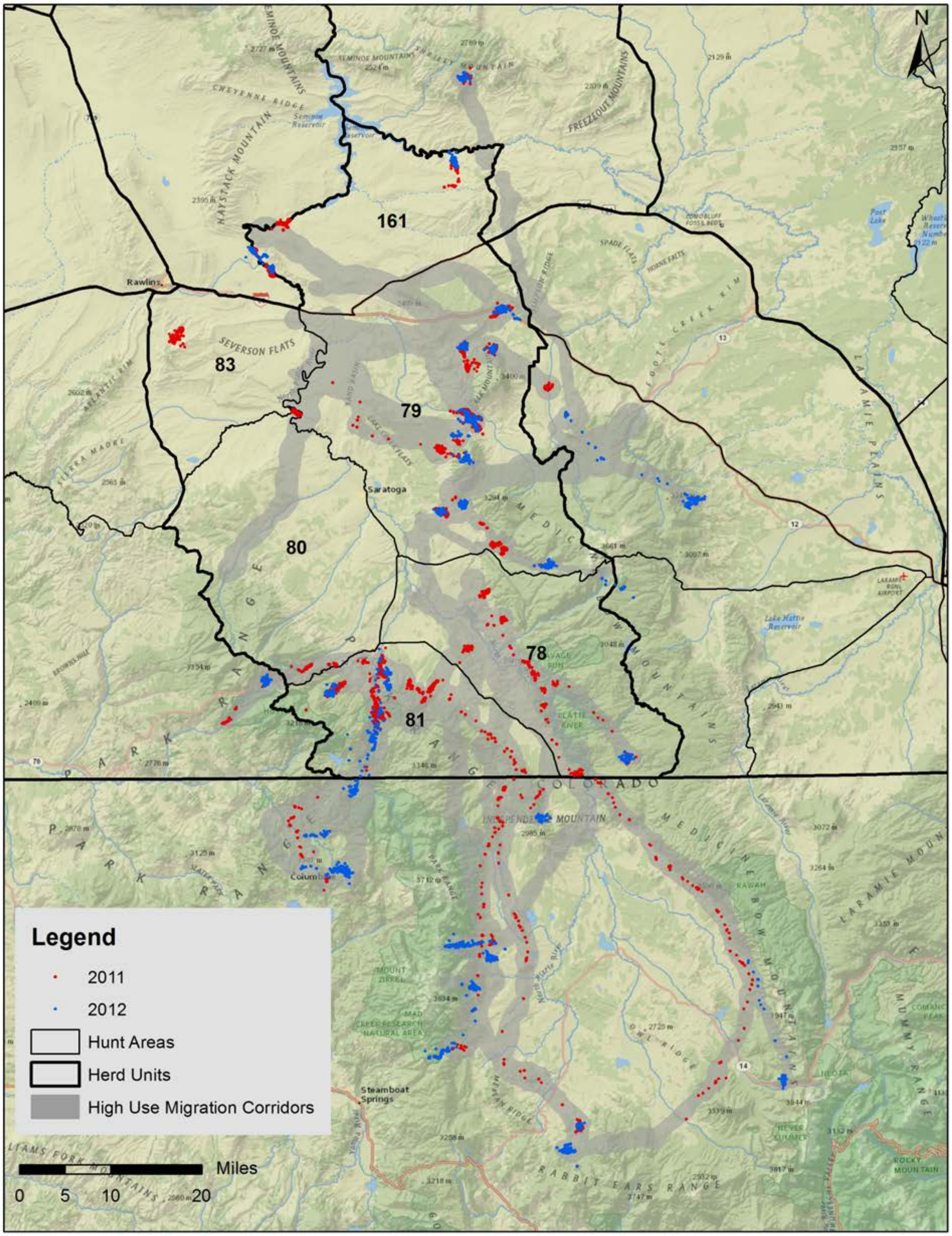

Figure 13. Parturition areas of Platte Valley deer. Locations assume a general parturition period from June 1 to June 23.

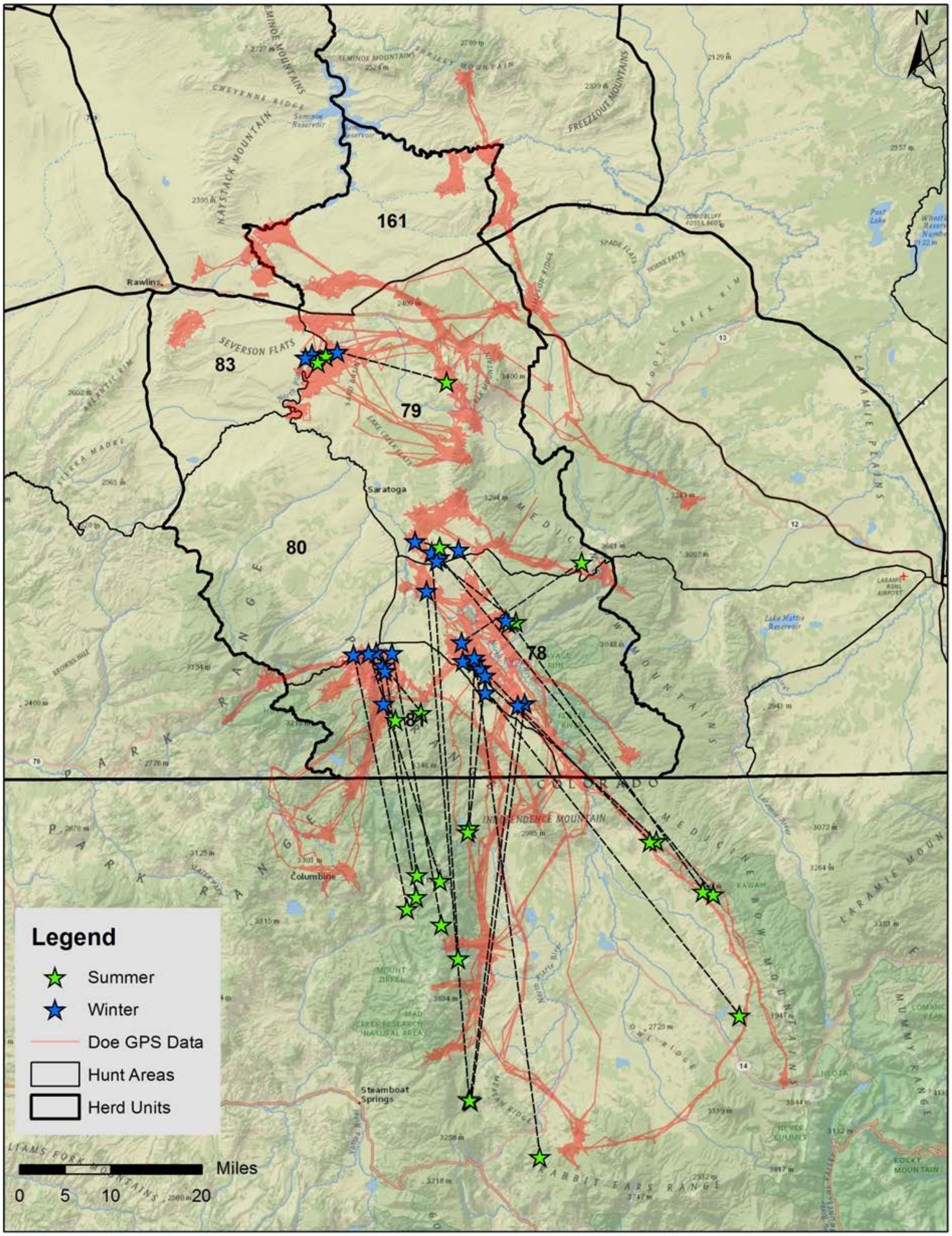

Figure 14. Seasonal relocations of mule deer bucks, derived from occasional telemetry flights. Bucks appeared to use migration routes similar to does except for those wintering just south of Encampment.

DISCUSSION AND MANAGEMENT IMPLICATIONS

Collar data suggests that the Platte Valley herd unit may function as several different sub-herds, roughly associated with hunt areas, 78, 81, 79, and 161. There is very little mixing of these sub-herds during winter, and most migrate to summer ranges that are in different mountain areas. This creates the possibility for each sub-herd to be influenced by different landscape changes. For example, the deer that winter in hunt area 78 summer in North Park, CO and are subject to land-use changes occurring in those areas, which could be different than changes within Wyoming. Similarly, some deer may summer in areas with higher levels of beetle kill than others. The timing of spring and fall migrations also differ across hunt areas, by roughly a month in the spring and as much as two months in the fall. Such differences in migration timing have implications for harvest management, as some sub-herds may be more vulnerable to harvest than others. The diverse migrations of this herd also complicate its management due to the long distances travelled across various jurisdictional boundaries and habitat types.

Interestingly, this herd may still harbor some lingering long-term effects on migration that likely followed the construction of Interstate-80 and the installation of game-proof fencing along portions of the I-80 right-of-way. It is notable that deer wintering close to I-80 had migrations shorter than those that winter south of Saratoga, and some of these animals had movements approaching a resident strategy. Although sample sizes are low, the high rate of residency of deer in hunt area 161 (Table 1) is higher than we have observed for other mule deer herds in Wyoming. Interstate 80 no doubt disrupted some mule deer migration routes when it was built and as traffic intensified; it seems likely that the short migrations that exist today are a legacy of the I-80 corridor. We did document 5 deer from HA 161 using the machinery underpass near Dana Ridge to access their summer ranges south of Interstate 80. Another deer was documented crossing the Interstate under the bridge of the Medicine Bow River, near Elk Mountain. Such crossings are possible, but the permeability of the interstate could be much improved by installation of crossing structures designed for wildlife.

Our analysis revealed numerous stopover sites that Platte Valley deer use along their migration routes. Recent research indicates that connectivity between seasonal ranges must include access to forage for migration routes to be functional (Sawyer et al. 2013). In particular, mule deer rely on stopovers along the migration route for energy intake, often spending 95% of their time in stopover areas during their seasonal migrations (Sawyer & Kauffman 2011). Access to forage is especially crucial in spring when animals leave winter range in an energy deficit (Torbit et al. 1985). We now understand migration routes as critical seasonal habitat, as are summer, winter or parturition areas, rather than simply movement routes between seasonal ranges (Sawyer et al. 2005). In recognition of the importance of stopovers, habitat managers may benefit mule deer by seeking to enhance or protect habitat at stopover sites. Stopover sites used by a large proportion of deer (i.e., those overlapping with moderate and high-use routes) are likely to have the larger population-level benefits. And because deer use the same stopovers year after year, conservation and management of those habitats should provide long-term benefits.

This study has provided the first reliable quantification of the migration routes of Platte Valley deer. Seasonal migration of mule deer is a key element of their year-long foraging strategy, and thus conservation of migration routes should be considered fundamental to any effort to enhance habitat and boost herd performance. Recognizing the specific locations of migration routes, their width, and the use they receive from deer is a necessary step in maintaining mule deer migrations across this multiple-use landscape. These migration routes could be further refined by additional GPS data, especially from mule deer bucks. GIS data on migration routes and stopovers presented in this report are available for state or federal biologists seeking to incorporate such information into land-use planning. Migration data from this study is viewable by managers, conservationists, and the general public at http://migrationinitiative.org/content/migration-viewer.

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