Seasonal distribution patterns and migration routes of mule deer in the Red Desert and Jack Morrow Hills Planning Area

Final Report

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NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS

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SUGGESTED CITATION

Sawyer, H. 2014. Seasonal distribution patterns and migration routes of mule deer in the Red Desert and Jack Morrow Hills Planning Area. Western Ecosystems Technology, Inc., Laramie, WY.

INTRODUCTION

The Red Desert and Great Divide Basin of southwest Wyoming is renowned for its wildlife, unique geology, desolate landscapes, and rich energy resources. Most of the Red Desert is comprised of federal lands administered by the Bureau of Land Management (BLM) and managed for multiple-use. As resource use (e.g., recreation, energy development) steadily increases, the management of these lands becomes more difficult and complex. To address such management concerns in the northwest part of the Red Desert, the BLM initiated the Jack Morrow Hills Coordinated Activity Plan (JHMCAP; BLM 2004, 2006). The JMHCAP *"provides management direction for important resources and uses in the planning area. It also addresses conflicts between development of energy resources, recreational activities, and other resource uses. The JMHCAP also provides management direction for certain resources, such as big game habitat,….while allowing recreational activities, mineral leasing and development, livestock grazing, and other activities (BLM 2006)."*

This JMHCAP focused on the Jack Morrow Hills Planning Area (JMHPA) – a 622,000 acre area located in the Rock Springs BLM field office, north of Interstate 80, east of US 191, and south of Wyoming State Highway 28 (Fig. 1). The JMHPA contains some of the key landmarks of the Red Desert, including Killpecker Sand Dunes, Steamboat Mountain, Oregon Buttes, Boar's Tusk, and the Honeycombs. Additionally, the JMCAP supports the largest desert elk herd in the U.S. and provides seasonal range for mule deer and pronghorn populations. Although the seasonal distribution patterns of elk in and around the JMHPA are well-known (Sawyer and Nielson 2005, Sawyer et al. 2007), similar information for mule deer and pronghorn are lacking. Accordingly, one of the efforts that stemmed from the JHMCAP was to gather baseline data on the seasonal distribution and migration patterns of mule deer in and around the JMHPA.

It should be noted that the resource management plan (RMP) for the Rock Springs BLM field office (BLM 1997) is currently under revision (BLM 2012) and that revised plan will replace the JMHCAP for guiding future land-use management in the region.

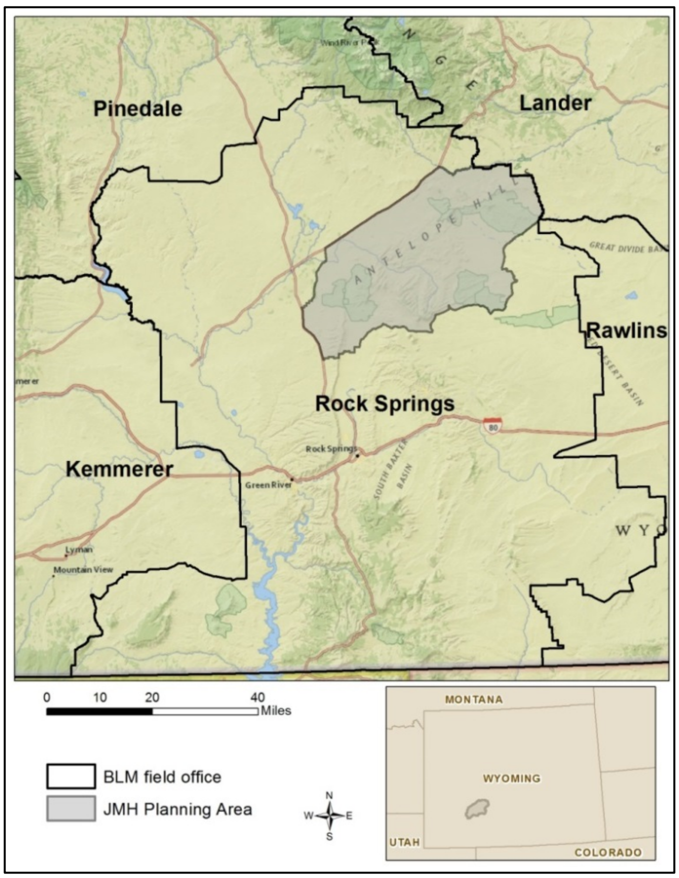

Figure 1. Location of Jack Morrow Hills Planning Area relative to the Rock Springs BLM field office.

Mule deer in JMHPA region are part of the Steamboat herd unit - one of many herd units in the state managed by the Wyoming Game and Fish Department (WGFD). The Steamboat herd unit generally overlaps with the Rock Springs BLM Field Office between Interstate 80 and Wyoming State Highway 28, and includes most of the JMHPA (Fig. 2). The herd unit is believed to support approximately 4,000 mule deer and, prior to this study, little was known about these deer in terms of where or if they migrate to various seasonal ranges. The goal of this study was to identify seasonal distribution patterns and migration routes of mule deer that utilize the JMHPA and Steamboat herd unit, with an emphasis on crucial winter ranges extending from Interstate 80 north through the Leucite Hills.

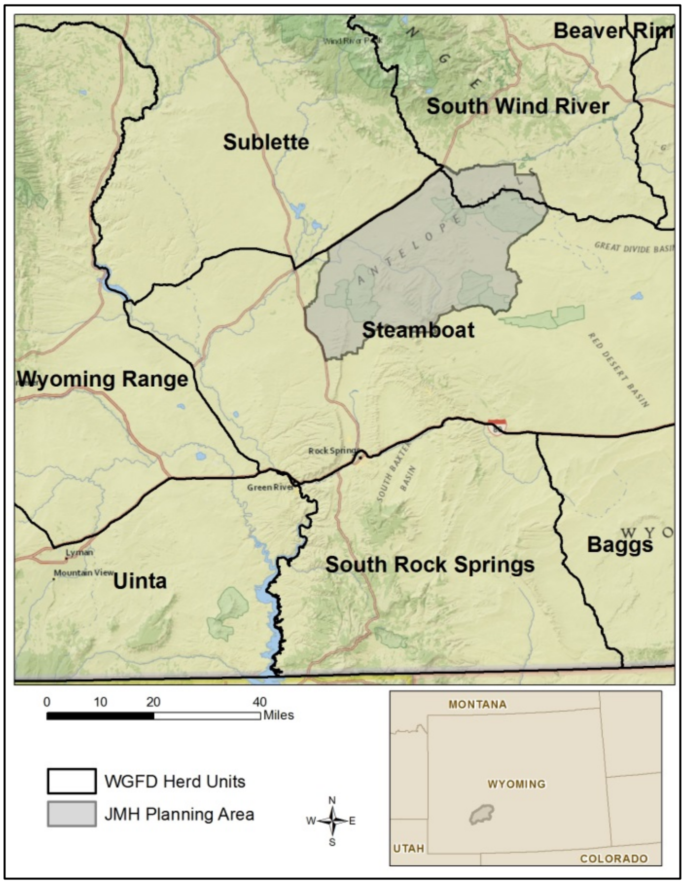

Figure 2. Location of Jack Morrow Hills Planning Area (JMHPA) relative to Wyoming Game and Fish Department (WGFD) mule deer herd units.

METHODS

Capture and Data Collection:

We used helicopter net-gunning to capture 60 adult female deer, including 40 in January 2011, 14 in January 2012, and 6 in December 2012 (Table 1). Deer were captured on winter ranges south of the JMHPA (Leucite Hills, White Mountain) and equipped with store-on-board GPS radio-collars (Telonics TGW-4500) programmed to collect locations every 13 hours during summer (June 15 – September 15) and every 3 hours for the remaining part of the year. Release mechanisms were programmed to drop GPS collars on April 1, 2013.

Of the 60 GPS-collars that were deployed, 55 were recovered. Collars not recovered were either never found (*n*=4) or the release mechanisms failed and did not release the collar (*n*=1). Of the 55 recovered collars, 1 died of capture-related injuries and 14 died the winter or spring following capture. The winter of 2010-11 was unusually severe and deer populations throughout western Wyoming suffered serious losses. We collected 152,655 locations from 54 individual deer (Fig. 3). Overall, we recovered 34 collars that had at least one year of data and were suitable to evaluate seasonal distribution and migratory patterns.

Table 1. Mule deer capture dates, migration status, and summer herd unit.

ID	Capture	Notes	Migrate	Summer HU
1	1/25/2011	NOT FOUND	-	-
2	1/25/2011	Died 5-12-11	n/a	n/a
3	1/25/2011	Died 2-18-12	Yes	Sublette
4	1/25/2011	Died 4-23-12	Yes	Sublette
5	1/25/2011	Died 5-21-11	partial	unknown
6	1/25/2011	Capture-related mortality	-	-
7	1/25/2011	Recaptured December 2013	Yes	Sublette*
8	1/25/2011	Died 2-3-13	Yes	Steamboat
9	1/25/2011	NOT FOUND	-	-
10	1/25/2011	Died 5-18-11	n/a	n/a
11	1/25/2011	Died 9-15-12	Yes	Sublette*
12	1/25/2011	Recaptured November 2013	Yes	South Wind River
13	1/25/2011	Died 5-28-11,	Yes	Sublette
14	1/25/2011	Recovered May 2013	Yes	South Wind River
15	1/25/2011	Died 3-05-11	n/a	n/a
16	1/25/2011	Died 4-5-11	n/a	n/a
17	1/25/2011	Died 10-25-13	Yes	Sublette
18	1/25/2011	Died 3-19-11	n/a	n/a
19	1/25/2011	Died 10-2-12	Yes	Sublette*
20	1/25/2011	Recaptured November 2013	Yes	Sublette
21	1/25/2011	Died 4-19-11	n/a	n/a
22	1/25/2011	Recovered May 2013	Yes	Sublette
23	1/25/2011	Died 5-15-11	n/a	n/a
24	1/25/2011	Recovered May 2013	Yes	Sublette
25	1/25/2011	Recovered May 2013	Yes	South Wind River
26	1/25/2011	NOT FOUND	-	-
27	1/25/2011	Recovered May 2013	Yes	Sublette*
28	1/25/2011	Died 5-6-11	n/a	n/a
29	1/25/2011	Recovered May 2013	Yes	South Wind River
30	1/25/2011	Recaptured December 2013	Yes	Sublette
31	1/25/2011	Recovered November 2013	Yes	Sublette
32	1/25/2011	Died 4-6-11	n/a	n/a
33	1/25/2011	Recovered May 2013	Yes	Sublette*
34	1/25/2011	Died 4-6-11	n/a	n/a
35	1/25/2011	Died 4-14-12	Yes	Sublette
36	1/25/2011	Died 5-13-11	n/a	n/a
37	1/25/2011	Died 4-7-11	n/a	n/a
38	1/25/2011	Died 4-8-13	Yes	Sublette
39	1/25/2011	Died 3-2-11	n/a	n/a
40	1/25/2011	Recovered May 2013	Yes	South Wind River
41	1/12/2012	Recaptured November 2013	Yes	Steamboat
42	1/12/2012	Died 2-27-12	n/a	n/a
43	1/12/2012	NOT FOUND	-	-
44	1/12/2012	Recovered May 2013	Yes	Sublette
45	1/12/2012	Recovered May 2013	Yes	Sublette
46	1/12/2012	Recovered May 2013	Yes	Sublette
47	1/12/2012	Died 2-12-12	n/a	n/a
48	1/12/2012	Died 3-5-12	n/a	n/a
49	1/12/2012	Recovered May 2013	Yes	Steamboat
50	1/12/2012	Recovered May 2013	Yes	Sublette
51	1/12/2012	Recovered May 2013	Yes	Steamboat
52	1/12/2012	Recovered May 2013	Yes	Steamboat
53	1/12/2012	Died 10-25-12	Yes	Steamboat
54	1/12/2012	Recovered May 2013	No	Steamboat
55	12/13/2012	Died 12-31-12	n/a	n/a
56	12/13/2012	Recovered May 2013	n/a	n/a
57	12/13/2012	Recaptured November 2013	Yes	Steamboat
58	12/13/2012	NO DROP	-	-
59	12/13/2012	Recaptured November 2013	Yes	South Wind River
60	12/13/2012	Recovered May 2013	n/a	n/a

*Mule deer (*n*=5) that were captured in Steamboat herd unit during severe winter of 2010-11, then migrated to Sublette herd unit and never returned to Steamboat.

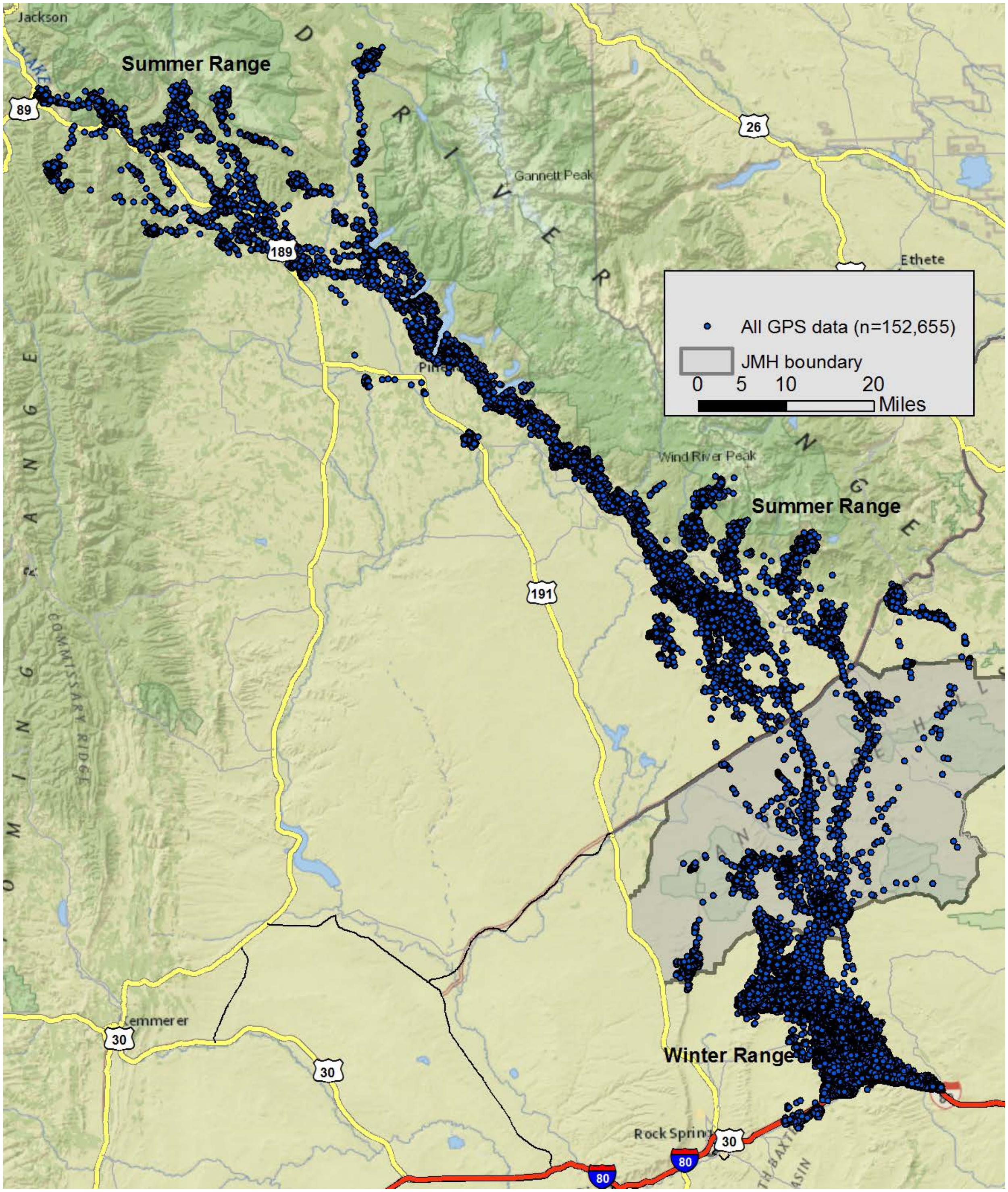

Figure 3. GPS locations (*n*=152,655) collected from 54 mule deer, 2011-2013.

Migration Patterns:

We used the Brownian bridge movement model (BBMM; Horne et al. 2007) and the "BBMM" package in R (Nielson et al. 2011) to estimate population-level migration routes from GPS data. A key advantage of the BBMM is that it provides a utilization distribution (UD) for each migration sequence. The UD is a probabilistic surface that accounts for GPS error and uncertainty in animal movement between locations. The UDs from individual animals can be combined to estimate a population-level migration route (Sawyer et al. 2009*a*). This UD approach 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 ungulates because they allow animals to maximize energy intake by migrating in concert with plant phenology (Sawyer and Kauffman 2011). Another benefit of this approach is that when multiple migration routes radiate from a common winter range, we can identify which segments are most heavily used.

The GPS collars collected locations at 3-hr intervals during migration periods and fix success was 99%. To estimate population-level migration routes, we followed the methods outlined by Sawyer et al. (2009*a*) where: 1) the BBMM was used to estimate migration routes of individual animals, 2) individual routes were then combined to estimate a population-level migration route, 3) segments within the population-level route were delineated as stopover sites or movement corridors, and 4) the 99% UD contours were used to delineate route segments as high, medium, or low-use based on the proportion of the sampled animals that used them. Assuming a representative sample of animals, the estimated migration routes should reflect migratory patterns of the larger wintering populations.

In addition to the BBMM, we used the individual migration sequences to calculate net displacement and evaluate patterns in migration timing. Net squared displacement (NSD) is an intuitive and powerful method for describing migration patterns from GPS data (e.g., Bunnefeld et al. 2011). The NSD simply measures the straight line distances between the starting location (i.e., winter capture location) and the subsequent locations for the migration route of an individual.

Winger Distribution Patterns

We used GPS data collected December through March to document winter distribution patterns in winters 2010-11, 2011-12, and 2012-13. We used the BBMM to estimate a winter UD for each animal and then averaged the individual UDs to create population-level winter UD. We then mapped population-level UDs for each year and average across years, to illustrate how marked deer were distributed during winter. For winter areas, we also calculated the “core-use” areas based the top 50% of UD values to help agencies identify or modify existing crucial winter ranges boundaries.

Parturition Ranges

We used GPS data collected between June 1 and June 20 to document parturition areas in the Steamboat herd unit. We used a simple kernel analysis in ArcGIS to estimate a UD from all the parturition data collected during spring 2012 and 2013. The spring of 2011 was not included because the unusually severe winter and spring weather conditions delayed migration by several weeks. This analysis was further restricted to animals that resided in the Steamboat herd unit (*n*=8).

RESULTS

Migration Patterns

Overall, we recovered 34 collars that had at least 1 year of data and were suitable to evaluate migratory patterns. Of those 34, there were 5 deer that migrated north to the Sublette herd unit and never returned. Presumably, this was because a segment of the Sublette population moved south to I-80 during the unusually harsh winter of 2010-11, when our initial capture occurred. In normal years, those deer do not migrate that far south; rather they reside on winter ranges north of WY 28, near the Prospect Mountains (see Appendix A). We chose to exclude these 5 deer from our migration analysis, as the primary goal was to describe migratory patterns of animals that winter south of WY 28 in the Steamboat herd unit. Of the 29 deer used to examine migration patterns, 97% (*n*=28) were migratory. The lone resident deer resided in the southern part of the Leucite Hills. Among the migratory animals, only 25% (*n*=7) stayed in the Steamboat herd unit. Another 54% (*n*=15) went to the Sublette herd unit and 21% (*n*=6) to South Wind River herd unit (Fig. 4). Regardless of which herd unit deer migrated to, individual animals tended to use the same migration routes year after year. Interestingly, the migration timing and duration of three sub-populations varied (Fig. 5). Deer that migrated the furthest (Sublette) departed winter range earliest and returned the latest. In contrast, deer that migrated short distances (Steamboat) began spring migration later and returned to winter range earlier. For example, in 2011 the Sublette deer began migrating in March whereas the Steamboat deer did not start until May. These start dates were earlier in 2012, following a much milder winter (Fig. 5).

We estimated population-level migration routes from 111 migration sequences (58 spring, 53 fall) collected from 34 individual deer (Fig. 6). The population-level route contained distinct stopover areas where mule deer spent the majority of their time during migration. Based on the proportional level of use, there were two distinct high-use routes radiating from the winter range; one extending north across the Red Desert and Jack Morrow Hills into the Sublette herd unit and another extending north to Oregon Buttes (Fig. 7). Both of the high-use routes originate near Zirkel Mesa and travel northerly to North and South Table Mountain, then through a gap in the sand dunes and on to Steamboat Mountain. From Steamboat Mountain, the high-use route splits into two. The west route leads deer north across the Jack Morrow Hills to WY 28, then up to the Prospect Mountains near the base of the Wind River Range. From there, these deer follow a relatively narrow corridor north along the base of the Wind River Range for approximately 60 miles, until they reach Willow Lake and veer off westerly across the upper Green River Basin and into the Hoback Basin. The other high-use route leads deer north from Steamboat Mountain along Monument Ridge, then northeasterly to Oregon Buttes. The high-use routes extending north from Steamboat appear to be used exclusively by mule deer that reside in Sublette and South Wind River herd units.

Winter Distribution Patterns

Winter distribution patterns were estimated from 22,764 locations collected from 36 GPS-collared deer during the winter of 2010-11 (Fig. 8), from 22,251 locations collected from 29 GPS-collared deer in the winter of 2011-12 (Fig. 9), and from 26,474 locations collected from 27 GPS-collared deer during the winter of 2012-13 (Fig. 10). Winter distribution patterns were estimated for all years combined by using 71,489 locations collected from 54 GPS-collared deer across winters 2010-11, 2011-12, and 2012-13 (Fig. 11). Core-use winter areas were defined from the top 50% of the population-level utilization distribution (Fig. 11). Crucial winter ranges designated by the WGFD included approximately half of the core-use winter areas identified from GPS data (Fig. 12). Areas not included in the current crucial winter ranges included the CR 371 corridor from I-80 to Superior, the I-80 corridor near Point of Rocks, the Long Canyon/Cedar Canyon area, and a portion of White Mountain. Aside from the harsh winter of 2010-11 when deer were pushed down to I-80, population-level UDs indicated that deer showed strong fidelity to winter ranges across years.

Parturition Areas

Three distinct parturition areas emerged, including Essex Mountain, Steamboat Mountain, and the Steamboat Rim/Box Canyon area (Fig. 13). Two other areas were used to a lesser degree, including the Buffalo Hump and Potash Wash/Pine Ridge area. The parturition areas currently recognized by the WGFD covered most of the high-use parturition areas identified from GPS data.

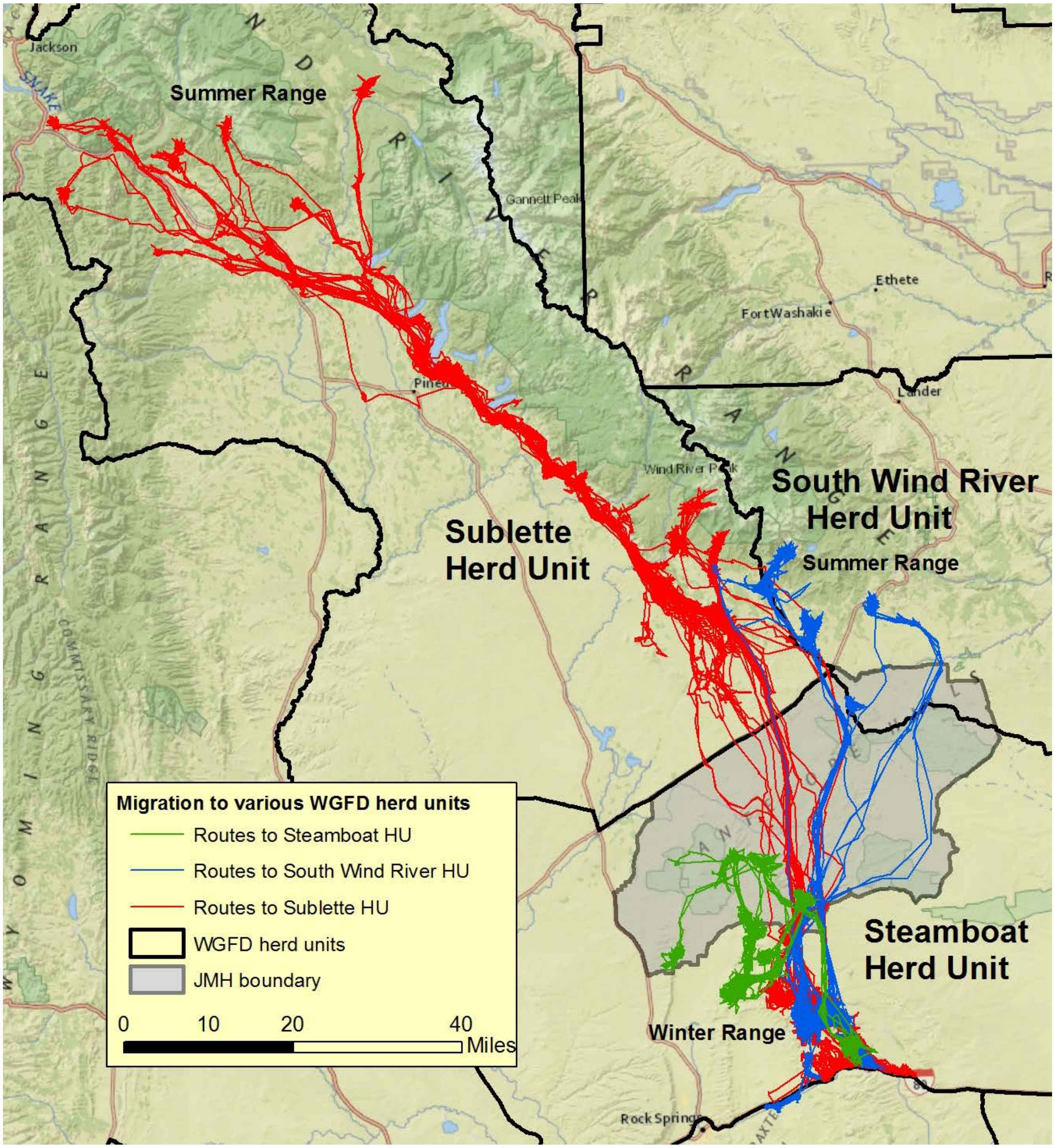

Figure 4. Most mule deer (75%) migrated 50 to 150 miles north from winter ranges in the Steamboat herd unit to summer ranges in the Sublette and South Wind River herd units.

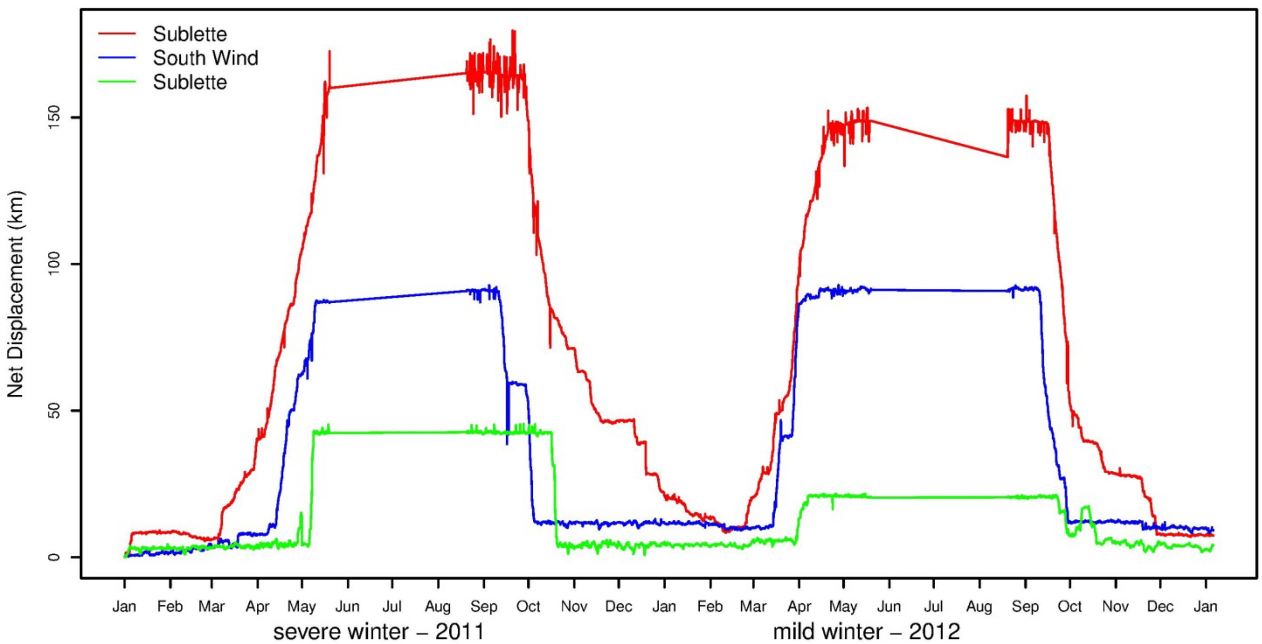

Figure 5. Average net displacement of mule deer that migrated within Steamboat herd unit (*n*=7), to South Wind River herd unit (*n*=6), and to Sublette herd unit (*n*=15), 2011–2012. Net displacement shows the timing of spring and fall migrations, as well as the duration spent on winter (graph valleys) and summer (graph peaks) ranges.

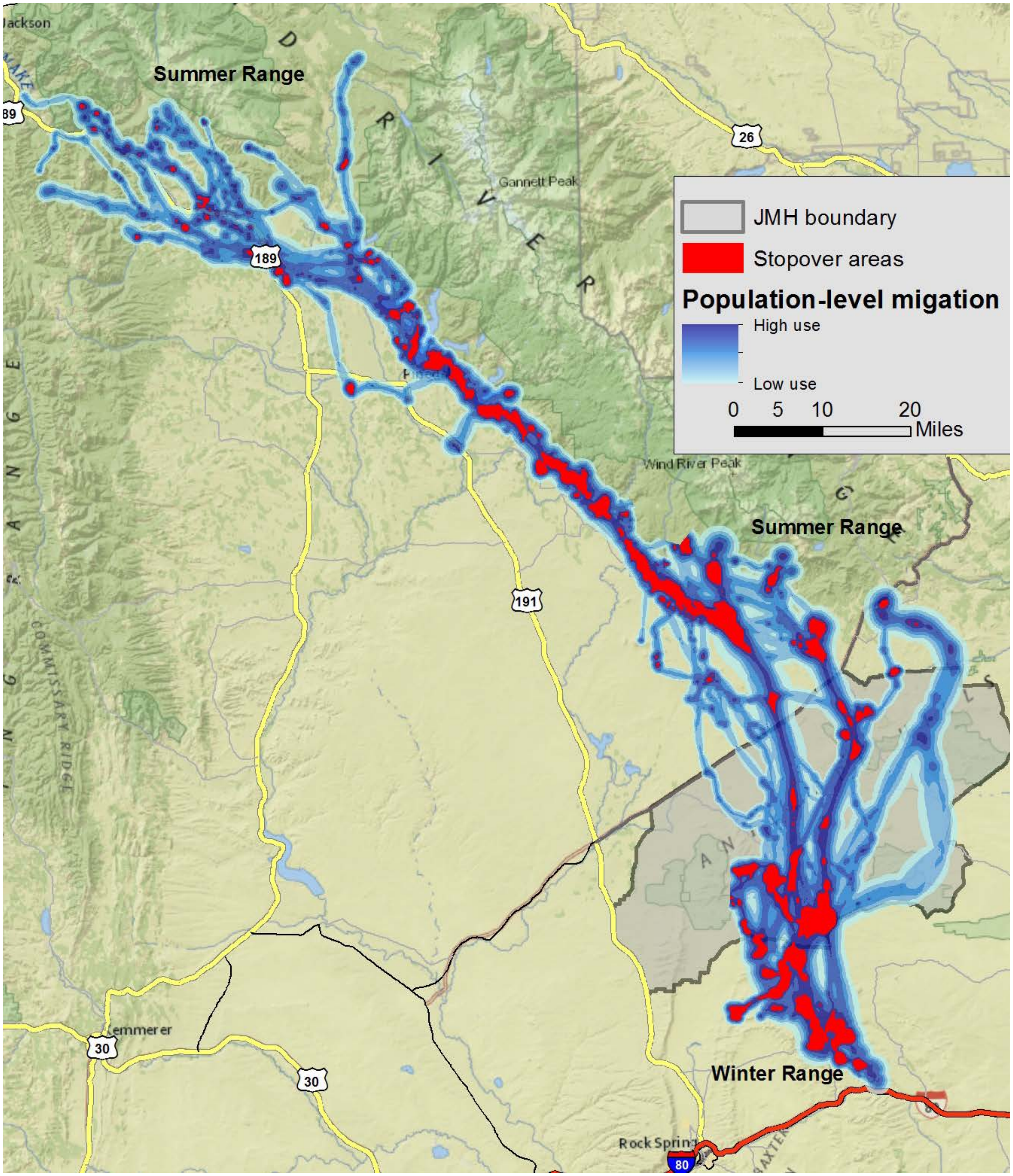

Figure 6. Population-level migration route estimated from 111 migration sequences collected from 34 mule deer, 2011-2013. Stopover areas highlighted in red show where animals spent the majority of their time during migration.

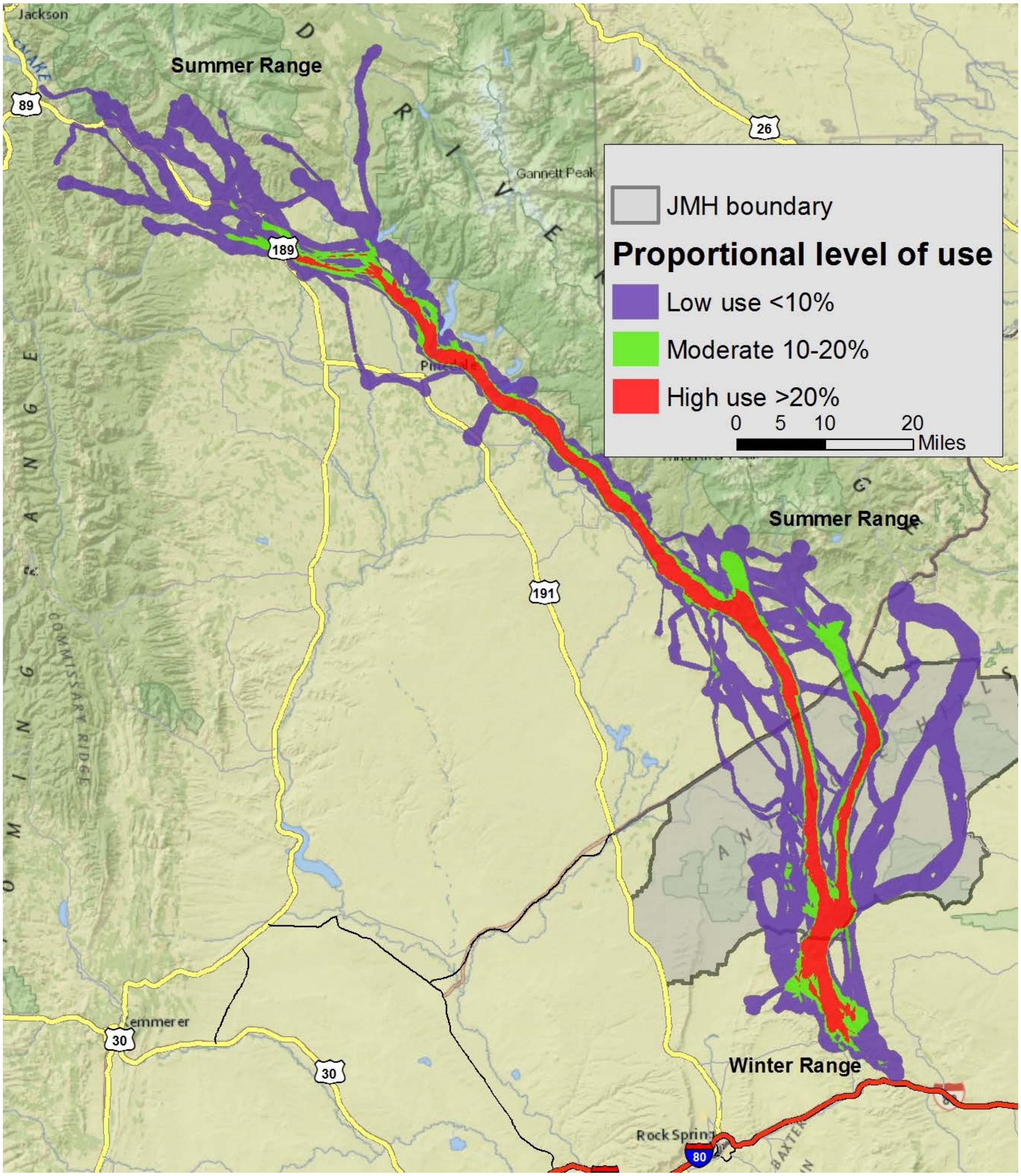

Figure 7. High, moderate, and low-use segments within the population-level migration route, estimated from routes of 34 individual deer, 2011-2013.

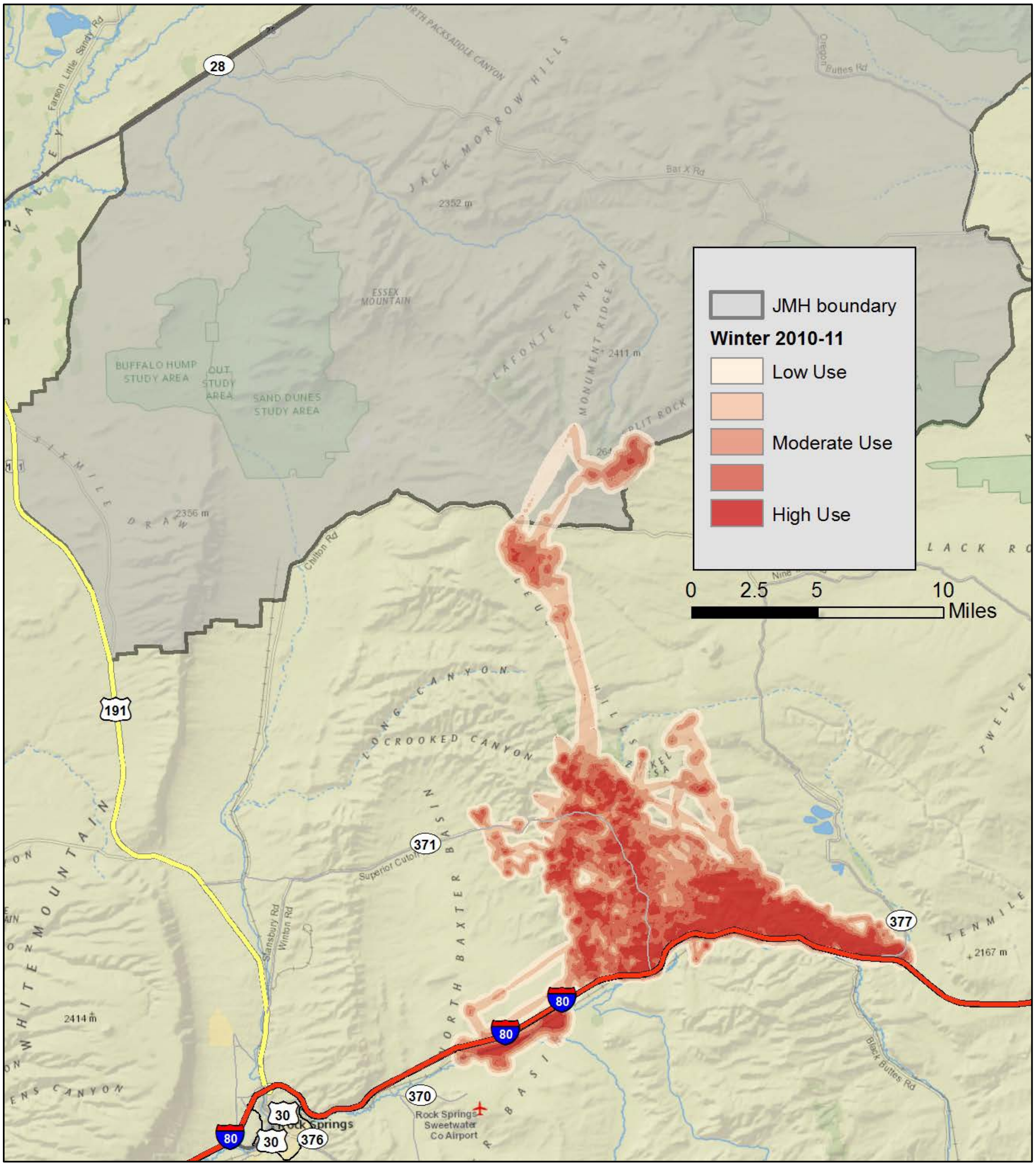

Figure 8. Winter distribution patterns estimated from 22,764 locations collected from 36 GPS-collared deer during the winter of 2010-11. The winter was unusually severe and concentrated animals along Interstate 80.

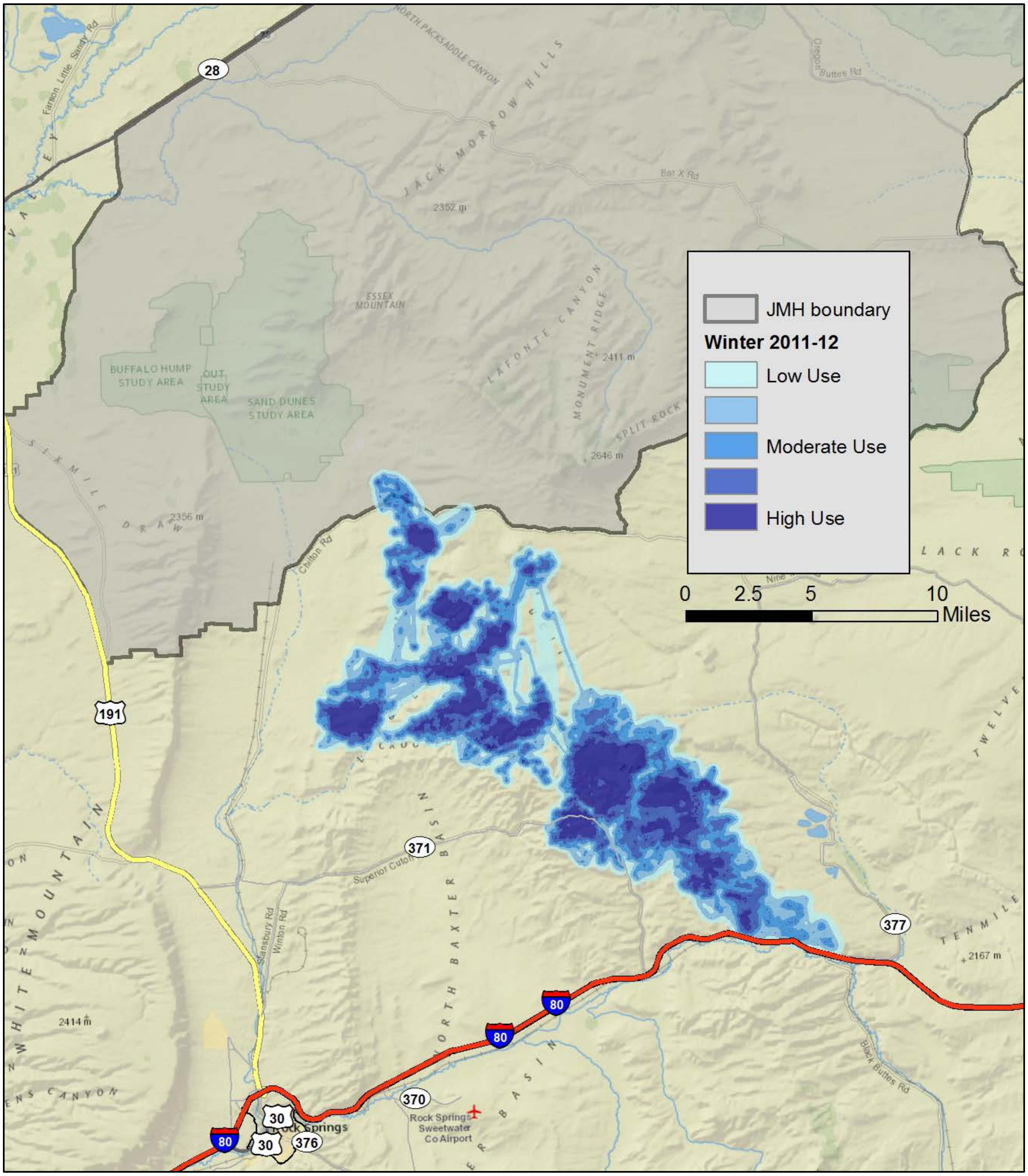

Figure 9. Winter distribution patterns estimated from 22,251 locations collected from 29 GPS-collared deer during the mild winter of 2011-12.

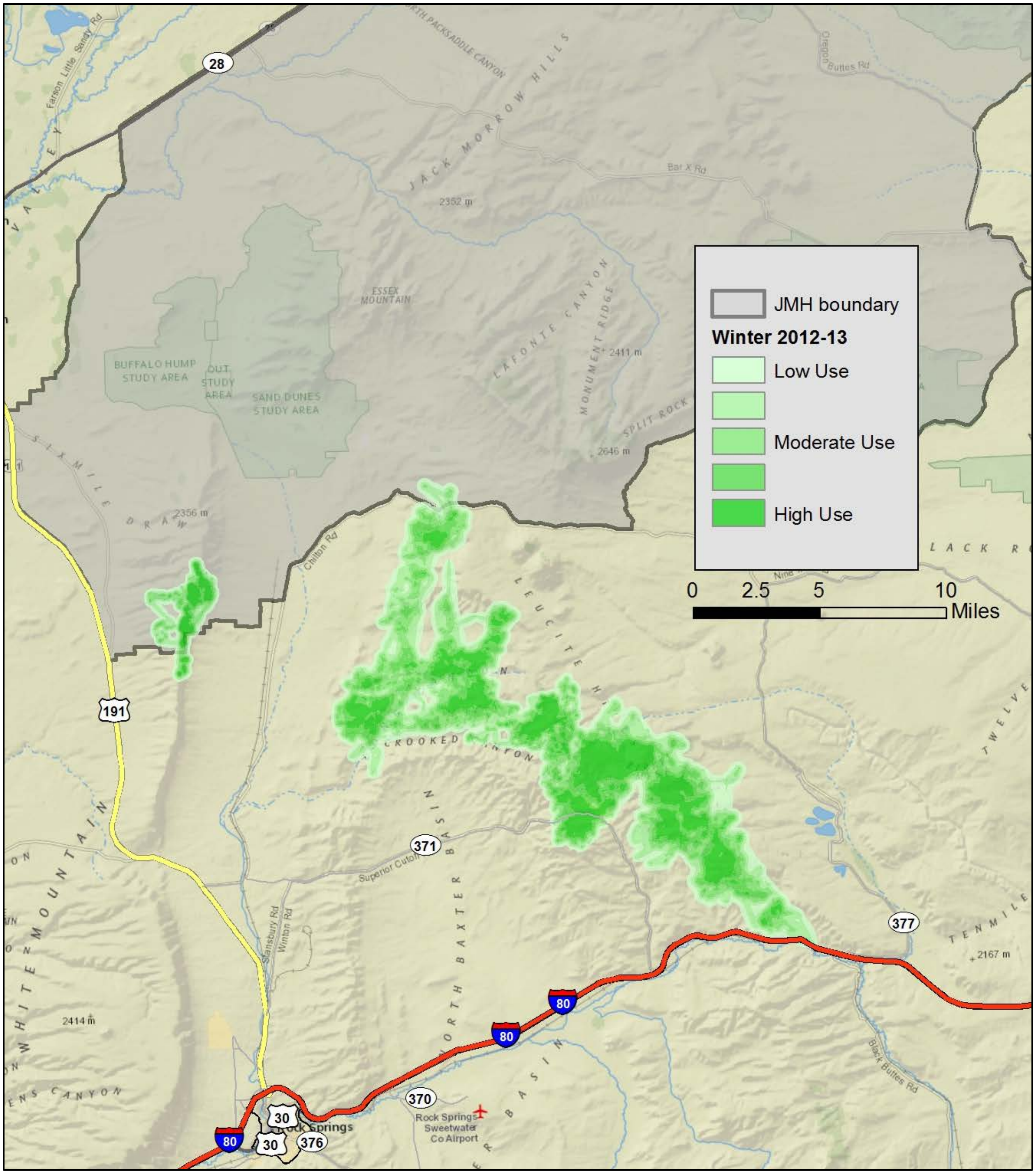

Figure 10. Winter distribution patterns estimated from 26,474 locations collected from 27 GPS-collared deer during the average winter of 2012-13.

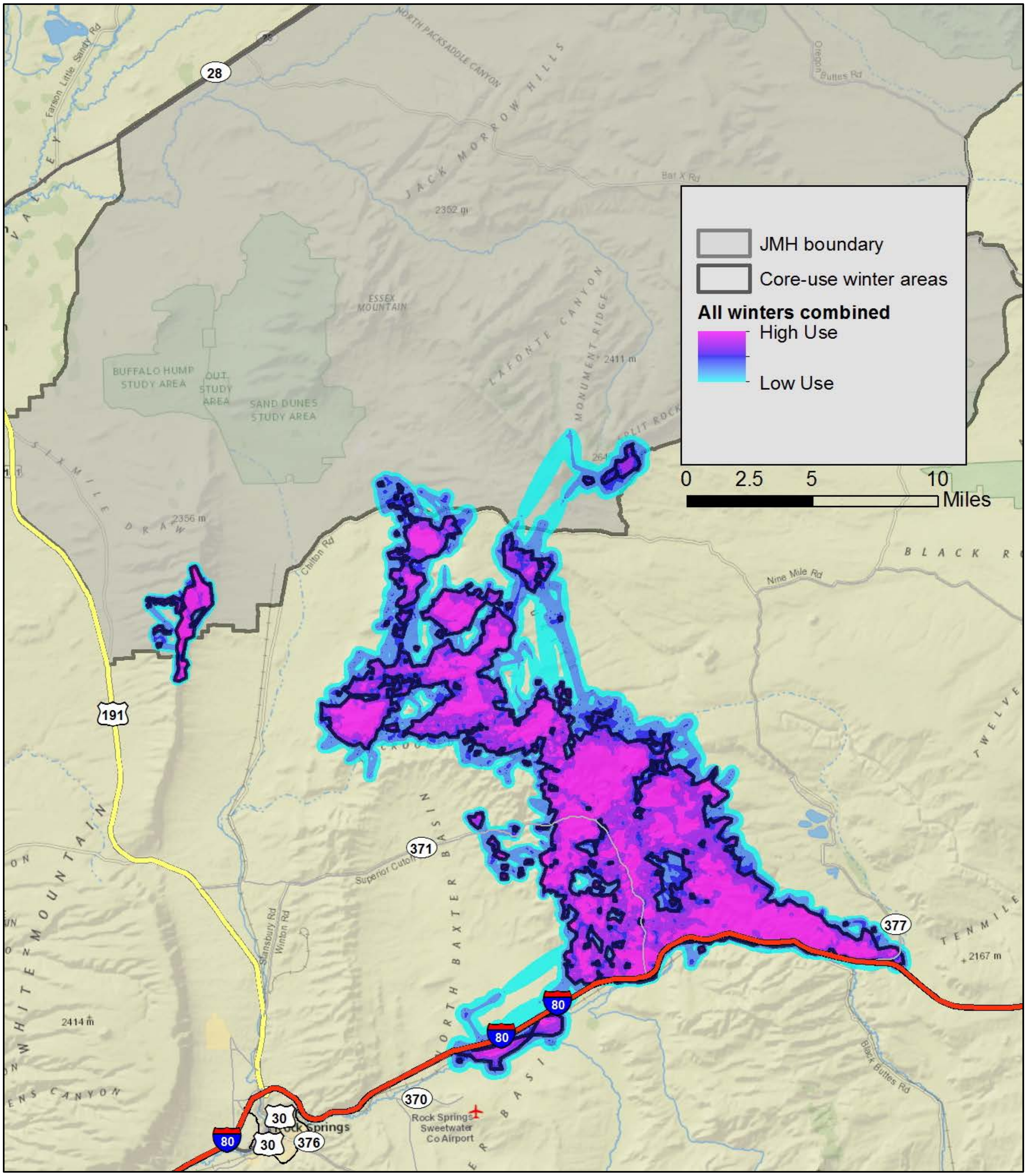

Figure 11. Winter distribution patterns estimated from 71,489 locations collected from 54 GPS-collared deer across winters 2010-11, 2011-12, and 2012-13. Core-use winter areas were defined from the top 50% of the population-level utilization distribution.

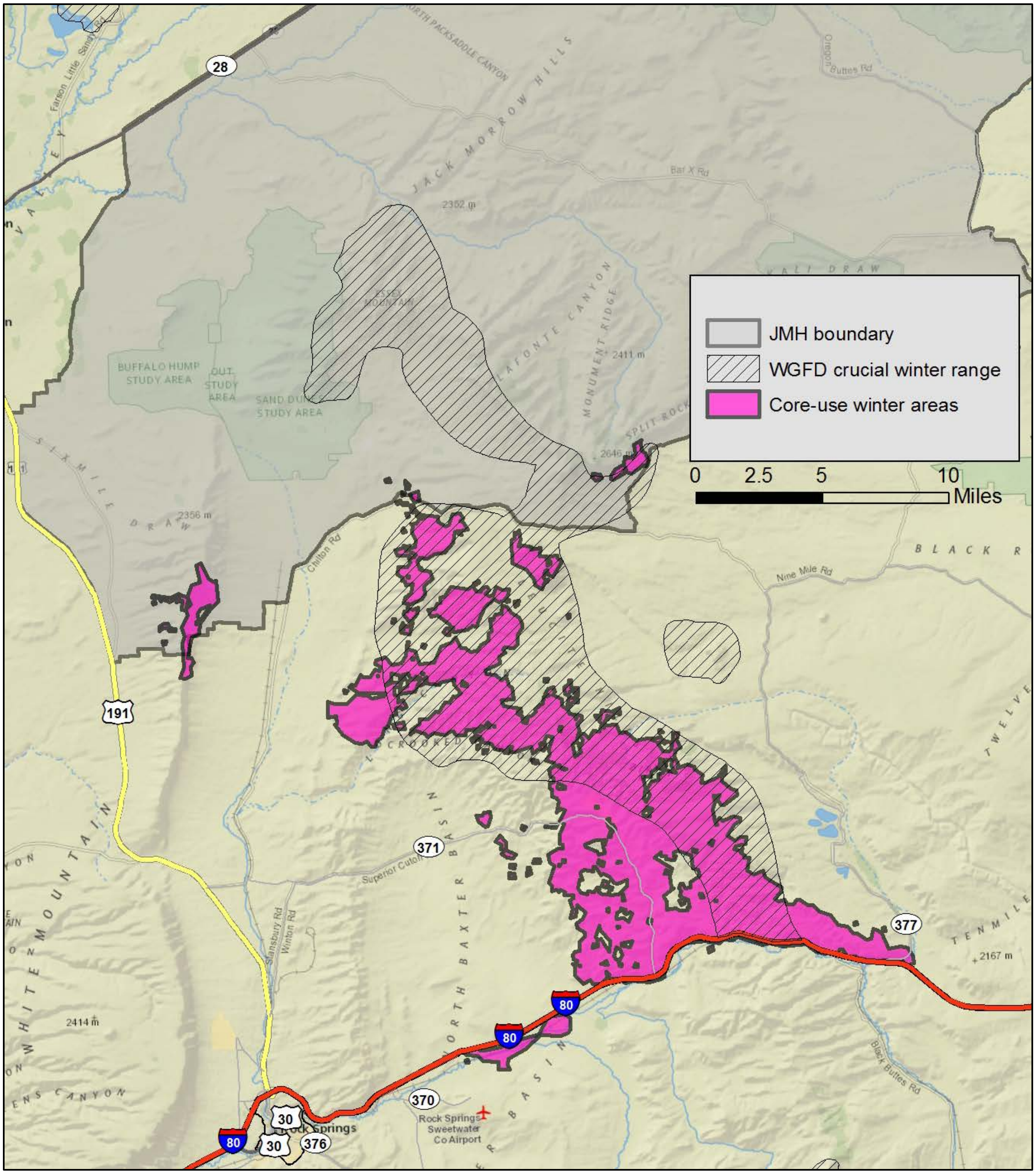

Figure 12. Crucial winter ranges designated by Wyoming Game and Fish Department (WGFD) compared with the winter core-use areas delineated from GPS data, 2011-2013.

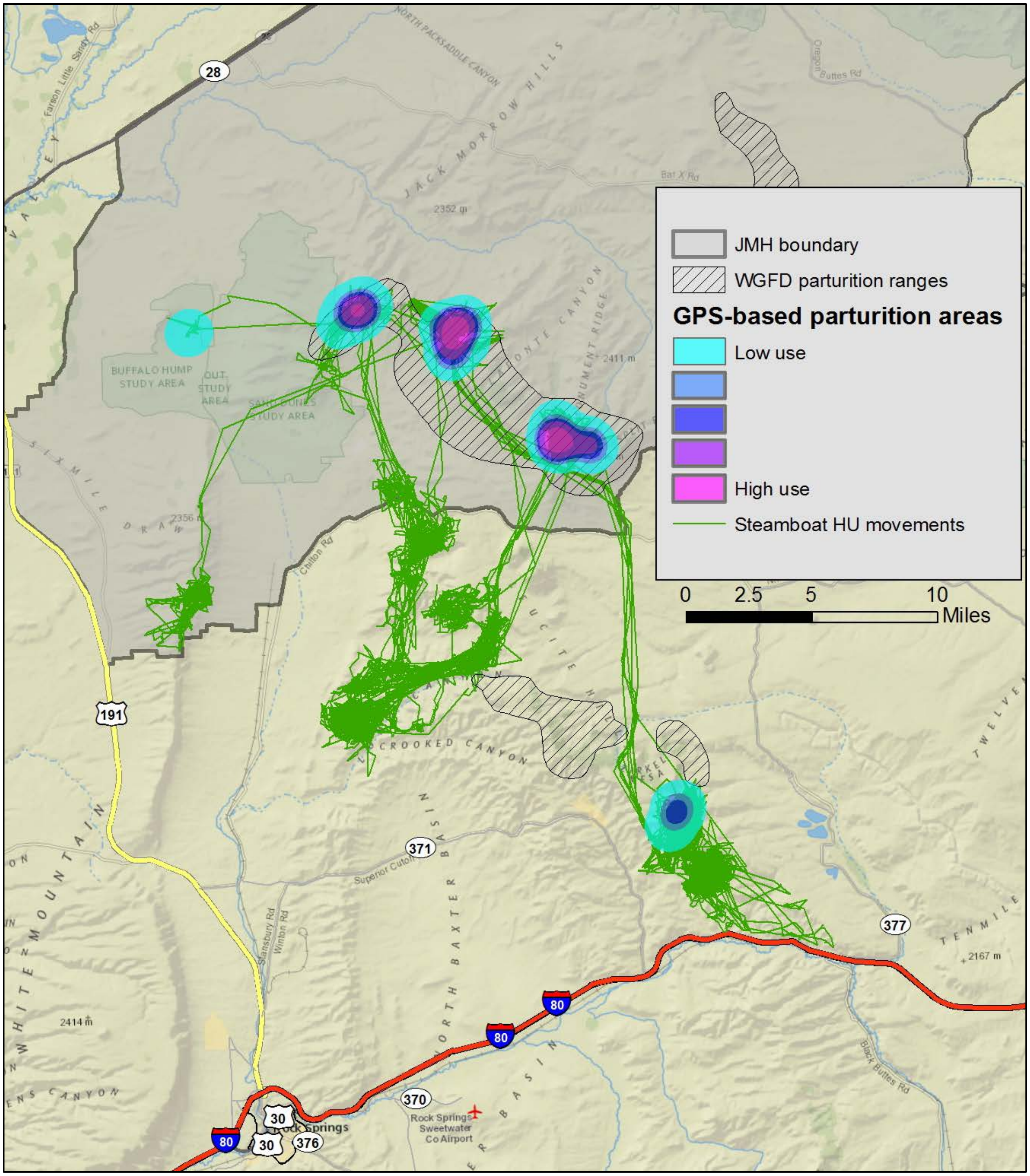

Figure 13. Parturition areas designated by Wyoming Game and Fish Department (WGFD) compared to those delineated from GPS locations (n=1,109) collected from 8 mule deer in between June 1 and 20, 2012 and 2013.

DISCUSSION

The seasonal distribution and migration patterns of mule deer in and around the Jack Morrow Hills Planning Area (JMHPA) are complex and more fluid than previously thought. Prior to this work, it was believed that most of the mule deer in the Steamboat herd unit and this part of the Red Desert were either non-migratory or only migrated short distances to other parts of the desert (e.g., Steamboat Mountain). Our GPS data indicate that only 25% of deer that winter in the Steamboat herd unit reside there year-around. The other 75% migrate 50 to 150 miles north to summer ranges in the South Wind River and Sublette herd units. Of particular interest is the population segment that migrates 150 miles to the Hoback Basin and surrounding mountain ranges (Wyoming Range, Gros Ventre Range). Additional work and analysis on this migratory segment is currently underway (Sawyer et al. 2014). This was the longest mule deer migration ever recorded and among the longest land-mammal migrations in the lower 48 states. Once they cross WY 28, these deer mix with an estimated 4,000 other deer that winter near the Prospect Mountains and all of them follow the same migration route(s) north to summer ranges in and around the Hoback Basin (see Appendix A).

Understanding where these migration routes occur, which routes are used by the most animals, and how these sub-populations interact with one another should improve the management and conservation of mule deer in western Wyoming. The population-level migration routes provide a probabilistic measure of where routes occur on the landscape and importantly, highlight those areas along the route that are used as stopover sites. Stopovers are especially important for migratory mule deer because they allow deer to track vegetation phenology (Sawyer and Kauffman 2011). Mule deer spend 95% of the migration period in stopover areas, which they revisit year after year (Sawyer and Kauffman 2011). In addition to delineating stopover sites, our migration analysis revealed the high-use routes, or those route segments used by >20% of the marked animals. High-use routes provide an intuitive approach for prioritizing routes for management and conservation efforts (Sawyer et al. 2009*a*). By recognizing that not all routes receive the same amount of use, managers can focus efforts on the relatively narrow corridors that are most heavily used by the population. In contrast to a migration route depicted by a simple line, the high-use routes have an area associated with them and are easily incorporated to planning documents (e.g., Resource Management Plans [RMP], National Environmental Policy Act [NEPA] documents) and on-the-ground management or conservation actions (Sawyer et al. 2009*a*).

The long-distance movements of deer from the JMHPA and Steamboat herd unit highlight both the complexities of managing migratory populations and importance of consolidating management efforts across jurisdictional boundaries (e.g., BLM field offices, WGFD herd units). Common to all the migration routes are the winter ranges that extend south from the JMHPA to Interstate 80. Similar to other deer populations (Garrott et al. 1987), these deer showed strong fidelity to winter range. The winter distribution of animals during the average and mild winters (2011-12 and 2012-13) was very similar. However, during the severe winter of 2010-11, deer were pushed up against the right-of-way fencing along Interstate 80 between WY 371 and Point of Rocks, and could not move any further south. This stretch of interstate is a barrier to mule deer and other ungulate movements, but there is growing interest and effort in developing wildlife crossings structures into transportation plans (Forman et al. 2003). Combined with game-proof fencing, underpasses can effectively reduce wildlife-vehicle collisions and allow migratory mule deer to safely cross roadways (Sawyer et al. 2012). Wyoming now has >15 underpasses and 2 overpasses designed specifically ungulates, but all are on 2-lane highways (US 30, US 189/US 191). Construction of such structures in 4-lane interstate systems is possible, but more costly.

The core-use winter ranges were clearly defined from GPS data, but approximately half did not overlap with current crucial winter range designation. The core-use winter ranges identified in this study may help agencies update or modify current seasonal range designations to better reflect deer distribution.

A decade ago the BLM led a successful effort to document the seasonal distribution and migration patterns of elk in the JMHPA (Sawyer and Nielson 2005, Sawyer et al. 2007). With this study complete, the same information is now available for mule deer. Unlike the elk that reside in the desert year-around, most of the mule deer that winter in the desert migrate to summer ranges 50 to 150 miles away. This type of long-distance migration makes mule deer management inherently more difficult, but the detailed spatially-explicit data for winter ranges, parturition areas, and migration routes provide key components for the long-term management and conservation of mule deer in the region. A similar pronghorn study is currently underway and will be completed by 2016.

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Seasonal distribution of GPS-collared mule deer in southern part of Sublette herd unit:

As part of the Sublette Mule Deer Study, Sawyer et al. (2009*b*) collected 90,710 GPS locations from 41 individual deer between 1999 and 2009. All these deer were captured on winter ranges near Big Sandy, Prospect Mountains, and Elk Mountain. During that time, only 2 animals moved south into Steamboat herd unit (#246, #262) and that was only for a brief time during the harsh winter of 2005-06 (Fig. A-1). None of these deer were ever documented moving into South Wind River herd unit. Most of these deer winter near Buckskin Crossing, south to Elk Mountain and Prospect Mountains. Several years of helicopter survey indicate approximately 4,000 mule deer winter in this region. All 41 deer marked in this area migrated north along the western base of the Wind River Range, and northwest across the upper Green River Basin to summer ranges surrounding the Hoback Basin (Fig. A-1).

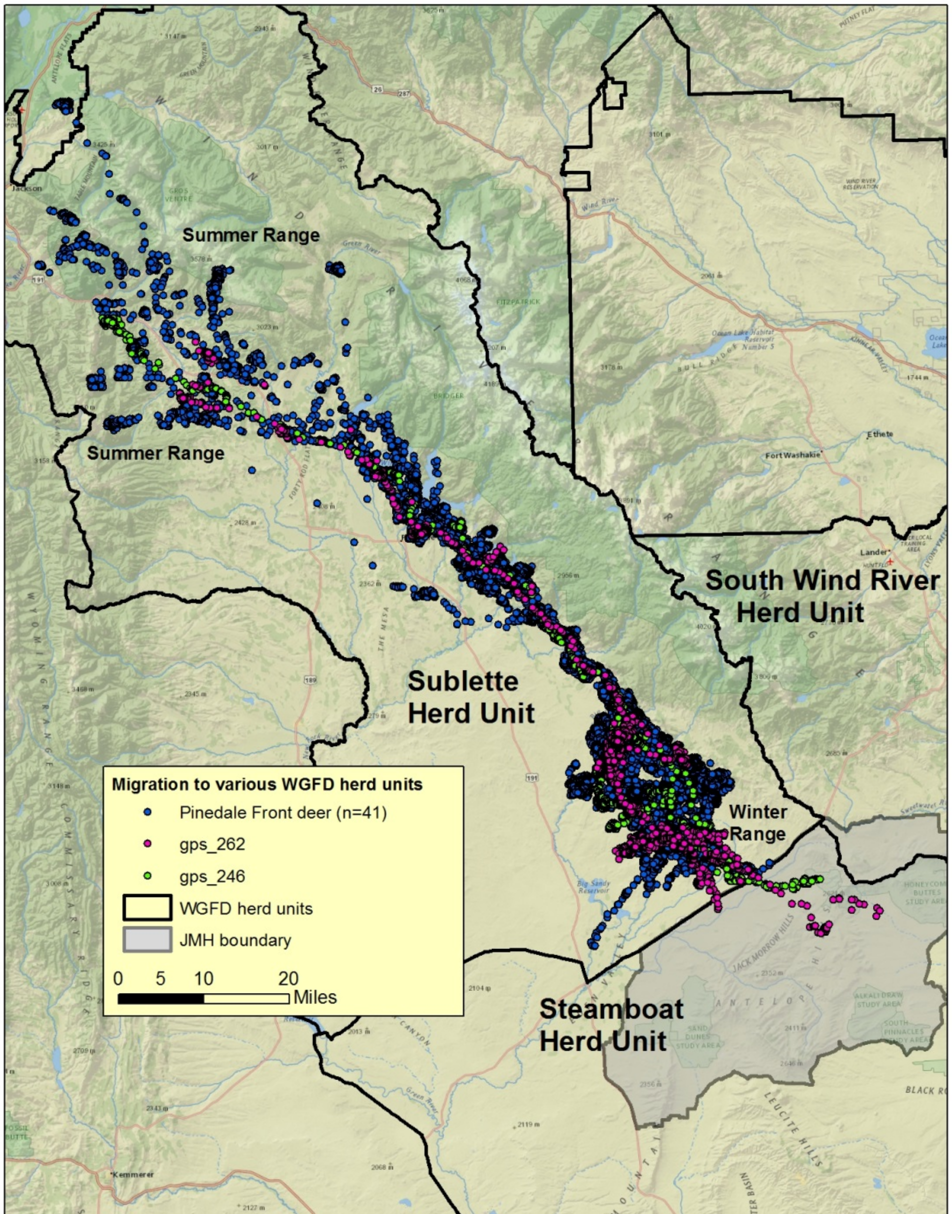

Figure A-1. GPS locations (*n*=90,710) collected from 41 mule deer captured in the southern part of the Sublette herd unit, 1999-2009. Only two deer ever moved south into Steamboat herd unit.