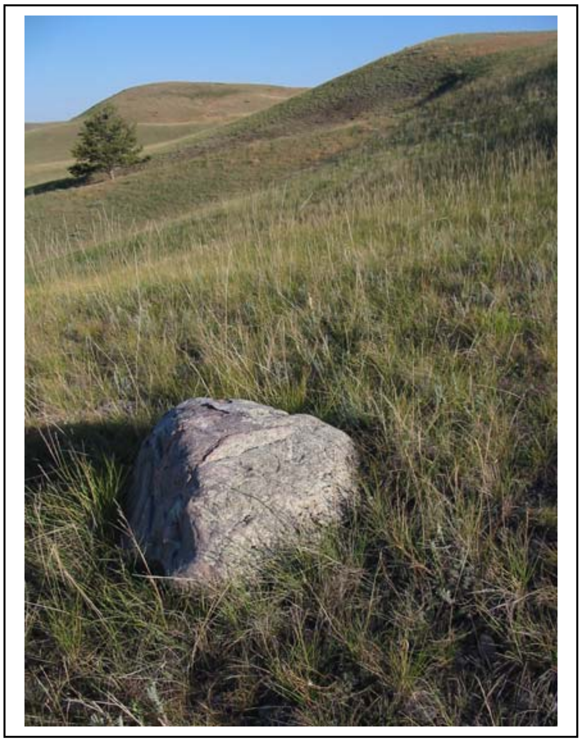
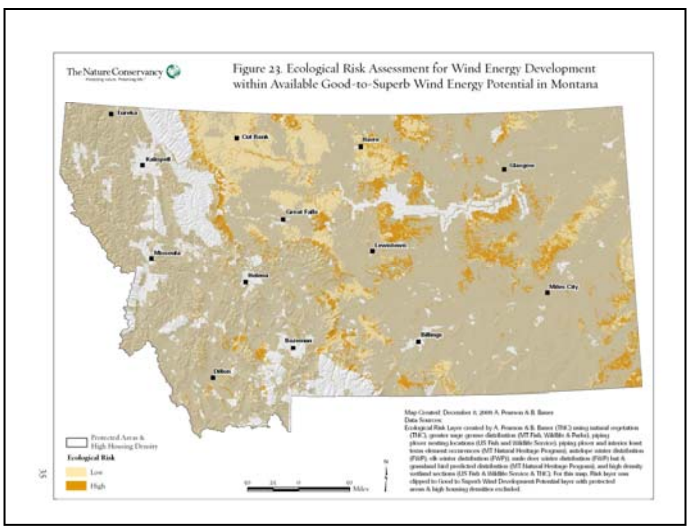
An Ecological Risk Assessment of Wind Energy Development in Montana





Brian Martin, Amy Pearson, Brad Bauer
The Nature Conservancy
Helena, Montana
January 2009

TABLE OF CONTENTS

TABLES

FIGURES

ACKNOWLEDGEMENTS

We would like to thank many persons that provided input to this project. We would also like to thank persons that reviewed this document and provided valuable comments. Finally, we would like to thank the Priscilla Bullitt Collins Trust Northwest Conservation Fund for providing funding for this project.

EXECUTIVE SUMMARY

In 2008, the United States led the world in wind-power generation, providing 35% of the nation's new electrical generating capacity via wind power facilities. Montana ranks fifth among states for wind energy potential. While only two large-scale wind-energy facilities currently exist within the state, numerous others are planned, and several pending projects stand to vastly increase electrical transmission out of state, which will spark additional development.

Wind facilities are not stand-alone features—they cover vastly more area than the footprint of the turbines, requiring extensive road systems and transmission corridors. Significantly increasing wind-energy production will require millions of acres to accommodate development. The challenge for wind energy development in Montana is to produce relatively clean energy that does not contribute to global climate change, while minimizing impacts to wildlife and cultural and aesthetic resources.

Wind-energy development has progressed with very little science-based policy analysis to examine costs of biodiversity impacts, or for that matter, state or local regulation applicable to similar development of this magnitude. Further, since wind-power projects are proposed individually, cumulative impacts at regional scales are left unaddressed. Proper siting of wind energy facilities is key to reducing potential impacts and conflict. Towards this end, we have completed an ecological risk assessment, using broad-scale habitat information, as well as fine-scale data for 30 wildlife species of concern, selecting for those that research suggests would be the most susceptible to the impacts from wind-energy development.

We estimate that in total about 17 million acres of available good-to-superb wind energy potential exists within Montana. We identified at least 7.7 million acres that have a high risk to ecological values if projects were developed in those areas. We strongly suggest that high risk areas be avoided as locations for wind energy development, rather than considering mitigation approaches, as the lands identified are often critical habitat for multiple species. We also recognize that our efforts are based on breeding and resident species, and we have not considered migratory bird and bat species. Future research and monitoring is required to build our understanding of critical migratory routes, and there is also a need to develop best management practices for operations that will limit significant mortalities.

Finally, we hope this publication will spark cooperative efforts between wind energy and conservation interests, so that the promise of renewable energy can be achieved without sacrificing Montana's cultural, aesthetic, or biological heritage. This report should be viewed as a first version that will be updated and improved through on-going research and data collection. The latest information on distribution (observations, species occurrences, predictive models, range maps) can be obtained from the Montana Natural Heritage Program.

INTRODUCTION

In 2008, the United States led the world in wind power generation with 116,000-MW of capacity, and its importance in supplying electrical power continues to grow, providing 35% of the nation's new electrical generating capacity (AWEA 2008, USDOE 2008). Concerns about conventional energy sources and related carbon emissions, public policies mandating power generation from renewable resources, and declining production costs of wind energy are spurring additional wind development. For these reasons and others, President Bush established a goal of 20% of U.S. energy production coming from wind by 2030. In order to meet that goal, the U.S. Department of Energy (USDOE) (2008) estimates that 290,000-MW of additional generation will be required.

Wind facilities are not stand-alone features—they cover vastly more area than the footprint of the turbines, requiring extensive road systems and transmission corridors. Wind turbines themselves must be spaced to allow for maximum capture of wind, necessitating dispersed placement of turbines. Meeting the country's 20% wind energy generation goal will likely require an additional 241,000-MW from land-based facilities, with the remaining being water-based wind farms (USDOE 2008). Estimated land area required for the land-based wind farms is approximately 12.3 million acres (USDOE 2008), or roughly an area the size of New Hampshire and Vermont combined. Additionally, wind energy development will require extensive transmission line construction. For example, Montana currently has relatively expansive areas with no significant transmission infrastructure and most of the existing transmission lines are at or near maximum capacity. To deliver wind energy out of state will require future construction of perhaps thousands of miles of new transmission lines.

Wind energy development has progressed with very little science-based policy analysis to examine costs of biodiversity impacts. Further, since wind power projects are proposed individually, cumulative impacts at regional scales are left unaddressed. Overall, few research projects have been completed that document the impact of wind farms for a wide diversity of birds and bats (Kunz et al. 2007, Stewart et al. 2007). Additionally, very little is known about impacts to other local endemic species. In terms of birds and bats, research and monitoring completed to date has documented wind farms impacting species by: 1) destruction and fragmentation of habitat from the extensive footprint of the facilities and infrastructure, 2) significant impacts for birds and bats through displacement caused by the structural intrusion of turbines and transmission lines, noise, and down wash of air generated by blades, and 3) direct avian and bat mortality (Kunz et al. 2007, Kuvlesky et al. 2007, Stewart et al. 2007). In the case of bats, direct mortality may be significant, especially among tree-roosting species (ranging from 15.3 to 41.1 bats per MW per year) (Kunz et al. 2007). Additionally, construction and roads have the potential to facilitate the spread of invasive plant species (Kuvlesky et al. 2007).

Aside from individual species losses, these mortalities may have broader significance to the American public. For instance, bats are both pollinators and insect eaters. Their relevance to American agriculture for both pest management and propagation of crops should not be overlooked. Bats are experiencing downward trends in population due to both disease and human-caused decreases in habitat value (Mickleburgh et al. 2002).

Therefore, cumulative effects from existing stresses on bats, when taken into account with potential effects from wind projects, may add to the decline or local extirpation of these economically advantageous species.

To counter better-known environmental impacts, some states, such as Washington, California, and Minnesota, have adopted a regulatory framework to review wind projects on an ad-hoc basis, whereas many states, such as Montana, lack any regulation and generally rely on wind energy producers to essentially regulate themselves. In the absence of formal review, the purpose of this report is to identify potential risk to a subset of species found in Montana. As has been proposed in Wyoming (Molvar 2008), we believe that it is essential that wind farms are properly sited to avoid adverse impacts to biodiversity. At this time, we lack much of the research required to adequately assess all of the impacts wind energy development may have. However, we compiled the best available spatial data for resident and breeding populations to begin an initial analysis of locations that would have lesser and greater risk for biodiversity in Montana (Appendix A). In contrast, we do not address potential impacts on migratory species; future planning will need to focus much more effort on documenting migratory corridors for siting purposes and minimizing impacts to migrating species.

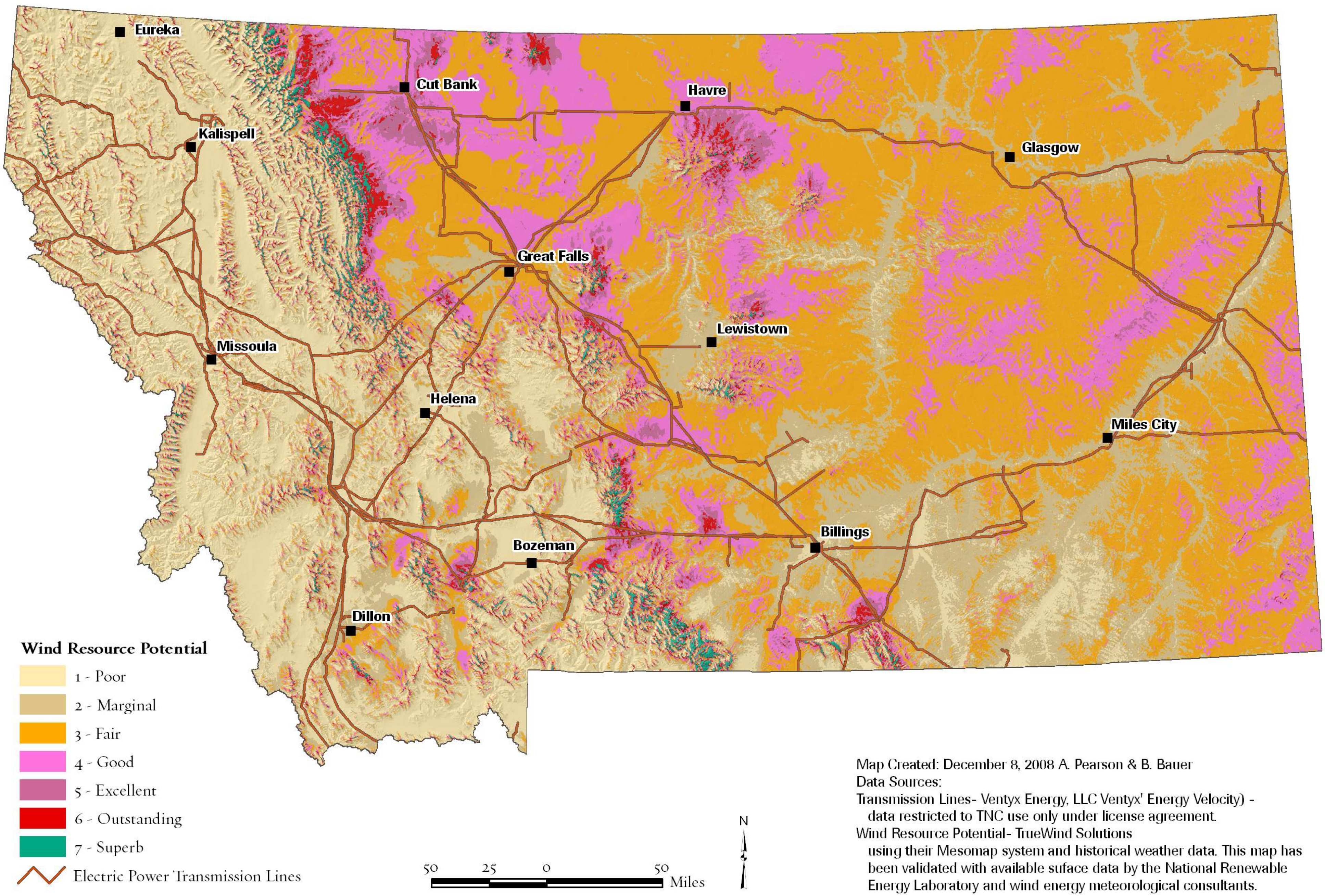
MANAGING ECOLOGICAL RISK THROUGH WIND ENERGY SITING

The challenge of wind energy development in Montana is to produce relatively clean energy that does not contribute to global climate change, while minimizing impacts to biodiversity. Montana is home to extensive intact habitats, retaining much of the species and viewsheds first documented by European explorers. It contains some of the largest, intact grasslands remaining in North America and more mixed-grass prairie than any other state in the Great Plains. It also retains extensive examples of montane coniferous forest systems that today support the most complete carnivore assemblages in the lower 48 states. Compared to most of the West, it has some of the least developed intermountain valleys. It also is home to the nation’s longest free-flowing river and harbors high quality aquatic and riparian habitats across the state.

Montana ranks fifth among states for wind energy potential, with an estimated average wind power output of 116,000-MWs (Wind Today 2008). As of 2007, Montana had 146-MW of capacity and another 500-MW under construction, illustrating the vast gap between current and potential development. Wind energy potential is predominantly located east of the Continental Divide (Figure 1). For the purposes of this project, we conducted our analysis of likely locations for wind energy development using the National Renewable Energy Lab (NREL) wind power class 4 or higher, since those classes have the greatest potential of generating wind power with large turbines (Figure 2). Within those wind power classes, we excluded urban areas and public lands that prohibit wind energy development, such as national parks, wilderness areas, and wildlife refuges. We also excluded private lands under conservation easement or managed by a conservation organization from consideration (although some easements may not restrict wind development) (Figure 3).

The Nature Conservancy
Protecting nature. Preserving life.™

Figure 1. Wind Energy Potential in Montana



Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Transmission Lines- Ventyx Energy, LLC Ventyx' Energy Velocity) - data restricted to TNC use only under license agreement.
Wind Resource Potential- TrueWind Solutions using their Mesomap system and historical weather data. This map has been validated with available suface data by the National Renewable Energy Laboratory and wind energy meteorological consultants.

Figure 2. Good-to-Superb Wind Energy Potential in Montana

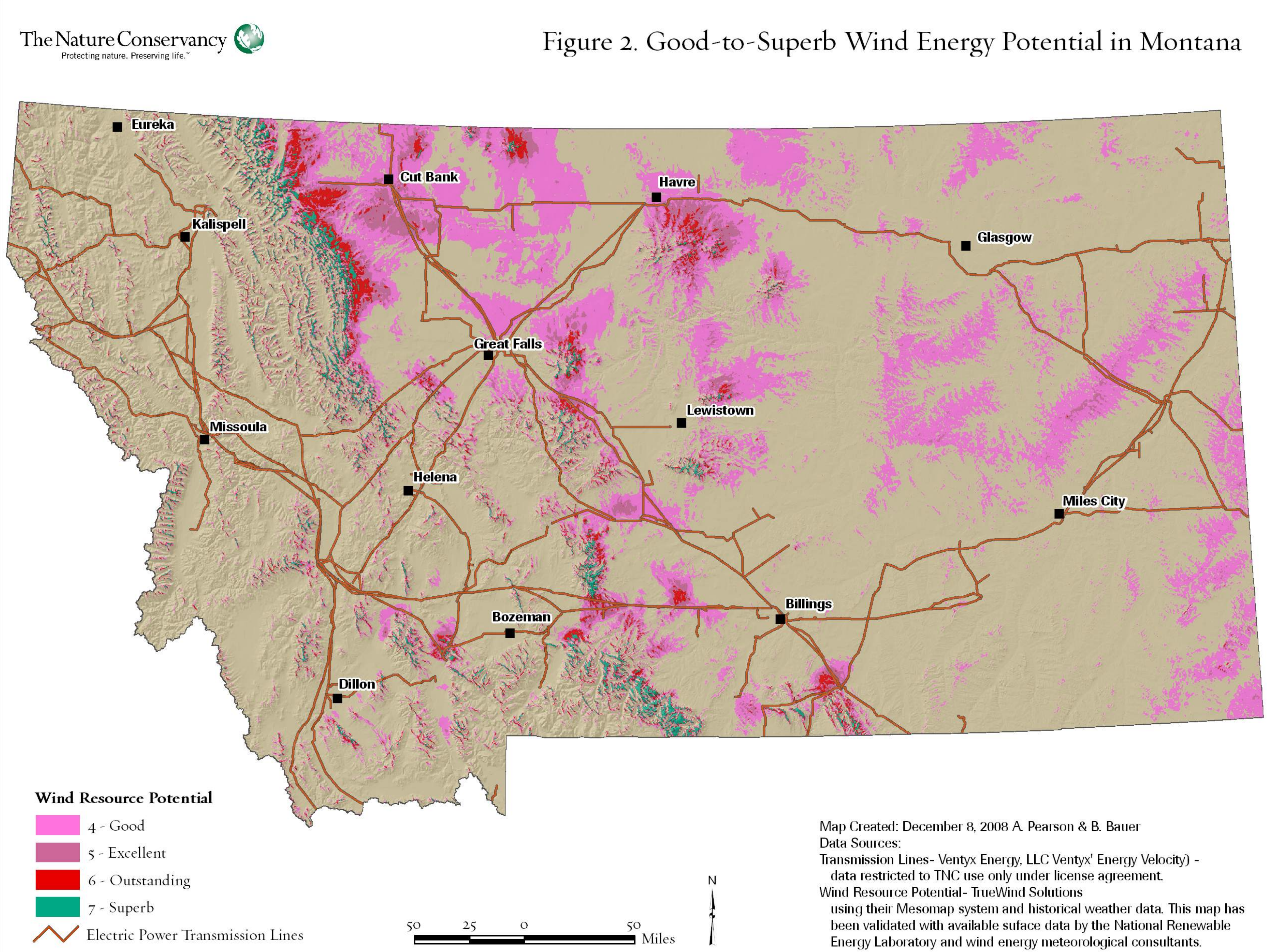
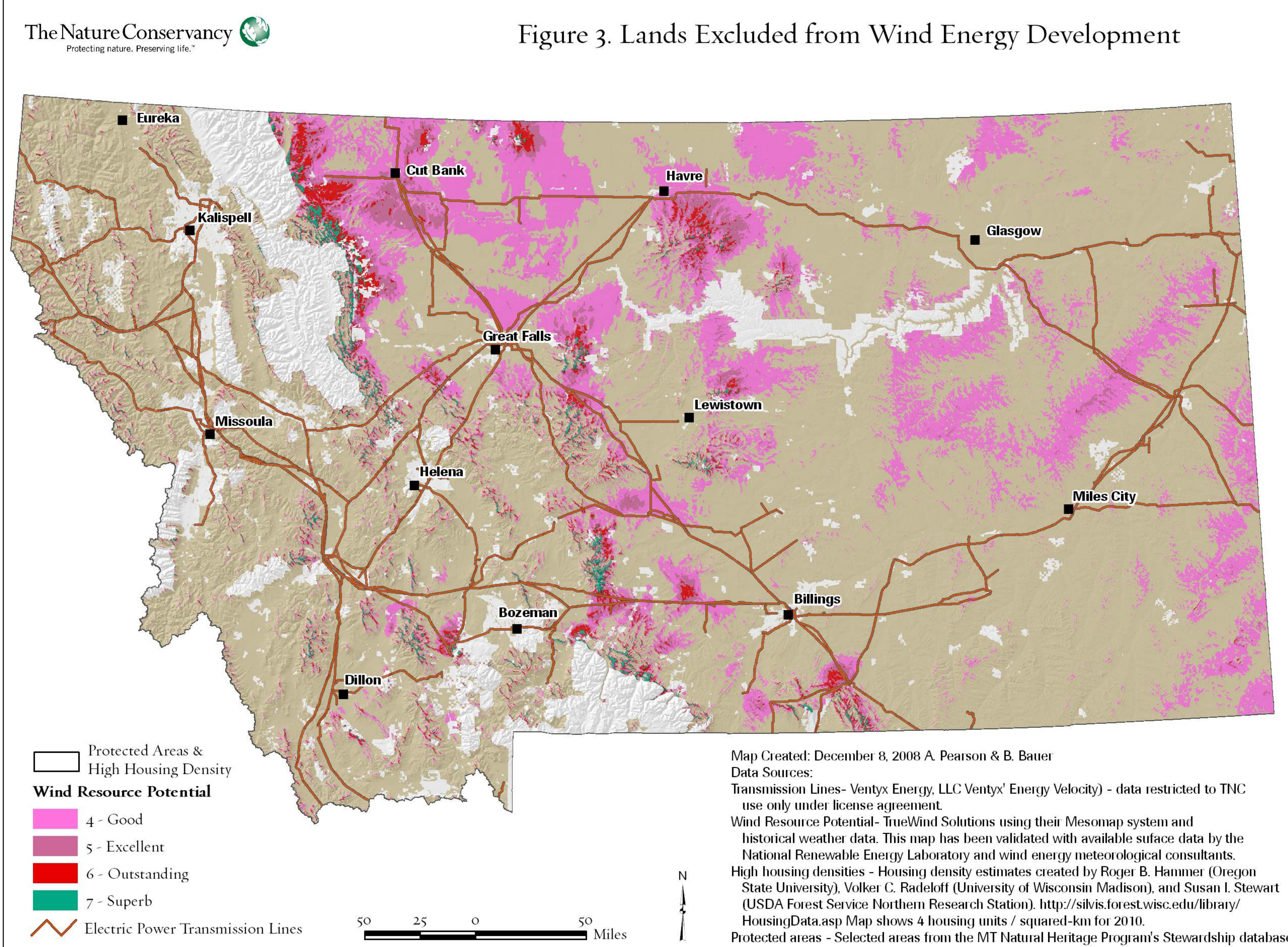


Figure 3. Lands Excluded from Wind Energy Development



Low Risk Lands

We thought it was important to first identify those lands most conducive to wind energy development and have the lowest risk for resident and breeding wildlife. Extensively altered habitat, such as cropland, provide lower wildlife habitat values than intact habitats for resident or breeding birds, bats, and most other wildlife. This is also the case for most wide-ranging species of wildlife in lands already extensively fragmented by land use change (e.g., cropland) or through intensive industrial development activities, such as oil drilling and development. Therefore, wind energy development in cropland or highly fragmented habitats have intrinsically lower risk for conflict with many species of wildlife. We have identified approximately 4.4 million acres in Montana that have good or better wind energy potential and are relatively low risk (Figure 4). One caveat: these lands may retain importance as a portion of migratory flyways for birds and/or bats, and site-based management actions may still be required to reduce direct mortality.

SPECIES AT RISK FROM WIND DEVELOPMENT

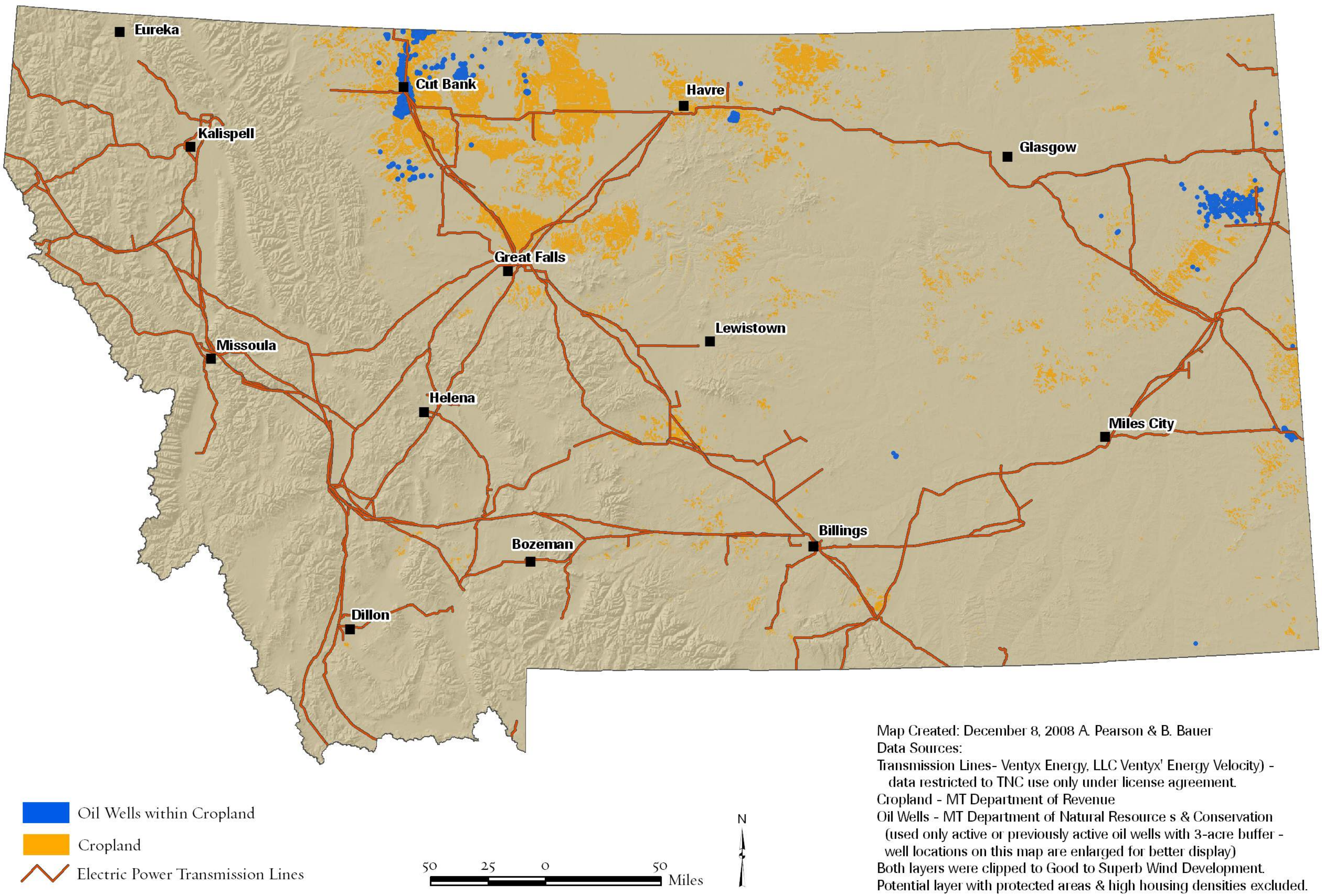
This risk assessment for wind energy development impacts on biodiversity begins at the coarsest level of intact habitats that generally support a rich diversity of plant and animal species. As a coarse-scale assessment, we have utilized National Land Cover Classification to identify relatively intact habitats (Figure 5). From there we selected a subset of species to evaluate the risk of wind energy for biodiversity within Montana, recognizing that birds and bats are the most widely researched species, but that other species may be impacted. Species selected were also biased towards eastern Montana, recognizing that large-scale wind energy development will mostly occur east of the continental divide and generally at lower elevation settings. Therefore, we selected species using three criteria: 1) the availability of relatively high quality spatial data; 2) apparent sensitivity to wind or other large-scale industrial development; and, 3) species with generally large ranges (versus more site restricted or incidental, but rare species). For each species or group of species we have briefly summarized published research or widely available information. The purpose of this summary is not meant to be an exhaustive review of wind impacts, but rather as supporting information as to the rationale for evaluating risk. We also recognize that insufficient research exists for many species and response to wind energy development, so our assessment is couched within the context of risk, often rather than known impacts.

Greater Sage-Grouse

In general, prairie grouse including sage grouse (*Centrocercus urophasianus*) exhibit high site fidelity and require extensive intact habitat with open horizons. Montana hosts two species of grouse that are likely to be located in areas of interest for wind development, sage grouse and plains sharp-tailed grouse (*Tympanuchus phasianellus*). Evaluation was restricted to sage grouse, due to well-documented sensitivity to disturbance, the geographic scope of their distribution across the state, and the importance of habitat in Montana for the northern Great Plains population.

Sage grouse are widely distributed across sagebrush grassland habitat in eastern Montana and portions of valleys in southwestern Montana. Sage grouse are entirely dependent

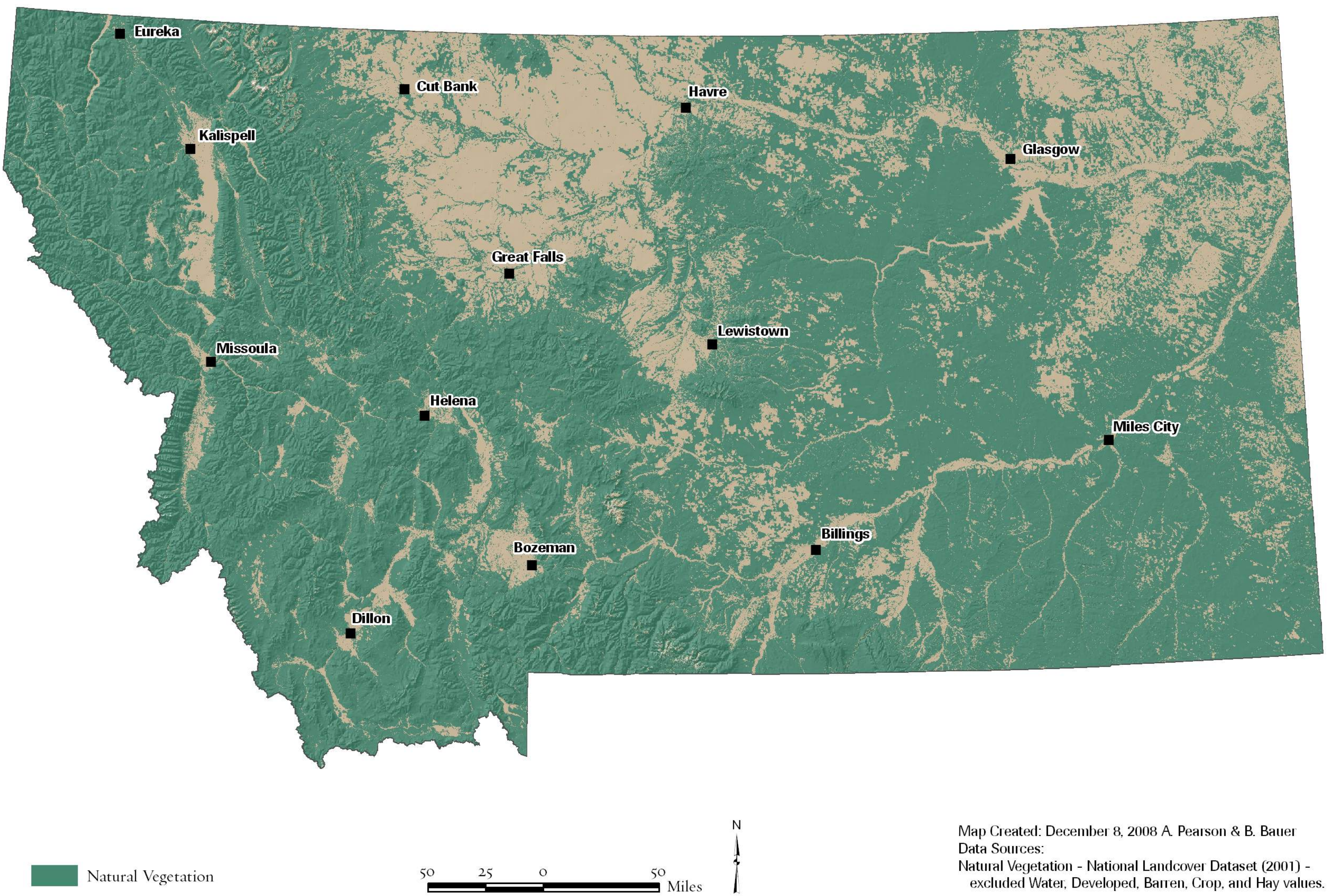
Figure 4. Low Ecological Risk Lands for Wind Energy Development



Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Transmission Lines- Ventyx Energy, LLC Ventyx' Energy Velocity) - data restricted to TNC use only under license agreement.
Cropland - MT Department of Revenue
Oil Wells - MT Department of Natural Resource s & Conservation (used only active or previously active oil wells with 3-acre buffer - well locations on this map are enlarged for better display)
Both layers were clipped to Good to Superb Wind Development.
Potential layer with protected areas & high housing densities excluded.

The Nature Conservancy
Protecting nature. Preserving life.

Figure 5. Relatively Intact Natural Habitat



Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Natural Vegetation - National Landcover Dataset (2001) - excluded Water, Developed, Barren, Crop, and Hay values.

upon sagebrush for a portion of their lifecycle and stable populations in the state are largely attributed to relatively large, intact, and good quality habitat. Sage grouse are a long-lived species and females generally breed within about 4 miles or less from a lek (Walker 2008). Birds may travel considerable distances between breeding and wintering grounds.

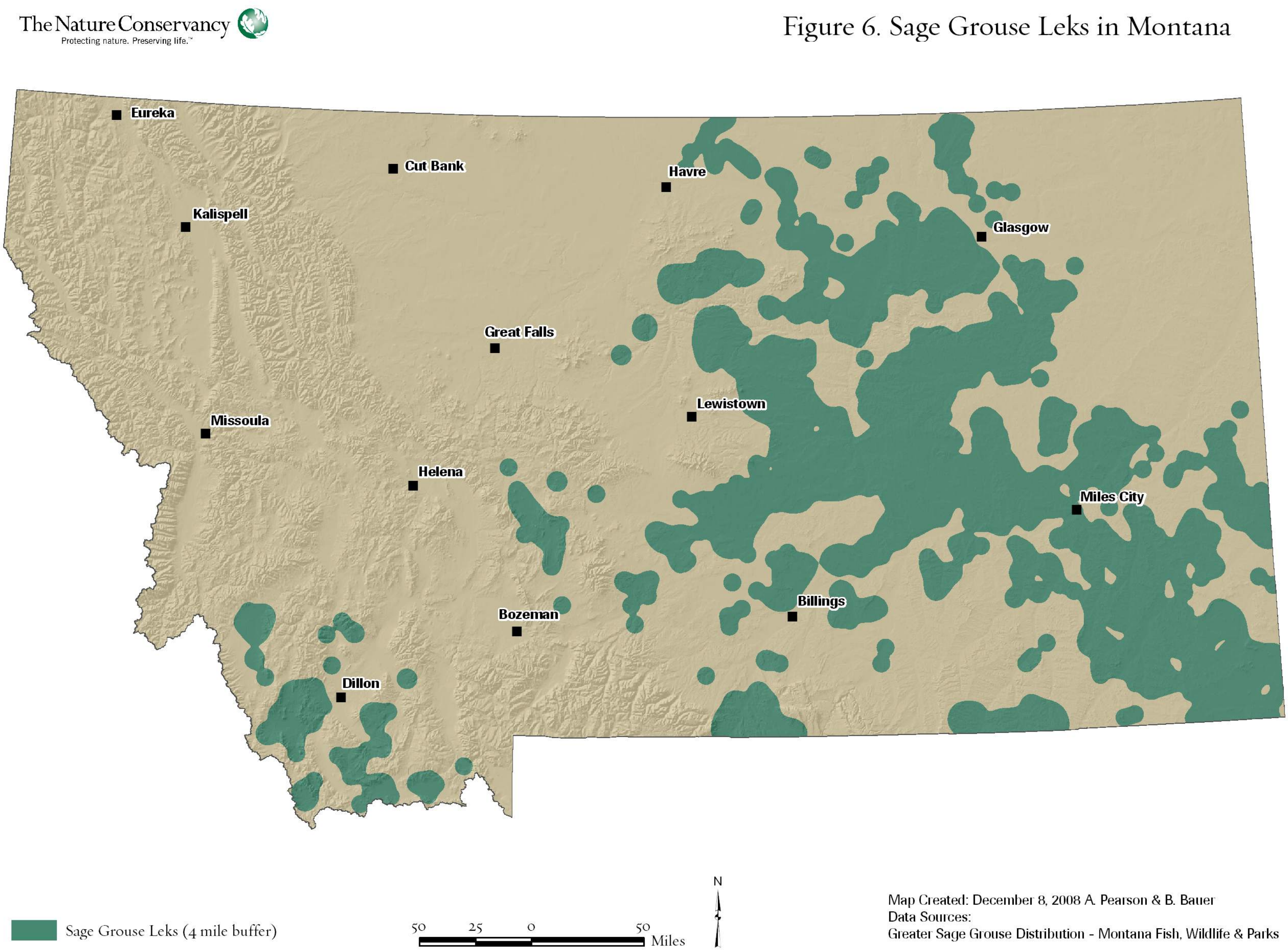
Impact of wind farms on sage grouse have not been documented, however, it has been suggested that as a large-scale industrial development it may have similar effects as natural gas (shallow and coal-bed) development (Montana Fish, Wildlife and Parks 2005a). In Wyoming, gas development has resulted in wide-scale extirpation or reduction of populations at distances as great as 4 miles from leks (Holloran 2005, Walker 2008). Both gas development and wind farms are characterized by extensive road developments that fragment habitat and increase potential of vehicle collisions. Vertical structures, transmission lines, and turbines may decrease survival or reproductive success as a result of collisions and creation of habitat for predators. Additionally, the structures themselves may alter habitat suitability, resulting in abandonment. One apparent example of this was documented in Idaho, where 8 meteorological towers, 30 to 150 feet in height and topped with anemometers, were installed to measure wind velocity for a commercial wind power feasibility study. Over a period of five years, 7 of 9 sage grouse leks were abandoned and the overall population declined about 75% (Collins and Reynolds 2006). In contrast, sage grouse populations were relatively stable in the remainder of the county where the project was located.

The U.S. Fish and Wildlife Service recommended that wind farms be located 5 miles from active leks to avoid disturbance of prairie grouse (Manville 2004). In our analysis, we utilized data of lek locations for sage grouse from Montana Fish, Wildlife and Parks (MFWP). We have buffered occupied leks a distance of 4 miles (Figure 6 and Figure 7), because research suggests that sage grouse generally nest within 4 miles of a lek (Walker 2007). Wind farm or transmission line construction within the areas highlighted on the map may create high risk for negative impacts to sage grouse, with risk being especially high for smaller and migratory populations. For example, a population that may be especially vulnerable is located in northern Valley County, where birds occupy widely scattered habitat that extends into portions of southern Saskatchewan. This population is also migratory, occupying habitat north of the Milk River during breeding and brood rearing and wintering south of the river.

Grassland Endemic Birds

Endemic grassland birds in North America have been recognized as suffering the most consistent and widespread declines of any avian assemblage in North America (Knopf 1994). As a result, numerous species have been identified as priorities for conservation (Table 1). Because there is substantial habitat overlap among many of these species, we have considered them as a suite, rather than individually. We anticipate that there may be a variety of responses to wind energy development, and some of these species may need to be evaluated individually as data become available.

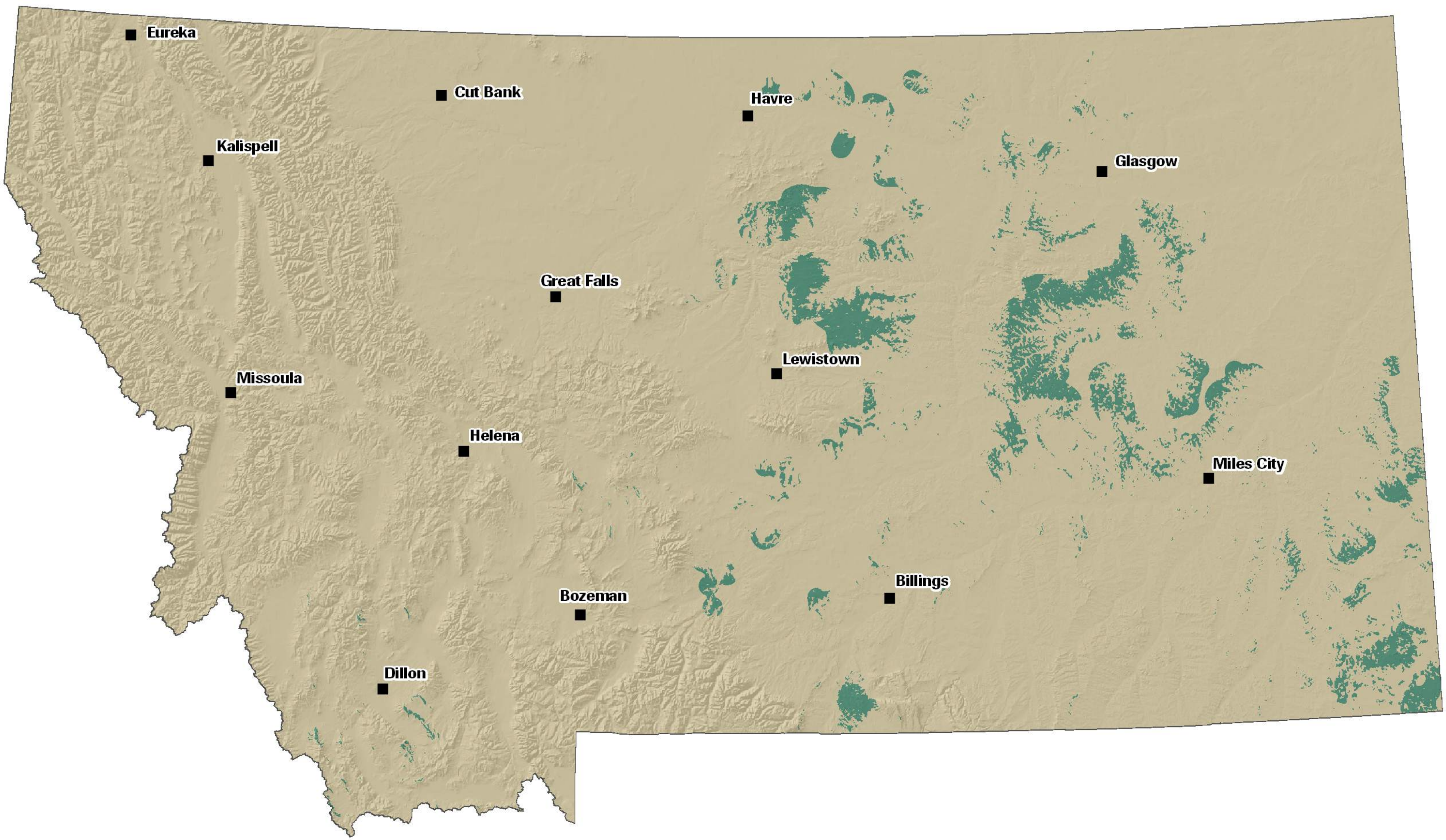
Figure 6. Sage Grouse Leks in Montana



Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Greater Sage Grouse Distribution - Montana Fish, Wildlife & Parks

Figure 7. Sage Grouse Leks within Good-to-Superb Wind Energy Potential

The Nature Conservancy
Protecting nature. Preserving life.



Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Greater Sage Grouse Distribution - Montana Fish, Wildlife & Parks, clipped to Good to Superb Wind Development Potential layer with protected areas & high housing densities excluded.

Table 1. Declining Grassland Birds Evaluated for the Risk Assessment

Species	Conservation Status		
	Partners in Flight (Casey 2008) or US Shorebird Conservation Plan (2004)	USFWS (2002)	Tier 1 Species State Comprehensive Conservation Strategies
Ferruginous hawk	Regional Concern	BCC	NE, ND, WY
Mountain plover	Highly Imperiled	BCC	MT, NE, WY
Long-billed curlew	Highly Imperiled	BCC	MT, NE, ND, WY
Marbled godwit	High Concern	BCC	ND, SD
Burrowing owl	Regional Concern	BCC	MT, NE, SD
Sprague's pipit	Continental importance	BCC	ND, SD
Lark bunting	Continental importance		MT, ND, SD, WY
Baird's sparrow	Continental importance	BCC	ND, SD
McCown's longspur	Continental importance	BCC	NE, WY
Chestnut-collared longspur	Continental importance	BCC	ND, SD, WY

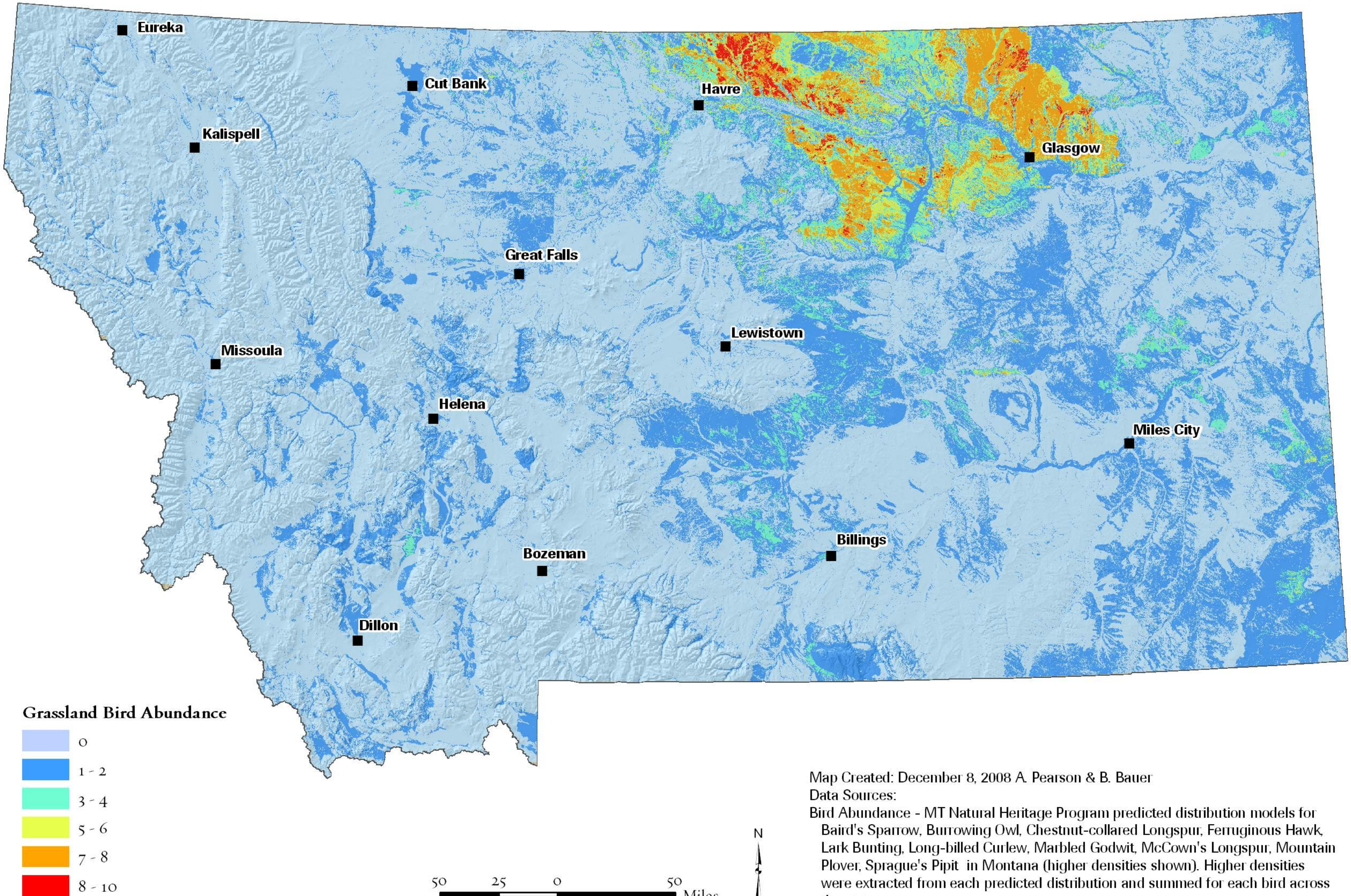
Mixed-grass prairie in Montana north of the Missouri River, and especially in the north central portion of the state, supports the highest number of declining, breeding grassland birds in North America (Figure 8) (Knopf 1996). Species diversity and abundance is most likely attributable to the diverse geological substrates and associated plant communities, as well as the extensive and relatively intact grasslands, coupled with relatively low human disturbance. The mixed-grass prairie north of the Missouri is especially significant for Baird's sparrow (*Ammodramus bairdii*) and Sprague's pipit (*Anthus spragueii*), both of which have breeding ranges restricted primarily to portions of Montana, North Dakota, Saskatchewan, and Alberta.

Declining populations of many grassland birds have been attributed, in large part, to alteration of disturbance regimes and extensive conversion of habitat to cropland (Samson and Knopf 1994, Fitzgerald et al. 1999, Knapp et al. 1999, Blann 2006). Data from the U.S. Department of Agriculture show that the nation's private grassland and rangeland declined by 25 million acres in just 20 years (1983 to 2003), largely as a result of conversion to cropland (GAO 2007). The greatest losses occurred in the northern Great Plains, specifically in Montana and the Dakotas. Conversion may accelerate in the near future to accommodate a projected four-fold increase in biofuels (Nash 2007, U. S. Department of Agriculture National Agricultural Statistics Service 2007).

The presence of wind turbines may displace some species of grassland birds (Leddy et al. 1999, Johnson et al. 2000), however, data are lacking for most mixed-grass and shortgrass affiliated birds. Response of grassland passerines to wind energy development is currently under investigation in North and South Dakota (Shaffer and Johnson 2008). Very preliminary data suggest that grasshopper sparrow avoid turbines, whereas western meadowlark and chestnut-collared longspur do not avoid turbines. In addition to turbines, construction of roads may negatively impact grassland birds by fragmenting habitat. Sprague's pipit relative abundance and productivity increased with area of available habitat (patch size), and chestnut-collared longspur and Baird's sparrow relative abundances were also influenced by patch size and shape (Davis 2003).

The Nature Conservancy
Protecting nature. Preserving life.™

Figure 8. Declining Grassland Bird Predicted Species Diversity in Montana



Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Bird Abundance - MT Natural Heritage Program predicted distribution models for Baird's Sparrow, Burrowing Owl, Chestnut-collared Longspur, Ferruginous Hawk, Lark Bunting, Long-billed Curlew, Marbled Godwit, McCown's Longspur, Mountain Plover, Sprague's Pipit in Montana (higher densities shown). Higher densities were extracted from each predicted distribution and summed for each bird across the state.

We utilized the predicted distribution for declining grassland birds as a means of highlighting the geographic portions of the state that supported the largest number of species and potential risk of wind development. As noted above, northcentral Montana (large portions of Blaine, Phillips and Valley counties) is a critical area for grassland birds and a portion of this area overlaps with good or better wind resource potential (Figure 9). Several grasslands and sagebrush grasslands south of the Missouri River also stand out as important habitat for these species. Other areas previously identified through inventory efforts as being important for grassland birds and having good or better wind energy potential included portions of Glacier, Pondera, Teton, and Sheridan counties (Casey 2006).

To strengthen the predicted distribution model, we contracted the Montana Heritage Program to document grassland bird presence and abundance in other grassland regions of the state with limited data, but good wind resource potential. In total, they completed inventories in five areas of the state, Kevin, Bear's Paw, Rapelje, Little Big Sheep, and Baker (Appendix B). In all five areas, the majority of the declining grassland birds identified above were present, and at times with relatively high abundance. This very preliminary inventory points to the need for additional efforts to document declining grassland bird abundance to help guide wind farm siting.

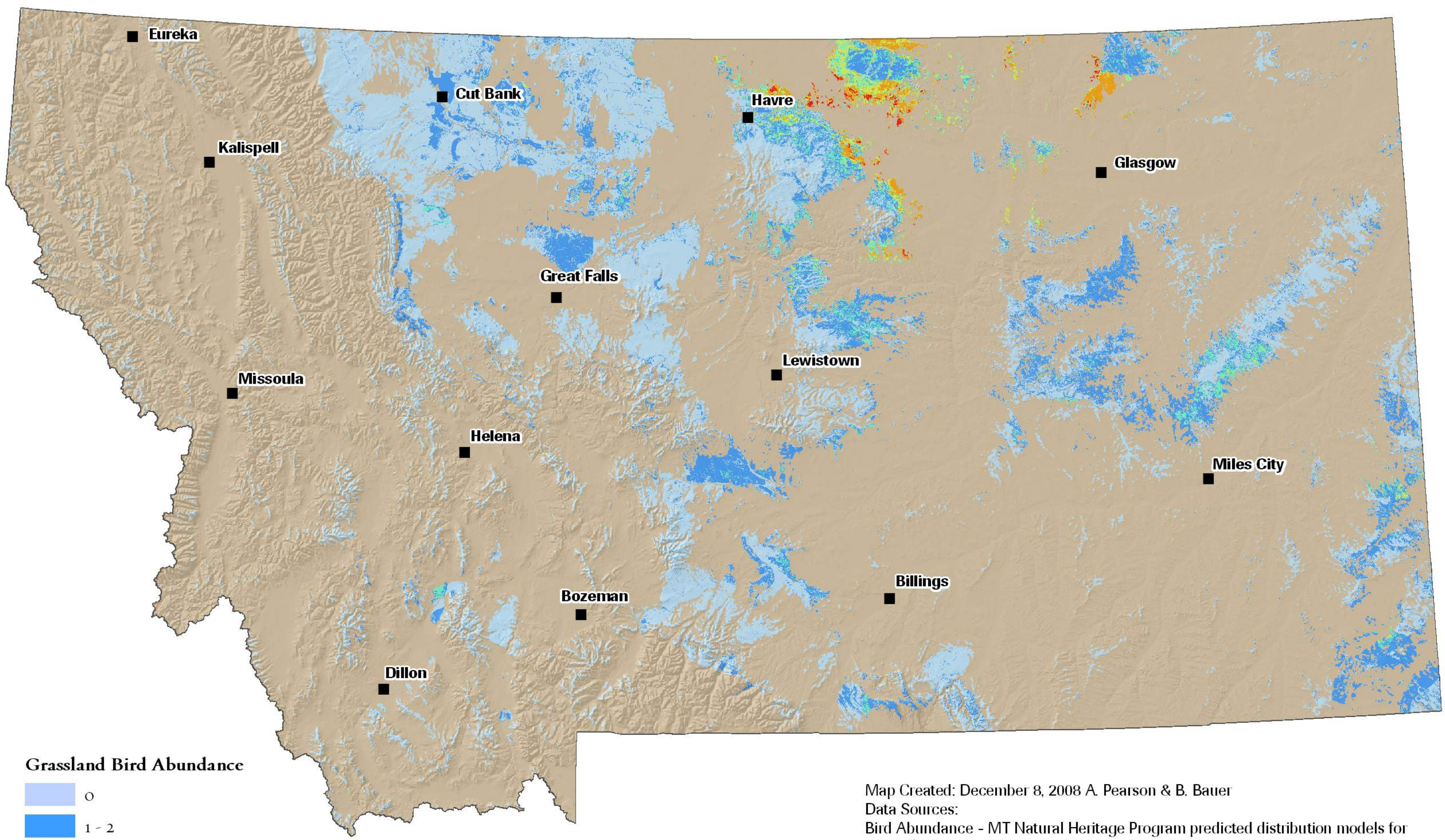
Piping Plover and Interior Least Tern

The northern Great Plains (NGP) population of piping plover (*Charadrius melodus*) was listed as threatened in the United States and endangered in Canada in 1985. Each summer, 25 to 40% of the NGP population (50 to 80% of plovers in the U.S. NGP) nest on open beaches associated with alkali wetlands in an eight-county area of northwestern North Dakota and northeastern Montana (Plissner and Haig 2000a), with most of the remaining birds nesting on the Missouri River system. In Montana, piping plovers are primarily located on alkali wetlands in Sheridan County, with a smaller population associated with sandbar habitat on the Missouri River below Fort Peck Dam and on barren beaches associated with Fort Peck Reservoir (Atkinson and Dood 2005) (Figure 10). Very small populations are also found at Bowdoin National Wildlife Refuge, Nelson Reservoir, and Alkali Lake in Pondera County.

Stewart et al. (2007) reviewed numerous avian and wind studies and noted that birds in the order Charadriiformes (shorebirds) were among those most impacted by wind energy globally (second only to waterfowl). Recent declines in plover numbers have been largely attributed to inadequate productivity stemming from extraordinary predation on eggs and chicks (Larson et al. 2002, Plissner and Haig 2000*b*, Ryan et al. 1993). Predators such as striped skunks, raccoons, great-horned owls, American crows, and ring-billed gulls that were uncommon on the prairie landscape are now numerous, due to planted trees, increased woody cover, rockpiles, junkpiles, utility poles, abandoned buildings, and supplemental food sources that provide habitat and resources for them. Locating wind energy development in proximity to breeding or foraging habitat may further contribute to already fragmented habitat and provide additional habitat for predators.

The Nature Conservancy
Protecting nature. Preserving life.™

Figure 9. Declining Grassland Bird Predicted Species Diversity within Available Good-to-Superb Wind Energy Potential in Montana



Grassland Bird Abundance

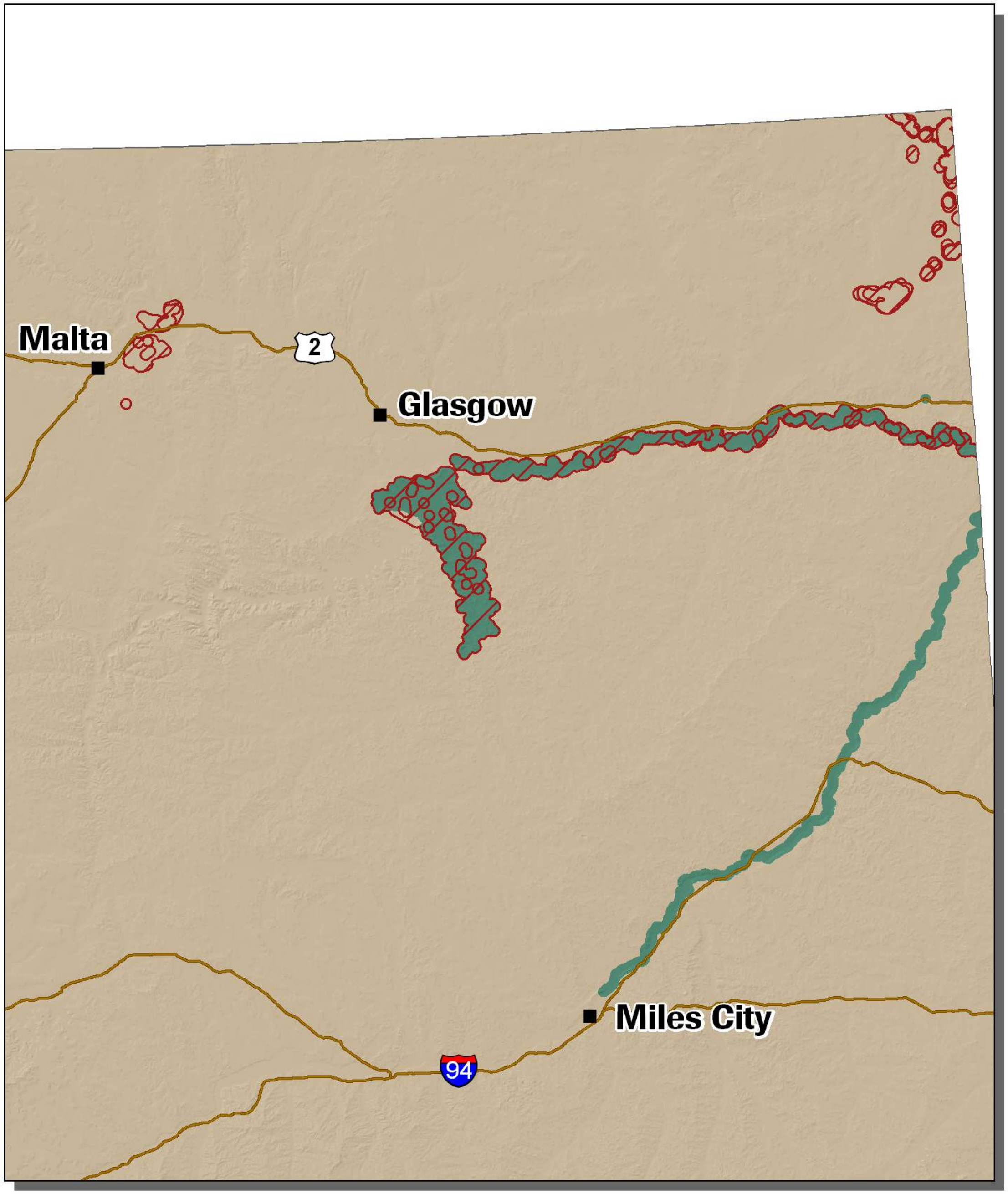
- 0
- 1 - 2
- 3 - 4
- 5 - 6
- 7 - 8
- 8 - 10

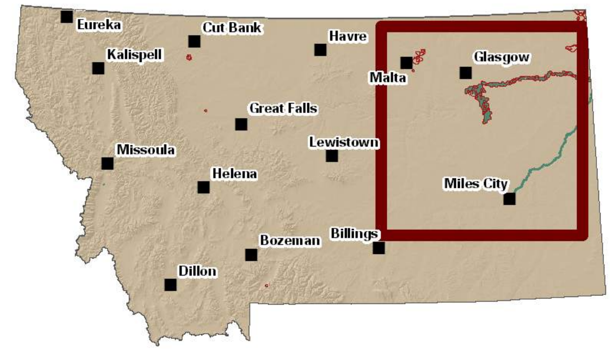
50 25 0 50 Miles

N

Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Bird Abundance - MT Natural Heritage Program predicted distribution models for Baird's Sparrow, Burrowing Owl, Chestnut-collared Longspur, Ferruginous Hawk, Lark Bunting, Long-billed Curlew, Marbled Godwit, McCown's Longspur, Mountain Plover, Sprague's Pipit in Montana (higher densities shown). Higher densities were extracted from each predicted distribution and summed for each bird across the state.
Predicted distribution models were clipped to Good to Superb Wind Development Potential layer with protected areas & high housing densities excluded.

Figure 10. Piping Plover and Interior Least Tern Breeding Habitat in Montana





Interior Least Tern

Piping Plover

20 10 0 20 Miles

N

Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Piping Plover w/ 1 mile buffer- US Fish and Wildlife Service (nesting locations), MT Natural Heritage Program (element occurences).
Interior Least Tern w/ 1 mile buffer- MT Natural Heritage Program (element occurences)

Interior least tern (*Sterna antillarum*) was listed as endangered in 1985, primarily due to loss of sandbar habitat associated with large interior rivers. In Montana, this species is found primarily on the lower Missouri below Fort Peck Dam and the lower Yellowstone River below Miles City (Atkinson and Dood 2006).

Terns may be susceptible to direct mortality from collisions with turbines. A wind farm constructed on a coastal wetland, which provided breeding habitat for three species of terns had an average collision rate 6.7 birds per turbine per year over a two year period (Everaert and Steinen 2006). Presence of the wind farm did not appear to displace the terns.

Due to intensive census efforts, habitat for piping plover and interior least tern has been well studied and described. To identify risk potential for piping plover we used data from the U.S. Fish and Wildlife Service that indicate where they breed at alkali lake basins in Sheridan County. Populations of piping plover outside of Sheridan County and for interior least tern were available as element occurrence data through the Montana Natural Heritage Program. Although there is not good guidance on distance recommendations, we selected a 1-mile buffer around each breeding location (Figure 11). The potential for wind energy development potential is relatively low along the riparian habitat of the Missouri and Yellowstone rivers utilized by both species, being mapped as marginal wind resource potential. Wind energy potential in the remaining habitat associated with alkali lakes in Sheridan County is primarily mapped as fair, whereas a portion of habitat on Fort Peck is rated as good. Given the protected status of both species, frequency of collisions of shorebirds with wind turbines in other areas, and limited wind resources in these areas, risks of development in plover and tern habitat appear to far outweigh return from potential wind development.

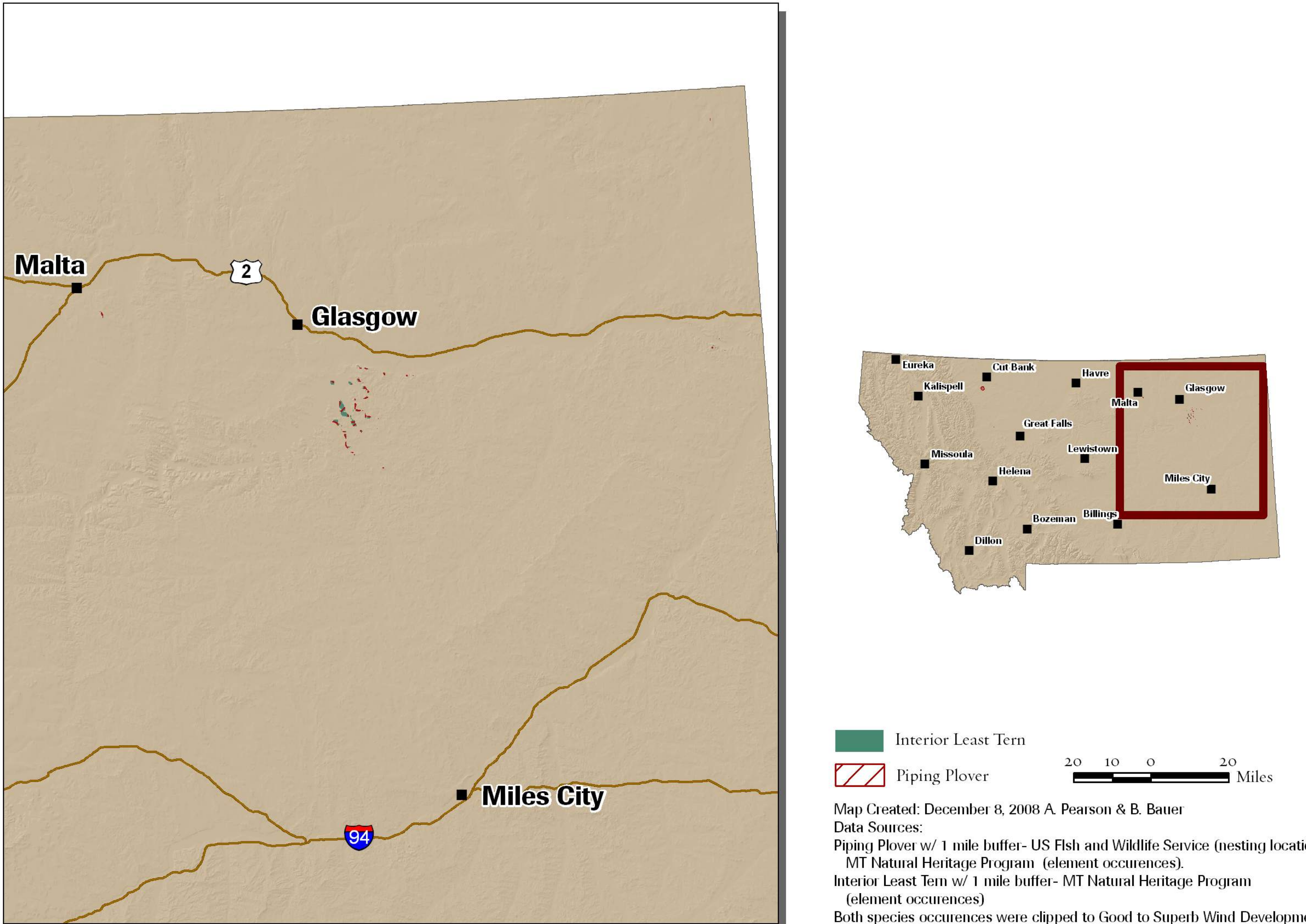
Waterfowl, waterbirds, and wetland concentration areas

In review of wind farm impacts, Stewart et al. (2007) noted that waterfowl and wading birds experienced the most consistent declines in abundance of all bird groups. They recommended caution in development in waterfowl concentration areas. Montana provides significant habitat for numerous wetland-associated species. The most recognized of these areas is the Prairie Pothole Region, which provides breeding habitat for the majority of the continent's breeding ducks, as well as significant habitat for numerous waterbirds. In Montana, the Prairie Pothole Region encompasses portions of the northern tier of counties from the North Dakota border to the Rocky Mountains. Some of the key habitat and high concentration areas have been protected as National Wildlife Refuges, including Benton Lake, Bowdoin, and Medicine Lake or State Wildlife Management Areas, such as Freezout Lake. Other critical habitat that coincides with good to superb wind potential is throughout northern Montana, with especially significant wetland complexes in portions of Sheridan, Phillips, Blaine, Liberty, Glacier, Pondera, and Teton counties and in some of the intermountain valleys (Bitterroot, Blackfoot, Centennial, Flathead, and Swan).

Utilizing National Wetland Inventory data, we have identified areas of highest wetland concentrations, where mapping has been completed (Figure 12). Portions of the Prairie

The Nature Conservancy
Protecting nature. Preserving life.

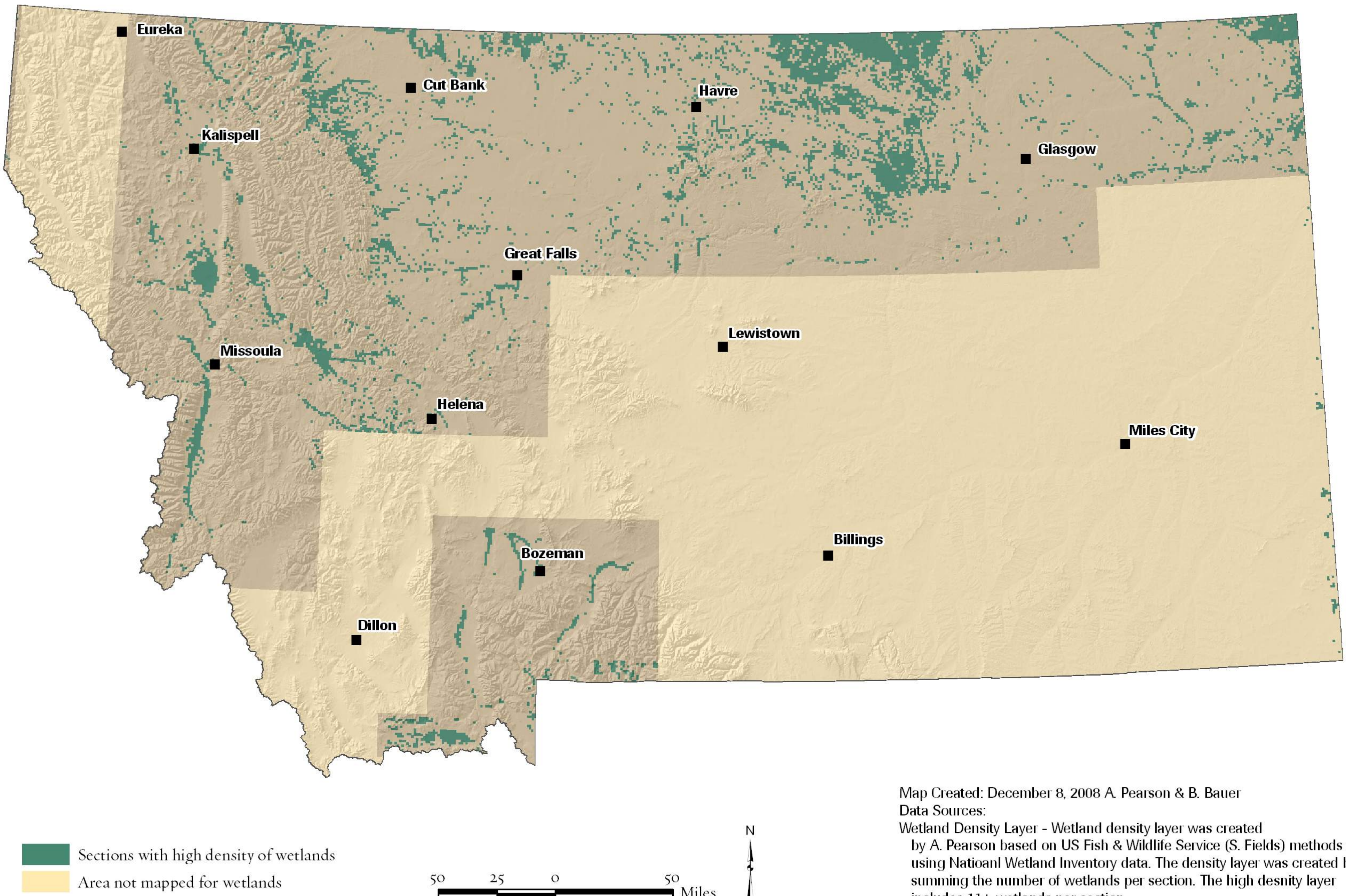
Figure 11. Piping Plover and Interior Least Tern Breeding Habitat within Available Good-to-Superb Wind Energy Potential in Montana



Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Piping Plover w/ 1 mile buffer- US Fish and Wildlife Service (nesting locations), MT Natural Heritage Program (element occurences).
Interior Least Tern w/ 1 mile buffer- MT Natural Heritage Program (element occurences)
Both species occurences were clipped to Good to Superb Wind Development Potential layer with protected areas & high housing densities excluded

The Nature Conservancy
Protecting nature. Preserving life.™

Figure 12. High Wetland Densities in Montana



Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Wetland Density Layer - Wetland density layer was created by A. Pearson based on US Fish & Wildlife Service (S. Fields) methods using Natioanl Wetland Inventory data. The density layer was created by summing the number of wetlands per section. The high desnity layer includes 11+ wetlands per section.

Pothole Region are coincident with good or better wind energy potential, especially along the Rocky Mountain Front from Glacier to Teton county (Figure 13). While wetlands are generally most productive as waterfowl habitat in areas embedded in grasslands, even in intensively cropped locations, wetlands may still attract significant numbers of breeding or migrating waterfowl. Therefore, wind energy development in wetland concentration areas across the state poses a potentially high risk for negative impacts.

Bats

Wind energy development has been demonstrated through numerous studies and monitoring efforts to kill large numbers of bats in some locations (Kunz et al. 2007). It is likely that the number of bats killed is greater than estimated, due to errors in sampling, suggesting that the numbers killed may be greater than already acknowledged (Smallwood 2008). Mortality is the result of direct collisions, as well as, barotrauma, rapid pressure reductions caused by wind turbines, which causes fatal lung damage (Baerwald et al. 2008).

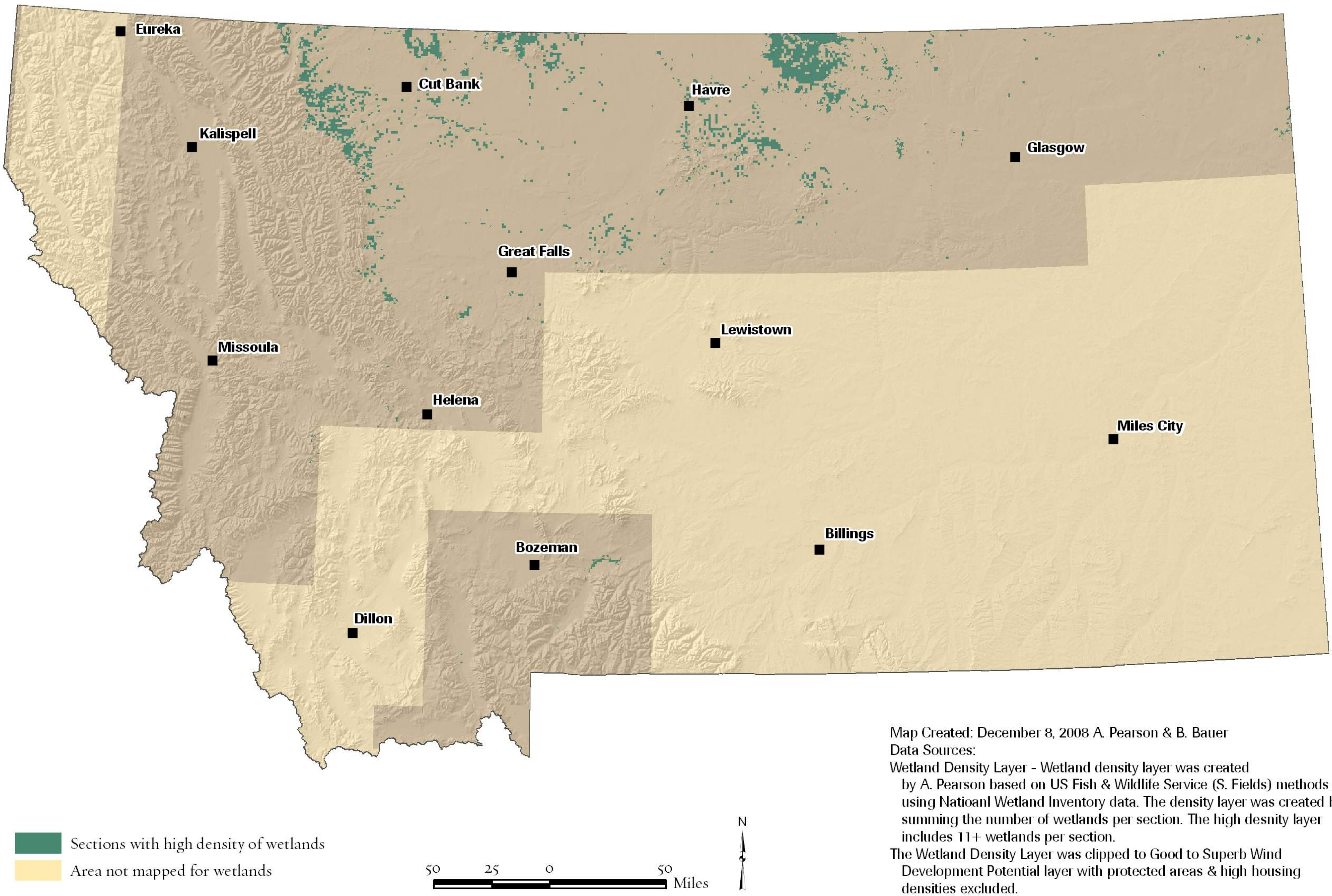
Mortality among bats is highest among migratory tree roosting species, and the fatalities occur in greatest numbers during fall migration when juveniles are present (Kunz et al. 2007). Recent research for hoary bat (*Lasiurus cinereus*) suggested that relatively low wind speeds, low moon illumination, and relatively high degrees of cloud cover were important predictors of migration (Cryan and Brown 2007). While fatalities have been most often recorded to be the highest in the eastern United States, mortality of hoary bats in Montana is expected to be most similar to mortality patterns reported from a wind farm in southwestern Alberta (Barclay et al. 2007). Due to the fact that bats are long-lived and have low reproductive rates, mortality caused by wind farms may result in significant population declines and local extinctions.

Fifteen species of bats breed in Montana, and of these, seven are listed by the Montana Natural Heritage Program and MFWP (2008) as species of concern. All three species most frequently killed by wind turbines occur in Montana, silver-haired bat (*Lasionycteris noctivagans*), eastern red bat (*Lasiurus borealis*) and hoary bat, with the latter two being species of concern (Kunz et al. 2007, Arnett et al. 2008). All three of these species roost in riparian and forested habitats and migrate long distances.

To address the potential risk of wind energy development on bats in Montana, we utilized predicted distributions for 13 species of bats developed by the Montana Natural Heritage Program (Table 2). Figure 14 shows predicted bat species diversity across the state. Areas for breeding species which stood out as especially important were coniferous forests in the western portion of the state, the Pryor Mountains and surrounding area south of Billings, extensive ponderosa pine habitats in the eastern part of the state (e.g., Bull Mountains), and significant riparian habitat along larger rivers, including the Yellowstone, portions of the Missouri, Powder, and Tongue. Considering only species diversity, it appears that the area around the Pryor Mountains, the Big Snowy Mountains, Little Rockies, and portions of the Little Belt Mountains has the highest potential for risk among breeding species of bats (Figure 15). Hoary and silver-haired bat were present in all five locales inventoried with good or better wind potential (Appendix B), suggesting

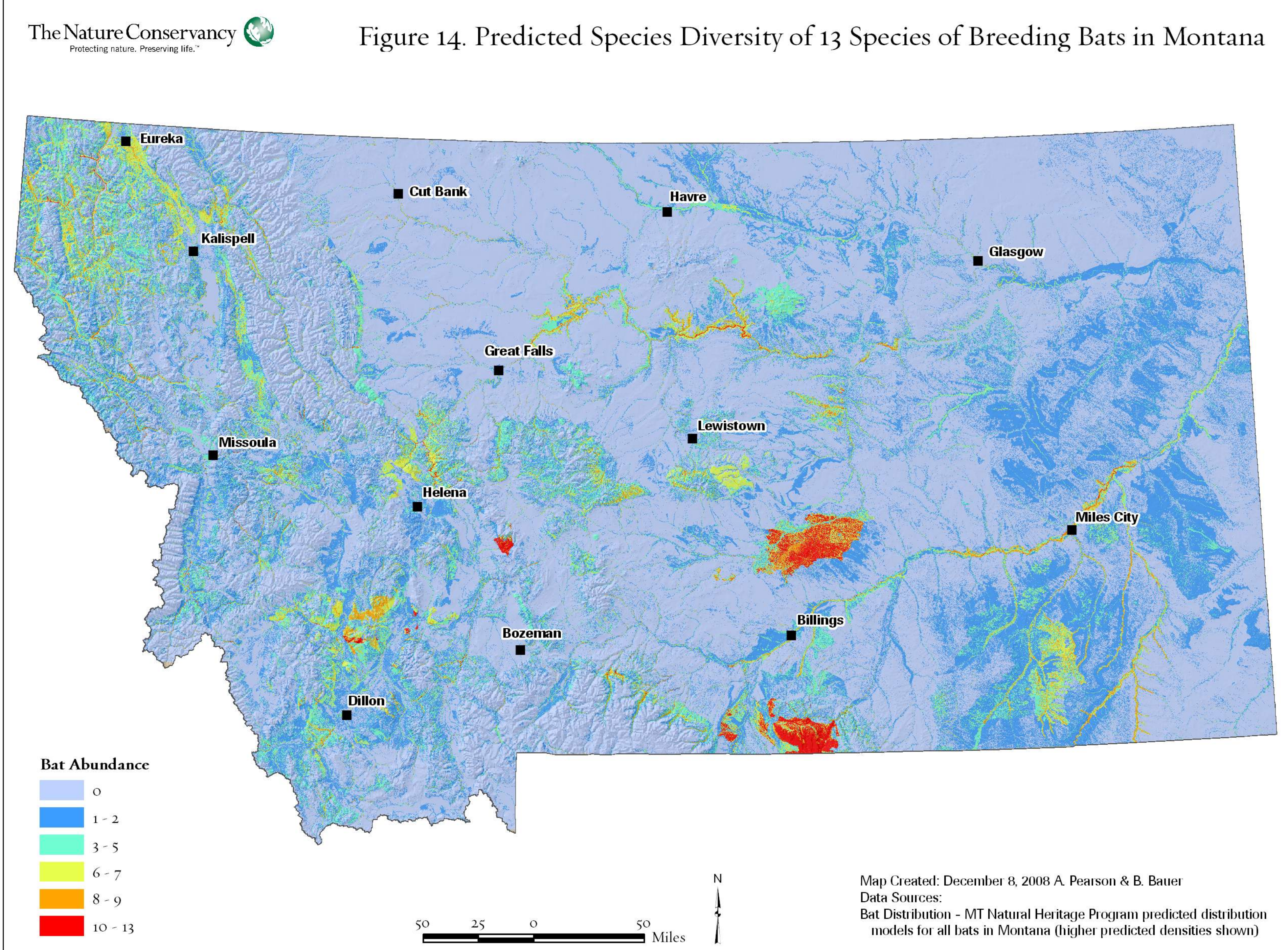
The Nature Conservancy
Protecting nature. Preserving life.™

Figure 13. High Wetland Densities within Available Good-to-Superb Wind Energy Potential in Montana



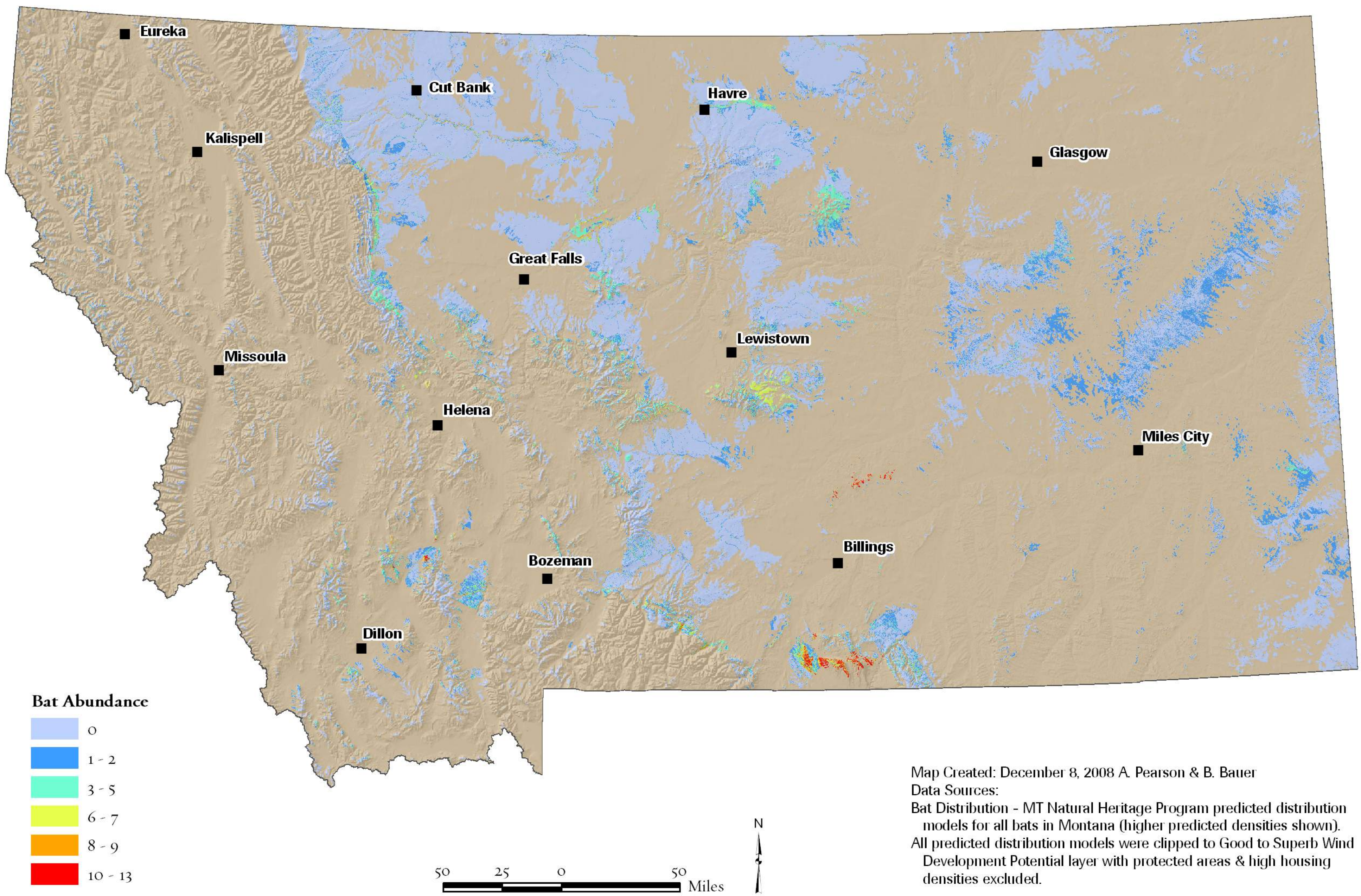
Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Wetland Density Layer - Wetland density layer was created by A. Pearson based on US Fish & Wildlife Service (S. Fields) methods using Natioanl Wetland Inventory data. The density layer was created by summing the number of wetlands per section. The high desnity layer includes 11+ wetlands per section.
The Wetland Density Layer was clipped to Good to Superb Wind Development Potential layer with protected areas & high housing densities excluded.

Figure 14. Predicted Species Diversity of 13 Species of Breeding Bats in Montana



The Nature Conservancy
Protecting nature. Preserving life.™

Figure 15. Predicted Species Diversity of 13 Species of Breeding Bats in Montana within Good-to-Superb Wind Energy Potential



Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Bat Distribution - MT Natural Heritage Program predicted distribution models for all bats in Montana (higher predicted densities shown).
All predicted distribution models were clipped to Good to Superb Wind Development Potential layer with protected areas & high housing densities excluded.

that substantially more data are needed on individual species, especially those that are most susceptible to direct mortality.

In general, several species of bats frequent riparian habitat and open water for foraging, suggesting that for site-level decisions, turbines should be avoided in these habitats as they may have higher risk for mortality. To date in the West, the highest incidence of bat mortality has occurred during migration. Because we lack data on migratory patterns of bats in Montana, emphasis should be placed on researching migration locations and timing to determine if siting can be accomplished to minimize impacts or whether other management actions, such as feathering down turbines during migration may be required.

Table 2. Bat Species Predicted Distribution Selected for Risk Assessment.

Species	Scientific Name	Montana Habitat	Status
Big brown bat	*Eptesicus fuscus*	Wide variety of habitats with roosts in natural cavities and manmade structures	
California myotis	*Myotis californicus*	Usually forested habitats in mountainous regions, but also found in open habitats	
Eastern red bat	*Lasiurus borealis*	Riparian cottonwoods	Species of concern
Fringed myotis	*Myotis thysanodes*	Riparian and dry mixed conifer	Species of concern
Hoary bat	*Lasiurus cinereus*	Riparian and forest	Species of concern
Long-eared myotis	*Myotis evotis*	Wooded and rocky areas	
Long-legged myotis	*Myotis volans*	Usually forested habitats with roosts in natural cavities and manmade structures	
Pallid bat	*Antrozous pallidus*	Arid landscapes rock outcrops	Species of concern
Spotted bat	*Euderma maculatum*	Arid landscapes rock outcrops	Species of concern
Silver-haired bat	*Lasionycteris noctivagans*	Wide variety of habitats with roosts in natural cavities and manmade structures	
Townsend's big eared bat	*Corynorhimus townsendii*	Forested areas in landscapes with caves	Species of concern
Little brown myotis	*Myotis lucifugus*	Wide variety of habitats with roosts in natural cavities and manmade structures	
Western small footed myotis	*Myotis ciliolabrum*	A variety of more open and arid habitats with roosts in natural cavities and manmade structures	

Grizzly bear

Significant wind energy potential exists along the Rocky Mountain Front (Front), defined as the area encompassing the transition of the mountains and plains stretching from the Canadian border to Rodgers Pass and extending eastward approximately 30 miles. This area is home to a diverse mixture of wildlife species and often is recognized as sustaining some of the highest quality wildlife habitat in the Nation. Among the species occurring on the Front is the last remaining population of Great Plains dwelling grizzly bear (*Ursus arctos*). Grizzlies seasonally occupy various habitats along the Front, showing preference for riparian and wetland habitat, but also utilizing grasslands. These habitats are among the most productive for grizzly bear in the United States.

Grizzly bear were listed as a threatened species in 1975, due to direct mortality and loss or degradation of habitat. Grizzly bears consistently underutilize habitat and experience higher mortality near roads or other human facilities (Mattson et al. 1996). Vehicle collisions and malicious killing near roads are currently among the most important sources of human-caused mortality in the Northern Continental Divide Ecosystem. As noted previously, wind energy development at commercial-scale requires extensive road development and on-going vehicle traffic to maintain turbines.

We overlaid an existing predicted habitat model (IGBC 2004) for grizzly bear on the Front (Figure 16), with wind energy potential (Figure 17). Development of wind energy presents a significant risk to the persistence of grizzly bear along portions of the Front. While upland ridges would be of greatest value for wind development, the model classified these areas as of lower value to grizzly bears. However, on-going research using satellite transmitters suggests that these areas are frequented by bears for travel between riparian areas and as foraging habitat. Development of these ridges would reduce grassland habitat use, increase mortality, and fragment linkages between riparian habitats.

We did not utilize other grizzly bear data to evaluate the risk of wind energy development for the species in other portions of its range in Montana. Rationale for this primarily related to location of key habitat for bears and wind energy development potential. Most of the remaining populations are in areas where development is prohibited or is of good or better wind energy potential primarily along the ridgelines of mountains. Wind development along ridgelines faces numerous operational obstacles (roads, transmission lines, maintenance). Therefore, the primary concern for other grizzly bear populations in the state would be more in relation to corridors, which are still in the process of being identified.

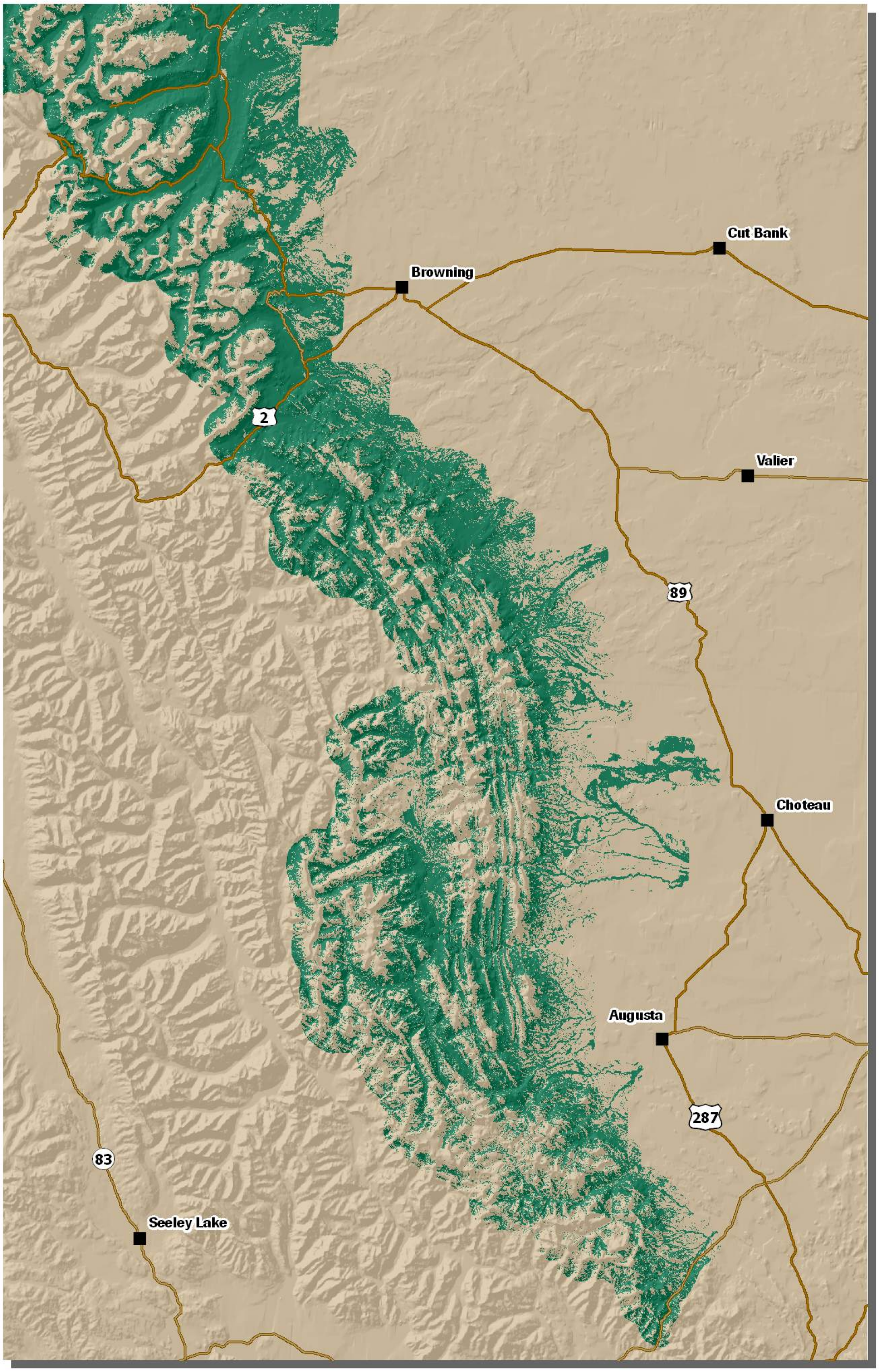
Mule deer, antelope, and elk winter range

Mule deer, antelope, and elk have been noted to be susceptible to intensive energy development associated with oil and gas production, as well as other extensive development with road networks. Wind farms are not likely to occur at the same scale (at least initially) as oil and gas development, therefore, we have restricted our analysis to winter range considerations, as these species are perhaps most susceptible to disturbance during winter. We also recognized that all three species are sensitive to construction activities in migration routes, although we lacked good data that adequately presented migration corridors for all three species. For example, on-going research on antelope in eastern Montana has just begun documenting what appears to be the longest big game migration in the lower 48 states (S. Forrest personal communication).

Winter range locations of each species were available from MFWP (Figure 18). Because these species occur over large expanses of Montana, considerable overlap exists between winter range and good to superb wind resources (Figure 19). Decisions about potential impacts on each species will most likely need to be evaluated on a project-level basis, but in general, wind energy development should be avoided in the most critical habitats.

The Nature Conservancy
Protecting nature. Preserving life.™

Figure 16. Grizzly Bear Modeled Habitat along the Rocky Mountain Front



High Probability of Use by Grizzly Bears

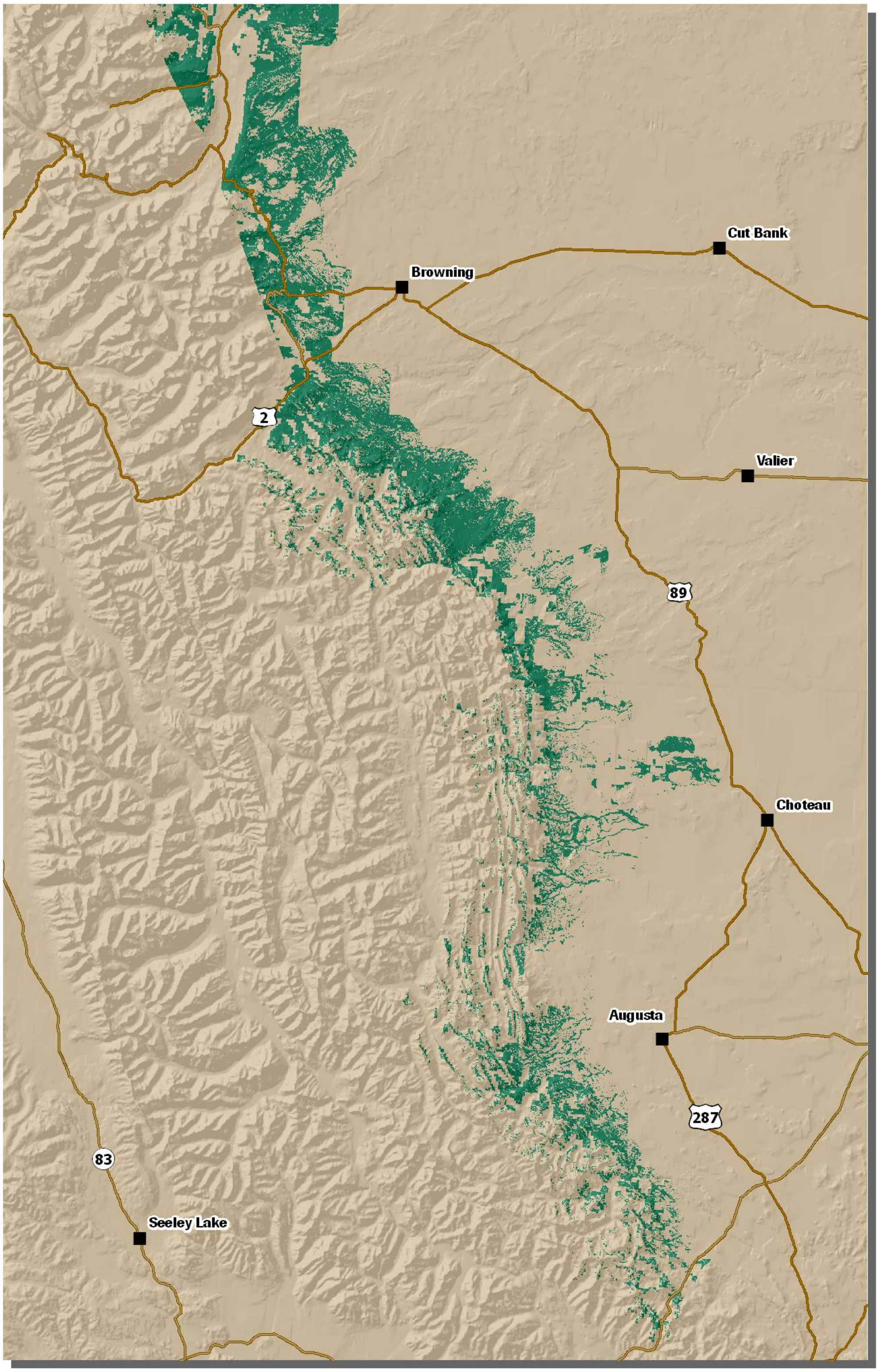
10 5 0 10 Miles

N

Map Created: December 8, 2008 A. Pearson and B. Bauer
Data Sources:
Grizzly Bear Layer - Cumulative Effects Model (CEM) for the Northern Continental Divide Ecosystem (US Forest Service & CEM Working Group, 2003). Resource Selection Function (RSF) values 6+ were extracted for Habitat Value (Potential Value) in Spring. Habitat Value represents the value in the absence of human activities across the landscape. RSF is a scale from 0-100 as the probability of Grizzly Bears using the landscape.

The Nature Conservancy
Protecting nature. Preserving life.™

Figure 17. Grizzly Bear Modeled Habitat along the Rocky Mountain Front within Available Good-to-Superb Wind Energy Potential



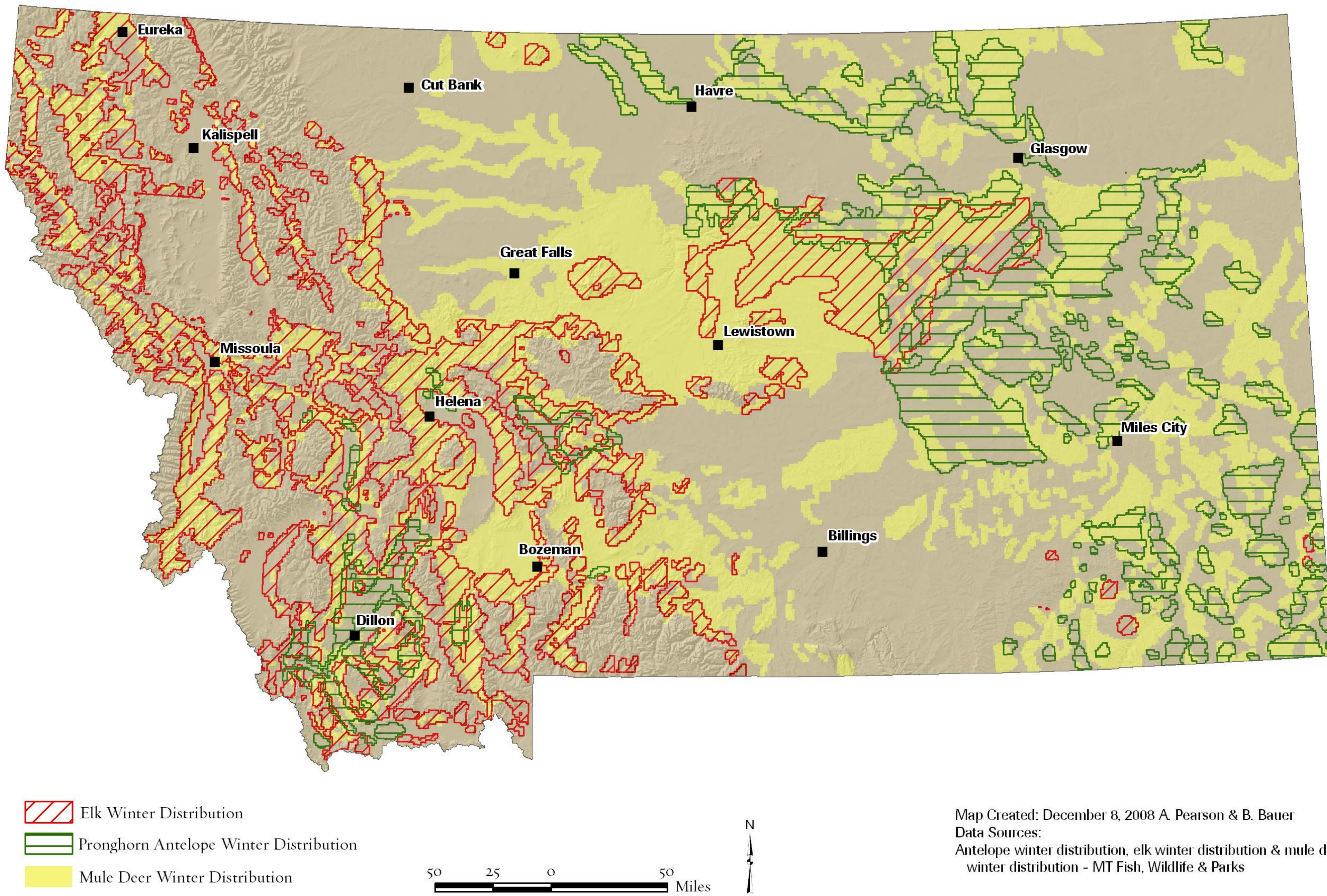
High Probability of Use by Grizzly Bears

10 5 0 10 Miles

N

Map Created: December 8, 2008 A. Pearson and B. Bauer
Data Sources:
Grizzly Bear Layer - Cumulative Effects Model (CEM) for the Northern Continental Divide Ecosystem (US Forest Service & CEM Working Group, 2003). Resource Selection Function (RSF) values 6+ were extracted for Habitat Value (Potential Value) in Spring. Habitat Value represents the value in the absence of human activities across the landscape. RSF is a scale from 0-100 as the probability of Grizzly Bears using the landscape. For this map, the Grizzly Bear data was clipped to Good to Superb Wind Development Potential layer with protected areas & high housing densities excluded.

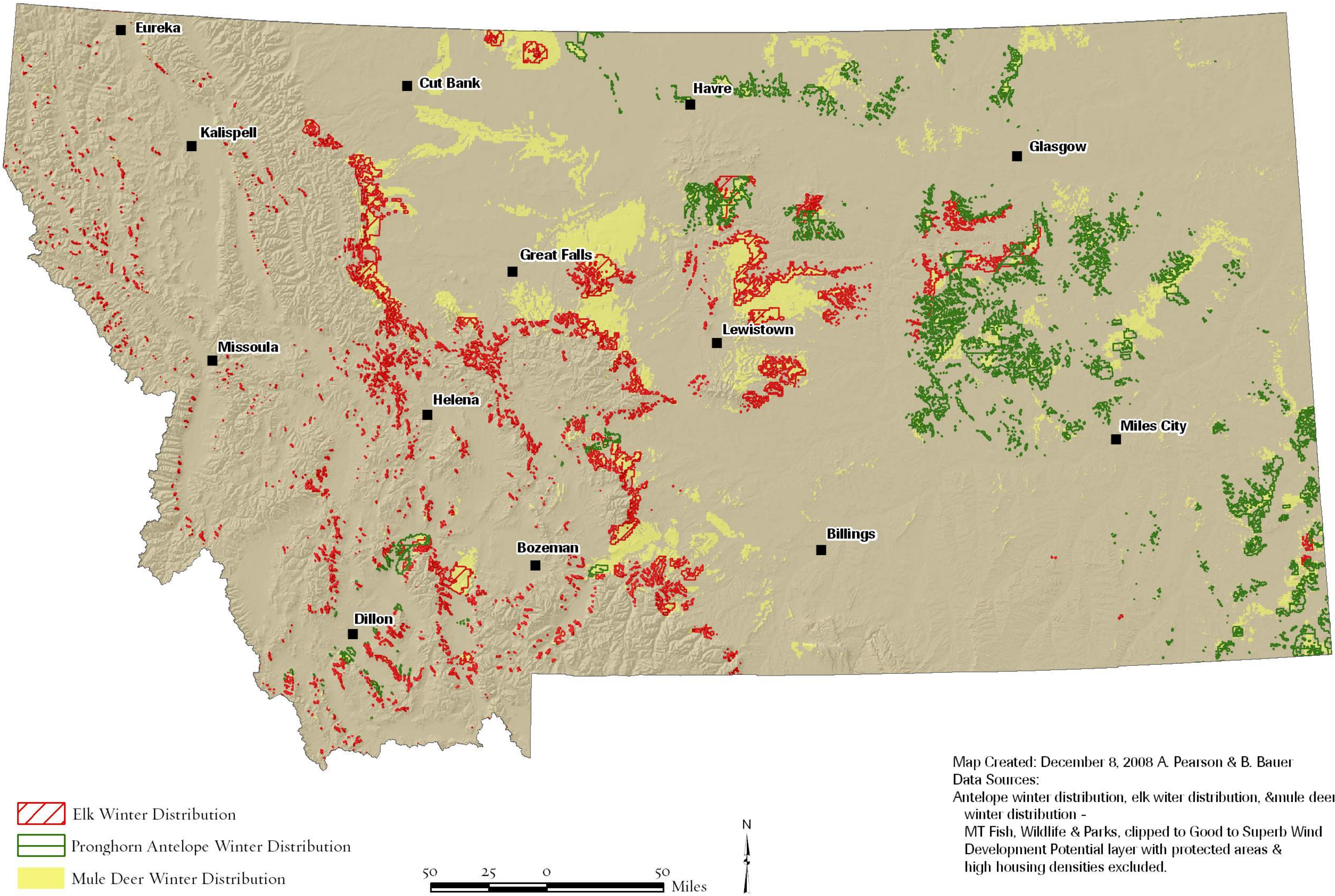
Figure 18. Mule Deer, Antelope, and Elk Winter Range in Montana



Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Antelope winter distribution, elk winter distribution & mule deer winter distribution - MT Fish, Wildlife & Parks

The Nature Conservancy
Protecting nature. Preserving life.™

Figure 19. Mule Deer, Antelope, and Elk Winter Range within Available Good-to-Superb Wind Energy Potential in Montana



Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Antelope winter distribution, elk witer distribution, &mule deer winter distribution -
MT Fish, Wildlife & Parks, clipped to Good to Superb Wind Development Potential layer with protected areas & high housing densities excluded.

LANDSCAPE CONSIDERATIONS

Extensive conservation planning has been completed within Montana to identify species in greatest need of conservation and landscapes of greatest ecological importance for supporting those species. The Nature Conservancy (TNC) recognizes six ecoregions within Montana and has developed ecoregional assessments for each, with revision currently in process for the Northern Great Plains Steppe (Figure 20). It should be noted that the portfolio sites identified mostly intact habitats and were selected to both capture species of conservation concern, as well as common species. MFWP has also completed substantial planning through the development of a comprehensive wildlife strategy for the state, which prioritized conservation and inventory efforts (MFWP 2005b). MFWP is currently building on that effort and is in the process of developing a crucial areas and connectivity assessment (personal communication MFWP).

Among the portfolio sites identified by TNC, several have extensive areas of good to superb wind resources. Among the most notable are the Bear's Paw Mountains, Beartooth Front, Big Sheep Mountains, Montana Glaciated Plains, Porcupine Creek Shrublands, Pryor Mountains, Rocky Mountain Front, and Slim Buttes (Figure 21). Numerous other portfolio sites have lesser, but potentially still significant good to superb wind resources. In addition to those areas frequented by species noted above, wind energy development within these portfolio sites has greater risk of ecological impacts for other species of concern not treated in this analysis.

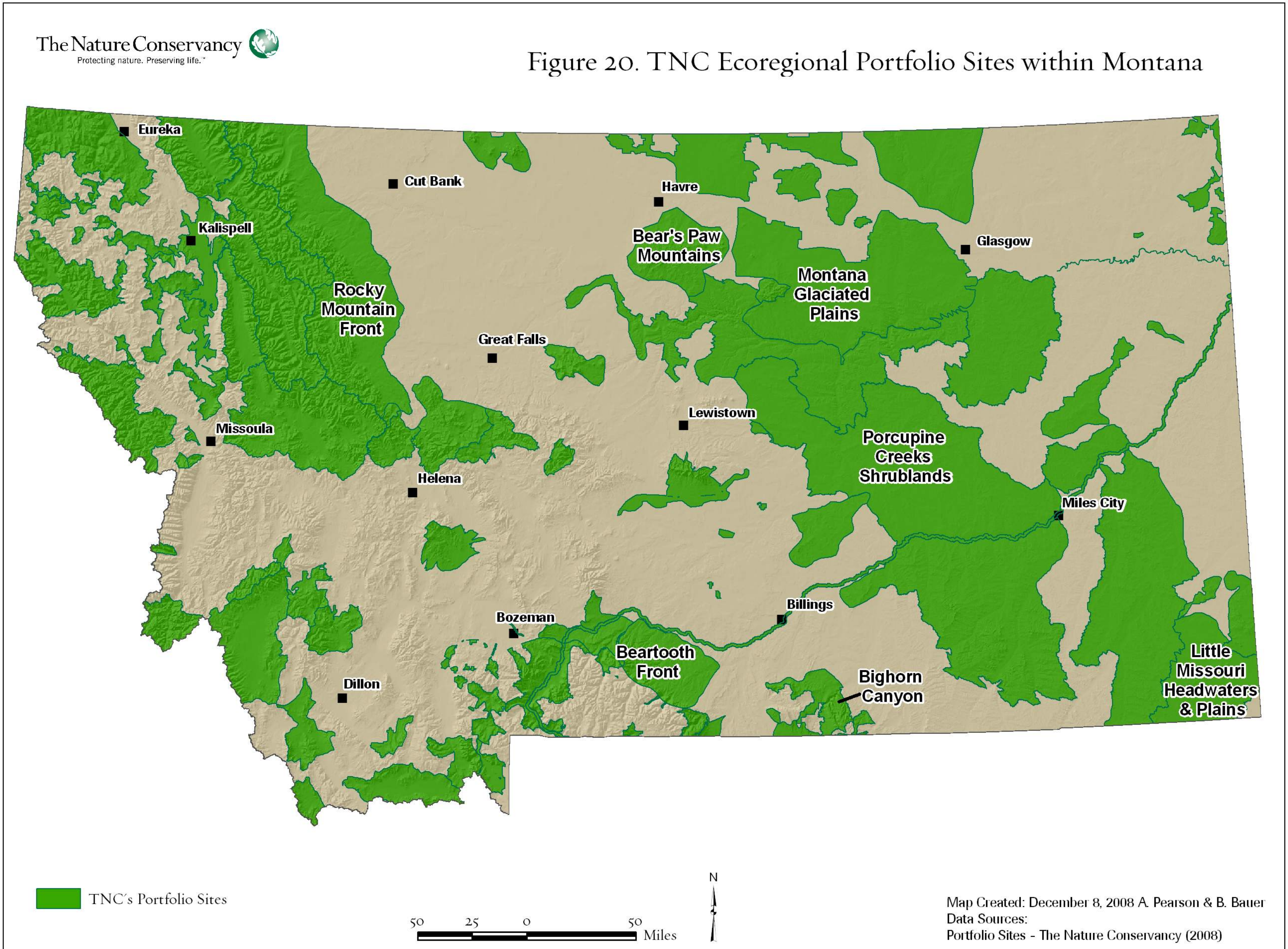
CONCLUSION

Montana has significant wind energy potential and it also contains some of the continent's most intact and valuable wildlife habitat. Developing wind energy within the state that protects wildlife habitat can be achieved. We estimate that in total about 17 million acres of available good-to-superb wind energy potential exists within Montana. Of that total, we have identified roughly 7.7 million acres with high risk (Figure 22 and 23). We strongly suggest that these areas be avoided as locations for wind energy development, rather than considering mitigation approaches, as the lands identified are often critical habitat for multiple species.

Through our analysis we have identified about 9.2 million acres that most likely present a lower risk of impact to resident and breeding species. This total includes the roughly 4.4 million acres of cropland we noted earlier in the report, as well as other areas. In considering the low risk lands, we have most likely over estimated the total number of acres for three reasons. First, while we attempted to consider risk for a broad diversity of species that will most likely be impacted by wind energy development, we may have overlooked species that may be especially vulnerable. Second, we biased our species selection to those that occur mostly in lower elevations, east of the continental divide. We did not consider, for example, the suite of forest carnivores present in the western portion of the state. Third, we lack data for large portions of Montana. As we noted previously we contracted for limited inventory of birds and bats in five regions of the state with good or better wind energy potential and documented the location of numerous species we considered within this analysis. Additional research on the distribution, status, and migratory patterns of a number of species are needed. In the mean time, we believe that wind energy development should focus first on those lands with the least intrinsic wildlife habitat values, such as cropland or areas significantly fragmented by cropland, before considering other low risk lands identified within the report. We also suggest that as MFWP completes its corridors and connectivity planning over the next year, maps and information we offer here be updated by the most recent information.

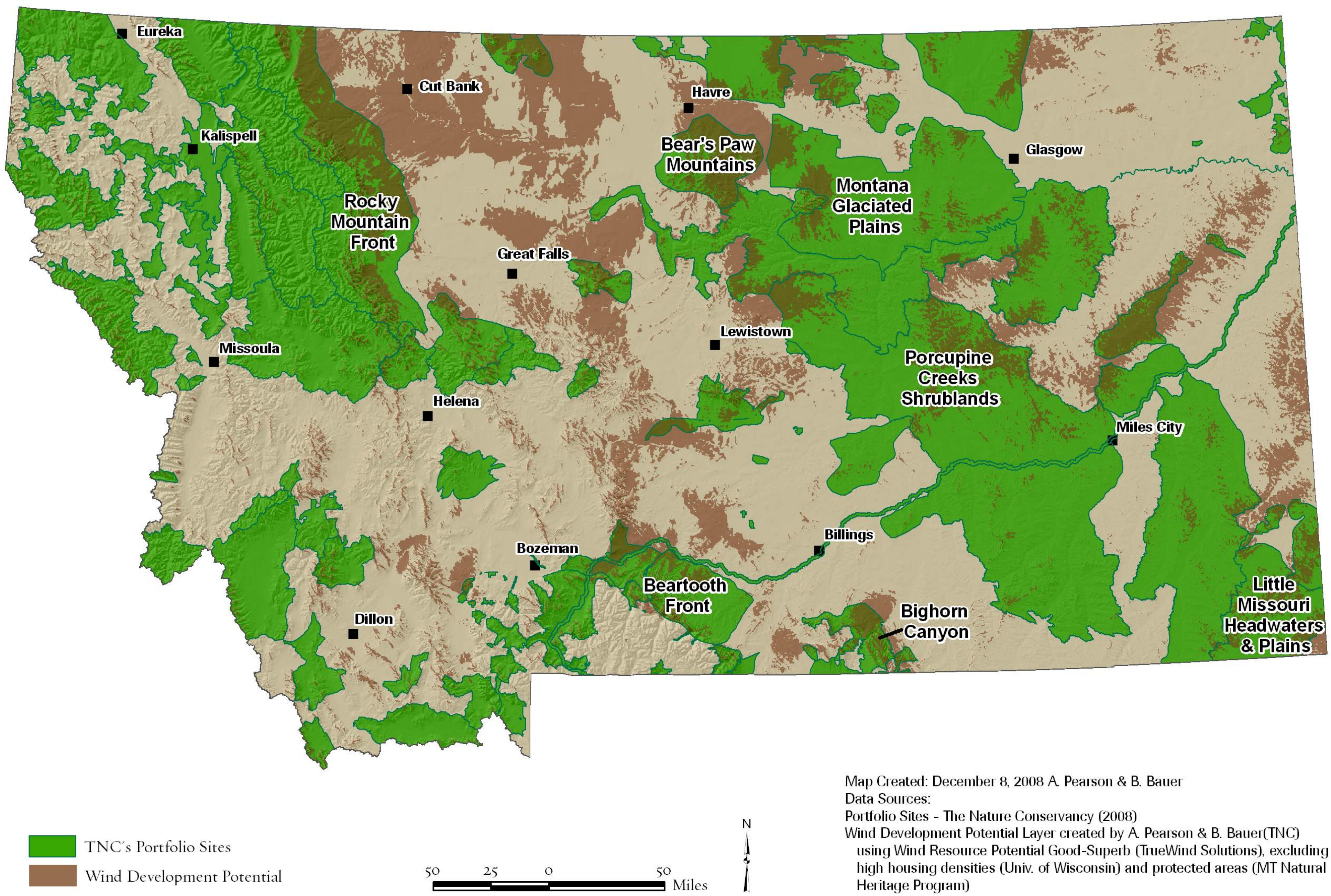
Finally, wind energy development will ultimately need to be considered in terms of the cumulative effects. The sum of the parts will most likely be greater than each project considered individually. Wind energy holds great promise for providing clean energy, but it needs to be advanced through a process that ensures the reduction in reliance on fossil fuels does not come at a price that diminishes the overall quality of the environment.

Figure 20. TNC Ecoregional Portfolio Sites within Montana



The Nature Conservancy
Protecting nature. Preserving life.

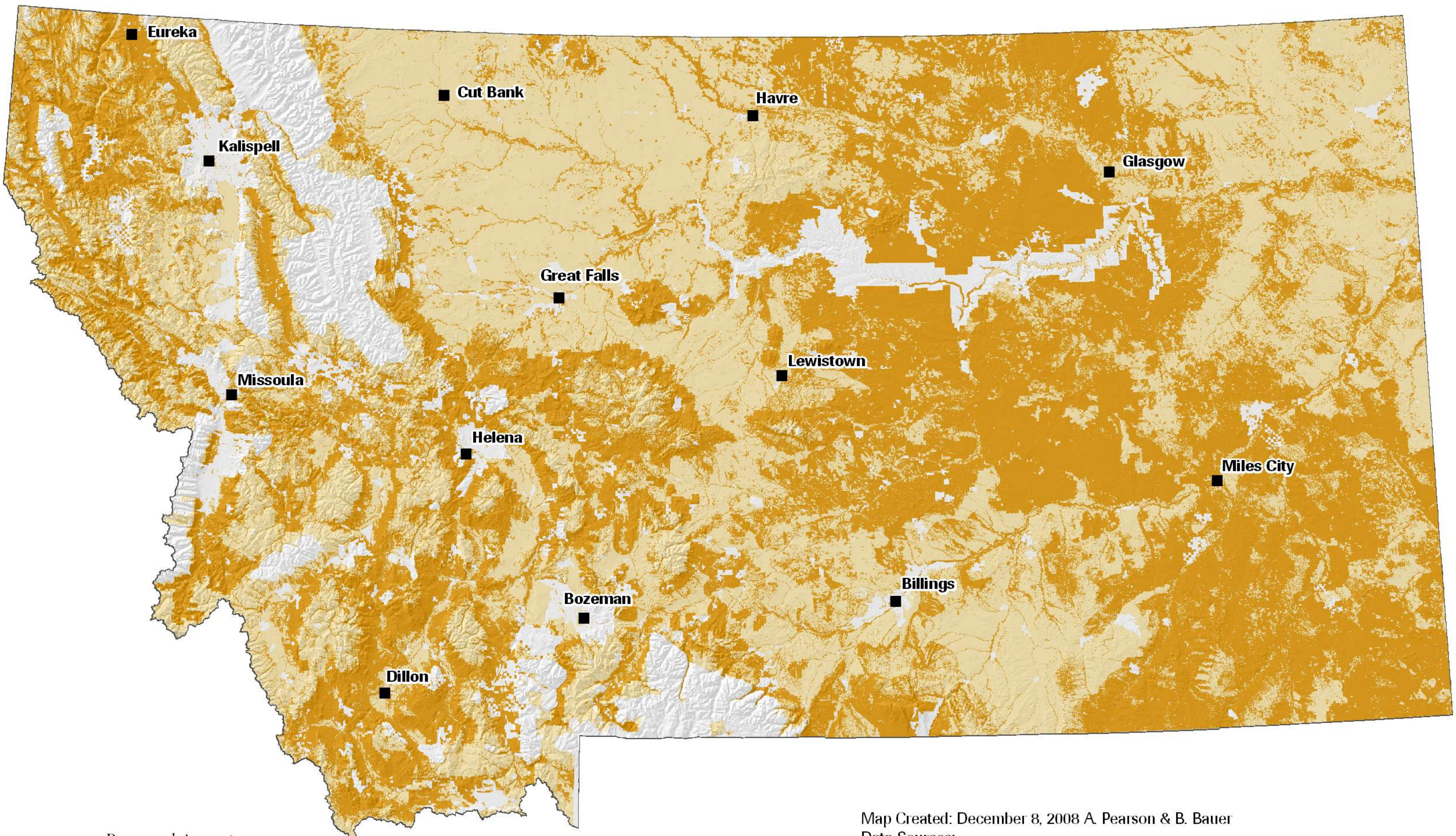
Figure 21. TNC Ecoregional Portfolio Sites and Good-to-Superb Wind Energy Potential



Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Portfolio Sites - The Nature Conservancy (2008)
Wind Development Potential Layer created by A. Pearson & B. Bauer(TNC) using Wind Resource Potential Good-Superb (TrueWind Solutions), excluding high housing densities (Univ. of Wisconsin) and protected areas (MT Natural Heritage Program)

The Nature Conservancy
Protecting nature. Preserving life.

Figure 22. Ecological Risk Assessment for Wind Energy Development in Montana



Protected Areas & High Housing Density

Ecological Risk

Low

High

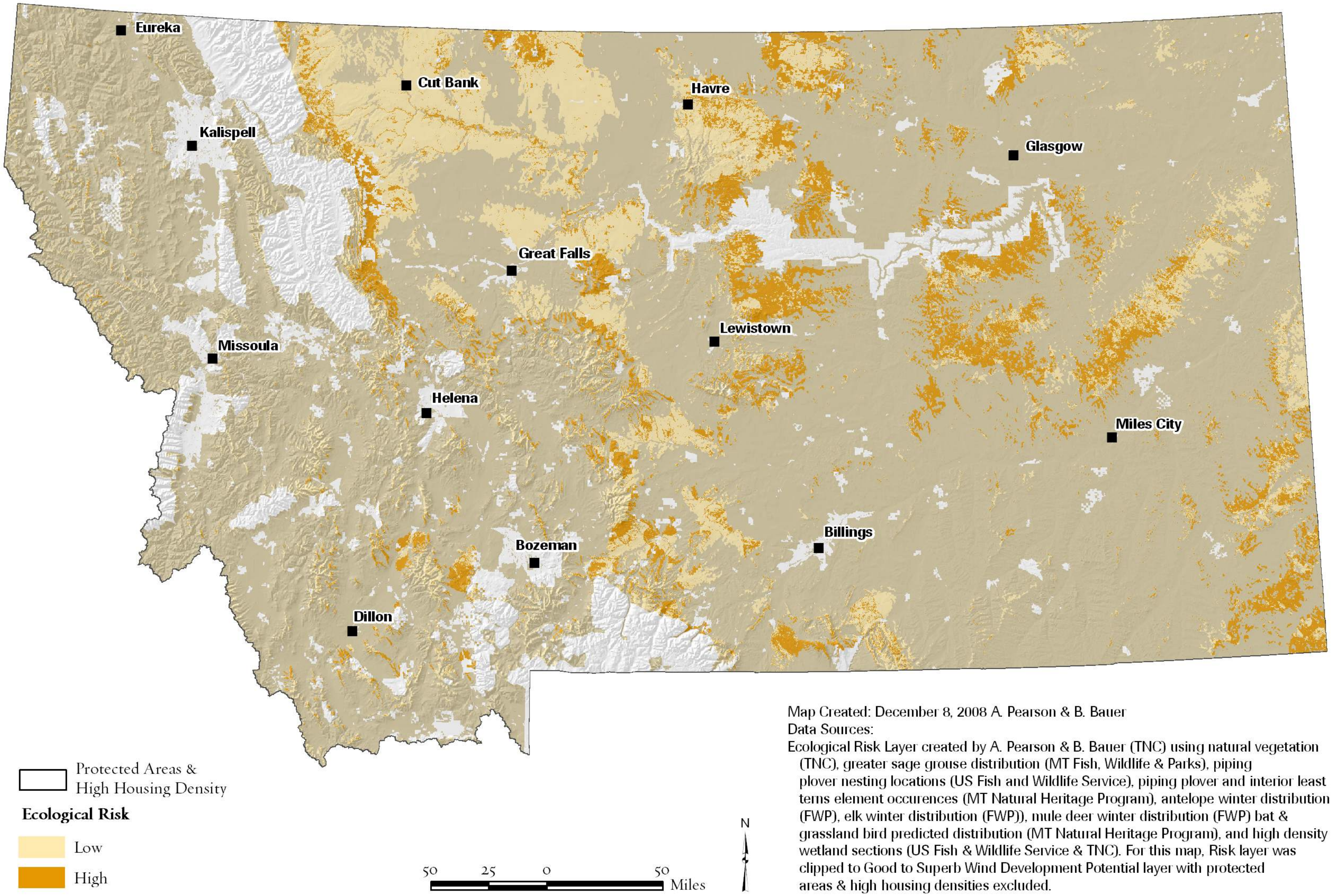
50 25 0 50 Miles

N

Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Ecological Risk Layer created by A. Pearson & B. Bauer (TNC) using natural vegetation (TNC), greater sage grouse distribution (MT Fish, Wildlife & Parks), piping plover nesting locations (US Fish and Wildlife Service), piping plover and interior least terns element occurences (MT Natural Heritage Program), antelope winter distribution (FWP), elk winter distribution (FWP)), mule deer winter distribution (FWP) bat & grassland bird predicted distribution (MT Natural Heritage Program), and high density wetland sections (US Fish & Wildlife Service & TNC).

Figure 23. Ecological Risk Assessment for Wind Energy Development within Available Good-to-Superb Wind Energy Potential in Montana

The Nature Conservancy
Protecting nature. Preserving life.™



Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Ecological Risk Layer created by A. Pearson & B. Bauer (TNC) using natural vegetation (TNC), greater sage grouse distribution (MT Fish, Wildlife & Parks), piping plover nesting locations (US Fish and Wildlife Service), piping plover and interior least terns element occurences (MT Natural Heritage Program), antelope winter distribution (FWP), elk winter distribution (FWP)), mule deer winter distribution (FWP) bat & grassland bird predicted distribution (MT Natural Heritage Program), and high density wetland sections (US Fish & Wildlife Service & TNC). For this map, Risk layer was clipped to Good to Superb Wind Development Potential layer with protected areas & high housing densities excluded.

LITERATURE CITED

American Wind Energy Association. 2008. Wind energy for a new era: an agenda for the new president and congress. Available from: http://www.newwindagenda.org/pdf/Report_RES_Section.pdf (Accessed December 2008).

Arnett, E. B., W. K. Brown, W. P. Erickson, J. K. Fiedler, B. L. Hamilton, T. H. Henry, A. Jain, G. D. Johnson, J. Kerns, R. P. Koford, C. P. Nicholson, T. J. O'Connell, M.D. Piorkowski, and R. D. Tankersley, Jr. 2008. Patterns of bat fatalities at wind energy facilities in North America. Journal of Wildlife Management. 72: 61-78.

Atkinson, S. J. and Dood, A. R. 2005. Montana Piping Plover Management Plan. Montana Department of Fish, Wildlife and Parks. Unpublished Report 72 pp.

Atkinson, S. J. and Dood, A. R. 2006. Montana Interior Least Tern Management Plan. Montana Fish, Wildlife and Parks, Bozeman, Montana. 47 pp.

Baerwald, E. F., G. H. D'Amoour, B. J. Klug, R. M. R. Barclay. 2008. Barotrauma is a significant cause of bat fatalities at wind turbines. Current Biology 18:695-696.

Barclay, R. M R., E. F. Baerwald, and J. C. Gruver. 2007. Variation in bat and bird fatalities at wind energy facilities: assessing the effects of rotor size and tower height. Canadian Journal of Zoology 85:381–387.

Blann, K. 2006. Habitat in Agrultural Landscapes: How much is enough? A State-of-the Science Literature Review. Defenders of Wildlife. Washington, D.C. 84 pp.

Casey, D. 2000. Montana Partners in Flight. Draft Conservation Plan Montana. January 2000. Kalispell, MT 281 pp.

Casey, D. 2006. Rocky Mountain Front Avian Inventory: Final Report. Unpublished report, American Bird Conservancy.

Collins, C. P., and T. D. Reynolds. 2006. Greater sage-grouse lek surveys and lek counts on Cotterel Mountain, 2006 Results. Ribgy, ID: TREC, Inc.

Cryan, P. M. and A. C. Brown. 2007. Migration of bats past a remote island offers clues toward the problem of bat fatalities at wind turbines. Biological Conservation 139:1-11.

Davis, S. K. 2003. Habitat selection and demography of mixed-grass prairie songbirds in a fragmented landscape. Ph.D. thesis. University of Regina, Regina, SK.

Everaert, J., and E. W. M. Steinen. 2006. Impact of wind turbines on birds in Zeebrugge (Belgium). Biodiversity and Conservation. http://www.springerlink.com/content/n724201117657644/

?p¼df214abe5a3b4eb69c12b8ea210b3e66&pi¼0. Accessed 27 Nov. 2008.

Fitzgerald, J., D. Pashley, and B. Pardo. 1999. Partners in Flight Bird Conservation Plan for The Northern Mixed-grass Praire (Physiographic Area 37). American Bird Conservancy, Jefferson City, Missouri. 65 pp.

GAO. 2007. Farm program payments are an important factor in landowners' decisions to convert grassland to cropland. GAO-07-1054. 70 pp.

Holloran, M. J. 2005. Greater sage grouse (*Centrocercus urophasianus*) population response to natural gas field development in western Wyoming. Dissertation. University of Wyoming, Laramie, Wyoming.

Interagency Grizzly Bear Committee. 2004. Cumulative Effects Model, Northern Continental Divide Ecosystem. Draft version.

Johnson, G. D., W. P. Erickson, M. D. Strickland, M. F. Shepherd, and D. S. Shepherd. 2000. Avian monitoring studies at the Buffalo Ridge, Minnesota Wind Resource Area: Results of a 4-year study. Western Ecosystems Technology, Inc., Cheyenne, Wyoming.

Knapp, A. K., J. M. Blair, J. M. Briggs, S.C. Collins, D. C. Hartnett, L.C. Johnson, and E. G. Towne. 1999. The Keystone Role of Bison in North American Tallgrass Prairie. Bison increase habitat herterogeneity and alter a broad array of plant, community, and ecosystem processes. BioScience 49:39-50.

Knopf, F. L. 1994. Avian assemblages on altered grasslands. Studies in Avian Biology 15:247-257.

Knopf, F. L. 1996. Prairie Legacies – Birds *in* Prairie Conservervation: preserving North America's most endangered ecosystem edited by F.B Sampson and F.L. Knopf. Island Press. 339 pp.

Kunz, T. H., E. B Arnett, W. P. Erickson, A. R Hoar, G. D. Johnson, R. P. Larkin, M. D. Strickland, R.W Thresher, and M. D. Tuttle. 2007. Ecological impacts of wind energy development on bats: questions, research needs, and hypotheses. Front Ecol Environ 2007; 5(6): 315–324.

Kuvlesky, Jr W. P, L. A. Brennan, M. L. Morrison, K. K. Boydston, B. M. Ballard, F. C. Bryant. 2007. Wind Energy Development and Wildlife Conservation: Challenges and Opportunities. Journal of Wildlife Management 71(8):2487–2498

Larson, M. A., M. R. Ryan, and R. K. Murphy. 2002. Population viability of Piping Plovers: effects of predator exclusion. Journal of Wildlife Management 66:361-371.

Leddy, K. L., K. F. Higgins, and D. E. Naugle. 1999. Effects of wind turbines on upland nesting birds in conservation reserve program grasslands. Wilson Bulletin 111:100-104.

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.

Mattson, D.J., S. Herroro, R.G. Wright, C.M. Pease. 1996. Science and Management of Rocky Mountain Grizzly Bears. Conservation Biology 10: 1013-1025.

Mickleburgh, S. P., Hutson, A. M. and P. A. Racey. 2002. A review of the global conservation status of bats. Oryx. 36(1): 18-34.

Molvar, E.M. 2008. Wind power in Wyoming: Doing it Smart from the Start. Laramie, WY: Biodiversity Conservation Alliance, 55 pp.

Montana Fish, Wildlife and Parks 2005a. Management plan and conservation strategies for sage grouse in Montana – final. Montana Fish, Wildlife and Parks, Helena, MT, 200 pp.

Montana Fish, Wildlife and Parks 2005b. Montana's comprehensive fish and wildlife conservation strategy, executive summary, 2005. Montana Fish, Wildlife and Parks, Helena, MT, 91 pp.

Montana Natural Heritage Program and Montana Fish, Wildlife and Parks. 2008. Montana animal species of concern. Helena, MT: Montana Natural Heritage Program & Montana Department of Fish, Wildlife & Parks. 17 pp.

Nash, S. 2007. Decrypting Biofuel Scenarios. Bioscience 57:472 – 477.

Plissner, J. H., and S. M. Haig. 2000a. Status of a broadly distributed endangered species: results and implications of the second International Piping Plover Census. Canadian Journal of Zoology 78:129-139.

Plissner, J. H., and S. M. Haig. 2000*b*. Viability of piping plover *Charadrius melodus* populations. Biological Conservation 92:163-173.

Ryan, M. R., B. G. Root, and P. M. Mayer. 1993. Status of Piping Plovers in the Great Plains of North America: a demographic simulation model. Conservation Biology 7:581-585.

Samson F. B. and F. L. Knopf. 1994. Prairie conservation in North America. Bioscience 44:418-21.

Shaffer, J. A. and D. H. Johnson. 2008. Displacement effects of wind developments on grassland birds in the northern Great Plains. Available from: http://www.nationalwind.org/pdf/ShafferJill.pdf. (Accessed December 2008).

Smallwood, K. S. 2007. Estimating Wind Turbine–Caused Bird Mortality. Journal of Wildlife Management 71(8):2781–2791.

Stewart, G. B., A. S. Pullin, and C. F. Coles. 2007. Poor evidence-base for assessment of windfarm impacts on birds. Environmental Conservation 34 (1): 1–11.

United States Department of Agriculture National Agricultural Statistics Service. 2007. Prospective plantings report – March 30, 2007. United States Department of Agriculture Washington, D.C., USA. Available from http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do? documentID=1136

United States Department of Energy. 2008. 20% wind energy by 2030: increasing wind energy's contribution to US electrical supply. DOE/GO-102008-2578. 27 pp.

U.S. Fish and Wildlife Service. 2002. Birds of conservation concern 2002. Division of Migratory Bird Management, Arlington, Virginia. 99 pp.

U.S. Shorebird Conservation Plan. 2004. High Priority Shorebirds ─ 2004. Unpublished Report, U. S. Fish and Wildlife Service, 4401 N. Fairfax Dr., MBSP 4107, Arlington, VA, 22203 U.S.A. 5 pp.

Walker, B. L. 2008. Greater sage grouse response to coal-bed natural gas development and west Nile virus in the Powder River Basin in Montana and Wyoming, USA. Dissertation. University of Montana, Missoula, MT.

Wind Today. 2008. State wind capacity and resource rankings. Available from: http://www.windtoday.net/pdf/State__Energy_Potential.pdf (Accessed December 2008).

Appendix A. Figure Data Sources.

Figure	Layer	Description	Source	Website
1 and 2. Wind Energy Potential	Electric Power Transmission Lines		Ventyx Energy, LLC	
	Wind Resource Potential	Annual average wind resource potential measured at 50 meters above ground level. Wind power density (w/m²) were broken down into 7 "wind power classes"	True Wind Solutions/ NREL	http://www.windpowermaps.org
3. Lands Excluded	Protected Areas	Conservation Easements, Wilderness Areas, Wildlife Refuges, National Parks, Private Conservation Lands, RNAs, WMAs, ACECs extracted from Stewardship database	MT Natural Heritage Program	http://nhp.nris.mt.gov/
	Housing Densities	2010 predicted Housing density (housing units/km²)	Roger B. Hammer (Oregon State University), Volker C. Radeloff (University of Wisconsin Madison), and Susan I. Stewart (USDA Forest Service Northern Research Station).	http://silvis.forest.wisc.edu/library/HousingData.asp
4. Low Ecological Risk Areas	Cropland	Fallow, Irrigated, Grazed, Hay, and Continuously Cropped delineations	Montana Department of Revenue (2008)	
	Oil Wells		MT Department of Natural Resource s & Conservation	
5. Intact Natural Habitat	Natural Vegetation	National landcover Dataset classes for forest, shrub/scrub, grassland, sedge & herbaceous (2001)	Multi-Resolution Land Characteristics (MRLC) Consortium	http://www.mrlc.gov/nlcd.php
6 and 7. Sage Grouse Leks	Sage Grouse Leks	Leks with 4 mile buffer	MT Fish, Wildlife & Parks	http://fwp.mt.gov/doingBusiness/reference/gisData/default.html
8 and 9. Grassland Bird Abundance	Grassland Bird Distribution	High densities extracted from predicted distribution models and summed for 12 birds	MT Natural Heritage Program & MT Fish, Wildlife & Parks	

10 and 11. Plover & Tern	Piping Plover	Nesting locations with 1 mile buffer	US Fish & Wildlife Service	
	Interior Least Tern	element occurrence data with 1 mile buffer	MT Natural Heritage Program	http://nhp.nris.mt.gov/
12 and 13. Wetland Densities	High Wetland Densities	Density layer created using National Wetland Inventory polygons and summed by section	US Fish & Wildlife Service	
14 and 15. Bat Abundance	Bat Distribution	Used high densities from predicted distribution models for all bats in Montana, summed all bats together	MT Natural Heritage Program	http://nhp.nris.mt.gov/
16 and 17. Grizzly Bear Habitat	Grizzly Bear Cumulative Effects Model	Habitat Values 6+ from Spring Cumulative Effects Model (2003)	US Forest Service & CEM Working Group	
18 and 19. Mule Deer, Antelope & Elk	Mule Deer Distribution	Winter Range	MT Fish, Wildlife & Parks	http://fwp.mt.gov/doingBusiness/reference/gisData/default.html
	Pronghorn Antelope Distribution	Winter Range	MT Fish, Wildlife & Parks	http://fwp.mt.gov/doingBusiness/reference/gisData/default.html
	Elk Distribution	Winter Range	MT Fish, Wildlife & Parks	http://fwp.mt.gov/doingBusiness/reference/gisData/default.html
20. TNC Ecoregional Portfolio Sites	Portfolio Sites	Priority landscapes for conservation identified in TNC's ecoregional planning process (2008)	The Nature Conservancy	
21. Wind Development Potential	Wind Development Potential	created by TNC using Wind Resource Potential and excluding protected areas & high housing densities		
22 and 23. Ecological Risk	Ecological Risk	summed raster created by TNC using intact vegetation, sage grouse, piping plover, interior least tern, antelope, mule deer, elk, bat, grassland bird, and high density wetland data		

Appendix B

Brief: Grassland bird and bat presence and abundance at select locations in Montana with high wind-power development potential

Susan Lenard
Montana Natural Heritage Program
December 2008

Introduction

This appendix documents bird and bat species presence in areas identified as high potential for wind-power development in Montana. This project was conducted to contribute to current knowledge of avian and bat species distribution to identify potential impact of wind development activities. Because both birds and bats use flight as a means of migration and foraging, the potential impact to these organisms extends beyond simple displacement resulting from wind-farm construction and operation. Wind turbines have the potential to kill numerous species, especially in migratory corridors and areas of high habitat quality. Additionally, a number of bird and bat species documented in these areas are of high conservation concern, a result of widespread and consistent declines across their ranges.

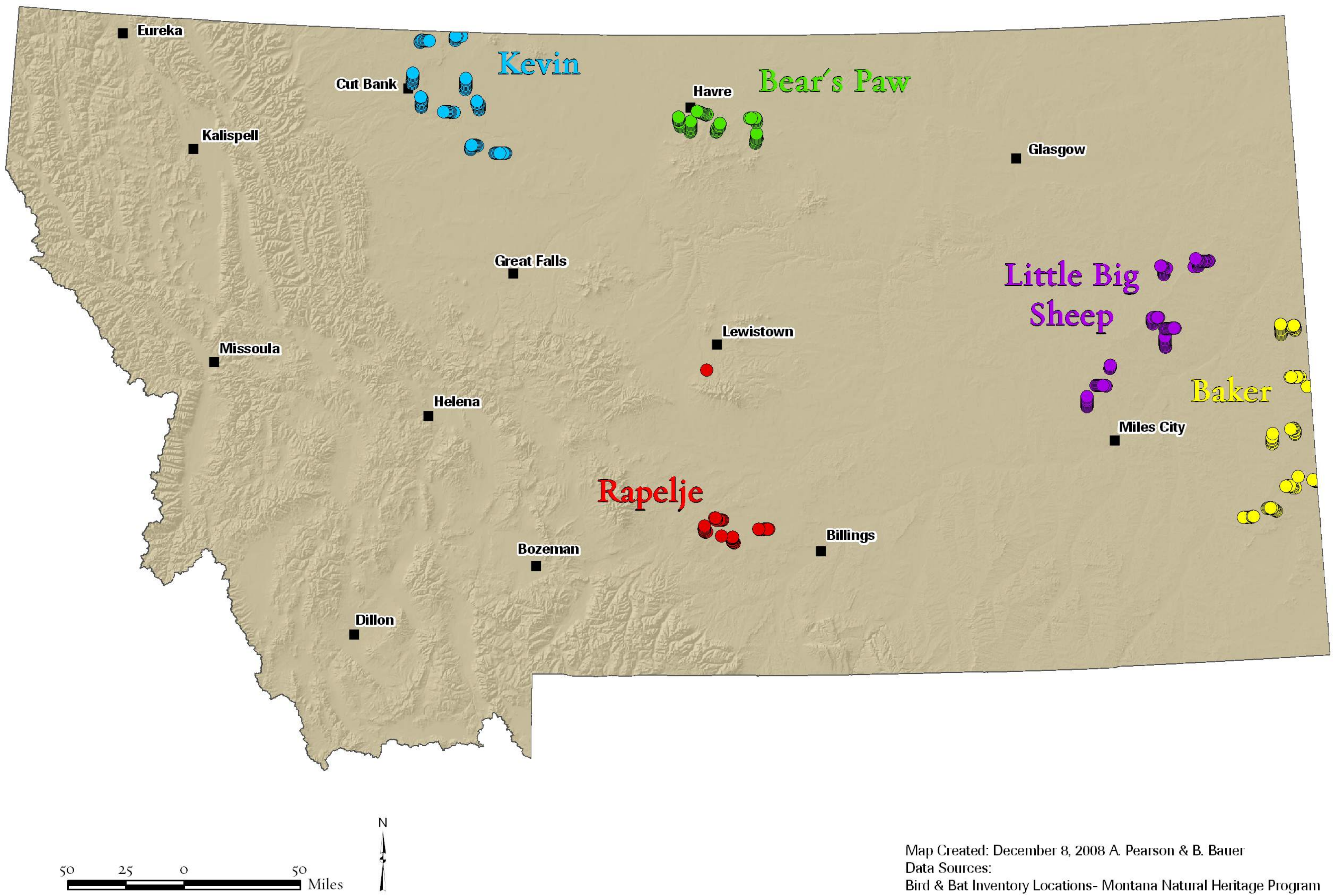
Methods

Polygons were drawn around high wind-power areas in the following regions: Wibaux to Ekalaka (Baker); Big Sheep-Little Sheep; Rapelje to Ryegate; north side of the Bears Paw; and the Kevin Rim area (Appendix Figure 1). Bird surveys within these areas were stratified spatially by random selection of 1:24,000 scale USGS quadrangle maps. Within each randomly selected quad map, the observer was allowed to choose a road intersection at which to start a route and the route to follow within the selected quad map. Flexibility to choose the location of the route on the ground was necessary as the conditions of the roads were not known prior to the survey. Paved roads were eliminated as were all roads that appeared impassable on NAIP imagery and/or in the Montana Gazetteer.

On each route, the first point was selected no less than 400 meters from the selected intersection, with subsequent points placed at 0.5 mile intervals along the route. Ten points were surveyed per route resulting in a total transect length of at least 4.5 miles. In order to maximize the time for point counts in the morning, one observer noted it was necessary to conduct all work relating to recording the points (GPS), field sketching and/or photographing, and recording associated vegetation (macro vegetation and dominant plant species) at least one day prior to the point count. Provided all physical site characteristics were recorded prior to the count morning, three transect routes could be accomplished in one morning, otherwise, only two transect routes were completed. GPS coordinates were taken either at the time the point counts were performed or when the vegetation measurements were taken, whichever came first.

Appendix Figure 1. MT Natural Heritage Program Bird & Bat Inventory Locations

The Nature Conservancy
Protecting nature. Preserving life.™



Map Created: December 8, 2008 A. Pearson & B. Bauer
Data Sources:
Bird & Bat Inventory Locations- Montana Natural Heritage Program

Bat surveys consisted of deploying acoustic recording devices within the identified polygons. While sampling for bats was conducted via road, wetlands and other water sources were targeted, so bat surveys were not tied to the same bird survey routes. Acoustic recording devices (consisting of a Pettersson Ultrasound Detector D 240x, and a MP3 recording device) were placed in a waterproof container and secured on a 5 foot piece of conduit which was placed adjacent to an open water area or beneath a potential roof site (bridge or overpass). The recording device was turned on shortly before dusk to eliminate extraneous daytime noise while still detecting the first emerging bats of the evening. Calls were downloaded each morning at each site, translated to wave files, and subsequently analyzed using SonoBat v2.6 software and the acoustic key developed by Szewczak and Weller (2006).

Point Count Protocol

Point counts were conducted between 7 June and 30 June, 2008 by three individuals. All point counts were five minutes in duration and were conducted between 5:30 am and 10:00 am. Counts were not conducted if continuous rain and high wind were present. All birds detected visually and/or aurally within a 100-meter radius circle from the fixed transect point were recorded with each individual species documented with the appropriate 4-letter AOU code and abundance noted. Birds outside of the 100-meter circle were also recorded, but noted as outside the point count circle.

Vegetation Measurement Protocol

Vegetation measurements were recorded at all points along each transect and consisted of 5 categories of cover type (grass, bare, shrub, water, and wet meadow) for which percentages were assigned. The dominant species within the 100-meter count circle were also recorded.

Results and Discussion

Bird Surveys

Three hundred fifty-nine point counts were conducted along 39 transects resulting in 1,917 recorded bird observations for 92 species of birds. Thirty-three of the 39 transects consisted of ten points each, while six transects conducted consisted of less than ten points due to time or wind constraints. The data derived from these points were added to the Montana Bird Distribution Database housed at the Montana Natural Heritage Program. All data contained in the database that fell within these polygons were summarized collectively and are listed in the tables below (see tables 1-6). [*The column labeled Number of Species Breeding consists of records for which there was direct or indirect evidence of breeding. The Species of Concern list includes Species of Concern as well as Potential Species of Concern as indicated by PSOC*].

Table 1. Bird species overview for wind power analysis areas

Wind Polygon	Number of Documented Species	Number of Species Breeding	Number of Species of Concern
Kevin	153	114	28
Bear's Paw	195	146	40
Little Big Sheep	211	135	41
Baker	154	129	37
Rapelje	77	47	14

Table 2. Kevin Area – List of documented bird species with a count of 10 or more.

Common Name	Record Count	S Rank	Breeding	SOC
Horned Lark	577	S5	Yes	
Vesper Sparrow	336	S5B	Yes	
Savannah Sparrow	264	S5B	Yes	
Western Meadowlark	197	S5B	Yes	
Ferruginous Hawk	173	S3B	Yes	SOC
Red-winged Blackbird	137	S5B	Yes	
Brewer's Blackbird	107	S5B	Yes	
Brown-headed Cowbird	100	S5B	Yes	
Chestnut-collared Longspur	92	S3B	Yes	SOC
House Sparrow	76	SNA	Yes	
Gadwall	73	S5B	Yes	
Mallard	72	S5	Yes	
Killdeer	66	S5B	Yes	
Rock Pigeon	65	SNA	Yes	
European Starling	63	SNA	Yes	
Mourning Dove	59	S5B	Yes	
Swainson's Hawk	58	S3B	Yes	SOC
Northern Harrier	56	S4B	Yes	
Long-billed Curlew	53	S2B	Yes	SOC
McCown's Longspur	53	S2B	Yes	SOC
Eastern Kingbird	43	S5B	Yes	
American Robin	43	S5B	Yes	
Willet	41	S5B	Yes	
American Avocet	37	S4B	Yes	
Northern Shoveler	36	S5B	Yes	
Ring-necked Pheasant	36	SNA	Yes	
American Crow	36	S5B	Yes	
Northern Pintail	34	S5B	Yes	
Clay-colored Sparrow	34	S4B	Yes	
Wilson's Phalarope	33	S4B	Yes	
Marbled Godwit	32	S4B	Yes	

Black-billed Magpie	32	S5	Yes	
Blue-winged Teal	31	S5B	Yes	
American Wigeon	31	S5B	Yes	
Barn Swallow	31	S5B	Yes	
Red-tailed Hawk	30	S5B	Yes	
Ring-billed Gull	29	S5B	Yes	
Western Kingbird	29	S5B	Yes	
Say's Phoebe	27	S5B	Yes	
Yellow-headed Blackbird	26	S5B	Yes	
Golden Eagle	25	S4	Yes	PSOC
California Gull	25	S5B	Yes	
American Coot	22	S5B	Yes	
Cliff Swallow	19	S5B	Yes	
Eared Grebe	18	S5B	Yes	
Cinnamon Teal	18	S5B	Yes	
Gray Partridge	18	SNA	Yes	
Canada Goose	17	S5B	Yes	
Lesser Scaup	17	S5B	Yes	
Loggerhead Shrike	15	S3B	Yes	SOC
Redhead	14	S5B	Yes	
Yellow Warbler	14	S5B	Yes	
Sora	12	S5B	Yes	
Spotted Sandpiper	11	S5B	Yes	
Wilson's Snipe	11	S5	Yes	
Prairie Falcon	10	S4	Yes	

Table 3. Bear's Paw – List of all documented bird species with a count of 10 or more.

Common Name	Record Count	S Rank	Breeding	SOC
Western Meadowlark	93	S5B	Yes	
Vesper Sparrow	63	S5B	Yes	
Horned Lark	56	S5	Yes	
Ring-necked Pheasant	38	SNA	Yes	
Mourning Dove	24	S5B	Yes	
Brewer's Blackbird	23	S5B	Yes	
American Robin	18	S5B	Yes	
Sprague's Pipit	15	S2B	Yes	SOC
Northern Harrier	14	S4B	Yes	
Killdeer	14	S5B	Yes	
Brown-headed Cowbird	13	S5B	Yes	
Long-billed Curlew	12	S2B	Yes	SOC
Eastern Kingbird	12	S5B	Yes	
Clay-colored Sparrow	12	S4B	Yes	
Red-winged Blackbird	12	S5B	Yes	
Mallard	10	S5	Yes	

Table 4. Little Big Sheep Area – List of documented bird species with a count of 10 or more.

Common Name	Record Count	S Rank	Breeding	SOC
Western Meadowlark	102	S5B	Yes	
Horned Lark	82	S5	Yes	
Grasshopper Sparrow	61	S3B	Yes	SOC
Greater Sage-Grouse	51	S2	Yes	SOC
Vesper Sparrow	48	S5B	Yes	
Lark Bunting	46	S3B	Yes	SOC
Brown-headed Cowbird	42	S5B	Yes	
Mourning Dove	37	S5B	Yes	
Chestnut-collared Longspur	33	S3B	Yes	SOC
Eastern Kingbird	25	S5B	Yes	
Brewer's Blackbird	25	S5B	Yes	
Northern Harrier	23	S4B	Yes	
Ring-necked Pheasant	23	SNA	Yes	
Western Kingbird	23	S5B	Yes	
Sharp-tailed Grouse	22	S4	Yes	
Loggerhead Shrike	22	S3B	Yes	SOC
Lark Sparrow	22	S5B	Yes	
Red-winged Blackbird	22	S5B	Yes	
Killdeer	20	S5B	Yes	
American Robin	19	S5B	Yes	
Red-tailed Hawk	18	S5B	Yes	
Yellow Warbler	18	S5B	Yes	
Savannah Sparrow	18	S5B	Yes	
Mallard	17	S5	Yes	
Barn Swallow	17	S5B	Yes	
Sprague's Pipit	16	S2B	Yes	SOC
Brown Thrasher	15	S5B	Yes	
Baird's Sparrow	15	S2B	Yes	SOC
Common Grackle	14	S5B	Yes	
European Starling	13	SNA	Yes	
Brewer's Sparrow	13	S2B	Yes	SOC
Great Horned Owl	12	S5	Yes	
House Wren	12	S5B	Yes	
Blue-winged Teal	11	S5B	Yes	
Gadwall	11	S5B	Yes	
American Kestrel	11	S5B	Yes	
Rock Pigeon	11	SNA	Yes	
House Sparrow	11	SNA	Yes	
Long-billed Curlew	10	S2B	Yes	SOC

Table 5. Baker Area – List of documented bird species with a count of 10 or more.

Common Name	Record Count	S Rank	Breeding	SOC
Western Meadowlark	389	S5B	Yes	
Lark Bunting	234	S3B	Yes	SOC
Mourning Dove	194	S5B	Yes	
Brown-headed Cowbird	190	S5B	Yes	
Horned Lark	183	S5	Yes	
American Robin	128	S5B	Yes	
Red-winged Blackbird	125	S5B	Yes	
House Wren	120	S5B	Yes	
Grasshopper Sparrow	106	S3B	Yes	SOC
Chipping Sparrow	98	S5B	Yes	
Eastern Kingbird	74	S5B	Yes	
Myrtle Warbler	65	S5B	Yes	
Red-breasted Nuthatch	64	S5	Yes	
Greater Sage-Grouse	52	S2	Yes	SOC
Ovenbird	52	S3S4B	Yes	PSOC
Dark-eyed Junco	49	S5B	Yes	
Black-capped Chickadee	42	S5	Yes	
Savannah Sparrow	42	S5B	Yes	
Western Kingbird	41	S5B	Yes	
Yellow Warbler	41	S5B	Yes	
Vesper Sparrow	41	S5B	Yes	
Killdeer	40	S5B	Yes	
Brewer's Blackbird	40	S5B	Yes	
Bobolink	39	S2B	Yes	SOC
Western Tanager	37	S5B	Yes	
Red Crossbill	34	S5	Yes	
Loggerhead Shrike	32	S3B	Yes	SOC
Chestnut-collared Longspur	32	S3B	Yes	SOC
White-breasted Nuthatch	30	S4	Yes	
Cliff Swallow	28	S5B	Yes	
Barn Swallow	28	S5B	Yes	
Hairy Woodpecker	27	S5	Yes	
American Goldfinch	27	S5B	Yes	
Mallard	25	S5	Yes	
Ring-necked Pheasant	25	SNA	Yes	
Western Wood-Pewee	25	S5B	Yes	
Spotted Towhee	25	S5B	Yes	
Baird's Sparrow	24	S2B	Yes	SOC

Northern Harrier	23	S4B	Yes	
Common Grackle	23	S5B	Yes	
Red-headed Woodpecker	22	S3B	Yes	SOC
Say's Phoebe	22	S5B	Yes	
European Starling	21	SNA	Yes	
Mountain Bluebird	19	S5B	Yes	
Dickcissel	19	S1S2B	Yes	SOC
Ferruginous Hawk	18	S3B	Yes	SOC
Red-tailed Hawk	17	S5B	Yes	
House Sparrow	17	SNA	Yes	
Blue-winged Teal	16	S5B	Yes	
American Kestrel	16	S5B	Yes	
Swainson's Hawk	14	S3B	Yes	SOC
Brown Thrasher	14	S5B	Yes	
Northern Flicker	13	S5	Yes	
American Crow	13	S5B	Yes	
Townsend's Solitaire	12	S5	Yes	
Wild Turkey	11	SNA	Yes	
Wilson's Phalarope	11	S4B	Yes	
White-throated Swift	11	S5B	Yes	
Northern Flicker (Red-shafted)	11	SNRB	Yes	
Yellow-rumped Warbler	11	S5B	Yes	
Common Yellowthroat	11	S5B	Yes	
Field Sparrow	11	S4B	Yes	
Lark Sparrow	11	S5B	Yes	
Turkey Vulture	10	S4B	Yes	
Sharp-tailed Grouse (Plains)	10	S4		
Least Flycatcher	10	S5B	Yes	
Black-headed Grosbeak	10	S5B	Yes	

Table 6. Rapelje Area – List of documented bird species with a count of 10 or more.

Common Name	Record Count	S Rank	Breeding	SOC
Western Meadowlark	123	S5B	Yes	
Vesper Sparrow	109	S5B	Yes	
Horned Lark	82	S5	Yes	
McCown's Longspur	27	S2B	Yes	SOC
Mourning Dove	26	S5B	Yes	
Long-billed Curlew	25	S2B	Yes	SOC
Lark Bunting	25	S3B	Yes	SOC
Brown-headed Cowbird	22	S5B	Yes	
Brewer's Blackbird	21	S5B	Yes	
Savannah Sparrow	18	S5B	Yes	
American Robin	13	S5B	Yes	
European Starling	11	SNA	Yes	
Upland Sandpiper	10	S4B	Yes	

Bat Surveys

Sixty-two acoustic bat surveys were conducted across the five areas of interest. Over 6,600 calls were recorded and analyzed resulting in 153 new bat observations across the sites. Since an individual bat can make multiple calls over the course of a recorded survey, the data only infers relative activity and can not be used to infer overall abundance. Multiple calls of each species at each site are recorded in the Heritage Program's Point Observation Database (POD) as one observation. Sonograms that were suggestive of a particular species, but did not meet all of the definitive characteristics in Szweczak and Weller (2006) were classified as probable. These data were not put into the database, but are considered separately as tentative identifications of the species in these areas. All data from POD (a total of 173 bat acoustic identifications for the analysis areas) were used to generate Table 7 (below).

Table 7. Bat Species Observations in wind power analysis areas

Wind Polygon	Common Name	Number of Locations Documented	S Rank	SOC
Kevin				
	Little Brown Myotis	12	S4	
	Silver-haired Bat	9	S3S4	PSOC
	Hoary Bat	5	S3	SOC
	Western Small-footed Myotis	3	S4	
	Big Brown Bat	1	S4	
	Long-legged Myotis (probable)	(2)	S4	

Bears Paw				
	Little Brown Myotis	8	S4	
	Silver-haired Bat	7	S3S4	PSOC
	Hoary Bat	7	S3	SOC
	Western Small-footed Myotis	5	S4	
	Long-eared Myotis	2	S4	
	Fringed Myotis	1	S3	SOC
	Big Brown Bat	1	S4	
	Long-legged Myotis (probable)	(4)	S4	
Little Big Sheep				
	Hoary Bat	10	S3	SOC
	Silver-haired Bat	7	S3S4	PSOC
	Little Brown Myotis	5	S4	
	Long-eared Myotis	3	S4	
	Big Brown Bat	2	S4	
	Fringed Myotis	1	S3	SOC
	Long-legged Myotis	1	S4	
	Spotted Bat	1	S2	SOC
Baker				
	Little Brown Myotis	12	S4	
	Silver-haired Bat	11	S3S4	PSOC
	Hoary Bat	10	S3	SOC
	Long-eared Myotis	6	S4	
	Fringed Myotis	4	S3	SOC
	Big Brown Bat	4	S4	
	Long-legged Myotis	3	S4	
	Western Small-footed Myotis	3	S4	
	Townsend's Big-eared Bat	1	S2	SOC
	Long-legged Myotis (probable)	(10)	S4	
Rapelje				
	Long-eared Myotis	6	S4	
	Silver-haired Bat	6	S3S4	PSOC
	Hoary Bat	5	S3	SOC
	Western Small-footed Myotis	4	S4	
	Big Brown Bat	3	S4	
	Little Brown Myotis	2	S4	
	Fringed Myotis	2	S3	SOC
	Long-legged Myotis (probable)	(7)	S4	

Need for Additional Surveys

While survey work in 2008 contributed greatly to information on the distribution of avian and bat species in these selected areas, the data in no way suggests the information is a complete inventory of species found in these regions. Further surveys are needed, especially in specific locations without survey effort. Also, surveys during other times of the year, especially during migratory periods, will provide a more comprehensive picture of the full complement of species within the areas assessed during this project.