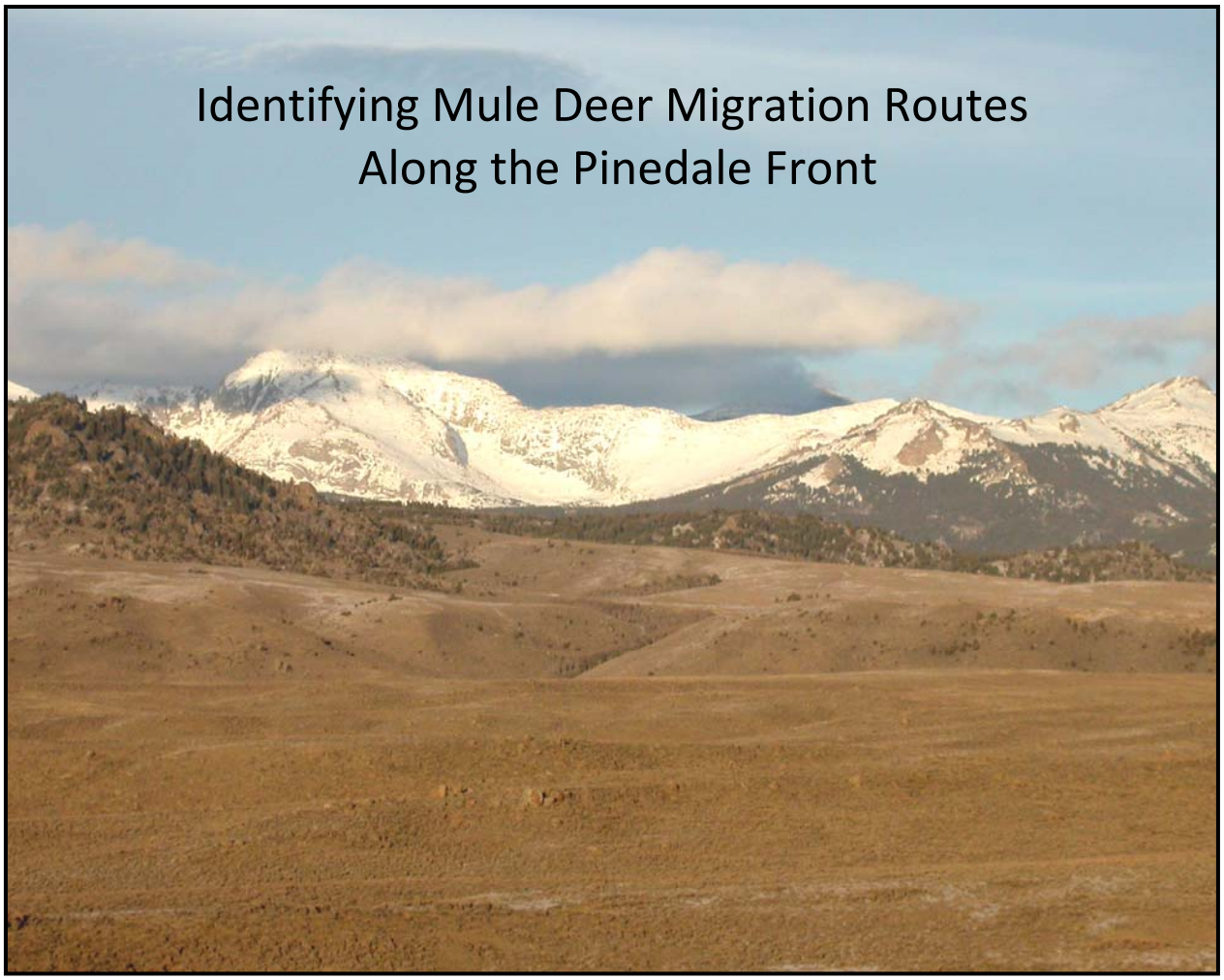
Identifying Mule Deer Migration Routes Along the Pinedale Front



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Overview:

There are an estimated 28,000 mule deer in the upper Green River Basin (i.e., Sublette Herd, Wyoming Game and Fish Department [WGFD] 2006), most of which annually migrate 40 to 100 miles to summer in portions of 5 mountain ranges (Sawyer et al. 2005). Accordingly, successful management of this deer herd will require that functional migration routes remain intact. Given the increased levels of both energy (Bureau of Land Management [BLM] 2005) and housing (Taylor and Lieske 2002) development in Sublette County, identifying and conserving migration routes has become increasingly important. Currently, migration routes are depicted by simply connecting the dots between locations of marked animals (e.g., Sawyer et al. 2005, Berger et al. 2006, White et al. 2007). However, because a line has no area associated with it (i.e., is it 10 feet or 1 mile wide?), the management value of this approach is limited and can be especially difficult to incorporate into planning documents (e.g., National Environmental Policy Act, Resource Management Plans, etc.) or on-the-ground management prescriptions (e.g., water development, prescribed burns, sagebrush treatments). Further, without specific knowledge of the relative amounts of use (high, medium, low) migration routes receive, it is difficult to prioritize specific segments for conservation or enhancement.

The purpose of this project was to use existing GPS data collected from radio-collared mule deer to estimate the utilization distributions (UD) of migration route(s) originating from the Pinedale Front Winter Range, located along the southwest base of the Wind River Range. The UD provides information on both the width of migration route(s) and intensity of use across the route(s). Having the ability to estimate the width and relative amounts of use migration routes receive should assist agencies, industry, and non-government organizations (NGO) with incorporating them into land-use planning and to identify specific segments for habitat improvement. This science-based tool was also intended to compliment and improve on-the-ground enhancement projects aimed at benefiting mule deer migration by ensuring that they are implemented in appropriate areas. On-the-ground habitat manipulations are becoming more common in the region because of funding opportunities available through the Wildlife and Natural Resource Trust (http://wwnrt.state.wy.us/) and the Jonah Interagency Mitigation and Reclamation Office (http://www.wy.blm.gov/jonah_office/). Accordingly, there is a need to

identify areas where management prescriptions may be most beneficial to wildlife and provide effective off-site mitigation. Additionally, the methods developed for this project may be used with other GPS data sets across the state to identify migration routes of other species, especially those threatened by energy or housing development (e.g., Sawyer and Kauffman 2008).

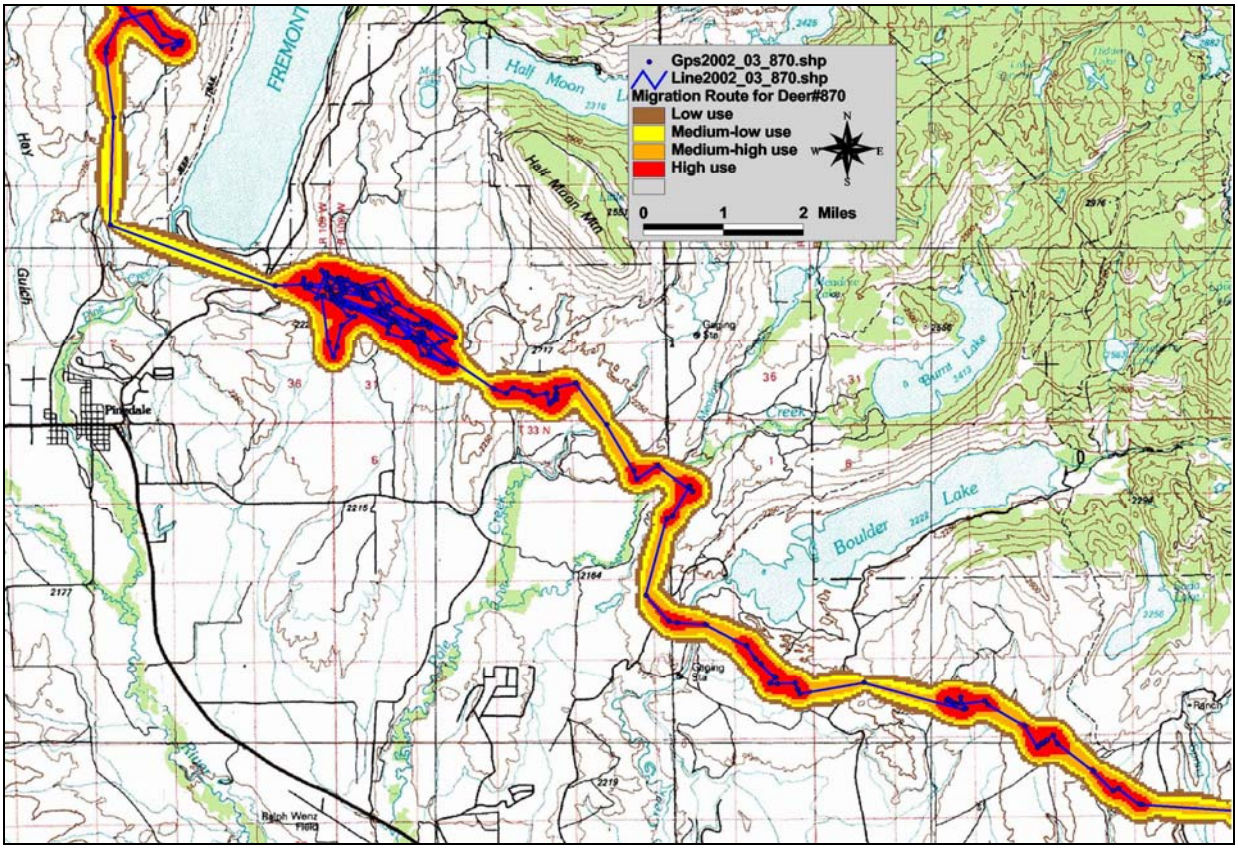

Figure 1. Example of a utilization distribution (UD) estimated for an individual migration route. The UD provides information on both the width and relative amounts of use across the route, whereas a typical migration route line (blue) has no area associated with it.

Project Area

The project area begins approximately 15 miles northeast of Farson and extends 40 miles north to Pinedale and Fremont Lake (Figure 2). The project area overlaps with priority sagebrush (Figure 3) and mountain shrub habitats identified in the Strategic Habitat Plan developed by the WGFD (2001) and contains areas designated as crucial mule deer winter range (Figure 4). The general project area includes approximately 210,000 acres, of which 65% is administered by the BLM, 20% Private, 9% State, 3% WGFD, and 2% USFS (Figure 5).

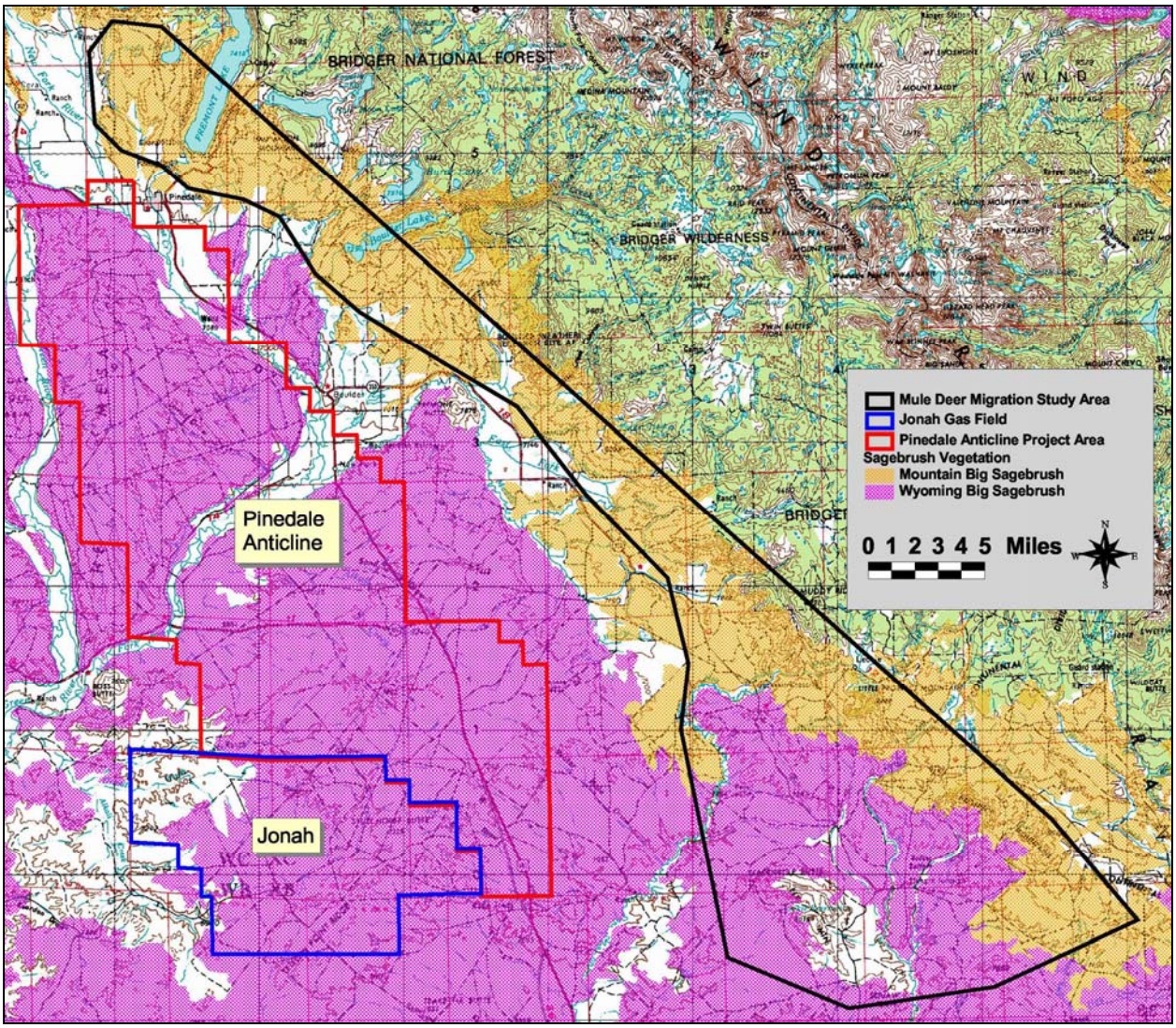

Figure 2. Location of project area and sagebrush habitats in the Upper Green River Basin.

Figure 3. Typical sagebrush habitat in the project area.

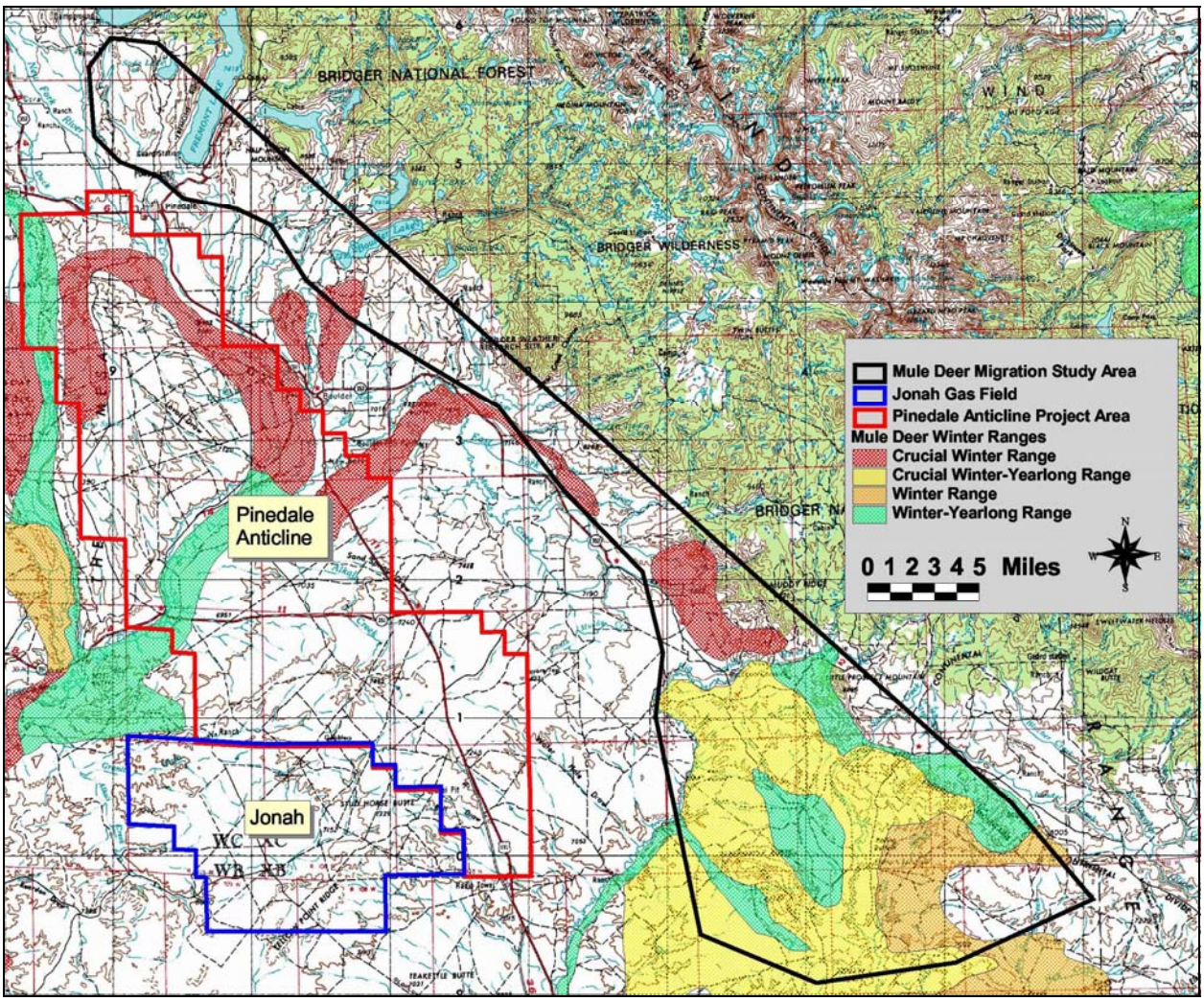

Figure 4. Location of designated mule deer winter ranges in the general project area.

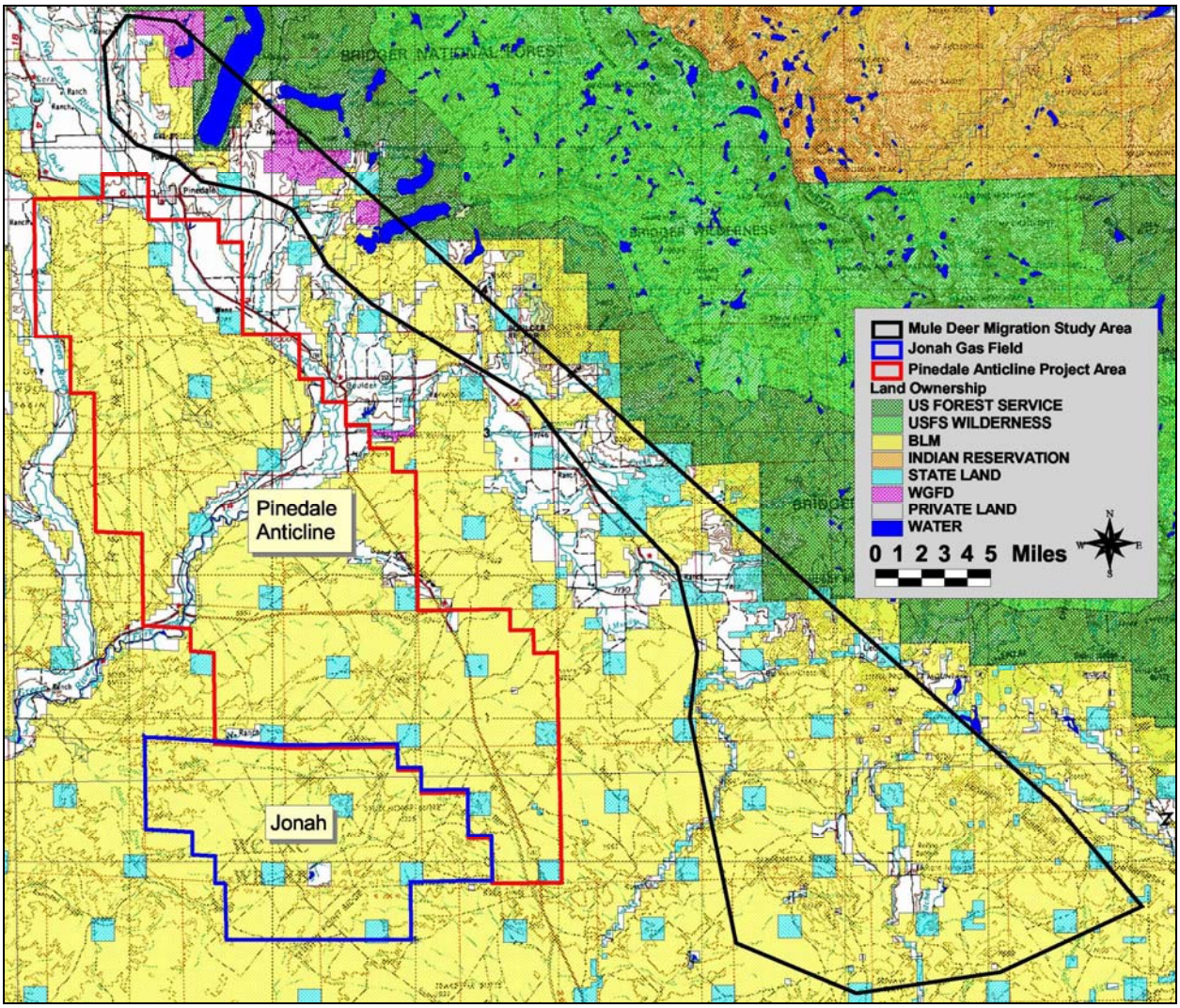

Figure 5. Land ownership across the general project area.

Methods

We used existing GPS data collected from 24 radio-collared mule deer between 2003 and 2007 to estimate the UDs of migration routes originating from the Pinedale Front Winter Range Complex. A UD refers to the relative frequency or probability of an animal's location over time (Worton 1987). In the case of migration routes, a UD provides a probabilistic measure of where mule deer migrations occurred. A portion of our GPS-collars were deployed for 1 year, while others were functioning for a full 2 years. Depending on how long the GPS-collar was deployed, an individual deer collected data for one or more spring and fall migrations (Table 1). We documented 40 migrations for the 24 radio-collared mule deer, including 28 spring and 12 fall migrations (Table 1).

We used a Brownian Bridge Motion Model (BBMM; Horne et al. 2007) to estimate UDs for migration routes of individual deer (n=24), using the sequence of GPS locations that occurred between the Big Sandy River and Fremont Lake. Areas south of the Big Sandy River were not included because it was considered winter range. Areas north of Fremont Lake were not included because we did not have enough data to analyze beyond that point. The BBMM uses the time elapsed between locations and the rate of movement to estimate the probability of occurrence between successive locations (Horne et al. 2007). All of our mule deer locations were collected at 2-hr intervals, but depending on the rate of movement, the predicted width of the migration route varied (Figure 1). Probabilities were calculated for every 50 x 50m cell in the study area. Because mule deer demonstrated a high fidelity to their migration routes across seasons and years, we combined individual UDs to generate a population-level UD or migration route. We color-coded the probability values into 25% quartiles and classified the top 25% as high use and the lowest 25% were as low use. The width of the UD corresponds to a 99% contour interval. The population-level migration route was generated as a grid theme in ArcView to provide easy digital access for agencies and others who want to access this information to indentify priority conservation areas.

Table 1. Utilization distributions (UD) were estimated for 40 migrations (28 spring, 12 fall) collected from 24 radio-collared mule deer. The number of migrations collected for each mule deer ranged from 1 to 3.

DEER ID	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Spring 2005	Fall 2005	Spring 2006	Fall 2006	Spring 2007
gps0203_871a	X	X	X						
gps0203_870	X								
gps0203_873a	X	X	X						
gps0203_867	X								
gps0203_855	X								
gps0203_844	X								
gps0203_874		X							
gps0304_876			X						
gps0304_870a			X	X	X				
gps0304_867a			X	X	X				
gps0304_864a			X	X	X				
gps0304_861			X						
gps0405_878a					X	X			
gps0405_877a						X			
gps0405_872					X				
gps0405_869					X				
gps0405_861					X				
gps0405_860					X				
gps0506_869a								X	
gps0506_867a									X
gps0506_866a							X	X	X
gps0506_862a							X	X	X
gps0506_861a									X
gps0506_860a							X	X	

Results

We calculated a UD for the population-level migration route of mule deer that winter in the Pinedale Front Winter Range (Figures 6 and 7). The UD included 40 migrations from the 24 radio-collared mule deer (Table 1). The UD represents a probabilistic measure of where both spring and fall migrations occurred during 2003 through 2007, although the fall migrations (n=12) were not represented as well as the spring (n=28). In Figures 6 and 7, the red and orange coloring represent areas with the highest probability of use, while yellow and brown represent areas with lowest probability of use. Importantly, higher-use areas (red and orange) corresponded to areas where rates of movement were slow, whereas lower-use areas (yellow and brown) corresponded to areas with high rates of movement. Two segments of the

migration route had unusually high movement rates, where deer spent little time. These segments included the area around Muddy Creek and the area between Silver and Scab Creek, where a pronounced split in the route occurred.

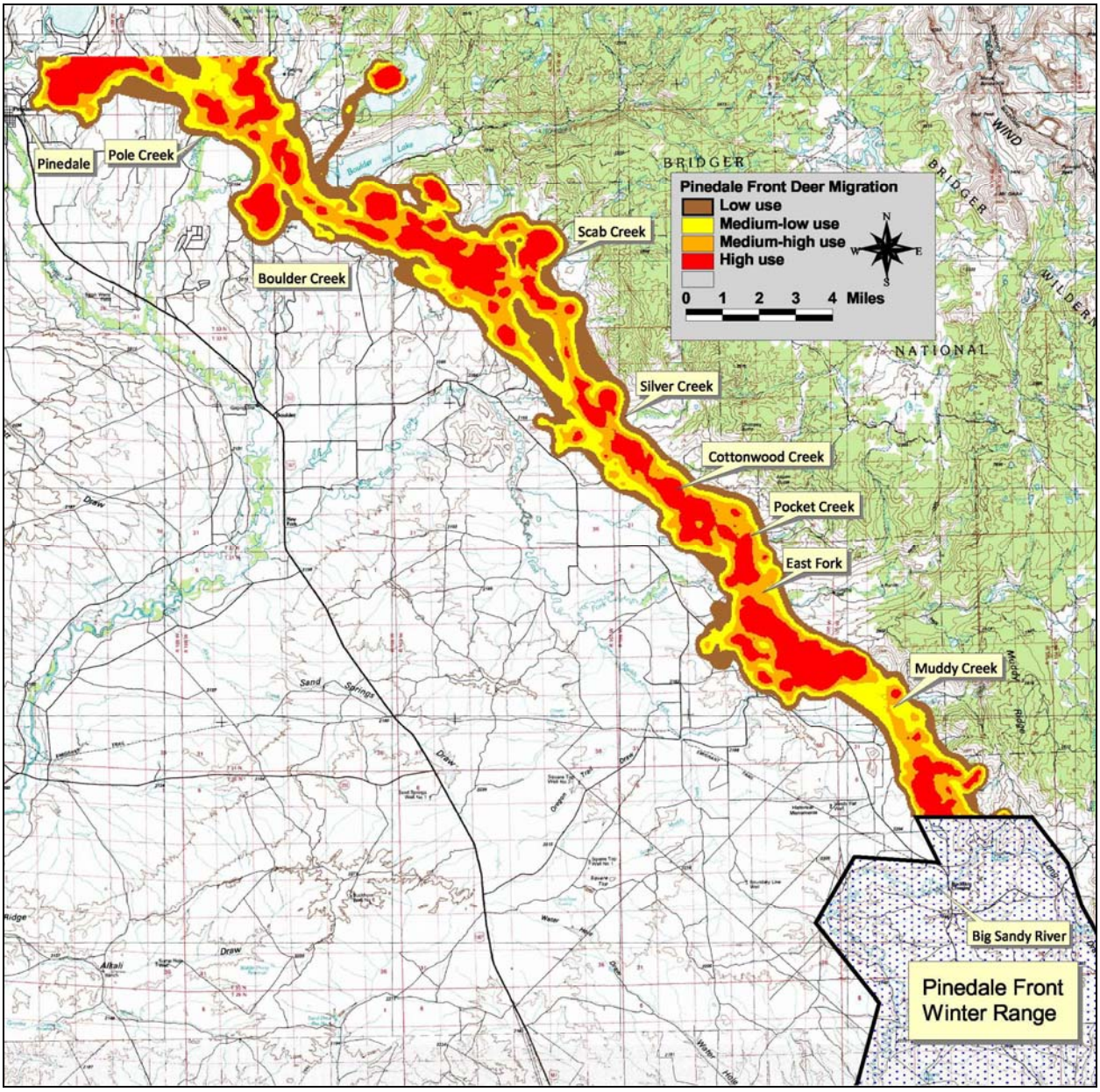

Figure 6. Utilization distribution (UD) of population-level migration route from the Pinedale Front Winter Range to Fremont Lake, based on 40 migrations collected from 24 radio-collared mule deer, 2003-2007. Background is 1:100,000 topo map.

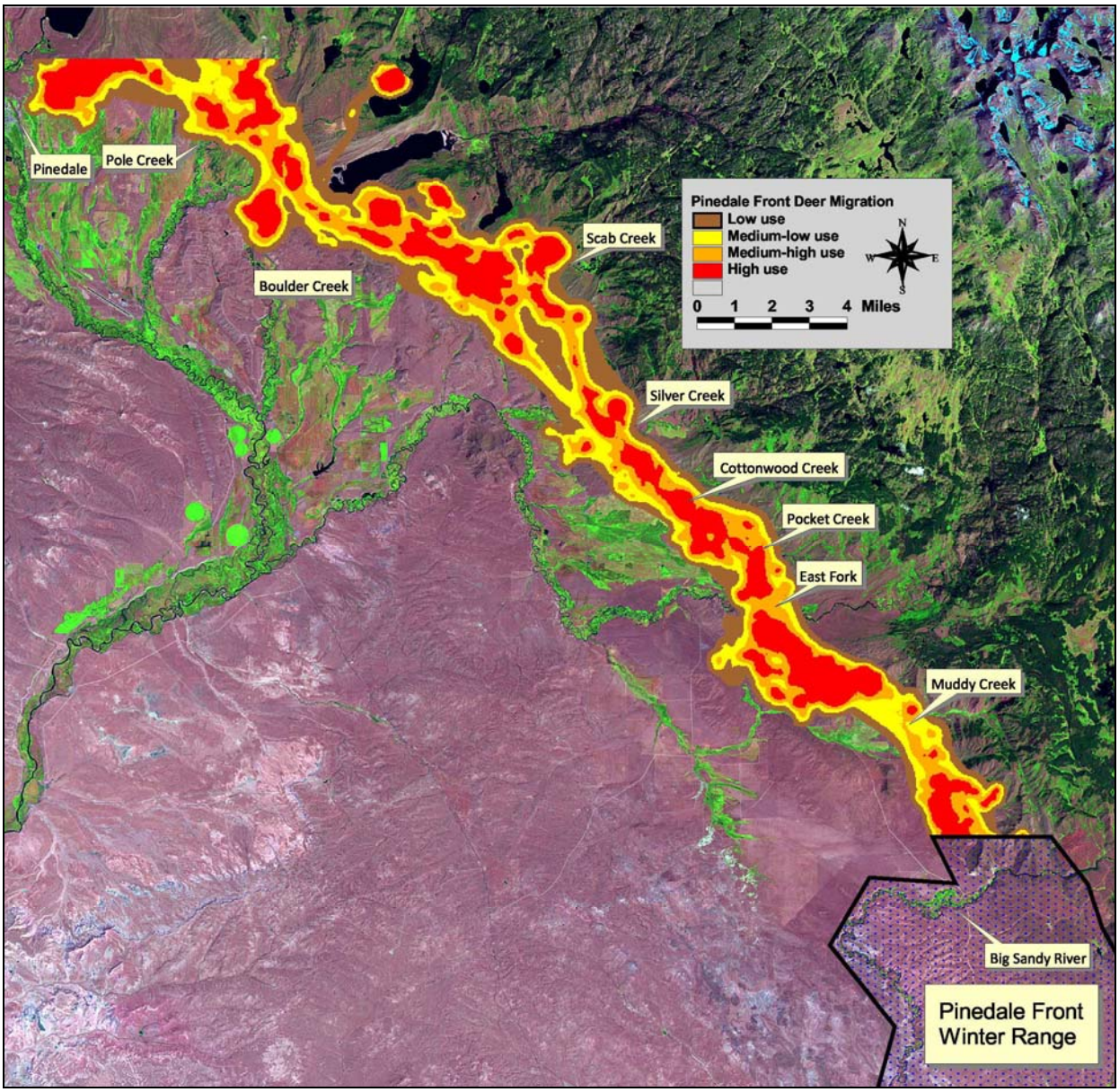

Figure 7. Utilization distribution (UD) of population-level migration route from the Pinedale Front Winter Range to Fremont Lake, based on 40 migrations collected from 24 radio-collared mule deer, 2003-2007. Background is satellite image taken in 1999.

Discussion and Management Implications

This project provides an objective and empirically-based delineation of the population-level migration route used by a large segment of mule deer in the upper Green River Basin. When relative amounts of migration route use are mapped, as in Figures 6 and 7, the natural tendency is to interpret high-use areas as the most biologically important and low-use areas as

the least important. While this interpretation is generally correct, it is important to recognize that high-use areas reflect habitats where deer moved slowly (e.g., foraging, resting) and low-use areas reflect habitats where deer moved quickly. Thus, we assume that high-use areas provide key foraging and resting habitat, while lower-use areas provide movement corridors and connectivity between high-use areas. High-use areas were typically connected by medium-high (orange) and medium-low (yellow) use areas, providing the necessary connectivity to ensure mule deer can move between winter and summer ranges.

From a management perspective, distinguishing between high and low use areas across a population-level migration route may be useful for planning, prioritizing land-use decisions, and identifying where on-the-ground habitat enhancements should occur. For example, given that high-use areas provide foraging and resting habitat along the migration route, management strategies may focus on maintaining healthy sagebrush habitats in these areas, while minimizing human disturbance (e.g., road construction) and habitat loss. Or, in a scenario where limited funds are available for a conservation easement, the high-use segments would take priority over the low-use. In contrast to the high-use areas, the low-use areas appear to function as simple movement corridors, rather than major foraging or resting areas. However, given that mule deer use these areas considerably less, they may have the most potential for improvement. For example, why do mule deer move quickly through the Muddy Creek region? And why does the migration route split into 2 distinct routes between Silver and Scab Creek? Is there potential to improve these areas for mule deer migration by habitat enhancement, fencing modification, or some other management prescription? Figures 6 and 7 provide a valuable tool for not only identifying where mule deer migrations occur, but also what segments of the migration route may require, and benefit from, the most attention.

Another important management consideration is that mule deer migration routes tend to become less distinct as distance from winter range increases (Thomas and Irby 1990, Sawyer and Kauffman 2008). A recent analysis conducted in south-central Wyoming illustrates that common and intensively-used migration routes splinter into multiple, less distinct routes, as mule deer move further from winter range (Sawyer and Kauffman 2008). A useful analogy for this pattern is to think of the population-level migration routes as a road system, where the

heavily-used routes close to winter range are analogous to interstates. As distance from winter range increases, those interstates turn into highways that receive less deer use (traffic) and eventually county roads with even lower levels of use. Accordingly, the migratory segments most important to the mule deer population occur along the interstates (close to winter range), because those are the regions that receive the highest levels of use from the most number of deer. The mule deer in this study migrated 50 – 100 miles between seasonal ranges, but we were only able to precisely document 32 miles of the migration route. Had we documented the entire length of the migration routes, we would have seen the population-level route splinter into multiple routes with lower levels of deer use, as distance from winter range increased. It is important to recognize that the 32-mile segment in this study represents a common, high-use route analogous to an interstate, and as such, conservation of this segment should be a top priority for managers. Because mule deer from this winter range migrate to 5 different mountain ranges (i.e., Wind River Range, Wyoming Range, Salt River Range, Snake River Range, and Gros Ventre Range), the benefits of conserving this relatively small migration route will indirectly affect a much larger area. And because the migration route occurs almost exclusively in sagebrush habitats, any subsequent conservation or enhancements efforts directed to the migration route will benefit other sagebrush-dependent species, such as sage grouse and pronghorn.

Delineating accurate boundaries of population-level migration route should improve the ability of agencies, like the Jonah Interagency Office (JIO) to meet their stated objectives that include "*Maintaining migration corridors sufficient to allow the unimpeded seasonal movements of migratory wildlife*." Maps and data from this project will be made available in digital (GIS) format to the WGFD, the BLM, the JIO, the Nature Conservancy, and the Wyoming Wildlife and Natural Resource Trust. We encourage conservation easements and habitat improvements aimed at benefiting migratory mule deer on the east side of the upper Green River Basin be targeted within the region delineated in Figures 6 and 7. We recommend future research efforts 1) identify migration routes to and from other winter ranges that support large numbers of ungulates, and 2) determine the habitat characteristics (e.g., shrub characteristics,

slope, aspect, etc.) of high-use and low-use areas, such that managers can determine how best to mitigate migratory segments when or if they are impacted by development.

We recognize that most WWNRT and JIO funding is allocated to on-the-ground habitat manipulation or conservation easement projects, and we understand the importance of implementing these types of direct conservation efforts. However, in order for habitat improvements, conservation easements, or off-site mitigation to benefit migratory species whose ranges extend 50 – 100 miles, we must have the ability to identify where site-specific improvements should occur. We hope this project provides the necessary tool to identify and prioritize those areas along the Pinedale Front that are most important for sustaining migration routes of mule deer in the upper Green River Basin.

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