Conservation Strategy for the Greater Prairie-Chicken and the Plains and Prairie Subspecies of Sharp-tailed Grouse

Greater prairie-chicken: Greg Kramos; Sharp-tailed grouse: Nebraskaland Magazine; landscape: Greg Kramos.

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Developed by the Greater Prairie-Chicken and Sharp-Tailed Grouse Interstate Workgroup*

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This project drew together wildlife biologists from each of the participating 14 state wildlife agencies, plus representatives from USFWS Ecological Services and the USFWS Habitat and Population Evaluation Team. The methodology and results were developed through an iterative process of exploring situations and conditions in each state and working together to identify a conservation strategy to conserve and restore grassland habitats critical to prairie grouse and many other species.

Priority areas and most text developed by the GPC/STG Interstate Working Group members*. GIS analysis, report compilation, and principal editor, Michael Houts; Kansas Biological Survey and Center for Ecological Research at the University of Kansas. Editing provided by Jon Haufler, Ecosystem Management Research Institute, and Kent Fricke, Kansas Department of Wildlife and Parks.

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(CO) David Klute, Liza Rossi; (IA) Todd Bogenshutz, Stephanie Shepherd; (KS) Kent Fricke; (MI) Adam Bump, Jacob Trowbridge; (MN) Jodie Provost, Charlotte Roy; (MO) Tom Thompson; (MT) Heather Harris; (ND) Jesse Kolar; (NE) Bill Vodehnal, John Laux; (OK) Brett Cooper, Kurt Kuklinski; (SD) Travis Runia; (WI) Bob Hanson; (WY) Nyssa Whitford, Zack Walker, and Martin Hicks; (WAFWA) Bill Van Pelt.

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Greater prairie-chicken and sharp-tailed grouse project partners:

Executive Summary

The overall goal of this effort is to develop a range-wide conservation strategy for greater prairie-chickens (GPC) and the plains and prairie subspecies of sharp-tailed grouse (STG) that will expand and coordinate grassland and shrubland conservation efforts using these birds as flagship species. The long-term objective is to develop large blocks of native grasslands and shrublands of sufficient size, arrangement, and quality to support populations of GPC and STG and associated grassland and shrubland wildlife species. Once completed, it is the goal of the IWG that the project deliverables be used by agencies, industry, NGOs and decision makers to facilitate conservation efforts and inform future decisions.

Project objectives and results:

1. **Delineate the estimated occupied range (EOR) for GPC and STG.**
    a. Completed delineation of range for GPC and STG
    b. STG range delineation includes Canadian extent.
2. **Identify focal areas across ranges that are sufficient to maintain viable populations.**
    a. Priority areas were identified in 8 of the 13 states
        i. ND, SD, NE, KS, MN, IA, WI, MI
    b. Total priority area = 179,737 sq. km, mean size is 988 sq km.
3. **Identify additional species that will benefit from the grassland and shrubland conservation efforts for GPC and STG.**
    a. 113 different SGCN species identified that shared habitat with GPC/STG
    b. SGCN details 10 mammals, 27 birds, 13 reptiles, 8 amphibians, and 55 insects.
    c. Report details which SGCN species are present in each state
4. **Develop recommendations for policies, management priorities, and funding needed to effectively reverse population declines of prairie grouse and associated species.**
    a. Increase delivery of conservation efforts into strategically located priority areas.
        i. Conservation, management, restoration depending on needs/availability.
    b. Establishing core areas consisting of 50,000-acre blocks of high-quality habitat distributed across the range of each species was deemed essential to assure long-term viability of each species.
5. **Develop and recommend consistent monitoring approaches for GPC and STG.**
    a. State methodologies were compiled, assessed, and recommendations made to compile observation data every 3-5 years to track range and population trends.
6. **Develop an innovative habitat assessment tool for GPC and STG.**
    a. A project web page and web mapping application are being finalized to share the report and provide users web interface with the GIS data.
    b. Final products of the effort were shared with WAFWA for inclusion the WAFWA Crucial Habitat Assessment Tool (CHAT).

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Introduction

The Great Plains of North America were once covered with grasses and colorful wildflowers. However, since the early 1900s, these grasslands and many of their associated species have experienced significant declines, primarily due to habitat loss from multiple sources (Samson et al. 2004, Koper et al. 2010, Fuhlendorf et al. 2012). Additionally, shrublands of the Lake States have seen major alterations since European settlement due to conversions and lack of adequate disturbance processes. Since the 1990s, conservationists have launched numerous initiatives designed to conserve and restore grassland and shrubland ecosystems. State Wildlife Action Plans address long lists of grassland species in need of conservation and numerous land trusts and conservation organizations administer easement programs to preserve grasslands from development or conversion to other uses. Some foundations also have offered funding for grassland conservation efforts (Haufler et al. 2018). Despite considerable conservation efforts, declines in grassland habitats and threats to populations of grassland-associated species continue, highlighting the need for more effective conservation implementation if these trends are to be reversed.

Prairie grouse are species with relatively large home ranges and their populations require vast acreages of grassland/prairie to sustain populations. The amounts and qualities of available habitat within the Great Plains are the primary determinants of the sizes and viability of prairie grouse populations. Managing for quality habitats, while maintaining and restoring habitat quantity, are likely the two most important factors for long-term sustainability of prairie grouse populations. Prairie grouse, unlike many grassland birds, are year-round residents of the prairie and their presence indicates quality grasslands, thus making them flagship species for other grassland wildlife. In addition, their habitat depends on ecosystem conditions that are some of the most susceptible to alteration by post-European settlement changes. As charismatic and desired game species, these flagship species can enhance public interest as well as financial support for broader conservation efforts (Caro 2010). Two grouse species can play key roles in guiding grassland restoration efforts in the Great Plains due to their broad spatial and habitat requirements, aesthetic breeding displays and status as game species desired by hunters and supported by state wildlife agencies. The greater prairie-chicken (*Tympanuchus cupido*) can serve as a flagship species for tallgrass and mixed grass prairie ecosystems, while plains (*T. phasianellus jamesi*) and prairie sharp-tailed grouse (*T. phasianellus campestris*) can serve a similar role for northern mixed grass prairies and northern shrublands.

Project Goal and Objectives

The goal of this effort was to develop a range-wide conservation plan for greater prairie-chickens (GPC) and the plains and prairie subspecies of sharp-tailed grouse (STG) that will expand and coordinate grassland and shrubland conservation efforts using these birds as flagship species. The long-term objective is to develop large blocks of native grasslands and shrublands of sufficient size, arrangement, and quality to support populations of GPC and STG and associated grassland and shrubland wildlife species. Once completed, it is the goal of the IWG that the project deliverables be used by agencies, industry, NGOs and decision makers to facilitate efforts and informs decisions into the future. This project aims to assist future efforts with coordinated delivery of conservation actions into core areas, the creation of state and rangewide population and/or habitat restoration goals for GPC and STG, connecting fragmented populations, and expanding the population distribution.

Project Objectives:

- Delineate the estimated occupied range (EOR) for GPC and STG.
- Identify focal areas across the species' ranges that are sufficient to maintain viable populations.
- Identify additional species that will benefit from the grassland and shrubland conservation efforts for GPC and STG.
- Develop recommendations for policies, management priorities, and funding needed to effectively reverse population declines of prairie grouse and associated grassland species.
- Develop and recommend consistent monitoring approaches for GPC and STG.
- Develop an innovative habitat assessment tool for GPC and STG.

Threats to Grassland Habitat

The primary threats to GPC and STG populations are habitat loss, fragmentation, and reductions in habitat quality (McNew 2010). Habitat loss has resulted from conversion of grasslands to other landcover types such as row-crop agriculture, urban development, energy developments, and invasion of woody species. These impacts have reduced the overall area of grasslands and shrublands available to grouse species while also fragmenting many remaining areas of grasslands or shrublands into small patches. Many of these patches are too small to support sustainable populations and many are isolated from other patches. Remaining areas of grasslands have been further impacted by reductions in habitat quality. Common rangeland management, grazing practices, and the lack of periodic fire have reduced vegetative diversity and the amount of structure necessary to meet the needs grouse and many other grassland species.

Threat Analysis

Greater prairie-chickens and sharp-tailed grouse need large areas of contiguous and heterogenous grasslands throughout their life, requiring different grassland vegetation structure for breeding, nesting, brood-rearing and winter survival. Loss and degradation of habitat are therefore the two biggest threats to persistent, healthy populations of these species.

Loss or Degradation of Habitat through Conversion

While most of the grassland loss across the Great Plains happened rapidly and at a large scale throughout the last century, the conversion of grassland to other uses is still occurring. The most recent Plowprint report by the World Wildlife Fund (2021) estimated that in 2019, 2.6 million acres of grass were plowed across the Great Plains, with 600,000 of those acres being in the Northern Great Plains where the majority of Greater Prairie-chicken and Sharp-tailed grouse reside. It is estimated that 70% of the destruction was to plant these acres to corn, soybeans or wheat.

Loss and fragmentation of habitat that results from the activities described below, has reduced the amount of suitable habitat available for prairie grouse. The Eastern, and particularly Southeastern portion of the range now have isolated populations with little to no gene flow. Highly isolated Greater Prairie-chicken populations in Illinois and Iowa showed very low levels of genetic diversity that in some cases were having a demonstrably negative impact on population fitness (Johnson 2009, Bouzat et al. 1998)

Agriculture

While the introduction of agriculture at a small scale in the late 1800s enhanced habitat for prairie grouse populations, the increasing rate of conversion and the decline in the diversity of agriculture being implemented quickly devastated prairie grouse habitats especially in the Southeastern range of the Greater Prairie-chicken. As technology advances and demand increases, agriculture is utilizing more marginal acres with poorer and dryer soils, threatening the Western ranges. Programs such as the Conservation Reserve Program has in the past helped bring more land back to grass from agriculture; but these conversions are not permanent and driven by economics (Drummond 2007).

The development of agriculture not only removes habitat from the landscape but also increases the grassland fragmentation. Some estimates are that prairie-grouse require 25,000 or more acres of contiguous grassland to support a viable and sustainable population (Vodehnal and Haufler 2007, Prose 1985). Greater Prairie-chickens thrive where cultivation makes up only about 20-30% of the landscape (Svedarsky et al. 2000) and grassland is upwards of 65-70% (Ryan et al. 1998). In addition, areas with higher levels of agriculture can also be more attractive to other kinds of development, such as wind farms (Williams and Zivkovic 2016), which can then fragment habitat further.

Other Forms of Conversion: Urban Development, Energy Development

- Wind energy : Several studies have examined the effect of wind energy development on prairie grouse. In addition to habitat fragmentation that might result, the presence of wind turbines may have a negative effect on the lekking behavior of prairie grouse. Leks closer to a turbine were less likely to persist (Winder et al. 2015) and lek attendance and behavior was altered for males (Smith et al 2016). In later life stages, such as nesting, wind turbines did not appear to have a significant impact (Harrison et al. 2017, McNew et al. 2014).
- Raynor (et al. 2019) found that there was no selection or avoidance based on wind turbines, and that acoustics were not a factor in habitat selection by GPC. Overall, physical landscape changes appear to be more important than altered acoustic environments in mediating GPC habitat selection (Raynor et al. 2019).
- Oil and Gas: In the Great Plains, oil exploration began as early as the late-1800s and commercial production began as early as the 1880s. By 1920, oil and gas production had dramatically increased. As demand for energy has continued to increase nationwide so has oil and gas development in the Great Plains. Oil and gas development involves activities such as surface exploration, exploratory drilling, field development, and facility construction, as well as access roads, well pads, and operation and maintenance. Associated facilities can include compressor stations, pumping stations, and electrical generators. Activities such as well pad construction, seismic surveys, access road development, power line construction, and pipeline corridors can all result in direct habitat loss by removal of vegetation. As documented in other grouse species, indirect habitat loss also occurs from avoidance of vertical structures, noise, and human presence

(Weller *et al.* 2002, entire), which all can influence GPC behavior in the general vicinity of oil and gas development areas. These activities can affect GPC by disrupting reproductive behavior (Hunt and Best 2004, p. 41) and through habitat loss and fragmentation (Hunt and Best 2004, p. 92).

- Numerous studies demonstrate the impacts that anthropogenic features, such as oil and gas wells, have on the lesser prairie-chickens by affecting the behavior of individuals and altering the manner in which they use the landscape (Hagen *et al*. 2011, pp. 69–73; Pitman *et al*. 2005, entire; Hagen 2010, entire; Hunt and Best 2004, pp. 99–104; Plumb *et al.* 2019, pp. 224–227; Sullins *et al.* 2019, pp. 5–8; Peterson *et al.* 2020, entire). Less research is available for GPC. A study of LPC in the Shinnery Oak Ecoregion found that petroleum production was not compatible with healthy populations of LPC (Hunt and Best 2004, p. 99).
- Urban Development: Models developed by Sohl et al. (2012) suggest that Urban development is not a high threat in the area of the Great Plains occupied by Greater Prairie-chickens and Sharp-tailed Grouse, especially when compared to agriculture. More of a concern may be ancillary elements of human expansion such as roads, fences and powerlines.

Fragmentation by Roads, Fences and Powerlines

The addition of roads, fences, and powerlines to a grassland landscape can shift prairie grouse use of an area as well as cause direct mortality through collisions. Wolfe et al. (2007) found that collisions with fences was the second highest cause of mortality in one Lesser Prairie-chicken population with collisions with powerlines and cars also appearing on the list. In addition, several studies have found that lek location is often negatively correlated with the density of roads and the presence of powerlines. Planning for these potentially detrimental elements in areas that support prairie grouse is also a challenge as lek locations can be dynamic (Hovick et al. 2015).

Degradation of Habitat Through Poor Management

Loss of grassland habitat to some other type of land use is the biggest threat to prairie grouse persistence but there are also processes happening that are negatively impacting the grassland habitat that still remains on the landscape. Prairie Grouse are highly dependent on there being large blocks of this grassland habitat, containing variable levels of vegetation structure compatible with different grouse life stages and needs.

For example, lack of adequate cover during nesting and brood-rearing can lead to high rates of nest and young predation (McNew et al. 2012a, McNew et al. 2014). While trees can be used by prairie grouse during certain times of the year, they are actively avoided during lekking, nesting and brood-rearing because of an increased risk of predation (Svedarsky 1979, Prose 1985, Niemuth 2003, Svedarsky et al. 2003, SDGFP Division of Wildlife 2022). Furthermore, woody encroachment can be so pervasive, such as the expansion of *Juniperus spp.*, that the integrity of grassland ecosystems becomes compromised (Engle et al. 2008, Miller et al. 2017).

For the remaining grasslands to provide the needed complex vegetative structure and also avoid succession into a more wooded habitat, disturbance through habitat management is necessary. Habitat degradation can occur if management is absent, mis-timed or applied improperly.

Altered Fire Regimes

Prescribed fire is an important management tool in grassland management that is necessary for controlling woody encroachment as well as maintaining habitat quality for prairie grouse. The absence or misapplication of fire can have many detrimental effects. Burning at the wrong time of year can lead the grassland to become homogenous, dominated by grass which is not as supportive of prairie grouse (Svedarsky et al. 2003). Too frequent burns (such as annual), especially paired with grazing as in the Flint Hills of Kansas, can also create grasslands that are less able to support grouse (Robbins et al. 2002, Svedarsky et al 2003).

Early settlers of the Flint Hills of Kansas and northern Oklahoma observed that cattle selected forage from burned range more readily than unburned range and that steers gained weight faster on burned range than unburned range (Higgins et al. 1989b). More recently, the management practice of spring burning in the Flint Hills has been intensified (100% of pastures) to improve forage value and utilization by livestock (Applegate and Horak 1999). Consequently, minimum nesting cover values for GPC often are lacking in the Flint Hills of Kansas and Oklahoma due to a combination of annual spring burning and intensive grazing stimulated by the burning regime. “Good” range management is good for livestock production in this setting, but is detrimental to prairie grouse because there is “virtually no cover for spring nesting” (Clubine 2002:2). Clubine (2002) reported that patch burning and grazing, which involves rotationally burning a third of a parcel, offers ranchers an environmentally sensitive alternative which doesn’t greatly diminish livestock yields. This could dramatically improve nesting conditions, however, by leaving as much as 2/3 of the range unburned throughout the nesting season.

However, while the misuse or high intensity use of fire is a problem on managed lands at more local scales, a much broader threat is the absence of fire. Prescribed fire likely had a key role in creating the grassland landscapes in the Midwest and Great Plains, and its loss in much of the remaining grassland has led to significant grassland loss and fragmentation (Engle et al. 2008, Falkowski et al. 2017). The loss degradation and fragmentation of habitat to woody encroachment is one of the key largescale threats to grouse and should be a priority for conservation efforts (Fuhlendorf et al. 2012).

Woody encroachment is a common problem, particularly in the eastern portion of the range. This has created a particularly precarious situation for sharptails in Wisconsin. Kumlien and Hollister (1951:48) commented on sharp-tails, "At the present time (1903) it is found in any numbers only in isolated sections of the central and northwestern part, and is probably doomed to speedy extinction in the state." Grange (1948: 235-236) also noted the precarious status of the sharp-tail. "The sharptail in Wisconsin is similarly doomed as a hunted species but is apt to persist longer as a rare species. It may continue to survive another five decades, but again in the absence of adequate management techniques or of wide-spread fire, it inevitably will go on the rare or non-hunted bird list." Hamerstrom et al. (1952) called for action to prevent the disappearance of sharptails "into the shadows." Since the time of these earlier surveys, Wisconsin has continued to lose sharptails because of habitat changes as has adjacent Upper Michigan (Ammann 1963).

Grazing

Much of the privately-owned grassland in the Midwest and Great Plains is used as pasture. Grazing can have a beneficial impact on grassland and has important effect on vegetation composition and height which are key components of prairie grouse habitat (Svedarsky et al. 2003). Season long high stocked grazing, which is a common approach, is detrimental to prairie grouse nesting success (Kobriger et al. 1988, Robbins et al. 2002, Kraft et al. 2021).

Dettenmaier et al. (2017) found in a meta-analysis that overall, current grazing methods had a negative impact on prairie grouse. There are grazing methods such as rotational or patch-burn grazing, which lead to a more heterogenous grassland, that support prairie grouse habitat while also producing livestock (McNew et al. 2015). Some studies, however, have suggested that in some aspects the benefit from having large areas of contiguous grassland for cattle outweighs the slight negative impacts of detrimental grazing practices (Milligan et al. 2020).

Climate Change and Extreme Weather Events

Some of the threats that prairie grouse face are issues that cannot be solved at the local or even national scale. In the Midwest, two of the effects of climate change are changes in temperature and precipitation, both of which impact prairie grouse and their habitats.

Both too little and too much precipitation at the wrong times of the year can have negative impacts on the reproductive success of grouse (Flanders-Wanner et al). The eastern portion of Prairie-chicken and sharp-tailed grouse ranges has heavier precipitation and a trends toward increasing precipitation in the spring (U.S. EPA 2017) which can negatively impact lekking and nesting success. In the western part of the range it is trending towards drier summers which decreases the success of brood rearing.

Temperature can also have an impact on prairie grouse, with evidence that prairie-grouse choose cooler locations for nesting (Hovick et al 2014b). Heterogenous grasslands provide more variability in temperature, so supporting these types of landscapes can provide some mitigation from rising temperatures caused by climate change (Hovick et al. 2014b).

Finally, climate change can also increase the local variability of weather and lead to more extreme weather events such as flooding, tornados, hale, High intensity early stocking flint hills violent thunderstorms etc. While it is difficult to enumerate the magnitude these impacts may have on prairie grouse, events such as these likely will increase variability in population stability and increase the risk of local extinctions.

Greater Prairie-Chickens

Two male GPC displaying.
Photo by Greg Kramos

Two male GPC sparring.
Photo by Greg Kramos

GPC Background and Distributions

At the turn of the century, the population of GPC was estimated to be less than 500,000 individuals (Westemeier and Gough 1999). Of these, about 75% of the population occurred in three of 17 states that constituted the historical range of the species in Kansas, Nebraska, and South Dakota (Westemeier and Gough 1999). Currently, only two small, isolated, remnant GPC populations remain east of the Mississippi: one in southern Illinois and the second in central Wisconsin. The loss of suitable grassland habitat, primarily to farming and woody plant encroachment has resulted in the extirpation of the species throughout much of its historical range. GPC are currently listed on the IUCN Red List as "Near Threatened" and are listed as a species of concern by several state wildlife management agencies in their state wildlife action plans (Rowheder 2015).

Wildlife populations that have undergone large decreases in population in portions of their range—such as GPC—are prone to decreased genetic variation (Nei et al. 1975, Maruyama and Fuerst 1985). This loss sometimes results in the need for intensive management actions such as translocations from larger populations (e.g., Wisconsin and Illinois) to increase genetic diversity to maintain genetically viable populations.

Recent genetic research with greater prairie-chickens has provided a better understanding of the number of GPC necessary to sustain viable populations. However, setting minimum quantities to sustain genetically viable populations does not consider annual catastrophic events that often affect populations. Total local annual recruitment failures have been documented in several GPC populations (Toepfer 2007). Optimal management security, genetic and catastrophic, for GPC will only be achieved with populations 2-3 times the genetically calculated minimum number. Therefore, to maintain a genetically healthy minimum population size of 2,500 birds, an isolated greater prairie-chicken population requires a "minimum" breeding population of 1,250 cocks or 125 display grounds with 10 cocks per ground (Walk 2004). However, 10,000 individuals or 500 booming grounds would be needed to withstand 2 years of reproductive failure at 50% annual survival. A prairie grouse population of 500 display grounds would require about 450 acres per ground or 225,000 acres (350 square miles) of biologically interconnected grassland reserves to sustain genetic diversity in an isolated population (Toepfer 2003).

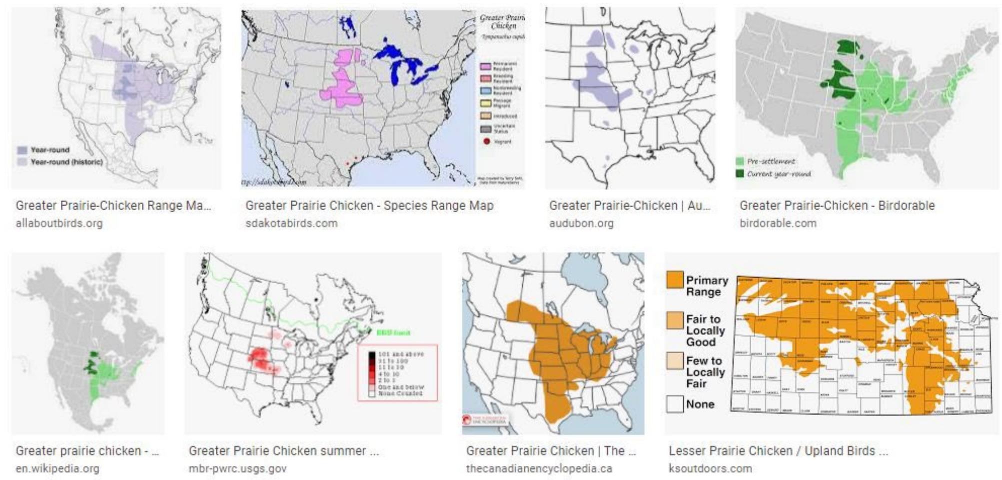


Figure 1. Results returned from a Google search for “greater prairie-chicken range”.

The distribution of display grounds and distance between them provides another approach to assess the area necessary to sustain a viable prairie grouse population. The mean distance between greater prairie-chicken booming grounds in Minnesota and Wisconsin is about 1.2 miles. This distance creates an exclusive area per booming ground of 1.1 square miles. This would mean that 10,000 birds (e.g., 500 booming grounds) would cover an area of 550 square miles or 350,000 acres to support viable greater prairie-chicken populations. Hamerstrom et al. (1957) indicated that GPC populations occurred on a sustainable basis in areas with a minimum of 33% relatively undisturbed grassland. This would require about 115,500 acres (180 square miles) of permanent grass habitat within this area to maintain a viable—but isolated—GPC population.

GPC Leks

Greater prairie-chicken lek locations have been evaluated in relation to landcover, land use, and habitat quality. Kansas GPC lek location models found elevation to be the most influential variable in predicting lek locations (Hovick et al. 2015b). In addition to elevated areas, lek locations were associated with low tree cover and low road density, near tallgrass prairie patch edges in recently burned patches in Oklahoma (Hovick et al. 2015c). Regarding land use, GPC lek occurrence appears to be negatively related to agricultural fields and crops. Winder et al. (2015) observed decreased rates of lek persistence for leks located in agricultural fields, while Hiller et al. (2019) reported that radiomarked GPC distribution probabilities were greater in areas more distant from center-pivot irrigation locations, proximate to wet meadows, and at moderate distances from crop fields in the Nebraska Sandhills region.

Proximity to wind energy development appears to influence GPC vocalizations at lek sites. Whalen et al. (2018) reported that boom and whoop sound pressure levels were higher (boom 2% higher; whoop 5% higher), boom duration was 3% shorter, whine fundamental frequency was 11% higher, and biphonations in cackle vocalizations occurred 15% less often at Nebraska leks within 1,000 m of a wind energy facility.

GPC Nesting Habitat

Greater prairie-chicken nesting site selection appears to be driven by landscape and habitat factors, and avoidance of anthropogenic features. For example, Nebraska GPC nest site selection and nest survival results indicated an avoidance of roads (74% of GPC nesting 700 m or more from roads) and in habitats with twice the visual obstruction and residual standing dead vegetation of random points (Harrison et al. 2017). The same study found little evidence of an effect of a wind energy facility on GPC nest site selection or nest survival (Harrison et al. 2017). Other studies similarly report GPC nest site selection is related to greater visual obstruction and vegetative canopy, nests are located farther from roads and edges, and occurred in areas with a greater proportion of grassland when compared with random points (McNew et al 2013a). Selected nest sites have abundant grass cover and moderate levels of forb cover and standing litter at upper elevations (Matthews et al. 2013). Additionally, Hovick et al (2015b) found GPC chose nest sites that maximized time since fire while minimizing tree cover and distance to leks in Oklahoma's tallgrass prairie, and that solar radiation negatively affected nest survival.

Nest survival of GPC is influenced by habitat and environmental conditions. GPC nest survival was greater in CRP fields and greatest for nests with abundant grass cover and forb cover and moderate levels of residual litter (Matthews et al 2013). In addition, Matthews et al. (2013) reported peak nest survival when nests were initiated in late May. Londe et al. (2020) stated, "Daily nest survival was primarily influenced by conditions experienced during incubation with daily nest success declining in years with wetter than average springs and during extreme precipitation events. Daily nest survival also declined under higher maximum daily temperatures, especially in years with below-average rainfall. Greater prairie-chickens began nesting earlier and had smaller clutch sizes for initial nests and renests in years with warmer temperatures prior to the nesting season. Additionally, incubation of nests started later in drought years, indicating carry-over effects in greater prairie-chicken reproductive behaviors." Studies in several states have yielded similar in informative measurements of the vegetation characteristics at nest sites (Table 1).

Table 1 Reported vegetation characteristics at nest sites across three states.

	Grass	Forbs	Shrubs	Bare	VOR
Kansas*	46-57%	11-25%	3%	9-13%	24-30 cm
Nebraska**	29-31%	3-5%	2-6%	4.5%	9-21 cm
Oklahoma***	-	41.85%	-	-	-

* McNew et al. 2013b and McNew et al. 2015
** Andersen 2012 and Harrison 2015
*** Hovick et al 2015a

GPC Brood Habitat

Following successful nesting, GPC brood habitat has been studied. Hens with broods in the Nebraska Sandhills selected upland, rolling hills sites that had relatively thick vegetation with relatively high horizontal vegetation structure (Anderson et al. 2015). Also in the Nebraska Sandhills, forb cover is generally believed to have a positive effect on brood survival (Anderson et al. 2015). Studies by Anderson (2012) and Mathews et al. (2013) in Nebraska found brood sties had 40% grass, 4% forbs, 5% shrubs, 13%

bare, and had a visual obstruction height (VOR) of 6-24 cm. Successful Minnesota broods spent significantly less time in grass-dominated habitats and more time in mixed grass/forb habitat than unsuccessful broods (Syrowitz 2013). Northwest Minnesota broods appeared to use habitats with increased invertebrate resources, although invertebrate biomass was not related to forb occurrence (Syrowitz 2013).

GPC Seasonal Habitat Use

Habitat selection by GPC varies across seasons. Spring through fall GPC selected for core prairie habitat over agriculture, and birds avoided wooded areas (Carlsson et al. 2014). Differences in niche selection and individual specialization between males and females was smaller in spring suggesting they may exhibit similar feeding behaviors in lekking season (Blanco-Fontao et al. 2013). Females showed broader niches and higher individual specialization than males in winter and autumn (Blanco-Fontao et al. 2013).

GPC Home Range and Movement

There have been a number of studies that have assessed the home range of the GPC. Overall ranges extended between 190 – 2,070 hectares for females and averaged 153 hectares for males (Augustine and Sandercock 2011, McNew et al. 2013b, Kirschenmann 2008, Robel et al. 1970, Kemink and Kesler 2013, Winder et al. 2014). Breeding ranges were found to have a mean area of 21 km^2, while non-breeding home ranges extended to 34 km^2 (Winder et al 2016)

GPC Optimal Habitat

GPC generally avoid wooded areas and row crop agriculture (Raynor et al. 2019). Restored grasslands can be important to decreasing habitat fragmentation within a landscape. Conservation Reserve Program (CRP) improves grassland contiguity when applied strategically in fragmented landscapes (Adkins et al. 2021).

Within intact grasslands, prescribed burning frequency is important to maintaining and creating GPC habitat. In the Flint Hills of Kansas and Oklahoma, patch-burn grazing management approaches yielded increased quality and quantity of nesting sites (McNew et al. 2015) and female survival rates were higher (Winder et al. 2018) than properties managed with annual burning and intensive early cattle stocking (a management approach unique to the Flint Hills of Kansas and Oklahoma). Moreover, females that selected habitats associated with intensive management had increased mortality risk and were particularly vulnerable to avian predators, whereas females that selected habitats created by patch-burn grazing experienced lower overall mortality risk but were more vulnerable to mammalian predators (Winder et al. 2018). Carlson et al. (2014) recommended management for GPC habitat focus on the expansion of core protected patches of prairie to promote elevated survival and increase probability of conservation success.

Sharp-Tailed Grouse

Sharp-tailed grouse
Photo by Nebraskaland Magazine

Sharp-tailed grouse
Photo by Nebraskaland Magazine

STG Background and Distributions

The sharp-tailed grouse (*Tympanuchus phasianellus*) is a resident of primarily brushy grassland plant communities consisting of various amounts of woody vegetation and belongs to the Order Galliformes, Family Phasianidae, and subfamily Tetraoninae (Aldrich 1963, Prose 1987). Seven subspecies are documented of which one is extinct (Ridgway and Friedmann 1946, Miller and Graul 1980, Dickerman and Hubbard 1994). Sharp-tailed grouse populations depend on comprehensive conservation actions that focus on understanding habitat requirement of the species, utilizing an ecosystem diversity approach to conservation, and implementing conservation strategies at a landscape level. The focus of this conservation plan is addressing the issues and conservation needs of the prairie and plains subspecies of the central Great Plains.

The prairie STG (*T. p. campestris*) occurs from east-central Saskatchewan, southern Manitoba, and western Ontario, south across the Upper Peninsula of Michigan, Minnesota, and Wisconsin (Connelly et al. 1998) and inhabits oak (*Quercus* spp.) savannas and early succession stages of eastern mixed deciduous-coniferous forests (Prose 1987). The plains STG (*T. p. jamesi*) occurs in the Great Plains east of the Rocky Mountains from central and southern Alberta, southern Saskatchewan, and southwestern Manitoba, south to northeast Colorado and Nebraska and inhabits sub-climax brushy grasslands habitats (Connelly et al. 1998). The mix of habitat quality and remote landscapes makes mapping the range of the sharp-tailed grouse a task that has generated a wide range of results (Figure 2).

Sharp-tailed grouse originally occurred in at least 6 Canadian provinces, 2 territories, and 21 states in North America (Aldrich 1963) and were extirpated from 8 states; Connelly et al. (1998) recorded Kansas and Illinois in early 1900s (Miller and Graul 1980), California in 1920s (Starkey and Schnoes 1976), Oklahoma in 1932 (Sutton 1974), Iowa in 1934 (Grant 1963), Nevada by 1952 (Wick 1955), New Mexico by 1954 (Dickerman and Hubbard 1994), and Oregon by 1969 (Olsen 1976). The loss of STG populations in these states added up to an overall range reduction out of the southern and western portions of the historical range.

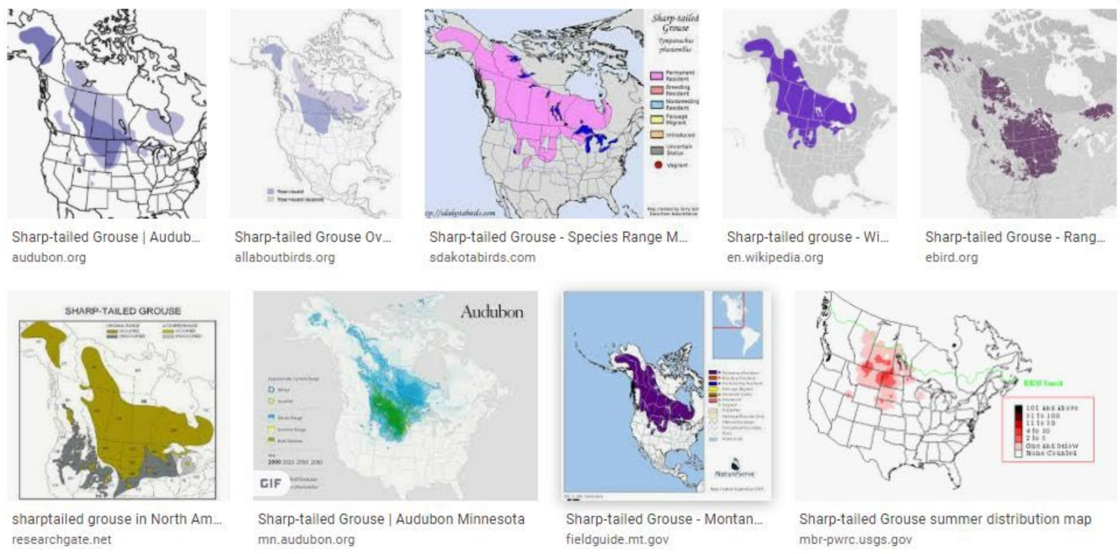


Figure 2. Results returned from a Google search for “sharp-tailed grouse range”.

The prairie subspecies (*T. p. campestris*) occupies less than 10% of its historical range in Michigan and Wisconsin, 30% in Minnesota, and 50-90% of Manitoba and Saskatchewan (Miller and Graul 1980) with the primary cause of decline attributed to losses of preferred oak-savanna habitats in Wisconsin and Minnesota. The population is estimated at between 600,000-2,000,000 birds (Miller and Graul 1980, Johnsgard 1983) with populations stabilized at very low numbers in Michigan and Wisconsin, and populations reduced 53-70% in Minnesota between 1980-1993 (Berg 1990, Dickson 1993). Conversion of sharp-tailed grouse habitat to agriculture is considered the principal cause of distributional losses and population declines while fire suppression inducing succession, and housing development have contributed to population declines (Miller and Graul 1980).

The plains subspecies (*T. p. jamesi*) occupies the most extensive range (Figure 1) of the 6 North American subspecies and is the most secure of the 3 southern species as the species occur as large, contiguous populations throughout most of their range (Miller and Graul 1980). The subspecies is absent from western Oklahoma and Kansas and the range is appreciably shrunk in eastern Colorado (Johnsgard and Wood 1968). Plains sharp-tails occupy less than 10% of their historical range in Colorado, from 10-50% in North Dakota and Wyoming, and greater than 50-90% in Montana, Nebraska, Saskatchewan, and South Dakota (Miller and Graul 1980, Johnsgard 1983). The population of the species is between 600,000-3,000,000 birds, exclusive of the peripheral edges of Manitoba and British Columbia (Miller and Graul 1980). Intensive grazing and conversion of rangeland to cropland are the principal reasons for losses in distribution.

Reintroduction attempts have occurred to return sharp-tailed grouse to its historic range in Colorado from 2004 through 2006, Iowa in 1990 (Jackson et al. 1996), Kansas in 1985 (Rodgers 1992), and Oregon from 1991 through 1997 (Crawford and Snyder 1995, Connelly et al. 1998).

STG Leks

Lek attendance by males during the spring and fall is influenced by weather and photoperiod (Marshall and Jensen 1937, Kermott 1982) with females visiting potential mates on leks between March and July (Connelly et al. 1998). Spacing between leks varies from 1.6-3.5 km (Hillman and Jackson 1973, Kirsch et al. 1973, Rippin and Boag 1974a). Initial peaks in female attendance occur mid- to late April and early May with later peaks occurring for mating for renests due to loss of initial nests (Schiller 1973, Sisson 1976, Kermott 1982, Gratson 1989, Landel 1989, Gratson et al. 1991, Meints 1991). Variations occur with respect to peaks of breeding due to weather and latitude (Edminster 1954).

Vegetation types vary across the large breeding range of sharp-tailed grouse and are usually characterized as dense herbaceous cover and shrubs (Hanson 1953, Sisson 1976, Baydack 1988, Saab and Marks 1992). Bluestems (*Andropogen* spp.), bluegrasses (*Poa* spp.), wheatgrasses (*Agropyron* spp.), and needlegrasses (*Stipa* spp.) are common grasses and rose (*Rosa* spp.), cherry (*Prunus* spp.), serviceberry (*Amalanchier* spp.), snowberry (S*ymphoricarpos* spp.), sagebrush, and hawthorn (*Crataegus* spp.) are common shrubs (Parker 1970, Hillman and Jackson 1973, Sisson 1976, Baydack 1988).

Structural vegetative characteristics common to leks is low, sparse vegetation allowing good visibility and unrestricted movements (Johnsgard 1973). Leks are usually associated with elevated sites, but may occur on lower areas such as mowed wet meadows (Kobriger 1965), cattle tramped areas around windmills (Sisson 1976), low ridges and knolls (Rippin and Boag 1974a, Sisson 1976), muskegs (Hanson 1953, Hillman and Jackson 1973, Baydack 1988, Meints 1991, Tsuji 1992, Giesen and Connelly 1993).

In Manitoba, Baydack (1988) estimated lek vegetation composition of 70% grass, 15% forbs, 15% bare ground, and <1% shrub. The highest elevation was within 500 m, escape cover within 500 m, and perch trees within 400 m from leks. Average distance between leks was 2.2 km. Probability of lek abandonment increased when tree cover exceeded 56% and grassland coverage decreased below 15% (Berger and Baydack 1992).

In Minnesota, Berg (1997) reported $\geq$0.1 ac of grass, forbs, bare ground, and no shrubs on the lek, with distances from the lek to scattered brush, dense brush, and trees of at least 179, 252, and 275 m, respectively. Leks were often on bare, grassy or sparse shrubland on a rise or hill (Berg 1999).

In Wisconsin, wild hay meadows and marshes were frequent lek locations (Grange 1948). Abandoned fields, cultivated fields, and less commonly upland grassland, peat burns, and clover fields were also used. Ammann (1957) noted that in the upper peninsula of Michigan, within 1 mi^2 of leks, at least 6-10% should be open. Of 95 leks, 27 were on cultivated lands and 68 on wildlands. Just 35% of the leks had woody cover and it was rarely >30% of the area. Favored sites appeared to be low or sparse vegetation with good visibility and 47% were elevated.

STG Nesting Habitat

Nesting and brood-rearing generally takes place within 3.2 km of the lek (Kobriger 1965, Gratson 1988, Meints 1991) and the distance from nest site to nearest lek ranges from 0.4-1.8 km (Artmann 1970, Christenson 1970, Schiller 1973, Kohn 1976, Kobriger 1980, Bergerud and Gratson 1988, Meints 1991) and hatching peaks based on immature molts of hunter killed birds range from 25 May to 22 June (Ammann 1957, Pepper 1972, Hillman and Jackson 1973, Sisson 1976).

Nesting cover for prairie STG tends to be shrubbier and less grassy than that of plains sharp-tailed grouse (Pepper 1972, Prose 1987). Berg (1999) reported that STG in Minnesota typically nest in grass or next to a brush clump, a stump or other protective cover. Females nested under or close to shrubs or small trees if available, or in thicker and taller residual vegetation (Pepper 1972). Connelly et al. (2020) summarized studies concluding structurally diverse habitat provides high quality nesting areas and that sharp-tailed grouse nest in relatively heavy cover, often under a shrub in vegetation ≥30 cm high with dense foliage.

Nesting cover for plains STG tends to be grassier and less shrubby than that of prairie STG of the Great Lakes States (Pepper 1972, Prose 1987). Females nested under or close to shrubs or small trees if available, or thicker and taller residual vegetation (Pepper 1972, Kohn 1976, Sisson 1976, Meints 1991, Roersma 2001, Manzer 2004, Goddard et al. 2009). Moss, grasses, sedges, ferns, herbaceous plants, leaves from woody species, and breast feathers generally lined the nest bowl (Gross 1930). Berg (1999) reported that sharp-tailed grouse in Minnesota usually nest within 0.5 mile of the lek. Shartell (2017) reported that in east-central Minnesota, nests averaged 1.2 km from the lek where females were trapped, but ranged from 0.6-3.8 km from the lek. In Wisconsin, Hamerstrom (1939) found most nests were located <1 mi from the nearest lek.

Shartell (2017) observed that nest sites in east-central Minnesota included a wide variety of cover types and vegetation structure, but had greater overhead cover, shrubs at the nest, lower vegetation density at 0.5-1.0 m height measured at 15 m from the nest, lower soil moisture, and greater vegetation density at 0-0.5 m height measured at 2 m from the nest. Successful nests tended to have more overhead cover and higher vegetation density than unsuccessful nests. Artmann (1971) found nests at the base of 2-4 foot tall willow.

In Wisconsin, sharp-tailed grouse prefer to nest in structurally diverse habitat, dominated by dense herbaceous cover and often under or near shrubs or small trees (Marks 2007, Connelly et al. 2020). The amount, height and density of residual cover appear to be an important factor in nest site selection (Marks 2007). Vegetation at the nest site is ≥30 cm in height with shrub cover ≤1.2 m high near the nest (Connelly et al. 2020). In Wisconsin, Hamerstrom (1939) observed cover types for 17 nests, including 8 at the edge of marshes, brush, or woods in brushy or woody cover, 3 in small openings of dense brush, 2 in openings or edges of jack pine-scrub oak woods, 2 in grass meadow, 1 in dry marsh, 1 in a mix of scattered brush, trees and marsh. Cultivated areas were apparently avoided for nesting. In northwest Wisconsin, nests were under or near shrubs (Connelly et. al. 2020). Vegetation at nests was >30 cm in height with shrub cover ≤1.2 m high in the nest area. Nests were located 0.4-1.8 km from the nearest lek, with a maximum distance of 2.2 km. In the late 1990s, the highest and densest populations of sharp-tailed grouse in Wisconsin were found in a complex of clear-cuts in southeastern Douglas County (Niemuth and Boyce 2004). Leks were clustered on the landscape, with distance to nearest neighboring lek shorter for leks than unused points. Leks were characterized by higher proportions of grass and shrub cover classes, lower proportions of forest, fewer forest patches, and greater distances to forest edge relative to unused points. Number of sharp-tailed grouse attending leks was positively associated with recently created habitat and proportion of grass cover in the landscape.

Sharp-tailed grouse in Michigan chose nest sites varying from open to 75% shaded (Amman 1957). Most were protected by overhead cover or within a few feet of cover. Of 29 nests, none were >10 ft from brushy or woody cover. Of 10 nests studied, 6 were in open aspen, 1 in cutover pine, 1 in open marsh, and sites averaged 43% shrub cover 3-6 ft high, and 4% tree cover >6 feet. Of 7 additional nests, 4 were at the base of a small tree or bush and 1 each in a hayfield, on an aspen-birch ridge, and in heavy grass-sweet fern site. Associated shrubs and trees were chokecherry, willow, alder, aspen, spruce, and juneberry. Peterle (1954) found that nesting habitat in Michigan had 42% cover by shrubs 1-2 m in height. Ammann (1957) observed nests near small trees or thick residual cover.

Connelly et al. (1998) summarized by stating that generally structural diversity of habitat provides high quality nesting areas and sharp-tails nest in relatively heavy cover, often under a shrub in vegetation at least 30 cm high with dense foliage. Christenson (1970) found in North Dakota that females tended towards uniform vegetation at least 30.5 cm tall or patchy vegetation at least 35.6 cm tall. Pepper (1972) found females to select nest sites based on foliar density rather than height in Saskatchewan, indicating females selected heavier cover within patchy cover landscapes. Manzer (2004) found that nest success increased with greater height of concealment cover within 50 meters of nest sites and nests were more likely to succeed in landscapes with less than 35% crop and sparse vegetation at the 1,600 meter scale.

Kohn (1976) found the average visual obstructive reading (VOR) for vegetation at 40 or 43 nests in North Dakota was greater than 1.5 dm and VORs at more than 75% of the brood locations was greater than 2.2 dm. He concluded that if pasture VORs averaged 1.1 dm in the spring, they would provide some areas of suitable nesting and brood-rearing cover. Prose (1987) concluded that optimal nesting and brood-rearing conditions were realized when residual vegetation was greater than 2.0 dm over the entire area.

STG Brood Habitat

Soon after hatching, broods begin movement towards brood-rearing habitat and summer ranges. Connelly et al. (1998) stated that broods remain close to nesting areas throughout the summer (Marks and Marks 1987, Gratson 1988, Meints 1991) and have daily summer movements of 45-276 m (Schiller 1973, Gratson 1983,1988, Meints 1991). Chicks achieve approximately half their adult body weight by 8 weeks of age and attain nearly complete body growth by 12 weeks (McEwen et al. 1969, Pepper 1972). Broods begin to break up and disperse by mid- to late September and early October (Caldwell 1976, Gratson 1988). Similar to other sharp-tailed grouse habitat, plant species composition at nest sites is less important than vegetation structure, allowing for a wide variety of plants to be observed in nesting habitat and at nest sites.

In Minnesota, brood-rearing habitat of prairie sharp-tailed grouse is similar to nesting cover, except broods prefer burned or lightly grazed habitats with abundant insects and openings for movement (Berg 1999). In fall, birds foraged on small grains and weed seeds in cropands and on fruits and green vegetation in brushlands. Shartell (2017) found hens used brushland, open upland, agriculture, and hayfield in greater proportion than their availability. Brooding hens showed similar use of cover types, with a notable higher use of hayfields. When brooding hens were located in hayfields, the fields were always un-mowed.

Broods seek out areas of abundant forbs and insects, often with high diversity of shrubs and interspersion of cover types (Connelly et al. 1998). These areas include food patches, farm fields, and early successional vegetative sites with dense forb cover (Hamerstrom 1963, Hillman and Jackson 1973, Sisson 1976, Klott 1987, Marks and Marks 1987, Meints 1991). Marks and Marks (1987) reported canopy cover of 9% shrubs, 30% forbs, and 30% grasses during spring and summer use in Idaho.

Ammann (1957) assessed brood-rearing habitat in Michigan and concluded that birds tend to favor more woody cover than that chosen for nest sites, but generally selected areas less than 50% shading by woody species. Artmann (1971) observed that post-hatch vegetation within 0.25 mile of nests was 10-20% brushland and 45% wooded land. Other studies expressed the importance of shrubs and forbs in brood-rearing habitat and that the shrubby component is used more during early stages of brood-rearing and grassland and agricultural areas are used during later stages (Artmann 1970, Schiller 1973). Hamerstrom (1963) concluded that brood habitat should basically be grasslands with some shrubs and trees present; shrubs have higher importance as they not only produce cover, but foraging areas for broods. Brood observations stressed the importance of open areas in forested areas since 80% of the observations were in open situations, 14% in edge situations, and only 5% were more than 50 yards inside woody habitat. Others studies expressed the importance of shrubs and forbs in brood-rearing habitat and that the shrubby component is used more during early stages of brood-rearing and grassland and agricultural areas preferred during later stages (Artmann 1970, Schiller 1973, Sisson 1976). Goddard and Dawson (2009) found that increased travel distances were related to chick mortality, suggesting the importance of having nesting and brood-rearing habitat in close association.

In the Wisconsin pine barrens, Hamerstrom (1963) observed about 190 broods. Eighty percent were observed in the open, 14% in edge, and 5% were >50 yds inside woody habitat. These areas included food patches, farm fields, and early successional vegetative sites with dense forb cover. Brood cover was grassland with some shrubs and trees, but few taller woody species (Hamerstrom 1963). Shrubs were more important than trees since they provided cover and food for chicks. Berry producing shrubs of blueberry, cherries, and juneberries were valuable. Aspen and willows were most useful in small thickets, and catkins in winter. Predominantly open herbaceous brood habitat was used in fall and in winter, woody cover became important. Grange (1948) noted that grasshoppers were a major summer food in Wisconsin. Hamerstrom and Hamerstrom (1951) observed a rather large covey range 100-200 acres in fall with 3-6 such coveys in an area of 1000-1500 acres.

In Michigan, sharp-tailed grouse favored more woody cover for brood-rearing than for nesting, but generally selected areas <50% shaded by woody species (Ammann 1957). During fall, sharp-tailed grouse concentrated on grain plantings near summer habitat while it was available. A variety of grains were taken if available, including wheat, buckwheat, field peas, corn, barley, soybeans, millet, and rye. For night roosting, fairly open and upland cover with good ground cover was preferred over marsh and bog vegetation.

STG Seasonal Use Habitat

Habitat requirements during the fall and winter indicate narrower preferences with greater reliance on riparian areas, deciduous hardwood shrub draws, and deciduous and open coniferous woods (Aldous 1943, Moyles 1981, Gratson 1983, Swenson 1985, Giesen and Connelly 1993, Ulliman 1995). Important woody species for feeding, roosting, and escape cover throughout the range include quaking aspen (*Populus tremuloides*), cherry, serviceberry, snowberry, sagebrush, hawthorn, willow (*Salix* spp.), and birch (Parker 1970, Hillman and Jackson 1973, Sisson 1976, Berg 1990, Meints 1991).

Berg (1990) noted that important woody species for prairie sharp-tailed grouse feeding, roosting, and escape cover include quaking aspen (*Populus tremuloides*), cherry, serviceberry, snowberry, sagebrush, hawthorn, willow (*Salix* spp.), and birch. In Minnesota, sharp-tailed grouse may travel several miles to find food and roost sites, including buds of aspen, willow, and bog birch, and lowland, brush thickets and deep snow for roosting (Berg 1999). In Ontario, (Snyder 1935) paper birch was a primary winter food, supplemented by browse of willow, aspen, blueberry, and mountain ash.

Swenson (1985) found habitat use during winter months was diverse in Montana and varied with snow depth. Hardwood draws and croplands received higher use than grassy uplands and grassy upland use was greatest when snow depth was the lowest. The primary food on upland sites when snow depth was less than 14 cm was sumac, but riparian forest and hardwood draws became critical habitat use areas as greater snow depths occurred (Swenson 1981, 1985). Gregg (1987) observed that increased snow depth caused sharp-tailed grouse to move larger distances in search of winter food and cover. During snowless periods, birds preferred dense marshy vegetation while upland forests and black spruce bogs were used during deep snows. Grange (1948) noted use of snow burrows in marsh or swamp vegetation, or open stands of tamarack or spruce if no snow existed. Paper birch buds and catkins were a primary winter diet, with aspen of secondary importance. Rose hips, hazel buds, and catkins were also important. Hamerstrom and Hamerstrom (1951) observed that the usual winter cruising radius was about 1 mile.

Ammann (1957) observed in Michigan that when snow was deep and grain unavailable, sharp-tailed grouse ate catkins, buds, and twigs of aspen and birch. Sharp-tailed grouse also preferred juneberry, bog birch and hazel, and fruit of mountain ash, sumac, common juniper, rose and black chokecherry. Adequate snow in unusually severe weather may be important.

In Wisconsin, habitat requirements during winter indicate narrower preferences than any other season. Wintering sites often contain a higher shrub component in areas with less snow cover as birds shift from open to forested or marshy cover (Gregg 1987, Sample and Mossman 1997, Connelly et al. 2020). Sharp-tailed grouse often depend on deciduous and open coniferous woods, woody draws and riparian areas characterized by small trees and shrubs (Connelly et al. 2020).

During mild winters, use of crop fields and Conservation Reserve Program fields increase (Meints 1991, Schneider 1994, Ulliman 1995). Swenson (1985) concluded that sharp-tailed grouse used croplands more than hardwood draws during mild winters and used croplands only when near hardwood draws or riparian forests. Approximately 90% of cropland use occurred within 500 m of woody cover and 100% use occurred within 750m. Birds rarely used areas within crop fields that were greater than 50 m from field edges.

STG Home Range and Movement

A minimum viable population is the estimated population size necessary for a given probability of population persistence over a specified length of time, given foreseeable demographic, genetic, and environmentally stochastic variation (Meffe and Carrol 1994, Walk 2004). Sharp-tailed grouse require large open blocks of early successional habitat to support viable populations (Gregg 1987, Temple 1992, Sample and Mossman 1997, Niemuth and Boyce 2004, Niemuth 2006, Connelly et al. 2020). Studies indicate that successful management for sharp-tailed grouse should be conducted at the landscape level and consider brush, open and upland forest cover types (Hanowski et. al 2000).

The exact amount of habitat needed to sustain a viable population likely varies with the landscape. Berg (1999) reported in Minnesota that habitat blocks must be a minimum of 2 mi^2, preferably 4 mi^2 where suitable habitat is remotely scattered. In areas where habitat exists rather uniformly in scattered but connected blocks, open habitat must be at least 0.5 mi^2. Temple (1992) estimated that in Wisconsin, 4000 ha is required to have a 95% probability of a population persisting over 50 years, and that a metapopulation needs to consist of at least 280 birds in each of 5 separate populations. Grange (1948) estimated a minimum of 2000 acre blocks are needed in Wisconsin. Gregg (1987) reported that 50,000 acres is needed to sustain 500 sharp-tailed grouse in Wisconsin. Ammann (1957) estimated that 260 ha units are needed in the upper peninsula of Michigan. Toepfer et al. (1990) suggested that the minimum area necessary for successful reintroduction of prairie grouse is 30 km^2 of which 33% should be undisturbed grass-shrub habitat.

The Minnesota Prairie Conservation Plan strives for habitat patches that are $\leq$6 miles apart with patches that are 9 mi^2 with 40% grassland and 20% wetland within the connectivity zones/corridors (Minnesota Prairie Plan Working Group 2011). The Northwest Sands Habitat Corridor Plan in Wisconsin (Wisconsin DNR 2013) strives for habitat patches $\leq$3 miles apart.

STG Habitat Requirements

Sharp-tailed grouse occupy a broad range of plant communities including steppe, grassland and mixed-shrub vegetation types and vary in subspecies distribution according to tolerance to woodland components of their habitat (Aldrich 1963).

Grange (1948) and Ammann (1957) evaluated habitat characteristics of prairie sharp-tailed grouse in Wisconsin and Michigan, respectively, and Grange concluded that grouse were abundant in grasslands with 25-50% woodland vegetation and Ammann believed 20-40% woodland was preferred (Connelly et al. 1998, Johnsgard 1983). Ammann (1957) believed that sparse ground cover and bare patches should not exceed half of the total area in optimal habitat conditions and suitable open vegetation within woodland areas should not be less than 1 square mile. He believed ideal summer vegetation types to be comprised of 6% open space for display site, loafing and foraging habitat for adult males and broods, and roosting sites for males; 50% open grasslands of various herbaceous structural levels with scattered shrubs/trees not exceeding 20% of the area for resting, dusting, and feeding areas, particularly broods; and 44% of the area in small, alternating series of 10-acre brushy clearings and heavier second-growth timber stands of mixed hardwoods and conifers that serve as a source of winter browse and protection from severe weather and escape cover.

The plains subspecies has different habitat needs than the prairie subspecies as it occurs in semi-desert scrub and relatively dry grasslands. These grouse use grassland, woody cover, and grain fields year-round, but certain vegetation types are important during different seasons (Sisson 1976, Moyles 1981, Nielsen and Yde 1982, Swenson 1985). The plains subspecies that occupy the Sandhills of Nebraska and comparable sand dune areas in North Dakota are essentially independent of extensive tree cover (Aldous 1943, Kobriger 1965, Sisson 1976).

Shrub canopy of 1% is suitable for plains sharp-tailed grouse habitat, but greater than 5% is more desirable habitat (Grange 1948, Janson 1953, Edminster 1954, Brown 1968, Pepper 1972). Populations declined when woody cover became too excessive as Moyles (1981) found displaying male numbers in Alberta declined as the percent area of aspen stands within 0.8 km of leks exceeded 10-15% and numbers were low at 30-45% area of aspens. Caldwell (1976) found sharp-tails abandoned leks when grasslands with 0.8 km of leks were less than 58% of the area. Prose (1987) stated that during a 6-year study in South Dakota, typical sharp-tailed grouse habitat contained 74% grassland, 21% cropland, 3.5% weedy cover, and 1.5% woody cover (Janson 1953, Podoll 1955).

In Minnesota, Berg (1997) suggested an ideal habitat composition consisted of 35% grass-legume, 15% crop, 7% sedge, 25% lowland brush and 13% young aspen/willow/birch. Sharp-tailed grouse were abundant in Wisconsin in grasslands with 25-50% woodland vegetation (Grange 1948). Dense herbaceous cover and shrubs were important habitat components where they occurred (Connelly et al. 2020).

In the upper peninsula of Michigan, Ammann (1957) suggested that 20-40% woodland was preferred, and that sparse ground cover and bare patches should not exceed half of the total area with suitable open vegetation within woodland areas not <1 mi^2. Ammann (1957) suggested summer vegetation types be comprised of 6% open space for display site, loafing and foraging habitat for adult males and broods, and roosting sites for males; 50% open grasslands of various herbaceous structural levels with scattered shrubs and trees not exceeding 20% of the area for resting, dusting, and feeding, particularly for broods; and 44% of the area in small, alternating series of 10-acre brushy clearings and heavier second-growth timber stands of mixed hardwoods and conifers to serve as winter browse and protection from severe weather and escape cover. Porter (2016) found habitat with $\geq$ 50% open land and 40% shrubland was used in Michigan. In the eastern, upper peninsula of Michigan, the best habitat model included open land, upland forest, lowland forest and upland shrub (Porter 2016). The likelihood of sharp-tailed grouse occurrence increased sharply around 50% open land and 40% shrubland respectively, and with lower proportions forest and forested wetlands. Sections with >50% forest had low probabilities of occurrence.

Simulations of habitat improvement indicated greater increases in sharp-tailed grouse viability when modeled in one large patch versus addition of small, scattered patches.

STG Food

Sharp-tailed grouse are primarily herbivorous and survive on a wide variety of buds, cereal grains, herbaceous matter, fruits, forbs, grasses, insects, and flowers throughout the year (Marshall and Jensen 1937, Jones 1966, Harris 1967, Johnsgard 1973, Sisson 1976, Schneider 1994). Preferences vary according to seasons, nutritional needs of birds, species location in ecoregions, winter severity, and food availability. Sisson (1976) analyzed plant material content of the diet in Nebraska Sandhills and found that adult plains STG consumed 99.5% plant material in spring diets, 56.9% in summer, 83.1 in fall, and 99.7% in winter; animal matter composed 41.8% of the summer diet. Dependable and nutritious foods during winter appear to be most critical to survival of grouse and ultimately sustaining populations.

Sharp-tailed grouse rely less on woody mast food during the spring and summer months than they do in winter months (Johnsgard 1983). Connelly et al. (1998) list spring and summer diets containing clover (*Trifolium repens*), fruits, goldenrod (*Solidago* spp.), hawkweed (*Hieracium canadense*), grasses, grass seed, rose, dandelion (*Taraxacum* spp.), corn, gromwell (*Lithospermum* spp.), smartweed (*Polygonum* spp.), alfalfa (*Medicago* spp), Oregon grape (*Berberis repens*), goatsbeard (*Tragopogon dubius*), wheat, yarrow (*Achillea millefolium*), dock (*Wyethia amplexicaulus*), sagebrush buttercup (*Ranunculus glaberrimus*), ants (Hymenoptera: Formicidae), crickets (Orthoptera: Gryllidae), moths (Lepidoptera), grasshoppers (Orthoptera: Locustidae), and beetles (Coleoptera) (Marshall and Jensen 1937, Grange 1948, Jones 1966, Parker 1970, Hillman and Jackson 1973, Sisson 1976).

Jones (1966) concluded that prairie chickens relied more heavily on insect and animal foods during summer than do sharp-tailed grouse. Grange (1948) and Hillman and Jackson (1973) found grasshoppers to be a major component of the summer diet while Edminster (1954) estimated that insects comprised 10-20% of adult summer diet. Kobriger (1965) found juvenile grouse less than 10 weeks of age consumed principally insects and the bulk of the biomass was short-horned and long-horned grasshoppers, beetles, and ants. At 12 weeks of age, the juvenile diet mimicked the adult in that the diet was 90% plant material consisting of clover, rose, cherry, and dandelions. Seeds, cultivated grains, and fruits from shrubs are eaten in the fall, reflecting the abundance of available foods (Johnsgard 1983). Cultivated grains were commonly used by STG during the summer, fall, and winter in South Dakota, comprising 23.1%, 54.8%, and 63.9% of the food volume (Hillman and Jackson 1973).

Optimal Habitat for Plains Sharp-tailed Grouse

Sharp-tailed grouse occupy a broad range of plant communities, including steppe, grassland and mixed-shrub vegetation types and vary in subspecies distribution according to tolerance to woodland components of their habitat (Aldrich 1963). The prairie STG (*T. p. campestris*) occurs from east-central Saskatchewan, southern Manitoba, and western Ontario, south across the Upper Peninsula of Michigan, Minnesota, and Wisconsin (Connelly et al. 1998) and inhabits oak (*Quercus* spp.) savannas and early succession stages of eastern mixed deciduous-coniferous forests (Prose 1987). The plains STG (*T. p.*

jamesi) occurs in the Great Plains east of the Rocky Mountains from central and southern Alberta, southern Saskatchewan, and southwestern Manitoba, south to northeast Colorado and Nebraska and inhabits sub-climax brushy grasslands habitats (Connelly et al. 1998).

Grange (1948) and Ammann (1957) evaluated habitat characteristics of prairie sharp-tailed grouse in Wisconsin and Michigan, respectively, and Grange concluded that grouse were abundant in grasslands with 25-50% woodland vegetation and Ammann believed 20-40% woodland was preferred (Connelly et al. 1998, Johnsgard 1983). Ammann (1957) believed that sparse ground cover and bare patches should not exceed half of the total area in optimal habitat conditions and suitable open vegetation within woodland areas should not be less than 1 square mile. He believed ideal summer vegetation types to be comprised of 6% open space for display site, loafing and foraging habitat for adult males and broods, and roosting sites for males; 50% open grasslands of various herbaceous structural levels with scattered shrubs/trees not exceeding 20% of the area for resting, dusting, and feeding areas, particularly broods; and 44% of the area in small, alternating series of 10-acre brushy clearings and heavier second-growth timber stands of mixed hardwoods and conifers that serve as a source of winter browse and protection from severe weather and escape cover.

The plains subspecies has different habitat needs than the prairie subspecies as it occurs in semi-desert scrub and relatively dry grasslands. These grouse use grassland, woody cover, and grain fields year-round, but certain vegetation types are important during different seasons (Sisson 1976, Moyles 1981, Nielsen and Yde 1982, Swenson 1985). The plains subspecies that occupy the Sandhills of Nebraska and comparable sand dune areas in North Dakota are essentially independent of extensive tree cover (Aldous 1943, Kobriger 1965, Sisson 1976).

Optimal Habitat for Prairie Sharp-tailed Grouse of the Great Lakes Region

Habitat of the prairie STG is described as central lowlands and prairies, including brushy successional stages of deciduous and mixed deciduous-coniferous habitats (Marks 2007). Winter habitat consists of wooded areas where tree buds are available and grassy areas that supply seeds. Forest areas and tree rows are avoided. The best habitat is a mix of grass-brush and agricultural lands. Prairie sharp-tailed grouse are more tolerant of woody vegetation than plains sharp-tailed grouse. More literature exists describing preferred (when compared to random habitat) and used habitat than optimal habitat.

Like other subspecies of STG, the prairie subspecies is area-sensitive, requiring large, open expanses of grassland and mixed-shrub vegetation to sustain viable populations. Lek complexes in a declining population in east-central Minnesota were 40-1,460 ha and grouse locations were <4.1 km from leks (Shartell 2017). Spring and autumn home ranges varied in size for both sexes from 13-105 ha in Minnesota and Wisconsin (Connelly et al. 2020). Average winter home range in Wisconsin was 149 ha for females and 259 ha for males, with daily movements of 200-400 m for both sexes in the summer and 0.8-1.2 km in winter (Gratson 1983). By comparison, grouse in the Upper Peninsula of Michigan had home ranges of 641 ha (Sjogren 1996).

In Minnesota, the prairie STG prefers transitional habitat of open grass-brushland, savanna, and open boreal peatlands (Berg 1999). Habitat is a complex of grassland mixed with brush and open woodland and includes meadows, pasture, open bogs, abandoned farm clearings, small grain cropland, inactive commercial rice paddies, as well as large grass or herbaceous areas resulting from fire, logging, abandoned farms, and sometimes, abandoned iron mine tailings basins.

In Wisconsin, prairie STG use a variety of habitat types including brush prairie, barrens, cut or burned-over forest, wet meadows, pine/oak savannah, mixed deciduous-conifer forest, and abandoned farmland (Sample and Mossman 1997, Evrard et al. 2000, Gregg and Niemuth 2000, Niemuth 2006). In northwest Wisconsin, vegetation types that are heavily used vary by season but typically include grass-shrub, shrub-grass, shrub, open conifer woods, sedge (*Carex* spp.) meadows, shrub marshes, and croplands (Wisconsin Bird Conservation Initiative 2013).

In the upper peninsula of Michigan, Ammann (1957) believed 20-40% woodland was preferred, and that sparse ground cover and bare patches should not exceed half of the total area in optimal habitat conditions and suitable open vegetation within woodland areas should not be less than 1 square mile. He believed ideal summer vegetation types to be comprised of 6% open space for display site, loafing and foraging habitat for adult males and broods, and roosting sites for males; 50% open grasslands of various herbaceous structural levels with scattered shrubs/trees not exceeding 20% of the area for resting, dusting, and feeding areas, particularly broods; and 44% of the area in small, alternating series of 10-acre brushy clearings and heavier second-growth timber stands of mixed hardwoods and conifers that serve as a source of winter browse and protection from severe weather and escape cover.

Estimated Occupied Range (EOR)

The Estimated Occupied Range for GPC and STG (GPC EOR, STG EOR) were manually delineated based on observation data, landcover data, imagery, and expert opinion similar to a previous EOR delineation for lesser prairie chickens and greater prairie-chickens in Kansas (Houts 2008). Each of the states participating in this effort provided observation data to help assess rangewide population distribution and abundance. Due to the large differences in the type of data collected by each state, the observation data was simplified to presence and year. State observation data depicts known locations based on surveys and opportunistic reports. Since state observation data is limited in its scope (6,555 GPC observations, 13,157 STG Observations) and left lots of areas un-assessed, ebird data was downloaded to increase the amount of observation points available. The state and eBird data points represent data from 2000 - 2019, and the eBird observations were filtered to only include data from the months of March through June (Figure 3) to correspond with lek locations. In total, there were 13,525 GPC observations and 22,065 STG observations occurring within their (soon to be defined) estimated occupied range.

Utilizing occurrence data, landcover (CITE, 2019 NLCD), available species distribution and habitat models, and aerial imagery (ESRI base maps), a polygon was manually delineated that encircled most all known occurrences and potentially used habitat. Some outlier points that represented one-time occurrences or known local extinctions were not included to keep the EOR focused on the current distribution of birds and habitat. We recognize lack of observation data does not indicate species absence. The observation data used represents a very small proportion of the overall range within each state. Much of the best habitat for GPC and STG (along with a lot of other species) is in remote roadless areas that are not easily or consistently surveyed. If the habitat appeared to remain contiguous or similar in composition to nearby occupied areas, the EOR was drawn to include those areas of potential habitat. The EOR includes areas with a range of habitat quality, and does include some areas of poor habitat, particularly if they occurred between two areas of higher quality habitat. Depending on the situation, these poor habitat areas within the EOR could be potential habitat improvement or restoration areas.

The draft EOR was made available to states for review and edit. The review process sometimes evolved into multiple personnel and states working together to delineate portions of the EOR together and/or deciding whether to connect separate habitat areas in the EOR or leave them separate EOR polygon islands. This was an iterative process in the United States. The range of the plains and prairie sharp-tailed grouse, however, extends north into the Canadian provinces of Alberta, Saskatchewan, Manitoba, and southwest Manitoba. Initially, in this northern extent, the only information to guide the first delineation of the EOR was a continental landcover map and eBird observation data. The first draft of the Canadian portion of STG EOR was shared with a couple suggested wildlife personnel in Canada and the request for delineation edits and assistance was well received. Multiple people from within each province's wildlife departments and academia offered datasets and suggestions. The largest obstacle in delineating the northern extent in Canada was accounting for the focus on the plains and prairie sub species and not all STG. The observation data from eBird and the provinces do not differentiate to the subspecies level. Since the northern STG extend much further north and are more accepting of trees this makes the distinction between species and delineation complicated. The northern edge of the plains sharp tail boundary is an approximation, guided largely by the boundary of the Central Parkland Natural Region of Alberta, and the Aspen Parkland ecoregion in Saskatchewan, and a geological feature called the Arden Ridge was used to approximate the boundary in Manitoba. Using an interpretative touch, observation records, landcover, ecoregions, geology, and expert opinion were used to guide the delineation of the GPC and STG across the US and in Canada (Figure 4).

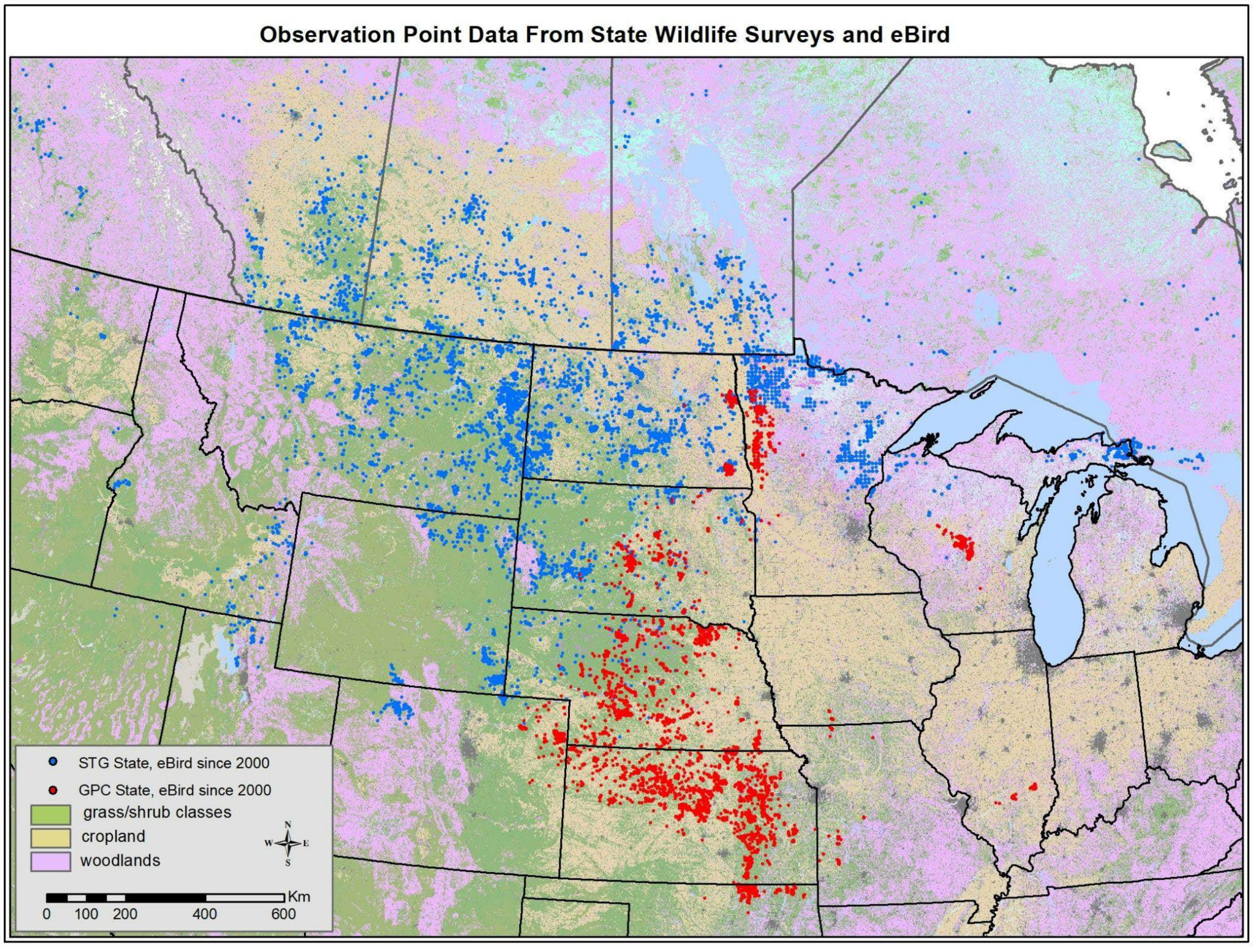


Figure 3. Observation data for greater prairie-chickens and sharp-tailed grouse collected from state wildlife agencies and eBird. All observations were filtered to only include data from 2000- 2019, and eBird data was further filtered to the months of March through June.

The final delineation of the EOR for GPC and STG produced areas covering 151,575 mi^2 (392,578 km^2) and 490,502 mi^2 (1,270,394 km^2) respectively. When the overlap between the two species range's were accounted for, the combined grassland grouse EOR covered 1,511,051 km^2 (574,784 mi^2). These generalized range delineations include areas of occupied high-quality habitat, potentially occupied habitat, areas of degraded habitat, and areas of cropland in the vicinity of potential habitat that could occasionally be used by GPC/STG. While GPC and STG may occasionally occur beyond this extent, this boundary is believed to areas where GPC and STG are most likely to occur.

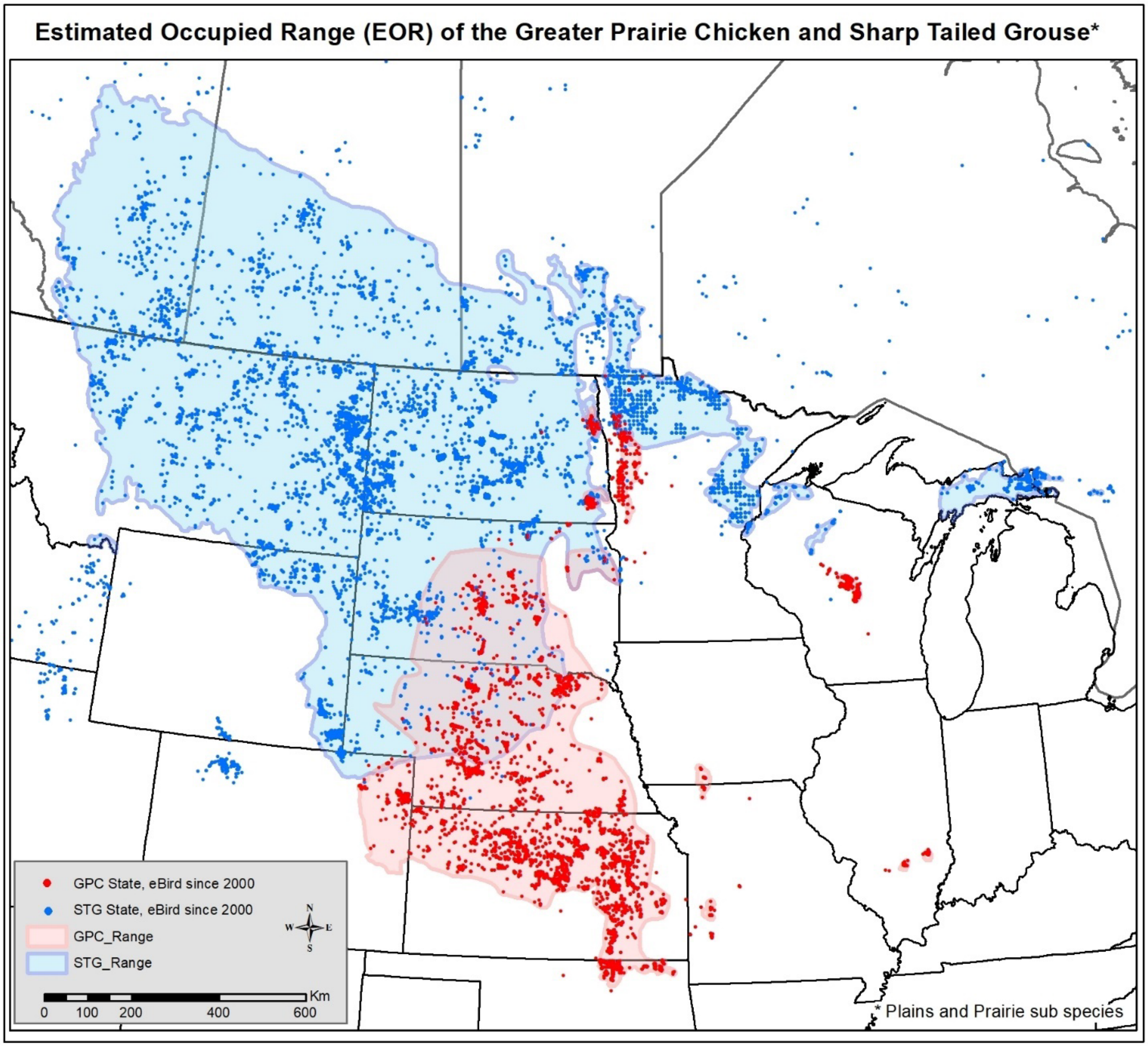


Figure 4. Delineation of the estimated occupied range for the greater prairie-chicken and sharp-tailed grouse.

Habitat and Ecoregions

The landcover proportions and the land management practices differ widely across the range of the GPC and STG. In general, the potential habitat is much more abundant and in larger patches in the west compared to the east. To account for this variation, the EOR was divided into pieces that reflect differences in habitat (and bird density). The techniques that the states used to conduct their surveys of GPC/STG was also a factor for including these regional divisions. In the west where suitable habitat is more abundant and bird populations are higher, surveys provide representative data to interpolate across the landscape. In the eastern region where habitat and birds are sparse, a more focused survey method is often utilized that allows more complete surveys of known population. To divide the area, the Bird Conservation ecoregion dataset initially defined the regions, but the boundaries were modified in a few instances to avoid dividing known occupied areas between two different regions (i.e. northeast OK, east MN) (Figure 5). When the landcover composition of the GPC and STG EOR is calculated using landcover data from the 2015 North American Environmental Atlas, the difference between regions becomes clear, with the western half of GPC/STG EOR contained 40% and 42% rangeland respectively, while the eastern region only had 17% and 4% rangeland respectively (Table 2, 3).

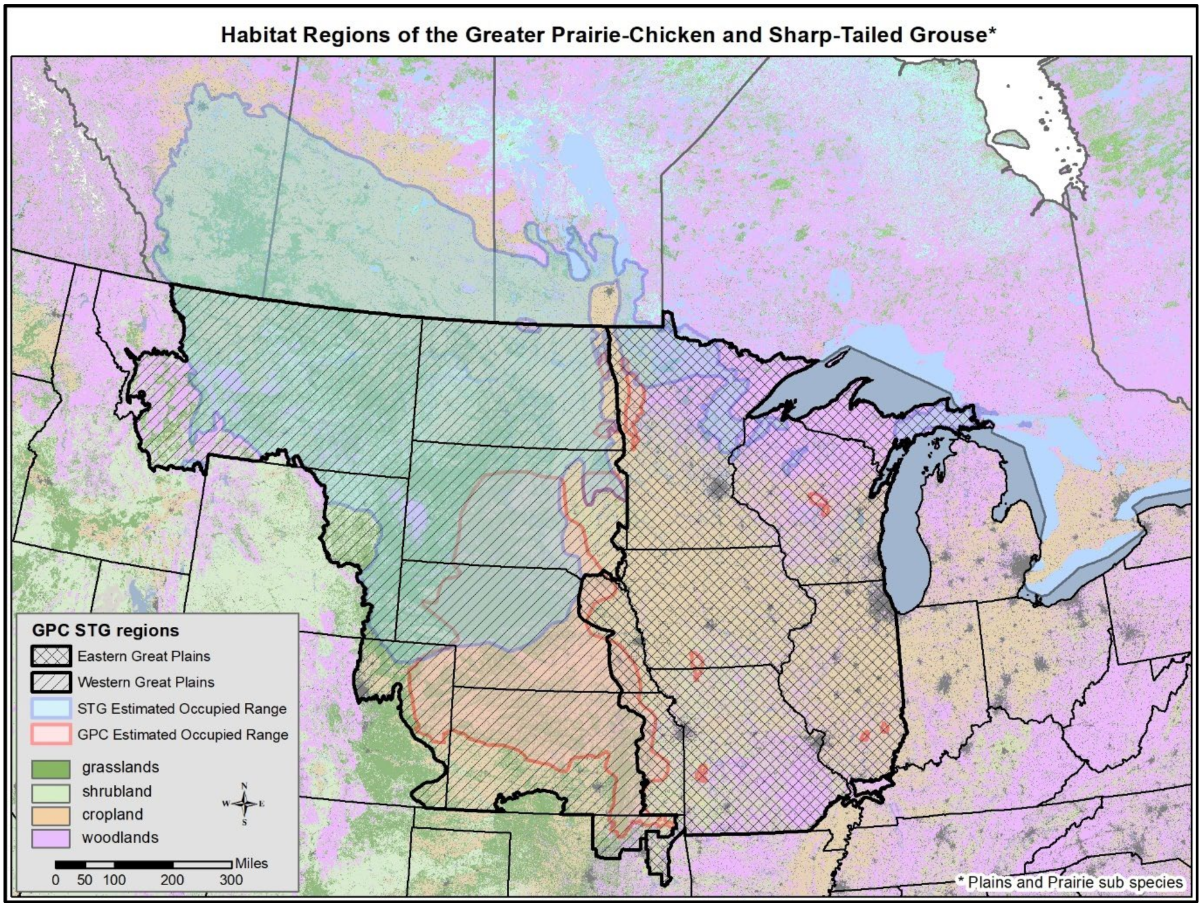


Figure 5. Habitat regions that reflect the difference of landscape composition in the western portion of the occupied prairie grouse range compared to the more fragmented eastern portion of their range.

Table 2. Area (km^2) of landcover by species EOR and ecoregion divisions.

Region	Total sq km	Rangeland	Cropland	Woodland	Wetland
GPC West	353,257	183,917	140,035	6,634	7,779
GPC East	39,323	6,551	25,894	2,889	1,355
GPC Rangewide	392,578	190,468	165,929	9,522	9,134
STG West	1,190,400	551,992	502,739	47,033	23,585
STG East	79,994	3,302	15,575	20,223	35,790
STG Rangewide	1,270,394	555,294	518,314	67,255	59,375

Table 3. Percent landcover by species EOR and ecoregion divisions.

Region	% Rangeland	% Cropland	% Woodland	% Wetland	% Other
GPC West	52	40	2	2	4
GPC East	17	66	7	3	7
GPC Rangewide	49	42	2	2	4
STG West	46	42	4	2	5
STG East	4	19	25	45	6
STG Rangewide	44	41	5	5	5

Associated Grassland Species

This multi-state plan is designed to use the GPC and STG as flagship species and identify priority grassland habitats that will support the target GPC/STG species, but also provide improved habitat conditions for a host of other grassland species. The grassland habitats of the Great Plains support a wide range of species, and many of these species use areas that overlap with the habitats used by GPC and STG. The participating states reviewed internal information and identified a list of species of greatest conservation need (SGCN) that use grassland habitats similar to GPC and STG. The results showed that there was a total of 113 different SGCN species identified across the states that shared habitat with GPC/STG, with 10 of those species being mammals, 27 bird species, 13 reptiles, 8 amphibians, and 55 insect species. More specifically, Table 4 and 5 show the number of states associated with each mammal and bird SGCN. The complete list of SGCN and the states that identified as recognizing them as a SGCN are summarized in Appendix 1.

Table 4. Mammals of conservation concern that share habitat with GPC/STG.

Common Name	Latin Name	States with species
Black-footed Ferret	*Mustela nigripes*	5
Franklin's Ground Squirrel	*Poliocitellus franklinii*	5
Hispid Pocket Mouse	*Chaetodipus hispidus*	3
Olive-backed Pocket Mouse	*Perognathus fasciatus*	2
Plains Harvest Mouse	*Reithrodontomys montanus*	2
Plains Pocket Gopher	*Geomys bursarius*	1
Plains Pocket Mouse	*Perognathus flavescens*	4
Silky Pocket Mouse	*Perognathus flavus*	2
Spotted Ground Squirrel	*Xerospermophilus spilosoma*	2
Swift Fox	*Vulpes velox*	6

Table 5. Birds of conservation concern that share habitat with GPC/STG.

Common Name	Latin Name	States with species
Baird's Sparrow	*Ammodramus bairdii*	4
Barn Owl	*Tyto alba*	5
Bell's Vireo	*Vireo bellii*	4
Bobolink	*Dolichonyx oryzivorus*	7
Buff-breasted Sandpiper	*Calidris subruficollis*	4
Burrowing Owl	*Athene cunicularia*	6
Chestnut-collared Longspur	*Calcarius ornatus*	5
Common Nighthawk	*Chordeiles minor*	6
Dickcissel	*Spiza americana*	8
Eastern Meadowlark	*Sturnella magna*	6
Ferruginous Hawk	*Buteo regalis*	5
Grasshopper Sparrow	*Ammodramus savannarum*	7
Greater Prairie-Chicken	*Tympanuchus cupido pinnatus*	8
Henslow's Sparrow	*Ammodramus henslowii*	7
Lark Bunting	*Calamospiza melanocorys*	2
Le Conte's Sparrow	*Ammodramus leconteii*	5
Loggerhead Shrike	*Lanius ludovicianus*	8
Long-billed Curlew	*Numbenius americanus*	6
Northern Bobwhite Quail	*Colinus virginianus*	5
Northern Harrier	*Circus hudsonius*	5
Sedge Wren	*Cistothorus stellaris*	2
Short-eared Owl	*Asio flammeus*	9
Smith's Longspur	*Calcarius pictus*	4
Sprague's Pipit	*Anthus spragueii*	5
Swainson's Hawk	*Buteo swainsoni*	6
Thick-billed Longspur Longspur	*Rhynchophanes mccownii*	4
Upland Sandpiper	*Bartramia longicauda*	8

State Surveys and Population Estimates

Spring lek counts are used for prairie grouse population monitoring throughout their range, and there are several survey techniques. Most methodologies could be classified as either listening surveys or a site census. Listening surveys are focused on observers driving, walking a route and stopping at fixed intervals to look and listed for the calls or "drumming" of the birds displaying on the mating grounds (i.e. 10 mile route, with listening stops spaced one mile apart at the section mid-points). This is a good way to get an estimate of the presence/number of birds across an area and is often used in landscapes with relatively large areas of potential habitat with vague estimates of population levels and distribution. Because these are simple transect surveys through a larger potentially occupied area, it is important to remember the at the absence of an observation does not mean the species is not present in the area, merely not detected. Conversely, a site census is a thorough and intensive assessment over an entire area. Census surveys are useful for providing presence data, but also for the confidence to declare an area as unoccupied, a useful input for many models. Because of the time required to conduct census surveys, they are often much smaller in scope and often done to closely monitor small or isolated populations. As a third population monitoring technique, population information is also collected by some states through harvest surveys. Not all states have hunting seasons, so these data would be limited to those that still have sufficient populations to allow hunting. These data are another method of estimating trends for each species. While limited in its application as it only provides one measure of population status with various sources of variation, it would still be useful for states to compile this information in as standardized a manner as possible.

The results from survey and census types of survey are often used in models that estimate population trends or apparent density within designated survey areas. Specific protocols vary widely among states which has hampered the ability to compare populations or combine data sets for broader analyses. A summary of the survey methodologies used by each state is presented in table 6, while a detailed methodologies for each state are in Appendix 2. Unfortunately, most survey programs fall short of producing defensible abundance estimates with measures of error.

One common problem associated with many well-intended and longstanding surveys is the lack of random sampling. Many survey plots were historically established in high quality habitat with known high grouse populations. Although the survey results may be useful in estimating local population trend or apparent density, the data are unlikely to be useful in estimating those same metrics for the broader population. Attempts have been made to estimate prairie grouse abundance over large geographic areas. McDonald et al. (2015) used helicopter lek surveys and random sampling to estimate abundance of greater prairie-chickens in Kansas and Oklahoma. Because the design included random sampling, both abundance and error could be estimated. The survey was conducted in 2012-2015, therefore a series of abundance estimates with error are available to interpret trend. Due largely to low lek detection rates, the abundance estimate 90% confidence intervals were fairly wide (e.g. 2015: 60,098-114,123). This methodology may have merit in other areas, although lek detection rates could vary as topography, vegetation cover, or other factors change across the prairie grouse range.

The South Dakota Department of Game, Fish and Parks, North Dakota Game and Fish Department, and the U.S. Fish and Wildlife Service collaboratively designed and implemented a pilot study to evaluate improved methods for estimating the distribution and abundance of prairie grouse in the Dakotas (Runia et al. 2021). Ground observers searched randomly selected Public Land Survey Sections (1 mi2) for leks from 2010-2016. Occurrence and density data were combined with landcover and climate data to develop spatially explicit models and associated maps. Relative abundance of males was calculated from the random sample, but also by summing the spatially explicit density estimates. In both cases, measures of error were estimated. Because data collection for this pilot study occurred over a span of 7 years, the estimates are for a period of time, not a point in time. Regardless, the well-designed protocol yielded the ability to estimate the distribution of prairie grouse across state lines which has

State	Species	Opportunistic/Route/Census	Count (L/M/F/T)*	Ground/aerial	# Routes	Apx. total surveyed area (sq mi)	comments
CO	GPC and STG	Listening routes (northeast) Census (southeast)	L/M/F/T	ground	5 routes/yr - alternate each year		Known STG leks are counted from public roads.
IA	GPC	Census known leks + listen at potential	L/M/F/T	ground	4 routes, 33 sites		
Il	GPC	Census (2 sites)	L/M	ground			
KS	GPC	Listening routes	L/M (x2 for T)	ground w/ aerial (every third year)	37 (3 overlap with LPC)		
MI	STG	Opportunistic (survey known leks) and routes (survey points within a square mile).	Lek survey attempts to count all birds using leks. Occupancy survey is presence/absence within the square mile	ground	The lek survey has a variable number of known leks that are surveyed. The occupancy survey covers 37 square miles (37 routes).	37	The lek survey attempts a minimum count of birds at known leks and determines use/non-use of a lek in a given year. Our occupancy survey focuses on the portion of STG range open for harvest. Surveys are not comprehensive and do not cover all of occupied STG range in Michigan.
MN	GPC	17 survey blocks in core and periphery areas based on density	L/M/F/T	ground	17 survey blocks (4 sections in size each)	17 x 4144 ha	standardized in 2004
MN	GPC and STG	Survey known leks (low density areas) & survey routes in higher density areas	L/M/F/T	ground	Different approach depending on density of leks in geographic		
MO	GPC	Census known leks + listen on routes	L/M/F/T	ground			
MT	STG	Block and Routes	L/M/F/T	ground and aerial	6 + more as time allows		
ND	STG	Census blocks	L/M/F/T (x2-3)	ground	27 blocks, historic USFWS refuges		
ND	GPC	Survey areas	L/M/F/T	ground	3 areas, all known leks		
NE	GPC and STG	Breeding Ground Survey (19-mile transects)	L/M/F/T	ground	varies (recent = 11 routes per year)	440 sq miles per year (11 routes x 40 sq mi per route)	Number of routes and sampling frequency variable (1956-present).
NE	GPC and STG	Census Blocks (1 sq. mile)	L/T	ground	216 blocks per year (random selection)	216 sq miles per year	3-year monitoring effort (2020-2022)
OK	GPC	Listening routes	L/T	ground	26		
SD	GPC and STG	Listening routes and census blocks	L/M/F/T	ground	10 + __ census areas		
WI	GPC and STG	Listening routes	L/M	ground			
WY	STG	census known leks + listen on routes	L/M/F/T	ground	25 routes, ~75% run every year		Male, Female and Unknown birds are collected at each lek, both stand alone leks and along routes. We sum to get total.

Table 6. Summary of state survey methods for GPC and STG. * LMFT --- what is counted (Lek, Male, Female, Total birds)

obvious advantages overestimating only abundance. The interstate cooperation of this pilot study continues as similar data collection and analysis is underway in Nebraska (John Laux, personal communication).

Until common population monitoring approaches are applied across management authorities, assessing prairie grouse populations at broad scales will remain challenging. We recommend continued dialogue among management authorities which could ultimately lead to cooperative survey efforts. We recommend survey designs that can produce spatially explicit estimates of abundance because of the more relevant uses for conservation (developing priority areas) than estimating only abundance. Development of spatially explicit habitat-based density models would also be useful for developing population and habitat goals in a linked process.

Population and Habitat Goals

Setting population goals is an important consideration for species management plans. However, setting such goals typically requires a reasonable assessment of current population numbers. This information is available in some of the eastern portions of GPC range, where smaller isolated populations of this species occur, but is lacking further west where populations of both GPC and STG are widely distributed and in much higher numbers. Further, the fluctuations in population sizes of these species that can occur in response to varying weather conditions makes estimating populations challenging. Given this lack of reliable and consistent population estimates across the ranges of both species, setting numerical population goals at this time was not determined to be prudent. What is desired is to continue to monitor populations using methods that are as consistent as possible across states, and to establish population trends. The goal is to reverse the declines in population trends that have occurred, and over time to show stable and increasing populations.

Setting habitat goals is also challenging, as the accurate determination of habitat quality requires on-the-ground assessment of grassland conditions. While coarse evaluations of habitat are possible using remotely sensed data as discussed in this plan, the actual condition of grasslands in terms of the composition and structure of grasses at a site cannot be determined remotely. Thus, while remote sensing may indicate that a particular area has large enough amounts of grassland with few disturbances and minimal amounts of woody invasion to be potentially suitable habitat, unless the area has also been managed to provide good grass composition and structure, it may not be suitable as habitat. Further, the of lack specific population goals that could be used to determine the amounts of habitat needed to support an expected density of birds as a basis for setting overall habitat goals, setting habitat goals in terms of total desired amounts is difficult.

What has been identified is that to sustain populations of these two flagship species, the goal of establishing a strategically located system of 50,000 acre blocks of high-quality habitat is needed. The number and distribution of these large blocks is an on-going focus of conservation work that needs to be integrated with other grassland conservation initiatives. Further, once numbers and locations of desired areas are formulated, then efforts at also identifying connectivity among these sites can be addressed. These remain as significant challenges but are vital steps for achieving significant gains in grassland conservation and for the future status of these two flagship species.

A Multiscale Spatial Database

With such a large and diverse landscape, a wide variety of goals, and different applications, it became clear that a unique approach to identify and map priority GPC/STG grassland habitat was needed. After exploring other methods, the IWG agreed to use the grid of the nested hexagon framework (NHF) to assess the landscape and define the priority areas. The NHF grid covers all North America and is based around a 1 km^2 hexagon unit that is aggregated up by units of 7 to generate coarser resolution cells of 7 km^2 cogs, 49 km^2 wheels, and 343 km^2 rings (Figure 7). The cells of the NHF serve as a standardized way to summarize data and make them comparable, providing the ability to inform a wide range of questions and objectives. Instead of creating products focused on answering a couple specific objectives, the NHF functions as a data aggregator and summarization tool that can provide information to inform a wide range of questions and objectives (Figure 8). Additionally, the multiple resolutions facilitate cross scale analysis of habitat associations and allow users to select the optimal mapping resolution for conveying information while obscuring precise spatial locations.

To provide guiding information for the creation of grassland priority areas, documented habitat preferences and expert opinion were used to compile a suite of landscape information that was integrated into the NHF. Datasets related to landcover, habitat threats, and energy development were all summarized per NHF cell. This created a geo-spatial database with information associated with each NHF grid cell (Figure 9). For this project, over 25 data variables were represented per NHF grid cell (% landcover, mean value, majority category…), to provide a range of information to use for identifying and delineating priority areas (Table 7).

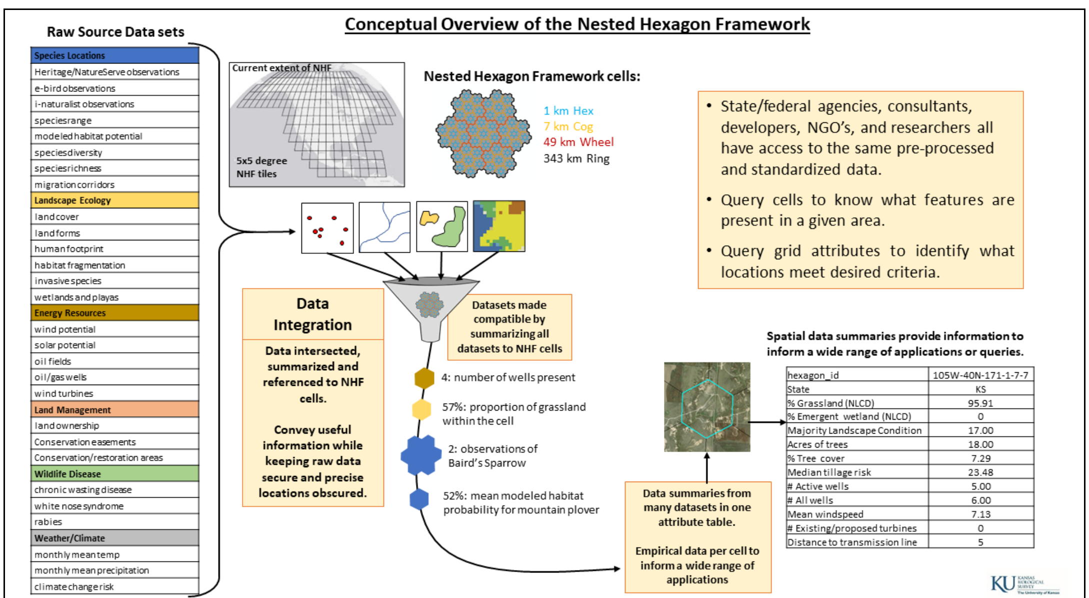


Figure 7. Functional diagram of how the NHF can be used to summarize datasets.

Table 7. A list of the datasets integrated into NHF, the data summarization method used, and the variable name in the NHF dataset.

NHF Variable	Data Source and Summarization Method
Habtiat and Suitability	
Pct_range	percent of rangeland in the cell (NLCD classes 52, 71, 81, 95)
Pct_Forest	percent of NLCD woodlands in the cell (classes 41, 42, 43)
Pct_Crop	percent of NLCD cropland in the cell (82)
Pct_Urban	percent of NLCD urban areas in the cell (21, 22, 23, 24)
Tree_acres	acres of trees, based on merge of NLCD woodland classes and invasive cedar/mesquite layers from PLJV
Tree_pct	percent trees, based on merge of NLCD woodland classes and invasive cedar/mesquite layers from PLJV
Maj_LSCond	Majority value from NatureServe Landscape Condition layer
LIRangeland	large intact rangelands. 50,000 acre blocks (via contiguous NHF cells) that meet : ">=75 rangeland and <20% trees"
MeanDistToFrag	Mean distance to a habitat fragmenting feature. From published raster surface layer
Management and Conservation	
PADUS_GAP1	acres of GAP 1 conservation areas
PADUS_GAP2	acres of GAP 2 conservation areas
PADUS_GAP3	acres of GAP 3 conservation areas
PADUS_GAP4	acres of GAP 4 conservation areas
NCEDplus_ac	acres of conservation areas from National Conservation Easement Database
Max_MOBI	maximum number of species at risk, from Nature Serve Map of Biological Importance
Species Range and Presence	
GPC_present	yes/unknown based on GPC records from states and Ebird. (2000-2018, March-June)
GPC_range	cells intersect the GPC EOR
STG_present	yes/unknown based on STG records from states and Ebird. (2000-2018, March-June)
STG_range	cells intersect the STG EOR
GPCSTG_region	habitat regions (east or west)
Energy Potential	
Cnt_wells	number of active wells in the cell
WellDensity	number of all wells (all status, all ages) in the well database.
MN_windspeed	Mean windspeed per cell. "developable wind as about 7.8 meters per second
Wind_turbines	Presence of planned or proposed wind turbines from FAA obstruction analysis database
Mtrs_to_Trans	Mean distance to a transmission line
Derived Data	
Energy	Energy risk (>=1 well per km, OR active or proposed turbines present, OR (Windspeed >= 7.8 AND distance to Trans <10km)
Grassland_habitat	Cells with >= 75% rangeland AND <20% NLCD woodlands)
Other_priority_areas	Available for states to use to intersect and attribute cells with existing priority areas.
Mn_GPCSTG_suitability	Available to be used to generate mean habitat suitability (continuous probability) per cell
Maj_GPCSTG_suitability	Used by ND, SD, and NE to generate majority habitat suitability category (1,2,3) per cell
GPCSTG_PriorityArea	State determined grassland priority areas

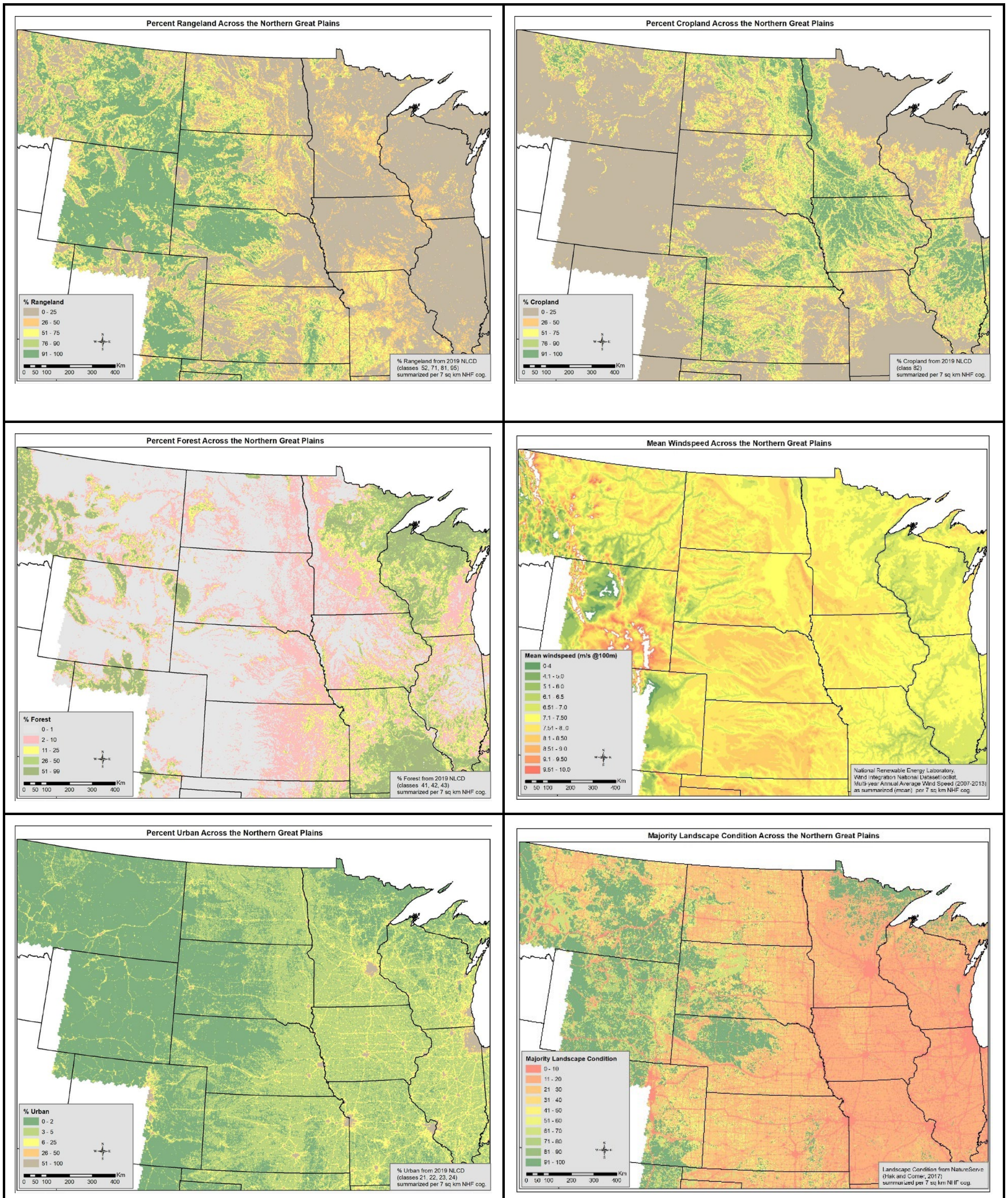
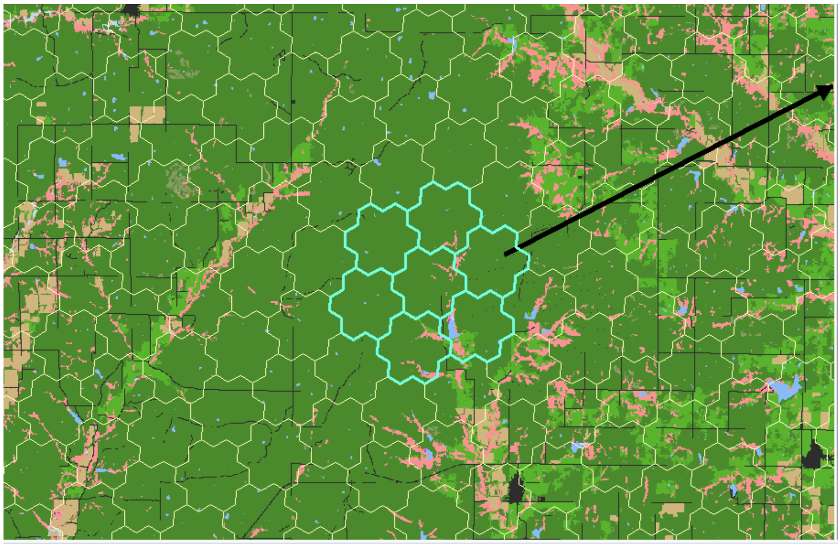


Figure 8. Some of the variables as summarized by the NHF 7 km^2 cogs representing the proportions of NLCD landcover classes, the mean of ENREL wind speed data, and the majority NatureServe Landscape Condition score.



Field	Value
grid_id	100W-40N
ring_id	100W-40N-368
wheel_id	100W-40N-368-6
cog_id	100W-40N-368-6-1
Cell_ac	6984000
R52718195	6786000
F41424390	143100
C82	0
U21222324	37800
Pct_range	97
Pct_Forest	2
Pct_Crop	0
Pct_Urban	1
Tree_acres	153
Tree_pct	8.865544
Cnt_wells	1
WellDensity	19
MN_windspeed	7.997812
Mtrs_to_Trans	2799
Wind_turbines	Turbines present or proposed
energy	Energy dev risk
GPC_present	unknown
LIRangeland	part of >= 50,000ac block with>=75rangeland
PADUS_GAP1	<null>
PADUS_GAP2	<null>
PADUS_GAP3	<null>
PADUS_GAP4	<null>
NCEDplus_ac	0
MeanDistToFrag	<null>
Max_MOBI	1
GPC_range	in GPC range
STG_present	unknown
STG_range	outside STG range

Pct_range	Pct_Forest	Pct_Crop	Pct_Urban	Tree_acres	Tree_pct	Cnt_wells	WellDensity	MN_windspeed	Mtrs_to_Trans	Wind_turbines	energy	GPC_present	LIRangeland
100	0	0	0	<Null>	<Null>	<Null>	5	8.316426	3048	<Null>	<Null>	unknown	part of >= 50,000ac block with>=75r
98	2	0	0	88	5.095853	<Null>	2	8.140129	1497	<Null>	<Null>	unknown	part of >= 50,000ac block with>=75r
93	6	0	0	192	11.118225	<Null>	9	7.694206	7210	<Null>	<Null>	unknown	part of >= 50,000ac block with>=75r
97	2	0	1	153	8.865544	1	19	7.997812	2799	Turbines present or proposed	Energy dev risk	unknown	part of >= 50,000ac block with>=75r
89	6	0	1	331	19.16242	<Null>	2	7.566165	5655	Turbines present or proposed	Energy dev risk	unknown	part of >= 50,000ac block with>=75r
96	4	0	0	167	9.670539	<Null>	22	7.822341	4354	Turbines present or proposed	Energy dev risk	unknown	part of >= 50,000ac block with>=75r
100	0	0	0	<Null>	<Null>	<Null>	22	8.259965	5904	<Null>	Energy dev risk	GPC present	part of >= 50,000ac block with>=75r

Figure 9. View of some of the attribute data summarized to the NHF cogs.

Identifying Large Intact Rangelands

Working from the generalization that the GPC and STG species prefer habitats that are generally grassland/shrubland dominated landscapes with few trees, one of the first tasks was to identify contiguous areas of intact rangeland with limited tree presence. Due to the highly fragmented landscape of the Midwest with roads following section lines, it is often difficult to map extents larger than 640 acres even though these rural roads often do not function as habitat barriers. The NHF provided a way to look for the overall proportion of grassland-rangeland within an area and then further assess the proportion of trees (or a wide range of other variables) within that same area. After some preliminary analysis of occupied NHF cells, a threshold of 75% rangeland (NLCD classes 52,71,81,95) was used to represent cells that were "mostly rangeland". A second threshold of less than 20% woodlands was also included to filter out cells with an abundance of trees. Because the NHF cells cover a broader area than a field or observation site, the 20% threshold allows for some areas of trees within the cell such as a riparian corridor, that may exist away from adjacent upland treeless habitat areas. The NHF cells at each resolution were first classified based on those that met the 75% rangeland /20% woodland criteria. Qualifying cells were then dissolved to identify contiguous blocks of NHF cells. The dissolved polygons were then filtered to identify only those greater than 50,000 acres (Figure 10). There are more connected areas of "intact rangeland" when mapped at the hexagon level where it is easier to meet 75% rangeland threshold than at the courser cell resolutions. Figure 10 helps to illustrate that while there is potentially suitable habitat at the local level (1 km^2 hexagon) in lots of areas, there are fewer areas that meet the 75% rangeland composition requirement at the larger Wheel level.

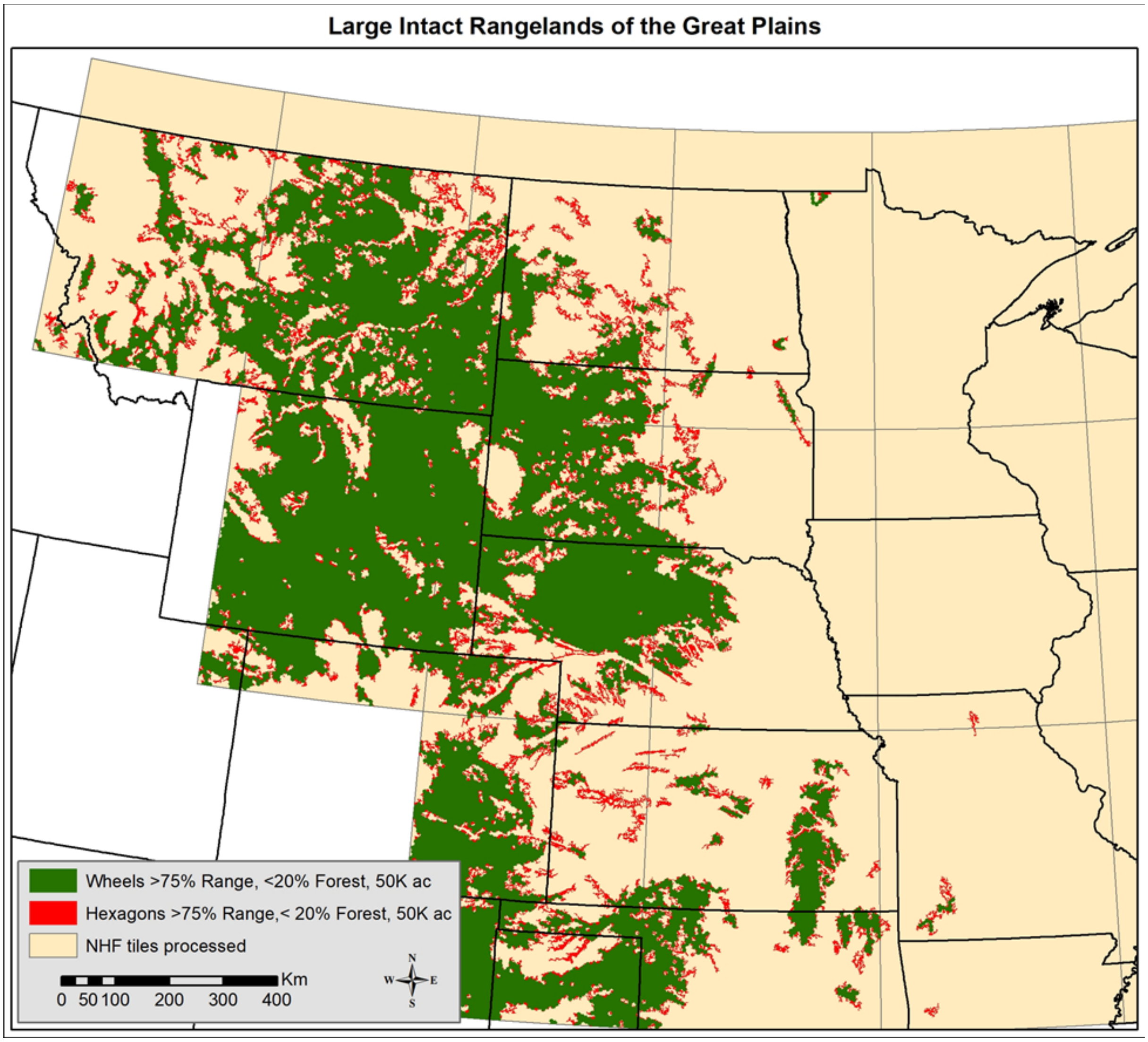


Figure 10. Intact rangelands as analyzed and mapped using 1 km^2 hexagons and 49 km^2 wheels to identify areas that met the requirements to be considered large intact rangelands.

Analysis and Summary of GPC/STG Occupied Areas

While generally referred to simply as grasslands, the grassland biome is incredibly complex spatially, taxonomically, and temporally. The patchwork of different uses and land cover patterns that cover the landscape show blocks of grassland habitat, mixed with cropland and encroaching woodland areas. Healthy grassland habitats rely on a diverse vegetation community that supports a thriving insect population (including pollinators). These plants and insects serve as the base sustenance for a complex food chain that includes grassland birds, small mammals, reptiles, and raptors. The grassland landscape is always changing however, and frequent disturbances are necessary to maintain the composition, diversity, and vegetative structure. The species composition of the grassland habitat, the vertical structure of the vegetation, and type and timing of management practices all play a critical part in determining a sites actual suitability. Unfortunately, these habitat metrics must be collected at the field level and are not readily available across the range.

Data integrated into the NHF was analyzed based on intersection with an EOR, and based on known presence of GPC/STG. The analysis was done across the EOR as a whole, and also split by habitat regions to better represent western conditions and eastern conditions. Based on the skewed data distributions visible in most of the histograms, the regional summary across the cells was done using the median value instead of the mean. The data integration and analysis was performed using three of the NHF spatial resolutions to explore differences in habitat metrics and identify the best resolution to depict grassland priority areas (Fig 11, Tables 8-10b). Table 8 shows that while the hexagons in the GPC EOR had a median of 59% rangeland, when focused just on hexagons in the EOR and occupied by GPC, the median percentage of rangeland increased to 84%. Further assessment shows that the western occupied cells the median was 89%, while in the eastern region the median was only 47% rangeland.

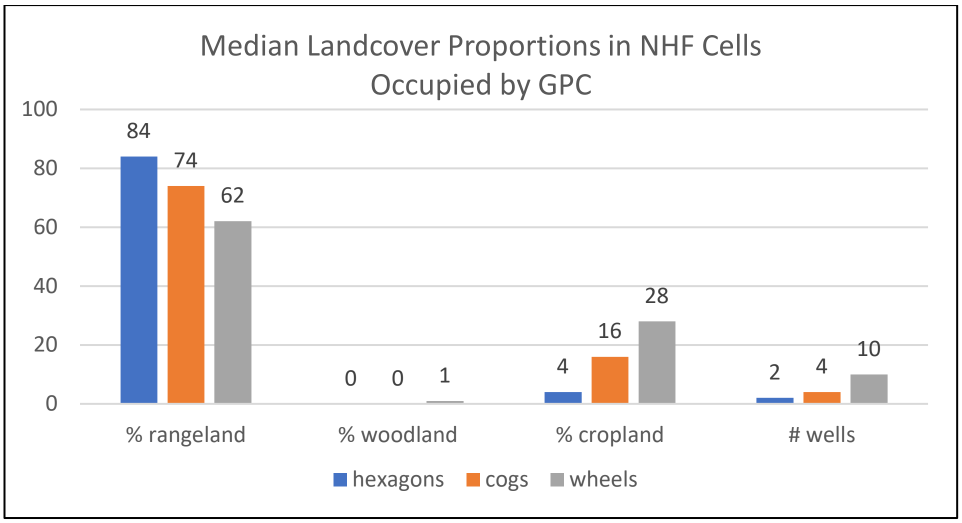


Figure 11. Landcover proportions at three spatial resolutions of NHF cells occupied by GPC.

Table 8. The number of cells, the km², and the median landscape metric for cells within each regional subset and grouse occupation status (US extent only).

Hexagons	# cells	km²	Med% rangeland	Med % woodland	Med % cropland	Med # active wells	Med Distance to transmission (meters)
GPC EOR	396,283	396,283	59	0	28	2	6,133
GPC EOR + occupied	3,761	3,761	84	0	4	2	6,024
GPC EOR + occupied (West)	3,051	3,051	89	0	1	1	6,155
GPC EOR + occupied (East)	710	710	47	1	34	2	5,390
STG EOR	956,563	956,563	75	0	0	1	6,464
STG EOR + occupied	6,949	6,949	77	0	0	1	4,758
STG EOR + occupied (West)	5,414	5,414	84	0	0	1	4,566
STG EOR + occupied (East)	699	699	24	2	0	Null	6,057

Table 9. The number of Cogs, the area, and the median landscape metric for cells within each regional subset and grouse occupation status (US extent only).

Cogs	# cells	km^2	Med % rangeland	Med % woodland	Med % cropland	Med # wells	Med Distance to transmission (m)
GPC EOR	55,788	390,516	56	0	33	4	5,103
GPC EOR + occupied	2,687	18,809	74	0	16	4	4,980
GPC EOR + occupied (West)	2,231	15,617	78	0	13	4	5,060
GPC EOR + occupied (East)	456	3,192	36	4	40	5.5	4,428
STG EOR	137,811	964,677	70	0	9	3	5,459
STG EOR + occupied	5,785	40,495	70	0	10	3	3,872
STG EOR + occupied (West)	4,441	31,087	76	0	11	3	3,599
STG EOR + occupied (East)	606	4,242	23	6	4	Null	5,718

Table 10. The number of Wheels, the area, and the median landscape metric for cells within each regional subset and grouse occupation status (US extent only).

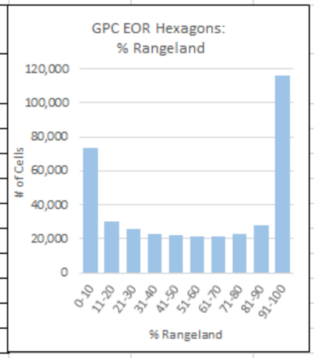
Wheels	# cells	km^2	Med % rangeland	Med % woodland	Med % cropland	Med # wells	Med Distance to transmission (m)
GPC EOR	8,515	417,235	54	0	36	12	2,280
GPC EOR + occupied	1,538	75,362	62	1	28	10	2,063
GPC EOR + occupied (West)	1,282	62,818	66	1	25	9	2,232
GPC EOR + occupied (East)	256	12,544	31	7	49	33	1,583
STG EOR	20,145	987,105	67	0	13	9	2,759
STG EOR + occupied	3,841	188,209	65	0	15	11	1,309
STG EOR + occupied (West)	2,874	140,826	71	0	17	11	1,028
STG EOR + occupied (East)	456	22,344	21	7	4	10	3,301

The data in the NHF is not field level data, but rather reflects the landscape at a given cell resolution (1 km^2 hexagon, 7 km^2 cog…). Most wildlife species, especially birds, utilize a larger landscape than the location at which they were observed. The NHF cells that are attributed as having GPC/STG observations represent a "use area" and help to identify broader landscape conditions associated with suitable habitat. With the EOR extent and occupied cells identified in the NHF, it was possible to analyze the landscape variables integrated into the NHF. Researchers analyzed the data at three spatial resolutions (1, 7, 49 km^2) to assess the conditions within GPC/STG occupied cells. Histograms of each variable were created to examine the data distribution and data values that represented data quantiles (10%, 25%, 50%, 75%, 90%). Additionally, the mean and median values of cells across the entire EOR and from occupied cells were calculated to serve as reference threshold values. (Figure 12,13, Appendix 3). The thresholds provide useful insights into the conditions across the EOR and within occupied cells. Additionally, the thresholds can guide future queries of the NHF to identify areas meeting the desired criteria.

Using the threshold values that include top 10% of the occupied cells from a series of variables, a map can be created that identifies areas throughout the range that match the best conditions across multiple variables. To accomplish this for GPC, the 2,765 hexagon cells occupied by GPC were sorted from high to low based on the percent rangeland and the 276th cell down the list (representing the top 10%) was used to identify the 97% threshold value. This process was repeated for % woodland, % cropland, number of active wells, and the distance to transmission lines.

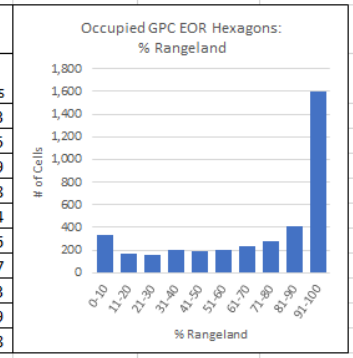
Using the NHF to identify areas within the EOR with greater or equal to 97% rangeland identified 15% of the GPC EOR, however once the top 10% thresholds from four other variables were included, the area was reduced to 7.7% of the GPC EOR based on the cumulative thresholds being applied (Figure 14). A similar process conducted on the STG EOR (US portion only), initially identified 20.8% of the EOR based just on areas with greater or equal to 98% rangeland but was reduced to 6.0% of the STG EOR once the cumulative effects of other variables were added (Figure 15).

GPC EOR Hexagons % Rangeland		
% of data	Threshold Values (%)	# Cells
0-10	2	73,614
11-20	12	29,889
21-30	25	25,658
31-40	41	23,251
41-50	59	22,326
51-60	76	21,790
61-70	91	21,568
71-80	97	22,795
81-90	100	27,728
91-100	100	115,771



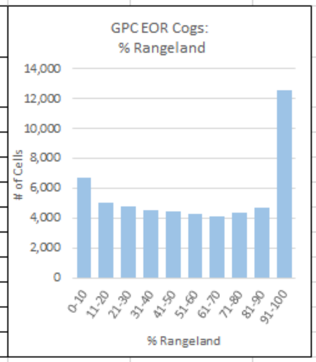
mean	55.2
median	59

GPC EOR Occupied Hexagons % Rangeland		
% of data	Threshold Values (%)	# Cells
0-10	13	333
11-20	35	165
21-30	55	159
31-40	71	198
41-50	84	194
51-60	92	206
61-70	96	237
71-80	97	273
81-90	99	409
91-100	100	1,598



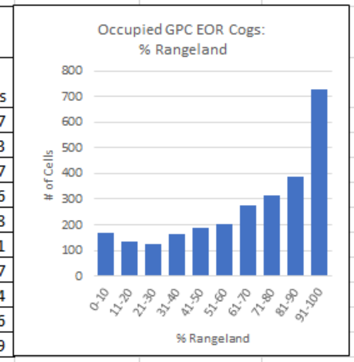
mean	69.3
median	84

GPC EOR Cogs % Rangeland		
% of data	Threshold Values (%)	# Cells
0-10	8	6,730
11-20	19	5,075
21-30	31	4,818
31-40	43	4,568
41-50	56	4,453
51-60	69	4,325
61-70	82	4,165
71-80	93	4,397
81-90	99	4,685
91-100	100	12,572



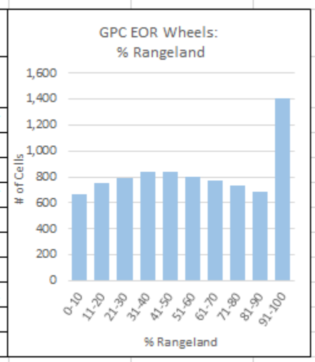
mean	54.9
median	56

GPC EOR Occupied Cogs % Rangeland		
% of data	Threshold Values (%)	# Cells
0-10	18	167
11-20	37	133
21-30	52	127
31-40	64	166
41-50	74	188
51-60	81	201
61-70	89	277
71-80	94	314
81-90	97	386
91-100	100	729



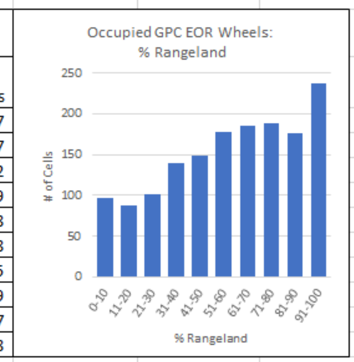
mean	65.8
median	74

GPC EOR Wheels % Rangeland		
% of data	Threshold Values (%)	# Cells
0-10	13	667
11-20	23	756
21-30	34	789
31-40	44	837
41-50	54	840
51-60	64	803
61-70	75	776
71-80	87	734
81-90	96	688
91-100	100	1,405



mean	54.1
median	54

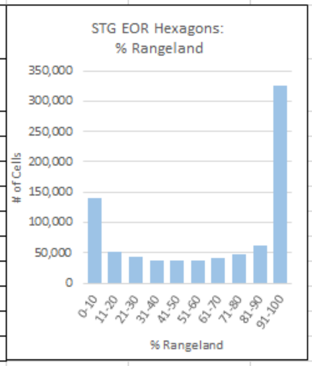
GPC EOR Occupied Wheels % Rangeland		
% of data	Threshold Values (%)	# Cells
0-10	17	97
11-20	33	87
21-30	44	102
31-40	54	139
41-50	62	148
51-60	70	178
61-70	78	185
71-80	86	189
81-90	94	177
91-100	100	238



mean	58.8
median	62

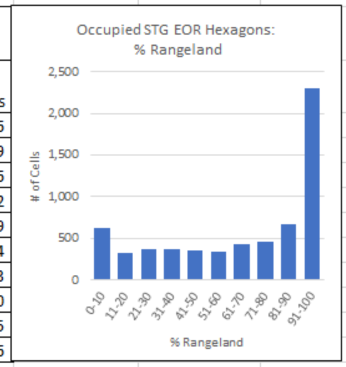
Figure 12. Summary statistics of the percent rangeland in NHF cells (hex, cog, wheel) as split into all the cells in the GPC EOR (left column) and the cells in the EOR occupied by GPC (right column). The tables show the threshold (or breakpoint) that divides percentiles of the data when sorted. The histograms show the number of cells that have different percentiles of rangeland. By comparing across cells resolutions, insights into the effects of scale are evident. At the local hexagon level there is a steep drop off in the number of occupied cells when you drop below 90% rangeland. Conversely, many occupied cells occur all the way down to 51-60% rangeland when the landscape is assessed at the broader wheel level.

STG EOR Hexagons % Rangeland		
% of data	Threshold Values (%)	# Cells
0-10	3	140,997
11-20	15	52,466
21-30	33	42,480
31-40	55	38,238
41-50	75	37,151
51-60	90	37,752
61-70	97	40,583
71-80	100	46,658
81-90	100	61,195
91-100	100	325,846



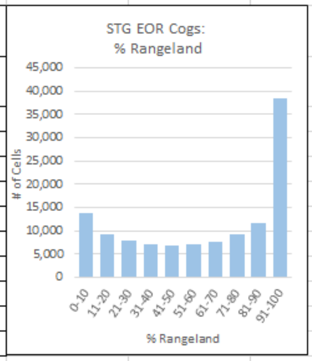
mean	61.8
median	75

STG EOR Occupied Hexagons % Rangeland		
% of data	Threshold Values (%)	# Cells
0-10	10	626
11-20	28	329
21-30	45	366
31-40	63	372
41-50	77	349
51-60	88	344
61-70	94	423
71-80	97	460
81-90	100	665
91-100	100	2,306



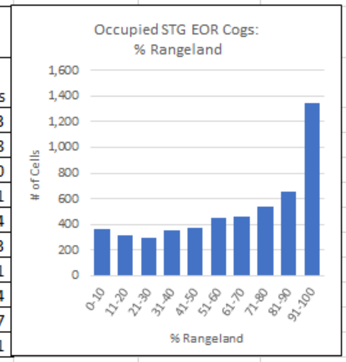
mean	65.5
median	77

STG EOR Cogs % Rangeland		
% of data	Threshold Values (%)	# Cells
0-10	9	13,703
11-20	22	9,111
21-30	38	7,772
31-40	55	7,101
41-50	70	6,916
51-60	83	7,185
61-70	92	7,719
71-80	98	9,168
81-90	100	11,708
91-100	100	38,323



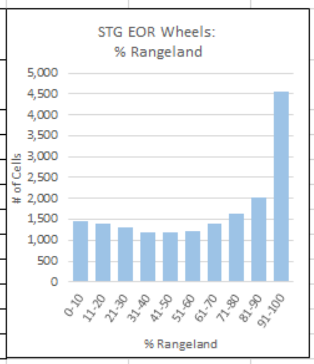
mean	61.5
median	70

STG EOR Occupied Cogs % Rangeland		
% of data	Threshold Values (%)	# Cells
0-10	15	363
11-20	32	318
21-30	47	300
31-40	58	351
41-50	70	374
51-60	79	453
61-70	88	461
71-80	94	544
81-90	98	657
91-100	100	1,341



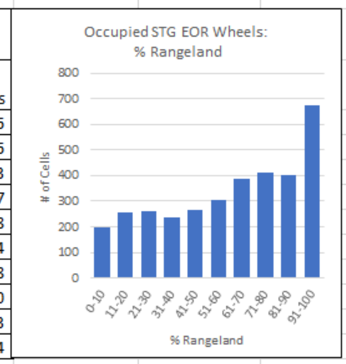
mean	63.2
median	70

STG EOR Wheels % Rangeland		
% of data	Threshold Values (%)	# Cells
0-10	13	1,442
11-20	25	1,410
21-30	39	1,308
31-40	54	1,198
41-50	67	1,202
51-60	78	1,222
61-70	88	1,393
71-80	94	1,633
81-90	98	2,021
91-100	100	4,540



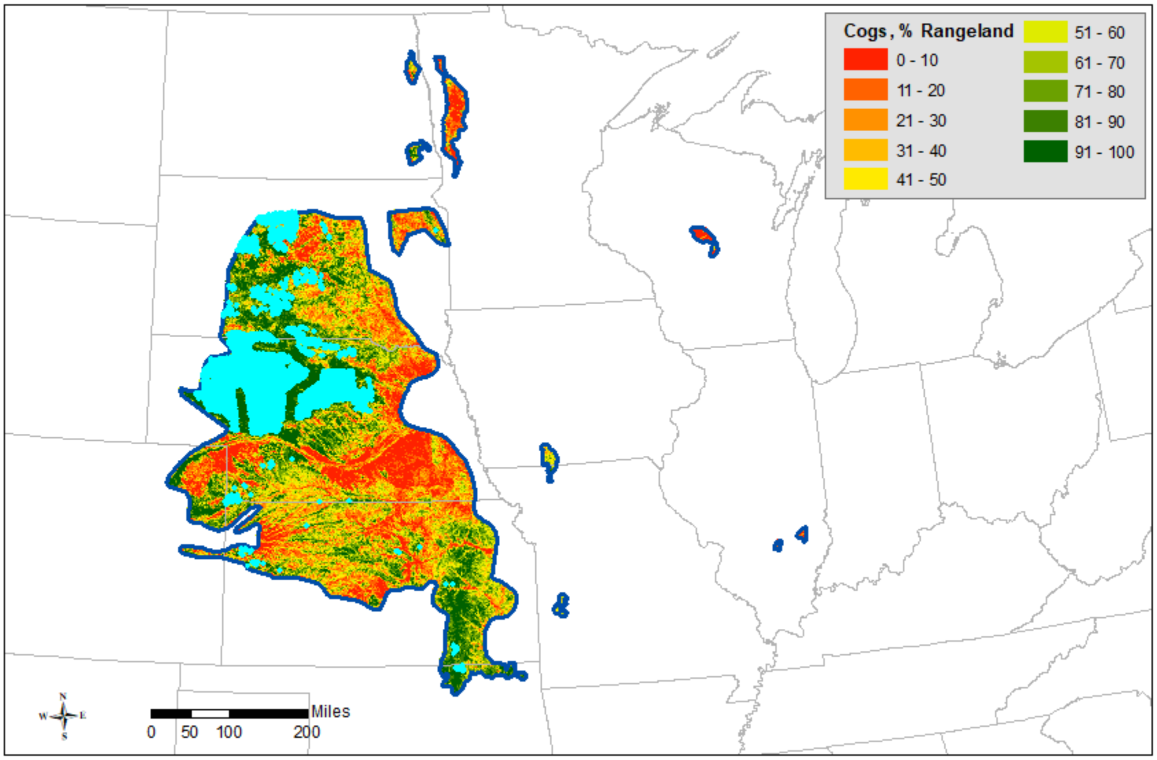
mean	60.7
median	67

STG EOR Occupied Wheels % Rangeland		
% of data	Threshold Values (%)	# Cells
0-10	16	196
11-20	29	256
21-30	43	263
31-40	55	237
41-50	65	268
51-60	74	304
61-70	82	388
71-80	90	410
81-90	96	403
91-100	100	674



mean	60.3
median	65

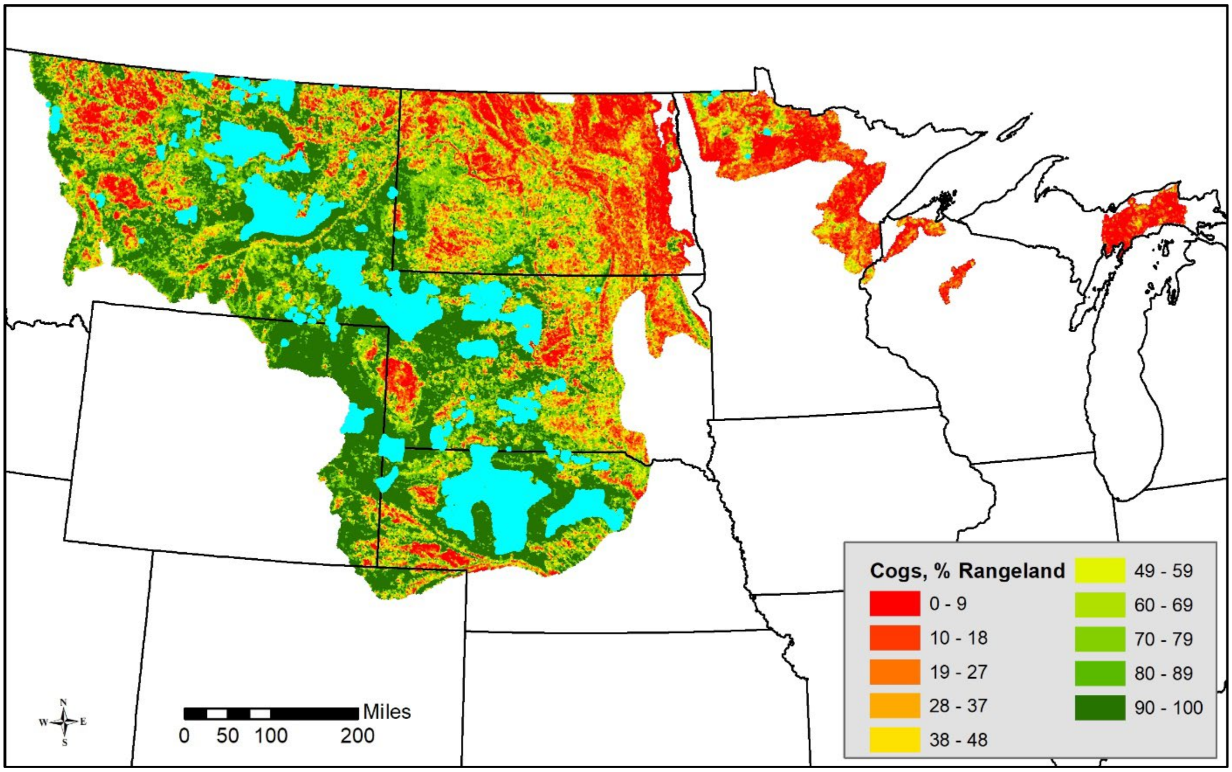
Figure 13. Summary statistics of the percent rangeland in NHF cells (hex, cog, wheel) as split into all the cells in the STG EOR (left column) and the cells in the EOR occupied by STG (right column). The tables show the threshold (or breakpoint) that divides percentiles of the data when sorted. The histograms show the number of cells that have different percentiles of rangeland. By comparing across cells resolutions, insights into the effects of scale are evident. At the local hexagon level there is a steep drop off in the number of occupied cells when you drop below 90% rangeland. Conversely, a moderate number of occupied cells continue to occur down to 61-70% rangeland when the landscape is assessed at the broader wheel level.



Cells highlighted in blue meet the top 10% criteria for all five of the below variables and represent a total of 7.7% of the GPC EOR.

Variable	Top 10% threshold value from occupied cogs	Percent of the EOR meeting threshold	Cumulative proportion of EOR meeting criteria.
% rangeland	>= 97%	8,359 / 55,788 = 15.0 %	8,359 / 55,788 =15.0 %
% woodland Alt. % woodland	= 0% *< 3%*	34,391 / 55,788 = 61.6% *43,207/ 55,788 = 77.4%*	7,785 / 55,788 = 13.9% *8,321/55,788 = 14.9%*
% crop Alt. % crop	= 0% *< 25%*	11,279 / 55,788 = 20.2% *24,438/ 55,788 = 43.8%*	7,152 / 55,788 = 12.8% *8,321/55,788 = 14.9%*
# active wells Alt. # active wells	= 0 *= 0*	51,641 / 55,788 = 92.6% *51,641/ 55,788 =92.6%*	7,043 / 55,788 = 12.6% *8,181/55,788 = 14.7*
Meters to Trans. *Alt. meters to transmission*	>= 12,306 *>= 5,000*	13,736 / 55,788 = 24.6% *1,341/ 55,788 =2.4%*	4,270 / 55,788 = 7.7% *6,369/55,788 = 11.4%*

Figure 14. Map of the areas of the GPC EOR that match the conditions found at the top 10% of GPC occupied cells. The table provides the variables assessed, the top 10% threshold value used, and the proportion of the EOR that qualifies (both individually and cumulatively with the other variables). As an exercise to explore the results of a different threshold scenario, an alternative and slightly less restrictive threshold was selected and the proportions of the EORs that met that scenario are provided in gray italics.



Cells highlighted in blue meet the 10% criteria for all five of the below variables and represent a total of 6 % of the STG EOR (US only).

Variable	90% threshold value from occupied cogs	Percent of the EOR meeting threshold	Cumulative proportion of EOR meeting criteria
% rangeland	>= 98%	24,446 / 117,460 =20.8%	24,446 / 117,460 = 20.8%
% woodland	= 0%	78,872 / 117,460 = 67.1%	22,193 / 117,460 = 18.9 %
Alt. % woodland	*< 5%*	97,886 / 117,460 = 83.3%	24,446 / 117,460 = 20.8%
% crop	= 0%	46,810 / 117,460 = 39.9%	20,791 / 117,460 = 17.7%
Alt. % crop	*< 25%*	74,509 / 117,460 = 63.4%	24,446 / 117,460 = 20.8%
# active wells	= 0	111,182 / 117,460 = 94.7%	19,878 / 117,460 = 16.9%
Alt. # active wells	*< 2*	112,988 / 117,460 = 96.2	23,708 / 117,460 = 20.2%
Meters to Trans.	>= 20,002	18,849 / 117,460 = 16.0%	7,066 / 117,460 = 6.0%
Alt. meters to transmission	*>= 5,000*	62,100 / 117,460 = 52.9%	15,082 / 117,460 =12.8%

Figure 15. Map of the areas of the STG EOR that match the conditions found at the top 10% of STG occupied cells. The table provides the variables assessed, the top 10% threshold value used, and the proportion of the EOR that qualifies (both individually and cumulatively with the other variables. An alternative and slightly less restrictive threshold was selected and the proportions of the EORs that met that scenario are provided in gray italics.

As mentioned previously, the habitat varies widely across the range of the GPC and STG, with the biggest difference occurring between the eastern and western portions of the range. This section will explore the conditions in each region as defined by the habitat ecoregion (Figure 5) and also how rangeland proportions change with the cell resolution. In the east, where larger areas of rangeland habitat are scarce, the top 10% of GPC occupied cogs were 83% rangeland, however habitat conditions quickly declined for the GPC beyond the top 10% of occupied cells with the top 25% of occupied cogs having 64% rangeland, and there was less than 35% rangeland at 50% of occupied GPC cogs. In the eastern region of the GPC EOR, the top 10% of occupied GPC hexagons had greater than 94% rangeland, while at the 7 km^2 cog level the top 10% of cogs had more than 83% rangeland, and at the 49 km^2 wheel level the top 10% of cells were greater than 67% rangeland (Table 11).

For the STG, the habitat availability is very similar. In the eastern portion of the STG range the top 10% of occupied STG hexagons had greater than 75% rangeland, while at the 7 km^2 cog level the top 10% of cogs had more than 61% rangeland, and at the 49 km^2 wheel level the top 10% of cells were greater than 50% rangeland. In the eastern part of the range for STG, woody wetlands and forest edge make up a large portion of the STG habitat, so while proportions are lower for the STG than the GPC, it is likely due to this account focusing just on rangeland and not accounting for the woodier habitat areas (Table 12).

Table 11. Number of GPC occupied cells per habitat region and the proportion of the EOR that meets the percent rangeland threshold that was derived from the top 10% of occupied cells.

	# cells with GPC present - west	# cells with GPC present - east	Top 10% of occupied GPC cells - west	Top 10% of occupied GPC cells - east
# of Hexagons	3,051/355,645	710/40,638	(Rangeland =100%) 56,722/355,645	(Rangeland >=94%) 896/40,638
% of Hexagons	0.9%	1.7%	15.9%	2.2%
# of Cogs	2,252/51,637	512/6,124	(Rangeland =98%) 7,311/51,637	(Rangeland >=81%) 197/6,124
% of Cogs occupied	4.3%	8.4%	14.2%	3.2%
# of Wheels	1,282 / 7,519	256 / 996	(Rangeland >=95%) 1,049/7,519	(Rangeland >=68%) 59/996
% of EOR Wheels	17.1%	25.7%	14.0%	5.9%

Table 12. Number of STG occupied cells per habitat region and the proportion of the EOR that meets the percent rangeland threshold that was derived from the top 10% of occupied cells.

	# cells with STG present - west	# cells with STG present - east	Top 10% of occupied STG - west	Top 10% of occupied STG - east
# of Hexagons	5,414/749,677	699 /65,040	(Rangeland >=100%) 180,233/749,677	(Rangeland >=75%) 2,937/65,040
% of Hexagons	0.7%	1.1%	24.0%	4.5%
# of Cogs	4,441/107,774	606/9,646	(Rangeland >=99%) 20,046/107,774	(Rangeland >=61%) 478/9,646
% of Cogs	4.1%	6.3%	18.6%	5.0%
# of Wheels	2,874/15,574	456/1,572	(Rangeland >=97%) 2,727/15,574	(Rangeland >=51%) 87/1,572
% of Wheels	18.5%	29.0%	17.5%	5.5%

The higher proportions of hexagon cells meeting the upper 10% threshold value for rangeland than were reported for cogs or wheels may indicate that smaller local areas are meeting general grassland habitat needs, but at more regional levels, the habitat composition is more fragmented and less suitable for the birds. This mirrors what was observed in the classification of large intact rangelands (Figure 10) that showed lots of sites that had greater than 75% rangeland and were greater than 50,000 acres when mapped by connected hexagons, but far fewer when larger landscapes (wheels) were used to identify areas that were at least 75% grassland and over 50,000 acres.

GPC/STG Grassland Habitat Priority Areas

The creation of priority areas for GPC and STG is an important step towards a coordinated effort around rangewide population and habitat strategies. While part of a rangewide plan, states participating in this effort needed the independence and flexibility to create their own priority areas. This was to be expected given the broad and diverse landscape, with different grouse population levels, and different habitat priorities. To address this, each state developed their own priority areas, informed by the data sets that were intersected and summarized into the NHF. In instances where more (state specific) information was needed, states could summarize those layers using the grid and integrate them into the NHF to further assist the delineation. Additional datasets that were suggested include: state specific habitat probability models, existing or planned priority areas from other compatible causes, current conservation or management areas. Even with all this information available, expert opinions from people familiar with the region were important when identifying the particular cells to define each priority area.

Since the NHF cog cells generalize the landscape and map with coarser spatial resolutions (7 km^2), some priority areas will likely include a mix of habitat types and levels of suitability. In this way, the coarser spatial resolution of the priority areas offers some benefits. The larger area allows for flexibility in identifying the best project locations based on the landowner interest, issue of concern, and project objectives. Going forward, the priority areas could be used as common focal points for grassland habitat efforts, including those targeting preservation, conservation/management plans, or restoration activities. States were free to identify whatever types and/or sizes of priority areas suited their particular needs.

Priority Area Example

While the specific method of identifying priority areas varied by each state, there were some common datasets used to inform priority areas such as known bird observations, percent rangeland, being part of a 50,000 acre large intact rangeland, wind turbine presence, well presence, and custom integrated datasets.

An example query process like the one provided here could easily be adjusted to meet particular state needs. In this example, a series of selections were made with increasingly more restrictions. Starting with the least specific goal of identifying “cells of grassland landscapes with few trees”, that were ranked as “3’s”. Those same areas, but further filtered to also require cells to be “part of a 50,000 acre intact rangeland” were ranked as “2’s”. Adding on the requirement of being a “GPC occupied cell” further trimmed the cells selected, with the final selection of cells ranked as “1’s” (Figure 16).

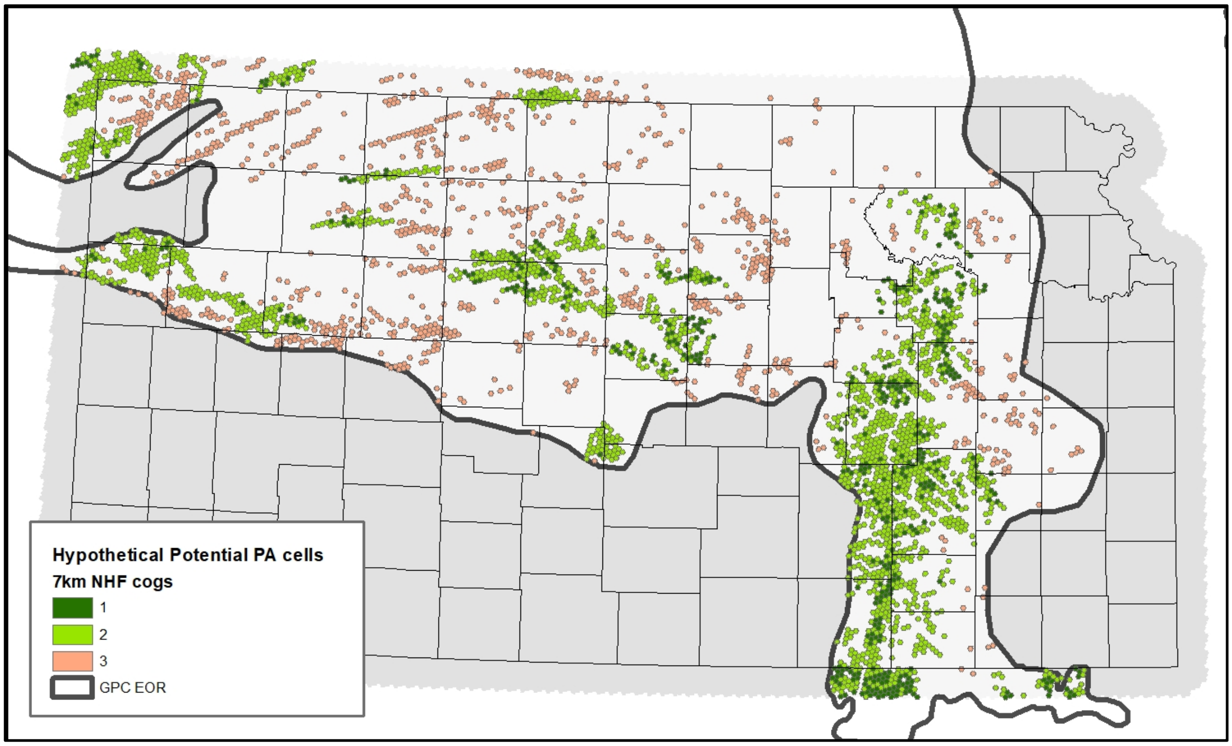


Figure 16. Example of ranking process that could be used to guide the creation of priority areas.

ArcGIS process used to identify and rank hypothetical potential priority area cells.
GPC_range = 'in GPC range' AND Pct_range >=75 AND Pct_Forest <5
Calculate field, **Priority area = 3** (3,182 cogs)

Add on, AND part of 50 k rangeland:
GPC_range = 'in GPC range' AND Pct_range >=75 AND Pct_Forest <5 AND LIRangeland = 'part of >= 50,000ac block with>=75rangeland and <20%forest'
Calculate field, **Priority area = 2** (2,204 cogs)

Add on, AND GPC present:
GPC_range = 'in GPC range' AND Pct_range >=75 AND Pct_Forest <5 AND LIRangeland = 'part of >= 50,000ac block with>=75rangeland and <20%forest' AND GPC_present = 'GPC present'
Calculate field, **Priority** area = 1 (438 cogs)

State Priority Areas

When the priority area from each state were assembled, a rangewide view of priority areas was created (Figure 17). Rangewide, priority areas submitted by Iowa, Minnesota, Nebraska, North Dakota, Oklahoma, South Dakota Wisconsin, cover a total of 179,737 km^2 (69,397 mi^2). The 208 priority areas had a mean size of 988 km^2 (Table 13), with the largest priority area being 52,401 km^2 in the Sandhills of Nebraska. State specific maps of priority areas and the process used to define the priority areas can be found in appendix 4. The landcover within each states priorities areas were summarized and expected, rangeland was the dominant cover (Table 14).

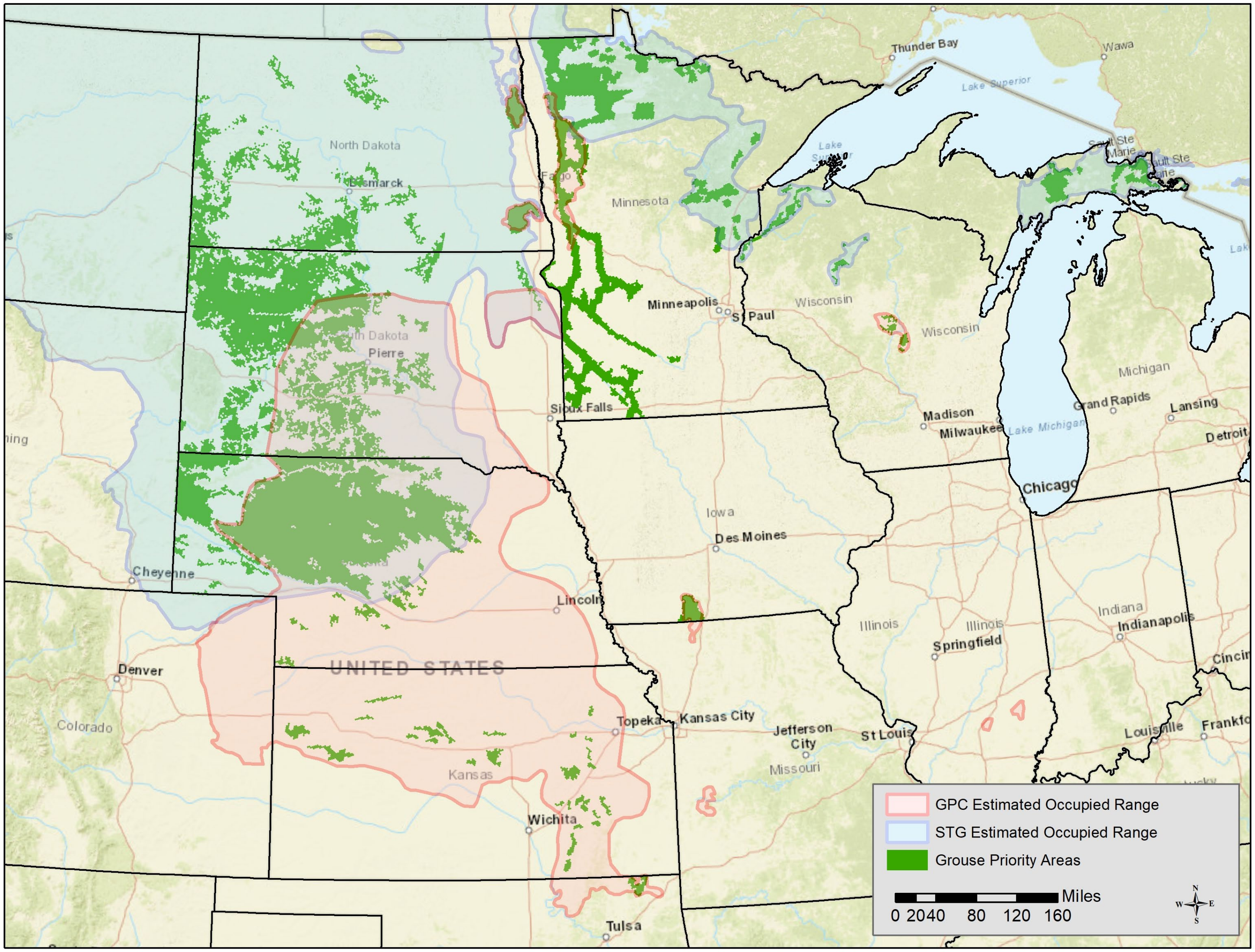


Figure 17. Priority grassland habitat areas to support greater prairie-chickens and sharp-tailed grouse.

Priority areas may function in different ways across the states, but a common objective of these areas is for them to be sustained as good to high quality grassland and shrubland habitats able to sustain local grouse populations as well as other species in need of conservation. Progress towards more rangeland habitat within the priority areas may be due to land management plans, tree/brush removal, prescribed fire, or other activities as needed. The landcover change within priority areas can be tracked every couple years as the NLCD landcover updates. Additionally, the priority areas, can serve as places to monitor as representatives of important grasslands landscapes. These areas likely contain a range of habitat conditions and a rich diversity of species that could provide useful information.

Table 13. Assessment of the size of priority areas by state and region.

State/Region	Total km^2 (mi^2)	Mean km^2 (mi^2)	Max km^2 (mi^2)
CO	NA	NA	NA
IA	1,165 (450)	1,165 (450)	1,165 (450)
Il	NA	NA	NA
KS	4,955 (1,913)	191 (74)	650 (251)
MI	3,405 (1,315)	567 (219)	1,786 (690)
MN	32,707 (12,628)	1,817 (702)	26,036 (10,053)
MO	NA	NA	NA
MT	NA	NA	NA
ND	19,883 (7,677)	288 (111)	9,199 (3,552)
NE	59,606 (23,014)	1,753 (677)	49,203 (18,997)
OK	531 (205)	531 (205)	531 (205)
SD	55,328 (21,362)	1,287 (497)	31,857 (12,300)
WI	2,156 (832)	180 (69)	1,078 (416)
WY	NA	NA	NA
Western	**140,303** (54,170)	**757** (292)	**49,203** (18,997)
Eastern	**39,433** (15,225)	**738** (285)	**26,036** (10,053)
Rangewide	**179,737** (69,397)	**749** (289)	**49,203** (18,997)

Table 14. Assessment of the landcover composition (from 2019 NLCD) of priority areas by state and region.

state/region	Total km^2 (mi^2)	% Rangeland	% Trees	% Cropland
CO	NA	NA	NA	NA
IA	1,165 (450)	50.6%	9. 2%	34.6%
Il	NA	NA	NA	NA
KS	4,955 (1,913)	89.5%	1.1%	6.5%
MI	3,405 (1,315)	61.9%	26.4%	0.1%
MN	32,707 (12,628)	24.0%	6.2%	44.6%
MO	NA	NA	NA	NA
MT	NA	NA	NA	NA
ND	19,883 (7,677)	79.6%	0.8%	14.1%
NE	59,606 (23,014)	93.0%	0.1%	0.9%
OK	531 (205)	88.6%	5.7%	2.9%
SD	55,328 (21,362)	93.9%	0.2%	3.3%
WI	2,156 (832)	30.7%	41.1%	14.6%
WY	NA	NA	NA	NA
Western	**140,303** (54,170)	91.3%	0.3%	4.0%
Eastern	**39,433** (15,225)	28.4%	9.9%	38.8%
Rangewide	**179,737** (69,397)	77.5%	2.4%	11.6%

Exploring Conservation, Restoration, Risk, and Effort Tracking.

The data in the NHF can be explored further to identify groups of cells for specific project goals. There are many types of priorities, and states often have different priorities, and priorities change. In the below scenarios, the data within the cells of priority areas can be further analyzed to highlight information useful to target applications. Figure 18 shows examples of how certain efforts might want to identify what cells may be good tree removal priority areas (A), or areas where coordination with the energy industry may be important (B), or areas where conditions appear favorable and represent good candidates for conservation efforts (C).

It is also vitally important to track the efforts on the landscape to highlight the progress made. Since most of these conservation efforts come from a mix of funding and implementation sources, and landowner privacy is a critical issue, the NHF can help aggregate efforts while keeping precise spatial details obscured. Data from conservation efforts such as acres, practice, program, and partner agency/organization can all be summarized per cell to both show the cumulative efforts and the amount of each type of effort per cell, all while keeping sensitive data private.

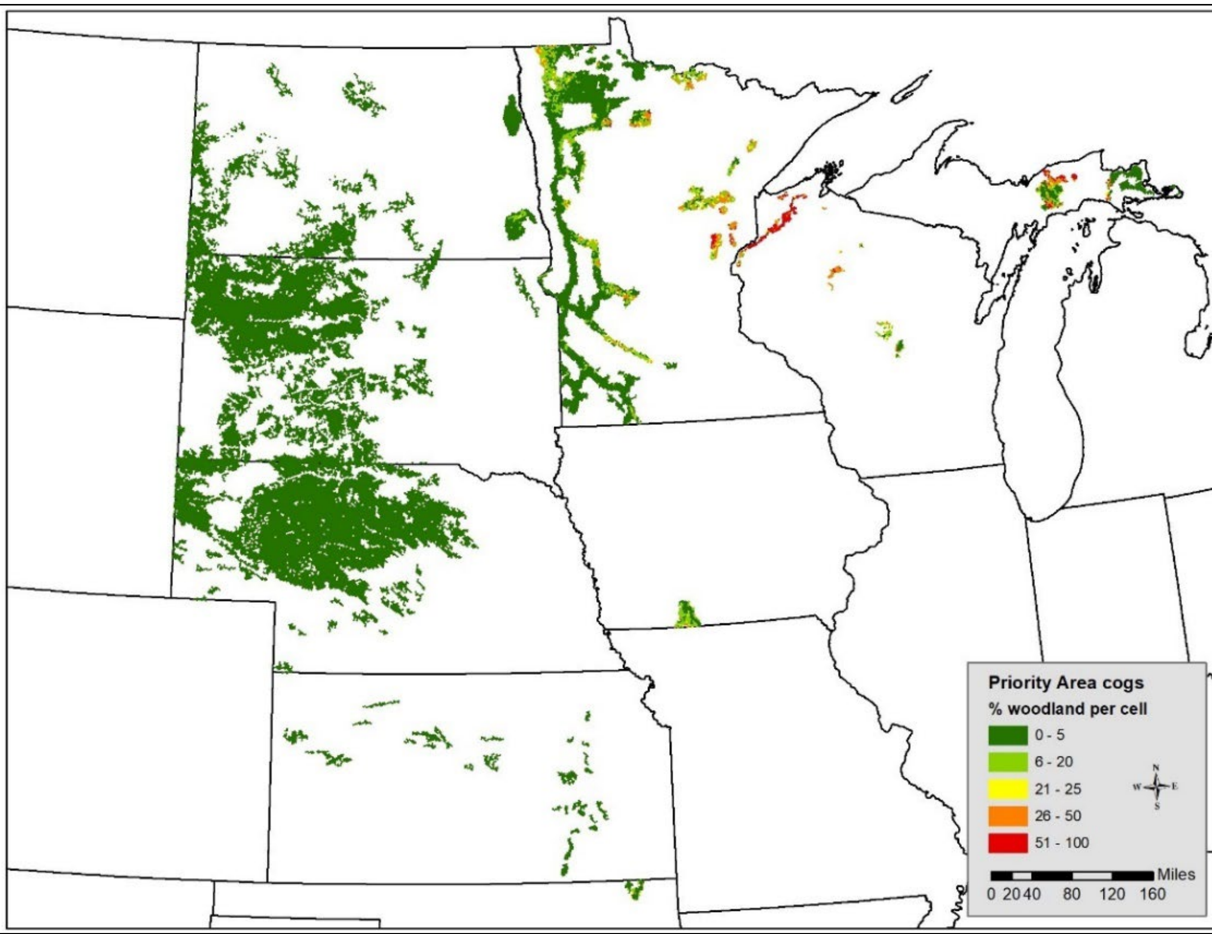


Figure 18A. Tree encroachment risk per cog in priority areas.

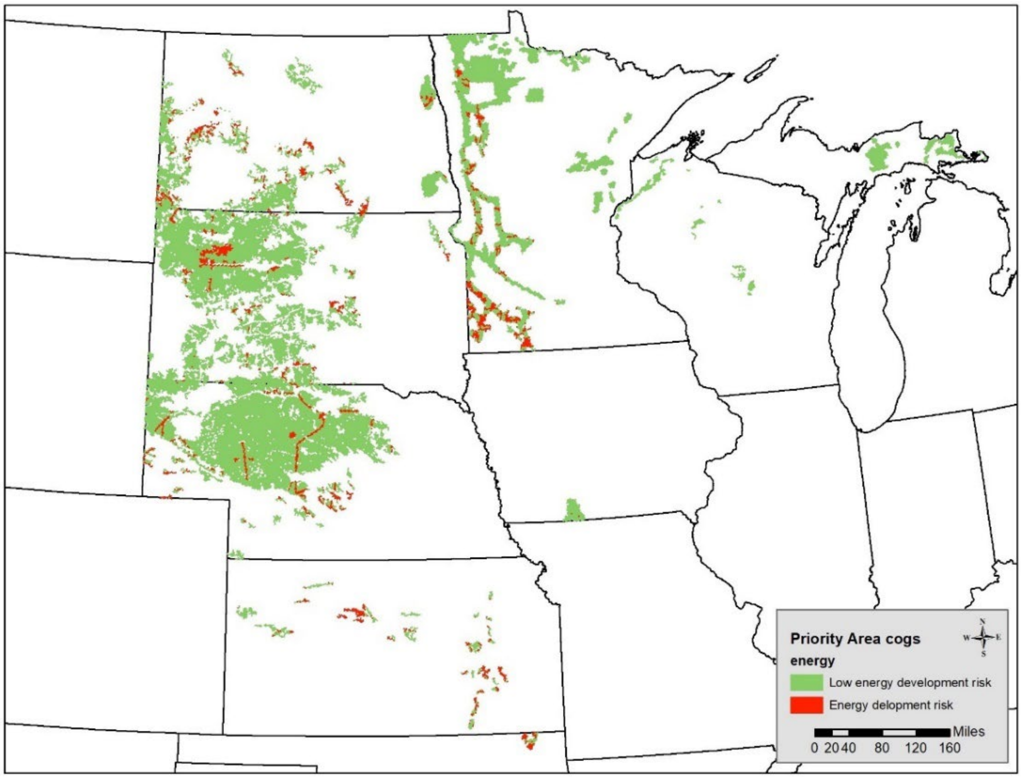


Figure 18B. Energy development potential per cog in priority areas.

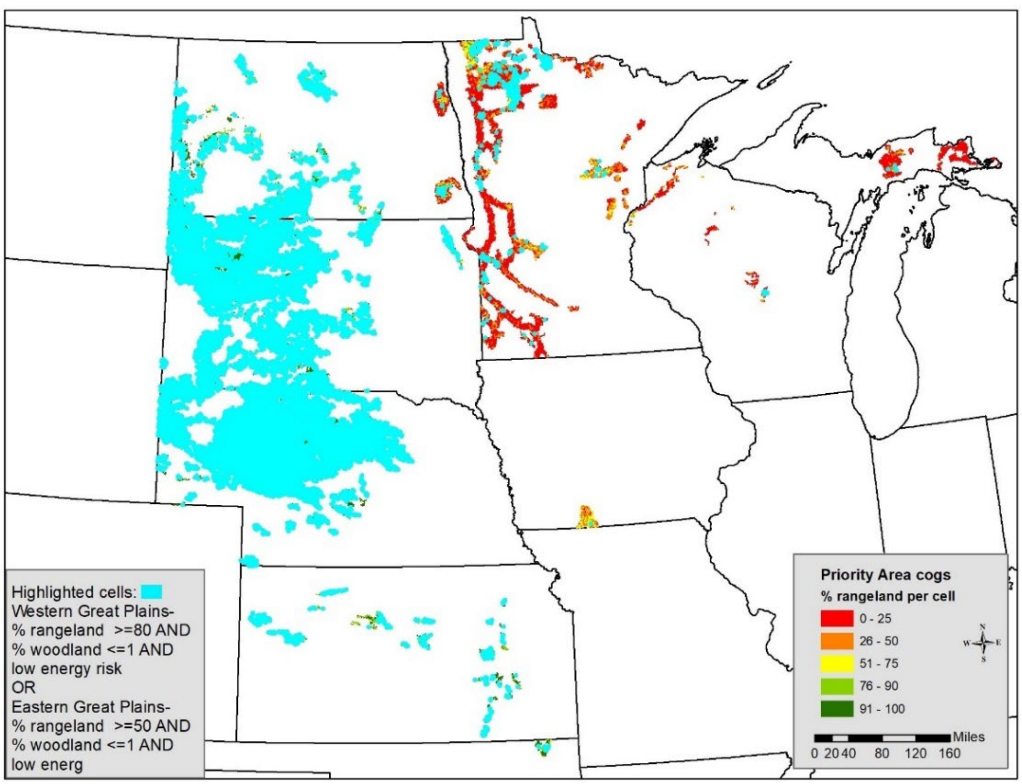


Figure 18C. Regionally high proportions of grass (>80, >50 in west /east respectively), AND less than or equal to one percent of woodlands present, AND low energy risk.

Existing Conservation Programs

United States Fish and Wildlife Service (USFWS) - https://www.fws.gov/

The USFWS influences prairie grouse habitat through direct ownership and management of habitat, protection of habitat through easements, and cooperation with private landowners. The Partners for Fish and Wildlife Program provides technical and financial assistance to landowners interested in restoring and enhancing wildlife habitat on their land. Projects are custom-designed to meet landowners' needs. Since the program's start in 1987, some 50,000 landowners have worked with Partners staff to complete 60,000 habitat restoration projects on 6 million acres. Participation is voluntary and landowners continue to own and manage their land to serve their needs while they improve conditions for wildlife.

The goal is to maintain productive working lands while improving their health as wildlife habitat. Efforts are focused on areas of conservation concern, such as upland forests, wetlands, native prairies, marshes, rivers and streams. Projects are designed to benefit federal trust species including migratory birds, endangered, threatened and at-risk species. Prairie grouse will benefit from Partners projects that promote sustainable and well managed grazing lands. Projects could include technical assistance related to grazing plans integrated with financial assistance for necessary infrastructure (fence, livestock water). The Partners program could also be help grass-based producers control woody encroachment which would improve livestock production and improve prairie grouse habitat. Technical and financial assistance for cropland to grassland conversions would also benefit prairie grouse in select landscapes.

The USFWS owns and manages prairie grouse habitat, most notably through lands of the National Wildlife Refuge System. Overlap between these lands and occupied prairie grouse range is most common in the Dakotas, Montana, Minnesota and Nebraska. Prairie grouse will benefit when adequate resources are available to manage for healthy prairie habitat on these lands. The USFWS also protects grasslands on private lands through the purchase of voluntary grassland easements. Most grassland easements are focused on the prairie pothole region (PPR) in areas of high wetland density, but substantial overlap with occupied prairie grouse habitat occurs. Although this program focuses on waterfowl habitat and is funded with primarily Migratory Bird Conservation Stamp funds, it represents one of the most important habitat protection mechanisms for prairie grouse habitat in the PPR. Prairie grouse would benefit from the continued implementation of this program or enhanced funding for program expansion.

The North American Wetlands Conservation Act (NAWCA) is a non-regulatory, incentive-based, voluntary wildlife conservation program. NAWCA stimulates public-private partnerships to protect, restore, and manage wetland habitats for a diversity of migratory birds and other wildlife. NAWCA is administered by the USFWS. NAWCA provides challenge grants for wetlands conservation projects in the U.S., Canada and Mexico. NAWCA projects commonly protect grasslands with easements which directly benefit prairie grouse. State wildlife agencies and non-profit conservation groups should continue to provide required match and use these grants for upland conservation. The program will be most successful if funding remains steady or increases.

United States Department of Agriculture (USDA) - https://www.usda.gov/

Prairie grouse populations benefit from a number of USDA Farm Bill conservation programs that are designed to restore and enhance grassland and wetland habitats on private lands. These voluntary programs are administered by the Farm Service Agency (FSA) and Natural Resources Conservation Service (NRCS), who provide technical and financial assistance to private landowners.

The Conservation Reserve Program (CRP) provides cost-share and an annual rental payments to private landowners willing to convert marginal cropland to perennial vegetation, such as native grasses and forbs. Prairie grouse benefit from this program when implemented in landscapes with high amounts of existing grass or where the addition of CRP is expected to meet grassland need thresholds. The program could provide enhanced benefits to prairie grouse by targeting favorable landscapes in occupied range with well-funded and coordinated initiatives. Establishment and management of CRP grasslands should be conducted consistent with prairie grouse habitat needs, which may benefit from consultation with state wildlife agencies.

The Environmental Quality Incentives Program (EQIP) is a voluntary conservation program that promotes agricultural production, forest management, and environmental quality as compatible goals. Through EQIP, farmers and ranchers may receive financial and technical assistance to install or implement structural and management conservation practices on eligible agricultural land. NRCS administers EQIP with funding derived from the Commodity Credit Corporation. EQIP offers contracts with a minimum term that ends one year after the implementation of the last scheduled practice and a maximum term of 10 years. EQIP activities are carried out according to a conservation plan of operations developed with the program participants. Similar to CRP, prairie grouse will benefit most from EQIP with coordinated, well-funded and strategic implementation of the program. Collaboration should occur with state wildlife agencies to tailor program specifics to maximize benefits to prairie grouse. The flexibility of EQIP provides a tremendous opportunity to address specific threats across the North American range of greater prairie-chickens and sharp-tailed grouse. These species benefit from EQIP practices designed to restore grasslands, improve management and habitat quality of existing grasslands, and control woody encroachment.

The Agricultural Conservation Easement Program (ACEP) protects the agricultural viability and related conservation values of eligible land by limiting nonagricultural uses which negatively affect agricultural uses and conservation values, protect grazing uses and related conservation values by restoring or conserving eligible grazing land, and protecting and restoring and enhancing wetlands on eligible land. Prairie grouse will benefit from the protection of grassland habitat in occupied range, especially where large intact grasslands are vulnerable to conversion to other uses. Prairie grouse will benefit most when ACEP is focused on protecting grasslands and remains well funded.

Bureau of Land Management (BLM) - https://www.blm.gov/

The BLM owns and manages land and sub-surface mineral estate across the west. Within the prairie grouse range, BLM lands are most prominent in the Dakotas, Wyoming, Montana and Colorado. BLM lands are managed for multiple uses under the direction of Resource Management Plans (RMP) developed for specific planning areas. Most BLM lands consist of upland prairie or shrub/steppe habitat and many support sharp-tailed grouse populations. Prairie grouse will benefit when RMPs are developed with adequate habitat protections while still maintaining the necessity to be available for multiple uses. State wildlife agencies should coordinate closely with BLM during RMP development and assure stipulations within existing RMPs are adhered to. The BLM and State wildlife agencies should continually monitor the state of the science related to prairie grouse and revise/update plans as appropriate.

United States Forest Service (USFS) - https://www.fs.usda.gov/

The USFS owns and manages vast acreages of grassland habitat within various National Grasslands and National Forests, particularly the former. Similar to BLM lands, National Grasslands and National Forest management are guided by resource management plans specific to planning areas. Specific management provisions within management plans will ultimately dictate the value of these lands as prairie grouse habitat. Balancing livestock grazing and management for desired vegetation structure and diversity for prairie grouse is paramount for USFS lands. Wildlife agencies should be engaged in USFS planning processes to assure prairie grouse habitat needs are considered. Well managed grazing is key to sustainability of rangeland production and equally as important to maintain favorable habitat for prairie grouse. Other management actions such as prescribed fire or control of woody encroachment may or should be high priority management considerations for some planning areas to restore and maintain suitable habitat conditions.

The Nature Conservancy (TNC) - https://www.nature.org/en-us/

The TNC has various ongoing programs and initiatives that provide benefits to prairie grouse. TNC owns a number of preserves within our planning area that are actively managed for prairie grouse and other grassland-dependent species. TNC also offers conservation easements to interested landowners in select areas throughout the planning area. TNC is also engaged in various local efforts coordinated within each state program.

Migratory Bird Joint Ventures - https://mbjv.org/

Migratory Bird Joint Ventures are cooperative, regional partnerships that work to conserve habitat for the benefit of birds, other wildlife, and people. Since the North American Waterfowl Management Plan called for our establishment in 1986, Joint Ventures (JVs) have grown to cover nearly all of the U.S. and Canada, and much of Mexico. We are inspired by a shared vision of a North American Landscape where diverse populations of native birds thrive. We believe the well-being of our nations depends upon the health of our landscapes and our wildlife. There are twenty-two habitat-based Joint Ventures, each addressing the bird habitat conservation issues found within their geographic area. In addition, three species-based Joint Ventures, all with an international scope, work to further the scientific understanding needed to effectively manage populations of specific bird species.

Most Joint Venture offices are run through the U.S. Fish and Wildlife Service, although several JVs are operated with support from non-profit conservation partners or are stand-alone NGOs. Each JV has an overall Coordinator (larger JVs may also have individual State Coordinator, in addition), who oversees other technical JV staff. Each Joint Venture has a Management Board, which is made up of key representatives from the organizations that form the JV partnership. The Management Board provides overall leadership, guidance, resources, and support to partners to ensure that the JV reaches its bird and habitat conservation goals. Joint Ventures have one or more Technical Committees that serve as advisory groups to the JV and its staff. The primary role of the Technical Committee is to assist the JV in creating strategies, plans, and other guidance to advance the integrity and biological foundation of JVs' bird conservation planning efforts. Technical committee members include scientists, land managers, biologists, and others with expertise in migratory bird science and conservation. The committee includes individuals from universities, federal agencies, state fish and wildlife agencies, and non-governmental organizations.

Joint Venture funding comes from Congressional appropriations, administered through the U.S. Fish and Wildlife Service. Joint Venture partners bring other federal and non-federal dollars to the table to complement Congressional funds. Over the course of our history, Joint Venture partnerships have leveraged every dollar of Congressional funds 31:1 to help conserve 27 million acres of essential habitat for birds and other wildlife.

Ducks Unlimited (DU) - https://www.ducks.org/
DU has various programs that benefit prairie grouse. They have programs to protect upland and wetland habitats through easements. They commonly buy land, protect the lands with conservation easements, and then resell lands back to working ranches and farms. Some purchased lands are sold to state wildlife agencies and managed for wildlife. They also place biologists in USFWS and NRCS offices to facilitate conservation easement enrollments on private lands. Benefits to prairie grouse will be most realized where work occurs in high value landscapes that are vulnerable to loss such as cultivation. DU is a strong advocate of wetland and upland conservation and their lobbying efforts undoubtedly benefit prairie grouse populations by influencing agricultural and conservation policies at the highest levels.

Pheasants Forever (PF) - https://www.pheasantsforever.org/
PF has an expansive network of partnership biologists (e.g., Farm Bill Biologists, Coordinating Wildlife Biologists) working to deliver USDA conservation programs, increase capacity to deliver state programs, and manage public lands. These biologists are uniquely positioned to use their skills as biologists and access to well-funded programs to enhance habitat across large landscapes. The benefits to prairie grouse will be optimized when programs protect, enhance or establish grassland habitat in occupied range, especially priority areas. PF has other programs, initiatives and advocacy efforts that benefit prairie grouse and other wildlife. Their long history of relentless advocacy for strong conservation provisions of the Farm Bill are second to none.

Bird Conservancy of the Rockies (BCoR) - https://www.birdconservancy.org/
The BCoR mission is the conservation of birds and their habitats through an integrated approach of science, education and land stewardship. They envision a future where birds are forever abundant, contributing to healthy landscapes and inspiring human curiosity and love of nature. Their work radiates from the Rockies to the Great Plains, Mexico and beyond. Their efforts are advanced by sound science,

achieved through empowering people, realized through stewardship and sustained through partnerships. The BCoR maintains a network of partnership biologists in USDA service centers across much of the prairie grouse range.

American Bird Conservancy - https://abcbirds.org/

American Bird Conservancy is dedicated to conserving wild birds and their habitats throughout the Americas. This mission has guided them throughout their history of more than 25 years. With an emphasis on achieving results and working in partnership, ABC takes on the greatest problems facing birds today, innovating and building on rapid advancements in science to halt extinctions, protect habitats, eliminate threats and build capacity for bird conservation. Choosing a small but feisty hummingbird as its symbol, ABC has gone on to become known for conservation results and ability to leverage still greater accomplishments through partnerships.

State Conservation Programs

Iowa

The Iowa Department of Natural Resources (DNR) does have a greater prairie-chicken management plan (https://www.iowadnr.gov/Conservation/Iowas-Wildlife/Wildlife-Species-Restoration) to guide habitat programs and partner efforts within Iowa's GPC restoration area. One such program is the Bird Conservation Area (BCA) program (https://www.iowadnr.gov/Conservation/Bird-Conservation-Areas). Iowa's first BCA, the Kellerton Grassland BCA, was designated to encourage and focus habitat programs and partner efforts for greater prairie-chickens around the town of Kellerton, IA (https://www.iowadnr.gov/Portals/idnr/uploads/wildlife/bca/Kellerton-Prairie-Chicken.pdf).

The department also has a special Continuous CRP CP38 GPC-SAFE project with USDA to target larger blocks of CRP enrollment within Iowa's GPC focal area (https://www.iowadnr.gov/portals/idnr/uploads/Wildlife%20Stewardship/pchicken-safe.pdf).

This SAFE project puts specific restrictions on the types and amounts of native grass/forb species that landowners can plant on CRP with the specific goal to create preferred GPC habitat. The department also uses other UDSA programs like the wildlife subaccount within EQIP to encourage pasture management and tree removal on private lands within the GPC focal area. The department also partners with various non-profit organizations, like Pheasants Forever and The Nature Conservancy, to coordinate conservation efforts. The department uses funds from State Wildlife Grants and Wildlife and Sport Fish Restoration Program to fund habitat delivery. Passage of the Restoring America's Wildlife Act would increase capacity to deliver habitat.

Kansas

The Kansas Department of Wildlife and Parks' (KDWP) Habitat First program provides for the implementation of habitat management practices that include native grass/forb plantings, CRP disking, planting cover crops, tree and brush management, prescribed fire, and use exclusion (i.e., livestock exclusion).

KDWP implements a Walk-In Hunting Access program that was initiated in 1995 to enhance the hunting tradition in Kansas. The program provides recreational game hunters' access to private property, including many lands enrolled in the CRP. By 2004, more than 1 million ac (404,000 ha) had been enrolled in the walk-in hunting program. Landowners receive a payment in exchange for allowing public hunting access to enrolled lands. Payments vary by the number of acres enrolled and length of contract period. Such incentives encourage landowners to provide habitat for resident wildlife species, including the GPC.

Michigan

Michigan works with the US Forest Service, Tribal governments, local conservation districts, and private landowners to promote management for sharp-tailed grouse in the eastern Upper Peninsula. Most of the land in most of the sharp-tailed grouse range is privately owned, with public land ownership being primarily Federal ownership. Management activities on public lands include burning and timber harvest to maintain openings. On private land ownership, most of the land is used for agriculture, including hay production and pasture for livestock. Michigan also has prioritized lands in the eastern Upper Peninsula for our Hunter Access Program (HAP). This program provides monetary incentives to landowners to allow public hunting on private lands. Hunting is open in a limited area of the eastern UP and the sharp-tailed grouse range in the eastern UP, and HAP is available only within the hunting zone. A small portion of suitable habitat has been enrolled in HAP. In addition to providing more area open to sharp-tailed grouse hunting, HAP payments may also encourage landowners to continue to manage lands in a way that maintain sharp-tailed grouse populations and presence.

Outside the core range of sharp-tailed grouse, the MDNR also looks for public land locations to manage smaller pockets of habitat and known occupied leks, this activity is primarily on state owned lands. The US Fish and Wildlife Service also conducts management activity for sharptailed grouse on their lands. Management actions generally include burning, timber harvest, and brush removal to maintain open land habitats.

Minnesota

Minnesota has a variety of conservation programs that impact grasslands that are unique to the state. The Legislative-Citizen Commission on Minnesota Resources oversees the Environment and Natural Resources Trust Fund, funded by 40% of Minnesota State Lottery proceeds through 2024, private donations, and investment income, to support activities that "protect and enhance the environment and natural resources."

Reinvest in Minnesota was enacted in 1986 by the Reinvest in Minnesota Resources Act, to restore marginal and sensitive agricultural land to "protect soil and water quality and support fish and wildlife habitat." RIM is coordinated by the Board of Soil and Water Resources to protect and promote perennial vegetation land cover through permanent conservation easements on "working lands."

The Clean Water, Land and Legacy Amendment in 2008 increased the state sales tax by 3/8 of 1% to support clean water, the outdoors, arts and culture, and parks and trails. Thirty-three percent of these proceeds go to the Outdoor Heritage Fund through 2034 to provide funding ‘to restore, protect, and enhance Minnesota’s wetlands, prairies, forests, and habitat for fish, game, and wildlife” with oversight by the Lessard-Sams Outdoor Heritage Council. The Conservation Partners Legacy Grant Program, managed by the MN DNR, and funded by the Outdoor Heritage Fund, is a competitive matching grant program to non-profit organizations and government entities. Thirty-three percent of proceeds from the Clean Water, Land and Legacy Amendment fund the Clean Water Fund, overseen by the Clean Water Council, to “protect, enhance, and restore water quality.”

Native Prairie Bank easements are voluntary agreements between landowners and MN DNR, in which the landowner receives a one-time payment to manage the land in an easement to protect native prairie. The Native Prairie Tax Exemption eliminates taxes on enrolled parcels of native prairie and is administered by MN DNR and local County Tax Assessors.

Minnesota also has several nongovernmental organizations that have programs to promote habitat conservation including the Minnesota Sharp-tailed Grouse Society and Minnesota Prairie-chicken Society, both of which apply for grants to do habitat work for prairie grouse through various programs. Minnesota Land Trust protects land primarily through easements. Soil and Water Conservation Districts also manage natural resources and often work with landowners.

Nebraska

The Nebraska Game and Parks Commission (NGPC) and its partners have a long-standing history of providing technical and financial assistance to private landowners throughout the state. Collectively, there are over 50 NGPC private land biologists and partnership positions located throughout the state that help deliver USDA Farm Bill (e.g., CRP, EQIP, CSP) and state-funded conservation programs on Nebraska’s private lands. Over the past 5 years, NGPC and its partners (i.e., Natural Resources Conservation Service, Pheasants Forever, Rainwater Basin Joint Venture, Sandhills Task Force, and U.S. Fish and Wildlife Service) have leveraged significant resources to restore grassland habitat for prairie grouse on private lands. Initial efforts have been targeted in portions of the eastern Sandhills and focus on controlling eastern redcedar and improving rangeland health using mechanical tree removal and prescribed burning. More recently, this science-based approach is being expanded to other areas of the state as part of the USDA’s Great Plains Grassland Initiative.

North Dakota

The North Dakota Game and Fish Department offers incentives to allow hunter access and improve habitat primarily through their Private Lands Open To Sportsmen (PLOTS) program (see: https://gf.nd.gov/meadowlark-initiative/programs). The program offers increased payments for CRP Access, cost-shares for CRP grass and pollinator plantings, CRP Shrub plantings, CRP wildlife food plots, CRP mid-contract management, easements for wetland reserves, and match funding for the Conservation Reserve Enhancement Program. The NDGF has also recently implemented the Meadowlark Initiative (https://gf.nd.gov/meadowlark-initiative/faq) to promote native and restored grasslands. In addition to grassland conservation on private lands, the NDGF manages just over 220,000 acres of wildlife management areas, including roughly 70,000 acres of native grasslands.

South Dakota

The South Dakota Department of Game, Fish and Parks (GFP) offers a suite of habitat programs which can benefit prairie grouse (https://habitat.sd.gov/). Specifically, the department has private lands habitat biologists that work with private landowners to deliver GFP funded habitat programs. The department also partners with various non-profit organizations to place biologists in USDA service centers and USFWS offices to deliver federal conservation programs. The programs will be most beneficial to prairie grouse when grassland enhancements or restoration occur in occupied habitat, especially in priority areas. Prairie grouse will benefit most when GFP funded programs prioritize grass-based programs within budgets versus other habitat types (e.g. woody habitat establishment). The department uses funds from State Wildlife Grants and Wildlife and Sport Fish Restoration Program to fund habitat delivery. Future funding of these programs will dictate habitat delivery capacity. Passage of the Restoring America's Wildlife Act would increase capacity to deliver habitat.

Wisconsin

The Wisconsin Department of Natural Resources (WDNR) and its partners provide both technical and financial support to private landowners in efforts that benefit Greater Prairie-chickens. Pheasants Forever/Quail Forever Farm Bill Biologists and Wetland Easement Biologists are stationed throughout the state and work closely with WDNR and county USDA NRCS and FSA staff to provide consultations, site visits, technical assistance in planning and implementation of conservation practices, facilitation of enrollment in local, state, and federal financial incentive programs, and to offer trainings and workshops. There are several programs that support Greater Prairie-chicken habitat, including ACEP-WRE, EQIP, CSP, and CRP (CREP, grassland CRP, SAFE). Additionally, WDNR offers a Voluntary Public Access and Habitat Incentive Program (VPA-HIP) which provides financial incentives to private landowners who open their property to public recreation, as well as financial assistance to create or enhance wildlife habitat, such as invasive species control, native grass and forb establishment, and prescribed burning. The WDNR also offers the Wisconsin Habitat Partnership Fund, a program that involves partnerships with local government, tribes, and non-profit organizations with a focus on increasing the amount and quality of wildlife habitat on lands open for public recreation on both public and private lands.

Within the Wisconsin Sharp-tailed Grouse Range many of the same resources are available to private landowners. Partnerships involving Pheasants Forever/Quail Forever Farm Bill Biologists and Wetland Easement Biologists implement many of the same practices as in the Greater Prairie Chicken Range. An additional resource in the Northwest WI Sharp-tailed Grouse Range is the Ruffed Grouse Society that has programs to help support the Young Forest Initiative and barrens habitats. WDNR, Forestry offers the Managed Forest Law (MFL) Program providing a tax incentive to private landowners to write and follow a forest management plan.

Wyoming

The Wyoming Game and Fish Department (Department) has a long-term relationship with the USDA's Natural Resources Conservation Service and private landowners to implement Farm Bill Programs for the purpose of developing and/or enhancing perennial vegetation cover for soil erosion control and wildlife habitat. The Department has on staff terrestrial habitat biologists that work with federal/state/county and private partners to improve habitat conditions for upland game birds as opportunities arise. There are several key funding mechanisms that provide technical assistance, project design, engineering, and development. These include, but are not limited to, the Wyoming Governor's Big Game License Coalition, Wyoming Wildlife and Natural Resource Trust Fund, Department Funds, USFWS Partners for Fish and Wildlife and NGOs such as Pheasants Forever and Quail Forever. The Department also has Commission owned lands that provide habitat for sharp-tailed grouse in southeast Wyoming.

Recommendations

Conservation Approach

There are many conservation programs directed at grasslands and shrubland habitats currently available. However, as noted by the Central Grasslands Roadmap; "Disparate efforts are not adding up, and measures of wildlife populations, grassland acres, human community health and sustainability are down, and continue to decline. We have to think, act and do differently, and that starts with us working together to get on the same map, agreeing to the directions we need to go that focus on what we need to do more of, what we need to know more about, and what new strategies are critical to saving our grasslands over the next ten years" (Roadmap 2022). As flagship species for grassland and shrubland conservation, GPC and STG can play a critical role in efforts to stop the decline of not only these two species but the overall loss of functional grass and shrub ecosystems.

Recent years have shown an increase in regional landscape assessment and planning, and there are now a range of programs working at both broad and local scales. From Tri-national efforts like the Central Grasslands Roadmap that aim to create a strategy for sustainable multiple uses of this rich landscape, to local conservation groups working within a single county or watershed, it is a goal of this effort to help disparate efforts focus on particular areas to achieve greater results.

A key conclusion of this plan is that GPC and STG need a more concentrated delivery of conservation efforts into strategically located areas. A goal of establishing core areas consisting of 50,000-acre blocks of high-quality habitat distributed across the range of each species was deemed essential to assure long term viability of each species. The locations of some of these areas have been identified by this plan. In the eastern region where extensive habitat losses have left only small remnant habitats and populations, the delineation of locations was fairly easy. Further west, where populations of both species are much larger distributed over broad landscapes, defining focused priority areas was a tougher challenge. While a number of western states participating in this effort created priority areas, some states are still working on identifying priority areas. This plan recommends developing and utilizing a series of strategically located blocks of habitat areas to coordinate the targeting of grassland conservation efforts among grassland conservation initiatives. The priority areas identified by states as part of this plan are available via a web mapping application to provide easy access (https://kars.geoplatform.ku.edu/).

While a few areas of public lands, such as some National Grasslands and state wildlife management areas can provide locations that are large enough in size to provide a large block of high-quality habitat for GPC and STG, these are relatively few and inadequate to provide the necessary resources for populations even if managed specifically for these two species. Consequently, conservation of these species must focus on engaging voluntary participation of private landowners.

The existing scattered efforts are not “adding up” for a number of reasons. While some efforts to coordinate programs are occurring, most efforts are being delivered on an ad hoc basis where opportunities arise. For example, many Farm Bill programs wait for producers to come forward to sign-up for available programs and practices. This has led to many well intended applications that improve some areas of grassland but have often produced “random acts of conservation” that fail to provide enough large, connected patches to support populations of grassland or shrubland dependent species. Even when some programs attempt to target the delivery of conservation programs, the targeted areas are often so much larger than availability of funding that individual projects remain spread out and isolated.

Conservation delivery for GPC and STG currently occurs primarily within individual states. While this plan addresses rangewide considerations, each state generally works independently in directing conservation actions. State wildlife agencies have responsibilities for GPC and STG within their state boundaries. Through this plan, additional communication and coordination across state boundaries is occurring. It is important for this communication and coordination to continue and expand if effective conservation of these two species as flagships for grass and shrub ecosystems is to occur. The NRCS and FSA have initiatives such as Working Lands for Wildlife that attempt to target conservation delivery, but these still typically work within a decision and prioritization process within a state. Non-profit organizations have stepped up to assist with more focused delivery of conservation programs, but this is often still conducted within the existing system that makes concentrated delivery of actions difficult. Better methods that allow for concentrated delivery of conservation actions and provide landowners with a compilation of practices and incentives that make engagement highly desirable in targeted locations are needed.

State wildlife agencies should identify areas where they can begin to build 50,000-acre blocks of high-quality habitat for GPC and STG. Identification of such areas should be done in consultation with other partners including USDA (NRCS and FSA), USFWS Partners Program, non-profit organizations working within the state, foundations that can provide additional funding, Joint Ventures, Grassland Coalitions, Stockgrowers Associations, and/or others. Energy industry will be an important player as well to avoid future impacts and potentially to assist through mitigation processes.

Each strategically targeted location can be evaluated for its conservation needs. For example, areas with high levels of existing grassland would focus on delivery of conservation practices that would emphasize ranching methods that would optimize GPC and STG habitat and the needed incentives to engage landowners in using these methods. This may focus on use of prescribed grazing and prescribed burning practices but could also consider other types of incentives to produce and maintain high quality habitat into the future. In areas where existing grasslands are limited due to conversions to agriculture, restoration methods, such as CRP may be emphasized along with a suite of ranching methods. Where woody or invasive species invasions are limiting habitat quality, restoration of these areas would be emphasized.

One key to the success of conservation programs in the great plains is landowner participation and determining what landowners require to become voluntary participants in grassland conservation. Besides financial and technical support, this may also need to include regulatory guarantees, long-term commitments, or other considerations. To obtain high levels of enrollment within a strategic location, incentives may need to be substantially greater than currently offered through cost-share programs. Such an incentive program would need to be restricted to the strategic locations consistent with the available resources to fund and deliver the programs so as not to continue the random acts of conservation mentioned previously. New combinations of programs and the infusion of new funds or support will likely be needed to make such efforts feasible and effective.

Within the strategic locations identified as priority areas for grassland conservation, the desired conservation outcomes must become the dominant priority. Wildlife and other important grass and shrub ecosystem services cannot be a secondary priority to other economic drivers. This means that landowners must be provided with sufficient incentives and assurances so that they understand and support the primacy of the conservation objectives. This will require a careful melding of on-going land uses with constraints on those uses where potentially competing uses would undermine the conservation objectives. For example, incentives must be sufficient so that ranching operations within a strategic location, when faced with drought conditions, would not need to depend on an opening up of CRP lands to haying.

Plan Recommendations

1. Opportunities for long-term leadership and coordination within the GPC and STG ranges should be explored by state wildlife agencies and stakeholders in the prairie grouse conservation community. Leaders should strive to coordinate with stakeholders on the needs for prairie grouse conservation, facilitate grassland and shrubland conservation actions, and build upon this Conservation Plan.
2. State priority areas should continue to be identified and refined based on species needs, occurrence data, changing landcover, management practices, and conservation opportunities.
3. Conservation delivery within priority areas should be evaluated to determine if and how additional resources or tools can be targeted to increase implementation.
4. Prairie grouse occurrence data should be standardized to the extent possible and compiled for range wide analysis and assessments.
5. Each state in the GPC and STG ranges should conduct an analysis of its resource needs, including estimates of funding levels needed to produce a system of connected, high-priority areas, new tools or approaches for conservation delivery, and staffing needs for technical support. This information should be aggregated and advanced to conservation leaders.
6. Opportunities for coordination with other landscape-scale conservation efforts should be identified and pursued to increase program efficiency.

Research Priorities

- Call to broader conservation community to study grassland species, habitats, and changes in habitat quality/quantity.
- As populations—especially in the eastern portion of the ranges—become smaller and more fragmented, low genetic diversity becomes a risk. Studies in genetic connectivity between nearby populations and among/between isolated populations will provide useful insights.
- Continued and improved monitoring of GPC/STG populations and habitat availability across the range is critical to improve our understanding of prairie grouse populations, the grassland ecosystem, and the effectiveness of conservation efforts.

Funding and Resource Needs

Funding and other resources needed to implement this Conservation Plan need to be assessed and articulated. The Grassland Conservation Plan for Prairie Grouse adopted by AFWA in 2008 estimated that full implementation of that plan, calling for 10-20 percent grassland conservation across the Great Plains, would require $65 billion to complete. Such numbers seemed astronomical at the time, but with continued impacts and losses, the need for major and transitional shifts in funding and other resources to address the losses and challenges to maintaining functional ecosystems are being realized.

Funding estimates can be used by conservation leaders to seek such support. This may involve additions by partnering agencies to budgets directed at these flagship species, development of new delivery tools and priorities, and aggregating program delivery. It would also assist in ensuring that within the partnering agencies that delivery of conservation benefits identified by the planning effort would be priorities at all levels within the agency. Conservation leaders should also advocate for policies or legislation needed to increase funding and resources needed.

Committee Structure for Implementation

The IWG for GPC and STG should continue to coordinate the rangewide compilation and analysis of data on the two species. It should continue to report on its activities and accomplishments at annual MAFWA, WAFWA, and AFWA meetings.

Conclusions

This Conservation Plan for GPC and STG represents a starting point for a coordinated effort to use these two species as flagships for broader grassland and shrubland conservation. As evidenced in this plan, uncertainties remain regarding the effective implementation of conservation actions. Therefore, it is important that this plan be viewed as a work in progress and open to updates and revision as new data, research, and opportunities are identified. While some recommendations may appear daunting under current funding and resource availability, the status quo is not working. The continued declines of GPC and STG are clear harbingers of the broader decline of functional grassland and shrubland ecosystems. Given the increasing challenges of competing economic uses and climate change impacts, new and substantially increased efforts will be needed to stem continuing declines.

Appendices:

Appendix 1. Associated Grassland Species.

Targeted species conservation efforts are often beneficial for numerous other species and taxa that are present in shared habitats. Land management practices tend to have wide-reaching positive impacts on animal communities, even when focused on a single species of interest. The Prairie Grouse Range Wide Conservation Plan identifies 50,000 acre and larger blocks of grasslands as being sufficient to maintain prairie grouse populations and allow for genetic connectivity within the native range of these species. The goal is to limit habitat loss and fragmentation by applying conservation practices which will improve habitat for prairie grouse. The focus on the conservation of large blocks of habitat as well as the diversity of grassland structure required by grouse, means that the implementation of this plan can benefit a wide array of other grassland species including Species of Greatest Conservation Need (SGCN). SGCN were identified by each state in their Wildlife Action Plan. The following table lists SGCN by state that are expected to benefit from the conservation actions of the Prairie Grouse Range Wide Plan. For the Eastern states in the range, a list of Regional SGCN has also been created and are marked with a '*'.

Mammals of Conservation Interest by State

Common Name	Latin Name	CO	IA	IL	KS	MI	MN	MO	MT	ND	NE	OK	SD	WI	WY	#
Black-footed Ferret	Mustela nigripes	X			X				X	X			X		X	6
Olive-backed Pocket Mouse	Perognathus fasciatus	X									X				X	3
Hispid Pocket Mouse	Chaetodipus hispidus									X					X	2
Plains Harvest Mouse	Reithrodontomys montanus														X	1
Plains Pocket Mouse	Perognathus flavescens		X					X		X	X				X	5
Richardson's Ground Squirrel	Urocitellus richardsonii						X						X			2
Silky Pocket Mouse	Perognathus flavus										X				X	2
Spotted Ground Squirrel	Xerospermophilus spilosoma				X										X	2
Swift Fox	Vulpes velox	X			X				X	X	X		X		X	7
Franklin's Ground Squirrel*	Poliocitellus franklinii		X	X	X			X					X	X		6

Reptiles of Conservation Interest by State

Common Name	Latin Name	CO	IA	IL	KS	MI	MN	MO	MT	ND	NE	OK	SD	WI	WY	#
Ornate Box Turtle	Terrepene ornata		X	X				X					X		X	5
Plains Black-headed Snake	Tantilla nigriceps										X				X	2
Plains Hog-nosed Snake*	Heterodon nasicus				X				X	X					X	4
Blanding's Turtle*	Emydoidea blandingii		X	X		X					X			X		5
Slender Glass Lizard	Ophisaurus attenuatus		X					X			X					3
Eastern Massasauga*	Sistrurus catenatus		X		X	X										3
Western Massasauga*	Sistrurus turgeminus	X	X								X	X				4
Bullsnake	Piuophis catenifer sayi		X					X						X		3
Prairie Kingsnake	Lampropeltis calligaster		X								X					2
Smooth Green Snake*	Opheodrys vernalis		X			X			X	X	X				X	6
Northern Prairie Skink	Plestiodon septentrionalis		X					X						X		3
Plains Gartersnake	Thamnophis radix		X					X							X	3
Texas Horned Lizard	Phrynosoma cornutum	X			X							X				3
Greater Short-horned Lizard	Phyrnosoma hernandesi								X	X	X		X		X	5
Lined Snake	Tropidoclonion lineatum						X						X			2
Common Lesser Earless Lizard	Holbrookia maculata												X			1
Many-lined Skink	Plestiodon multivirgatus												X		X	2

Amphibians of Conservation Interest by State

Common Name	Latin Name	CO	IA	IL	KS	MI	MN	MO	MT	ND	NE	OK	SD	WI	WY	#
Great Plains Toad	Anaxyrus congnatus		X						X						X	3
Plains Spadefoot	Scaphiopus bombifrons		X							X					X	3
Small-mouthed Salamander	Ambystoma texanum		X					X			X					3
Eastern Tiger Salamander	Ambystoma tigrinum		X					X								2
Western Tiger Salamander	Ambystoma mavortium														X	1
Western Narrow-mouthed Toad	Gastrophryne olivacea							X								1
Northern Crawfish Frog	Lithobates areolatus		X	X				X				X				4
Wood Frog	Lithobates sylvaticus	X		X											X	3

Birds of Conservation Interest by State

Common Name	Latin Name	CO	IA	IL	KS	MI	MN	MO	MT	ND	NE	OK	SD	WI	WY	#
Greater Prairie-Chicken*	Tympanuchus cupido pinnatus	X	X	X	X		X	X		X	X	X	X	X		11
Sharp-tailed Grouse	Tympanuchus phasianellus	X					X			X						3
Dickcissel	Spiza americana		X	X	X	X		X		X				X	X	8
Baird's Sparrow	Ammodramus bairdii				X				X	X	X		X		X	6
Burrowing Owl	Athene cunicularia	X	X		X				X	X	X		X		X	8
Chestnut-collared Longspur	Calcarius ornatus	X			X				X	X	X		X		X	7
Ferruginous Hawk	Buteo regalis	X			X				X	X	X		X		X	7
Lark Bunting	Calamospiza melanocorys	X			X					X			X			4
Le Conte's Sparrow*	Ammodramus leconteii		X	X					X	X		X	X	X		7
Long-billed Curlew	Numbenius americanus	X	X		X				X	X	X		X		X	8
Sprague's Pipit*	Anthus spragueii		X					X	X	X	X	X	X			7
Bobolink*	Dolichonyx oryzivorus	X	X	X	X			X	X	X				X	X	9
Grasshopper Sparrow*	Ammodramus savannarum	X	X	X		X		X		X				X	X	8
Thick-billed Longspur	Rhynchophanes mccownii	X			X				X	X	X				X	6
Short-eared Owl*	Asio flammeus	X	X	X		X		X		X	X	X		X	X	10
Upland Sandpiper*	Bartramia longicauda	X	X	X	X			X		X		X		X	X	9
Common Nighthawk	Chordeiles minor		X	X	X	X								X	X	6
Henslow's Sparrow*	Ammodramus henslowii		X	X		X		X			X	X		X		7

Eastern Meadowlark*	Sturnella magna		X	X	X			X			X			X		6
Western Meadowlark*	Sturnella neglecta		X			X	X			X						4
Northern Bobwhite Quail*	Colinus virginianus	X	X	X	X			X				X				6
Northern Harrier	Circus cyaneus	X	X	X		X		X		X				X		7
Bell’s Vireo	Vireo bellii		X	X				X				X				4
Sedge Wren	Cistothorus platensis		X	X					X							3
Barn Owl	Tyto alba		X	X		X					X	X				5
Loggerhead Shrike	Lanius ludovicianus	X	X	X				X	X	X	X	X		X	X	10
Buff-breasted Sandpiper	Calidris subruficollis		X	X							X	X				4
Smith’s Longspur	Calcarius pictus		X	X	X							X				4
Swainson’s Hawk	Buteo swainsoni	X	X	X	X					X		X			X	7
Marbled Godwit	Limosa fedoa		X				X			X			X			4
Willet	Tringa semipalmata									X			X			2
Golden Eagle	Aquila chrysaetos	X							X	X	X		X		X	6
Prairie Falcon	Falco mexicanus	X								X						2
Brewer's Sparrow	Spizella breweri	X							X	X					X	4
Nelson's Sparrow	Ammodramus nelsoni						X		X	X						3

Invertebrates of conservation interest by state

Common Name	Latin Name	CO	IA	IL	KS	MI	MN	MO	MT	ND	NE	OK	SD	WI	WY	number of states with species
Monarch Butterfly*	Danaus plexippus		X	X		X		X		X	X			X		7
Regal Fritillary Butterfly*	Argynnis idalia		X					X		X	X	X	X	X		7
Byssus Skipper	Problema byssus		X								X	X				3
Mottled Duskywing	Erynnis martialis		X				X				X					3
Poweshiek Skipperling	Oarisma poweshiek		X				X			X			X			4
Dakota Skipper	Hesperia dacotae		X				X			X			X			4
Two-spotted Skipper	Euphyes bimacula		X				X				X					3
Leonard's Skipper	Hesperia leonardus		X				X									2
Karner Blue	Lycaeides melissa samuelis													X		1
Dusted Skipper	Atrytonopsis hianna		X								X			X		3
Gorgone Checker Spot	Chlosyne gorgone		X											X		2
Mottled Dusky Wing	Erynnis martialis		X								X			X		3
Persius Dusky Wing	Erynnis persius										X			X		2

Cobweb Skipper	Hesperia metea										X			X		2
Gray Copper	Lycaena dione													X		1
Arogos (Iowa) Skipper*	Atrytone arogos		X						X		X	X	X			5
Dotted Skipper	Hesperia attalus											X				1
Ottoe Skipper*	Hesperia ottoe		X						X		X		X			4
Crossline Skipper	Polites origenes		X								X			X		3
Rattlesnake master-borer moth*	Papaipema eryngii			X								X				2
Amphipoea erepta	Amphipoea erepta			X												1
Ignorant Apamea	Apamea indocilis			X												1
Gold Moth	Basilodes pepita			X												1
Meropleon titan	Meropleon titan			X												1
Liatris Borer Moth*	Papaipema beeriana			X										X		2
Ironweed Borer Moth	Papaipema cerussata			X												1
Vernonia Borer Moth	Papaipema limpida			X												1
Maritime Sunflower Borer	Papaipema maritime			X												1
Mayapple Borer Moth	Papaipema rutila			X												1
Silphium Borer Moth*	Papaipema silphii			X												1
Buffalo Moth	Parapamea buffaloensis			X												1
Prairie Cicada	Okananga balli			X												1
Ernestine’s Moth	Phytometra ernestinana			X												1
Goldenrod Flower Moth	Schinia nundina			X												1
Clouded Crimson	Schinia gaurae			X												1
Tricholita notata	Tricholita notata			X												1
Curve-lined Vaxi	Vaxi auratella			X												1
Ghost Tiger Beetle	Ellipsoptera lepida										X			X		2
Married Underwing	Catocala unijuga										X					1
Whitney Underwing	Catocala whitneyi										X					1
Chryxus Arctic	Oeneis chryxus													X		1
Doll's Merolonche	Acronicta dolli													X		1
Owl-eyed Bird Dropping Moth	Cerma cora													X		1
Phlox Moth	Schinia indiana													X		1
Shadow Gloss Snail	Zonitoides kirbyi											X				1
Yellow Bumble Bee	Bombus fervidus													X		1
Confusing Bumble Bee	Bombus perplexus													X		1
Yellowbanded Bumble Bee	Bombus terricola													X		1
Frigid Bumble Bee	Bombus frigidus													X		1

Northern Barrens Tiger Beetle	Cicindela patruela patruela													X		1
American Burying Beetle	Nicrophorus americanus										X	X	X			3
Loamy-ground Tiger Beetle	Dromochorus belfragei											X				1
A Leaf Beetle	Pachybrachis luridus													X		1
Speckled Rangeland Grasshopper	Arphia conspersa													X		1
Club-horned Grasshopper	Aeropedellus clavatus													X		1
Clear-winged Grasshopper	Camnula pellucida													X		1
Prairie Mole Cricket	Gryllotalpa major							X				X				2

The authority over and conservation of invertebrates varies across states and this may impact how many states list invertebrates as SGCN.

	CO	IA	IL	KS	MI	MN	MO	MT	ND	NE	OK	SD	WI	WY
total number of associated species of concern by state	25	55	43	23	12	12	26	22	38	43	24	27	41	35

Appendix 2. State Survey Methods for Greater Prairie Chicken and/or Sharp-Tailed Grouse

The spring breeding population survey methodologies from each state for greater prairie-chicken and/or sharp-tailed grouse to monitor population trends are provided for reference. State survey methods are listed in alphabetical order by state: CO, IA, IL, KS, MI, MN, MO, MT, ND, NE, OK, SD, WI, WY.

Colorado

Northeast Colorado

Colorado Parks and Wildlife (CPW) has established ground survey listening routes within greater-prairie chicken (GPC) core areas. Follow-up surveys to count number of males, females, and total birds are conducted with permission from private landowners. Beginning in 2006, half of the listening routes are surveyed annually on alternating years, thus every route is surveyed every other year. Plains sharp-tailed grouse are also surveyed from the ground listening routes. However, private land access is limited within plains sharp-tailed grouse range so listening routes are conducted from public roads and follow-up surveys to count leks are generally not possible.

Listening route surveys are during the early spring when greater prairie-chickens are congregated on lek sites. Surveys should be conducted between April 1 and April 20, which corresponds with the peak of male and hen attendance (Miller 1984, Schroeder and Braun 1992). Data collected after April 20 may be biased low due to the decline in male attendance following the time of peak hen attendance (Schroeder and Braun 1992). Surveys are conducted from 30 minutes before to 1–2 hours after sunrise, which is the period when birds are most active on leks (Schroeder and Braun 1992). Surveys are conducted only on calm, clear mornings, as the booming sound produced by males can be audible for nearly 3 km (Hamerstrom and Hamerstrom 1973, Miller 1984, Schroeder and Braun 1992). If wind speeds exceed 7 km/hr, surveys should be discontinued and rerun on the next available day.

For each survey route, an observer will determine the presence of active lek sites by listening at 1.6 km intervals along the route and recording compass directions for all audible leks. In order to compensate for potential "quiet" periods and the influences of time-of-day upon booming, routes should be run in two directions. This procedure was abandoned in the mid-1990's and has been reinstated. This procedure entails beginning at mile 0, listening for booming for 3 minutes, and proceeding along the selected route, stopping for 3 minutes at each 3.2 km interval until the end of the route. The observer should then retrace the route 1.6 km, stop, listen, and continue again at 3.2 km intervals to the 1.6 km stop on the route. All routes will be 16 km in length, thus consisting of 11 listening stations. A 16-km route would require approximately 80 minutes to complete, driving at 25 miles-per-hour, stopping at the 11 stations, and listening for 3 minutes at each stop. This is within the 90 minute time of peak activity (Miller 1984, Van Sant and Braun 1990). This procedure will further minimize bias from behavioral changes associated with time-of-day (Robb and Schroeder 2005).

Once all routes have been initially surveyed for leks, the leks will be surveyed for the number of males, females, and total birds on each lek on subsequent days. Leks will be counted if three or more birds are identified on a site. This is similar to the criteria used by Schroeder and Braun (1992).

Southeast Colorado

Greater prairie-chickens have been extending their range to the south and are now located within the lesser prairie-chicken (LPC) estimated occupied range. CPW conducts annual ground counts of all known prairie-chicken leks in Southeast Colorado and has documented LPC leks, GPC leks, and mixed GPC/LPC leks. Hybrid LPC/GPC individuals have also been documented with the LPC EOR. CPW attempts to count each known lek at least three times per year. The number of males, females, and total counts by species as well as hybrids are documented on each lek each spring. Listening surveys in suitable habitat are also conducted during the spring lekking season following the WAFWA LPC lek survey protocol.

Iowa

Lek Surveys. All currently and historically known lek sites are surveyed along with a selection of randomly placed points in potential habitat. They are surveyed 2-3 times during the lek season. 2 minutes per site. All birds seen and/or heard recorded.

Illinois

Illinois prairie-chicken populations are located on two state managed areas in Jasper and Marion Counties known as Prairie Ridge State Natural Area. These two areas are systematically censused each year for leks. The all-weather roads that surround almost every section facilitate thorough lek surveys. To ensure that all leks were located, audio census routes run each spring are based on predetermined stops, spaced about 2.6km apart, with listening for one minute at each stop. Calm, rainless mornings from mid-March through mid-April are selected because essentially all males are thought to be attending leks during this period. If leks are not viewable from roads, portable blinds situated on leks are used to count males and females. Each lek is censused twice per week with counts made within the first two hours after sunrise, with care not to flush the birds and thus minimize counting of the same birds on different leks. A series of counts are taken each spring for each lek. The maximum number of males regularly present during the major period of hen visitation was considered the best estimate of males for an individual lek. Summations of the maximum number of males regularly present for each lek are used to calculate the total number of males for the area.

Kansas

Observers traversed each survey route twice between March 20 and April 20 starting at 30 minutes before sunrise. They listened for booming prairie chickens for 3 minutes at established stops placed at approximately 1-mile intervals. After all of the listening stops had been completed, the observers backtracked along the route and flushed all the lek sites that they identified up through 90 minutes after sunrise. Observers recorded the geographic coordinates of each lek they located and the total number of birds flushed from each site. Observers were instructed to get two flush counts from each lek they identify within their standard survey area which included all habitats within approximately 1 mile of the survey route. To get all the required flush counts, it often took additional efforts beyond the two mornings when the listening stops were completed.

Flush counts collected from within each survey area were used to develop density indices for each route. The maximum counts for all leks within each survey area were summed and multiplied by two to represent the total number of birds in the survey area. Those figures were divided by the number of square miles surveyed along each route to produce an estimate of the total number of birds per square mile. This method of estimating density assumes 1.) only males are counted, 2.) all males attend leks, 3.) the sex ratio is equal, and 4.) all leks within the survey area are detected. It is likely that some of these assumptions are being violated and as a result the density estimates are probably biased (most likely low). It is assumed that the direction and degree of bias is fairly consistent across years and that the indices correlate with real changes in population abundance. However, there was no measure of variability associated with the route-specific indices so statistical tests could not be used to determine if annual changes were significant at that scale.

Data collected along all routes surveyed in consecutive years by the same observer were also used to estimate changes in abundance within each management region as well as species-specific changes in abundance across the entire state. Density estimates for all routes within each small game region (Figure 1) were weighted by the survey area associated with each route and averaged to produce regional indices. The statewide species-specific indices were developed using a similar weighted average procedure and were developed from density estimates derived for all routes located within the estimated occupied range (EOR) of each species. Three routes fall within the area where the GPCH and LPCH ranges overlap and data from those routes were incorporated into the density estimates for each species. Statistical tests can be used to identify significant annual changes at the regional level because there is cross-route variability in density indices. A two-tailed paired t-test that assumed equal variance was used to identify significant annual changes within each region and across the entire range of each species (Ott 1993). Indices were considered to differ significantly when $P<0.05$.

Long-term trends were developed for each small game management region. Annual indices used to develop each trend were only calculated for years in which density indices were available for all of the selected routes. This was done to ensure that the trend was based on indices developed for identical survey areas. The time period for which a trend can be developed differs across regions due to data availability. Due to a poor distribution of survey effort across the occupied ranges of each species, statewide trends could only be developed for LPCH and GPCH from 2004 and 2011, respectively. Linear regression was used to determine if the slope of each fitted trend line differed from zero (Ott 1993).
The estimated density within only occupied habitats was calculated for LPCH by dividing the route-specific indices by the proportion of each survey area classified as having a probability of lek occurrence ≥0.3 (Jarnevich and Laubhan 2011). This threshold encompasses >80% of the LPCH lek sites that were known to be active from 2005-2011. Density within occupied habitats was only estimated for LPCH because suitable GPCH habitat has not been quantitatively identified across the entire state.

Michigan

Sharp-tailed grouse are monitored in Michigan's Upper Peninsula utilizing two different survey methodologies. The first method is a lek count. Surveyors attempt to visit known lek locations at least twice between April 1st and May 15th. Surveyors enter leks early in the morning (or watch from a distance with binoculars), observe the sharp-tailed grouse activity and attempt to count the number of dancing males on the lek. When possible, after counting the dancing males, the surveyor then walks into the lek and attempts to count the total number of birds flushed from the lek. Surveys have been conducted by staff from the Michigan DNR, U.S. Forest Service, U.S. Fish & Wildlife Service, and local Tribes as well as volunteers.

The second method used to monitor sharptailed grouse is a section-based occupancy survey (Luukkonen et al. 2009). The survey is conducted in 37 1-square mile sections in the far eastern Upper Peninsula where agricultural open lands (mainly hay and low intensity pasture) are relatively abundant. Most of the assessed area is part of the limited hunting area. Surveys are conducted by Michigan DNR staff as well as staff with the Sault Ste Marie Tribe of Chippewa Indians and the Bay Mills Indian Community. The survey results are used both in occupancy modelling as well as a simple analysis evaluating the proportion of surveyed sections which had a detection of sharp-tailed grouse.

Both surveys are used to monitor trends in STG populations as well as the use or occupancy of areas (lek use for lek survey, habitat for section occupancy survey). This information informs management decisions related to habitat management and harvest regulations. Survey results are also used to assist in outreach and education efforts and in discussions with interested stakeholders. Survey efforts are not comprehensive throughout the estimated occupied range so do not reflect the entirety of sharp-tailed grouse populations in the state.

Luukkonen, D.R., T. Minzey, T. E. Maples, and P. Lederle. 2009. Evaluation of population monitoring procedures for sharp-tailed grouse in the eastern Upper Peninsula of Michigan. Michigan Department of Natural Resources, Wildlife Division Report 3503.

Minnesota

Greater prairie-chickens: Cooperating biologists and volunteers survey booming grounds on 17 designated survey blocks in western Minnesota during March-May. Each survey block was nonrandomly selected so that surveys are conducted in areas where habitat is expected to be good (i.e., remaining grassland is relatively abundant) and leks are known to occur. Each observer attempts to find and survey each booming ground repeatedly in the assigned survey block, which comprises 4 sections of the Public Land Survey (approximately 4,144 ha). Observers obtain multiple counts at each booming ground in the morning because male attendance at leks varies throughout the season and throughout the day.

During each survey, observers obtain visual counts of males, females, and birds of unknown sex. When vegetation or topography prevents a reliable count, birds are flushed for counts and sex is recorded as unknown. In the analysis, only counts of males and unknowns at each booming ground are used. Leks are defined as having ³2 males, so observations of single males are not counted as leks. Data are summarized by spring survey block and separated into a core group and a periphery group for analysis. The core group had a threshold density of approximately 1.0 male/km^2 during 2010, and was located proximally to other such blocks. Densities of leks and prairie-chickens in survey blocks are compared to estimated densities from previous years to obtain trend information (e.g., increasing, decreasing, stable). Observers are also encouraged to submit surveys of booming grounds outside the survey blocks. These data are included in estimates of minimum abundance of prairie-chickens. However, these data are not used in the analysis of lek and prairie-chicken densities because effort and methods may have differed from those used in the survey blocks.

Sharp-tailed grouse: Wildlife staff and volunteers survey known sharp-tailed grouse lek locations in the Northwest (NW) and East Central (EC) portions of Minnesota. In the EC region, and in eastern portions of the NW region where sharp-tailed grouse occur at low densities, most known leks are surveyed each year. Some leks may be missed, but most wildlife managers in these regions believe they survey most leks in their work area, with a few exceptions where workloads do not permit exhaustive surveys. In the western part of the NW region, sharp-tailed grouse occur at higher densities, and thus surveying all leks is not feasible. Therefore, in the western portion of the NW region, wildlife managers conduct surveys along 20-25 mile (32-40 km) routes. Given the uncertainty in the proportion of leks missed, especially those occurring outside traditional areas, the survey may not necessarily reflect STG numbers in larger areas.

Each cooperator is provided with instructions and asked to conduct surveys on ≥1 day in an attempt to obtain a maximum count of male sharp-tailed grouse attendance during the peak in lek attendance, which usually occurs in late April and early May. Observers conduct surveys within 2.5 hrs of sunrise during low winds (<16 km/hr) when lek attendance and ability to detect leks are expected to be greatest. Observers record the number of males, females, and birds of unknown sex during each lek visit.

The number of sharp-tailed grouse per dancing ground is used as the index value and is averaged for the NW region, the EC region, and statewide, using known males and birds of unknown sex. Observations of just 1 grouse are not included in the index. These surveys provide a reasonable index to long-term population trends.

Missouri

A visual census of all known booming grounds (active within last 5 years) is conducted annually during mid-March (15 minutes before sunrise and continue for up to 1 hr after sunrise) through mid-April. The area within one mile of known leks or routes. See separate attachments (2016 GPCH Lek Survey Instructions, Data Sheet example).

2016 PRAIRIE-CHICKEN LEK SURVEY INSTRUCTIONS, KEY POINTS TO REMEMBER

- Conduct counts between 14 March and 15 April
- Survey each route/lek area at least 3 times
- Start surveys 15 minutes before sunrise and continue to 1 hr after sunrise
- Run survey routes on clear, calm mornings
- Stop to listen every ½ mile and/or on high points
- Record data for all booming grounds detected

1) DESIRABLE WEATHER CONDITIONS
You should be able to hear birds booming from 1 mile away or greater from your stopping point. Surveys are best done on calm mornings. Clear, calm mornings after the passage of a weather front are probably the ideal conditions for surveys.

2) TIME
Late March is probably the ideal survey time for counting chickens in Missouri. Begin 15 minutes before sunrise and continue for up to 1 hr after sunrise. Birds are less reliably present outside of this time frame. Sunrise times are available for your area at the web site below. http://www.sunrisesunset.com/usa/Missouri.asp

3) AREA TO BE SURVEYED
Census areas are delineated on the map/survey form. Count all leks and birds within 1 mile of the route (i.e., the road). For public prairies and other surveyed areas, census all booming grounds within 1 mile of the perimeter of the area.

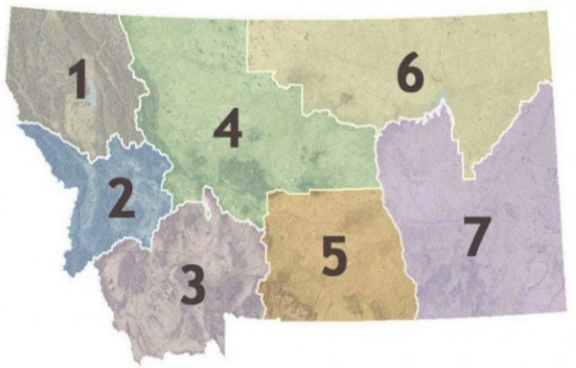
4) PROCEDURE
Stop and shut off vehicle at ½ mile intervals. Get out of the vehicle and stand a few yards away to get away from the noise of the cooling engine. Listen for booming/cackling for 2 to 3 minutes at each stop. Try to stop on high points on the road away from houses, barking dogs, livestock, or other sources of noise. Record the locations of booming grounds on the map using numbers. On the data form, write the number of the booming ground corresponding to the number you placed on the map. Record number of males, number of females and total the number of birds on the booming ground. Run each survey route 3 times between 14 March and 15 April. Please *record the local time at the beginning and end* of your survey runs. As before, indicate locations and numbers of birds for birds/booming grounds off the official survey area when convenient but *use capital letters to label these booming grounds* and be sure to record the numbers of birds *in the space provided on the bottom of the survey form*.

Montana

Sharp-tailed Grouse Survey Methods:

Montana Fish, Wildlife and Parks monitors trends in wildlife populations to inform management decisions that affect 1) population abundance, 2) wildlife conflicts, 3) hunting and harvest opportunity, 4) habitat management and land use decisions and 5) other recreational opportunities for diverse user groups.

Sharp-tailed grouse (STGR) are surveyed each spring in Regions 4, 5, 6, and 7 on known leks, an area where animals (such as the prairie grouse) carry on display and courtship behavior. The earliest record in our statewide database is 1956-57. Most leks are surveyed from the ground however some are conducted from the air.



Montana Fish, Wildlife and Parks Regions.

Data collected during spring STGR surveys are used to estimate trends in population levels using total number of males observed as well as an estimated males per lek within each trend area.
STGR trend data can be used to inform interested parties about population trends for future hunting seasons or can be referred to in land purchase (term lease, easement, or fee title) or habitat improvement proposals. The trend data can also used in comments on proposed state and federal land exchange projects, land use plans (such as grazing changes) and for development proposals (oil and gas lease, drilling, wind, subdivision, solar).

Methods
There have been three methods used when surveying STGR leks: 1) block surveys where the survey unit is defined by the distinct boundaries and survey coverage is complete for the geographic area 2) route surveys that have a predetermined route and geographic coverage is linear, 3) count opportunistic leks locations not included in block or route surveys, or in areas where activity is suspected but no previous surveys have been conducted.

In the block and route STGR survey areas, both historic as well as newly established leks, are monitored annually. Additional time is spent looking and listening for new leks withing the survey area each year.
STGR lek surveys are conducted from late March through mid-May. Timing varies between regions and spring weather conditions but leks are generally surveyed from ½ hour before sunrise to 2 hours after sunrise, depending on the date of the survey and weather conditions. Optimal counts are usually obtained from ½ hour before sunrise to 45 minutes after sunrise. An observation point is selected that allows the observer to see the entire lek. Total males and females are counted and recorded. Most counts are done from a vehicle, although some counts are conducted by observers on foot, in blinds or from an aircraft. Flush counts may need to be conducted, depending on height of grass or topography of the lek location.

Many observers count each lek a minimum of 3 times per visit to get the highest male count. When counting grouse from the air, it is more difficult to get multiple counts in a single visit without flushing the birds. Often males are counted while displaying and then the aircraft will swoop in on the lek, flush the birds and another count is done while the birds are in the air. Additional data such as wind speed, sky conditions, temperature, time, subjective disturbance and count quality rating are recorded with each visit.

Statewide databases were established in 2002 and are currently housed in the Wildlife Information System (WIS). STGR lek survey data is entered into a statewide database on an annual basis. Starting in 2002, individual lek counts are entered into the database, whereas prior to 2002, only the highest male count was entered, even if a lek had multiple observations each year.
The number of STGR leks surveyed varies annually and not all leks are visited. Although numerous lek locations are known across the state, annual trends are estimated from established block areas and routes. Leks are defined by the below Lek Status definitions:
Lek Status Definitions

Confirmed Active - Data supports existence of lek. Supporting data defined as 1 year with 2 or more males lekking on site followed by evidence of lekking (Birds - male, female or unclassified; -OR- Sign - vegetation trampling, feathers, or droppings) within 10 years of that observation.

Confirmed Inactive - A Confirmed Active lek with no evidence of lekking (Birds - male, female or unclassified; -OR- Sign - vegetation trampling, feathers, or droppings) for the last 10 years. Requires a minimum of 3 survey years with no evidence of lekking during a 10 year period. Reinstating Confirmed Active status requires meeting the supporting data requirements.

Confirmed Extirpated - Habitat changes have caused birds to permanently abandon a lek (e.g., plowing, urban development, overhead power line) as determined by the biologists monitoring the lek.

Never confirmed active – An Unconfirmed lek that was never confirmed active. Requires 3 or more survey years with no evidence of lekking (Birds - male, female or unclassified; -OR- Sign - vegetation trampling, feathers, or droppings) over any period of time.

Provisionally Active – Preliminary data supports existence of an active lek. This status can only apply during the first year of detection. Supporting data defined as 1 observation with 2 or more males lekking on site AND sign of lekking (vegetation trampling, feather, or droppings) or followed by a 2nd observation of 2 or more males lekking within the same survey year.
Unconfirmed - Possible lek. Grouse activity documented. Data insufficient to classify as Confirmed Active status.

North Dakota
Prairie grouse surveys in North Dakota consist of listening runs (March 15 – April 30) and male counts (April 1 – April 30). Listening runs include stops spaced at ½ across survey blocks when winds are <15 mph (ideally <5mph). Counts are made using binoculars or spotting scopes to classify males and females. In cases when leks cannot be seen, flush counts are used to get complete counts. Flush counts are typically made >1 hour after sunrise when males are not actively dancing, assuming no hens are present. Listening runs and counts are conducted from ½ hour before sunrise to 2 hours after sunrise.

Greater prairie chickens in North Dakota are surveyed in two populations: Grand Forks county and on the Sheyenne National Grasslands in Richland and Ransom counties. NDGF contracts the University of North

Dakota to conduct listening runs and counts of all booming grounds in Grand Forks County. The US Forest Service conducts a census of greater prairie-chickens on the Sheyenne National Grasslands proper, and the NDGF contracts a biologist to survey and count booming grounds in the areas around the SNG.

Sharp-tailed grouse are monitored on 32 survey blocks across the state. Survey blocks are approximately 36 square miles, and observers attempt to locate and count males on all active dancing grounds on each block—i.e. a complete census of males on the block.

In addition to counts and coordinates, observers record time, date, temperature, wind and nebulosity during lek counts only. Hens of both species are counted, primarily to monitor the periods of peak hen attendance at leks.

Nebraska

Prairie Grouse Breeding Ground Surveys (BGS) are used to ascertain breeding population trends for greater prairie-chickens and sharp-tailed grouse within their primary range and to inform management decisions. Surveys are conducted each spring (1-20 April) along established roadside transects that are approximately 19 miles in length. The BGS consists of both a listening and a locating portion. During the listening portion (1-9 April), surveyors make stops at 1-mile intervals along the route to listen for displaying grouse, beginning 45 minutes before sunrise. During the locating portion (10-20 April), surveyors locate the leks heard during the listening portion and count the number of individuals on each lek (by species and sex). Lek locations from previous years are checked regardless if they were heard during the first portion of the survey. Lek counts are completed no later than one hour past sunrise and flush counts are used to confirm counts following visual observations. Counts are made only on leks located within one mile on either side of the survey transect, which makes the total survey area approximately 40 square miles per route.

Nebraska's BGS dates back to 1956 but there has been variability over the years in terms of the number of routes surveyed each year and how frequently individual routes have been surveyed. In recent years, NGPC staff have surveyed the 11 "core routes" in the Sandhills region that have the longest-standing survey frequency.

Oklahoma

Survey Period: March 15th through May 7th.
Time of Day: 30 minutes before sunrise to 1.5 hours post-sunrise
Weather: wind < 12 mph sustained; no precipitation.
Observers: 1 or 2 observers per vehicle.
Sampling Effort: sample each route at least twice separated by a week.
Observer Position: turn off vehicle and step outside to conduct 5 minute sampling stops along routes.
Survey Stops: listening stops are spaced at one mile intervals. The observer can adjust the stopping points by plus or minus 0.1 mile to take advantage of better listening locations (hilltops, etc.), or to avoid bad locations (houses, valleys, etc.). The number and direction of all leks are recorded on the data sheet, a circled X is placed on the map in the general location of each lek (map the lek to the quarter mile).

Survey Routes: change direction of travel after each run.
Interference: it is okay to pause the survey to let interfering noises clear out (traffic) – make notes in data sheet comments column.
Lek Locations: be mindful of possible double-counting of leks – make notes in the comments column of the data sheet.
Record the number of prairie chickens, location, or GPS coordinates for any groups that are flushed or any leks that are seen while driving the survey route. Draw a legible mark (x and circle it) on the map for approximate lek location.

The Oklahoma Department of Wildlife Conservation (ODWC) has been surveying GRPC yearly since the early 1980's. We now ground survey 26 routes with 291 stopping points twice each spring. Some of these routes are completed by our partners and include the U.S. Fish and Wildlife Service, The Nature Conservancy, the Osage Nation, Sutton Avian Research Center, and Oklahoma State University. The ground survey protocol was changed slightly to mirror the lesser prairie-chicken range-wide plan survey protocol in 2015 (McDonald et al. 2015).

South Dakota
Traditional Lek Surveys require the observer to count both the number of leks and the number of individual birds on each lek in a pre-defined area (See below "Sharp-tailed Grouse and Prairie Chicken Traditional Lek Survey Routes"). Ten traditional lek routes have been established in primarily the central and western areas of the state. The survey areas range from 30 to 46 square miles per route, with most consisting of established transects two miles wide and twenty miles long. Other survey areas consist of blocks of land where all leks are surveyed.

A listening and locating portion is conducted with each route to determine the number of leks and birds for the given area of the route. Active leks and previously recorded leks are checked and counted during peak early morning breeding activity and the number of both male and female is recorded. Surveyors should record the "total" number of grouse from a distance as they approach a lek. The most important information item from each lek count is an accurate count of the number of males using the lek.

Wisconsin
The goal of Greater prairie-chicken surveys is to provide an annual index to population abundance in Wisconsin with which to make informed management decisions. Survey objectives are to count the number of males on identified booming grounds and determine the distribution of Greater prairie-chickens by documenting the occurrence of booming grounds. Attendance at leks by cocks varies temporally, making single counts of males at a specific booming ground unreliable as an indicator of abundance. However, multiple counts also do not account for detection probability. Consequently, our surveys are an index to population abundance, not a complete census.

Methods. In 2007, we established detailed scouting and survey protocols (e.g. minimum number of surveys required during peak breeding season, increased use of observation blinds where binoculars and spotting scopes resulted in incomplete counts). The most important index to population abundance continues to be the cumulative number of cocks counted on the grounds.

During March, trained observers scout for booming grounds by driving within assigned areas and stopping at ½ mile intervals to prepare for surveys during peak breeding activity in April. Observers then exit their vehicle and for three minutes, listen for prairie chicken vocalizations, as well as use binoculars or spotting scopes to observe prairie chickens. Observers record the date, time, weather conditions, legal description and GPS coordinates of the booming ground, method of observation (e.g. binoculars, spotting scope, observation blind), sex (classified as male, female, or unknown), number of birds, and other observations (e.g. presence of predators). Scouting and surveys occur 45 minutes before sunrise to 1-2 hours after sunrise on clear, calm mornings with winds <10mph.

During April, observers conduct surveys at known booming grounds using the same protocol as during the scouting period, with the exception of stopping at ½ mile intervals. Observers attempt to conduct surveys during peak breeding activity, during which the greatest number of hens are present on the booming grounds. Observers attempt to obtain a minimum of three good counts per booming ground where all birds are distinguished by sex. In order to better distinguish the sex of all birds observed on booming grounds, booming grounds on public lands re mowed in the fall, and observers use portable blinds and arrive at the blinds prior to the arrival of any males.

Results are summarized by booming grounds and prairie chickens by wildlife area, outlying area, and rangewide. For each wildlife area, the results are further summarized by number of prairie chickens by individual booming ground. Booming grounds are defined as having ≥2 males. Observations of single males are included in survey totals, but not counted as a booming ground.

<u>Sharp-tailed grouse</u> (*Tympanuchus phasianellus*) surveys are conducted each year in April and May. Surveyors locate sharp-tailed grouse dancing grounds, known as leks, and count the number of dancing male birds present. Surveys are conducted on 3 different property types: DNR managed properties, non-managed properties, and on private lands.

<u>Methods</u>
Sharp-tailed grouse surveys are conducted on dancing grounds, also known as leks. Dancing grounds included in annual surveys are selected based upon known presence, rather than on a spatial sampling design. The survey data is not a complete census of the entire sharp-tailed grouse population in the state. Additionally, it is not necessarily representative of the broader landscape that sharp-tails are known to occupy. However, it is believed that the majority of dancing grounds within each focus area are included. Ultimately, dancing ground surveys help to provide an index to population abundance and allow wildlife managers to make informed management decisions for sharp-tailed grouse.

Managed Properties - Sharp-tailed grouse populations on properties managed by the WI DNR are monitored by counting displaying males on dancing grounds. Known dancing ground locations are scouted for activity early in the season and any new dancing grounds located are added to the survey effort.

Dancing grounds are approached on foot or by vehicle and observations are made from blinds placed on dancing grounds. Surveys are conducted during clear, calm mornings with winds <10 mph. Dancing ground counts are replicated, ideally a minimum of 3 times, to account for variation in the attendance of male sharp-tailed grouse. Surveys are completed during the peak of the breeding season, typically in late April, and during the time of highest activity, from 45 minutes before sunrise to 1-2 hours after sunrise. Male birds are identified with the aid of field glasses and the total (maximum) count of male birds observed is recorded. Although the Barnes Barrens Management Area in Bayfield County has been surveyed regularly for decades it was specifically added to the formal list of managed properties surveyed in 2014.

Non-managed Properties - Sharp-tailed grouse surveys on lands not managed by the WI DNR are concentrated within a portion of northwestern Wisconsin, primarily in GMU 2 and 9 (Figure 1). Surveys on private lands generally involve selecting one or more blocks of the best available habitat and then conducting listening (or scouting) routes along roads transecting those blocks. Dancing grounds located within habitat blocks are approached and birds are flushed. The total number of birds flushed from each site is counted. Because estimating the exact number of males observed during a flush count may be unreliable, males are assumed to represent 75% of the total birds observed during these flush counts.
Private Lands - In 2008, additional survey efforts were started on non-managed lands within the North Central Forest, Northwest Sands, and Superior Coastal Plains Ecological Landscapes, as well as private lands in portions of Rusk County (GMU 19, 24, and 25). This effort was intended to update the current distribution of sharp-tailed grouse dancing grounds and in some cases estimate the total number of males on newly identified dancing grounds. Occupancy-based surveys were piloted in the Northwest Sands blowdown area in 2011 and were formalized in 2014 through collaboration with UW-Madison. Those results will be reported elsewhere.

Surveys are a cooperative effort between DNR, USFS, GLIFWC, Northland College, members of the Wisconsin Sharp-tailed Grouse Society, and volunteers.

Wyoming
a. Dancing Ground Locations – Plot locations of all permanent dancing grounds (leks) on either 1:24,000 or 1:100,000 USGS maps. Enter records of lek locations and annual count information in the Wildlife Observation System (WOS) database. Individual biologists may ds: legal description accurate to quarter/quarter section, UTM location, year of discovery, warden and biologist districts, surface ownership, and a narrative description of the location, including a general description of the terrain, man-made features, and land management practices. The database should also contain fields for date, time of day, number of males and females observed, code for observation of sign only, indication whether ground or aerial observation, observation type (lek count, status survey, lek search, casual observation), observer name, and other comments or notes.

b. Aerial Surveys – Plan flights within areas occupied by both sage grouse and sharp-tailed grouse to census leks of both species. Sharp-tailed grouse are more difficult to see from the air because they dance in unison, are smaller and lighter colored than sage grouse. Observers should become familiar with locations of STG leks to aid in their 14-4 detection from the air.

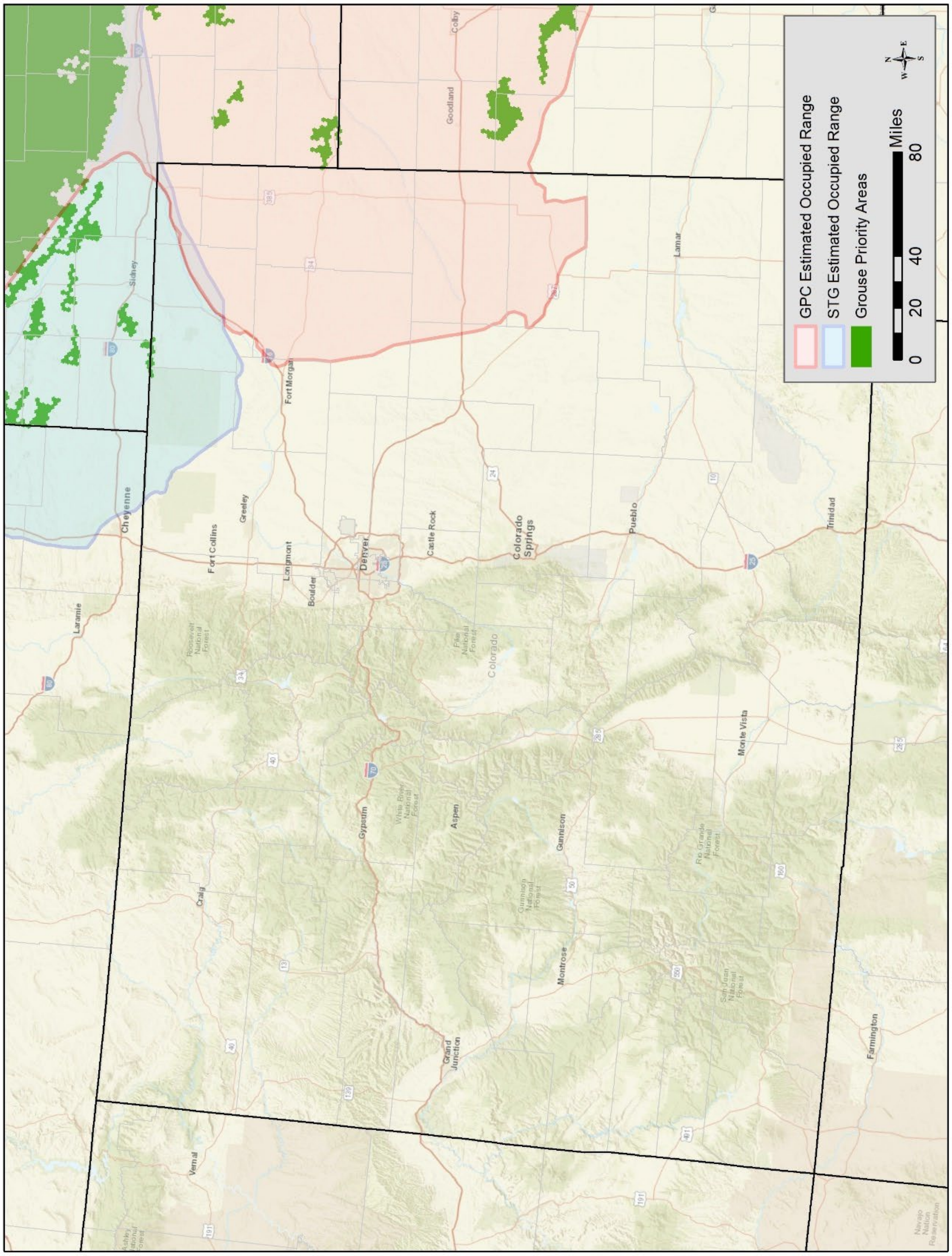
c. Ground Counts – A representative sample of leks within the range of a population should be counted 3-5 times annually during the breeding season. Data from these counts provide an indication of population size and trend. The remaining leks should be surveyed during the breeding season, at least once every 3 years to confirm location and status. These surveys also have some utility for monitoring general population trends. Counts and surveys should coincide with the peak of breeding activity between 1 April and 15 May. Begin counts 0.5-hour before sunrise and terminate them 0.5-half hour after sunrise. Each lek in the annual census should be counted 3-5 times. Allow 7-10 day intervals between counts. Tally numbers of males and females separately. Leks selected for the less intensive, status survey should be checked at least once every 3 years. During surveys and counts of known leks, look for new or previously unrecorded leks. Search within suitable habitats by periodically stopping and listening for vocalizations (turn engine off), and by glassing for birds. New dancing grounds may also be discovered during aerial surveys that cover broader regions and more remote locations. If evidence of a lek is observed, record the location and number of birds. Return the following year to confirm the site is a lek before formally designating it such.

d. Lek Routes – Lek routes serve the following major purposes: 1) search for evidence of breeding activity and lek locations; and 2) count attendance at known and newly discovered leks along each route. Lek routes have been established to monitor trends and distribution of STG populations in southeast 14-5 Wyoming. Indices that were correlated with fall harvest have been developed from lek route data and mid-summer brood surveys.

Standard routes of 20 miles each were established along suitable road networks. The same routes are followed each year. The observer stops for timed observation periods of 2-3 minutes each at ½ mile intervals. All grouse observed or heard are recorded on data sheets. Lek routes are run during the peak of dancing activity, typically the last two weeks of April. Begin each route at least 45 minutes before official sunrise to ensure the entire route can be completed before birds begin deserting leks. Conduct lek routes annually if trend data are desired. At a minimum, record the following data: 1) time; 2) lek location (indicate whether an ocular or auditory determination was made); 3) number male and female grouse on the lek; and 4) weather conditions (temperature, wind speed, cloud cover). If possible, drive lek routes on calm, clear days. Also indicate if incomplete counts, estimates, or unclassified grouse were recorded.

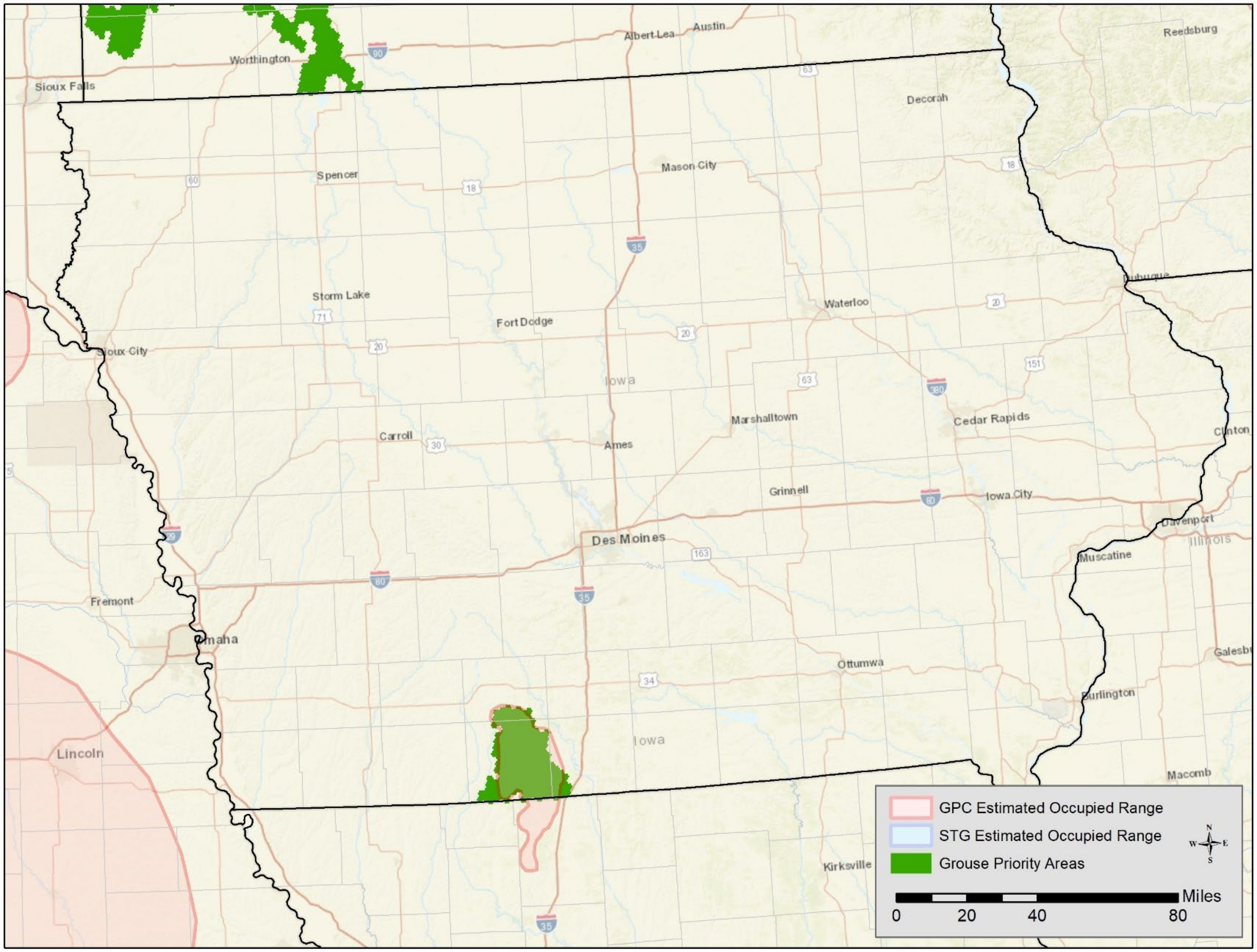
Appendix 3. State Specific Priority Area Maps and Methods

Colorado



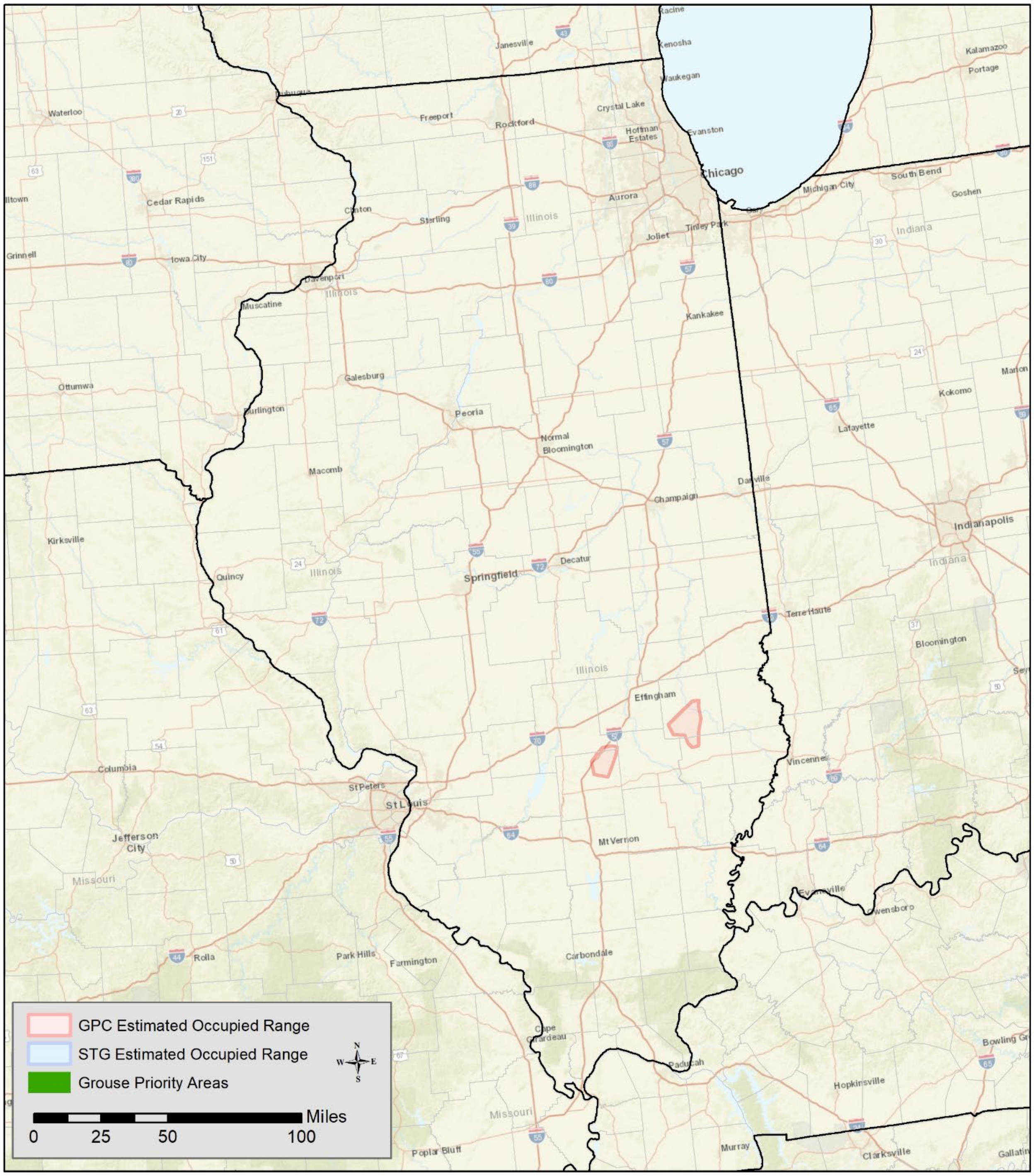
View of the GPC and STG EOR. No priority areas created for Colorado

Iowa



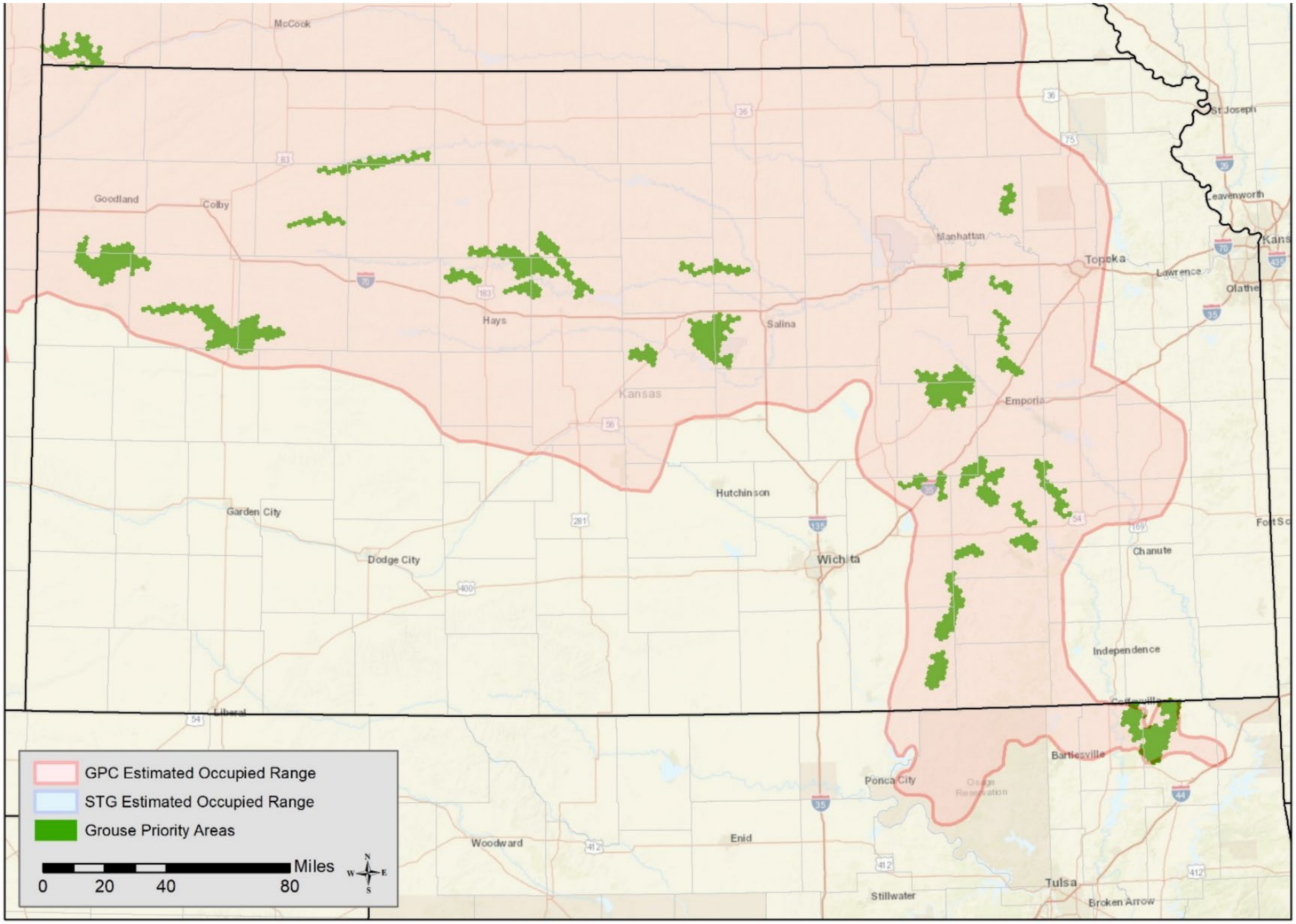
View of the GPC the GPC priority area created manually based on reference data and expert opinion

Illinois



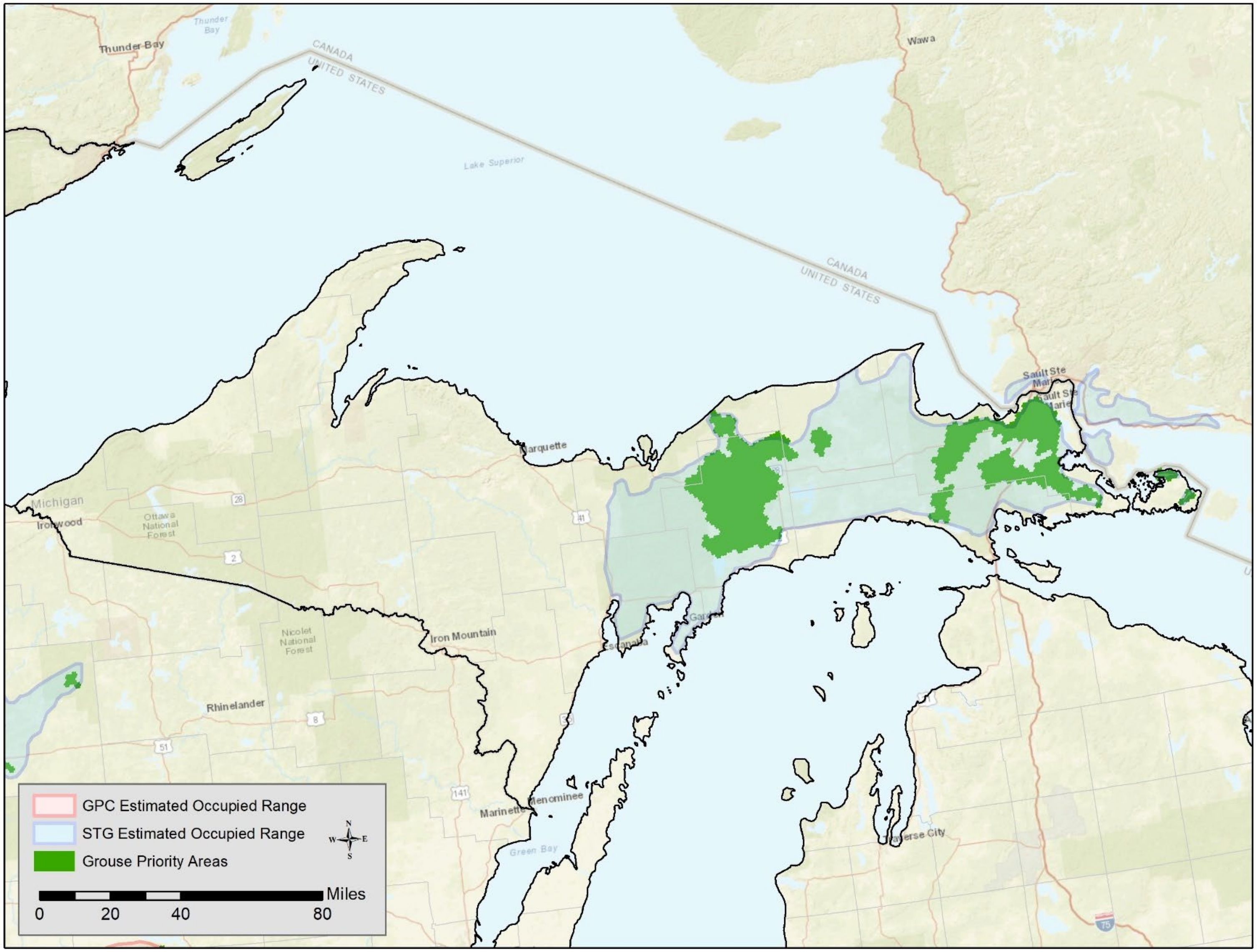
View of the GPC EOR. No priority areas created

Kansas



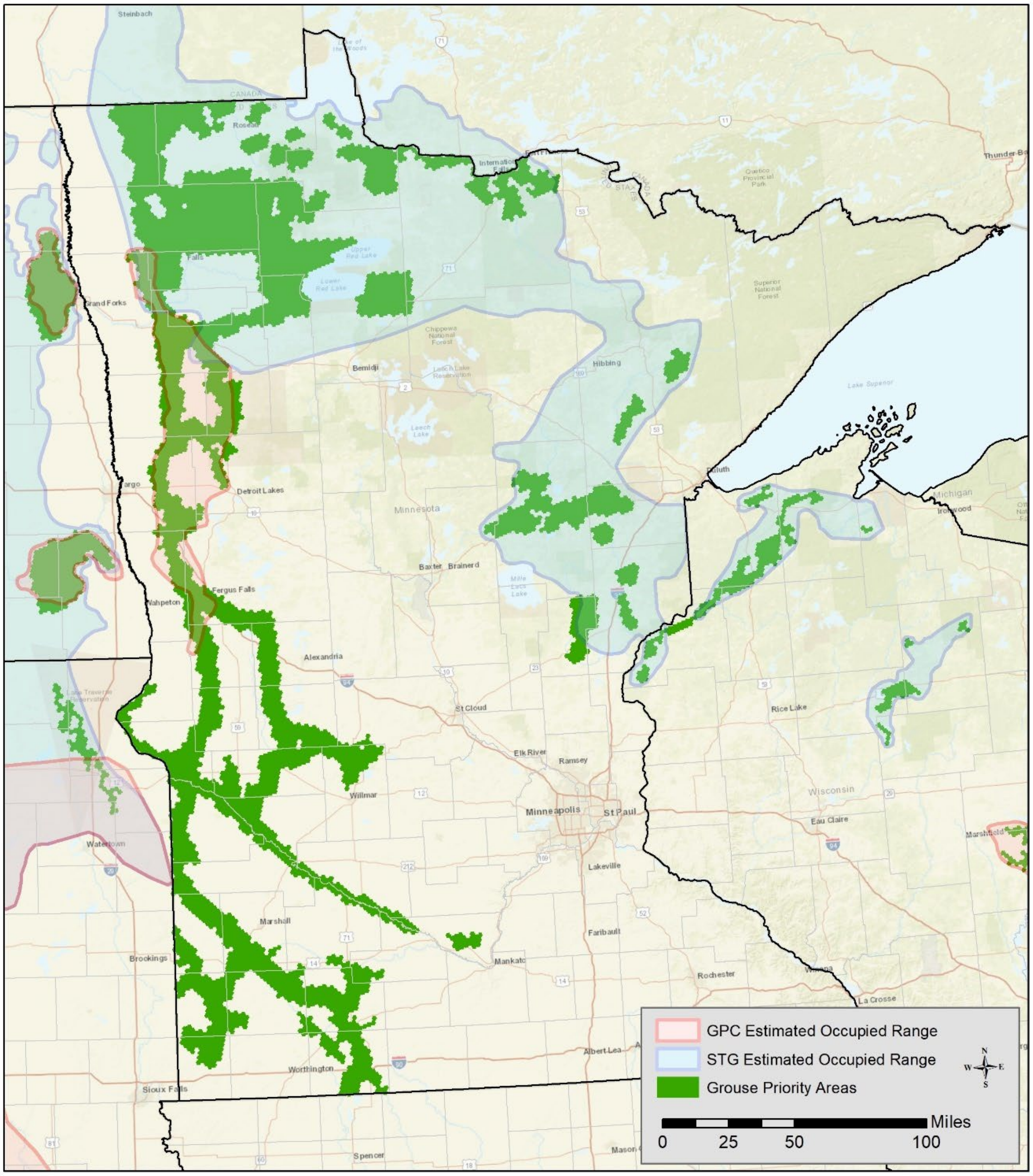
View of the GPC EOR the GPC priority area created manually from a targeted subset of an NHF query: GPC_range = 'in GPC range' AND GP_cog_NLCD_ZonalStats_Pct_range >=75 AND GP_cog_NLCD_ZonalStats_Pct_Forest <5 AND LIRangeland = 'part of >= 50,000ac block with>=75rangeland and <20%forest'

Michigan



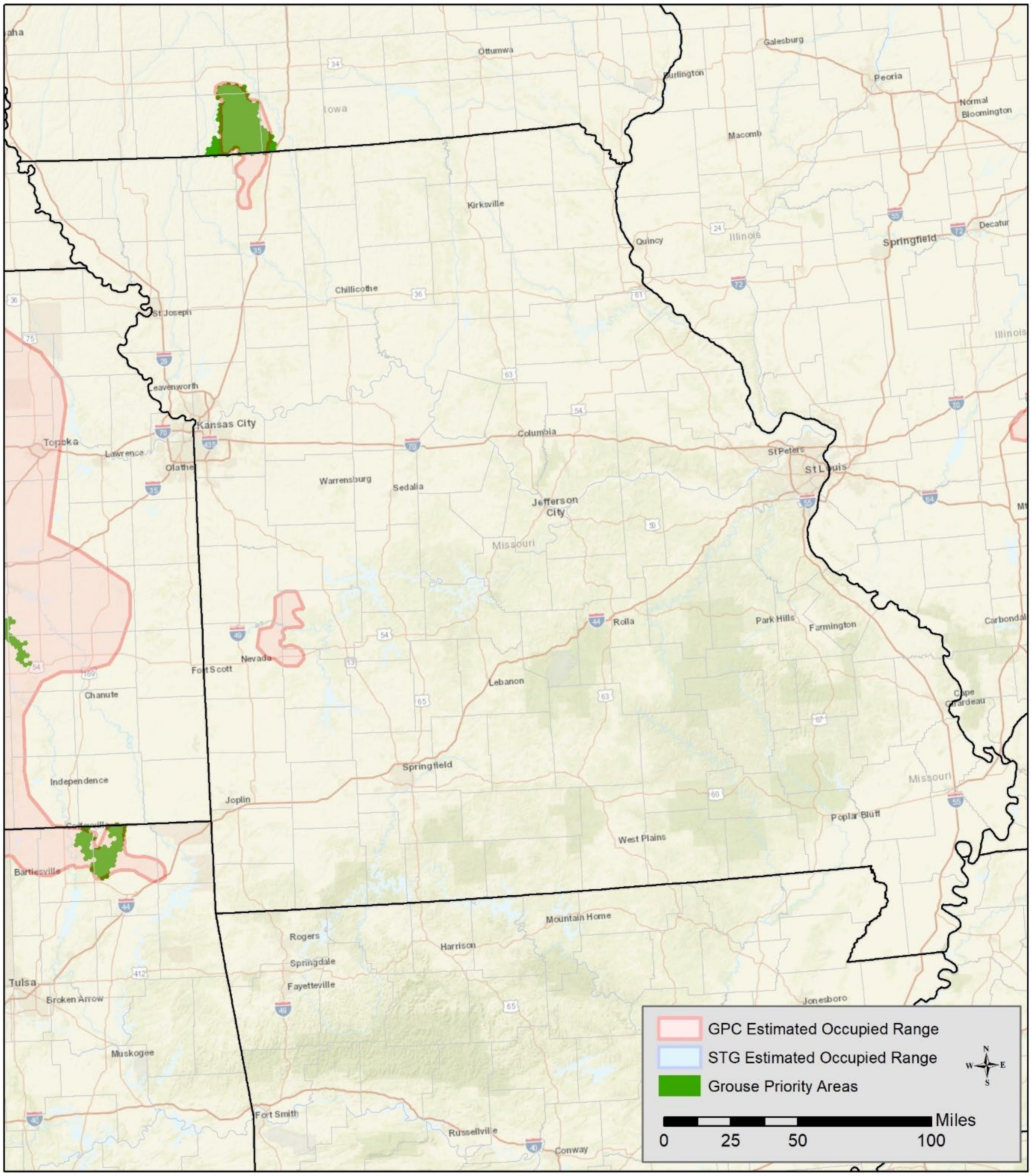
View of the GPC the GPC priority area created manually based on reference data and expert opinion.

Minnesota



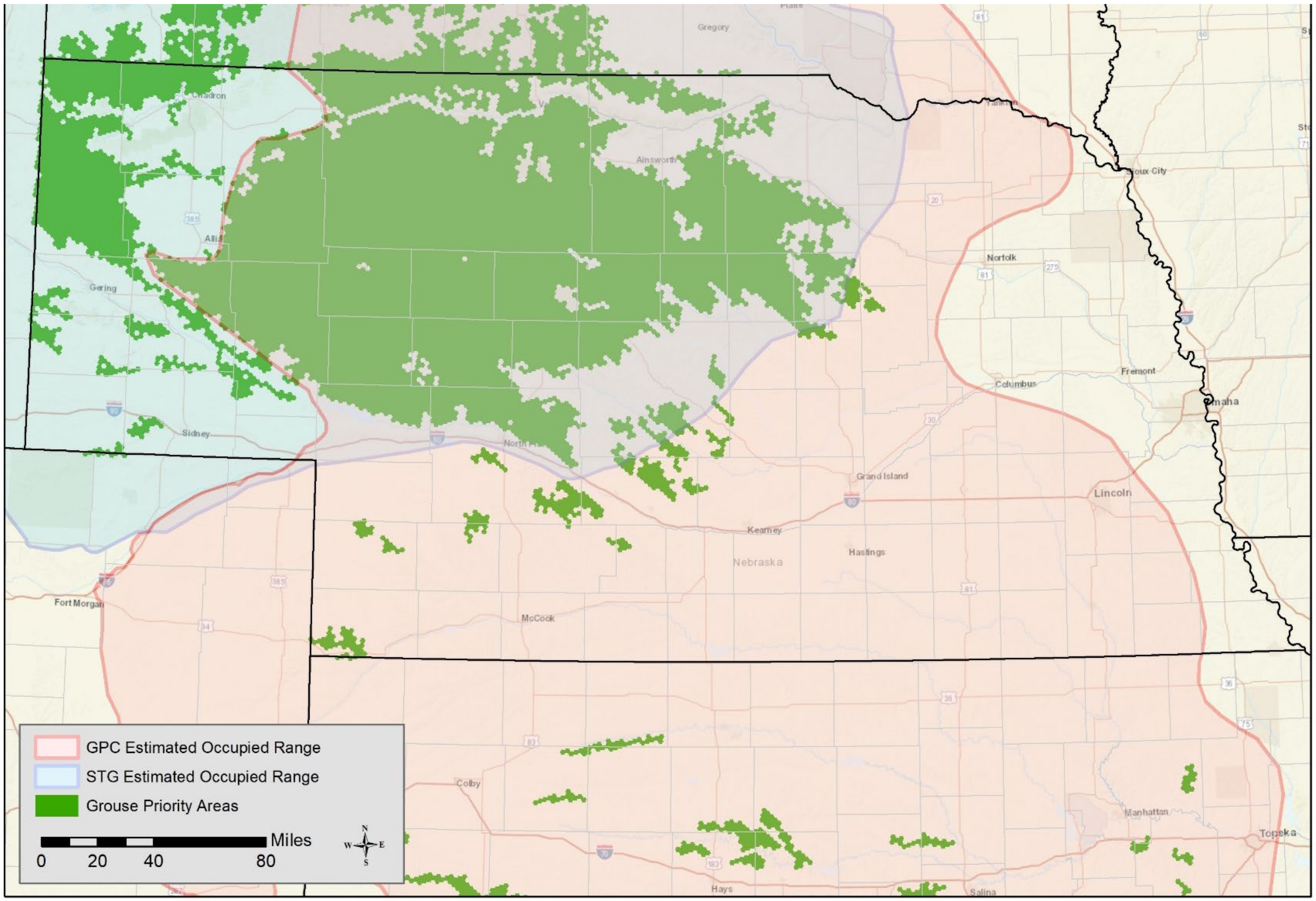
View of the GPC and STG EOR and the priority areas that were created from a manual selection of cells based on reference data and expert opinion.

Missouri



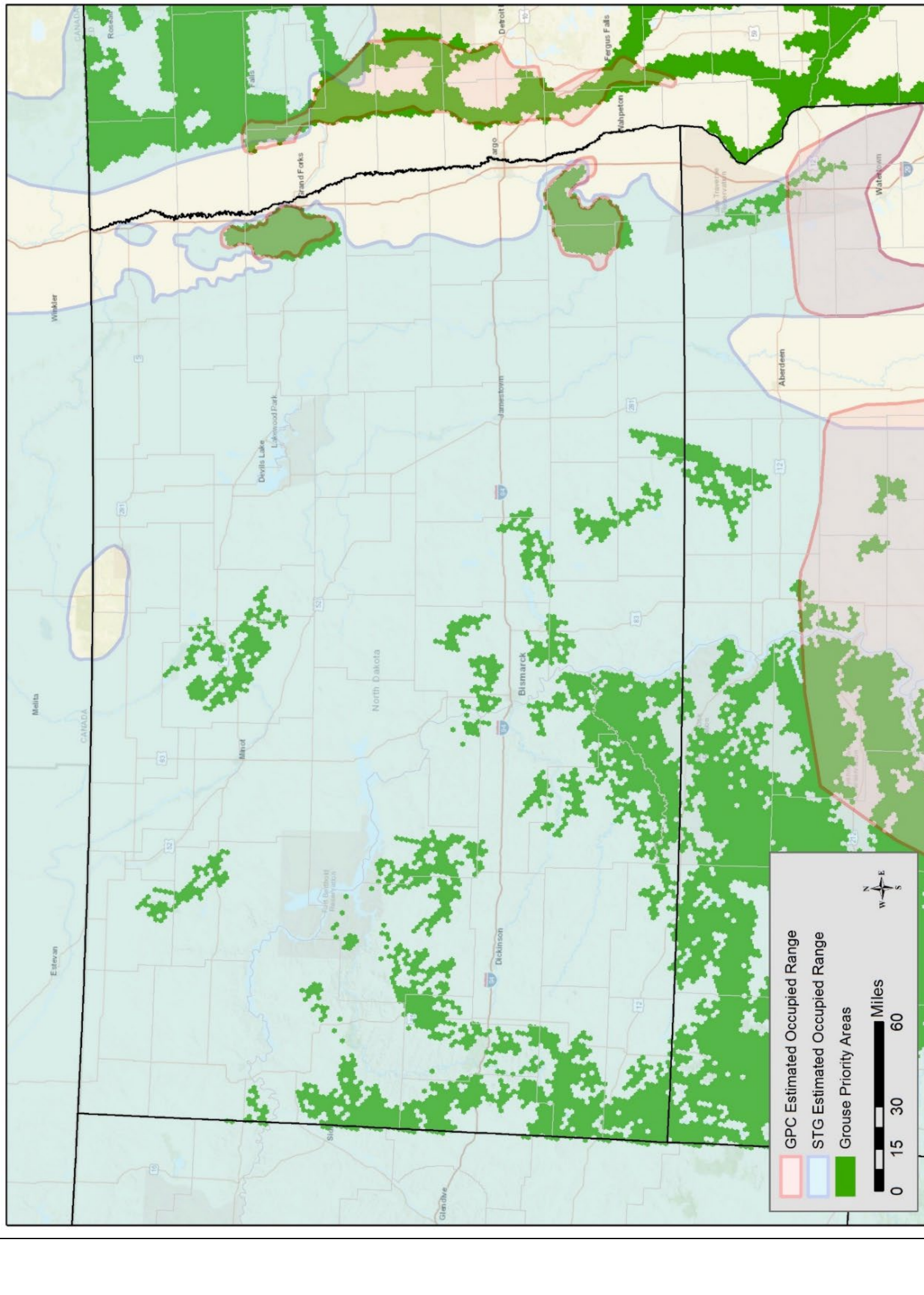
View of the GPC EOR. No priority areas created

Nebraska

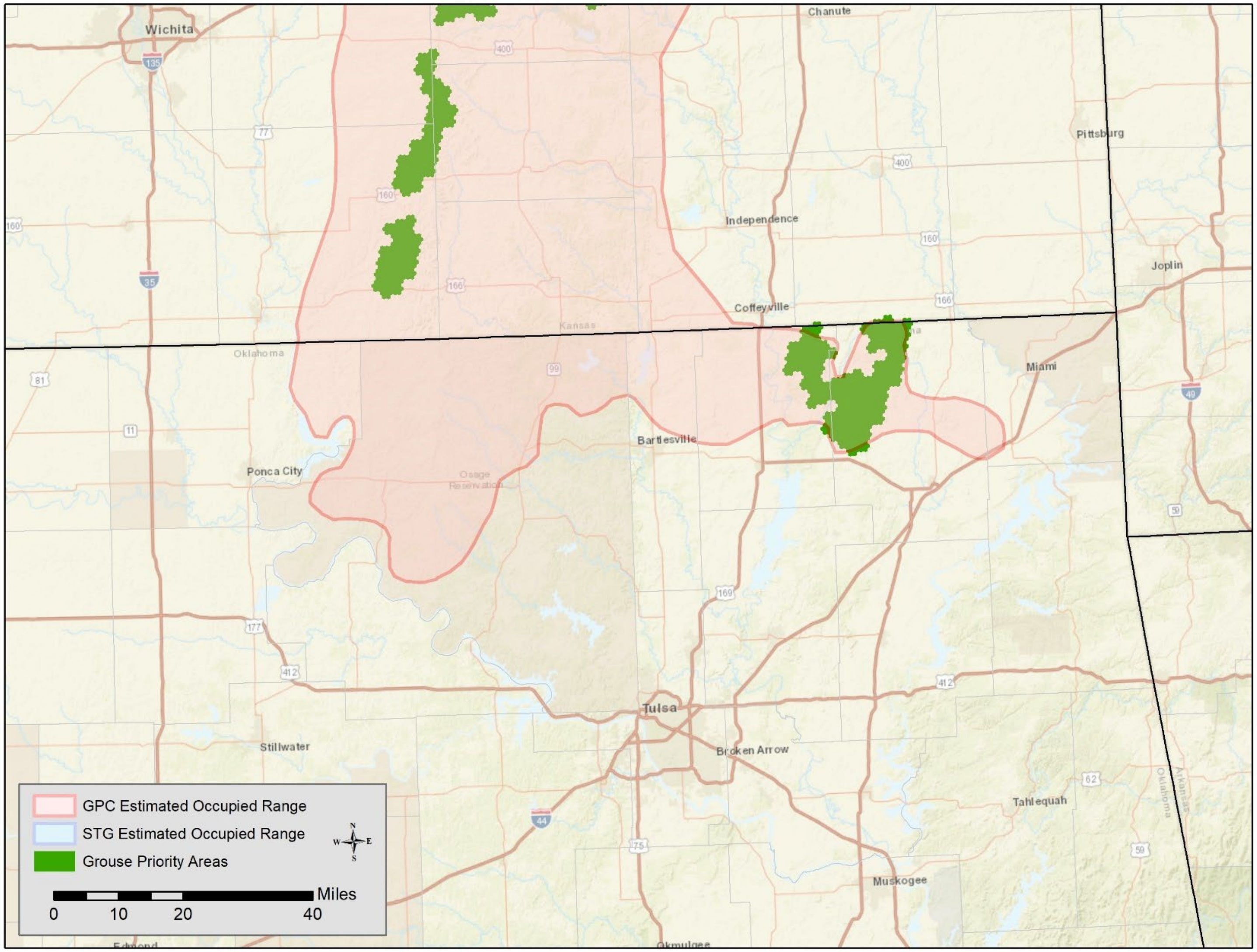


GP_cog_NLCD_ZonalStats_Pct_range >=90 AND GP_cog_NLCD_ZonalStats_Pct_Forest<5 AND LIRangeland = 'part of >= 50,000ac block with>=75rangeland and <20%forest'* applied the 15K acre minimum block size to selected groups of cells.

North Dakota

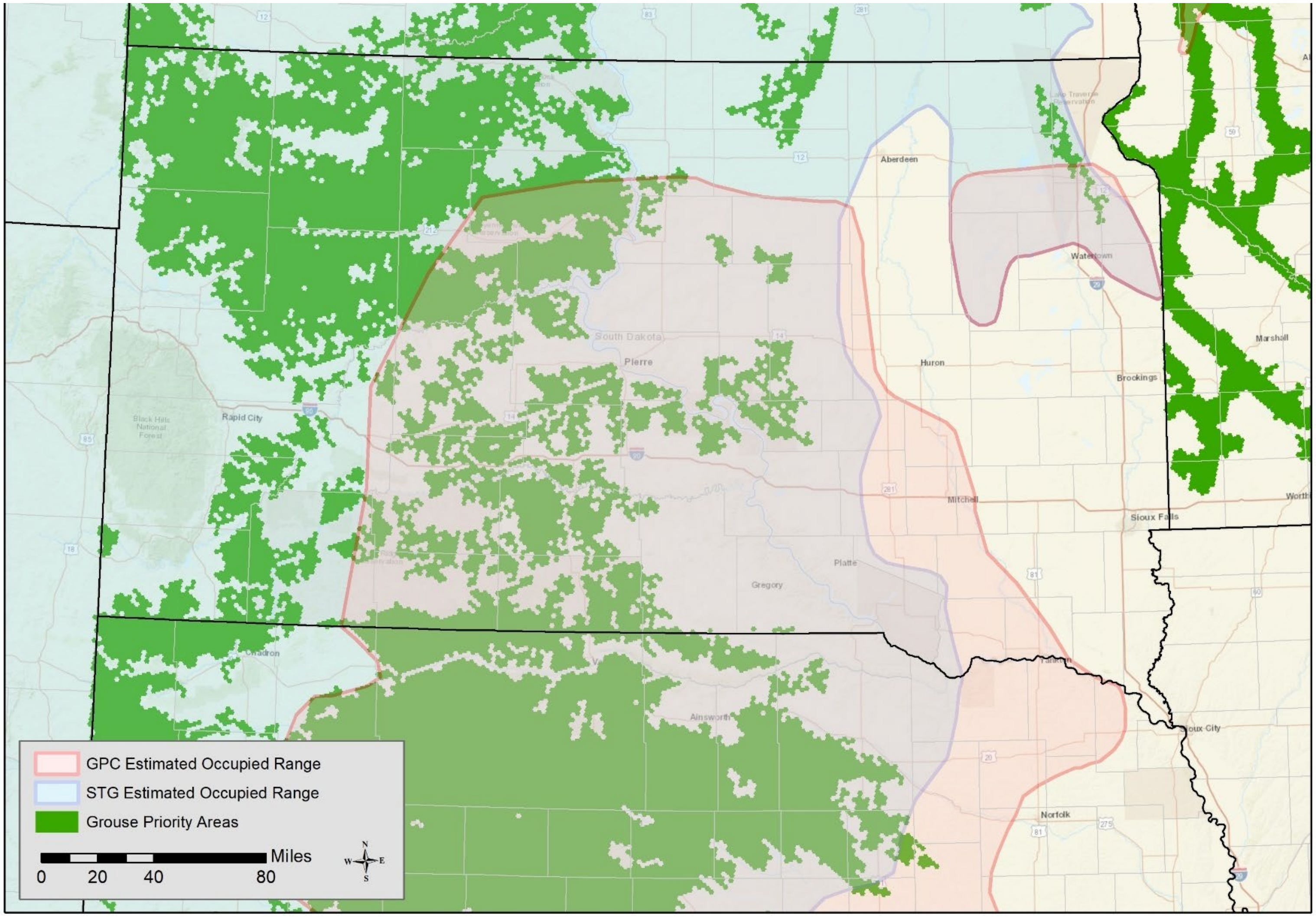


Oklahoma



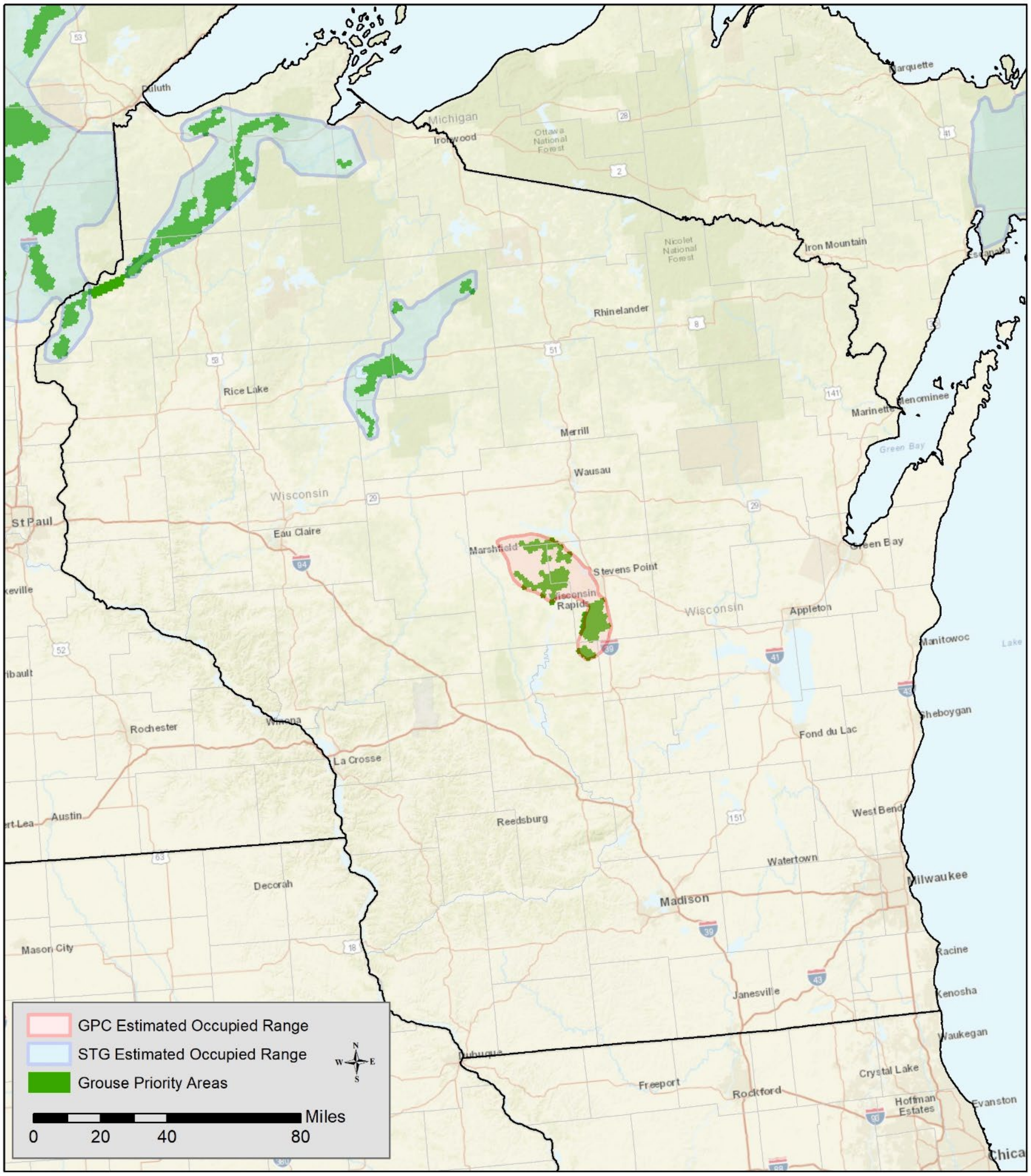
Manual selection of cells based on reference data and expert opinion

South Dakota

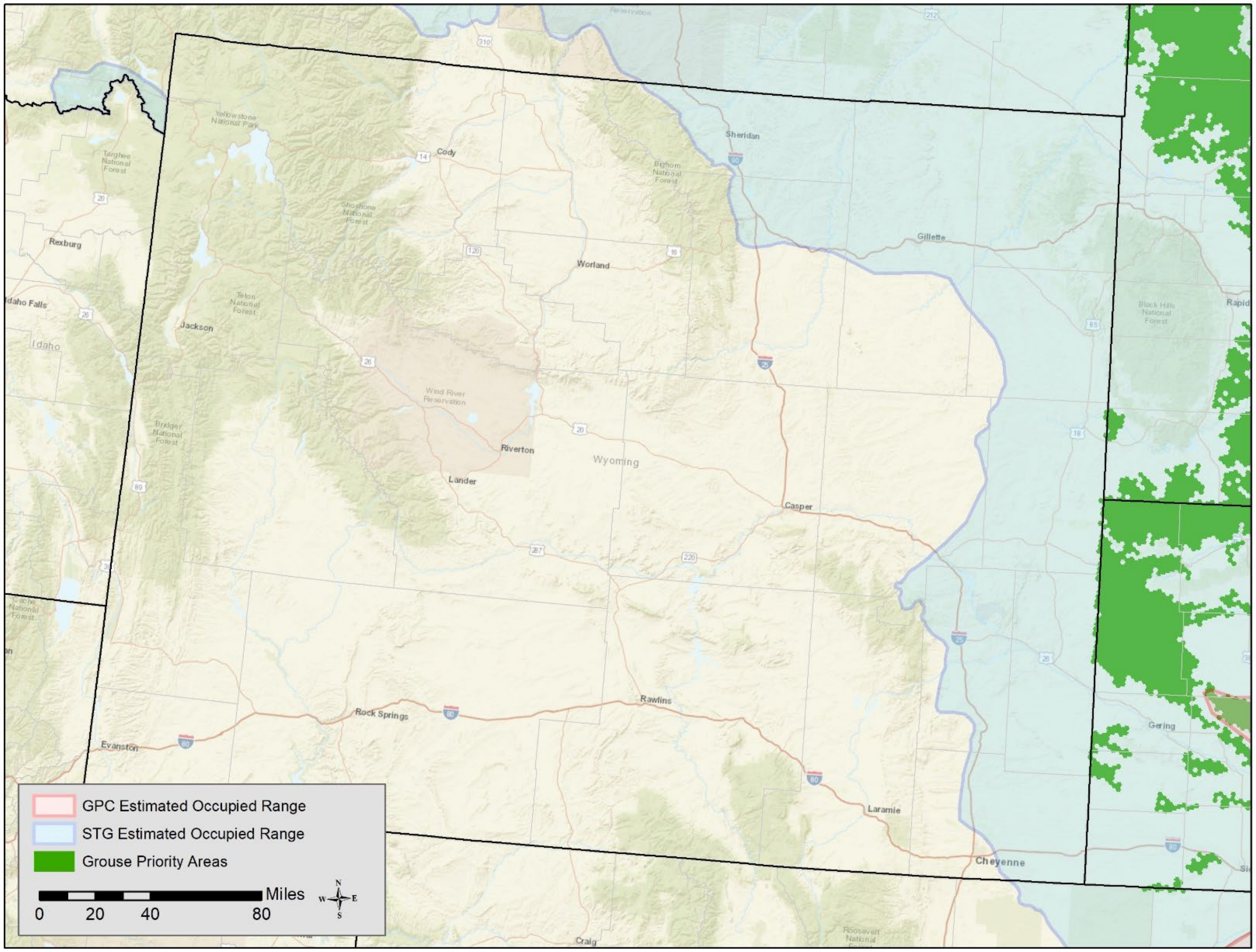


LIRangeland = 'part of >= 50,000ac block with>=75rangeland and <20%forest' And Majority GPCSTG suitability <= 3 And Pct_Forest < 5
*Dissolved Boundaries and extract polygons of >15,000 acres.

Wisconsin



Manual selection of cells based on reference data and expert opinion

Wyoming

View of the STG EOR. No priority areas created

Appendix 4. State Wildlife Action Plans-Specific Objectives/Conservation Actions to Support Prairie Grouse Conservation

Illinois (GPC)

- Farmland and Prairie Campaign in SWAP focuses GPC Recovery Plan (Walk 2004)
- Three year GPC transplant effort from Kansas started in 2014-No birds trapped in 2015-2016 due to Out-of-State travel authorization and Administrative Review
- Need 1 of Campaign and Conservation action includes managing existing grasslands and shrublands to maximize habitat quality and increase populations particularly as it relates to Prairie Ridge region
    - Restoration and enhancement efforts will focus on incorporating additional Habitat Teams, seeking dedicated funding for core areas and collaborative positions, and using opportunistic grants like Monarch Habitat funds
- Need 2 of Campaign and Conservation action includes significant achievements in creating/converting grassland and shrubland habitat from other land uses (i.e. row crops)
    - Work with Partners to better market existing Farm Bill programs, develop targeted focus areas, identify priority areas targeting reduction in nitrogen and phosphorous, and follow Landscape Scale Approach to acquisition of grasslands
- Need 3 of Campaign and Conservation action includes defining what is desirable when working with partners on acquisition and restoration efforts
    - Small-scale landscape grasslands should be 40-80 acres
    - Medium-scale landscape grasslands should be 1,000-1,500 acres with 250 - 1,000-acre core area; remaining landscape 35% grassland
    - Large-scale landscapes should be 10,000 - 50,000-acre areas with 2,000-acre core; 35% of remaining area in grasslands
    - Collaborate with private landowners and conservation organizations
    - Proportion of woody cover on and around grassland sites should be <10%
    - Potential grasslands to prioritize should be in areas with higher proportion of hay, pasture, small grains
- Highest Priority Areas
    - Prairie Ridge Landscape
    - Sibley/Saybrook Complex
    - Midewin Area
    - Nachusa Grasslands Complex
    - Kankakee Sands
    - Pyramid-Arkland Landscape
    - Green River State Fish and Wildlife Area
    - Illinois and Mississippi River Sand Areas

Iowa (GPC)

- Vision 1 strives for viable wildlife populations by focusing on greater emphasis on SGCN; focusing on protection, restoration, reconstruction, and enhancement of native plant communities; restore populations with relocation and reintroduction programs; and greater knowledge of species distribution and abundance-GPC not specifically mentioned, but implied
- Vision 2 strives for healthy ecosystems by protecting large and small blocks of private and public lands-GPC not specifically mentioned
- Vision 3 focuses on diverse wildlife communities on private and public lands that adaptive ecological management principles that are based on science

Kansas (GPC)

- GPC mentioned in SWAP as medium population abundance and declining population trend
- Major issues are altering of habitat, decline in quantity and quality of habitat due to invasive species, and improvement and preservation of key habitat is not assured
- Conservation Regions to focus efforts include Shortgrass Prairie (western 1/3rd of Kansas), Sandsage Shrubland Habitat (SW Kansas), Central Mixed-grass Prairie (Central Kansas), and Eastern Tallgrass Prairie (Eastern 1/3rd of Kansas)
- Regional conservation issues identified, but no conservation actions presented

Michigan (STG)

- Major issues concerning grouse habitat relate to invasive plant species, natural system modifications such as forest succession and urban development, and incompatible agricultural practices.
- Land and Water Management
    - Increase size of existing large grassland complexes and possibly remove hedgerows
    - Manage for structural and grassland successional diversity
    - Increase forbs component using local ecotypes
    - Conduct habitat management to mimic natural disturbance regimes using fire and large grazers
    - Prioritize and conduct targeted invasive species management
    - Promote Farm Bill programs and FWS Partners for Wildlife Program
    - Use easements and acquisitions to increase large grassland complexes
    - Promote landowner cooperatives for grassland habitat

Minnesota (STG)

- SWAP (Ch. 4., Goal 1, Objective 1)-maintenance and enhancement of habitats within the Wildlife Action Network that fall within DNR Priority Open Landscapes as identified through our DNR Subsection forest Resource Mgt. Planning
- SWAP (Ch. 4, Goal 3, Objective 1)-Increase and diversity funding and partnerships for implementing the SWAP and reporting on the plans effectiveness

Missouri (GPC)

- Grassland/Prairie Savanna conservation actions focus on protecting intact, remnant habitats and maintaining sites that have been successfully restored
- Conversion of cropland and fescue pasture to diverse reconstructed grassland communities of diverse native plants is a guiding objective
- SWAP identifies 3 conservation opportunity areas (COAs) which are Grand River Grasslands and Spring Creek Watershed, both in Central Dissected Till Plains region of north Missouri and Upper Osage Grassland, within Osage Plains of SW Missouri-GPC not mentioned, but implied

Nebraska (GPC and STG)

- SWAP is divided into 4 ecoregions consisting of 35 Biologically Unique Landscapes (BULs). Greater prairie-chickens were listed as a Tier 1 SGCN (most at-risk) in Nebraska's 2005 and 2011 SWAP editions and was downgraded to Tier 2 SGCN in the 2018 SWAP Supplement Revision. The species likely occurs in 14 BULs: Sandstone Prairies BUL, Southeast Prairies BUL, Elkhorn Confluence BUL, Ponca Bluffs BUL, Willow Creek Prairies BUL, Verdigris-Bazile BUL, Keya Paha BUL, Elkhorn River Headwaters BUL, Cherry County Wetlands BUL, Dismal River Headwaters BUL, Central Loess Hills BUL, Platte Confluence BUL, Loess Canyons BUL, and Sandsage Prairie BUL.
- Conservation Strategies listed in BULs where GPC likely occur, and which may benefit the species include:
    - Support voluntary implementation of ecologically-sensitive grazing and haying strategies on private and public lands, in combination with prescribed fire and rest, to improve native plant diversity and improve grassland wildlife habitat.
    - Implement eastern redcedar and other tree clearing programs on private and public lands, including cutting and prescribed burning, to improve grassland wildlife habitat.
    - Survey and implement control programs for other invasive plant species.
    - Implement integrated public and private lands management. For example, work with private landowners with properties bordering WMAs to manage larger habitat blocks.
    - Work with wind energy companies to select turbine sites that minimize fragmentation and impacts to native species. Wind farms should not be located within the recommended radius of prairie grouse leks and nesting grounds. See Nebraska Game and Parks guidelines for wind energy development.
- Species-specific research and inventory needs identified in the 2011 SWAP for GPC include continued surveys to assess distribution and abundance, study the effects of wind turbines, gain a better understanding of habitat use and demographics, and gain a better understanding of contribution of Nebraska's population to the species as a whole. Regular, species monitoring is being conducted, and is recommended to continue.
- Threats to GPC identified in the 2011 SWAP include habitat conversion and fragmentation, grassland management (loss of forbs), loss of some shrubs, wind energy development, woody species encroachment, and loss of CRP in eastern Nebraska.

North Dakota

- Greater prairie-chicken and Sharp-tailed grouse are Level II species of Conservation Priority

Greater Prairie-Chicken

- The North Dakota Game and Fish Department and the U.S. Forest Service conduct annual lek surveys counting the number of birds present.
- Explore strategic options for creating habitat corridors for interconnectivity between the Grand Forks and Sheyenne National Grasslands populations and other states.

Management Recommendations

• Protect remaining tallgrass prairie remnants, particularly where leks have been identified.
• Plant a mixture of grasses and forbs when reclaiming cropland to grassland.
• Use rotational disturbance every 3-5 years, with prescribed burning as the preferred method.
• Minimize woody vegetation in priority management areas.
• Create habitat corridors to connect isolated populations.
• Delay cutting from April 15 – August 1, and use a stripper header and flushing bars. When cutting, leave the highest possible height (12-24 inches).
• Conscientious use of pesticides.
• Avoid constructing fences through or near leks and install visibility markers to existing fences.
• Utility development should follow the guidance of "Reducing Avian Collisions with Power Lines" including marking power lines and creating an Avian Protection Plan.

Sharp-Tailed Grouse

- The North Dakota Game and Fish Department and several other federal and non-governmental organizations conduct annual lek surveys counting the number of birds present during the breeding season.

Management Recommendations

• Protect leks and the surrounding habitat from loss or destruction.
• Plant a mixture of grasses and forbs when reclaiming cropland to grassland.
• Use rotational disturbance every 3-5 years, with prescribed burning as the preferred method.
• Develop grazing plans that provide residual vegetation for the following spring and eliminate over-utilization of woody draws, mesic swales and riparian areas.
• Control tall woody vegetation.
• Delay cutting from April 15 – August 1, and use a stripper header and flushing bars. When cutting, leave the highest possible height (12-24 inches).
• Conscientious use of pesticides.
• Avoid constructing fences through or near leks and install visibility markers to existing fences.
• Utility development should follow the guidance of "Reducing Avian Collisions with Power Lines" including marking power lines and creating an Avian Protection Plan.

Oklahoma (GPC)

- Conservation Issues Related to Habitat Loss and Fragmentation as a Result of Large-scale and Small-scale Habitat Conversion
    - Focus on tallgrass prairie research on prairie restoration, establishing sources of native forb and grass seed, funding for prairie restoration, developing a conservation easement program particularly in Kay, Osage, Nowata, and Craig counties (probably GPC related), and other financial incentive programs for tallgrass prairie region
- Conservation Issues Related to Current and Historic Land Use Practices that Alter Habitat Quality
    - Evaluate grazing systems more closely to mimic historical grazing patterns to attain ecological benefits to wildlife and ranchers

    - Develop fire-grazing management program to promote landscape heterogeneity
    - Promote native plant communities over planting of exotics
    - Evaluate and educate on herbicide usage on grazing lands
    - Develop rancher-conservationist partnerships in Osage/Kay and Nowata/Craig counties to restore viable populations of GPC
- Conservation Issues Related to Information Gaps Associated with SGCN and their Habitats
    - Conduct research that identifies and remedies the factors that limit the distributions and population sizes of SGCN
    - Use remote sensing to identify landscapes that are dominated by grassland and prairies
    - Create long-term habitat monitoring programs based on photo documentation
    - Conduct surveys of distribution and ecological needs of SGCN
    - Develop population and habitat monitoring programs
- Conservation Issues Related to Invasive and Exotic Species that Alter Habitat Quality or Directly Affect SGCN
    - Develop education materials on negative aspects of invasives and the control measures that are available
    - Evaluate ecological damage of invasives and implement preventive control measures

South Dakota (GPC and STG)

- Coordination-Expand partnerships, identify programs, increase collaboration and communication, and identify funding sources-not specific to PG, but could be implied
- Management-Assess ecosystem function, develop new incentive programs, evaluate public lands, identify and map unique plant communities, expand efforts on exotic and invasive species, identify COA's, address connectivity concerns, etc.-not specific to PG, but identify COA's and address connectivity concerns would seem directed at PG
- Research-Develop prescribed burning methods, define ecosystem friendly grazing/haying practices, and better understand exotic and invasive species distributions-not specific to PG, but would seem directed at PG

Wisconsin (GPC)

- Loss and fragmentation of grassland habitat is critical issue in state and conservation actions focused on restoration, management, and protection of large blocks of grassland habitat for SGCN
- Maintain and restore oak barrens and sand-, dry-, or dry mesic- prairie habitats-GPC not mentioned, but implied in conservation actions

Wyoming (STG)

- Conservation actions focus on improving planning and mitigation design on wind and other energy development, reducing spread of invasive species, providing incentives for management of grasslands, pursuing conservation easements, and enhancing educational opportunities

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