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Science & Policy Brief

Habitat Fragmentation from Roads: Travel Planning Methods to Safeguard Bureau of Land Management Lands

Key Points

- Habitat fragmentation from roads presents a major threat to the survival of wildlife populations throughout the United States.
- In the United States, the public lands managed by the Bureau of Land Management (BLM) provide much of the remaining intact habitat—untouched by roads and unaffected by fragmentation from human activities—for a wide variety of species, particularly in the West.
- The travel management planning process provides the most logical and effective context within which to evaluate the current level of habitat fragmentation and take steps to reduce it.
- Robust and well-accepted metrics exist to measure habitat fragmentation and help design strategies to protect and improve wildlife habitat.
- Measuring and addressing habitat fragmentation is consistent with the BLM's legal obligations and its duties as a steward of the public lands.
- The BLM can and should use various analytical methods as part of its travel management planning process to ensure that decisions are based on an understanding of existing habitat fragmentation and its impacts on wildlife, and to develop road networks that will minimize future habitat fragmentation.

PHOTO COURTESY SUWA.ORG

One of the greatest threats to biological diversity worldwide is habitat fragmentation from roads, such as this one typical of the extensive road networks on BLM lands throughout the West.

Habitat Fragmentation, Roads, and Wildlife

> *"Among the most widespread forms of modification of the natural landscape during the past century has been the construction and maintenance of roads."*
>
> —S.C. Trombulak and C.A. Frissell, *Conservation Biology*, Vol. 14, 2000.

Habitat fragmentation has been defined as the "creation of a complex mosaic of spatial and successional habitats from formerly contiguous habitat" (Lehmkuhl and Ruggiero 1991). Habitat fragmentation alters the distribution of wildlife species across the landscape and affects many life functions such as feeding, courtship, breeding, and migration. Transportation networks are one of the most significant causes of habitat fragmentation, and negatively affect wildlife well beyond the amount of surface area disturbed by actual roads.[1] In fact, habitat fragmentation from roads and other human infrastructure has been identified as one of the greatest threats to biological diversity worldwide (Wilcove 1987).[2] The adverse effects of roads on wildlife have been well documented in several extensive literature reviews (Trombulak and Frissell 2000, Gucinski et al. 2001, Gaines et al. 2003, Wyoming Game and Fish Department 2004, New Mexico Department of Game and Fish 2005).

In an issue of the journal *Conservation Biology* dedicated to the ecological effects of roads, the opening review article by ecologists Trombulak and Frissell (2000) outlines the following general effects of roads on terrestrial and aquatic wildlife:

- Mortality from road construction
- Mortality from collisions with vehicles
- Modifications of animal behavior
- Disruption of the physical environment
- Alteration of the chemical environment
- Fragmentation of connected habitats
- Spread of exotic species
- Increased alteration and use of habitats by humans

More specific examples of some of these effects include:

- Habitat removal from road construction and loss of large, contiguous blocks of core habitat
- Diminished animal use of habitats because of noise, dust, emissions, and the presence of humans
- Loss of forage for herbivores
- Interference with wildlife life-history functions (courtship, nesting, migration, and others)
- Increased poaching or unethical hunting practices
- Increased dispersion of recreation impacts, particularly by off-road vehicles
- Degradation of aquatic habitats through alteration of stream banks and increased sediment loads

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1 In this document, we are using the term "road" to refer to defined motorized routes, including roads and designated motorized trails on BLM lands. Nonetheless, many such routes on BLM lands do not meet the legal definition of a "road," because they were illegally created and/or not improved or maintained by mechanical means to ensure regular use. *See* H.R. Rep. No. 94-1163 at 17 (1976). Existing routes that do not meet this definition should not ultimately be considered part of an existing transportation network and should be prioritized for closure and restoration. For purposes of this discussion, however, we are primarily using the term "road" for convenience and because the use of motorized routes, whether legal or not, nonetheless impacts wildlife and contributes to habitat fragmentation.

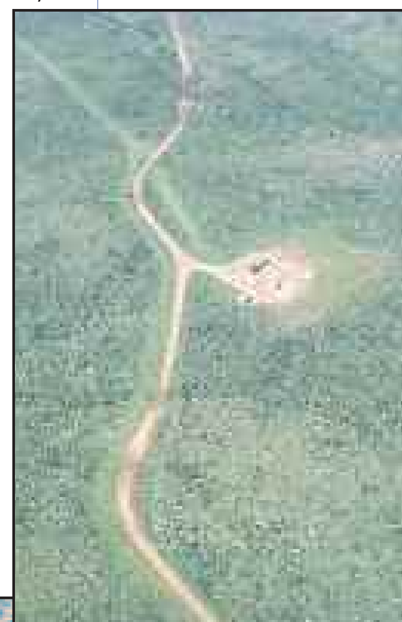
2 Habitat fragmentation also occurs naturally in landscapes due to heterogeneity in vegetation types and topography, wildfire, stream channels, and other natural biological and physical features and processes. This document addresses human-caused fragmentation from roads and other routes, which is additive to the landscape's natural heterogeneity.

The New Mexico Department of Game and Fish (NMGF) compiled a report (New Mexico Department of Game and Fish 2005) that focuses on roads as "a **major contributor to habitat fragmentation** because they divide large landscapes into smaller patches and convert interior habitat into edge habitat" (*p. 3, emphasis added*). Similar to Trombulak and Frissell's paper, the NMGF report identifies the adverse effects of habitat fragmentation on wildlife. The report states that habitat fragmentation from roads increases isolation of populations or species, leading to:

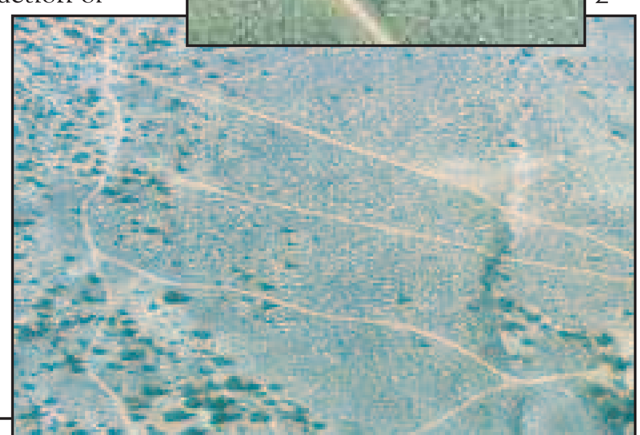
- Adverse genetic effects
- Increased potential for extirpation of localized populations or extinction of narrowly distributed species from catastrophic events
- Changes to habitat composition, from weedy and invasive species
- Changes to type and quality of food base
- Changes to microclimates by altering temperature and moisture regimes
- Changes to flows of energy and nutrients
- Changes to availability of cover and increasing edge effect, potentially bringing together species that negatively affect the survival of others
- Increased opportunities for exploitation by humans (*p. 3*)

The Wyoming Game and Fish Department (WGFD) prepared a report containing comprehensive guidelines for wildlife protection in areas of energy development, based on a literature review on the effects of roads, other infrastructure, and activities associated with energy development on Wyoming's sagebrush and grassland habitats and wildlife species (Wyoming Game and Fish Department 2004). Because a substantial portion of the impact of oil and gas development comes from its relatively dense road network, much of the literature cited in the report documents the impacts of roads on wildlife. The report acknowledges the threat to wildlife from fragmentation, identifying fragmentation and diminishing quality of sagebrush ecosystems as "the principal reasons why populations and distributions of wildlife are declining" (*p. 1*). The report demonstrates the likelihood of habitat fragmentation from roads and other disturbances associated with energy development, and emphasizes the range of damage to habitat that occurs from such development:

> Adverse effects of oil and gas development can be divided into 6 general categories: 1) direct loss of habitat; 2) physiological stress to wildlife; 3) disturbance and displacement of wildlife; 4) **habitat fragmentation and isolation**; 5) introduction of competitive and predatory organisms; and 6) secondary effects created by work force assimilation and growth of service industries. The direct loss or removal of habitat is always a con-



PHOTOS ON THIS PAGE: JANICE THOMSON



Views of motorized vehicle impacts on BLM lands. Top to bottom: Well pads and roads in the Little Snake Resource Area in northwestern Colorado; dirt roads crisscross arid lands in Utah; off-road driving damages vegetation and soils, as seen in this picture taken in Utah.

> cern, however oil and gas developments are typically configured as point and linear disturbances scattered across broad areas. **Collectively, the amount of disturbance may encompass just 5-10% of the land. However, avoidance and stress responses by wildlife extend the influence of each well pad, road, and facility to surrounding habitats.** (*p. 5, emphasis added*)

The report provides further details about how oil and gas development causes habitat fragmentation:

> **As densities of wells, roads, and facilities increase, the effectiveness of adjacent habitats can decrease until most animals no longer use the habitat**. Although vegetation and other natural features may remain unaltered within areas near oil and gas features, wildlife make proportionately less use of these areas than their availability. Animals attempting to forage inside the affected zones are also subjected to increased physiological stress. The avoidance/stress effect impairs function by reducing the capability of wildlife to use the habitat effectively. In addition, **physical or psychological (i.e., disturbance-related) barriers lead to fragmentation of habitats and further reduce the availability of effective habitat. These impacts can be especially problematic when they occur within limiting habitat components such as crucial winter ranges and reproductive habitats**. (*p. 5, emphasis added*)

The WGFD report further notes that the development, such as roads, associated with oil and gas activities will harm wildlife populations even if there is suitable habitat nearby:

> When activities associated with energy development displace animals from otherwise suitable habitats, the animals are either forced into marginal habitats or they compete with animals that already occupy the unaffected habitats. Consequences of such displacement and competition are lower survival, lower reproductive success, lower recruitment, and ultimately lower carrying capacity and reduced populations. (*pp. 6-7*)

As documented by comprehensive literature reviews and the additional conclusions reached by state agencies in their respective reports, the existence of a road can result in habitat fragmentation and, depending on the use of the roads, have impacts extending well into surrounding habitats. Such fragmentation from transportation networks is immediate and can lead to a range of risks to the survival of wildlife. Travel management planning determinations about the existence, closure, placement, and levels and types of use of roads are an ideal context for measuring and addressing habitat fragmentation.

BLM Lands and Transportation Planning

As landscapes become increasingly fragmented by roads and other human infrastructure, protection of the remaining areas of intact habitat becomes increasingly vital to the survival of wildlife—from game species and wide-ranging carnivores to songbirds—and more fundamentally to the natural functioning of ecosystems. In the United States, the public lands managed by the BLM provide much of this remaining intact habitat for a wide variety of species, particularly in the West and Alaska.

For example, Wyoming's Upper Green River Valley is the largest block of publicly owned winter range for big game in the 19-million-acre Greater Yellowstone Ecosystem. Compromising this winter habitat could affect ungulate populations in five surrounding mountain ranges of western Wyoming (Sawyer and Lindzey 2004). Similarly, in its *National Sage-*

Grouse Habitat Conservation Strategy (Bureau of Land Management 2004a), the BLM acknowledges both the amount of habitat under its control and the importance of its management, stating: "As the land manager of almost half of the remaining sagebrush habitat, BLM plays a key role in conserving sage-grouse and sagebrush habitat" (*p. 3*).

The placement, design, and use of roads determine which areas will remain or become intact habitat, and which areas will be fragmented by roads and how. In other words, decisions regarding roads and other motorized routes will determine the degree of modification that occurs to the composition, structure, and function of ecosystems, including water flow and quality, other physical elements, vegetation, and wildlife.

The travel management planning process, which requires agencies such as the BLM to manage motorized and other human travel across the landscape by defining a travel network and determining appropriate uses of various travel routes, provides the most logical and effective context within which to evaluate the current level of habitat fragmentation and take steps to reduce it. The BLM can and should use various analytical methods as part of its travel management planning process to ensure that decisions are based on an understanding of existing habitat fragmentation and its impacts on wildlife, and to develop road networks that will minimize future habitat fragmentation. Because of the importance of BLM lands in providing intact habitat for wildlife species, the decisions made in travel management plans for BLM lands will play an essential role in protecting critical wildlife habitat throughout the West.

Measuring Habitat Fragmentation

Measuring habitat fragmentation from roads is a key means of determining the status of existing wildlife habitats and developing management strategies to safeguard and improve them. There are many ways to measure habitat fragmentation; three of the most useful metrics, due to their ease of calculation and direct connection to biological field research, are road density, number and size of core areas, and distance to a road.

PHOTO BY JOHN FANDEK

PHOTO BY DAVE MENKE/US FISH AND WILDLIFE SERVICE

The BLM's transportation management decisions will play an essential role in protecting critical habitat for many wildlife species, such as the moose (top) and pronghorn (bottom) pictured here, that depend on BLM lands throughout the West.

Road density can be calculated by measuring the length of road divided by the area in a given region, and is often reported as **miles of road per square mile** (mi/mi^2). **Core areas** are defined as land beyond a given distance, or road effect zone, from transportation routes (Forman 1999). The **number and sizes of core areas** can be calculated, as can a region's total **amount of core area**

beyond a given distance or effect zone from roads. Because different wildlife species respond to road-related disturbances at varying distances (and depending on the road type and activity level), it is important to determine measures of core area for a range of effect zone widths relevant to particular species found in the area (e.g., 100 feet, 500 feet, 1 mile, 2 miles, etc.). Measuring the amount of **land within a given distance to a road or within an effect zone** is the inverse of measuring the acreage of core areas, and represents a measure of the habitat affected by roads.

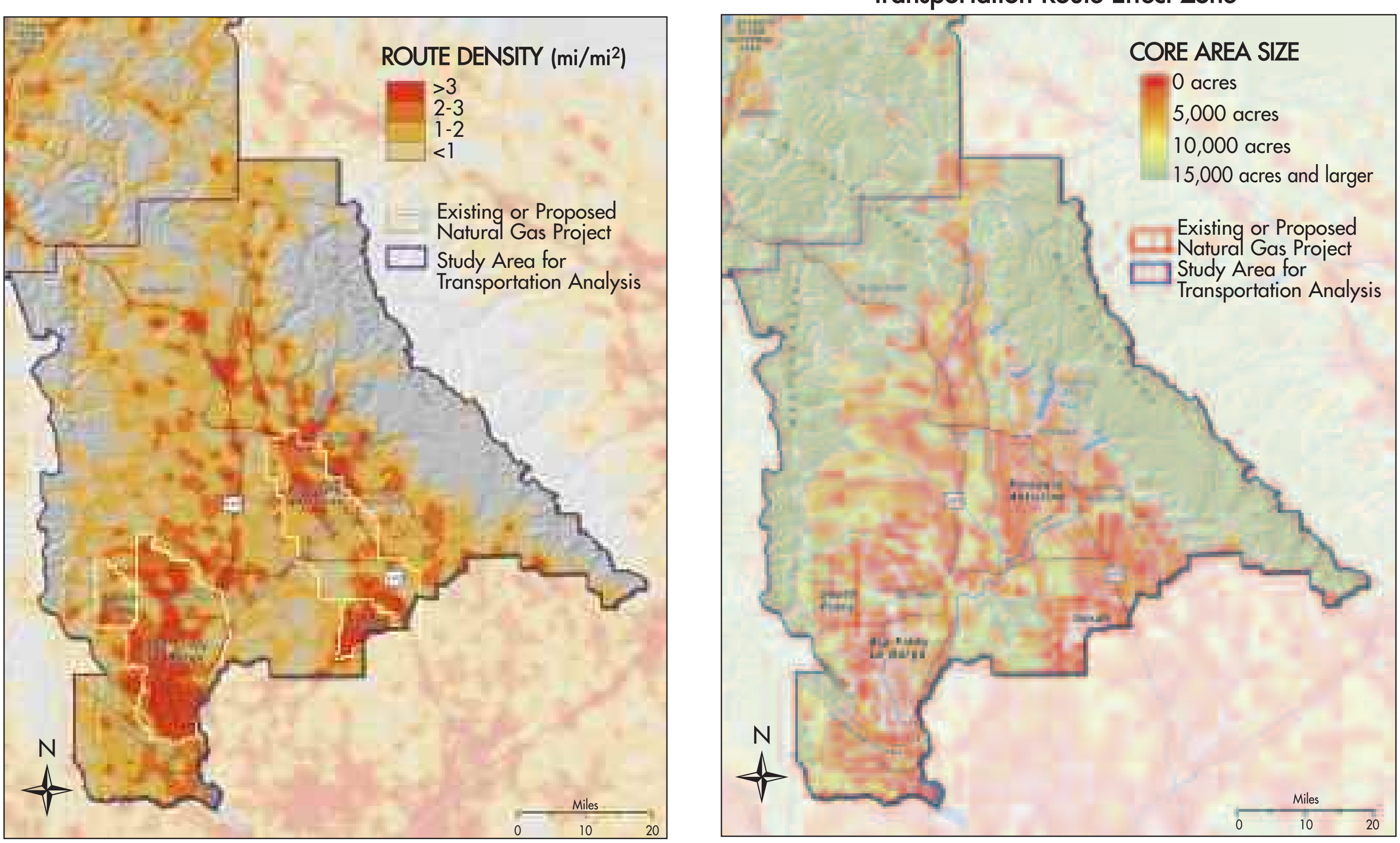
Several computer software packages can aid in calculating habitat fragmentation metrics. The BLM maintains the geographic information system (GIS) software ArcGIS, a commercial software package produced by the Environmental Systems Research Institute that can be used to calculate metrics including **road density, core area size, and road effect zone size** (Figure 1). RoadNET (Road Network Evaluation Tool) is a spatially based application developed by The Wilderness Society that enables quantitative assessment of habitat fragmentation due to roads. RoadNET can be used to measure **road density**, in order to identify roadless areas and **assess the degree of fragmentation**, and to measure the **location, size, and number of**

FIGURE 1.

Habitat Fragmentation Metrics

a. Transportation Route Densities

b. Core Habitat Areas Outside a 500-Foot Transportation Route Effect Zone



Areas of high habitat fragmentation may be identified by generating maps of road density (a) and core area size (b). These figures, from the Wilderness Society report *Wildlife at a Crossroads* (Thomson et al. 2005), were produced using ArcGIS and depict the BLM Pinedale Resource Management Area in Wyoming.

core areas, the size of the **road effect zone**, edge density,[3] and other relevant indicators of fragmentation. It was used in some of the Wilderness Society analyses discussed below to evaluate GIS-based road data obtained from the BLM representing existing transportation networks.

Measuring the Effects of Fragmentation on Wildlife

Wildlife literature can be tied directly to habitat fragmentation metrics through field studies measuring the effects of different road densities, the size requirements for core areas, and the widths of road effect zones for particular species (Gucinski et al. 2001, Gaines et al. 2003, Wyoming Game and Fish Department 2004, New Mexico Department of Game and Fish 2005). For instance, a study of grizzly bears in Montana (Kasworm and Manley 1998) showed that the bears used areas within 1,640 feet of a road substantially less than habitat more than 3,281 feet from a road. Field monitoring of bighorn sheep response to vehicle and mountain bike activity on roads (Papouchis et al. 2001) revealed that, on average, bighorn alerted at a distance of 1,190 feet and fled at 433 feet from these road-related disturbances. Meanwhile, an elk field study (Lyon 1983) suggested that road densities of 1 mi/mi^2 in forested landscapes reduce elk habitat effectiveness[4] by 25%. An ongoing study (Sawyer and Lindzey 2001, Sawyer and Lindzey 2004, Sawyer et al. 2005) of global positioning system (GPS)-collared deer in the Pinedale Anticline of Wyoming's Upper Green River Valley demonstrated that deer utilized habitat progressively farther from roads and well pads over three years of increasing gas development in the area, and showed no evidence of acclimating to energy-related infrastructure. Similar data for various species are also summarized in the NMGF and WGFD reports.

The Wilderness Society has evaluated the effects of roads on habitat for a variety of species, using GIS road data, wildlife habitat boundaries from the BLM and state agencies such as WGFD, and available literature on the responses of different species to road-related disturbances. *Protecting Northern Arizona's National Monuments* (Thomson et al. 2004) surveys the effects of road density on the desert tortoise, mountain lion, bighorn sheep, pronghorn, and mule deer. A similar analysis in *Wildlife at a Crossroads* (Thomson et al. 2005) details the effects of energy development (including wells and drill pads, but primarily roads) on mule deer, pronghorn, elk, and sage-grouse in the Upper Green River Valley of Wyoming.

Analyses by The Wilderness Society also show how the ecological effects of roads extend well beyond their physical footprint. For example, *Fragmenting Our Lands* (Weller et al. 2002) shows that roads causing direct disturbance to just four percent of a given landscape can have adverse ecological effects extending over nearly the entire area for species such as proghorn. Similarly, *Ecological Effects of a Transportation Network on Wildlife* (Hartley et al. 2003), an analysis of roads in the Upper Missouri River Breaks National Monument in Montana, showed that more than 86% of the 791-square-mile monument lies within one mile of a transportation

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3 Edge density refers to the length per unit area of edge habitat or the linear break in native habitat that is created along both sides of a road when it is built. Like road density, it can be measured in miles per square mile (mi/mi^2).

4 Habitat effectiveness refers to a landscape's ability to provide wildlife needs including forage, visual cover, and thermal cover. Habitat effectiveness is reduced by human infrastructure and disturbances such as motorized routes and their associated activities.

feature and that routes potentially reduce elk habitat effectiveness by 25% across 35% of the monument's habitat for this species.

The BLM already has the capacity to measure habitat fragmentation's effects on wildlife. For instance, a recent Draft Resource Management Plan/Environmental Impact Statement for the 5.5 million acres managed by the BLM's Vernal Field Office in Utah included extensive measurement of potential habitat fragmentation using a range of road effect zone sizes and specific impacts to be expected for different species (Bureau of Land Management 2005a, *see*, e.g., Appendix I and Section 3.19.2).

Evaluating Transportation Scenarios

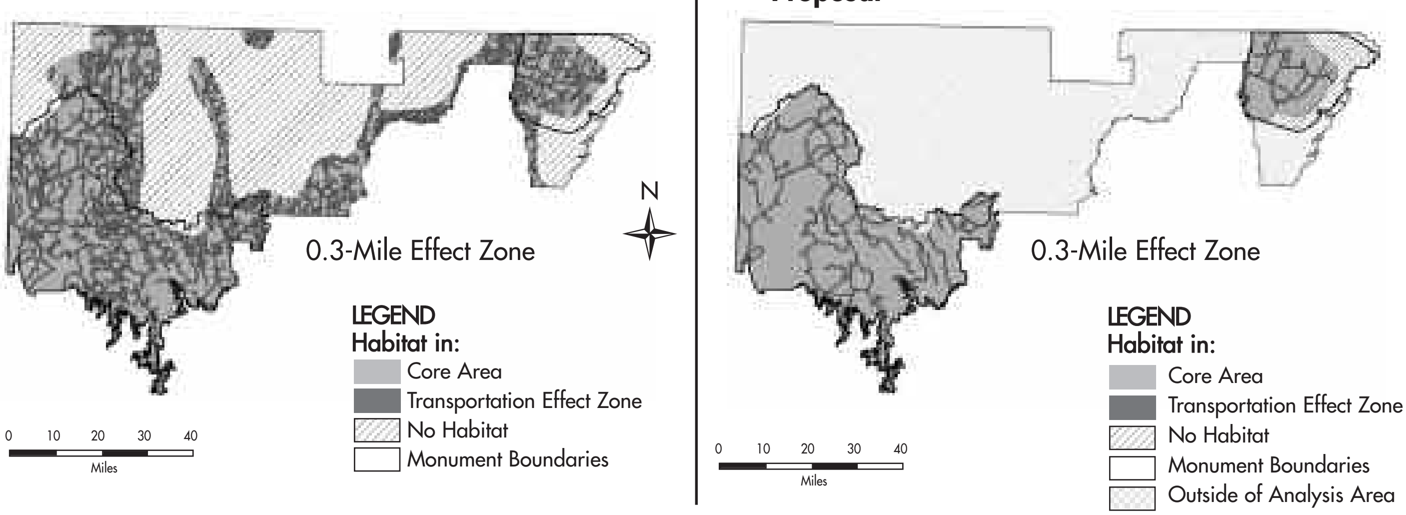
Readily available methodology and software can also help produce informed travel management scenarios that minimize habitat fragmentation. GIS analysis can be used to develop alternative transportation networks to help protect existing core habitat and linkages, as well as create new ones. RoadNET can perform **network tracing**, in order to trace the number of spur routes from a maintained or key access road, identify the miles of spur routes accessible from each junction with the main road, and identify the number of **access points**. Based on this information, an agency can identify the **most valuable location at which to construct a closure** gate or barrier to effectively close access to the greatest mileage of illegal or unwanted routes. The agency can also use this RoadNET information to identify **redundant roads** that grant access to the same place, showing which roads are not necessary to preserve. RoadNET can also show a **buffer** around roads, at various distances, to demonstrate the broader area impacted by roads (such as the differing effect zones discussed above). Further, RoadNET can consider **proximity** of roads to areas identified as in need of

FIGURE 2.

Evaluating Transportation Scenarios: Effect Zones and Core Area

a. Mountain Lion Habitat: BLM Route Inventory

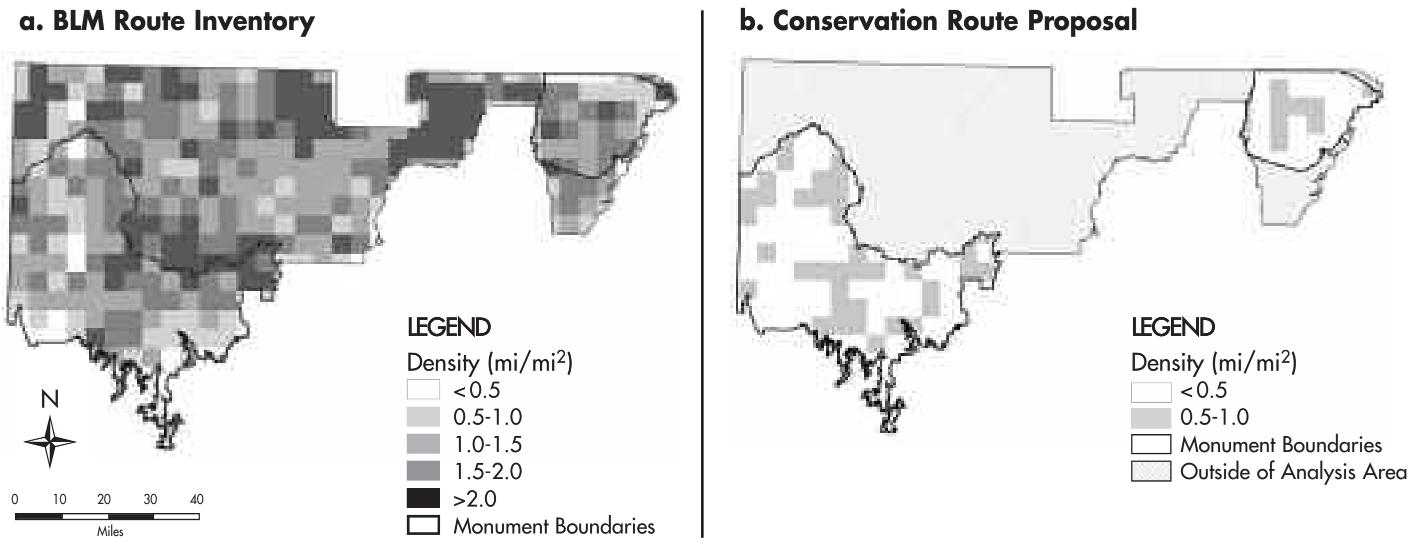
b. Mountain Lion Habitat: Conservation Route Proposal



Comparing different transportation network scenarios can help land management agencies minimize habitat fragmentation from roads. This figure, from the Wilderness Society Report *Protecting Northern Arizona's National Monuments* (Thomson et al. 2004), compares the amount of mountain lion habitat (outside a 0.3-mile road effect zone) that would be available under two different route scenarios for the BLM Arizona Strip Planning Area in northwestern Arizona.

FIGURE 3.

Evaluating Tranportation Scenarios: Route Density



Another figure from the Wilderness Society report *Protecting Northern Arizona's National Monuments* (Thomson et al. 2004) compares route density under two different transportation network proposals.

special protection, such as core habitat and linkages that are key to the continued survival of sensitive species.

The Wilderness Society has conducted such an analysis in *Protecting Northern Arizona's National Monuments* (Thomson et al. 2004), comparing the effects of an alternative transportation management plan developed to protect sensitive species with an expected BLM proposal (Figures 2 and 3). In addition to the differences depicted in the figures, the analysis of the BLM's current road inventory showed that only 10% of monument lands were more than one mile from a road, while the Conservation Route Proposal would result in 44% of monument lands more than one mile from a road, leaving substantially greater habitat for wildlife.

Travel management planning can and should seek to identify and reduce fragmentation and its potential effects on wildlife. Incorporating the methods, metrics, and literature discussed above as a vital part of travel planning on BLM lands can help safeguard the remaining intact habitat for a variety of wildlife species found on these lands.

Regulatory Context

Measuring and addressing habitat fragmentation is consistent with the BLM's legal obligations and its duties as a steward of the public lands. Applicable policy and law support the use of habitat fragmentation analysis by the BLM for informed travel management planning.

For example, the agency's *Land Use Planning Handbook* (Bureau of Land Management 2005b, Appendix C, Section II.D) requires that "Comprehensive Trails and Travel Management" address "all resource use aspects." Specifically, at the land use plan level, the BLM must identify: areas for use based on program goals and objectives, primary users, reasons for "allowing travel" in an area, setting character to be maintained (including Visual Resource Management and Recreation Opportunity Spectrum classifications), and primary means of travel appropriate to meet objectives and keep setting character. At the implementation level, the BLM must define a detailed travel management network and "establish a process" to identify roads, trails, etc., with criteria for selection, guidelines

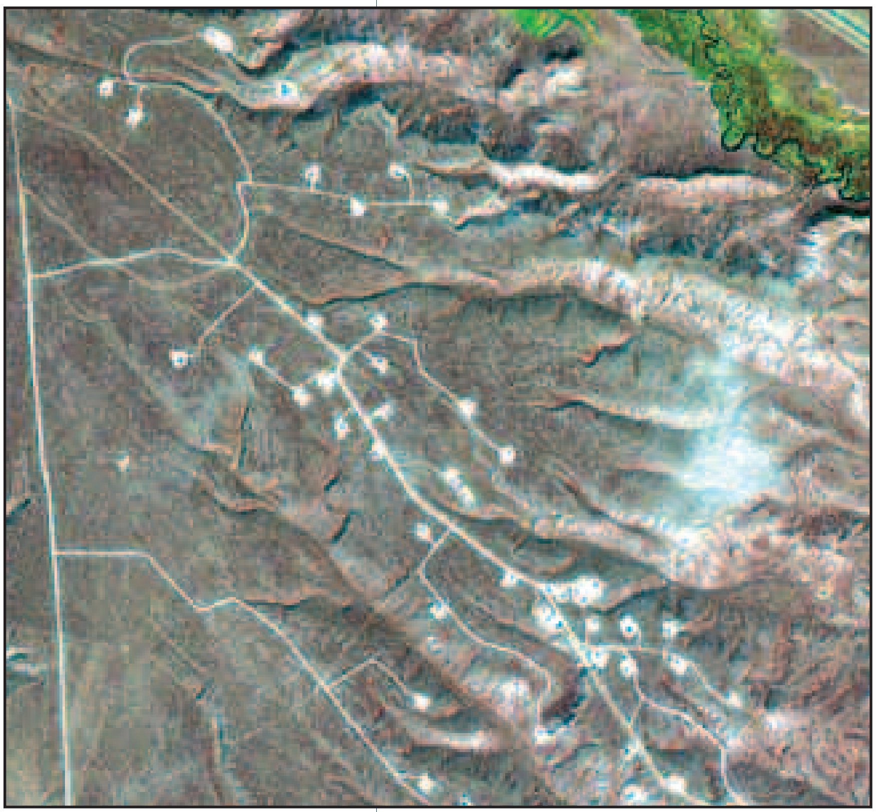


IMAGE BY SKYTRUTH

Roads and drill pads seen in Landsat satellite image of the BLM Pinedale Resource Management Area in Wyoming.

for management, monitoring, and maintenance, and measurable standards for future travel plan revision.

The Federal Land Policy and Management Act (FLPMA) obligates the BLM to manage the public lands based on its inventories of values and its assessment of potential uses, including consideration of how different uses may affect these lands.[5] The BLM can best determine the need and appropriate level of use for roads and other routes in the context of the variety of values and potential uses of the public lands, recognizing that all uses are not necessarily appropriate in all areas.[6]

FLPMA further requires that the BLM "take any action necessary to prevent unnecessary or undue degradation of the lands" and "minimize adverse impacts on the natural, environmental, scientific, cultural, and other resources and values (including fish and wildlife habitat) of the public lands involved."[7]

In certain circumstances, the BLM is required by law (in the form of both Presidential Executive Orders and the agency's own implementing regulations) to prioritize particular activities, such as protection of endangered species and archaeological and historic resources, over other potential uses or construction of roads. In general, the BLM is required to ensure that areas and trails for off-road vehicles are located:

- To minimize damage to soil, watersheds, vegetation, or other resources of the public lands
- To minimize harassment of wildlife or significant disruption of wildlife habitats
- To minimize conflicts between off-road vehicle use and other existing or proposed recreational uses of the same or neighboring public lands
- Outside officially designated wilderness areas or primitive areas[8]

The Endangered Species Act[9] requires the BLM to take actions to conserve threatened or endangered species, including designating critical habitat essential for conservation of species and developing site-specific recovery plans. Other requirements may apply to additional special-status species designated by federal or state agencies.

The National Environmental Policy Act (NEPA) requires the BLM to take a "hard look" at the potential environmental consequences of a proposed action, such as a travel management plan, so that the BLM must assess potential

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5 *See* FLPMA, 43 U.S.C. §§ 1711-1712.

6 *See* FLPMA, 43 U.S.C. 1702(c).

7 43 U.S.C. § 1732(b); §1732(d)(2)(a).

8 43 C.F.R. § 8342.1.

9 16 U.S.C. §§ 1531-1544.

impacts and effects including: "ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative."[10] NEPA's "hard look" at environmental consequences must be based on "accurate scientific information" of "high quality."[11] Essentially, NEPA "ensures that the agency, in reaching its decision, will have available and will carefully consider detailed information concerning significant environmental impacts."[12] The Data Quality Act and the BLM's interpreting guidance expand on this obligation, requiring that "influential information" (information that is expected to have a "clear and substantial" change or effect on important public policies and private sector decisions as they relate to federal public lands and resources issues, such as that information contained in or used to develop a resource management or travel management plan) use "best available science and supporting studies conducted in accordance with sound and objective scientific practices."[13]

NEPA also requires that the BLM conduct its environmental impact analysis based upon an adequate and accurate description of the environment that will be affected by the proposed action under consideration—the "affected environment."[14] The affected environment represents the baseline conditions against which impacts are assessed. The importance of accurate baseline data has been emphasized by courts, which have found that "a baseline against which to compare predictions of the effects of the proposed action and reasonable alternatives is critical to the NEPA process."[15]

The BLM has taken some steps to embrace the policy and legal obligations described above, issuing guidance that prescribes identifying habitat at risk, prioritizing protection and restoration, and using the land use planning process to accomplish these goals. For example, the BLM's *National Sage-Grouse Habitat Conservation Strategy* (Bureau of Land Management 2004a) is based on a preliminary

PHOTO TWS ARCHIVE

Sage-grouse are one of many wildlife species threatened by habitat fragmentation and loss due to roads throughout the West.

10 40 C.F.R. § 1508.8.

11 40 C.F.R. § 1500.1(b).

12 Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 349 (1989).

13 Treasury and General Government Appropriations Act for Fiscal Year 2001, Pub.L.No. 106-554, § 515. *See also*, Bureau of Land Management Information Quality Guidelines, available at http://www.blm.gov/nhp/efoia/data_quality/guidelines.pdf.

14 40 C.F.R. § 1502.15.

15 Half Moon Bay Fisherman's Marketing Ass'n v. Carlucci, 857 F.2d 505, 510 (9th Cir. 1988) ("without establishing...baseline conditions...there is simply no way to determine what effect [an action] will have on the environment, and consequently, no way to comply with NEPA.").

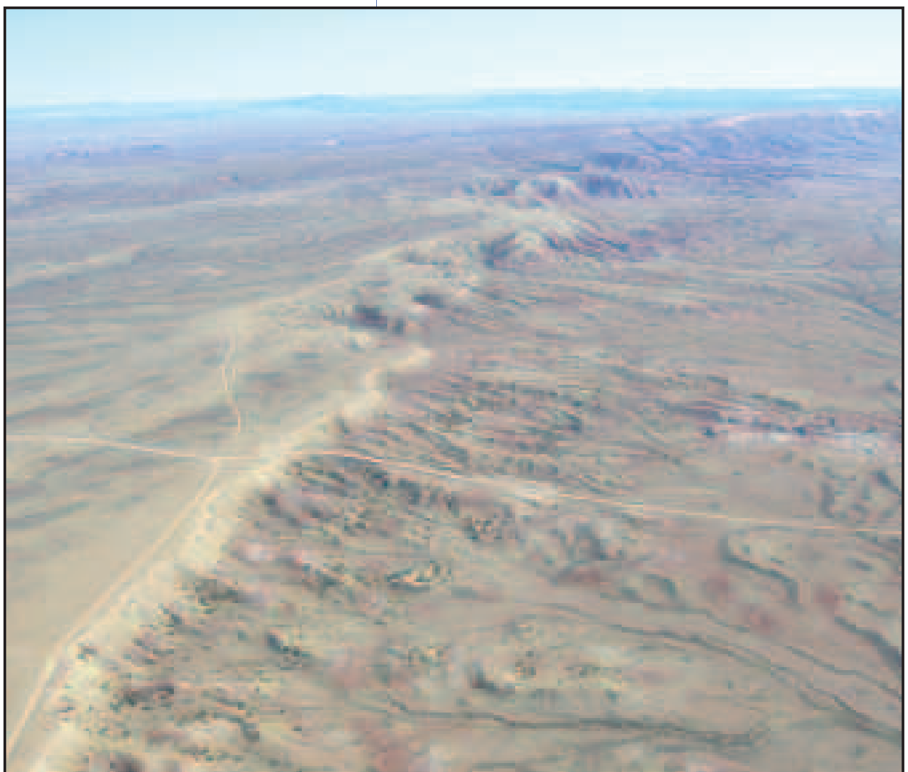

PHOTO BY JANICE THOMSON

Roads crossing sagebrush habitat in the Little Snake Resource Area in northwestern Colorado.

assessment of sage-grouse populations and habitat status, trends, and threats across the 11 contiguous Western states, with a commitment to ongoing information collection and implementation. Based on this evolving information, the agency is to "use the best available science" to develop conservation measures and then make necessary management decisions and implement "on the ground actions to conserve and restore sage-grouse habitats," with land use plans and associated implementation plans, such as travel management plans, serving as "the principal mechanisms" for doing so (*p. 7*). In order to make appropriate decisions for conserving and restoring habitat, the conservation strategy and the related planning guidance (Bureau of Land Management 2004b) prescribe identifying:

- Current condition and extent of habitat for sagebrush-obligate species
- Areas of highest priority for protecting, maintaining, and restoring habitat, taking into account size, condition, and connectivity of habitat areas
- Management opportunities to respond to identified issues or conflicts (*p. 4*)

This approach to measuring the condition of habitat and then taking action through land use planning decisions to both safeguard existing habitat and create additional habitat through restoration can and should be applied to the BLM's travel planning process for all species. Determining the existing degree of habitat fragmentation will provide the BLM with an accurate baseline against which to assess the potential impact of travel management decisions and to develop a travel management plan that can both provide a transportation network and preserve or create sufficient core habitat and linkages to support wildlife.

In this manner, wildlife and wildlife habitat, as well as the other natural, sustainable resources of the public lands such as soil, watersheds, vegetation, and wilderness, can be given the protection that they require and that the BLM is obligated to provide. Using available data and techniques for GIS analysis, the BLM can comply with its obligations to obtain baseline data on habitat fragmentation, consider the effects of various levels of fragmentation on wildlife species present, and develop a travel management plan that will achieve sufficient habitat to fulfill the agency's fundamental obligation: to protect wildlife habitat on the public lands.

What's Needed: A Travel Management Planning Process Incorporating Habitat Fragmentation Analysis

The BLM should collect and analyze the necessary data to make informed management decisions, yielding travel management plans that provide sustainable wildlife habitat. A travel management plan developed through thorough data collection and the use of fragmentation analysis will be based on a better understanding of the existing threats to wildlife habitat and the opportunities to safeguard and improve it. We recommend that the BLM incorporate this approach into travel management planning as follows:

1. Assemble wildlife habitat use information in compliance with agency obligations to use "accurate scientific information" of "high quality," and in sufficient quantity to perform the requisite thorough analysis. Information on the impacts of roads on wildlife can be collected from the published literature available for threatened and endangered species and other key plant and animal species in the area. The goal is to provide data needed to devise the parameters of fragmentation metrics and interpret the results. The information should include, but not be limited to, distribution of habitat types, the impacts of road density on local species, the distance of road effects to determine the width of effect zones for infrastructure features, and species dispersal distances to evaluate the size of core areas.
2. Generate transportation network scenarios based on the multiple resources the BLM is required to manage using reliable data and high-quality analysis.
   - Generate GIS data layers for all roads in each proposed transportation network alternative in a Draft Environmental Impact Statement.
   - Limit the potential transportation network scenarios to those that achieve long-term protection of a region's many resources for multiple use.
   - Limit roads included in the scenarios in order to: (i) eliminate user-created "wildcat" (illegal) routes in the transportation system; (ii) ensure that each road is justified and managed through an analysis of impacts on resources at the level required by NEPA, taking into account spatial patterns of roads in addition to road length; (iii) ensure that each road is necessary for its specified and defined uses.
3. Calculate landscape fragmentation metrics for all road network alternatives, guided by the best available science and supporting studies conducted in accordance with sound and objective scientific practices. Include, at a minimum, road density, road effect zones, and core areas. Metric parameters and the evaluation of results should be relevant to ecological conditions, species that are present, and human uses of the landscape.
4. Integrate the results of fragmentation analysis into management plan alternatives and use them as the basis for selecting the preferred alternative. Through the application of the metrics to relevant ecological conditions and other uses, evaluate the direct, indirect, and cumulative impacts of the various alternatives. The preferred alternative should be determined and modified based on the metrics with an objective to reduce impacts on wildlife. Include these wildlife impacts with other ecological impact data in the planning documents throughout the land use planning process and subsequent management or land use decisions.
   - To the extent that the BLM intends to rely on mitigation of potential impacts, sufficient support for the success of mitigation must be developed.
   - Include a road closure plan and define necessary mitigation to protect and improve habitat, core areas, and Areas of Critical Environmental Concern. Procedures, protocols, and priorities should be

defined and implemented to close and reclaim roads and routes that are unnecessary, do not meet the legal definition of a road, or are no longer actively used for a specified purpose.

- Establish an adaptive management plan to ensure that the effects of the existing plan are monitored and that additional road closures and other mitigation measures are completed if monitoring and additional data collection indicate that wildlife populations are negatively affected. Adaptive management can help fulfill the obligations to monitor, evaluate, and revise plans, but only so long as the adaptive management approach is actively monitored and enforced. There must be detailed, specific metrics and measurements to be monitored, with defined actions that will be taken if thresholds are met, and a clear mechanism for enacting needed changes to the plan.

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