Indirect Effects[1] – Draft and Pre-D

Feature	Avoidance Distance	Source
Habitat Conversion to Ag	6.9 km	BER
	1049 m	Hagen et al. 2004
	3 km	Bradley and Mustard 2006
	4 km	Bradley et al. 2010
	DO NOT APPLY BUFFER - GIVEN THE VARIABILITY OF DIFFERENT CROPS, DI DURING SOME LIFE HISTORY STAGES AND DURING DIFFERENT SEASONS, W	
Center-pivots	977-1142 m	Pitman et al. 2005
Power lines	6.9 km	BER
	1106-1320 m	Hagen et al. 2004
	1254 - 1385 m	Pitman et al. 2005
	≥100 m	Pruett et al. 2009
	500 m	Horton et al. 2009
	600 m	Gillan et al. 2013
	1 km	Braun 1998
	500 m	Hanser et al. 2011
		Johnson et al. 2011
	3500 m	Durtsche et al. unpublished report

	10.5 km lines >115 kV	Nonne et al. 2013
		LeBeau et al. 2014
	7.5 km	Schroeder 2008
		Ellis 1985
	2.5 km (low); 6.9 km (high)	Knick et al. 2011
		Wisdom et al. 2011
	2.2 km lines <115 kV	Coates et al. 2014
	7 km	Bradley et al. 2010
	4 km	Bradley and Mustard 2006
Communication Towers	6.9 km	BER
		Johnson et al. 2011
	500 m	Durtsche et al. unpublished report

	500 m	Balmori 2005, 2006; Balmori and Hallberg 2007; Everaert and Bauwens 2007 (cited in Wisdom et al. 2011)
		Wisdom et al. 2011
	DO NOT APPLY BUFFER	
Other Vertical Structure	6.9 km	BER
	500 m	Horton et al. 2009
Urbanization/Buildings	6.9 km	BER
	1397-2129 m	Hagen et al. 2004
	1951-2306 m	Pitman et al. 2005
	2129 m	Horton et al. 2009
	150 m	Gillan et al. 2013
	800 m	Braun 1998
	950 m	Holloran et al. 2010
	2.5 km	Aldridge et al. 2012
	5 km	Johnson et al. 2012
	3 km	Bui et al. 2010
Fences	Unspecified	BER
		Wolfe et al. 2007
		Stevens 2011
	DO NOT APPLY BUFFER	

Pipelines		Johnson et al. 2011
	30 m active; 15 m inactive	Durtsche et al. unpublished report
	DO NOT APPLY BUFFER	
Roads	7.5 km (Interstate); 3 km (Hwy): 3 km (secondary)	BER
	≥100 m	Pruett et al. 2009
	2000 m major highways; 300 m major roads; 30 m local roads; 15 m minor roads	Durtsche et al. unpublished report
	8 km	Aldridge et al. 2012
	193-214 m	Hagen et al. 2004
	7.5 km (Interstate)	Connelly et al. 2004
	3.3 km (Hwy)	Patricelli et al. 2013
	3 km (Secondary)	Holloran 2005
	3 km (Secondary)	Holloran et al. 2010
	3 km (Secondary)	Lyon and Anderson 2003
	400m (Secondary)	Blickley 2012

	2377 m	Hagen et al. 2004
	1526-3149 m	Pitman et al. 2005
	2377 m	Horton et al. 2009
	450 m	Gillan et al. 2013
	208-224m (Unimproved)	Pitman et al. 2005
	7 km	Knick et al. 2011
	Variable (loess curves)	Johnson et al. 2011
	295m (all roads)	Wisdom et al. 2011
	5km (highways)	Wisdom et al. 2011
	3.2 km (paved roads)	Fedy et al. 2014
	2.13 km	Howe et al. 2014
	500 m (Secondary)	Bradley et al. 2010
	700 m	Bradley and Mustard 2006
Railroads	3 km	BER
	90 m	Durtsche et al. unpublished report
	3 km	Knick et al. 2011
	DO NOT APPLY BUFFER	
O&G	19 km	BER
	435-564 m	Hagen et al. 2004

	539-588 m	Pitman et al. 2005
	564 m	Horton et al. 2009
	1.9 km	Carpenter et al. 2009
	3 km	Holloran et al. 2010
	300 m	Durtsche et al. unpublished report
	2 km	Gregory and Beck 2014
	19 km	Naugle et al. 2011, Tayler et al. 2012; Johnson et al. 2011
	pad density of > 1 pad/2.6 km2	Holloran 2005
	4 km	Johnson et al. 2011
	3.2 km breeding; 6.4 km wintering	Fedy et al. 2014
		Fedy et al. 2014; Coates et al. 2013
Coal	19 km	BER
	2 km	Braun 1986
	Unspecified	Moore and Mills 1977
	2 km	Remington and Braun 1991
	?	Taylor et al. 2012
	>18 km	Johnson et al. 2011
	USE DIRECT FOOTPRINT (LEASE BOUNDARY WILL LIKELY COVER DIRECT AN	
Mining	2.5 km	BER
	2.5 km	Bradley and Mustard 2006

	DO NOT APPLY BUFFER	
Wind	6.9 km	BER
	2000 m	Horton et al. 2009
	1.6 km	Robel et al. 2004
	5 km	LeBeau et al. 2014
	5 km	LeBeau et al. 2013
	5 miles (lek based buffer)	Manville 2004
Geothermal	Unspecified	BER
	1 km plus	Suter 1978
Predation	2.2 km	Coates et al. 2014
	2.13 km	Howe et al. 2014
		Coates and Delehanty 2010
	570 m (± 707.3 SD)	Boarman and Heinrich 1999
	6.9 km	Boarman and Heinrich 1999
	3 km	Bui et al. 2010
	GIVEN THE LACK OF SPATIAL INFORMATION RELATED TO ROOST AND DEN DISTANCES CITED FROM THE LITERATURE (IDENTIFIED ABOVE) TO HELP IN RANGE OF GRSG	

Noise		Hunt 2004
		Dantzker et al. 1999
		Blickley and Patricelli 2013

[1]ALL BUFFER DISTANCE (HIGHLIGHTED IN GREEN) REPRESENT THE RADIUS TO BE PLACED ON THE DISTURBANCE FEAT
DIRECT DISTRUBANCE FOOTPRINT, WE WILL ADJUST THE BUFFER DISTANCE AS SUCH TO ACCOUNT FOR THE DIRECT I

Comments
Based on Boarman and Heinrich (1999); Leu et al (2008); Connelly (2011)
Distances from LEPC nests taken from Pitman (2003) and other use sites from Hagen (2003) to ag edge
Cheatgrass was 20% more likely to be found w/in 3 km of cultivation
Lands w/in 4 km of ag are more likely to contain cheatgrass
FFICULTY IN DETERMINING IRRIGATED VS. NON-IRRIGATED, AND GRSG USE OF SOME AGRICULTURAL AREAS VE WILL NOT QUANTIFY THE INDIRECT AIO RELATED TO EXISTING AG ON THE LANDSCAPE
Distances of LEPC nests to anthropogenic features on 2 areas in SW Kansas
Telemetry data from CPW suggests that sage-grouse use areas in irrigated fields within 150 ft of intact sagebrush habitat
Based on Ellis (1985); Connelly et al. (2004); Bradley and Mustard (2006); Boarman and Heinrich (1999); Leu et al. (2008)
Distances from LEPC nests taken from Pitman (2003) and other use sites from Hagen (2003)
Distances of LEPC nests to anthropogenic features on 2 areas in SW Kansas
Avoidance behavior of prairie grouse
Avoidance buffers based on Pruett et al. (2009) applied to LEPC spatially-based planning tool for Oklahoma
GRSG avoidance of infrastructure
Study found there was less probability of GRSG pellet occurrence w/in 500 m of power lines
Found no negative effect of power lines on lek counts
Represents constructed buffers to incorporate factors that may impact or influence GRSG use beyond the direct physical limits of the disturbance component; Intended to represent the impact of raptor predation on the use of perches on transmission line towers.

Preliminary analysis found no support for an effect of distance from the transmission line on nest site selection and female nesting propensity, weak support for an effect on male survival, and strong support for an effect on nest survival and female survival; Female GRSG are exhibiting avoidance behavior of transmission lines for nesting habitat (landscape scale inflection point = 10.5 km from the line; local scale inflection point = 11.6 km from the line); Female GRSG nest survival is suppressed near transmission lines (inflection point = 9.2 km)
The relative risk of a nest failing decreased in habitats closer to transmission lines but the relationship between nest survival and distance to transmission line was not substantial.
In Washington, 19 of 20 leks (95%) documented within 7.5 km of 500 kV powerlines are now vacant while the vacancy rate for leks further away is 59% (22 of 37 leks).
The placement of transmission lines in close proximity to a lek (w/in 200 m) will cause an increase in usage of the structures as hunting sites by raptors; Recommended that new transmission lines should avoid leks and/or use areas aby at least 1.2 km and preferably by 1.5 km.
Low and high effect areas were estimated based on spread of exotic plant species (Bradley and Mustard 2006) and foraging distances of mammalian and corvid predators (Boarman and Heinrich 1999, Leu et al. 2008).
Mean distance to electric transmission lines was >2 times farther in occupied range than in extirpated range.
At a 660ha (6.6 km2) scale, ravens (on average) foraged out to 2.2 km on either side of power lines
Lands w/in 7 km of powerlines are more likely to contain cheatgrass
Cheatgrass was 15% more likely to be found w/in 1 km of a powerline with increased probability of presence up to 4 km from powerlines
Based on Boarman and Heinrich (1999); Leu et al (2008)
Found lek trends were reduced when communication towers were nearby (leveling off at 10 km); there was a steady downward pattern of trends of lek counts as the number of towers increased, either within 5 km or within 18 km
Represents constructed buffers to incorporate factors that may impact or influence GRSG use beyond the direct physical limits of the disturbance component; Intended to represent the impact of raptor predation

Reduced population or reproductive performance in birds and amphibians due to high levels of electromagnetic radiation.
The distance to cell towers averaged almost twice as far in occupied range.
Based on Boarman and Heinrich (1999); Leu et al (2008)
Vertical structures >99 ft; applied to LEPC spatially-based planning tool for Oklahoma
Based on Boarman and Heinrich (1999); Leu et al (2008)
Distances from LEPC nests taken from Pitman (2003) and other use sites from Hagen (2003)
Distances of LEPC nests to anthropogenic features on 2 areas in SW Kansas
Avoidance buffers based on Pitman (2003) in Hagen et al. (2004) applied to LEPC spatially-based planning tool for Oklahoma
GRSG avoidance of infrastructure
Fewer GRSG yearling females nested w/in 950 m of infrastructures than was expected
High density residential development was avoided at a landscape scale and nesting GUSG females chose to nest farther away from any single development at the patch scale; housing developments should minimally be placed 2.5 km from crucial habitat to protecting nesting birds.
Found fewer leks were located w/in 5 km of developed land (urban and suburban areas, and interstate and state highways)
Modeled that raven density declined sharply at distances beyond 3 km form city boundaries and into areas of infrequent human activity.
No indirect area of influence identified
Recommends marking fences w/in 1 km of prairie grouse leks
Recommends 2 km mitigation buffers around GRSG leks

Trends in lek counts seemed unrelated to distance to the nearest pipeline; the loess curve for the 5-km radius indicated a slight decline once length of the pipeline exceeded 6 km (16 km in the Great Plains, 1 km in Wyoming Basin, 10 km Snake River Plain); For the 18-km radius no pattern emerged when the data was combined but decreases were evident with ~200 km in Great Plains and from ~3 km in the Snake River Plain
30 m represents constructed buffers to incorporate factors that may impact or influence GRSG use beyond the direct physical limits of the disturbance component; Represents the average width of disturbance and associated zone of vegetation removal
Based on Holloran (2005); Lyon (2000); Connelly et al (2004)
Avoidance behavior of prairie grouse
Represents constructed buffers to incorporate factors that may impact or influence GRSG use beyond the direct physical limits of the disturbance component
GUSG females avoided areas with road densities >0.50 km/km2 for nesting; relative probability of nesting increased >8 km from high volume roads
Distances from LEPC nests taken from Pitman (2003) and other use sites from Hagen (2003); Hagen (2003) did not differentiate between road types
Documented 34 leks within 7.5 km of I-80 and 84 leks in an equivalent amount of area between 7.5 and 15km of the interstate. No leks found within 2 km of the interstate. Also leks within 7.5 km of I-80 appeared to decline at a higher rate than leks 7.5 to 15km from I-80 between 1970 and 2003.
Recommended management strategies to limit anthropogenic noise impacts on GRSG in Wyoming. Noise impacts (above ambient) for roads with a steady stream of vehicles can extend 5.3 to 6.4 km from the road. Traffic noise under conditions of a steady stream of vehicles would reach 10db above ambient at 2.3 to 3.3 km from the road.
Main haul roads within 3 km of leks negatively influenced GRSG male lek attendance
Yearling GRSG response to energy development in Wyoming. Leks that recruited more than the expected number of males were significantly farther from main haul roads than leks that recruited the same number of males as expected.
Found that nest initiation and movement was affected by presence of natural gas
Noise levels simulated from 400 m from main access roads decreased peak male lek attendance by 73%.

Distances from LEPC nests taken from Pitman (2003) and other use sites from Hagen (2003)
Distances of LEPC nests to anthropogenic features on 2 areas in SW Kansas
Avoidance buffers based on Pitman (2003) in Hagen et al.(2004) applied to LEPC spatially-based planning tool for Oklahoma
GRSG avoidance of minor roads; GRSG exhibited no detectable avoidance of major and minor roads;
Distances of LEPC nests to anthropogenic features on 2 areas in SW Kansas
Effect are of 7 km estimated from distribution of GRSG leks relative to I80 in Wyoming (Connelly et al. 2004)
Few leks currently exist near interstate highways and lek count trends were positively associated with distance to nearest interstate highway. In the Northern Great Basin and Colorado Plateau no leks were found within 5 km of an interstate. Distance to nearest other federal or state highway seemed only slightly associated with higher lek count trends across all SMZs and more so in the Great Plains. The presence of secondary roads appeared not to influence lek trends.
Mean distance of extirpated leks from nearest road. As opposed to 404m - the average distance of existing leks from nearest road.
Mean distance of extirpated leks from nearest road. As opposed to 8km - the average distance of existing leks from nearest road.
Statewide habitat models in Wyoming indicated a difference in seasonal sensitivity to density of paved roads, suggesting a decaying effects function approaching zero as distance approaches 3.2 km of leks (negative exponential) during the nesting and summer seasons, and a decay function approaching zero as distance approaches 1.5km of leks during winter.
At a 102ha (1km2) scale, ravens used areas closer to roads than available
Lands w/in 500 m of roads are more likely to contain cheatgrass
Cheatgrass was 20% more likely to be found w/in 700 m of a road
Knick et al. (2011)
Represents constructed buffers to incorporate factors that may impact or influence GRSG use beyond the direct physical limits of the disturbance component
Surface area of railroads was estimated from linear distance x width (9.4 m). Buffer sizes for ecological effect was 3 km to estimate spread of exotic plants
Based on Walker et al (2007); USFWS (2008); Johnson et al. (2011); Taylor et al. (2012)
Distances from LEPC nests taken from Pitman (2003) and other use sites from Hagen (2003)

Distances of LEPC nests to anthropogenic features on 2 areas in SW Kansas
Avoidance buffers based on Pitman (2003) in Hagen et al. (2004) applied to LEPC spatially-based planning tool for Oklahoma
GRSG avoidance wells during the winter
GRSG yearling males established themselves less often than expected on leks w/in 3 km of producing wells and more often on leks >3 km
Represents constructed buffers to incorporate factors that may impact or influence GRSG use beyond the direct physical limits of the disturbance component
Negatively affected lek attendance, but recorded density. Short term impacts seen when well pad densities were 0.19 well pads / km2 within 1 km of lek; 2.13 well pads/km2 within 2 km of lek; long term impacts observed when well pad density was 0.6 well pads/km2 within 1 km of lek and 0.7 well pads/km2 within 10 km of lek; some impacts observed out to 10 km
Displacement and habitat degradation from active rigs
Declining lek counts; lek abandonment at densities of 8 pads/2.6 km2
Negative lek trends, density of wells also important; population trends declines when > 8 active wells within 5 km of a lek; . 1 producing well/6.4 km2 within 18 km of lek negatively influenced lek trends
Relationship between well densities and sage-grouse nest and winter habitat selection. No real specific buffers identified.
Surface use designations (e.g., NSO) utilizing a 5-7.5 km buffer around leks is recommended
Johnson et al. (2011); Taylor et al. (2012)
Reduced lek counts compared to undisturbed areas
Noise was identified as a primary concern as it did not diminish with distance and did disturb leks. No specific distance identified.
Declining lek numbers, lack of recruitment of yearling males
No information on mining or distances for indirect effects. Wonder if the wrong paper was cited.
Did not specifically analyze coal mining, made the conclusion; found lower lek counts at both 5 and 18 km, which were the distances examined.
D INDIRECT IMPACTS)
Based on Bradley and Mustard (2006)
Based on indirect influence and distribution/spread of exotic plants

Based on Boarman and Heinrich (1999); Leu et al. (2008)
Avoidance buffer based on Hagen et al. (2004) applied to LEPC spatially-based planning tool for Oklahoma
The risk of a nest or brood failing decreased by 7.1% and 38.1%, respectively, with every 1.0 km increase in distance from nearest turbine
Did not find his thesis - this was a poster presented a national wind conference. Fitness parameters within 5 km were reduced - hypothesized due to increased predation and edge effects; https://www.nationalwind.org/wp-content/uploads/2013/05/41-LeBeau.pdf
Recommendation for siting, based on distance from active leks; used Connelly et al. (2000) guidelines for management of migratory sage-grouse populations identifying protection of breeding habitats within 11.2 mi of leks. Non-migratory populations were given a buffer of 2 miles but noise could carry further; References for prairie chickens were less so am assuming the 5 mi was a compromise.
Information cited in BER report did not discuss geothermal specifically - referenced similarity to traditional oil and gas wells
Based on noise attenuation - decreases from 95 Dba to 60 Dba at a distance of 1 km. May not sufficient to reduce impacts and likely need to increase distance to reduce noise to 10 Dba above ambient
At a 660ha (6.6 km2) scale, ravens (on average) foraged out to 2.2 km on either side of power lines
At a 102ha (1km2) scale, ravens used areas closer to roads than available
Odds of nest failure increased 7.4% for each observed raven per 10km
12 individuals hunted (in Mohave) from nest/roost
Distance from roost to foraging site (n=31) - And we don't have roost site information anyways
Modeled that raven density declined sharply at distances beyond 3 km form city boundaries and into areas of infrequent human activity.
SITES, ETC. WE WILL NOT A PPLY A BUFFER SPECIFIC TO PREDATOR LOCATION(S). HOWEVER, WE WILL USE FORM BUFFER DISTANCE FOR CERTAIN ANTHROPOGENIC FEATURS THAT ACT AS PREDATOR SUBISIDIES IN THE

Evaluation of noise impacts on LEPC indicated that abandoned leks were exposed to greater noise levels (34.8 dBA) than occupied leks (30.4 dBA) in New Mexico.
Grouse vocalizations are <20 dBA
Found noise levels >5 dBA reduced breeding activity and increased stress levels

TURE ITSELF. IF WE DO NOT HAVE SPATIAL LAYERS FOR THE FOOTPRINT ITSELF, BUT RATHER A BUFFERED DISTURBANCE BUFFER DISTANCE AS TO NOT OVERCALCULATE INDIRECT AREAS OF INFLUENCE (AOI)