

The Red Desert to Hoback

MULE DEER MIGRATION ASSESSMENT

HALL SAWYER
MATTHEW HAYES
BILL RUDD
MATTHEW KAUFFMAN



UNIVERSITY OF WYOMING

Spring is not yet here, but one can feel winter loosening its grip on Wyoming. Soon the snow will melt and the mountains will turn a vibrant green, flush with grasses and forbs. And soon, Wyoming's iconic ungulates will leave their low-elevation winter ranges and head up to the mountains, knowing they will find abundant forage there. Elk near Cody will travel west into Yellowstone; some of them mingling with moose arriving from as far south as Jackson. Near Dubois, bighorn sheep will start to follow the receding snow into the craggy peaks of the northern Winds. Down on the sagebrush steppe south of Pinedale, pronghorn and mule deer will begin their migrations toward the Wyoming Range, the Gros Ventre Range, and Grand Teton National Park. Throughout the state, the arrival of spring will set Wyoming's ungulate herds in motion once again. These long-distance movements are not only spectacular; they also allow our herds to exist in such high numbers.

The more we learn, the more these animals surprise us. Recently, wildlife researcher Hall Sawyer worked with the BLM to collar what they thought was a resident herd of mule deer living near Rock Springs. Remarkably, they discovered that those deer undertake the longest migration ever recorded in the Lower 48, connecting the sagebrush steppe of the Red Desert with the mountain meadows of the Hoback Basin. This report is an assessment of their remarkable journey and the obstacles these deer encounter along the way. We hope that our evaluation of this route will provide information to agencies, landowners, industry, and conservation groups interested in assuring the long-term viability of this unique migration.

This work is part of the new Wyoming Migration Initiative (WMI; migrationinitiative.org), which we initiated in 2012. Ungulate migrations require vast, wide open landscapes, and they are part of what makes Wyoming one of the few, truly wild places in the West. Wyomingites recognize this, and it was that broad public interest that prompted us to build the WMI. Our aim is to make research about Wyoming's ungulate migrations more accessible – and more useful – to people working to manage and conserve these herds and their habitats. The long-term goal of the WMI is to bring scientific information to managers and the public through new types of outreach. We are compiling an *Atlas of Wildlife Migration* that tells the stories of all of Wyoming's ungulate migrations, and we are building an online database to make migration data widely available. This report represents the first contribution of the WMI toward better understanding Wyoming's migratory ungulates. There is much more we hope to do with the support of partners across Wyoming.

Matthew J. Kauffman
Director, Wyoming Migration Initiative
Laramie, Wyoming
March 8th, 2014

BLM	Bureau of Land Management	SRMA	Special Recreation Management Area
BTNF	Bridger Teton National Forest	WSA	Wilderness Study Area
WGFD	Wyoming Game and Fish Department	WSR	Wild and Scenic River
WYDOT	Wyoming Department of Transportation	ACEC	Area of Critical Environmental Concern
USFS	United States Forest Service	CE	Conservation Easement
RMP	Resource Management Plan	RDH	Red Desert to Hoback
FLPMA	Federal Land Policy and Management Act	WY #	Wyoming State Highway
OSLI	Office of State Lands and Investments	US #	United States Highway
NSO	No Surface Occupancy	CR #	County Road
SMA	Special Management Area	FS #	Forest Service Road

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OTHER CONTRIBUTORS:

Photos by Joe Riis
Cartography by James Meacham, Alethea Steingisser, Lauren Tierney and Emily Nyholm, at the InfoGraphics Lab, Department of Geography, University of Oregon
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Front Cover Photo: Mule deer buck migrating south near Boulder Lake



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A mule deer buck pauses along the migration route at sunset.

Introduction

Migration is a common behavioral strategy used by all major animal groups, including insects, fish, reptiles, amphibians, birds, and mammals¹. Among the ungulates, or hooved-mammals, migration allows animals to access seasonal peaks in food availability and can reduce the risk of predation². Ungulates generally migrate along moisture gradients, where they track the vegetation green-up and take advantage of

young, nutritious plants^{3,4}. The increased foraging opportunities provided by migration allow animals to accumulate fat over the growing season, which in turn improves their reproductive capacity. Although some ungulates do not migrate and may even reside in semi-urban areas like backyards, parks, golf courses, or agricultural fields, migratory ungulates far outnumber their non-migratory counterparts worldwide⁵. In Wyoming,

collar studies that track the detailed movements of animals suggest that more than 90% of ungulates (including mule deer, elk, pronghorn, moose, bighorn sheep, mountain goat, bison, and white-tailed deer) are migratory.

Western Wyoming in particular, supports some of the largest and most diverse ungulate populations in North America⁶. The performance of these herds is largely dependent on their ability to seasonally migrate from low-elevation winter ranges to high-elevation summer ranges, where they convert abundant forage to fat reserves necessary to survive the long Wyoming winters. Landscapes of western Wyoming, including the southern Greater Yellowstone Ecosystem (GYE), are relatively undisturbed, allowing many migration routes there to remain intact. This is illustrated by the well-documented Path of the Pronghorn – a 100-mile route that pronghorn follow from the upper Green River Basin to Grand Teton National Park^{6,7}.

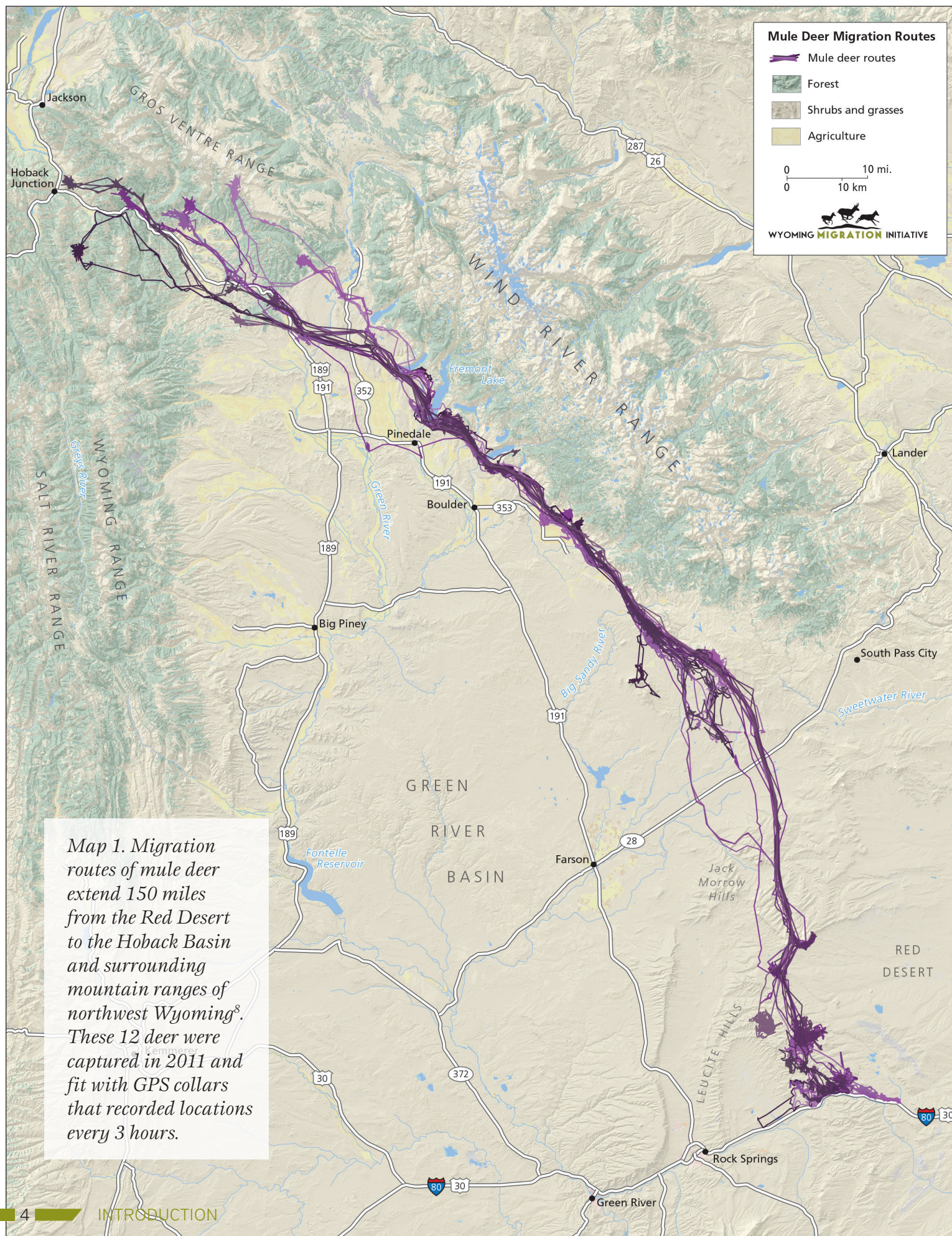
The longest ungulate migration ever recorded in the lower 48 states was recently discovered in western Wyoming. Here, mule deer travel a one-way distance of 150 miles from the Red Desert

to the Hoback Basin (RDH) and surrounding mountain ranges⁸ (Map 1). This newly documented RDH migration originates in the desert sagebrush basins where deer winter. In spring, an estimated 500 deer travel 50 miles north across the desert to the west side of the Wind River Range. From there, they merge with 4,000 to 5,000 other deer that winter in the foothills of the Wind River Range and then travel a narrow corridor along the base of the Winds for 60 miles before crossing the upper Green River Basin. In the final leg of the journey, they travel another 30-50 miles to their individual summer ranges in the Hoback Basin.

Migrations like this are an important part of Wyoming's cultural, hunting, and conservation heritage. The RDH route also reminds us why so many of Wyoming's ungulates migrate – because it is a seasonal foraging solution to living year-round in Wyoming's dynamic landscapes and climatic conditions. It allows deer to access the abundant forage of Wyoming's mountain ranges, but escape the deep snows that winter brings. This type of migration is a behavior shaped by a deep history of

mule deer interacting with their environment and passing information on from generation to generation⁹. The journey these deer undertake each spring and fall is truly remarkable and perhaps the best global example of a plains to mountains migration. Although this migration involves fewer animals, it is similar in scope and complexity to the well-known migrations of wildebeest on the Serengeti, or caribou on the arctic tundra. However, whereas wildebeest follow the rainfall patterns across the open plains, and caribou follow latitudinal variation in forage production, the RDH mule deer exploit a 3,000 to 4,000-foot elevation gain from desert to mountains. Long-distance migrations like these were no doubt common in the Rocky Mountain West before human settlement, but many have dwindled, as the winter ranges and migration routes have been converted through residential, agricultural, and other development. Wyoming's wide-open spaces and low human population have allowed this route, and others, to persist.

Increasingly, the landscapes that support these incredible migrations are becoming more





Mule deer follow the spring green-up across the upper Green River Basin.

difficult to navigate. Habitats are being fragmented by roads, well pads, and turbines associated with energy development. Wyoming's roadways are seeing increasing traffic levels, and private lands are increasingly at risk of development. Although migrating animals can typically move through disturbed habitats, so long as routes are not severed by impenetrable barriers (e.g., game-proof fencing or housing develop-

ments), recent research indicates that such disturbances alter the behavior of migrating animals^{10,11}. In a study before and after energy development in south-central Wyoming, deer migrated faster and stopped over to forage less often following development¹¹ (see Box 1). Such behavioral responses to development indicate that migratory ungulates may lose the foraging benefit of migration if they must move through areas of

intense disturbance along their routes. Although threshold levels are not known, high levels of disturbance certainly have the potential to diminish the functionality of migration routes and threaten their persistence¹¹. With a migration route as long as the RDH, proactive management will likely be necessary to assure persistence in the long-term.

The RDH migration crosses a mix of land ownership and



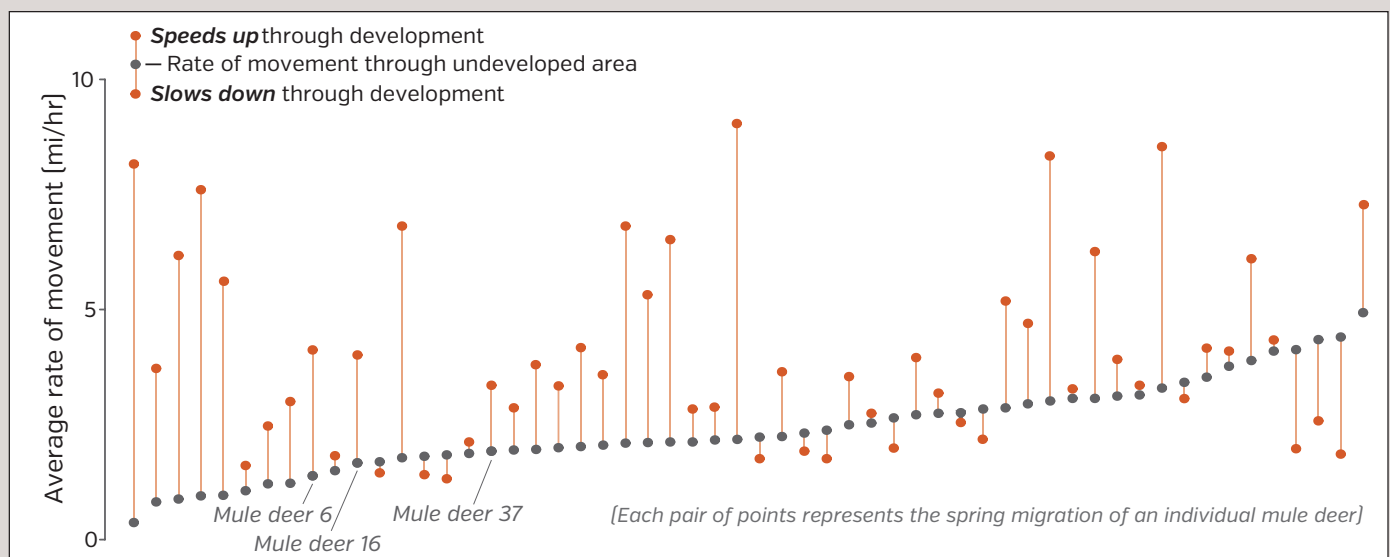
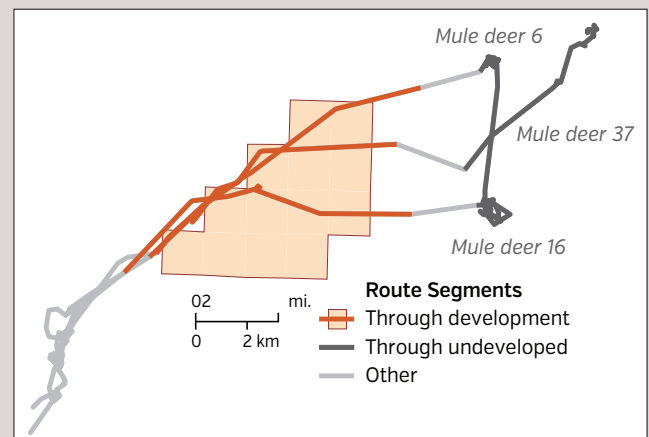
land-use patterns and highlights the challenges associated with conserving long-distance migrations outside of protected areas. Conservation efforts outside of national parks and other protected areas are, by necessity, more complicated because they must balance an assortment of competing land-uses and

require collaboration among a wide range of stakeholders. Stakeholders can work together to improve or protect habitat for Wyoming's fish and wildlife, but to be effective these efforts need reliable and accessible science. The goal of this migration assessment is to present the best available migration science in

a format that is accessible and useful for the stakeholders involved with local management and conservation efforts. Specifically, we provide an in-depth analysis of the RDH migration along its entire route and map the route in the context of land ownership patterns and land-use policies.

BOX 1. "SPEEDING THROUGH DEVELOPMENT"

A recent study in south-central Wyoming found that mule deer speed up while crossing developed gas fields compared to undeveloped areas. Individual deer migrate at different paces due to things like nutrition, past knowledge of the route, whether or not they have a fawn at side, and other factors. A few deer in the study slowed down as they moved through developed areas, but most individual deer sped up when they encountered development. Such a response could have a negative effect if a deer hurries past important food sources. Depending on geology and lease juxtaposition, directional drilling technology could allow no surface occupancy (NSO) in migration corridors while still extracting gas reserves below. It remains unclear how much development migrating ungulates can tolerate along their seasonal routes.



Source: © 2014 Atlas of Wildlife Migration: Wyoming's Ungulates (in production)



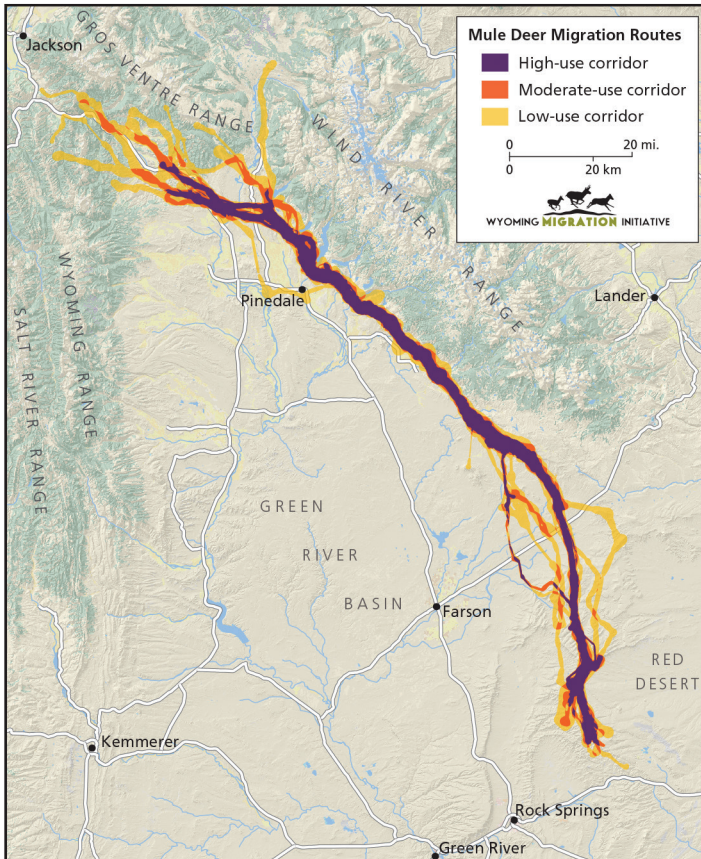
A mule deer buck considers the elk fence near Fremont Lake.

Approach

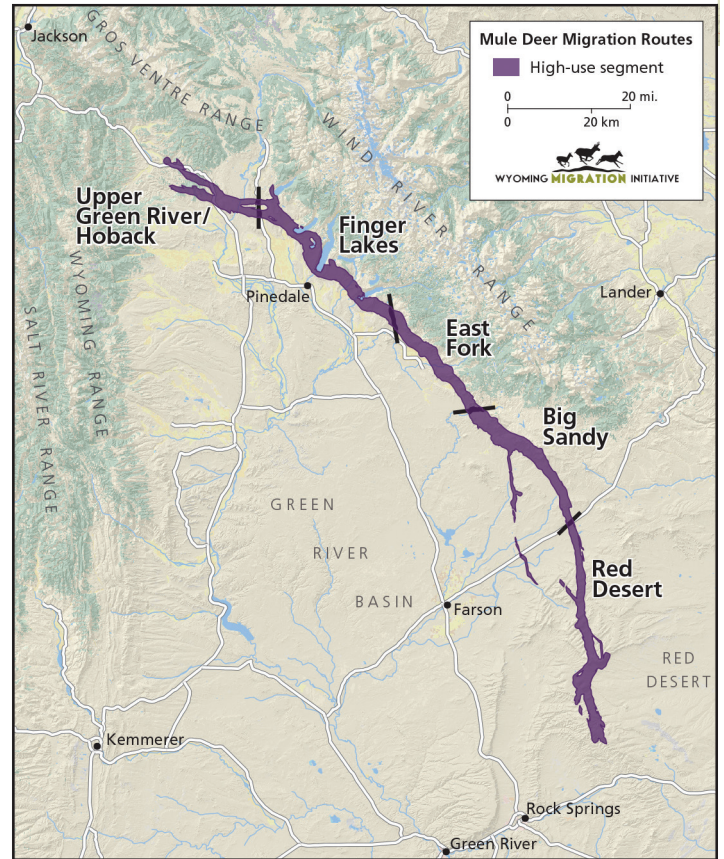
A recent study by Western EcoSystems Technology, Inc. used data collected from GPS-radio collars to delineate the RDH migration (Map 2a)⁸. For the purposes of this analysis, we focused on the “high-use” portion of the route, as this reflects the area where most animals shared a common migration route. This provided us with a narrow and well-defined corridor where we could identify potential movement barriers and evaluate land-use patterns¹². In general, the potential risks

to ungulate migration can fit into two categories: 1) physical barriers, like fences and roads, and 2) land-use practices, such as residential or energy development. Land-use practices, and the policies that shape them, are generally associated with land ownership. For example, private lands have the potential to be subdivided for residential development, whereas federal lands do not. Lands administered by the BLM are disproportionately at risk for oil and gas development compared to USFS admin-

istered lands that manage more acreage as designated wilderness or roadless areas. Accordingly, we characterized both the physical barriers and land-use patterns across the entire migration route. To further refine the assessment and account for regional differences, we divided the RDH migration into five segments (Map 2b). For each segment we provide detailed mapping, key summary statistics, and information on physical barriers and land-use patterns relevant to the RDH migration.



Maps 2a. High, moderate, and low-use areas of the Red Desert to Hoback mule deer migration route.



Map 2b. This migration assessment focuses on the high-use route area, which is further divided into 5 segments for analysis.

To conduct the migration assessment we combined field-work – including an aerial survey along the entire route – with GPS movement data from collared deer to identify the specific locales of potential risks (e.g., fences, road crossings, bottlenecks, energy development). We overlaid the RDH

route on agency maps and other GIS sources to develop a detailed view of land ownership and use along the core section of the route. The migration assessment makes this information available to agencies, industry, landowners, and NGOs so that they will have the information they need to

improve land-use planning and conservation efforts. Additionally, we worked closely with wildlife photographer Joe Riis to compile a traveling photo exhibit and short film to raise public awareness by providing a window into the journey that these deer complete each spring and fall.



Hall Sawyer and Joe Riis fly the entire migration route in May 2013.

Migration Assessment

Red Desert Segment

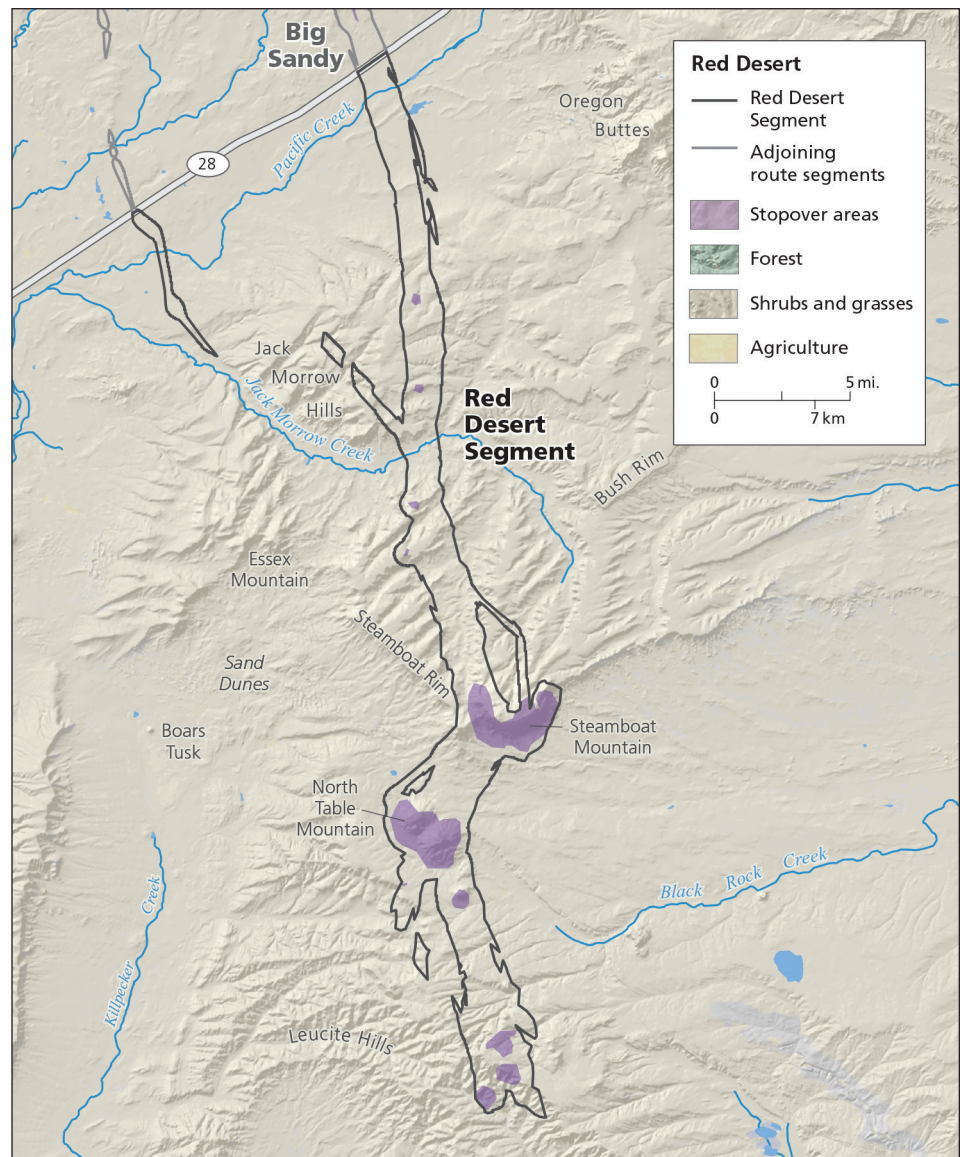
The Red Desert Segment is characterized by sagebrush basins, rolling topography, rocky canyons, and sand dunes. North (back) and South (front) Table Mountains are dominant landmarks in this part of the desert and provide key habitat for migratory mule deer.







The Red Desert Segment extends from winter ranges near the Leucite Hills and Interstate 80 (I-80) approximately 40 miles north to WY 28 (Map 3). In late winter or early spring, an estimated 500 mule deer leave winter ranges near I-80 and head north across Zirkel and Emmons Mesas to North and South Table Mountains. From there, deer continue north through a narrow 400-meter gap in the Killpecker Sand Dunes and enter Johnson Canyon between Steamboat Rim and Steamboat Mountain. The deer follow Johnson Canyon north, across the lower end of Box Canyon, and through the Jack Morrow Hills, then cross the historic Oregon, California, and Mormon Trails just before they reach WY 28. Recent research indicates that mule deer spend 95% of their migration period in a series of stopover sites, where they congregate to feed in areas where the forage is especially nutritious⁴. Key stopover sites in this segment included parts of Zirkel and Emmons Mesa, the North and South Table Mountains, and the Johnson Canyon/Steamboat Mountain area (Map 3). Stopovers are important for migratory mule deer because they allow animals



Map 3. Migration route and stopover sites for the Red Desert Segment.

to track the vegetation phenology, or green up, and access young nutritious forage, which helps them recover body condition earlier in the spring and maintain it longer in the fall⁴.

RED DESERT SEGMENT – PHYSICAL BARRIERS

To date, the 40-mile Red Desert segment of the RDH migration is relatively unaffected by physical barriers or impedi-



WY 28 and two right-of-way fences run perpendicular to the migration route.

ments (but see Box 2). In fact, the only fences deer must negotiate are the right-of-way fences on either side of WY 28, which is the only paved road crossed in the Red Desert Segment. The main part of the RDH migration crosses this rural 2-lane highway through a narrow (1-mile) corridor near milepost 24. A smaller branch of the migration route crosses at milepost 15. The right-of-way fencing along this section of highway is

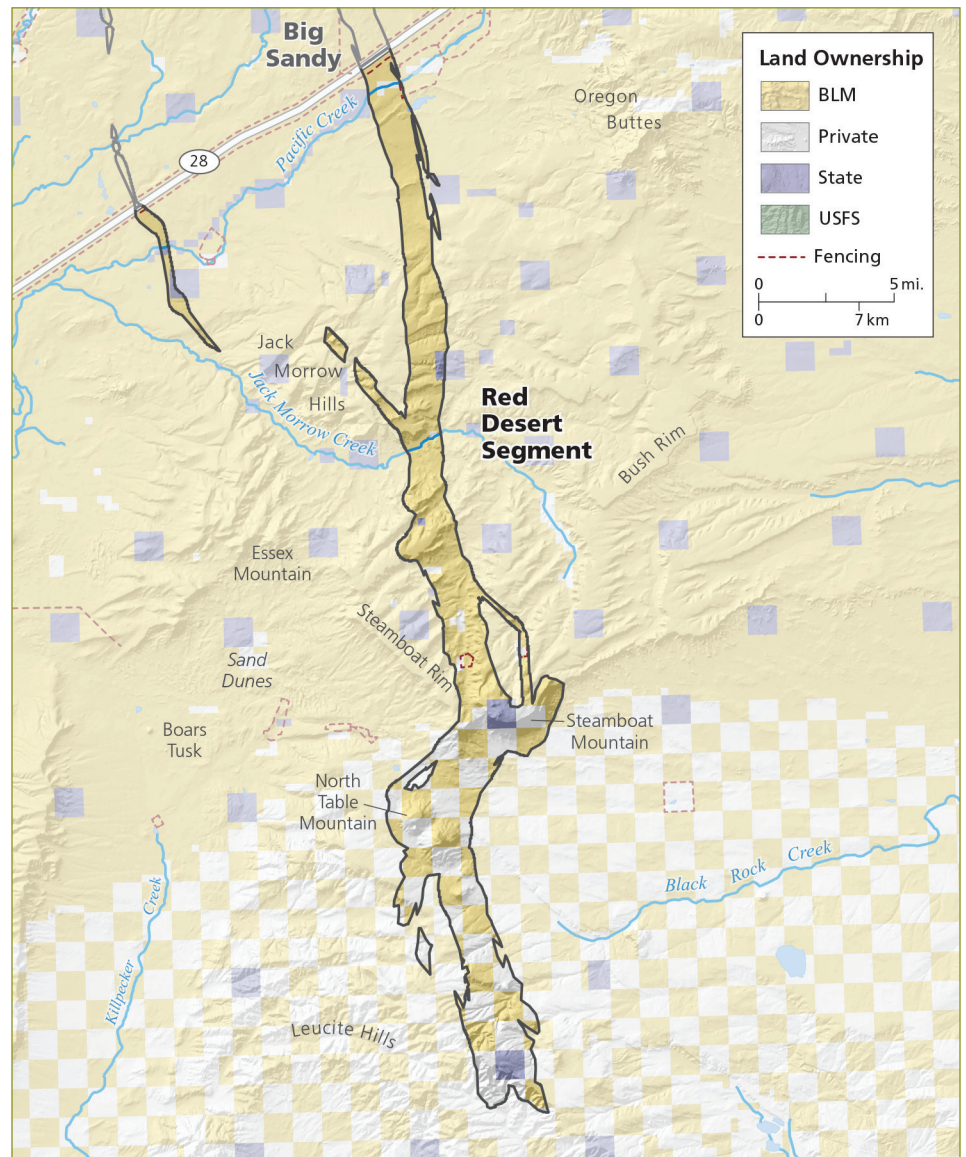
four strand barbed wire, with an exceptionally high ($\sim 52''$) top wire that requires deer find a place to move underneath the fence. When the Wyoming Department of Transportation (WYDOT) was informed of this unusually high fence and the difficulties that deer have crossing it, they committed to lower the top wire of the fence in summer 2014 and ensure gates are available to open at each crossing.

RED DESERT SEGMENT – LAND-USE

The Red Desert is characterized by sagebrush and desert shrub basins, rocky outcrops and canyons, and diverse topography. Most of this 40-mile segment consists primarily of federal lands (70%) administered by the Rock Springs Field office of the BLM (Map 4). Federal lands in the region are managed for multiple use and common uses include, livestock



grazing, motorized recreation, and energy development. Current guidance for land-use management of these federal lands is outlined in the BLM's Green River Resource Management Plan (RMP)¹³, which is currently under revision as the Rock Springs Resource Management Plan¹⁴. The Federal Land Policy and Management Act (FLPMA) of 1976 directs the BLM to inventory resources and values on the public lands and incorporate appropriate management into the RMP. The FLPMA also directs the BLM to manage some lands for retention of their natural condition to provide habitat for wildlife, and to prioritize special designations (see Box 3), like areas of critical environmental concern (ACEC). The RMP also identifies special recreation management areas (SRMA) and special management areas (SMA). The RDH migration route passes through the Greater Sand Dunes, Steamboat, and South Pass Historic Landscape ACECs, as well as the Steamboat Mountain SMA (Map 5). In general, these special use areas can be more restrictive in terms of allowable disturbance associated with recreation and energy development. Several

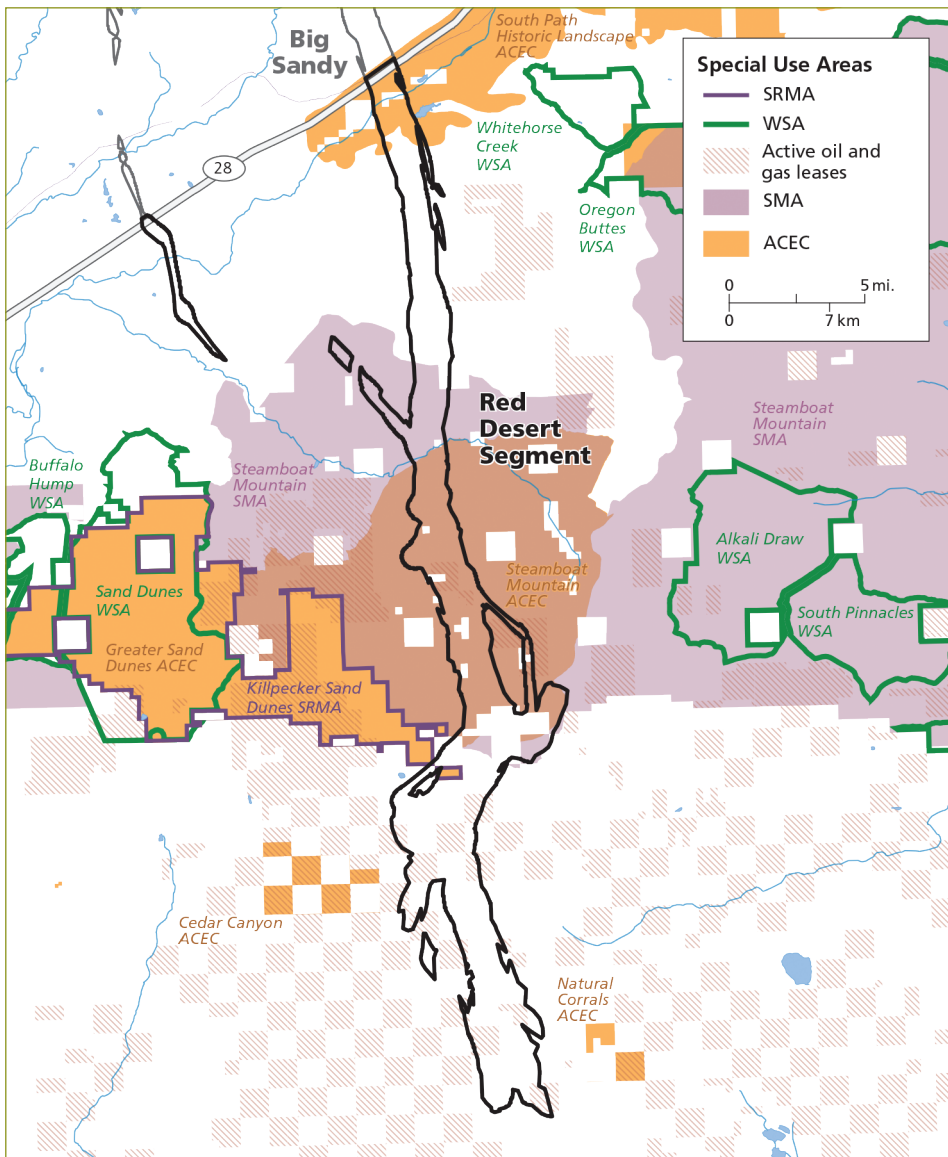


Map 4. Land-ownership patterns in the Red Desert Segment.

parts of the route also overlap with parcels leased for oil and gas or areas with ongoing energy development (Map 5).

The land-use activities and patterns in the Red Desert are influenced primarily by the BLM

and to a lesser degree, private and state lands. The southern portion of the Red Desert segment contains a considerable amount of private land (26%). However, most of the private land within the “checkerboard”



Map 5. Special-use areas in the Red Desert Segment.

pattern (every other section is private and public) along the I-80 corridor is owned by Anadarko Petroleum Corporation (a merger with Union Pacific) or the Rock Springs Grazing Association (RSGA); these

landowners have historically and currently allowed public access. The RSGA also holds most of the BLM grazing allotments in the area. The BLM does not have an official policy directed specifically at checkerboard

management, but development in these areas tends to be higher compared to areas with large blocks of federal land. To the best of our knowledge, none of the private lands in this segment have conservation easements and most remain unfenced.

In addition to federal and private lands, 4% of the Red Desert Segment is comprised of state lands managed by the Wyoming Office of State Lands and Investments (OSLI). By Wyoming legislative direction, state lands are managed primarily for “long-term growth in value” and “optimum, sustainable revenue production” to generate funds for public schools¹⁵. Accordingly, the primary uses of these lands are livestock grazing and energy development.

The Red Desert Segment overlaps with the WGFD Steamboat mule deer herd unit, which extends from I-80 north to WY 28. This herd unit is managed by the Green River region of the WGFD.

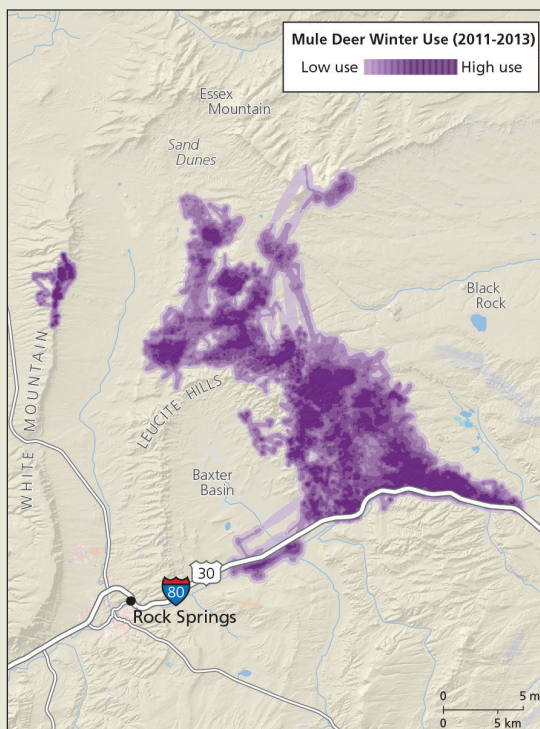


Box 2: Interstate 80 and mule deer migration



Interstate-80 is a barrier to the seasonal migrations of mule deer that winter in the Red Desert.

Winter distribution of mule deer during winters 2011 and 2012. Interstate 80 prevents movement to the south where deer would likely encounter less snow.



It is worth noting that although the RDH route does not extend south beyond I-80, the interstate appears to be a barrier to deer movement. The completed construction of I-80 in 1970 severed the migration routes of thousands of pronghorn and mule deer. During the severe winter of 2011-12, nearly 40 % of GPS-collared mule deer died on winter range adjacent to I-80⁸. Deer and pronghorn are especially vulnerable to deep snow that makes forage inaccessible and movement difficult. If deer were able to cross I-80 and move further south, it is likely that their mortality rates could be reduced, especially during severe winters. Restoration of such migrations through underpass or overpass construction has received serious consideration in recent years. Several crossing structures have been built in Wyoming and other western states and have proven effective at allowing mule deer and other migratory ungulates to safely cross roadways and access their seasonal ranges.²⁴

Box 3. Special Designation Areas on federal lands managed by BLM

AREA OF CRITICAL ENVIRONMENTAL CONCERN (ACEC):

Areas within the public lands where special management attention is required to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources, or other natural systems or processes, or to protect life and safety from natural hazards. The identification of a potential ACEC shall not, of itself, change or prevent change of the management or use of public lands.

SPECIAL MANAGEMENT AREA (SMA):

The SMA label is a locally generated identification designed to flag locations which have specialized management concerns or needs but did not warrant ACEC designation. Generally, the SMAs contain resources or opportunities that warrant a level of management narrowly focused on a localized resource (e.g., wildlife, vegetation) or resource use concern.

SPECIAL RECREATION MANAGEMENT AREA (SRMA):

The SRMA is a designation where public recreation (e.g., off-road vehicles) issues require special or more intensive types of management. SRMAs require detailed recreation planning and greater managerial investment (e.g. facilities, supervision, etc.).

WILDERNESS STUDY AREA (WSA):

WSAs are areas under study for possible inclusion as a Wilderness Area in the National Wilderness Preservation System. As outlined by Congress

in Section 2 (c) of the Wilderness Act of 1964, the characteristics of wilderness include:

“(1) generally appears to have been affected primarily by the forces of nature, with the imprint of man’s work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.”

WILD, SCENIC, AND/OR RECREATIONAL RIVER (WSR):

The three classes of what is traditionally referred to as a “Wild and Scenic River.” Designated river segments are classified as wild, scenic and/or recreational, but the segments cannot overlap.

- **Wild River Areas.** Those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.
- **Scenic River Areas.** Those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.
- **Recreational River Areas.** Those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development.



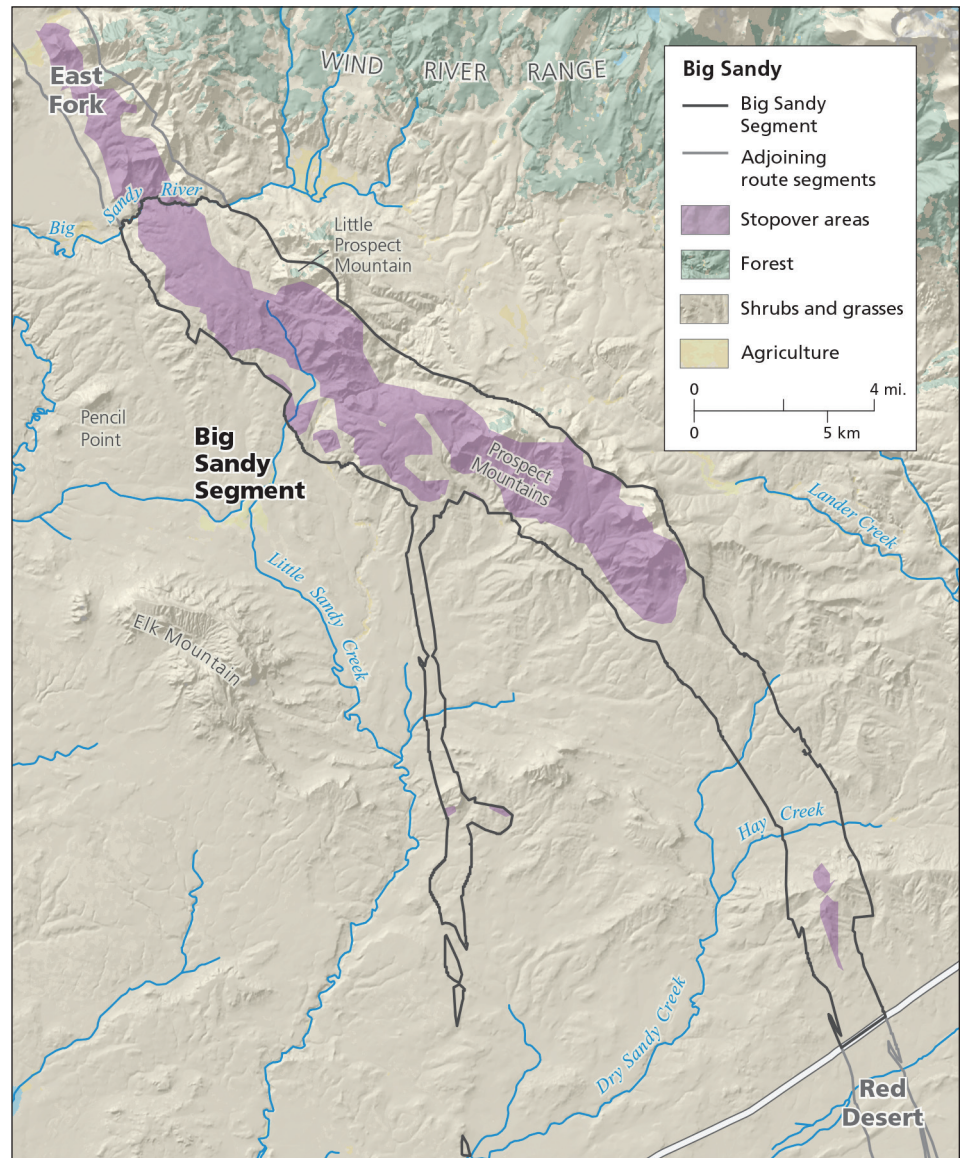


Big Sandy Segment

The Big Sandy Segment is characterized by sagebrush basins, rolling topography, rock outcrops, and scattered juniper.



The Big Sandy Segment of the RDH migration extends approximately 25 miles from WY 28 to the Big Sandy River (Map 6). Migrating deer use this portion of the route in March and April during the spring and October through December during the fall migration. From WY 28, deer move north across Hay Creek and Dry Sandy Creek, out of the sagebrush basins of the Red Desert and into the Prospect Mountains and foothills of the Wind River Range. From the Prospects, deer move northerly through Long Draw to the Big Sandy River, just east of Buckskin Crossing. It is in this general area where the estimated 500 mule deer from the Red Desert join another 4,000 to 5,000 mule deer that winter in the Buckskin Crossing/Prospects area. These deer represent the largest concentration of mule deer in the Green



Map 6. Migration route and stopover sites for the Big Sandy Segment.



Mule deer move along fence line near the Big Sandy River.



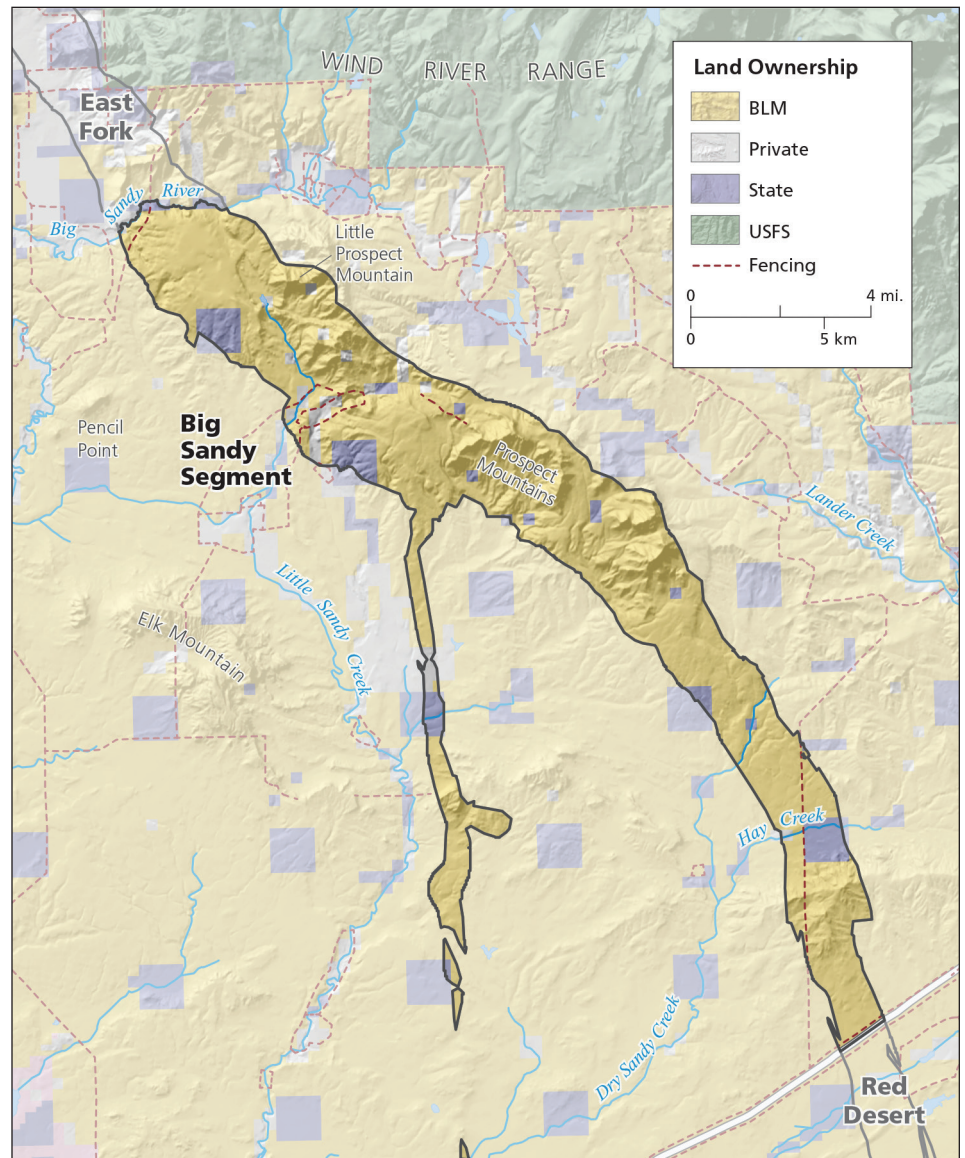
River Basin and as large as any in Wyoming. Together, these deer migrate the remaining 100 miles to the Hoback Basin. The northern half of this route segment, from the Prospect Mountains to Big Sandy River, is stopover habitat. Mule deer can spend days or weeks foraging in these large stopover areas.

BIG SANDY SEGMENT – PHYSICAL BARRIERS

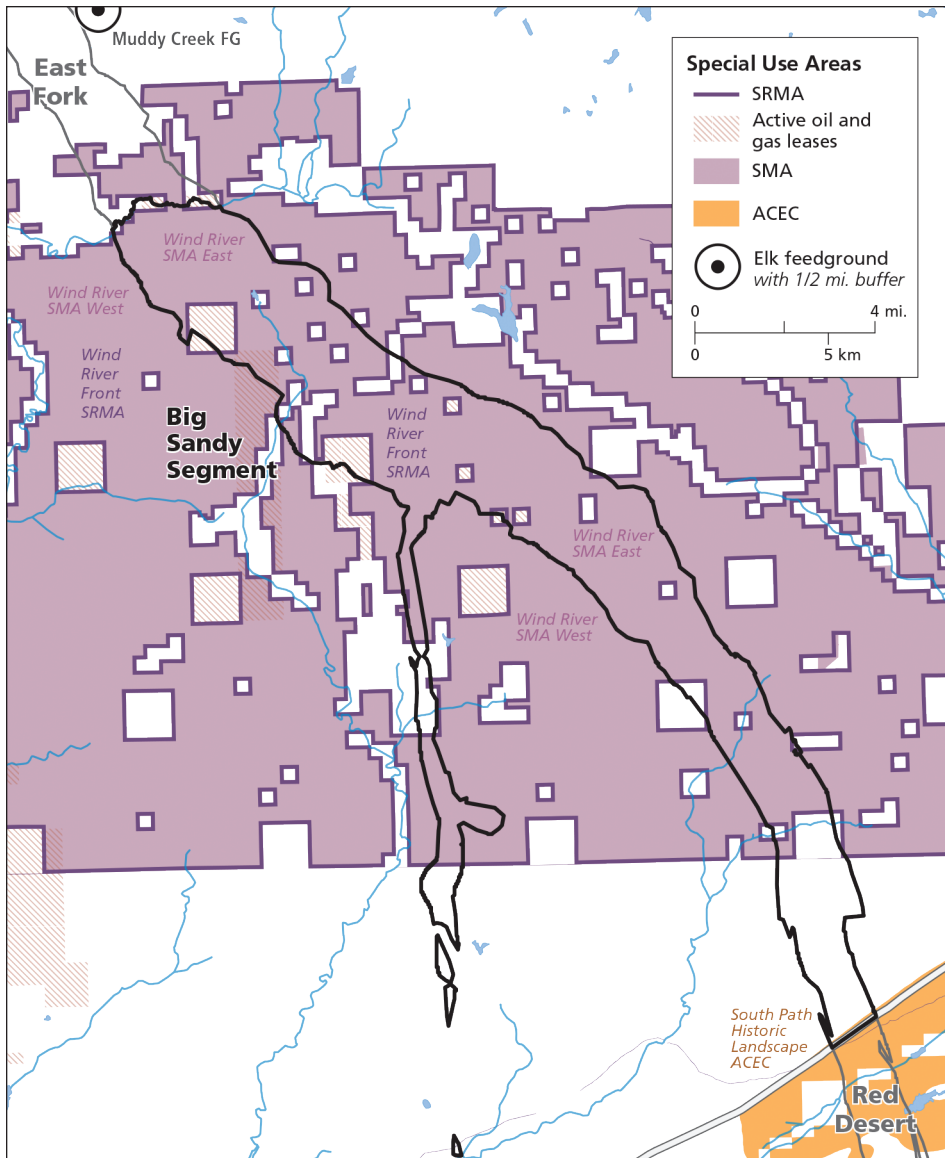
Similar to the Red Desert, this route segment has relatively few physical barriers or impediments. Mule deer cross approximately eight fences, six of which are woven wire (near the Little Sandy River). Woven wire fence is the most dangerous for wildlife and can be difficult for deer to maneuver through, especially fawns^{16, 17}.

BIG SANDY SEGMENT – LAND USE

Most of this 25-mile segment consists of federal lands (90%) administered by the



Map 7. Land-ownership patterns in the Big Sandy Segment.



Map 8. Special-use areas in the Big Sandy Segment.

BLM Rock Springs field office (Map 7). The migration route passes directly through the Wind River Front SMA, some of which has limited availability for oil and gas leasing (Map 8). We refer readers to the BLM's Green River RMP¹³ for specific information on the Wind River Front SRMA. The remaining 10 % of lands in the Big Sandy segment are state lands managed by OSLI (7%) and private (3%). None of the private lands have conservation easements. From WY 28 north, the entire Big Sandy Segment is in the WGFD Sublette mule deer herd unit, which is managed by the Pinedale region of WGFD. Because of deer declines associated with gas development in other parts of the herd unit, the deer in this region are especially important for sustaining herd unit population objectives.



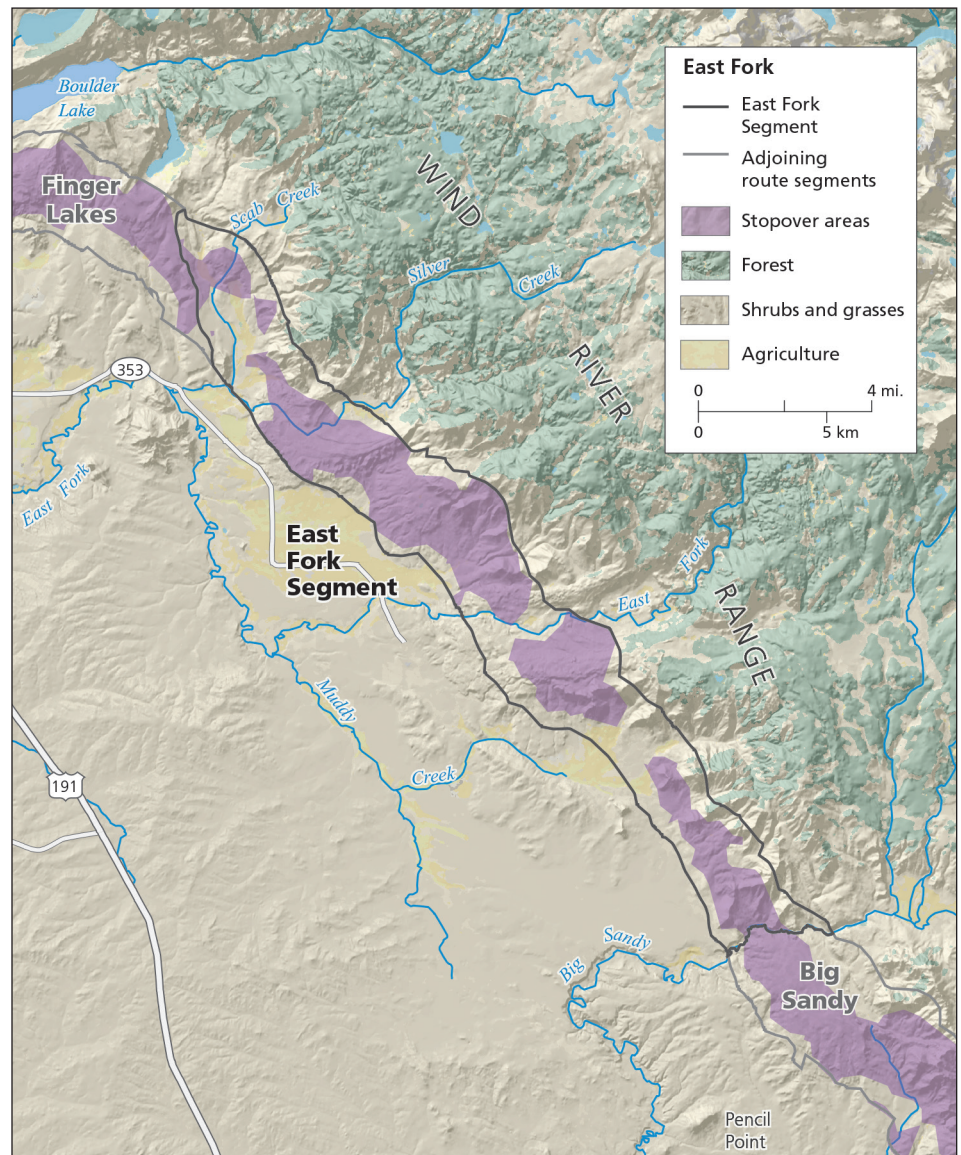


East Fork Segment

The mule deer migration through the East Fork Segment is characterized by rolling topography and sagebrush foothills at the base of the Wind River Range.



The East Fork Segment of the RDH migration extends approximately 25 miles from Big Sandy Creek to the Scab Creek Road (CR 122; Map 9). Most deer migrate through this area during April in the spring and late-October and November in the fall. From Big Sandy Creek, deer move north along the foothills of Muddy Ridge. At Muddy Creek, they negotiate through the first of several elk feedgrounds operated by the WGFD. From Muddy Creek, deer continue north across the East Fork River, Pocket Creek, Silver Creek and Scab Creek. This part of the migration route is restricted to a narrow sagebrush corridor that is bounded to the west by agriculture and rural residential development, and to the east by the rugged terrain of the Wind River Range. With the exception of a few agricultural areas, most of this route segment is stopover habitat. Deer often stopover to forage for days and sometimes weeks, during both spring and fall migration.



Map 9. Migration route and stopover sites for the East Fork Segment

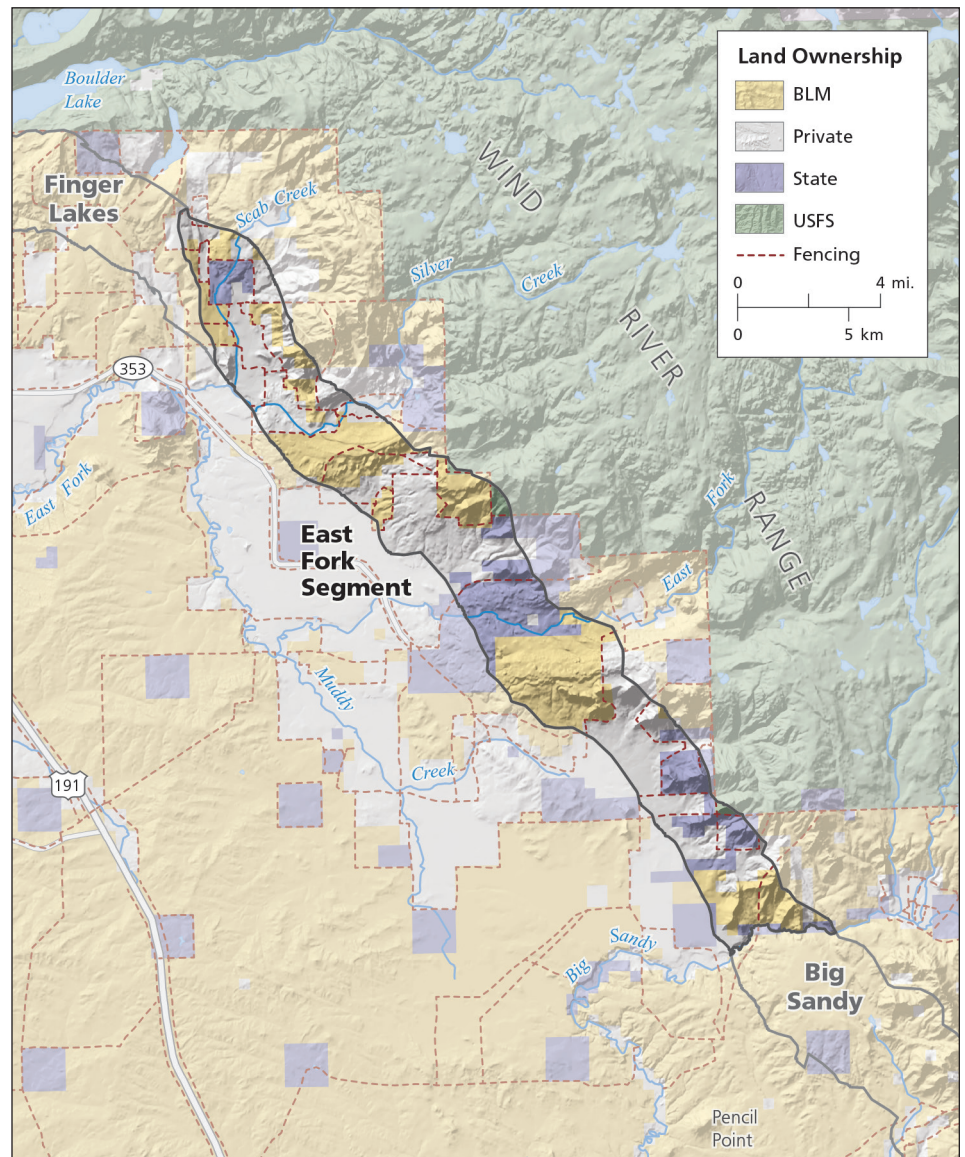


A young mule deer buck searches for a way around an elk fence.



EAST FORK SEGMENT – PHYSICAL BARRIERS

The East Fork Segment does not cross any paved roads. The few county roads that deer must cross have low traffic volumes and do not pose any significant obstacles to deer at this time. Because the East Fork Segment contains more private and state land (Map 10), there are a considerable number (15 to 27) of fences that mule deer must negotiate through in this area. As part of their Corridor Conservation Campaign, the Green River Valley Land Trust has already modified some of the fences in this area to meet wildlife-friendly specifications^{16, 19}. However, other fences remain difficult for mule deer to negotiate. As deer move through this section, they encounter the first elk feedground (Muddy Creek) of their journey that has 8 foot-tall woven-wire fences designed to keep elk off private lands (hereafter referred to as elk fences). In general, deer must move around these fences, but they will use open gates if available and sometimes find holes where they can move underneath. Just south of Muddy Creek, the elk fence extends



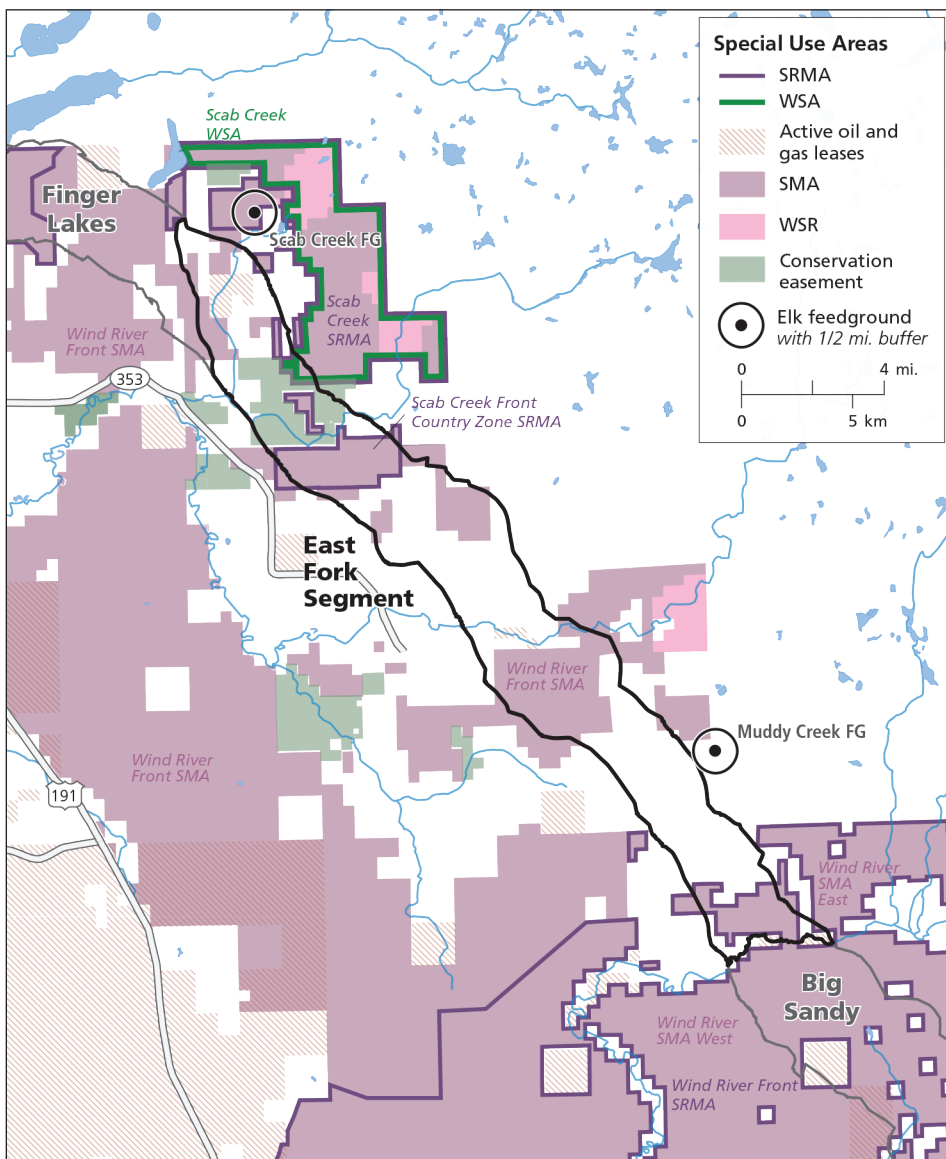
Map 10. Land-ownership patterns in the East Fork Segment.

into the eastern side of the mule deer migration route.

EAST FORK SEGMENT – LAND USE

The region is characterized by mixed-shrub and sagebrush

foothills along the base of the Wind River Range. This 20-mile segment crosses a mix of land ownership, including 43% private, 37% BLM, 19% state lands managed by OSLI, and 1% USFS (Map 10). The BLM



Map 11. Special-use areas in the East Fork Segment.

lands in the northern 17 miles of this segment are administered by the Pinedale field office, whereas the southern 3 miles are in the Rock Springs field office. The Pinedale RMP was updated in 2008 and pro-

vides direction for land-use practices and management of BLM lands¹⁸ in that field office. Federal lands in the region are managed for multiple-use, including livestock grazing, recreation, and energy develop-

ment. The route passes through several special use areas, including the Scab Creek WSA, Scab Creek SRMA, and the Wind River Front SMA, where, other than existing lease rights predating 2008, no additional oil and gas leasing is allowed on federal lands (Map 11). Specific information on special use areas can be found in the Pinedale RMP. Based on available data, 16% of the private land in the East Fork segment has been placed in conservation easement²⁰. The East Fork Segment contains a considerable amount (19%) of state land which is managed by the OS LI, and by Wyoming legislative direction, are managed to generate income for public schools. The East Fork Segment is in the WGFD Sublette mule deer herd unit, managed by the Pinedale region of WGFD.



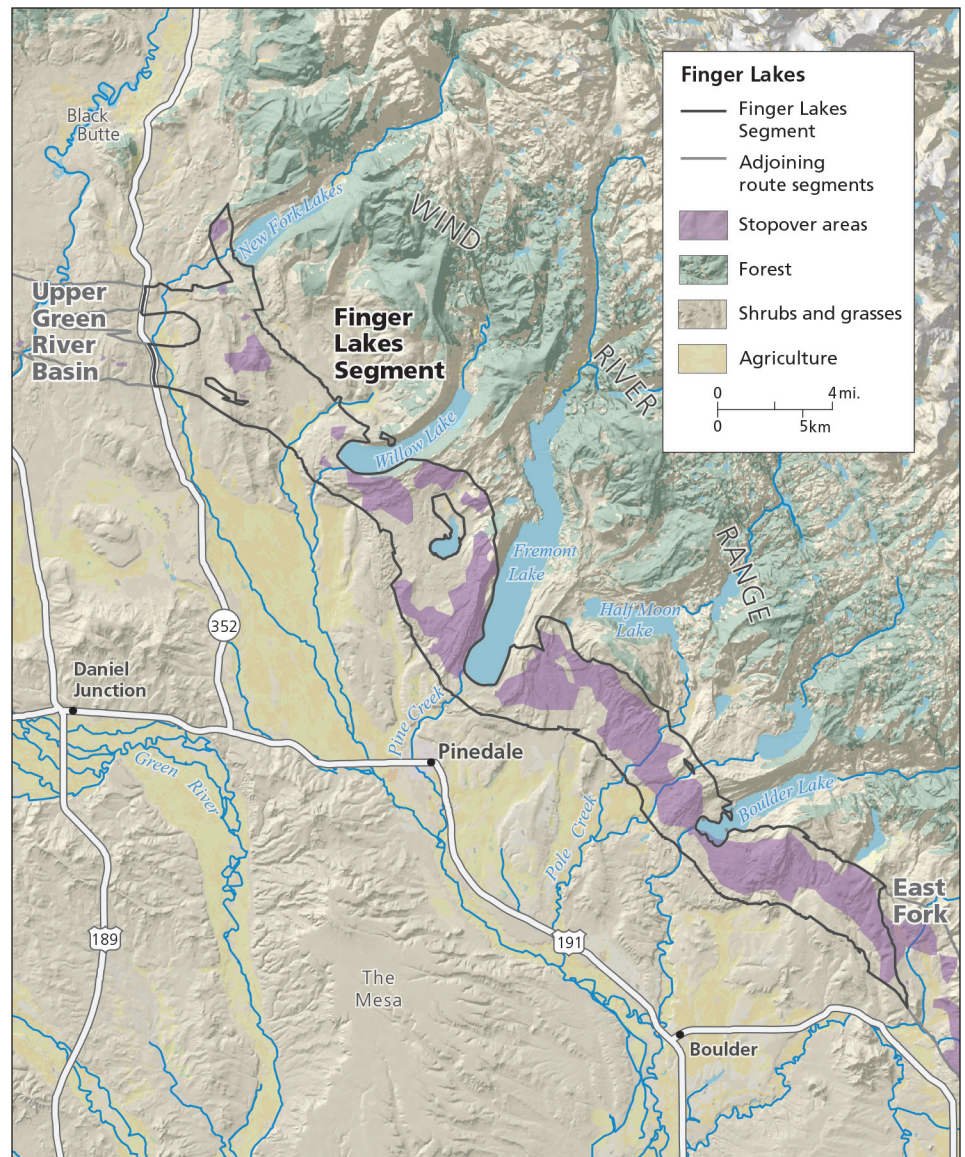


Finger Lakes Segment

The Finger Lakes Segment is characterized by a narrow band of sagebrush that runs along the base of the Wind River Range and crosses the outlets of Boulder, Fremont, Willow, and New Fork Lakes. An estimated 4,000 to 5,000 mule deer move through narrow bottlenecks (50 to 400 meters) at each of these lake outlets. Here, a group of 47 mule deer migrate across Pine Creek below the Fremont Lake outlet during fall migration.



The Finger Lakes Segment extends approximately 34 miles from the Scab Creek Road (CR 122) to WY 352, just west of New Fork Lakes (Map 12). Most deer migrate through this portion of the route during April and early-May in the spring and late-October and November in the fall. From the Scab Creek Road, deer move northwesterly towards the outlet of Boulder Lake, where they cross Boulder Creek about 200 meters below the outlet. Deer then move north across Pole Creek, into the flat and open shrubland at the base of Half Moon Ridge. From there, deer cross the Fremont Lake Road (CR 154) then travel in between the CCC Ponds and USFS Road 111 to the outlet of Fremont Lake. Here, most deer cross Pine Creek roughly 100 meters below the outlet. Other deer swim across Fremont Lake about 200 meters above the outlet, where the lake is 70 meters wide. From the northwest side of Fremont Lake, deer must negotiate approximately 20 miles of elk fence intended to keep elk off private land. Deer continue northerly along Fremont Ridge, then west of Soda Lake, and are funneled by the elk fence towards the



Map 12. Migration route and stopover sites for the Finger Lakes Segment.

outlet of Willow Lake. At Willow Lake, deer move through a narrow bottleneck (about 50 meters) between the elk fence and the Willow Lake Campground, then move west towards the outlet, where they move to the west

side of the elk fence and across Dumphy Hollow and the New Fork River to WY 352. A smaller segment of the population moves from Willow Lake north towards Little Flat Mountain, then west toward the outlet of New



A mule deer doe leads the way across Pine Creek, just below Fremont Lake.

Fork Lakes, where they cross an elk fence and continue to WY 352. Most of the stopover habitat in this route segment is located between CR 122 and Fremont Ridge. Deer stopover to feed in the Half Moon and Fremont

Ridge areas for days and sometimes weeks during both spring and fall migration.

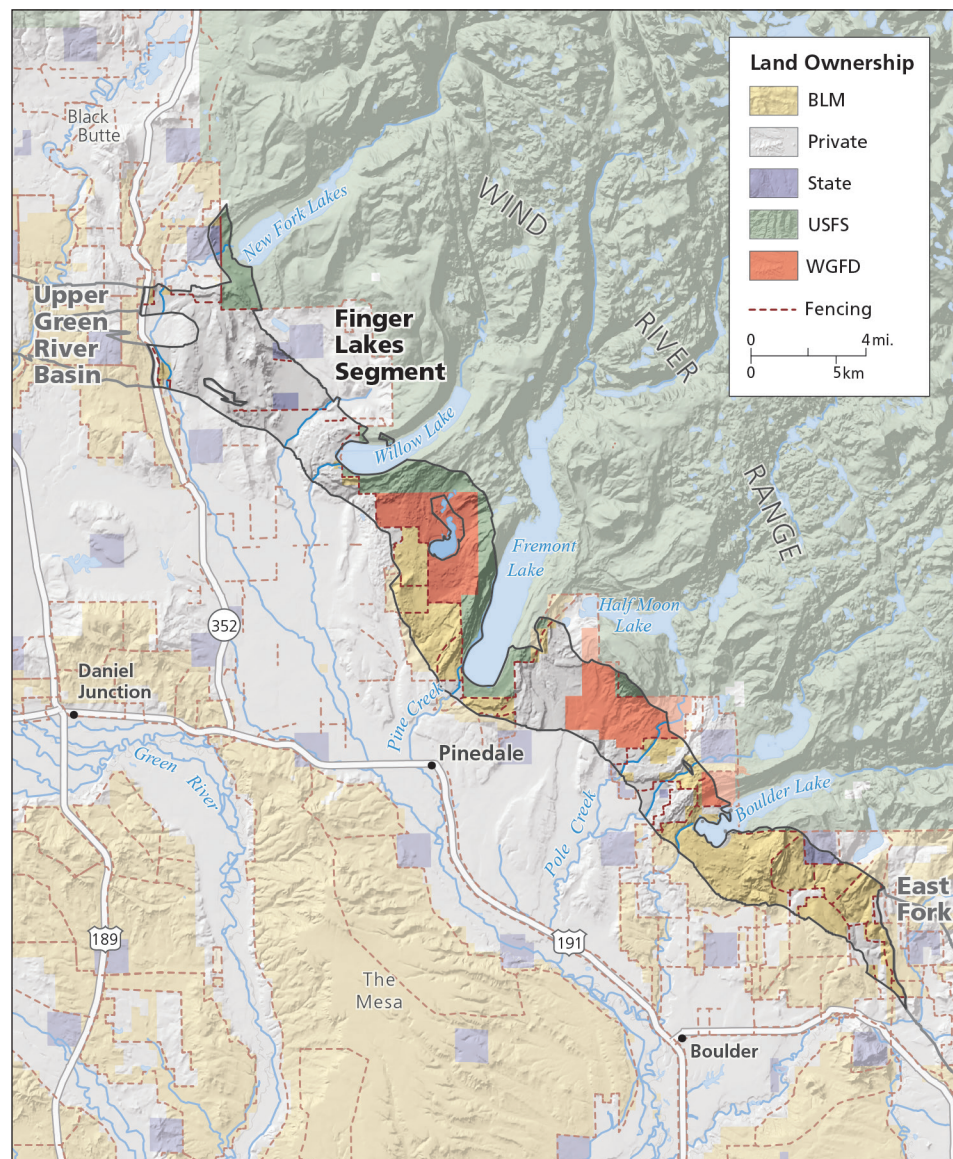
FINGER LAKES SEGMENT – PHYSICAL BARRIERS

The Finger Lakes Segment is among the most challenging

sections for mule deer to travel through because of the assortment of fences, paved roads, and narrow bottlenecks at the outlet of each of the Finger Lakes (Boulder, Fremont, Willow, and New Fork). Thousands of deer



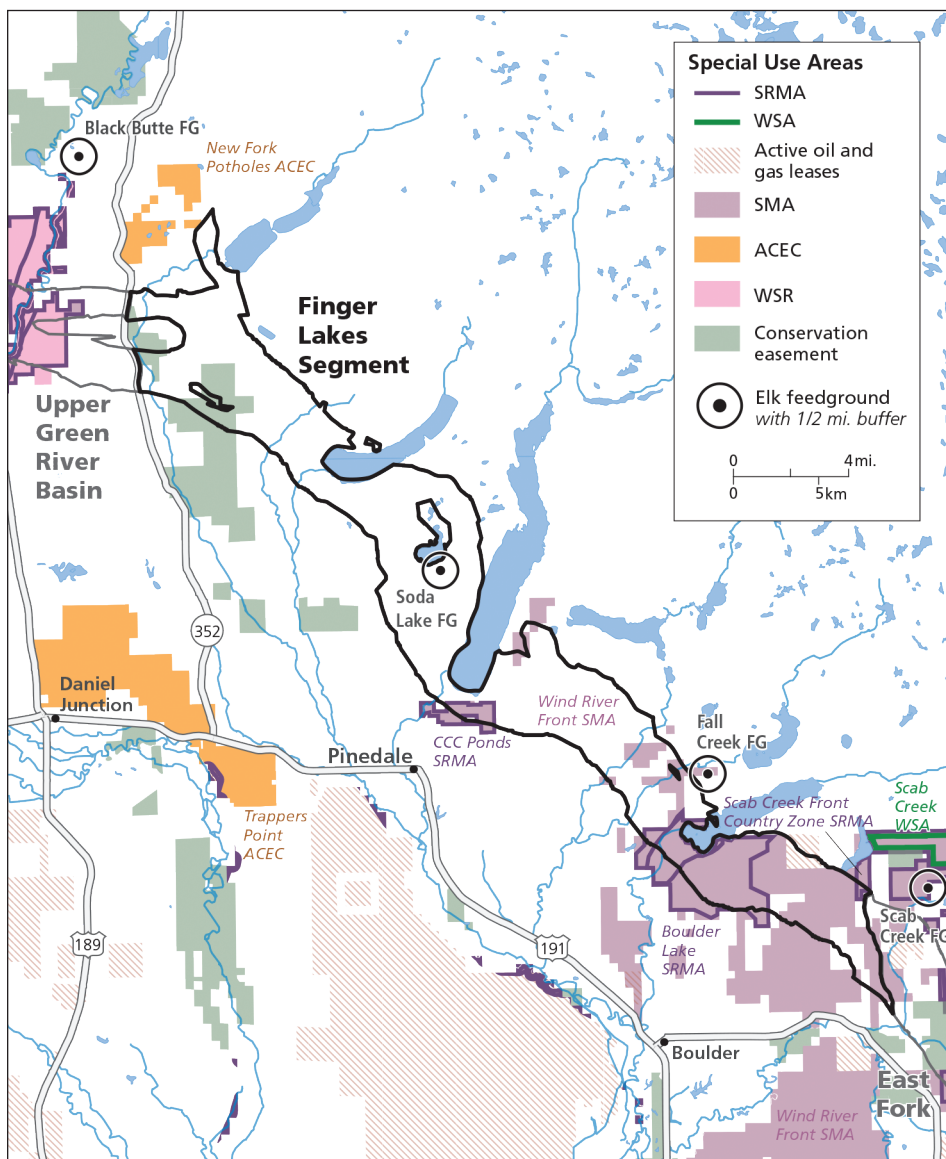
must cross these waterways in close proximity to recreational areas or rural residential development. The elk fence associated with the Soda Lake feedground extends approximately 20 miles from Fremont Lake to New Fork Lakes, keeping elk off private lands and containing them in the vicinity of Soda Lake. Mule deer will use open gates in the elk fence, but because the timing of the deer migration can overlap with elk feeding (or elk containment), gates are not always open when deer would be able to use them. The advantage of open gates is that deer can easily pass through them without spending extra time searching for an alternative route. Occasionally deer find small holes in the fence where they can crawl underneath, but this option appears limited to females and fawns, because the antlers of bucks prevent them from maneuvering underneath the fence. Seven of the fence corners have dirt jump-offs, intended to allow deer to move through the fence. However, the height (5 feet 6 inches) of the jump-off we monitored appeared to deter most deer from using it. The only deer we documented jumping were mature bucks.



Map 13. Land-ownership patterns in the Finger Lakes Segment.

Deer cross several county roads, including CR 125 to Boulder Lake, CR 154 to Fremont Lake, and CR 119 to Willow Lake. Of those, CR 154 is the only one that is paved and has the highest traffic

volumes. Most deer cross CR 154 within 200 meters of either side of the access road to Fremont Lake. The access road (FS 111) is also paved and receives a lot of recreational use, as it provides access to



Map 14. Special-use areas in the Finger Lakes Segment.

CCC Ponds, Pine Creek, and Fremont Lake. Mule deer cross FS 111 near CR 154, before the road veers off to the west. Although deer are able to cross these roads, they represent a challenging part of the route.

FINGER LAKES SEGMENT – LAND USE

This 30-mile segment crosses a mix of land ownership, including 46% private, 30% BLM, 14% USFS, 8% WGFD, and 2% OSLI land (Map 13). The BLM

Pinedale field office and the Bridger Teton National Forest (BTNF) administer the public lands in this segment. Federal lands in the region are managed for multiple-use, but recreation (e.g., boating, camping, fishing, hunting, biking) is the dominant use. There are no active oil and gas leases on federal lands in this segment. The route passes through several special management areas, including the Scab Creek, Boulder Lake, and CCC Ponds SMAs, where land-use guidelines differ from surrounding BLM parcels (Map 14). BLM lands in this segment are unavailable for oil and gas leasing. We refer readers to the Pinedale RMP for detailed information on special use areas¹⁸.

The route also passes through the Half Moon and Soda Lake wildlife habitat management areas, which are lands owned and managed by the WGFD for wildlife. Based on available data, approximately 9% of the private land in the Finger Lakes Segment has been placed in conservation easement²⁰ (Map 14). The Finger Lakes Segment is in the WGFD Sublette mule deer herd unit, managed by the Pinedale region of WGFD.



A mule deer buck swims across the outlet at Fremont Lake during fall migration.



Mule deer crossing FS 111 near Fremont Lake.



This corner jump-off in an elk fence near the Soda Lake feedground is approximately 5 foot 6 inches tall and rarely used by deer other than mature bucks.





Fishing and boating access points near outlet of Boulder Lake, where mule deer cross Boulder Creek.



Boating, fishing, and hiking access points at the outlet of Fremont Lake where mule deer either swim across the outlet (shown here) or cross Pine Creek.



Campground and fishing access near the outlet of Willow Lake where most deer migrate along CR 119 between the elk fence and campground.

Upper Green River-



The Upper Greer River portion is characterized by pothole lakes intermixed with sagebrush, riparian meadows, and hay fields.

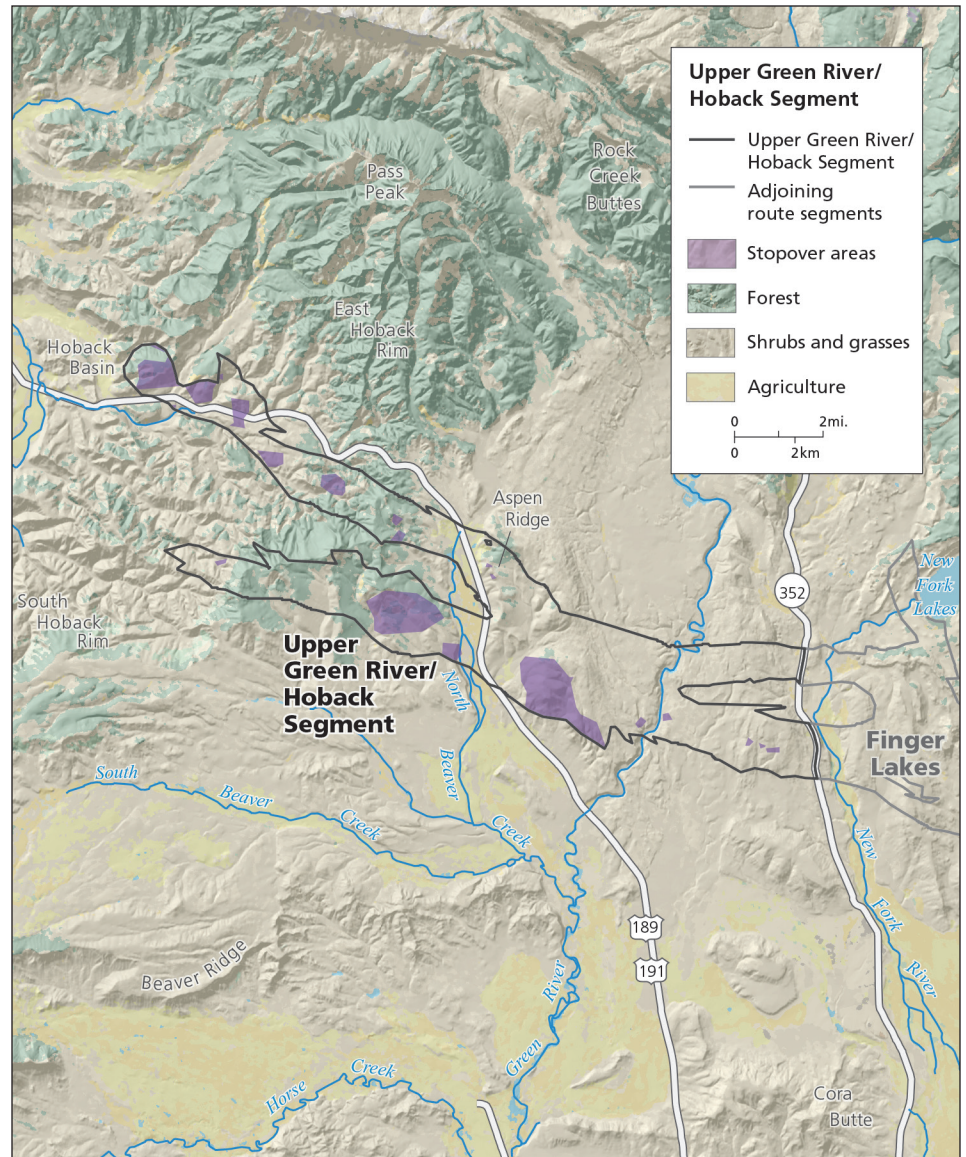
Hoback Segment



The Hoback Basin is characterized by timbered draws, aspen stands, sagebrush slopes, riparian draws and mountain meadows, bounded by the high-elevation peaks of the Wyoming Range to the west and Gros Ventre Range to north and east.



The Upper Green River–Hoback Segment extends approximately 25 miles from WY 352, northwesterly into the Hoback Basin and BTNF (Map 15). From WY 352, deer move west across mostly private land, traverse the Green River and move onto Aspen Ridge, where they stopover for several days. From there, deer continue west across the busy US 189/191 highway, across North Beaver Creek and onto the South Rim of the Hoback Basin, where they stopover on Signal Hill and Kismet Peak, just south of the BTNF boundary. Deer then move from the BTNF boundary into the Hoback Basin, where they break off from the core migration route and disperse to various summer ranges in the Hoback, including the Wyoming Range, Salt River Range, Snake River Range, and Gros Ventre Range. Some deer migrate another 10-30 miles to reach their respective summer ranges. Most mule deer cross US 189/191 one more time before reaching summer range. After travelling roughly 150 miles between winter and summer range, most deer spend summer in specific home ranges that



Map 15. Migration route and stopover sites for the Upper Green River - Hoback Segment.



A group of mule deer cross WY 352 and right-of-way fencing during the fall migration.



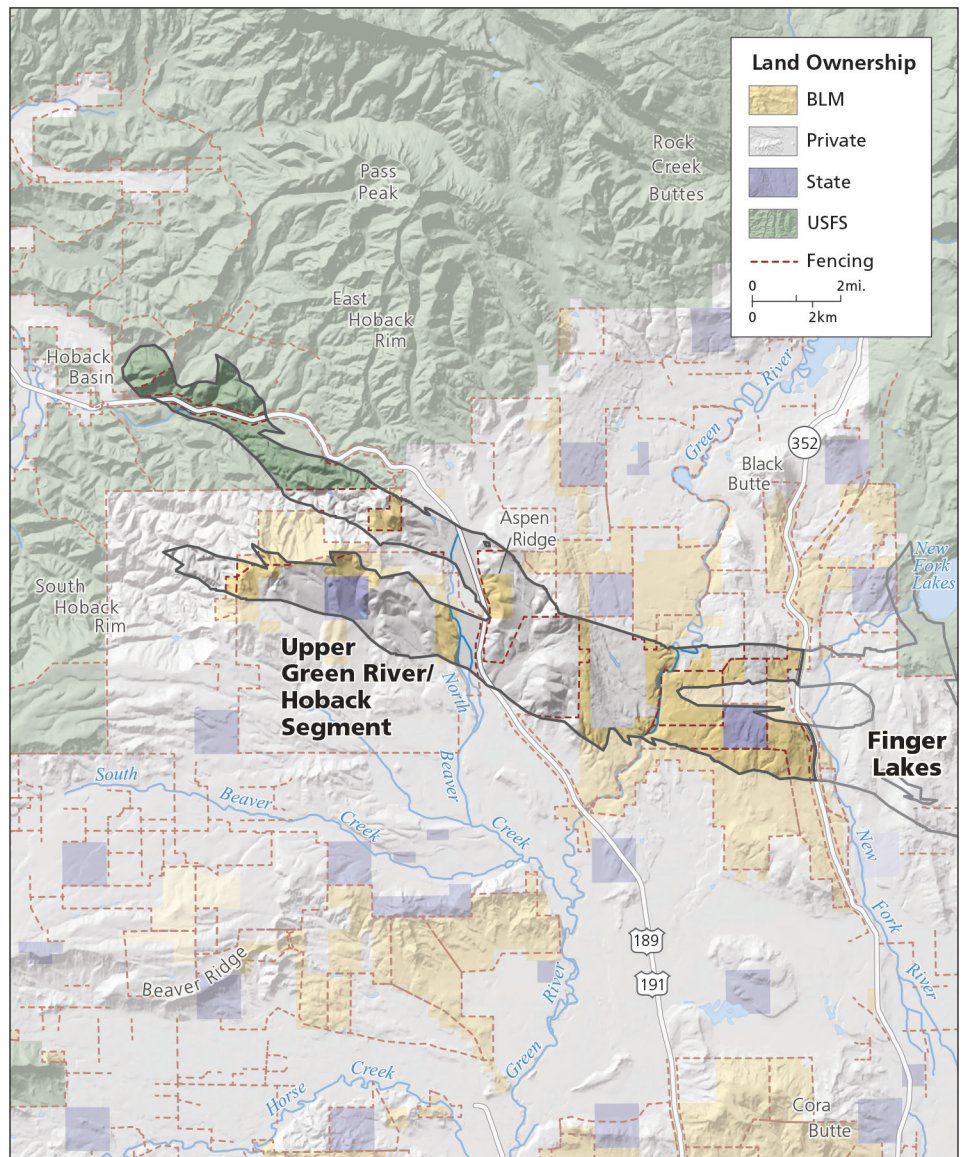
average 1 to 2 square miles and 3,000 to 4,000 feet higher than where they spent the winter

UPPER GREEN RIVER – HOBACK SEGMENT: PHYSICAL BARRIERS

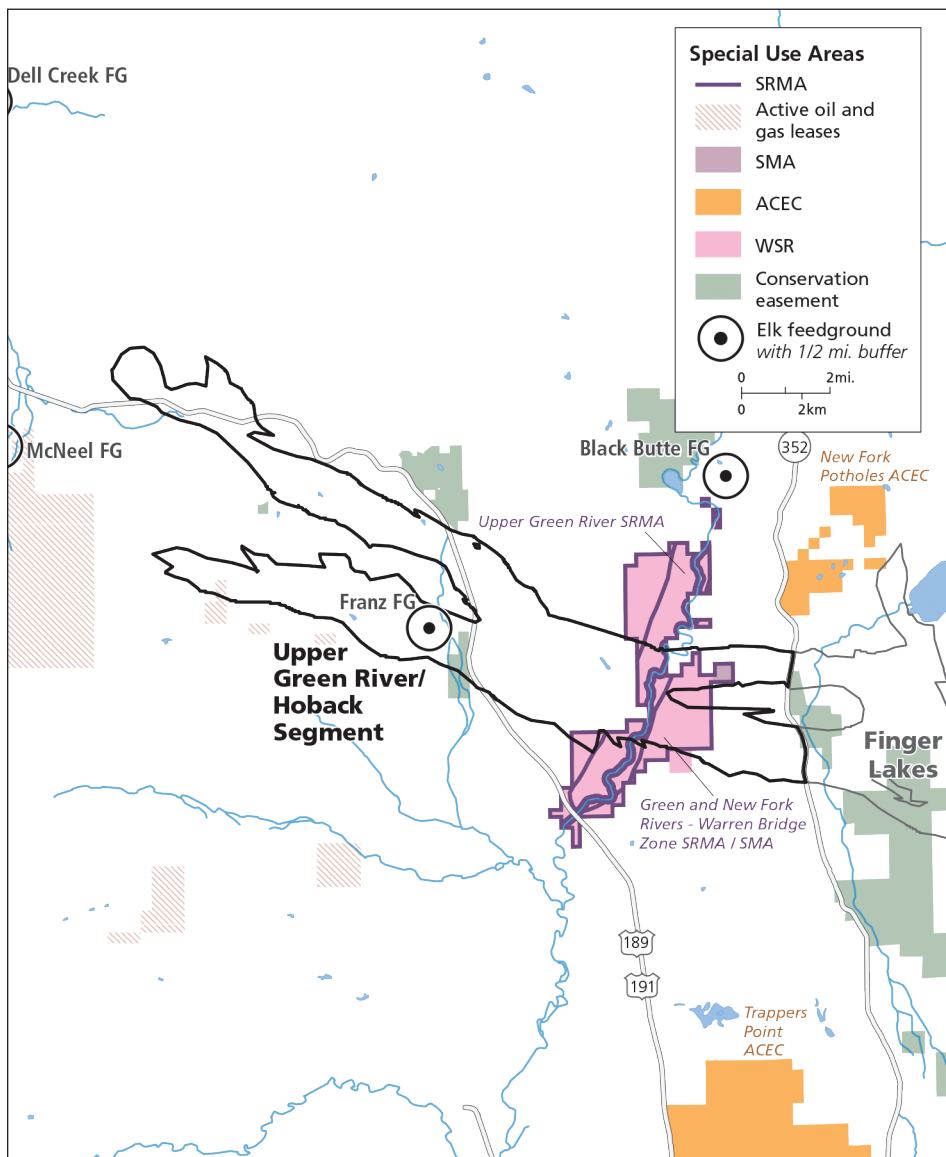
The Upper Green River–Hoback Segment has more fences per square mile than any other migration segment. This is due in large part to a higher percentage of private land, some of which consists of relatively small parcels with various owners. Additionally, the route crosses both WY 352 and US 189/191, which have right-of-way fencing on both sides. Mule deer-vehicle collisions occur on both roadways, but are more common along US 189/191 because of the volume and speed of traffic. Although the Green River is a formidable waterway, especially in the spring, mule deer are able to navigate it quickly.

UPPER GREEN RIVER– HOBACK SEGMENT: LAND USE

This 25-mile segment crosses a mix of land ownership, includ-



Map 16. Land-ownership patterns in the Upper Green River - Hoback Segment.



Map 17. Special-use areas in the Upper Green River - Hoback Segment.

ing 52% private, 28% BLM, 15% USFS, and 5% state (Map 16). The majority of private lands are used for agricultural purposes, such as hay production and livestock grazing. However, some of the private lands are rural residential developments. Based on available data, approximately 2% of the private land in the Upper Green River-Hoback segment has been placed in conservation easement²⁰ (Map 17). The BLM and USFS lands in this segment are administered by the Pinedale field office and BTNF, respectively. The route passes through the BLM's Green River SRMA and WSR (Map 17). On the west side of US 189/191, the route passes directly through the Franz elk feedground operated by WGFD. Guidance for management of the USFS lands is provided in the BTNF land-use plan²¹, which was recently amended to protect the Path of the Pronghorn migration²².

Summary

The RDH migration represents the longest mule deer migration ever recorded. Because it connects the desert region of the southwest with the mountainous region of northwest Wyoming, the journey these deer make is emblematic of the Wyoming landscape. This route also illustrates the tremendous effort ungulates undertake to access high-quality forage in distant mountain ranges. It is likely that other mule deer herds in Wyoming and the West historically migrated as far or farther than the RDH deer, but those migrations have been lost due to habitat loss, barriers, and other factors. This type of long-distance migration is still possible in parts of western Wyoming because the vast landscape remains relatively open and intact.

However, as more demands are placed on our public lands (e.g., recreation and energy development), and some private lands are converted from traditional ranches to residential development, the journey these deer make each year will become more difficult. The narrow width of this migration

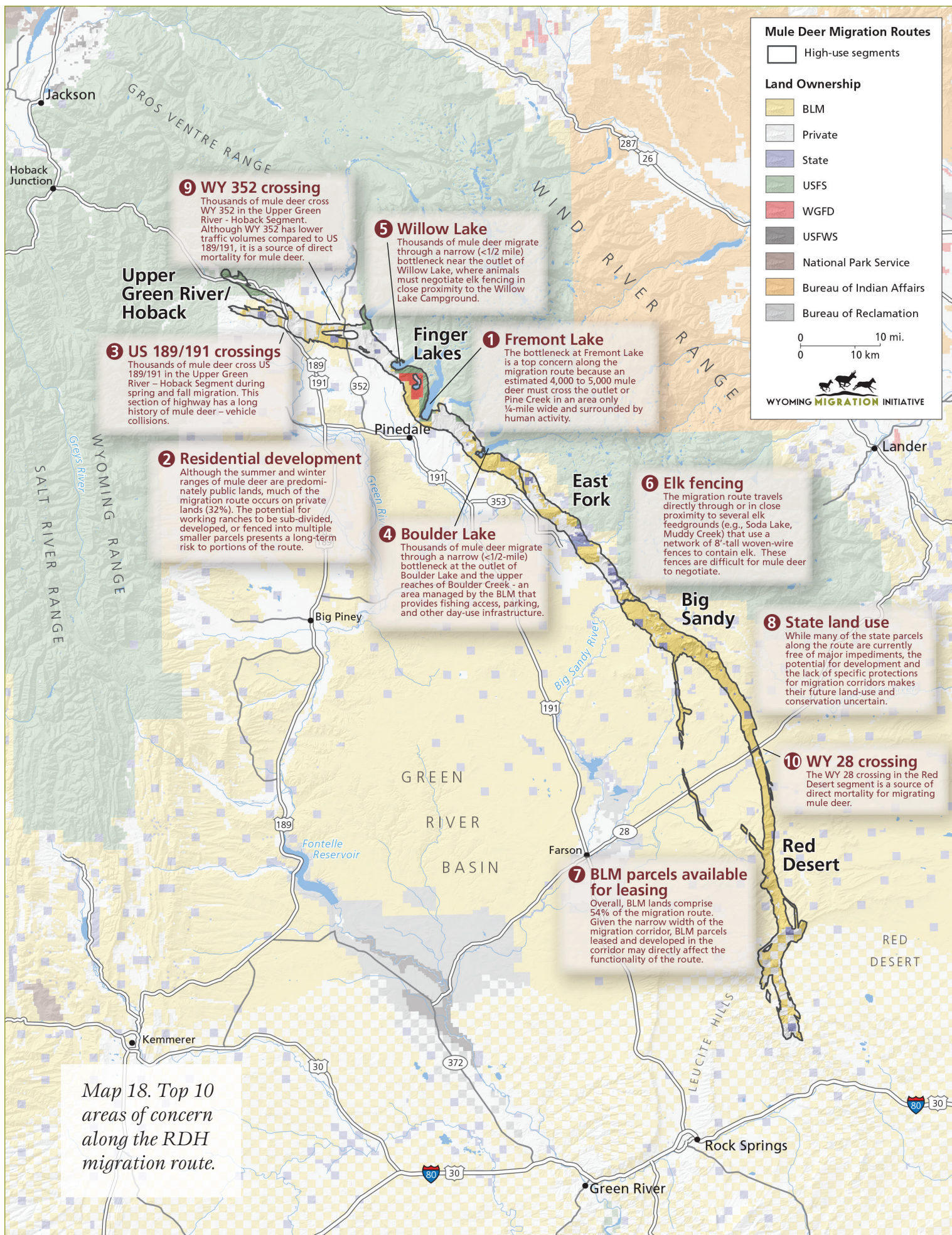


Mule deer on the move between Willow and Fremont Lake.

corridor reminds us that land-use decisions made in one small parcel could affect thousands of animals over a much larger region. Even though mule deer are able to navigate the migration route in its current form, there are areas where the route could be made more permeable for mule deer, which would improve the functionality (e.g., movement and foraging benefits) of the route¹¹. Fortunately, advances in GPS-telemetry and associated mapping methods now allow us to accurately delineate migration routes across

large landscapes and provide stakeholders with the information needed to effectively conserve ungulate migration.

With the help of state and federal agency managers, we identified the top 10 areas of concern along the entire route of the RDH migration (Map 18). In most cases, these areas represent opportunities to improve the permeability of the route by reducing the current challenges faced by deer thereby helping to sustain the RDH migration into the future.





Top 10 areas of concern along the RDH Migration

1 Fremont Lake – The bottleneck at Fremont Lake is a top concern along the RDH migration for several reasons. First, is the narrow width and number of animals – an estimated 4,000 to 5,000 mule deer cross the outlet or Pine Creek in an area only 400 meters wide. For mule deer that choose to swim the outlet, drowning is a real risk, especially in the spring when animals can break through the ice or have difficulty negotiating ice sheets. Adding to the concern is the high level of human activity that deer must contend with as they cross Pine Creek or swim the outlet, move past the marina and multi-use trails at CCC Ponds, and cross the paved FS 111 and CR 154 roads. The elk fence on the northwest side of the outlet can also be a source of confusion for deer, as it runs perpendicular to the lake, and the only place to easily cross is a short fence gap near the high water line. It is common to see deer walking back and forth along the north side of this fence during the fall migration, searching for a way through or around the fence. The outlet area is a mix of USFS, BLM, and private lands. We note that while Fre-

mont Lake is a difficult area for mule deer, it is also a promising area for public awareness and outreach. It is rare that such a migration coincides with a major recreational center on the outskirts of town.

2 Rural residential development – Although the summer and winter ranges of mule deer are predominately public lands, much of the RDH migration route (East Fork, Finger Lakes, and Upper Green River–Hoback segments) consists of private lands (32%). The functionality of such migration route segments rely on landowner tolerance of large numbers of animals moving through their property. Large, intact parcels of private land with wildlife-friendly fences are not a concern. However, the potential for working ranches to be subdivided, developed, or fenced into multiple smaller parcels presents a long-term risk to portions of the migration route²³.

3 US 189/191 crossings – Most mule deer cross US 189/191 at least two times in the Upper Green River–Hoback Segment. US 189/191 has a long

history of mule deer – vehicle collisions, which could increase with higher traffic levels as this route leads to popular national parks and forests. Right-of-way fencing on both sides of the highway is effective at keeping livestock off the highway, but can make these areas more difficult for the estimated 4,000 to 5,000 mule deer that must cross them multiple times each year.

4 Boulder Lake – Thousands of mule deer migrate through a narrow (less than 1/2-mile) bottleneck at the outlet of Boulder Lake and the upper reaches of Boulder Creek. This area is managed by the BLM as part of the Boulder Lake Special Recreation Management Area (SRMA). Currently, the area provides fishing access, a large parking lot, restrooms, and other day-use infrastructure. If or when additional infrastructure is built to accommodate increasing recreational use, careful planning will be needed to avoid impacts to migrating mule deer.

5 Willow Lake – Thousands of mule deer migrate through a narrow (less than 1/2-mile) bottleneck near the outlet of Willow



Thousands of mule deer cross US 189/191 each year, just south of the Hoback Rim.

Lake. Mule deer must negotiate elk fencing through gates, corner jump-offs, or other means. Most deer move along this elk fence to the corner at Willow Lake Campground. Here deer move a short distance on CR 119 in between the elk fence and the Willow Lake Campground. The Willow Lake Campground is a popular destination area during the fall migration, when many deer are forced (by the elk fence) to travel directly by the camp-

ground. The management of this area around the outlet is complicated by the mix of USFS, BLM, and private lands.

6 Elk fencing – The RDH migration travels directly through or in close proximity to several elk feedgrounds operated by the WGFD, including Muddy Creek, Scab Creek, Fall Creek, Soda Lake, Black Butte, Franz, and McNeel feedgrounds. Some of the feedgrounds, like

Soda Lake and Muddy Creek, use a network of 8-foot-tall woven-wire fences to contain elk. For example, approximately 20 miles of elk fence has been constructed between Fremont Lake and New Fork Lakes (see Finger Lakes Section). Although these fences have some gates and corner jump-offs, the gates are not always open when deer need them and the height (more than 5 feet) of some of the jump-offs discourages deer from using



them. Deer can find several places to crawl underneath these fences, but bucks are often prohibited from moving underneath because of their antlers. Snow events and human disturbance are likely to exacerbate the navigational challenge these fences pose for migrating deer.

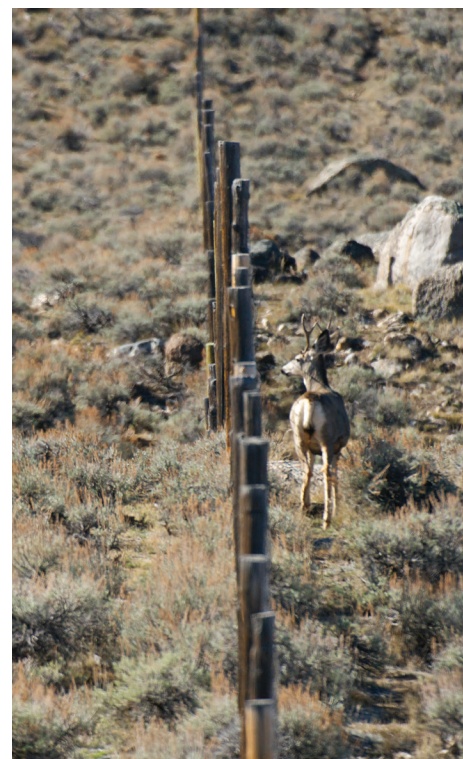
7 BLM parcels available for leasing – Overall, BLM lands comprise 54% of the RDH migration route. Much of the BLM lands along the Wind River Front are managed for wildlife and not available for energy leasing, as designated by the Wind River Front Management Area described in the Pinedale RMP. Not all of the BLM lands in the Rock Springs field office are similarly protected, either along the Wind River Front or in the Red Desert. Additional BLM parcels in the Red Desert have some wildlife protections through Areas of Critical Environmental Concern (ACEC) or other management area designations. Recent work in south-central Wyoming¹¹ and northern Colorado¹⁰ has documented impacts of oil and gas development to migratory mule deer (see Box 1). Given the narrow width of the RDH

migration corridor, BLM parcels leased and developed in the corridor may directly affect the functionality of this route.

8 State land use – Compared to BLM and private ownership, state lands make up a relatively small percentage (6%) of the RDH migration. Nonetheless, state parcels are located in several key areas of the route. While many of the state parcels in the RDH are currently free of major impediments to migration, state lands managed by the OSLI may experience a future increase in energy development, related infrastructure, and grazing allotment infrastructure (fencing), to meet their fiduciary responsibilities. Additional development in these key areas makes their future land-use and conservation uncertain.

9 WY 352 crossings – The WY 352 crossing(s) in the Upper Green River segment are a source of direct mortality for mule deer. The level of mule deer-vehicle collisions is expected to increase with traffic volume, as Sublette County grows and as recreation in the Wind River Range and Green River Lakes becomes more popular.

10 WY 28 crossing – The WY 28 crossing in the Red Desert segment is a source of direct mortality for mule deer. The traffic volume, high vehicle speeds, and unusually tall (52 inches) right-of-way fencing make this area problematic for migrating mule deer. The Wyoming Department of Transportation (WYDOT) has committed to lowering the top wire of this fence in 2014, but deer will still need to cross WY 28 at grade-level.



Mule deer searches for way around elk fence near Fremont Lake.



A mature buck pauses along migration route near Willow Lake.

Management Considerations

The intact long-distance ungulate migrations of western Wyoming are not only a highly valued local resource, but also an iconic symbol of wildness that resonates with a public far beyond Wyoming's borders. Sustaining such migrations presents a challenge that will require stakeholder collaboration to proactively implement effective measures to accommodate long-distance migration in a multiple-use landscape. The RDH migration highlights the need to coordinate such efforts

across agency jurisdictions and land ownership boundaries. The toolbox for migratory mule deer management and conservation continues to evolve and includes many management options.

- Modifying or removing fencing can improve landscape permeability for mule deer and other wildlife. Installing gates or let-down panels and ensuring they are open during migration can also help mitigate deer movement issues created by fences.
- Underpasses with game-proof fencing have effectively

reduced mule deer–vehicle collisions and maintained migration routes in other parts of western Wyoming²⁴. Given the relatively well-defined and narrow corridors where mule deer cross highways WY 28, WY 352, and US 189/191, the installation of wildlife underpasses and fencing modifications could improve roadway permeability and mitigate problems with mule deer–vehicle collisions.

- Dynamic signs and reduced speeds may help to warn mo-



torists of migrating deer and reduce collisions.

- Understanding the timing of migration can help reduce potential impacts or disturbance to deer, especially near popular recreation areas. Such information can also help agencies refine harvest strategies
- Given the desirable location and proximity to Pinedale, working ranches are increasingly at risk of rural development²⁵. Land trusts and off-site mitigation programs have been allocating considerable resources for conservation easement purchases in Sublette County. The land ownership and special use maps in this document may help identify areas where conservation easements would benefit migratory mule deer.

- For some parcels, land exchanges between state agencies or between state and federal agencies may be appropriate to consolidate lands and ensure consistent management for habitat conservation purposes.
- Habitat improvement projects can take many forms (e.g., fire, chemical, mechanical treatments, grazing modification, market-based mitigation²⁶) to improve forage conditions for mule deer. Maps of migration routes and stopover locations can help managers prioritize and appropriately target such projects.
- Clear and spatially explicit maps of migration corridors can be readily incorporated into land-use planning documents, such as Resource Management Plans

(RMP). In a few cases, federal land-use plans have designated special protections for migration routes, such as the (Trapper's Point ACEC and Path of the Pronghorn through BTNF). Directional drilling technology could provide a means to maintain no surface occupancy (NSO) in narrow corridors, while still accessing gas or shale, and ensure that developed parcels in the RDH route do not negatively impact the migration.

- Outreach and education can play an important role in long-term management or conservation efforts. The RDH migration presents a unique opportunity for the public to understand and appreciate this migration that is unique and emblematic of Wyoming's wide open landscapes.



Mule deer follow the spring green-up into the Hoback Basin.

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*Back Cover Photo: View from migration route as it passes sand dunes and approaches Steamboat Mountain.
View south of North and South Table Mountains*



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