WILDLIFE IMPACTS ANALYSIS

A Spatial Model for Minimizing Impacts to Wildlife from the Proposed Mountain States Transmission Intertie

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July 2012

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Produced for MSTI Review Project
by Craighead Institute

ABOUT THE MSTI REVIEW PROJECT

The MSTI Review Project is a joint effort between three Montana counties and five non-governmental organizations along the Montana-Idaho border to conduct an independent analysis of the Mountain States Transmission Intertie (MSTI).

For more information, please visit the project web site: www.mstireviewproject.org

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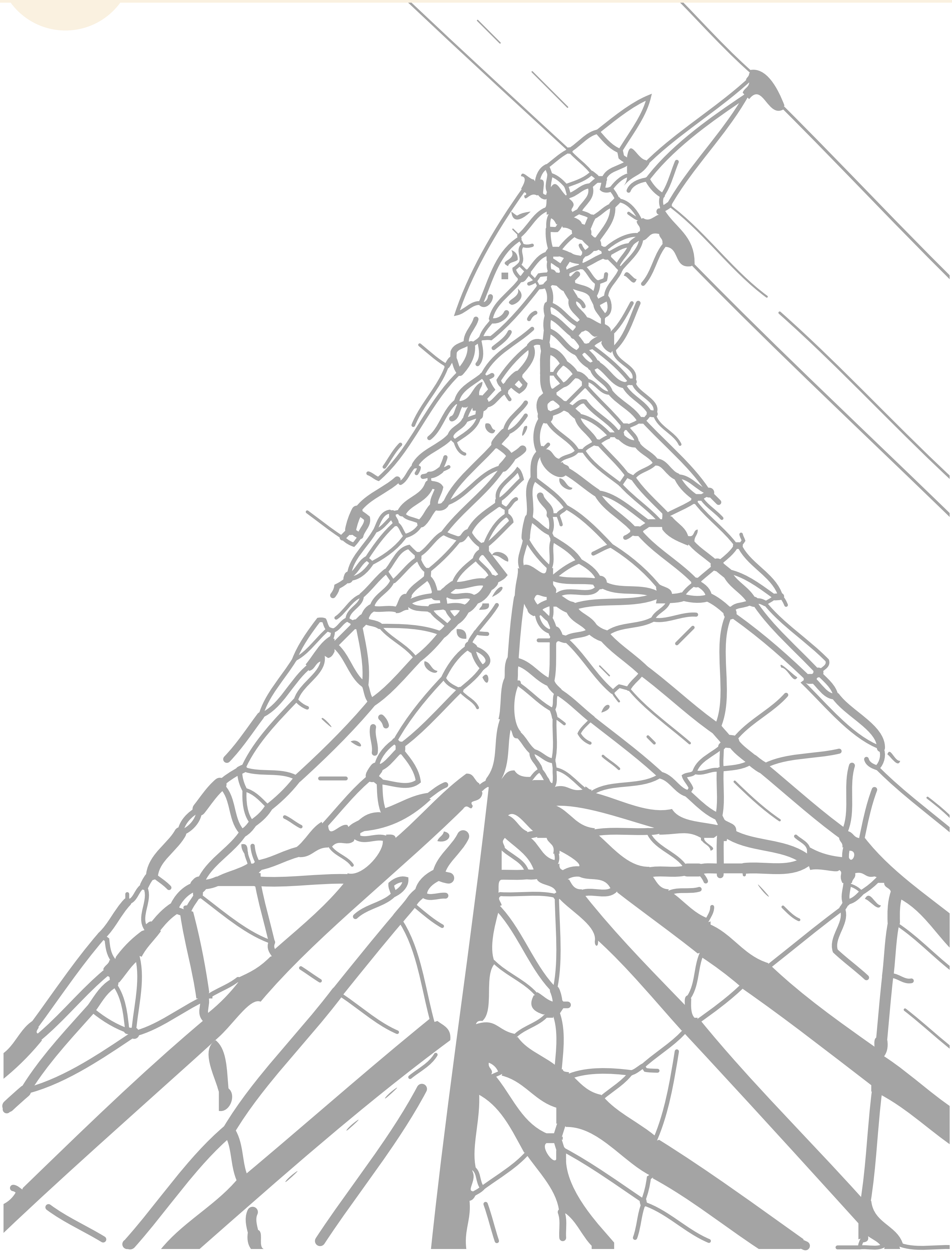


Introduction

The Mountain States Transmission Intertie (MSTI) proposed by NorthWestern Energy would be a 500 kV transmission line carrying energy from Townsend, Montana to Jerome, Idaho. The region of southwestern Montana and eastern Idaho this line would traverse is renowned for its abundant wildlife, scenic views, rural character, and outstanding outdoor recreation opportunities. A large transmission line in this area could potentially have significant impacts on area wildlife and proper siting of the line will be essential to minimize those impacts. As part of the MSTI Review Project (MRP), we developed a spatially explicit model as one tool for exploring alternatives that minimize potential impacts to wildlife from the proposed MSTI line. This tool does not address whether the transmission line should be built, replicate or replace the regulatory process, or estimate the actual impacts to wildlife likely to occur. The model maps the relative effects on wildlife based on perceived and documented sensitivities according to published research or the expertise of qualified professional biologists. This map is used to generate a model that explores all possible routes connecting the endpoints of the proposed MSTI line to find the most suitable corridors that would result in the least accumulated costs in terms of reduction in wildlife populations or habitat quality.

Limitations and Use Guidelines

This report details the methodology used to develop the MRP wildlife model as well as key findings of the analysis. As with any analysis of this nature, there are inherent limitations which should be borne in mind when interpreting results. These limitations include:

- **Spatial Resolution** – The model is intended to identify potential corridors but not specific routes. Route siting depends on consideration of many local options at finer spatial scales than the model provides (90 meters or ~ 300 feet). Fine scale siting decisions could have significant impacts on wildlife which are not reflected in the lower resolution analysis of the model. Therefore, the model should be interpreted at the corridor level for comparing one alternative to another with an assumption that the best route along any potential corridor will generally be toward the areas with the least accumulated costs.

- **Regulatory Constraints** – To the extent practical, the model ignores regulatory constraints on transmission line siting in order to better estimate the "best case scenario" for wildlife and allow a better understanding of trade-offs involved in alternative routes. In order to produce the most useful model, however, it was necessary to account for areas where transmission lines are explicitly or likely prohibited due to legal protections or management constraints. Treatment of these areas in the model is described in detail under "Special Management Areas" in the Methods section. Areas with legal designations which *might* restrict transmission lines were uniformly assigned maximum cost values and are strongly avoided in the model, but the degree to which transmission lines are *actually* restricted is site-specific and may be open to interpretation. The model therefore likely avoids some areas that on close examination do not restrict transmission lines, and allows passing through some areas (although at maximum cost) that in reality prohibit transmission lines. Where the model suggests routes that pass through or around designated Special Management Areas, users are cautioned to examine the specific restrictions that may apply.

- **Mitigation** – Some impacts can potentially be alleviated through onsite mitigation measures. In some cases off site mitigation measures may be implemented in an attempt to offset impacts on wildlife near the line by enhancing habitat elsewhere. Mitigation options and costs are not incorporated in the MRP wildlife model. The model is designed to identify corridors that minimize potential impacts to wildlife, which would theoretically minimize mitigation costs. The model may also aid with identifying areas where mitigation is necessary by examining areas where preferred routes intersect with high potential wildlife impacts.

This report is divided into three sections: Introduction, Methods, and Results and Discussion. The methods section includes justification and relevant citations for model components and parameters, and therefore incorporates the information and literature review of this study. The results section includes key findings and quantitative comparisons of the MRP wildlife model, including an analyses comparing the MRP wildlife and community values models (see Community Model publication).

Model Development Timeline

- June 2011 – A proof-of-concept model was developed and presented by Brent Brock (Craighead Institute) to Madison and Jefferson County Commissioners demonstrating the potential for using GIS-based cost-distance modeling to identify potential corridors for minimizing impacts to wildlife for the Mountain States Transmission Intertie (MSTI).
    - The model **Does Not**:
        - Replace the regulatory processes
        - Estimate actual impacts to wildlife
        - Identify specific routes
        - Address **whether** MSTI should be built
    - The model **Does**:
        - Weight relative effects on wildlife based on perceived and documented sensitivities
        - Identify least-cost corridors among all possible routes with respect to wildlife impacts
        - Inform stakeholders about **where** the line might be built to minimize wildlife impacts
- March 29, 2012 – Biologists met in Twin Falls, ID to provide feedback and revisions to the proof-of-concept model. The following biologists participated in the review: Katie (Benzel) Iverson (BLM), Tom Bassista, Gary Vecellio (IDFG), Todd Stefanic (NPS), Trish Klahr, Bob Unnasch, and Chris Little (TNC). Some participants participated in a limited capacity to avoid potential conflicts with their agency roles and responsibility with respect to MSTI.

  Subsequent to the review meeting, Craig Fager (MTFWP) and Scott Bergen (IDFG) have provided comments via phone or email.

  Meeting participants provided a rigorous critique of the proof-of-concept model and many constructive suggestions for revision. A summary of those revisions was distributed to the group in the week following the meeting and is incorporated in the materials that follow.
- April 2012 – Brent Brock and Bob Unnasch worked on a logic model for calculating a final cost surface from model components. Preliminary models were run and revised to debug

the process flow and incorporate additional data layers as they became available. Major revisions are highlighted in the general comments below and are reflected in the details of the model provided in this document.

- May 23-May 30, 2012 – Final comments solicited from expert reviewers
- May 31 and June 1, 2012 – Final model presented at public briefings in Pocatello ID, and Butte MT

Acknowledgements

The MSTI Review Project team would like to thank the following individuals and entities for their involvement and support of the MSTI Review Project. This project would not have been initiated if not for the Madison County, Montana Commissioners who, concerned about the potential impacts of the proposed MSTI line, requested assistance from the non-governmental organizations that eventually came together to form the MSTI Review Project team. Later, Jefferson and Beaverhead Counties in Montana also joined this collaborative. The team wishes to thank the financial contributors including Madison and Jefferson counties and, the State of Montana through the Headwaters RC&D, individual donors, private foundations, and NorthWestern Energy. Without all of these individuals, organizations, agencies, local officials, and concerned citizens, this project would have never come to fruition.

We also wish to thank the following people who provided comment and expertise for the wildlife model, or who provided or helped locate data layers: Eric Aiello, Tim Bozorth, Katie (Benzel) Iverson and Karen Rice (Bureau of Land Management); Tom Bassista, Scott Bergen, Jim Strickland, and Gary Vecellio (Idaho Fish and Game); Craig Fager and Adam Messer (Montana Fish Wildlife and Parks); Todd Stefanic (National Park Service); Trish Klahr, Marilynne Manguba, Bob Unnasch, and Chris Little (The Nature Conservancy); Clint Evans and Jerry Korol (Natural Resources Conservation Service); Jeremy Shive and Jericho Whiting (Idaho National Lab); Matt Lucia (Teton Regional Land Trust); Scott Boettger and Keri York (Wood River Land Trust); Julie Pence (Idaho Land Trust); Michelle Pettit (CP Callahan Inc.); and Martin Miller (Montana Natural Heritage Program).

Methods

The model was developed in Model Builder, a development environment within ArcGIS 10 (ESRI, Redlands CA), a geographic information system (GIS). We used a cost-distance modeling approach (see below) to identify the shortest corridors accumulating the least impact to wildlife. We used the precautionary principle in developing the model by weighting the model to reflect the maximum impact that was realistically possible at each location. In other words, the cost weightings in the model do not necessarily indicate that impacts of the weighted magnitude *will* occur, but rather that they *could* occur. Therefore, the optimum corridors identified by the model represent areas with the highest certainty of minimized cumulative impacts. Cumulative impacts are the total potential impacts summed over the entire length of a corridor or route connecting the two end points (Townsend, MT and Jerome, ID).

Overview of Cost-Distance Modeling Approach

Cost-distance models are frequently used to identify paths or corridors of least resistance, highest efficiency, highest likelihood of use, or lowest impact, between two or more locations on a landscape. In cost-distance modeling, the term "cost" is used generically to indicate areas that are more difficult or less desirable to traverse than areas of lower cost. Costs can refer to any relative value such as monetary cost, energy expenditure, or impacts. With respect to the wildlife model, "costs" refer to the relative change that could potentially occur in a location's ability to support a full complement of native species if a 500 kV transmission line were built in or near the location of interest.

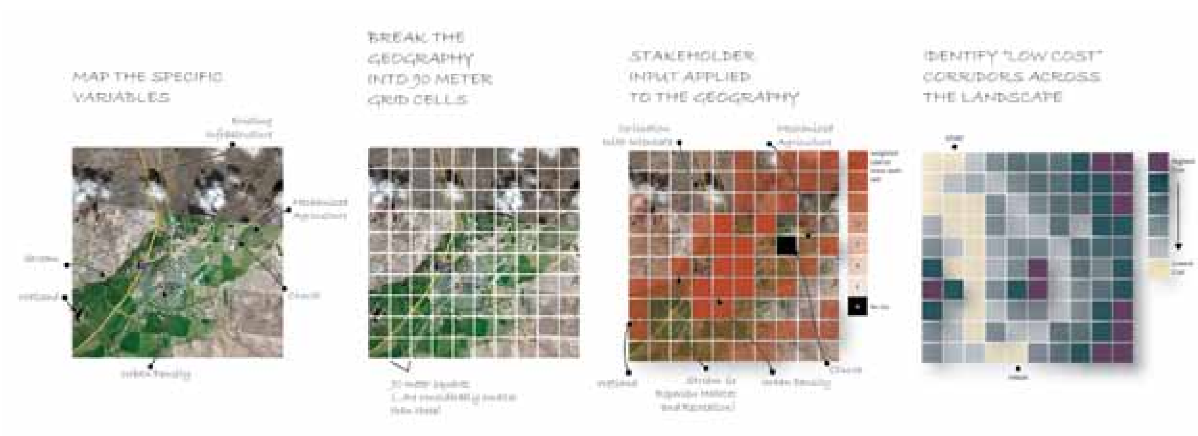


Figure 1 - An example of general process of cost-distance modeling.

The first step of cost-distance modeling is to divide the area of interest into gridded cells (90 meters or ~ 300 feet for the MRP wildlife model) and assign relative cost values to each cell, where high costs represent areas to be avoided and low values represent areas of low impact. Next, a cost-distance surface is generated from each source being modeled. A source is either an origin or destination for travel across the landscape. In other words, sources are the locations being traveled from or to. For the MRP wildlife model, the endpoint substations at Townsend, MT and Jerome, Idaho were used as the source and destination of the proposed MSTI line. A cost-distance surface is calculated by multiplying the assigned cost of a cell by the distance of traveling across the cell. This is called the "cost-weighted distance." For example, the cost-weighted distance of traveling orthogonally across a 90-meter cell with a cost value of 1 is

1 x 90 = 90; for a cell with a cost value of 2 the cost-weighted distance is 2 x 90 = 180. The *effective distance* of moving across the higher cost cell is twice the distance of the lower cost cell, whereas the *actual distance* is the same. The least accumulated cost-weighted distance is calculated for each cell by summing cost-weighted distances for all cells that are crossed to reach the source location. The cost-distance surface therefore represents the lowest possible effective distance between each cell and the source. Finally, cost-distance surfaces are combined for two different sources by overlaying the cost-distance surfaces and assigning the lower of the two values to the new surface. The resulting surface is called a "least-cost corridor" (Figure 1) because the values represent the lowest possible cost-weighted distance accumulated between each cell and either source. For the MRP wildlife model, the least-cost corridor values represent the least possible accumulated cost between each cell and either the Townsend or Jerome substation. Corridors are identified as swaths of relatively low-cost cells connecting the sources. These corridors are further delineated by extracting the lowest-value cells (e.g., the best 5% for the MRP wildlife model).

How Information Was Gathered

The MRP Wildlife model was developed using an expert-driven approach, which made the process quick and efficient. An exhaustive review and synthesis of all potential impacts of transmission lines on wildlife in the study area was beyond the scope of the project, would have significantly increased the cost and time of completing the study, and would unnecessarily duplicate work conducted in preparation of the Draft Environmental Impact Statement. In lieu of a comprehensive literature review, we relied on numerous regional wildlife professionals to point to relevant research findings and publications, and provide consensus for best practices to avoid or minimize impacts on wildlife from the proposed project. This information was supplemented with targeted literature searches to verify information provided by experts or to attempt to close knowledge gaps. We also relied heavily on review papers and reports that synthesized impacts of energy development or transmission lines on one or more wildlife species. Where review papers cited specific parameters useful for weighting the model, we reviewed and cited the original paper to ensure the correct interpretation and use of the parameter. The expert-driven approach was much more efficient than a comprehensive literature review would have been because it avoided the necessity of sifting through voluminous irrelevant or redundant works, revealed unpublished data and reports, and incorporated many combined years of professional experience.

Model Development

Our analysis study area included all counties potentially impacted by the proposed MSTI line. The counties were defined as any county intersected by any of the alternative routes under agency review as of March 2011. We developed a wildlife cost surface by estimating the total potential impacts of an overhead transmission line on wildlife or their habitats, and then subtracting the estimated total impacts already imposed by existing infrastructure (e.g., transmission lines, roads, buildings, etc.). Potential wildlife impacts were divided into five components (species of concern, habitat vulnerability, habitat fragmentation vulnerability, wildlife linkage areas, and protected areas). Existing impacts identified included housing density, road density, major highways, major transmission lines, and railroads (Figure 2).

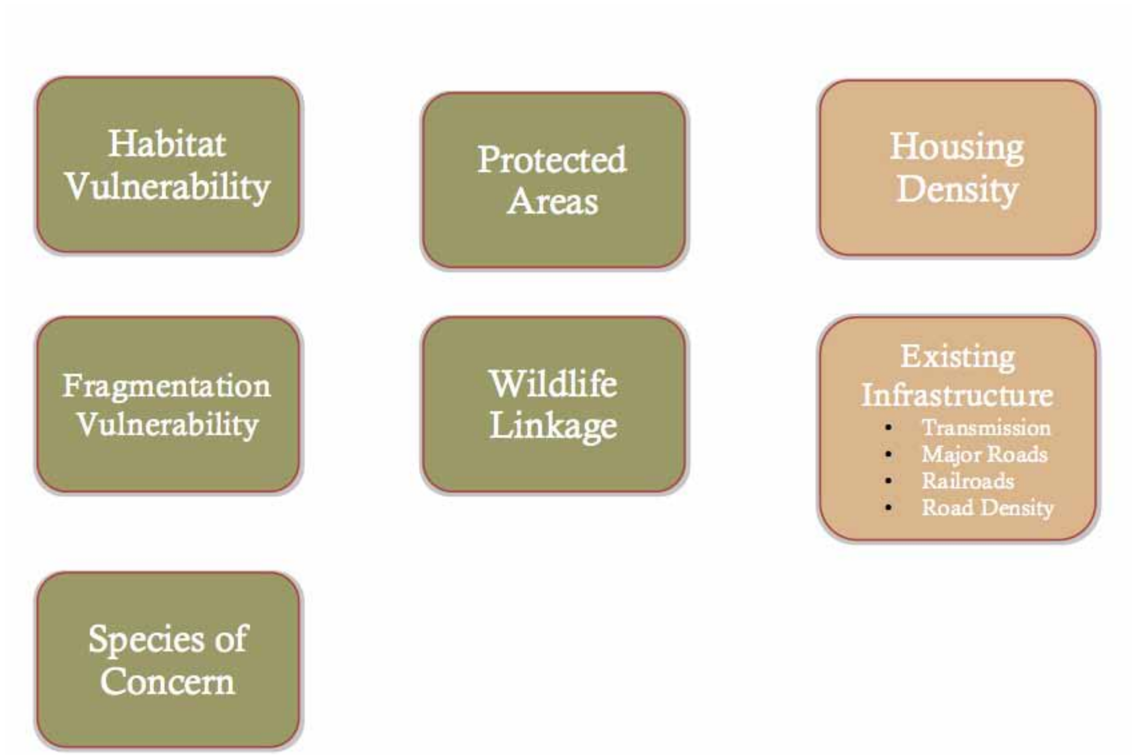


Figure 2 - Components of Wildlife Cost Surface – Green boxes are potential wildlife impact components. Brown boxes are existing impacts components. Existing impacts are subtracted from potential impacts to create final costs representing net potential wildlife impacts.

However, the linkage component was not included in the model (see below). Each component was assigned a score of 0-10; where 0 = no predicted impact and 10 = maximum predicted impact. We combined scored component values using a logic model that reflects how the components interact to create cumulative impacts (Figure 3).

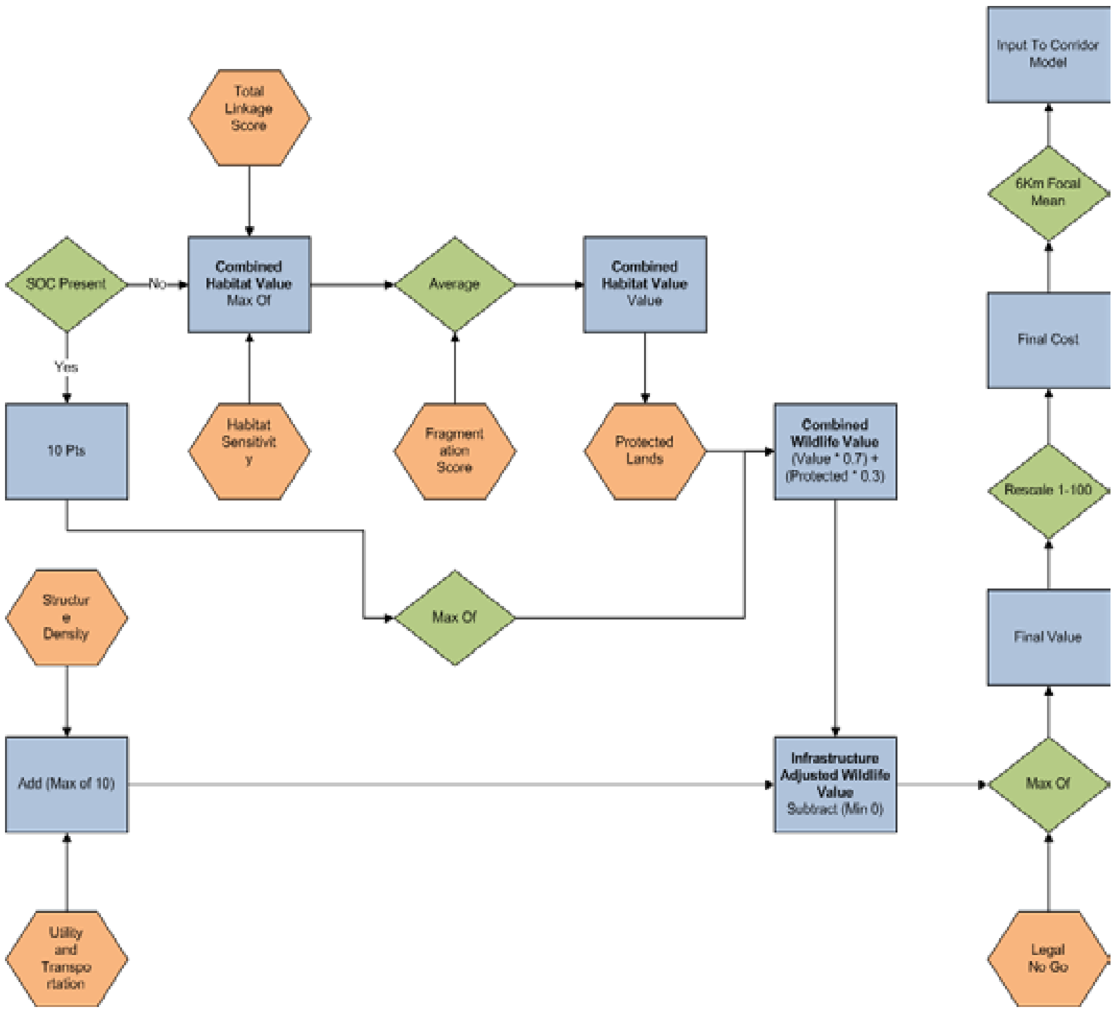


Figure 3 – Processing Logic Model for Wildlife Cost Surface – Blue boxes are calculated values. Green diamonds are mathematical operators. Orange hexagons are scored value inputs. Each 90-meter pixel in the analysis area receives a single final score.

Descriptions of model components and details of how they were scored are included below. These scores were rescaled to values 1-100 to scale the least cost corridor model, so traversing a cell of maximum impact would be the effective distance equivalent of traversing 100 cells of no impact.

We calculated the focal mean of the resulting final cost values to account for potential impacts of transmission lines beyond the immediate footprint of the structure. The focal mean calculates the average of all cell values within 6 Kilometers (3.7 miles) of each target cell and reassigns the cell value with the calculated mean. In other words, we created a new cost surface where each cell value represents the average values of the original cost surface within a 6-kilometer radius (Figure 4). This focal mean layer was used as the final cost surface input to generate a least-cost corridor model.

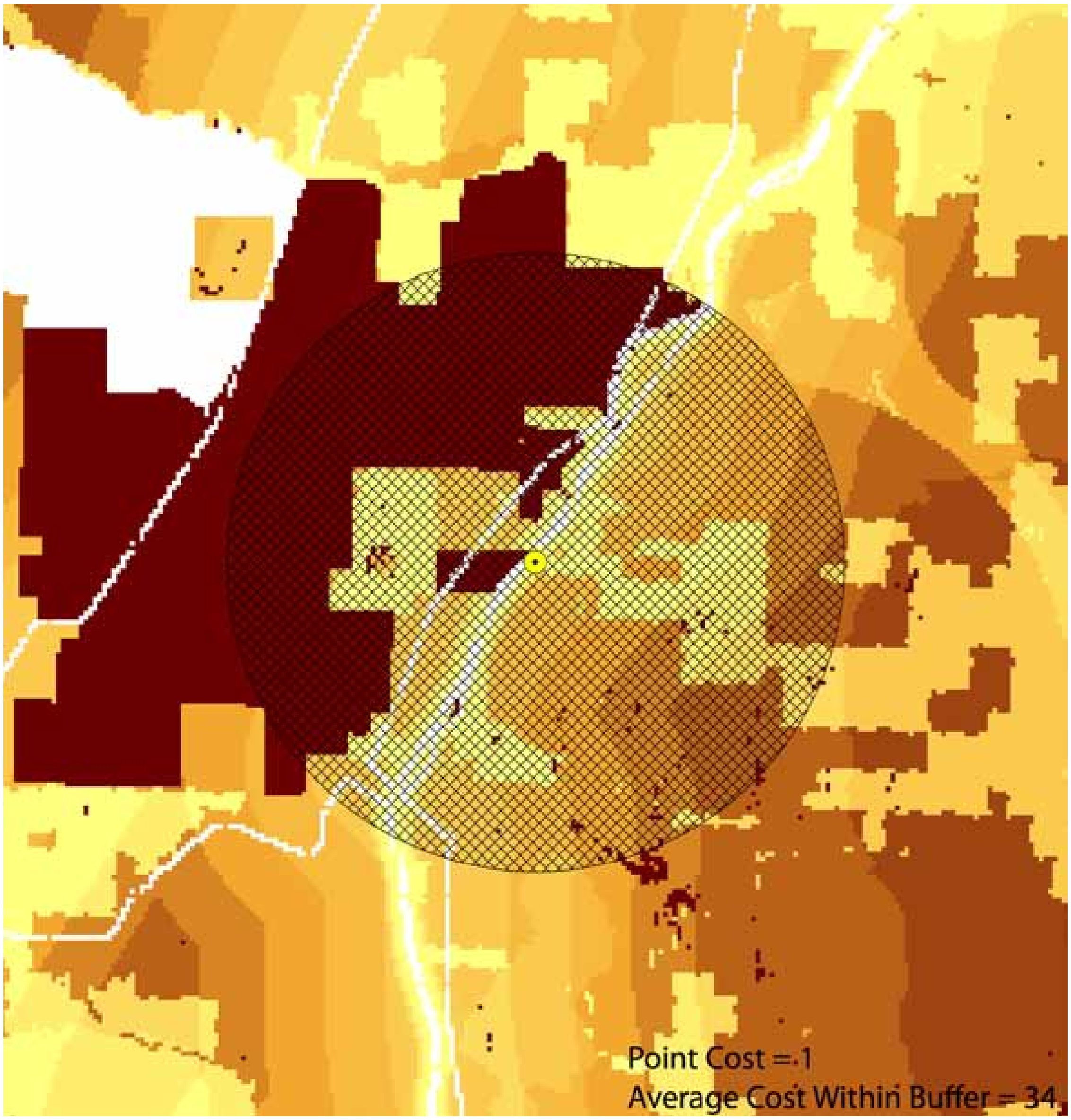


Figure 4 - Example of difference between local cost value (point cost) and focal mean (buffered average) of a target cell (yellow circle)

The behavior of the MRP model can be summarized fairly succinctly as avoiding location of the line near areas with declining species, in habitats most impacted by overhead towers and lines, and through large blocks of contiguous habitat. Areas protected for wildlife habitat are avoided more than unprotected areas. Also, areas already altered by human activities are preferred over relatively undisturbed areas.

Potential Wildlife Impact Scores

Potential wildlife impact scores represent the estimated relative impact the MSTI transmission line would potentially have on a cell's ability to support a full complement of potentially historical native wildlife species. We compiled digital maps for each potential wildlife impact component and assigned each cell a relative score of 0-10 using the following methods:

Species of Concern (10 points)

Species of Concern (SOC) are native animals breeding in the region that are considered to be "at risk" due to declining population trends, threats to their habitats, and/or restricted distribution. These include federally threatened or endangered species, as well as species identified by state and federal agencies not listed as threatened or endangered but that need special management consideration to stop or reverse declining population trends. All areas containing species of concern were assigned the maximum score of 10.

Layers Included:

Montana Natural Heritage Program Plant and Animal Species of Concern, Idaho Animal Conservation Database (Species of Special Status), MT core Sage-Grouse habitat (BLM), Montana Pygmy Rabbit core habitat (BLM), Idaho Primary Sage-grouse Habitat, and Montana Elk Calving Areas (BLM).

Processing Notes:

- Wolverine, gray wolf, grizzly bear, and fisher were eliminated from the model. In Montana, entire known ranges are mapped as areas of occurrence for these wide-ranging species, which cumulatively encompass the entire study area within Montana. Species ranges do not provide sufficient resolution for delineating areas critical for management or species protection, and were removed as inputs to the cost surface.
- Point observations for MT Natural Heritage Program SOC data are already converted to polygons representing estimated area of occupancy. No adjustments based on home range were made, because these are already incorporated in the data.
- ID Animal Conservation Database (special status species) was provided as point data. The following criteria were used to convert point data to areas for inclusion in the model:
    - If management guidelines for buffers around sensitive habitats (e.g., nests, leks, etc.) could be found, those distances were used to create buffers around points.
    - If no management guidelines were found, home range, foraging distance, or nest defense distance information gleaned from Natureserve was used to infer an area of likely occurrence around points.
        - If multiple range estimates were cited, the median of reported values was used.
        - If estimates from Idaho were available, only those estimates were used.
        - If no Idaho estimates were available, estimates from adjacent states or areas with similar habitat were used if available. Otherwise, the median value for all reported estimates was used.
        - If home range was reported as an area, a buffer distance was calculated equal to the radius of a circle with area equal to the home range value.
    - If no suitable information was found in Natureserve, estimates for other species within the same genus were used if available. Otherwise, a buffer of 0.4 km (1/4 mile) was used.

- Sage-grouse and sharp-tailed grouse leks were buffered by 4 miles to estimate the distance of potential impact from transmission lines (see "Calculating Final Costs" for justification of buffer).

Justification:

Species of Concern are already rare or declining and are often already subject to environmental stressors. The consensus among biologists providing review is that whenever possible, areas containing these species should be avoided to eliminate the possibility of creating additional stress. Examples of potential stress include: disturbance during construction, disturbance from maintenance or traffic along access roads, and physical alteration of habitat. Although it may be possible to mitigate some impacts (e.g., timing construction during periods when habitat is not occupied), it is preferable to avoid impacts as much as possible.

Sensitive Habitats (max 10 points)

Habitats are scored relative to their perceived sensitivity to overhead transmission lines and associated structures. Grassland/sagebrush steppe, forest, and wetland habitats are most strongly avoided.

Layers Included:

National GAP Analysis Program Land Cover version 2 (US Geological Survey, 2011), National Wetlands Inventory (U.S. Fish and Wildlife Service, 2012), Montana core Sage-Grouse Habitat (BLM), Montana Pygmy Rabbit Core Habitat (BLM), and Greater Sage-grouse Habitat in Idaho, 2011 (BLM).

Processing Notes:

- Areas within Montana core sage-grouse habitat or Idaho "key" and "R1" primary sage-grouse habitat were assigned a score of 10.
- All other areas were assigned scores based on GAP level 1 land cover classification (Table 1).

Habitat Type	Score
Agricultural Vegetation	2
Barren	0
Developed	0
Forest and Woodland	8
Introduced Vegetation	3
Polar and High Montane	5
Semi-Desert	7
Shrubland and Grassland	7
Sparse Rock Vegetation	5
Transitional Vegetation	4
Water and areas in National Wetlands Inventory	10
Sage-grouse/Pygmy Rabbit Core Habitat	10

Table 1 - Sensitive Habitat Scores

Justification:

Overhead utility lines alter habitats with the construction of towers and lines, clearing vegetation from the right-of-way (ROW), construction or increased traffic on access roads, and increased disturbance during construction and maintenance activities. The direct and indirect effects of these alterations on wildlife are expected to vary among habitat types.

In grassland, sagebrush, and other open habitat types, transmission lines and supporting towers represent significant change for species that have not evolved with tall structures in their habitat. Within the MRP study area, the effects of overhead power lines on grassland species is best exemplified by sage-grouse which has been relatively well-studied compared with other grassland species in the region due to concern over declining populations and a nearly 50%

reduction in species range. Impacts of transmission lines on sage-grouse were summarized in a report commissioned in preparation for the EIS on the proposed MSTI project (Johnson, 2009). Because negative impacts of transmission lines on sage-grouse and other open habitat species are well-documented, we assigned the highest scores to these habitat types. However, the GAP land cover classification used to delineate habitat types does not indicate habitat quality, and many of these areas are in a degraded state. Significant effort has been applied toward delineating high quality sage-grouse habitat in both Montana and Idaho. Therefore, we used the Montana core sage-grouse habitat (BLM) and the Greater Sage-grouse Habitat in Idaho, 2011 (BLM) layers to represent the highest quality sagebrush and grassland habitats that received the maximum score. For Idaho, we include areas classified as "key sage-grouse habitat areas" and "RI" areas, which are areas with high restoration potential.

Wetlands were also assigned the maximum score because avian collisions with power lines have been well documented (Manville, 2005). Wetlands create high concentrations of both species and numbers flying at low altitude during takeoff and landing. In addition, many waterfowl and other species that concentrate near wetlands are large-bodied and less able to maneuver quickly to avoid obstacles that suddenly appear in their flight path. This includes ducks, geese, trumpeter swans, and sandhill cranes. Additionally, when vegetation is cleared for transmission line ROWs, gaps are created along forested riparian corridors which may disrupt movement and habitat use by bats and other species.

Generalizing impacts of overhead transmission lines is difficult compared with open habitats and wetlands. The physical structure of transmission lines and support towers is more analogous to natural structures within a forest and therefore would be expected to have less effect than other habitats. However clearing vegetation for ROWs disrupts habitat structure and potentially impedes wildlife movement. For example, Smith (2011) studied flying squirrels (*Glaucomys sabrinus*) crossing highway gaps in Washington State and observed no squirrels crossing gaps that exceeded 80 meters. In addition, noise generated by transmission lines may influence the behavior of animals in the vicinity. But the response of forest species to transmission lines is variable. For example, Picton (1985) predicted long-term suppression of elk use within several hundred meters of the 500 kV Bonneville Power Administration (BPA) line in the Boulder River Valley, MT (within the MRP study area) based on his study of pellet counts, telemetry, and track data. Canfield (1984) studying elk behavior on the same line found no evidence of changes in behavior or distribution resulting from the line, but the elk did hesitate and become excitable when the line emitted noise during precipitation. In Canada, moose (*Alces alces*) used the open ROW less than adjacent forests but used the ROW edge more (Joyle et al. 1983). Areas within 250 meters of power lines in Oklahoma had a neutral effect on habitat use by Northern bowhite (*Colinus virginianus*) (Dunkin et al., 2009). In Pennsylvania, the wire zone within the ROW for a 500 kV transmission line contained more species of reptile amphibians (eight species) compared with the ROW border (five species) or adjacent forest (two species) (Yahner et al. 2001). This cursory review indicates that transmission line impacts on species living in or near forested habitats may be negative, neutral, or in some cases, positive. We concluded that a 500 kV line could potentially have moderate impacts on forest wildlife, but that the evidence is not as clear for sagebrush/grasslands or wetland habitats. Therefore these habitats were scored moderately high.

Habitat Fragmentation (max 10 points)

Habitat fragmentation occurs when a contiguous patch of similar habitat is broken into smaller patches (e.g., created when a road is constructed across a contiguous habitat patch). Habitat fragmentation has received a great deal of attention for several decades and is considered a major driver of species loss. Small patches support fewer species than larger patches; within them, populations are more vulnerable to local extinction, and reproduction and survival of individuals are vulnerable to competition and predation from species living on the edge.

Layers:

MT and ID updated GAP land cover, Montana Transportation Framework (roads), Idaho Roads.

Processing Notes:

- Cells classified as "Forest Woodland" were extracted into a separate data layer and cells classified as "Shrubland and Grassland" and "Semi-desert."
- Cells intersected by a road were set to "No Data" in each extracted layer.
- Area of each contiguous patch of cells was calculated for each extracted layer.
- Contiguous patch size was reclassified into three size classes and scored (Table 2).

Patch Size	Score
0-10 ha (0-~25 acres)	0
10-160 ha (~25-~395 acres)	5
> 160 ha (~395 acres)	10

Table 2 - Habitat Fragmentation Scores

Justification:

Roads are the most pervasive cause of habitat fragmentation and therefore were used to delineate unfragmented patches. We reviewed Conservation Thresholds for Land Use Planners – Appendix B (Environmental Law Institute, 2003) to assign fragmentation scores to patch size categories. Appendix B tabulates the results of a literature review of fragmentation research that reported responses of different species taxa in relation to habitat patch sizes. The studies reviewed indicated that loss of species or increased stress (e.g., predation or nest parasitism) could be expected when habitat patches fall below 10 hectares (~25 acres), while patches larger than 160 hectares (395 acres) typically retained high proportions of potential species richness. These thresholds were roughly the same for forested and grassland habitat types. Based on these generalized findings, we divided fragmentation scores into three patch size categories (Table 2) to reflect areas that have likely already lost habitat function due to fragmentation, areas that may be suffering consequences of fragmentation but probably still support a moderate complement of species, and areas with minimal effects of fragmentation. These scores reflect the consensus of experts that avoiding further fragmentation of remaining large blocks of habitat is important for maintaining healthy populations of wildlife and ecological processes needed to maintain their habitats over the region.

Habitat Protection (10 points)

Areas that are protected against habitat loss are avoided relative to similar habitats with no protection. Protected areas include public lands with multiple use or wildlife management mandates or private lands under conservation easement. Protected areas are scored according to degree of protection. Note that these protected areas are treated differently than "special management areas" described later.

Layers:

ID Surface Management Agencies, MT Land Ownership (NRIS), MT Wildlife Management Areas (MTFWP), National Wildlife Refuges, MT conservation stewardship layer (NRIS), Federal easements (NRCS), ID Nature Conservancy easements, Teton Regional Land Trust, Wood River Land Trust, Idaho Land Trust (verified no easements within study area).

Processing Notes:

- Conservation easements and wildlife management areas were compiled into a single layer.
- Federal public lands were extracted from ownership or surface management layers.

All federal public lands not included in the compiled easement and wildlife management area layer were assigned a score = 5 (Table 3).

Designation	Score
Private Conservation Easement	10
General Multiple Use	5
Wildlife Management Areas	10
Other	0

Table 3 - Protected Areas Categories

Justification:

The consensus of the reviewers was that private conservation easements and areas provided the strongest degree of habitat protection. Most of the easements in the region explicitly prohibit transmission lines and the land trusts interviewed during this study indicated they would vigorously protect those restrictions. Wildlife management areas do not necessarily prohibit activities not related to wildlife management, but management of these areas mus t be compatible with maintaining habitat for the species they were designated to conserve. Public multiple use lands provide moderate protection for wildlife habitat because wildlife are only one of many potentially competing uses that govern management of these areas. Therefore, public lands not part of special management areas and subject to the Multiple Use and Sustained Yield Act were given a lower score than other categories.

Habitat Linkage (not scored)

Habitat linkages (or connectivity) can be loosely defined as areas needed for wildlife to move from one habitat patch to another. This includes daily foraging movements (e.g., waterfowl movement between roosting and feeding areas), seasonal movements (e.g., big game moving from summer to winter range, or long-distance bird migration), or areas needed to allow species to expand their range or adapt to changing conditions. The latter type of linkage may include infrequent and/or multi-generational movements to facilitate genetic exchange with semi-isolated populations or for a species to re-colonize vacated habitat patches.

Processing Notes:

- Habitat Linkage was not included in the model (see justification below).

Justification:

There is strong consensus among experts that high voltage transmission lines have the potential to disrupt wildlife movements and in severe cases fragment habitat and populations. Within the MRP study area five linkage categories were identified: carnivores, wetlands, elk, pronghorn, and sage-grouse. We believe the potential impact of the MSTI line on habitat linkage is an important consideration, but because of data limitations, we chose not to include this component in the model. We do not believe exclusion of this component significantly alters the results (see below).

Relatively few usable spatial layers exist for wildlife linkages in the study area and development of such layers is beyond the scope of work here. Connectivity modeling has gained significant attention in the last few years through the Western Governors' Association and state wildlife agencies. MTFWP has been among the leaders in efforts to map important connectivity areas for wildlife and has drafted maps of connectivity for many species or species guilds in the state. Among these are raptors, waterfowl, ungulates, and sage-grouse. However, these layers are still in draft and have not been thoroughly evaluated with respect to accuracy and usefulness. With the exception of ungulate corridors, Craig Fager (MTFWP, pers. comm.) expressed doubts over the usefulness of these layers in the area. Linkage layers for grizzly bears (Craighead et al., 2006), and wolverine (Brock et al., 2007) were used in combination to represent general forest carnivore connectivity in the original model.

Even when linkage layers are available, uncertainty about the impacts of transmission lines on movement makes incorporating them with a sufficient degree of confidence a challenge. There is strong evidence that transmission lines pose a threat to waterfowl and sage-grouse, and where lines intersect important linkages, that the impacts could be severe (Johnson, 2009; Manville, 2005). Within the MRP study area, the Beaverhead River Valley (Craig Fager – MTFWP, pers. comm.) was identified as a particularly vulnerable migration funnel for swans, snow geese, and other waterfowl. As previously noted, suitable data layers were not available at the time of this study to map these important areas. Total potential wildlife impact scores before adjusting for existing infrastructure are already maximized in the Beaverhead River Valley and throughout potential sage-grouse habitat, so it does not appear the inclusion of waterfowl and sage-grouse migration corridors would change the outcome of the model. The response of elk and pronghorn movements to transmission lines is less certain. Canfield (1988) noted hesitation and excitability of elk approaching a noisy transmission line during precipitation, but this influence on movement presumably only occurs during inclement weather. In contrast, telemetry data in Idaho (Scott Bergen – IDF&G, pers. comm.) indicates pronghorn may preferentially travel along cleared right-of-ways under transmission lines. Similar uncertainty exists for carnivore response to transmission lines. We can hypothesize that the most significant influence would be due to clearing the right-of-way, which removes security cover, and that these impacts may actually be more pronounced in marginal habitat where animals are likely to feel stressed and insecure already. In such cases it is conceivable that a nervous animal may hesitate or turn back when encountering a cleared space with a potentially noisy transmission line.

To summarize, suitable habitat linkage layers are either not available, are available for only part of the study area, or would have required us to base scores on assumptions not supported by studies or expert consensus. There is therefore no way to estimate the relative potential impacts of habitat linkage consistently across the entire study area. We note that this is a deficiency that would ideally be remedied. However, examination of areas where potentially severe impacts on wildlife movement are most likely indicates that final impact scores would not be likely to change. We therefore conclude that within the specific context of the MRP wildlife model, omission of habitat linkage did not significantly alter final outputs or conclusions.

Existing Infrastructure Scores

To estimate negative effects on wildlife habitat already imposed by existing infrastructure, each cell in the landscape was assigned points according to the criteria below. Scores for each cell are summed with a maximum limit of 9 points.

Category	Score
Commercial/Industrial	10
Urban (<0.25 acres/unit)	10
Suburban (0.25-2 acres/unit)	10
Exurban (2-40 acres/unit)	5
Rural (>40 acres/unit)	0

Table 4 - Housing Density Scores

Existing Structures

The relative impact from existing infrastructure on wildlife habitat value is estimated to adjust final wildlife habitat scores to reflect impacts that have already occurred. Individual infrastructure components (see below) are summed and truncated to a maximum value of 10. These scores are inverted and rescaled to 0-1 to create coefficients that are multiplied by the total wildlife habitat score to create an infrastructure-adjusted wildlife habitat score. Therefore, the “cost” of cells with the highest infrastructure scores is reduced to zero while cells with an infrastructure score = 0 retain their full wildlife habitat value. In other words, areas with an infrastructure score of 10 assume that all potential wildlife value has already been lost due to existing infrastructure impacts or that no additional impacts from the addition of a 500 kV transmission line are expected.

Note: the only single entity features that can zero out all wildlife value are the existing 500 kV line (BPA) and high-density housing development. Also, the maximum impact of linear features (e.g., roads and utility lines) is applied only to cells intersected by the centerline of the feature and diminishes with distance to zero at the buffer distance specified. However, the cells intersected by linear features are also considered as “avoidance” areas (see below) because they are within the existing feature’s ROW. The model creates an incentive for areas near existing infrastructure but does not allow co-location within existing rights-of-way.

Existing Housing Density

We used housing density to estimate the impact of residential, commercial and industrial development and associated activities on wildlife habitat.

Layers:

Projected 2010 Housing Density (U.S. Environmental Protection Agency, 2009).

Processing Notes:

- Projected 2010 housing density was reclassified into three score classes (Table 4).

Justification:

The impacts of human development on wildlife and their habitats have been well documented. For reviews of these impacts see Glennon and Kretser (2005), and Hansen et al. (2005). Populations of non-native and human-adapted species increase with increasing housing density. Commercial/Industrial, urban, and suburban areas support only highly human-adapted species. These areas are heavily impacted by human activities and the addition of a new overhead transmission line is unlikely to impose any additional impacts. Low-density exurban areas (e.g., ranchettes) support native wildlife, but species present and their abundances are typically altered due to habitat alteration, increased predation, disturbance, and other stressors. Although these areas are slightly to moderately impacted by human activities, they still provide moderate to good quality wildlife habitat which could be impacted by the addition of an overhead transmission line. Rural areas with > 40 acres per housing unit are the least impacted by human activities and therefore receive no existing impact score.

Existing Transportation and Utility Infrastructure

We scored areas adjacent to existing major highways, railroads, and transmission lines relative to their estimated impact on wildlife habitat. Scores are reduced to zero with increasing distance from an infrastructure feature. In addition, we also scored overall road density as an estimator of cumulative impact of road networks on habitat quality.

Layers:

Montana Transportation Framework (NRIS), Idaho Roads, Idaho Railroads, 2010 TIGER Primary and Secondary Roads (U.S. Census Bureau, 2012)

Processing Notes:

- Feature Type categories listed in Table 5 processed separately.
- For each Feature Type:
  - Calculate Euclidean distance from features.
  - Set cells greater than distance-weighted buffer distance (Table 5) to Null.
  - Rescale remaining values 0-1.
  - Multiply by Max Score (Table 5).
- Merge road features from Montana Transportation Framework and Idaho Roads layer.

- Calculate line density of merged roads (use default search radius)
- Reclassify densities into 10 equal interval classes (Table 6).

Justification:

Numerous papers have been published on the impacts of roads on wildlife. For a review of these impacts, see Ament et al. (2008), Spellerberg (1998), and Switalski (2006) for reviews. Impacts typically increase with increasing traffic volume (Charry and Jones, 2009), and increased road density (Switalski, 2006). Roads also act as physical barriers to movement. Impacts of roads on wildlife extend well beyond the physical footprint of roads and associated structures. A study in Massachusetts found that measureable impacts of roads extended an average of 690 meters (~0.4 miles) into surrounding habitat, but that this distance varied by habitat, type of road effect, and topography (Forman and Deblinger, 2000).

Feature Type	Max Score	Distance weighted buffer
NHS Interstate	8	690 meters (0.43 miles)
non-Interstate Highways	3	690 meters (0.43 miles)
Railroads	5	690 meters (0.43 miles)
Utility lines (500 kV)	10	6 km (3.7 miles)
Utility lines (150 - 500 kV)	5	6 km (3.7 miles)
Utility lines (< 150 kV))	2	6 km (3.7 miles)

Table 5 - Maximum Scores and influence distances for existing infrastructure. Maximum score is applied at location of feature and degraded to zero at buffer distance.

Road Density (Km Road/Km2)	Score
0 - 0.1	0
0.1 - 0.32	1
0.32 - 0.54	2
0.54 - 0.74	3
0.74 - 0.93	4
0.93 - 1.16	5
1.16 - 1.41	6
1.41 - 1.7	7
1.7 - 2.12	8
2.12 - 2.62	9
2.62 - 3.27	10

Table 6 - Road Density Reclassification

We estimated that Interstate Highways removed 80% of a site's potential wildlife value because of high traffic volume and their physical structure, which presents formidable challenges for animals attempting to cross. We estimated that two-lane paved highways (non-Interstate Highways) impose 30% reduction in habitat value. This is a conservative estimate because

traffic volume on these roads varies considerably. We scored this road class according to the "best case" scenario to avoid under-estimating habitat value adjacent to highways with relatively low traffic volume. We used 690 meters (~0.4 miles) as the maximum distance of impacts from roads. This value was derived from Forman and Deblinger's (2000) 600-meter average distance of impact from roads plus 90 meters (one cell width) to adjust for the physical width of the road right-of-way. We assigned the maximum score to cells intersected by road centerlines and attenuated those scores to zero for cells ≥ 690 meters. Individual smaller roads with low traffic volume are less likely to have significant impacts on wildlife, but the cumulative effects of road density adversely impact wildlife (Switalski, 2006). We therefore estimated that areas with highest road densities (i.e., urbanized areas) negate all potential wildlife value while areas with lowest road density have no significant impact on wildlife. We treated railroads the same as highways but estimated they reduce habitat value by 50%. This estimate was based on expert consensus because the impact of railroad collisions on wildlife can be severe, particularly when wildlife congregates on tracks to avoid deep snows or feed on spilled grain.

We divided existing utility lines into three classes for scoring impacts. We made the obvious conclusion that an existing 500 kV transmission line is already imposing the same impacts as the proposed MSTI line would have. We also assumed that lower capacity lines with smaller support structures and potentially fewer wires would have reduced (although significant) impacts, and scored those lines accordingly. We reduced impacts of utility lines as the distance from those lines increased using the same methods applied to highways and railroads, except that we used a 6-kilometer (~4 mile) weighted buffer distance (see "Calculating Final Cost Surface" for an explanation of this value).

To account for restrictions on locating the MSTI line within the right-of-ways of existing infrastructure, we eliminated areas within existing right-of-ways from the model (see "Special Avoidance Areas" below for details). As a result, the model reduces potential impacts on wildlife near existing infrastructure while eliminating the unrealistic possibility of directly co-locating within existing right-of-ways.

Special Avoidance Areas

To create a useful model, we incorporated legal and engineering constraints to reflect, to the extent possible, the legal and engineering challenges that should be expected along any potential route. To accomplish this, we mapped "soft" and "hard" avoidance areas. Soft avoidance areas are those that could potentially be crossed but with a maximum cost imposed to reflect potentially severe legal or engineering challenges (see below for details). Hard avoidance areas are those places where transmission lines cannot go and are therefore removed from consideration in the model. Avoidance scores supersede all habitat and infrastructure scores described previously. Avoidance scores were assigned to Special Management Areas and engineering constraints as follows:

SMA Type	Avoidance Category	Score
Proposed ACEC (Area of Critical Environmental Concern)	Soft	10
National Natural Landmark	Soft	10
Proposed Research Natural Area	Soft	10
Special recreation management area	Soft	10
State recreation area	Soft	10
State wildlife management area	Soft	10
Nature Conservation Areas	Soft	10
ACECs(Area of Critical Environmental Concern)	Soft	10
National Conservation Area	Soft	10
National Historic Site	Soft	10
National Monument	Soft	10
National Recreation Area	Soft	10
State park	Soft	10
Other Congressional Designation	Soft	10
National Park	Hard	No Data
National Heritage Par	Hard	No Data
National Wildlife Refuge	Hard	No Data
Proposed wilderness	Hard	No Data
Recommended wilderness	Hard	No Data
Research natural area	Hard	No Data
Wilderness	Hard	No Data
Wilderness study area	Hard	No Data
Wild and scenic river	Hard	No Data
National Wildlife Refuge in Wilderness	Hard	No Data

Table 7 - Special Management Area Categories

Special Management Areas (SMA)

A layer of areas of public lands with special legal designations was provided by the BLM that included 24 types of designations for various degrees of management restrictions relevant to transmission line siting. With the assistance of Western Environmental Law Center, the management restrictions of each SMA type were reviewed. This review was limited to 24 relatively broad categories. We did not review legislation, management plans, or other documents for each of the 1,196 individual units represented in the SMA layer. Each type was assigned an avoidance category (Table 7). Hard avoidance areas are SMA types where siting a transmission line would be prohibited, very difficult, or highly unlikely due to legal constraints. Soft avoidance areas include types where siting a transmission line is not necessarily prohibited at the type level, but siting may be difficult depending on the individual SMA unit (e.g., purpose of designation, resource management plans, etc.). Again, the scope of this project precluded investigating each individual unit. Therefore, a soft avoidance designation indicates there is potential for significant legal difficulty in siting a line across the area.

Engineering Avoidance

Two categories of engineering avoidance are included in the model. Areas within rights-of-ways of existing roads, railroads, and transmission lines were assigned as hard avoidance areas, whereas areas with greater than 30 degree slope were assigned soft avoidance scores to reflect the extreme difficulty of building a line over rugged terrain.

We adjusted right-of-way avoidances to allow the model to cross right-of-ways by removing single cells at one-mile intervals from the engineering hard avoidance layer. This creates perforations along existing linear infrastructure where right-of-way restrictions do not apply. Without this adjustment the model would not be able to cross any existing roads, railroads or utility lines, which would produce meaningless results.

Calculating Final Cost Surface

Individual component scores were combined using logic models designed to reflect the cumulative impacts of individual components (Figure 3). A narrative description of the logic model processing is as follows:

Wildlife Score

1. If SOC present, assign max score of 10 regardless of other cell attributes.
2. If no SOC present, average habitat score and fragmentation score.
3. Combine result of step 2 with Protected Area score with habitat contributing 70% and protected areas 30% to combined score.

Infrastructure Score

1. Add Housing Density, Utility, and Transportation Scores together and truncate to maximum value of 10.
2. Invert Infrastructure scores and rescale 0-1 to create coefficients.
3. Multiply Combined Wildlife Score by Infrastructure coefficients.

Final Score

1. Combine Adjusted Wildlife and Avoidance Area scores to the maximum value of inputs and set hard avoidance areas to no data.
2. Remove hard avoidance for right-of-ways within ½ mile from substations. This was necessary because utility lines converge on substations, resulting in substations being isolated by hard avoidances.
3. Rescale Final Scores to 1-100 to create final cost surface.

Final Processing

1. Calculate focal mean of circular area with 6-kilometer (3.7 miles) radius.
2. Generate cost-distance surface from Townsend and Midpoint substations using final cost surface.
3. Generate corridor surface from the two cost-distance surfaces.

Justification for Focal Mean:

Transmission lines impact wildlife habitat beyond the physical footprint of structures and associated roads. The extent of impacts is likely to vary among habitat types and for different species. Transmission lines and towers provide perches for predatory birds (especially raptors and ravens), and the impact of elevated populations of these birds on sage-grouse and other species has been documented (e.g., Johnson, 2009; Manville, 2004). Manville (2004) reported significant effects on sage-grouse from overhead power lines up to 6 kilometers (3.7 miles), but recommended a 5-mile buffer between transmission lines and important sage-grouse habitat. We chose a 6-kilometer search radius based on Manville's reported effects for calculating focal mean, which is smaller than his 5-mile buffer recommendation but larger than buffer distances suggested by other researchers (see Johnson, 2009). It is important to note, however, that the focal mean merely averages cost values within the search radius and therefore estimates the cumulative impact of locating the line at any given point assuming those impacts will extend out to 6 kilometers (Figure 4).

Analyzing Results

Corridor Analysis

Corridor surfaces generate values for every cell within the analysis study area. We extracted the best (lowest accumulated cost) five percent of all values to limit the output to only those areas likely to provide suitable alternatives for siting the MSTI line with wildlife as the primary consideration. Limiting output to the best five percent also helps to highlight the relative values within suitable areas.

We compared total accumulated costs among the three northern alternatives to better assess the relative potential impacts on wildlife. This comparison is useful because it compares only the relative estimated impacts (costs) to wildlife regardless of the length of the route. We calculated the "least-cost paths" (LCP) for each of the three alternative corridors from Townsend to the point on I-15 where all corridors converge. An LCP is a single cell-width path that accumulates the lowest cost-weighted distances between two points. For the I-90 and BPA corridors we included LCP segments that would connect those routes to the Mill Creek substation, because tying that substation to the transmission network is in NorthWestern Energy's long-term plan and those routes run very near the substation anyway. Next, we calculated the sum of all cost values along each of the alternative LCPs. Distance for each alternative was calculated as the total number of cells included in the LCP. Total accumulated cost and distance for each alternative was divided by the values for the least costly alternative (I-90).

Comparison with Community Values Model

A model reflecting community values was created by the Sonoran Institute as part of the MSTI Review Project and is detailed in a separate report. We compared the wildlife and community models using weighted overlays that combined the models by multiplying the cells of each model by a weighting factor and summing the results. We combined the two models using the following weightings: 25% wildlife to 75% community, 50% wildlife to 50% community, and 75% wildlife to 25% community. These comparisons were quantified by calculating least-cost paths for each combined model and comparing the total accumulated costs with the original models using methods described above.

A second comparison was made by calculating a new cost surface using the maximum value of either the final wildlife or community cost surfaces at each cell location. This produces a corridor model that avoids high-cost areas of both models.

Results and Discussion

Wildlife Cost Surface

The wildlife cost surface reflects the abundance of wildlife and high quality wildlife habitat characteristic of the region (Figure 5).
High potential impacts are associated with most areas that have not been developed or converted to agriculture and are away from existing infrastructure. In other words, minimizing potential impacts of the MSTI line on wildlife requires co-locating the new line with existing infrastructures to cluster cumulative impacts into the smallest possible footprint.

Potential impacts on wildlife are highest in areas of high quality sage-grouse habitat that are concentrated in the southern Montana and central Idaho portions of the study area. Although emphasis is placed on sage-grouse in this study, it is important to recognize that sage-grouse are merely an indicator for grassland and sage-brush species which are in general decline. For example, continental breeding bird surveys from 1966-2010 indicate that approximately 40% of grassland species surveyed in the United States are in decline compared with 13% of wetland species and 29% of woodland species (Sauer et al., 2011). Due to the status of greater sage-grouse as "warranted but precluded" for protection under the Endangered Species Act, and efforts to take proactive recovery actions to avoid such listing, a considerable amount of effort has been expended to understand threats to sage-grouse populations and appropriate measures for recovery. The sage-grouse therefore has the dubious distinction of serving as the iconic species for grassland and sagebrush habitats that are under stress. We have relied heavily on scientific findings for sage-grouse conservation under the assumption that applying appropriate conservation measures for this species will help restore grassland and sagebrush species communities in general.

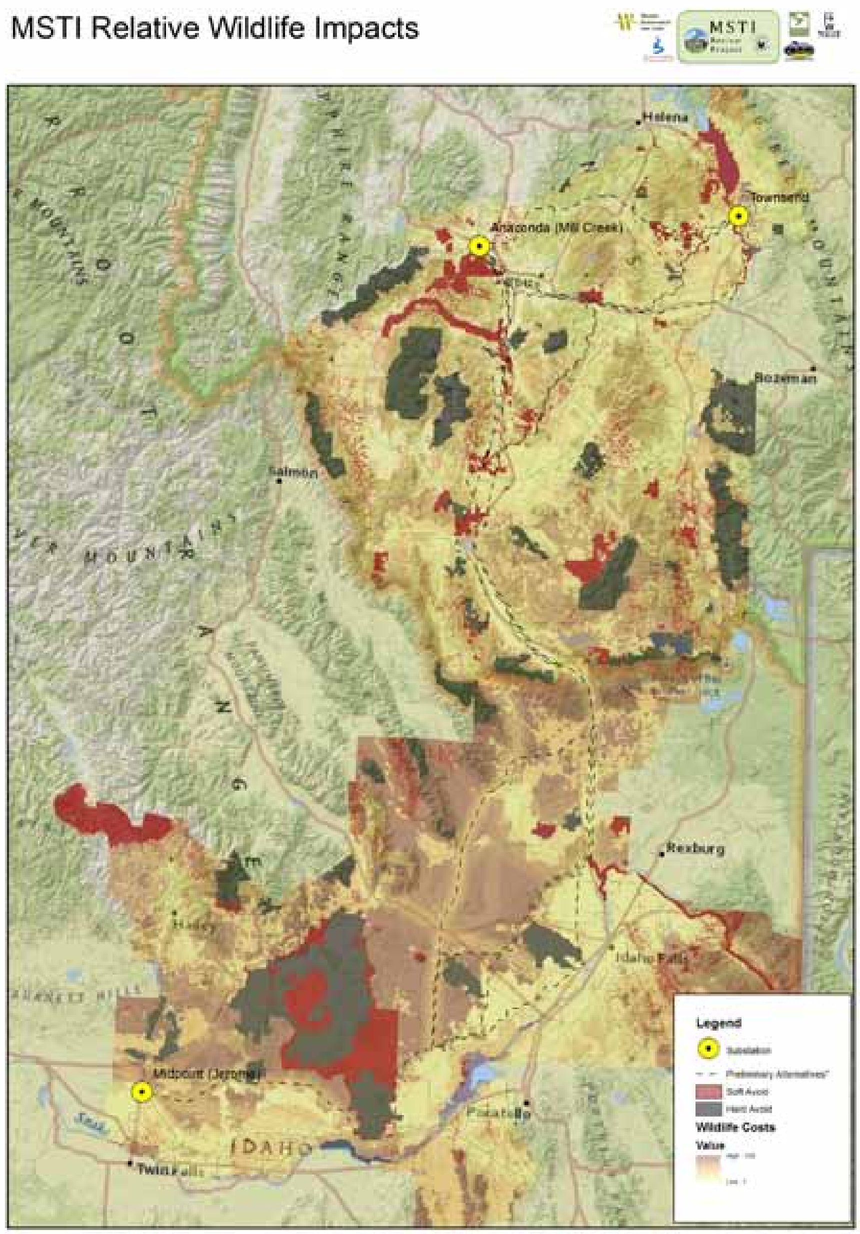


Figure 5 - MSTI Wildlife Costs (Impacts). Cost surface indicates that wildlife impacts are minimized near existing infrastructures or where natural vegetation has been significantly altered for human use. *Preliminary alternatives as of March 2010. For full resolution maps, visit: www.mistreviewproject.org

Corridor Analysis

Least-cost corridor analysis (Figure 6) indicates three potential corridors moving from the Townsend substation toward the west, then following the Interstate 15 (I-15) corridor south to approximately Idaho Falls, ID, then southwest through agricultural lands north of American Falls Reservoir, and then west to Jerome, ID, roughly following existing transmission lines north of Interstate 84.

The best five percent boundary encompasses 42% private lands and 58% public lands. This reflects the importance of both public and private lands for maintaining the region's outstanding wildlife resources. Many species depend on movement between high elevation summer range, which is predominantly public land, and low elevation winter range, which is predominantly privately owned. For other species, privately owned valley bottoms provide important connectivity habitat. A significant amount of private land is rangeland that is crucial for maintaining grassland and sagebrush species.

Three alternatives are identified for connecting the Townsend substation to I-15 (Figure 7). One alternative (I-90) runs south from Townsend roughly along US Highway 287 and then west along Interstate 90 to I-15. A second (BPA) runs west of Townsend, roughly following the existing Bonneville Power Administration 500 kV transmission line to I-15. A third corridor duplicates the I-90 alternative between the Townsend substation and I-90 and then continues southwest through the Jefferson River Valley to I-15. All alternatives converge near I-15 at a point just south of Dillon, MT.

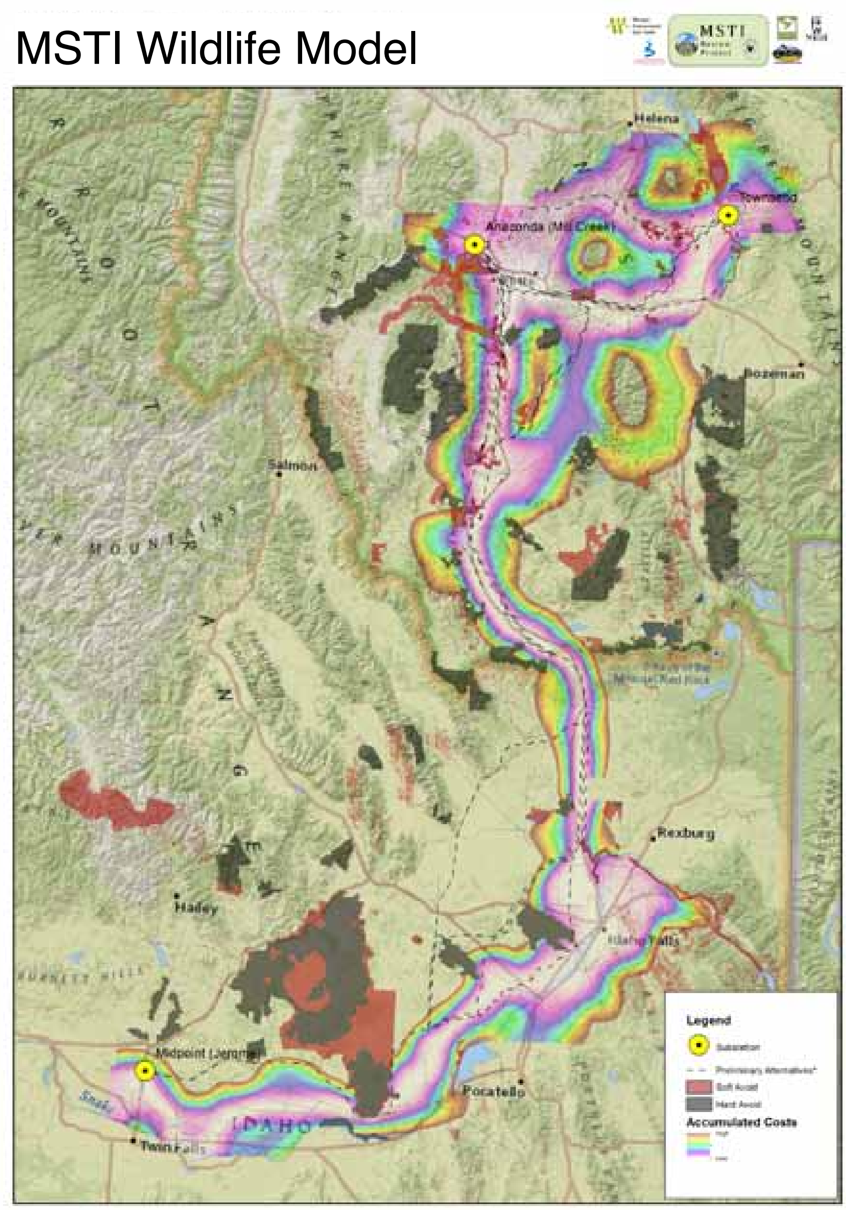


Figure 6 - Best 5% of Potential MSTI Corridors for Minimizing Wildlife Impacts. Corridors converge on I-15 corridor south of Dillon, MT. *Preliminary alternatives as of March 2010. For full resolution maps, visit: www.mistreviewproject.org

The I-90 corridor connecting the Townsend and Mill Creek substations and continuing along I-15 resulted in the least total costs for wildlife (Table 8 and Figure 7). In comparison, the BPA alternative is approximately the same distance as the I-90 alternative (less than 1% shorter) and accumulates 2% more total costs. It is worth noting that the LCP for the BPA alternative would route the line across Butte's Uptown district, which makes sense from a purely wildlife perspective, but is not a feasible route when other factors are considered. This indicates that once local routing options are considered, the total costs associated with the BPA route are likely to increase. The shortest alternative is via the Jefferson Valley, which is 29% shorter than the I-90 alternative but results in 6% more total accumulated costs. The Jefferson Valley alternative would bypass the Mill Creek substation and could result in an additional transmission line connecting Mill Creek to the Townsend substation in the future. Our models estimate that this would approximately double the potential accumulated costs to wildlife when compared with the I-90 alternative that connects Townsend to Mill Creek as part of the MSTI project.

	Difference from Least-Cost Alternative	
Alternative	Distance	Total Cost
BPA	- <1%	+ 2%
I-90*	0	0
Jefferson Valley	- 29%	+6%
*Least-Cost Alternative		

Table 8 - Comparison of Total Costs and Distances of Alternative Corridors.

In summary, the results of the cost surface and corridor analysis indicate that:

- Co-locating the MSTI line with existing infrastructure provides the best option for minimizing negative impacts to wildlife.
- Wildlife in the region depends on both public and private land for habitat. Attempts to route the MSTI line entirely through public or private lands would likely result in significantly increased negative impacts to wildlife.
- The I-90 alternative appears to be the least costly alternative for wildlife, but local siting adjustments could influence the relative costs between the I-90 and BPA alternatives.
- The Jefferson Valley alternative is considerably shorter than other alternatives, but appears to be more costly for wildlife. This alternative does not connect the Mill Creek substation, which leaves the possibility of future additional costs to wildlife if a connector line is built.

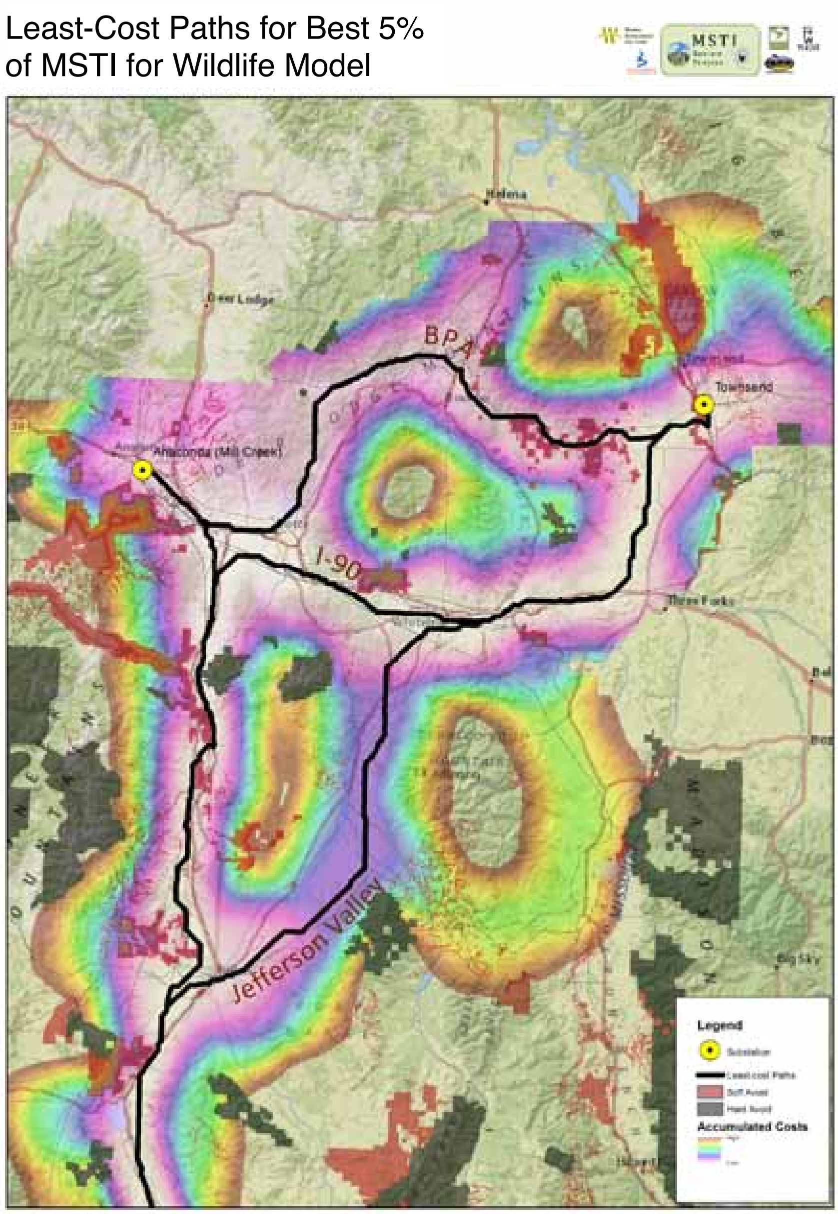


Figure 7 - Alternative Corridors from Townsend Substation to Interstate 15.

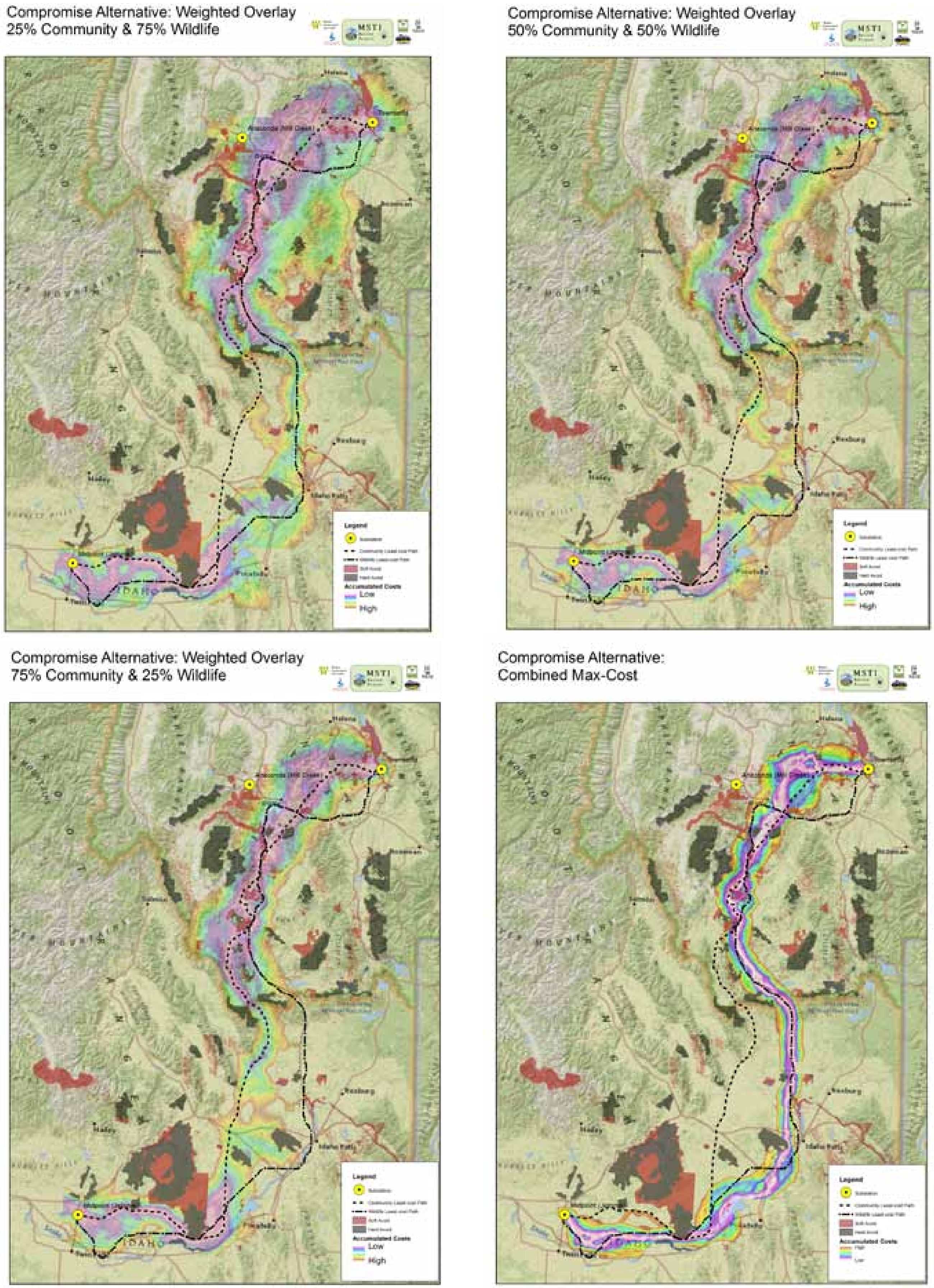


Figure 8 - Alternatives for compromise between wildlife and community values models. Weighted overlay map depict best 10% of values because best 5% does not provide a contiguous corridor. For high resolution versions of these maps, visit: www.MSTIReviewProject.org

Combined Wildlife and Community Values Analysis

Combinations of the wildlife and community values model (described in separate report) were analyzed in an attempt to provide insight into potential trade-offs associated with compromise solutions (Figures 8). As expected, total cost to wildlife increases as the percent of influence of the wildlife model decreases for weighted overlays, with an expected inverse result for total costs to community values (Figure 9 and Table 9). However, the maximum-cost alternative resulted in the smallest increase in total costs for community values (113% increase), and tied for the smallest increase in total cost (80%) for wildlife.

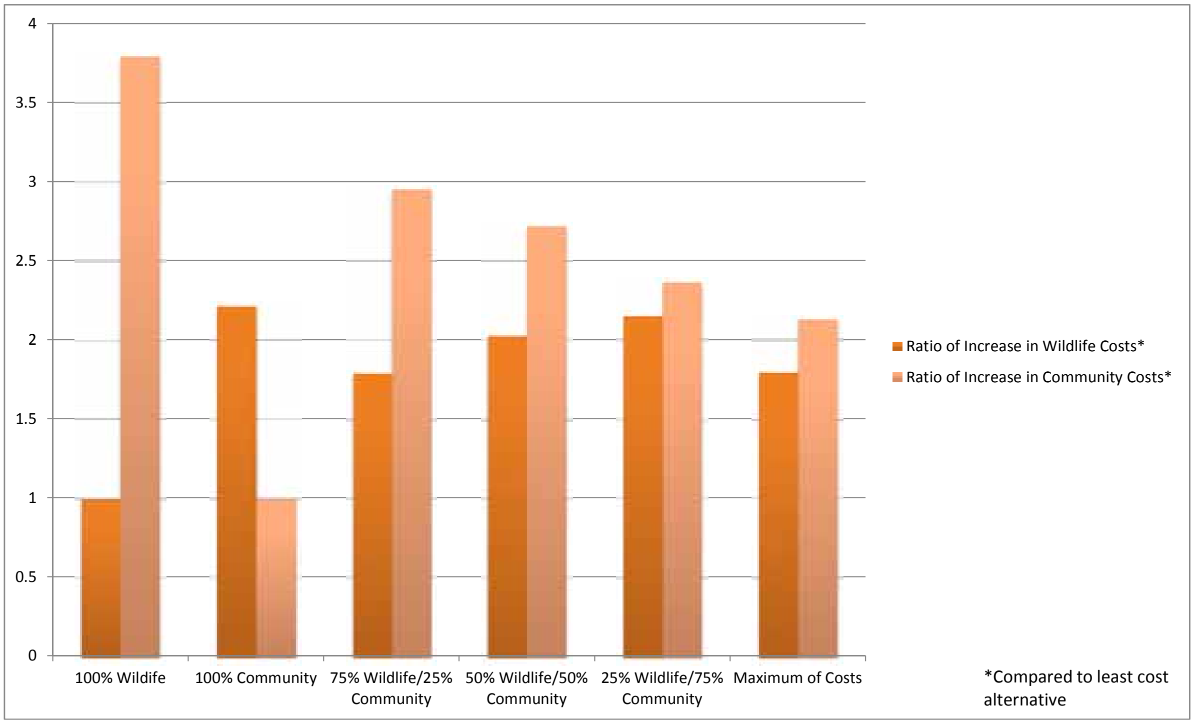


Figure 9 - Ratio of increase costs of compromise alternatives compared with least cost alternative.

Overlay Combination	Total Wildlife Cost Units[1]	Percent Difference Wildlife Costs[2]	Total Community Cost Units[1]	Percent Difference Community Costs[3]
100% Wildlife	126661	0	429531	279
75% Wildlife/25% Community	227221	79	334130	195
50% Wildlife/50% Community	256793	103	307968	172
25% Wildlife/75% Community	272980	116	268039	137
100% Community	280922	122	113208	0
Maximum-cost4	227499	80	240926	113

1 Equals the sum of all cost surface cell values intersected by the least-cost path of the combination.

2 Compared with original wildlife model

3 Compared with original community values model

4 Maximum costs derived by extracting the maximum value of either the wildlife or community values cost surfaces into a new cost surface and running a least-cost corridor model on the result.

Table 9 - Comparisons of wildlife and community values model combinations using different weightings.

It appears that combining models using the maximum-cost produces a better compromise than any of the weighted overlay alternatives. A balanced weighted overlay (equal weight for each model) resulted in a 103% increase in total costs for wildlife and a 172% increase for community values compared with 80% and 113% increases respectively from the maximum of costs compromise. As previously reported, the maximum-cost alternative was the best of all alternatives analyzed and essentially tied for the best alternative for wildlife. This is probably because the maximum-cost alternative simultaneously avoids the most sensitive areas identified in both models. This is reflected in the resulting corridor (Figure 8), which alternates between the least-cost corridors for wildlife and community values, presumably to avoid highest-cost areas of both models. However, it should be noted that none of the compromise alternatives would connect the Mill Creek substation to the MSTI line, so the potential for future impacts if the Mill Creek substation is connected should be considered with any compromise alternative.

Summary

As part of the MSTI Review Project, we developed a spatial model for exploring all possible alternatives for minimizing negative impacts on wildlife from NorthWestern Energy's proposed Mountain States Transmission Intertie. A cost surface was developed to map relative potential impacts on wildlife across all counties potentially impacted by the line. The cost surface reveals an abundance of wildlife resources within the study area. Of particular concern are areas of grassland, sagebrush, and wetland habitats. Corridor analysis indicates that impacts to wildlife are minimized by clustering the proposed line near existing infrastructure (in particular, major utility lines and Interstate corridors). The best five percent of modeled corridors includes approximately 42% private and 58% public land. Our model suggests three alternative corridors for connecting the Townsend substation to the I-15 corridor. The least-cost alternative roughly follows the I-90 corridor to I-15, but an alternative following the existing BPA 500 kV transmission line is nearly the same distance and increases total accumulated costs by approximately 2%. A third alternative along the Jefferson Valley would be approximately 30% shorter, but would increase wildlife impacts by approximately 6% over the least-cost I-90 alternative. Future plans to connect the Mill Creek substation to the MSTI power line are an important consideration. The I-90 and BPA alternatives would connect to the Mill Creek substation as part of the MSTI project, whereas the Jefferson Valley alternative may result in a future transmission line connection between Mill Creek and Townsend substations, with associated additional impacts on wildlife.

Our wildlife and community (described in a separate report) models identify significantly different corridors for minimizing impacts to their respective targets. We analyzed potential trade-offs between several compromise alternatives between the two models. Of the alternatives considered, an alternative based on the maximum cost values between the two models predicts the lowest increase in total impacts to both wildlife and community values.

Our analyses provide tools for identifying corridors that minimize impacts on wildlife and community values, evaluating alternative routes, and quantifying potential trade-offs among compromise alternatives. However, these analyses do not quantify or evaluate actual costs to wildlife. Users are cautioned not to equate "lower impacts" with "acceptable impacts."

Literature Cited

Ament, R., A.P. Clevenger, O. Yu, and A. Hardy. 2008. *An Assessment of Road Impacts on Wildlife Populations in U.S. National Parks*. Environmental Management 42:480-496.

Brock, B.L., R.M. Inman, K. H. Inman, A. J. McCue, M. L. Packila, and B. Giddings. 2007. Broad-scale wolverine habitat in the conterminous Rocky Mountain states. Chapter 2 in Greater Yellowstone Wolverine Study, Cumulative Progress Report, May 2007. Wildlife Conservation Society, North America Program, General Technical Report, Bozeman, Montana, USA.

Canfield, J.E. 1988. Impact mitigation and monitoring of the BP 500-kV Garrison-Taft transmission line -- effects on elk security and hunter opportunity. Final Rep. Montana Dept. Fish, Wildlife and Parks. 161 pp.

Charry B, Jones J (2009) *Traffic volume as a primary road characteristic impacting wildlife: a tool for land use and transportation planning*. In: Wagner PJ, Nelson D, Murray E (eds) Proceedings of the international conference on ecology and transportation. Center for Transportation and the Environment, North Carolina State University, Raleigh, NC, pp 159–172.

Craighead, L., M.A. Haroldson, T. Olenicki. 2006, unpublished manuscript. *Evaluation of grizzly bear habitat models for the Greater Yellowstone ecosystem using data from GPS instrumented bears*.

Dunkin, S.W., F. S. Guthery, S.J. Demaso, A.D. Peoples, and E.S. Parry. 2009+. Influence of Anthropogenic Structures on Northern Bobwhite Space Use in Western Oklahoma.

Journal of Wildlife Management, 73(2):253-259.

The Environmental Law Institute. 2003. *Conservation Thresholds for Land Use Planners*. 55pp. http://www.elistore.org/reports_detail.asp?ID=10839

Forman, R.T., and R.D. Deblinger. 2000. The *Ecological Road-Effect Zone of a Massachusetts (U.S.A.) Suburban Highway*. Conservation Biology 14:36-46.

Glennon, M., and H. Kretser. 2005. *Impacts to Wildlife from Low Density, Exurban Development: Information and Considerations for the Adirondack Park*. Technical Paper No. 3. Wildlife Conservation Society: Adirondack Communities and Conservation Program.

Hansen, A.J., R.L. Knight, J. M. Marzluff, S. Powell, K. Brown, P. H. Gude, and A. Jones. 2005. *Effects of exurban development on biodiversity: Patterns, mechanisms, and research needs*. Ecological Applications 15:1893-1905.

Johnson, G. 2009. *Greater sage-grouse technical report, Mountain States Transmission Intertie Project. Draft June 9, 2009*. Prepared for PBS&J.

Joyal, R., P. Lamothe and R. Fournier 1984. *L'utilisation des emprises de lignes de transport d'energie electrique par*

l'orignal (Alces nlc.c.\) en hiver. Can. J. Zool. 62: 260-266.

Manville, A.M., II. 2004. *Prairie grouse leks and wind turbines: U.S. Fish and Wildlife Service justification for a 5-mile buffer from leks; additional grassland songbird recommendations*. Division of Migratory Bird Management, USFWS, Arlington, VA, peer-reviewed briefing paper. 17 pp.

Manville, A. M., II. 2005. *Bird strikes and electrocutions at power lines, communication towers, and wind turbines: state of the art and state of the science – next steps toward mitigation*. *Bird conservation implementation in the Americas*. Pages 1051–1064 in C. J. Ralph and T. D. Rich, editors. Proceedings 3rd international Partners in Flight conference 2002. General technical report PSW-GTR-191. U.S. Department of Agriculture Forest Service, Pacific Southwest Research Station, Albany, California.

Picton, H.D., J.E. Canfield, and G. P. Nelson. 1985. *The impact of a 500 kV transmission line upon the North Boulder winter elk range: final rep*. Fish and Wildlife Management and Research, Dept. of Biology, Montana State University, Bozeman. 87 pp.

Sauer, J.R., J. E. Hines, J.E. Fallon, K.L. Pardieck, D.J. Ziolkowski, Jr., and W. A. Link. 2011. *The North American Breeding Bird Survey, Results and Analysis 1966 - 2010*. Version 12.07.2011 USGS Patuxent Wildlife Research Center, Laurel, MD

Spellerberg, I.F. 1998. *Ecological effects of roads and traffic: a literature review*. Global Ecology and Biogeography 7:317– 333.

Switalski, T.A. 2006. *How many is too many: a review of road density thresholds for wildlife*. The Road-RIPorter. 11:6-8. http://www.wildlandscpr.org/files/uploads/RIPorter/rr_v11-4.pdf

U.S. Census Bureau. 2012. *2010 TIGER/Line Shapefiles [machine-readable data files]/ prepared by the U.S. Census Bureau,* 2012

U.S. Environmental Protection Agency (EPA). (2009) *Land-Use Scenarios: National-Scale Housing-Density Scenarios Consistent with Climate Change Storylines*. Global Change Research Program, National Center for Environmental Assessment, Washington, DC; EPA/600/R-08/076F. Available from: National Technical Information Service, Springfield, VA, and online at http://www.epa.gov/ncea.

U.S. Fish and Wildlife Service. 2012. *Classification of Wetlands and Deepwater Habitats of the United States*. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC. FWS/OBS-79/31. Washington, D.C. U.S. Fish and Wildlife Service, Division of Habitat and Resource Conservation

US Geological Survey, *Gap Analysis Program (GAP)*. August 2011. National Land Cover, Version 2

Yahner, R.H., W.C. Bramble and W.R. Byrnes. 2001. *Response of amphibian and reptile populations to vegetation maintenance of an electric transmission right-of-way*. Journal of Aboriculture. 27(4):215-220.

Glossary of Agency Acronyms

BLM – Bureau of Land Management

IDFG – Idaho Fish and Game

MTFWP – Montana Department of Fish Wildlife and Parks

MTNHP – Montana Natural Heritage Program

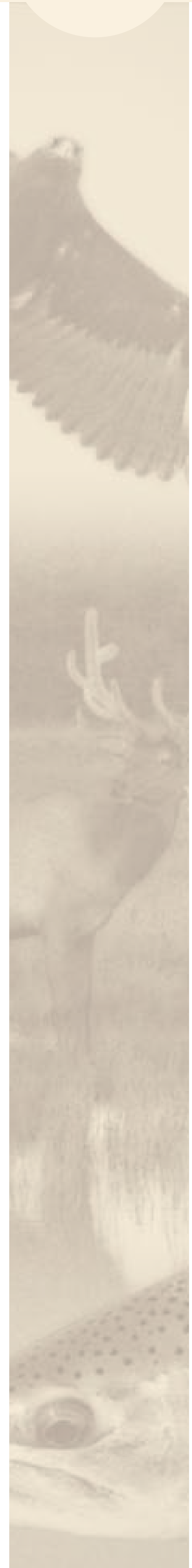
NHP – Natural Heritage Program

NPS – National Park Service

TNC – The Nature Conservancy

USFS – United States Forest Service

USFWS – United States Fish and Wildlife Service



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