WHAT DOES GREEN REALLY MEAN?

The Natural Resource Planner - A tool to help site development projects to minimize their impact on wildlife and sensitive habitats.

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Abstract

Kansas ranks third in the nation for wind energy potential, and the state’s existing wind power capacity has more than tripled since 2008 with five projects coming online in the past 15 months. Kansas is also home to extensive tall, short and mixed grass prairie habitats as well as a host of wetlands of continental and international importance; including the playa wetlands of western Kansas and the Cheyenne Bottoms/Quivira wetland complex in central Kansas. This rapid increase in wind power capacity, demand for future development, and the presence of sensitive habitats and migratory bird populations has left many debating the choice between developing wind energy or conserving wildlife and wildlife habitat.

The Natural Resource Planner (NRP) is an interactive web-based mapping tool designed to help site development projects so that Kansas can benefit from development of its wind energy potential while protecting wildlife and wildlife habitat. Data layers in the tool include wind power potential, proposed and current wind farms, infrastructure, land cover, sensitive species locations, managed/protected areas, and numerous others. Additional processing was done to add a grid that summarizes land cover as a percentage so that quantitative comparisons can be made between sites.

The information presented in the NRP is based on the collective judgment of a consortium of contributors with particular emphasis placed on the display of environmentally sensitive areas to provide planners, developers, and wildlife managers a proactive tool for site assessment that saves time, money, and resources. Additionally, while wind development is the current focus for its use, the NRP is designed to be broad enough in content to be applicable to any development or management project that could benefit from knowing the spatial distribution of surrounding resources.

Introduction

Wind Potential and Demand

Due to concerns about increasing energy costs, environmental issues of coal fired utility plants, foreign vs. domestic oil supply, and the subsequent concern of greenhouse gas emissions into the atmosphere, there has been a surge in efforts to explore and utilize renewable or “green” energy sources. Among the most prominent of these alternative energy sources (by both physical scale and public opinion) is the instillation of wind farms that utilize wind power to generate electricity. Wind turbines can effectively be installed pretty much anywhere wind energy potential exists, and the central portion of the Unites States represents some of the best wind power potential in the world (Lu et al. 2009). Kansas is located in the middle of a swath of 12 states that account for 90% of the potential wind energy from the conterminous United States, and ranks third overall for wind energy potential (Elliott, 1991). As a result of this massive wind
energy potential, Kansas has received a great deal of interest from wind energy developers and investors to build large wind farms that take advantage of both the wind energy potential and the economic opportunities. There are numerous loan incentives, tax credits, and development incentives for developers (DSIRE 2009) as well as the creation of local construction jobs and the long-term lease payments that help to make the development of wind farms very attractive to many people. With all this potential for economic opportunity, it should be remembered that part of the driving force behind wind energy is its ability to generate electricity in an environmentally friendly way. Accordingly, there should be a way to make informed decisions based on both ecological and economical information to help site wind energy in locations that do not degrade wildlife habitat or other important natural resources, thereby nullifying the goal of generating “green” energy from wind farms.

The Kansas wind energy boom has led to the existing wind power capacity more than tripling since 2008, with five projects coming online in 2008 and 2009. As of January 1, 2010, there were seven active wind farms in Kansas producing a total of 1,016 megawatts, one under construction that would add another 12.5 megawatts, and approximately 44 proposals for new sites (KEIN). The Kansas Department of Wildlife and Parks has reviewed over 70 proposed wind energy projects since 2001; with 30 of these reviewed since 2008 (Johnson, 2010). Currently the lack of transmission is the primary limiting factor to wind energy development in central and western Kansas (where the greatest wind potential exists), and has limited where and how many wind farms are being constructed. Several high voltage transmission lines are currently proposed for construction in Kansas that would open the door for the many wind facilities currently limited by transmission capacity. The location of these new transmission lines will have a large impact on where the next wind farm development surge will occur and how the particular sites will be selected.

Kansas’s Natural Landscape

In addition to the vast wind resource available, Kansas also contains vast grasslands that support livestock, a range of wildlife (both game and non-game species), and provide scenic natural areas for recreational activities. Among these grasslands in western Kansas are patches of short grass prairie, sand prairie, and sandsage shrub land that represent critical habitat for the federal candidate and state petitioned Lesser Prairie Chicken (Tympanuchus pallidicinctus) (ksbirds.org). The eastern portion of Kansas, according to Kuchlers potential vegetation (Küchler 1974), used to be almost completely covered by tallgrass prairie except for riparian corridors and a few other exceptions. When compared with the 2005 land cover map of Kansas (KARS 2009),

the portion delineated by Kuchler as Bluestem Prairie, is now 34% crop, 15% introduced cool season grasses, 43% native warm season grasses (including 3% replanted as CRP), with the remaining 8% divided between urban, woodland, water, and other cover classes. While Kansas has retained a sizable portion of the original grasslands, it is estimated that only approximately 29% of the pre-settlement grasslands remain in the United States (Loveland and Hutchinson 1995). The intense conversion of grasslands to cropland and the introduction of non-native grass species for pastures have created a highly fragmented ecosystem that has changed the plant and animal community composition and impacted the primary productivity (Gibson et al. 1993, Briggs and Knapp 1995, Collins and Steinauer 1998). Additionally, the native warm season grasses of the Great Plains, particularly the tall grass species, have substantially higher water use efficiencies and can absorb and fix more CO2 then their cool season counterparts (Knapp 1993, Tieszen et al. 1997). As more land use change occurs, and grasslands become more fragmented and influenced by non-native species, the risk of severely altering the biological composition and ecosystem function of grasslands in the Great Plains increases. This shift in ecosystem structure and function could potentially move concerns of fragmentation from just wildlife habitat to the bigger issue of carbon sequestration and climate change.

Depressions in the landscape that capture and hold water (even temporarily) create a unique environment of wetlands that are important to a large number of land, water and avian species. The Quivira National Wildlife Refuge and Cheyenne Bottoms Wildlife Area are two of the largest wetland complexes in Kansas, and both are included on the Ramsar List of Wetlands of International Importance. Being located in the middle of Kansas, also places these wetlands in the middle of the Central Flyway, and as a result, they host millions of migratory birds each year. Additionally, the state and federally endangered whooping crane (Grus Americana) utilize these large wetlands as well as smaller playa wetlands as they migrate (KSNHI). Playas are shallow, ephemeral wetlands that periodically fill from heavy rains and provide critical habitat for a wide variety of wildlife and plant species, including over 185 avian species, 13 amphibian species, 37 mammal species, and 124 aquatic invertebrate species (Haukos and Smith 2003). These small, but important wetland depressions are distributed across northern Texas, western Oklahoma, Kansas, Nebraska, and eastern New Mexico and Colorado and are a key component of a “stepping stone” habitat mosaic used by shorebirds during migration between the Arctic and South America (Skagen and Knopf 1993, Davis and Smith 1998).
When Wind and Wildlife Collide

Some of the best wind resources in the United States are in open grasslands of Kansas, unfortunately, these same grasslands also support a range of wildlife that could be at risk if commercial wind power facilities are built in sensitive locations (Figure 1). The ability of commercial wind power facilities to impact wildlife and habitat can be divided into direct and indirect impacts. Direct impacts are usually fairly easy to calculate as they include the amount of land physically impacted by the turbines, roads, power lines, and other infrastructure. This exact area varies by project, but has been generally reported to be between 0.7 to 1.0 acres per turbine, or 0.4 to 0.7 acres per MW (Strickland and Erickson.2004). Wildlife mortality is another direct impact that can be assessed. The death of birds and bats due to wind facilities have been well publicized (and contested), though the numbers and frequency of such deaths vary considerably (Arnett et al. 2008, Johnson 2004, Kerlinger 2004, Kunz 2004, Kunz et al. 2007). Mortality surveys are difficult because they are static estimates on particular sites, dates, and conditions, making them prone to both temporal and spatial anomalies. Additionally, researchers need to account for samples that went undetected because of either oversight or because scavengers moved and/or consumed the carcass.

While the number of studies focused on direct impact is substantial, research on indirect impacts, especially behavioral avoidance, is in its infancy. Relatively recent studies suggest that both greater (Tympanuchus cupido) and lesser prairie chickens (Tympanuchus pallidicinctus) have been found to avoid areas of human disturbances such as roads, oil and natural gas wells and electrical transmission lines (Leddy et al. 1999; Robel et al. 2004; Pitman et al. 2005). Pruett et al. (2009) found that prairie chickens avoided areas within 100 meters of transmission lines and roads, and avoidance distances of 785 meters from highways and 363 meters from transmission lines were observed by Pitman et al. (2005). With evidence like this to support that Prairie chickens and Sage grouse do avoid disturbed areas, a number of state agencies and the U.S. Fish and Wildlife Service have created voluntary guidelines that suggest a buffer area around wind facilities.

When abundant resources, high demand, and sensitive wildlife and/or habitats converge, the results can be detrimental to projects as additional studies and or conflicts significantly increase project timelines and budgets. Similarly, as some developers rush to get projects established by shortening the environmental review process (which is possible since there are no or limited sighting requirements for wind farms) the environmental impacts could be substantial. It was thought, that by creating a free online resource tool that developers could be proactive in making informed sighting decisions and the openly available data could help keep locals,
resource managers, and potential investors aware of what natural resource variables occurred around a given location. The Natural Resource Planner is a dynamic and non-regulatory sight assessment tool that is updated as necessary to keep it current and useful.

Methods

The Natural Resource Planner (NRP) began as a plan to create an interactive web mapping application that contained as much relevant and accurate information as possible so that users could fully assess a wide range of variables for pro-active site planning and assessment. GIS data was assessed and collected from three primary fields (1) Base data, (2) industry specific, and (3) natural resource (Figure 1). Many of the data sets were obtained from the Kansas Geospatial Community Commons (KGCC), however some were obtained from outside sources, and still others were either modified or generated internally. The data layers were processed and organized in ArcGIS 9.3 (ESRI 2008) with the goal of displaying all the data with intuitive symbology, while also keeping the layers visually separable if displayed at the same time. The map project was then imported into Arc Server.NET web ADF and the Natural Resource Planner web page was published online in September of 2008.

After the launch of the preliminary version, a panel of resource experts and potentially interested parties were invited to review and comment on the content and areas for improvement. Participants included representatives from the Kansas Department of Wildlife and Parks, Kansas Biological Survey, Kansas Applied Remote Sensing Program, The Nature Conservancy, Playa Lakes Joint Venture, University of Kansas, Kansas State University, Fort Hays State University, Emporia State University, and a utility company representative. An early decision was made that the NRP provide scientific data on a wide range of variables and allow users to disregard information not relevant to them. It was thought that this option to include more data would be better than 1) having relevant information missing if the NRP data was utilized for a different application, or 2) having a different set of data and maps for each type of application. Secondly, a consensus was reached that beyond the feature specific data and categorical land cover/habitat type data, some quantitative metrics would be useful to help compare sites. The 1x1 mile public land survey system (township/range/section) was used to provide landscape analysis since it was a mapping unit relevant to both wildlife managers and development projects. Within each 1x1 mile section, the area of grassland, cropland, and CRP land was calculated and converted to a percentage. Similarly, playa lakes were summarized by section, and the total number of playas, the percent of the section covered, and the sum of the perimeters was calculated. These calculations were displayed to differentiate sections with low, moderate, and high, amounts of a...
certain variable, and provided a reference for comparisons, but these metrics stopped short of providing a threshold value for defining what constitutes significant area for habitat conservation or sensitive to development. The exact numbers were available for a more detailed comparison by quarrying the PLSS Landscape Summary layer (Figure 2).

As part of the web-mapping application, there are the familiar tools for zooming in/out, panning, quarrying, and measuring, but additional links were placed at the top for users to access additional information. A “User Guide” is available to provide a detailed review of the tools, functionality, and the purpose of the NRP. There is a metadata document titled “About NRP” that provides a user-friendly narrative about the data layers in the NRP and the processing history. Users can also investigate “Additional Resources” to link to a web page populated with links to relevant web sites, a growing library of papers on wind and/or wildlife that can be downloaded, or .pdf posters of the NRP. Finally, by utilizing the “View in ArcMap” option, users can also download an ArcGIS layer file (.lyr) that can be added into an existing in-house ArcGIS project. This layer file will automatically link with all of the data layers on the website and bring the data into a GIS project so users can see their data in relation the NRP data layers.

*Data layers in the NRP*

The processing that was performed on the individual data layers varied considerably, but the following description provides a summary of the processing for some of the more prominent data layers in the NRP.

**Wind farm** information was derived from data obtained from the Kansas Energy Information Network (KEIN) and applications to connect to the Southwest Power Pool. Using hardcopy maps, site descriptions, and other contextual information (mean wind speed, existing power lines, and highways) the approximate proposed location was digitized. For existing wind farms, the exact turbine locations were digitized by identifying them on high resolution National Aerial Imaging Program (NAIP) imagery from the spring of 2008.

The **managed areas** data layer started from a dataset on KGCC regarding land stewardship that identified public and private areas. The layer was modified by adding in conservation easements obtained from The Nature Conservancy and the Kansas Land Trust, and a buffer was created to extend beyond the actual managed area (excluding private conservation easements) to help indicate that a conservation area was nearby. Through discussions with contributing partners, it was decided that a 2-mile buffer around wildlife and conservation areas would be an appropriate distance. An exception to this buffer distance was made for the Cheyenne Bottoms Wildlife Area and the nearby Quivera National Wildlife Refuge, both of
which are recognized as Ramsar wetlands of international importance. Each of these areas received a 10-mile buffer, which resulted in the two buffers intersecting and thereby keeping them functionally connected.

**Sensitive species** data started from a geospatial database of species available on KGCC compiled by the Natural Heritage Program that contained 5332 locations for 635 species. The database provided polygon locations (approximately 1-mile in area) that identified the general location of the species to assist planners while also protecting their exact location from the general public. This geospatial database was modified to include only species listed as threatened or endangered (state or national) plus 3 additional species (little blue heron, Texas horned lizard, and lesser prairie chickens) that were identified as Species of Greatest Conservation Need in A Future for Kansas Wildlife, Kansas’ Comprehensive Wildlife Conservation Strategy (Wasson et al. 2005). An additional polygon was later added to indicate a 15-mile buffer around a cluster of terrestrial caves in south central Kansas that were known to be important bat habitat. The new layer of sensitive species contained 2443 polygons for 125 species.

While **prairie chickens** are not the only species potentially affected by natural resource development in Kansas, the lesser prairie chickens’ status as a candidate for the threatened species list coupled with their documented aversion to anthropogenic features made their inclusion in the NRP a easy decision. The general range of prairie chickens as delineated by expert opinion (Houts et al. 2008) was obtained from the KGCC and included. To provide a more detailed reference to what may actually be usable prairie chicken habitat both inside and outside their current range, the potential prairie chicken habitat layer was also included. The potential habitat layer was created from warm season C4 grasslands and CRP data from the 2005 Kansas land cover map (KARS 2009). Buffered areas around highways (785 meters), transmission lines greater than 345 kV (363 meters), and woodlands by 200 meters were created and then removed from the grass and CRP layer. As a final step, polygons less than 32.4 hectares (80 acres) were removed to leave only grasslands that were away from roads, transmission lines, and trees, that were greater than 32.4 hectares as potential habitat.

**Playas** are shallow seasonal wetlands that support a wide variety of plant, mammal and bird species. In addition to being an important wetland habitat, the water captured in the playas also represents a primary source of recharge for the Ogallala aquifer. An updated map of playas in Kansas was recently completed by Johnson et al. (2008) after visually scanning multiple years of high-resolution aerial photography and manually digitizing the playa perimeters. The 22,045 playas identified covering 81,375 acres (min .08, max 464, mean 3.7) are not always wet, and in the dry season/years, they are often utilized as cropland. Identifying an ecologically important
measurement for playas (surface area, shoreline length, nearest neighbor…) proved to be a daunting task that was made even more difficult by the fact that they are only utilized intermittently when wet. The Playa Lakes Joint Venture is in the final stages of creating a two-tier assessment and ranking of playas. The first method ranks individual playas based on their size and surrounding land cover type, and connectivity (with larger playas, playas in grasslands, and clusters of playas ranking highest). The second approach focused specifically on ranking playa clusters, and utilized kernel density to assess clusters by both total area and by playa frequency (Mclachlan, 2010).

To provide a landscape summary of the variables present and a quantitative assessment of the land cover, the PLSS 1-mile grid was intersected with all the variable layers. The presence or absence of each variable was then added to the attribute table of the PLSS grid. Additionally, summary statistics were calculated on the 2005 Land cover Map to calculate the percentage of all grasslands, warm season (non-CRP), CRP, and cropland present within each section.

A variety of background layers and base data were added to help users put the natural resource data in context. Background layers included the 2005 land cover map for Kansas, the mean annual wind speed, and 2-meter resolution NAIP imagery from 2008. The mean annual wind speed at 100 meters above ground for Kansas was generated by AWS Truewind using the MesoMap system and subsequently obtained for this project via the Kansas Corporation Commission. Due to the a combination of the commercial value of the data and the interest in serving it over the internet, the data was resampled from its original 200 meter resolution to a 1.0 km resolution. Additionally, state highways and electrical transmission corridors were added. In an effort to show the area of potential impact that highways and electric transmission corridors can have on some wildlife species, buffers were created around these features. A 363-meter buffer was created around large electric lines (greater than 345 Volts) and a 785-meter buffer was created around state highways.

Results

After numerous meetings and revisions, the NRP emerged as a successful assemblage of data that integrated GIS data layers into a web based mapping environment so users could customize their viewing parameters. When first launched in September of 2008, the website was announced to potential users at the Kansas Wind and Renewable Energy Conference in Topeka, Kansas later that month. Since web page viewing statistics began being logged on August 28, 2009, there have been consistently about 500 viewers per month. Of these users, 14 percent were repeat users and 86 percent were new to the site. While we were not able to directly track who
the major users were, it is known that the NRP site was accessed most via a link on the Kansas Information and Energy Network and by people typing in the html address directly. The average time spent at the site was almost 5 minutes indicating that users found the site and information useful enough to stay and utilize it. Additionally, there have been several reports of the NRP being used as a resource for site assessment by developers as well as by resource professionals requested to inspect sites for project suitability further supporting the conclusion that the data and the site are a useful resource.

Discussion

With the goal of providing relevant and accurate information, the NRP website is not a one time static map. The content of the NRP page is updated as necessary to provide the best data possible, and as scientists identify significant wildlife/habitat relationships, those parameters will be added. Efforts are also being made to make the page more functional for public users, with possible updates including the addition of a mapping template for creating custom maps and a process by which users could upload a polygon and have the NRP generate a report of the variables intersected. There are also efforts being made by interested third parties to utilize the data in the NRP to develop a quantifiable ranking that approximates the “ecological importance” of a location to help identify conservation priority areas and/or natural areas that could be damaged by development projects. If successful, these measures could be used to help site projects and as a basis for a type of eco-labeling or green certification that indicates a project has met certain environmental criteria.

While already used by many in the wind development industry, the NRP gained additional momentum after it was presented to some members of the Kansas legislature and several State Agencies to demonstrate its functionality and value to a wide range of potential applications. Following the meeting, interest was shown by those in attendance to utilize the NRP and to participate in future plans and updates. Additionally, the Kansas Department of Wildlife and Parks is continuing to support the NRP through additional data development and the creation of a Decision Support System that will utilize data from within the NRP to analyze a projects potential impact, and then display the results on the NRP.
Figure 1. Overview of how the U.S. wind potential and the Kansas land cover patterns have a large area of co-occurrence.

Figure 2. A list of the data layers present in the Natural Resource Planner application sorted by theme.
Figure 3. Screen views of the Natural Resource Planner showing A) Statewide overview depicting grasslands (green) CRP (purple), and cropland (tan), sensitive species (red) and transmission lines (black). B) Closer view of a portion of SW Kansas showing more detail, and C) Same SW area, with percentages of grassland (greens) and total playa perimeter (blues) per PLSS section.
References


KSNHI, Kansas Natural Heritage Inventory.  http://www.ksnhi.ku.edu/


