From:	Wiechman, Lief
To:	Drue DeBerry; Jesse D"Elia; Pat Deibert; Dawn Davis
Subject:	Fwd: Sage Habitat Protection Review Team
Date:	Tuesday, January 06, 2015 9:09:48 AM
Attachments:	GRSG BufferDistances_CrosswalkLiteraturePlanningAnalyses_DRAFT3-InternalDistribution_20141002.xlsx

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---------- Forwarded message ----------
From: **Deibert, Pat** <pat_deibert@fws.gov>
Date: Mon, Dec 1, 2014 at 2:44 PM
Subject: Fwd: Sage Habitat Protection Review Team
To: Matt Kales <matt_kales@fws.gov>, Nicole Alt <nicole_alt@fws.gov>, Michael Thabault <michael_thabault@fws.gov>, Theresa Rabot <Theresa_Rabot@fws.gov>, Mary Grim <Mary_Grim@fws.gov>, Lief Wiechman <lief_wiechman@fws.gov>

Here is the buffer table summarizing all the buffers in the BLM planning documents that I referred to in our call this a.m.
I will try to sort through it before our call tomorrow.

p
---------- Forwarded message ----------
From: **Manier, Daniel** <manierd@usgs.gov>
Date: Mon, Oct 6, 2014 at 9:32 AM
Subject: Sage Habitat Protection Review Team
To: Douglas Johnson <douglas_h_johnson@usgs.gov>, Kevin Doherty <kevin_doherty@fws.gov>, Matthew Brooks <mlbrooks@usgs.gov>, Michael Casazza <mike_casazza@usgs.gov>, Pat Deibert <pat_deibert@fws.gov>, Peter Coates <pcoates@usgs.gov>, Steve Hanser <shanser@usgs.gov>, Zachary Bowen <bowenz@usgs.gov>

Friends and Colleagues,

Thank you, once again, for agreeing to help with this important effort - on short notice and with a very short fuse. As you'll recall, we expect to return a draft summary to DOI leaders (BLM and USGS) by the end of this week (10 October 2014).

In preparation for our discussion today, and to give you the baseline information that we've compiled and begun to evaluate - I'm attaching a spreadsheet with multiple tabs. Please note that this format can be a bit awkward in print (although each tab should be print-able), but is reasonable to review digitally, and it is helpful as we try to organize a complicated set of information. With apologies for the complexity, know that we expect to convert this to Word format for reporting, etc. with a simple, systematic format including: Topic, Distance Recommendation(s), Discussion (brief), and References.

In the attached, you should find 6 relatively clean tabs - I tried to set them up so each tab would print reasonably - so you may need to scroll down to find all content for each tab. Some of the tables are rather

complicated, but hopefully the consistent format will help you navigate.

We will discuss this information today - but to quickly guide you, the tables are as follows:

1. Collected references - citations provided from Land Management Plans, my literature review and brief discussion of distances and/or concepts found in literature

2. LMP distances - Buffer distances and brief discussion provided by BLM Rocky Mountain region states (RM)

3. LMP distances - Buffer distances and brief discussion provided by BLM Great Basis region states (GB)

4. Discussion - Additional, important comments from BLM SOs/FOs and repeat of literature discussion (partial repeat from Tab.1)

5. Full closures, NSO and similar protections employed by SO/FO - not buffer distances, but important for complete perspective of habitat protections

6. Development density literature review - slightly dated (OFR-2013-1098) to help provide some context/discussion of closures, etc. (i.e. consider with Tab.5)

We do not regard this information as complete or final - but hopefully it will be informative and help you rapidly review the topics and identify missing information. Your contributions, corrections, updates and opinions are important for improving this summary information.

Thanks for your input and participation.

Dan

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got leks?

	Surface Disturbance, immediate and cumulative: lost & altered habitat distribution & condition + activities (lead to aversion)	Linear features - esp. roads: habitat distrib., condit. & fragment. + aversion/displacement (due to noise)	Energy - esp. Oil & Gas - Development: habitat degradation; Indirct: aversion/displacement (noise & activity)	Tall structures. Direct: predation, Indirect: behavioral avoidance	Low structures (fences) - direct effect: injury/death	Activities affecting behavior (without habitat damage +/-): avoidance/stress
Specifically cited LMP references	NV: Connelly et al. 2011; Bloomberg et al. 2013; ID: Connelly et al. 2000; WY: The .6 mile buffer is based upon Wallestad and Schladweiler (1974) supported by Ellis et al. (1987), Carr (1967), Rothenmaier (1979), Emmons (1980), Schoenberg (1982): Carr, H. D. (1967) Report. Ellis K. L., J. R. Murphy, and G. H. Richins (1987) Western Birds, Emmons, S. R. (1980) Thesis. Rothenmaier, D. (1979) Thesis. Schoenberg, T. J. (1982) Thesis. Wallestad, R. O., and P. Schladweiler (1974) JWM. ID: "Colo. GRSG Plan" UT: Juniper removal; Baruch-Mordo et al. 2013 (BioCon)	**WY:** Core and Connectivity Areas: new BLM Local and Collector Roads (as defined in the **BLM Goldbook and BLM Handbook H-8342 [Travel and Transportation Handbook]**) are not allowed within 1.9-miles. Core Areas: new BLM Resource Roads (as defined in the **BLM Goldbook and BLM Handbook H-8342 [Travel and Transportation Handbook]**) are not allowed within 0.6-miles.	**UT:** Colorado Parks and Wildlife, Sage-grouse plan; info/table is also included in the NTT report (Table 1). **NV:** Connelly et al. 2011; Bloomberg et al. 2013; **WY:** Dougherty (2008) Thesis "95% of females nest within 5.3 miles of a lek " Holloran, M. J., and S. H. Anderson (2005) Condor 107:742-752. **ID:** Patricelli et al. 2012 ;WY: The .6 mile buffer is based upon Wallestad and Schladweiler (1974) supported by Ellis et al. (1987), Carr (1967), Rothenmaier (1979), Emmons (1980), Schoenberg (1982): Carr, H. D. (1967) Report; Ellis K. L., J. R. Murphy, and G. H. Richins (1987) Western Birds; Emmons, S. R. (1980) Thesis; Rothenmaier, D. (1979) Thesis; Schoenberg, T. J. (1982) Thesis; Wallestad, R. O., and P. Schladweiler (1974) JWM;	**WY:** The .6 mile buffer is based upon Wallestad and Schladweiler (1974) supported by Ellis et al. (1987), Carr (1967), Rothenmaier (1979), Emmons (1980), Schoenberg (1982). These citations include: Carr, H. D. (1967) Report; Ellis K. L., J. R. Murphy, and G. H. Richins (1987) Western Birds; Emmons, S. R. (1980) Thesis.Rothenmaier, D. (1979) Thesis. Schoenberg, T. J. (1982) Thesis; Wallestad, R. O., and P. Schladweiler (1974) JWM **WY:** Dougherty (2008) Thesis; Holloran, M. J., and S. H. Anderson (2005) Condor. **ID**: Connelly et al. 2000, Johnson et al. (2011); Gillan et al. (2013); Connelly et al. 2000	**UT:** Stevens 2012a&b (WSB and JWM). **ID:** "IDswMT biology team"; **UT:** STevens et al. (2012a&b) (WSB&JWM) **WY:** The .6 mile buffer is based upon Wallestad and Schladweiler (1974) supported by Ellis et al. (1987), Carr (1967), Rothenmaier (1979), Emmons (1980), and Schoenberg (1982). Carr, H. D. (1967) Report; Ellis K. L., J. R. Murphy, and G. H. Richins (1987) Western Birds; Emmons, S. R. (1980) Thesis; Rothenmaier, D. (1979) Thesis; Schoenberg, T. J. (1982) Thesis; Wallestad, R. O., and P. Schladweiler (1974) JWM.	**WY:** The .6 mile buffer is based upon Wallestad and Schladweiler (1974) supported by Ellis et al. (1987), Carr (1967), Rothenmaier (1979), Emmons (1980), Schoenberg (1982): Carr, H. D. (1967) Report; Ellis K. L., J. R. Murphy, and G. H. Richins (1987) Western Birds; Emmons, S. R. (1980) Thesis; Rothenmaier, D. (1979) Thesis; Schoenberg, T. J. (1982) Thesis; Wallestad, R. O., and P. Schladweiler (1974) JWM. **ID:** "2011 MS Thesis"
Additional Lit.Review References	Stiver et al. (2010); Connelly et al. (2000); Colorado Sage-Grouse Plan, v.2 (2008); Aldridge et al. (2008); Naugle et al. (2011; SAB38 ch.20); Johnson et al (2011; SAB38, ch.17); Holloran & Anderson (2005); Doherty et al. (2008); Taylor et al (2013). Walker et al 2007 (JWM71); USFWS 2008; Johnson et al. 2011 (SAB,ch17); Taylor et al. 2012 (JWM76); Blickley et al. 2012 (ConBio26); Knick et al 2011 (SAB, pp233-248…); Lyon and Anderson 2003 (WildSocBul). Hess and Beck 2012 (WildSocBul36); Beck et al 2012 (REM65); Davies et al 2011 (EnvMgmt48); Dahlgren et al 2006 (WildSocBull34); Aldridge et al. 2008 (DivDist14); Connelly et al. 2000 - pp.972-974	Blickley et al. (2012, ConsBio26)	Stiver et al. (2010); Connelly et al. (2000); Colorado Sage-Grouse Plan, v.2 (2008); Aldridge et al. (2008); Naugle et al. (2011; SAB38 ch.20); Johnson et al (2011; SAB38, ch.17); Holloran & Anderson (2005); Doherty et al. (2008); Taylor et al (2013); Blickley et al. (2012, ConsBio26)	LeBeau et al. 2014 (JWM78); Bradley and Mustard, 2006 (EcoApps), Boarman and Heinrich, 1999 (Birds of N. Amer.), Leu and others, 2008 (EcoApp18); Knick et al 2011 (SAB; pp233-248…); Blomberg et al. (2013; WildBio); Blickley et al. (2012, ConsBio26); Stevens et al. 2012 (JWM); Hess and Beck 2012 (WildSocBul36); Beck et al 2012 (REM65); Davies et al 2011 (EnvMgmt48); Davies et al. 2009 (); Dahlgren et al 2006 (WildSocBull34); Aldridge et al. 2008 (DivDist14); Connelly et al. 2000 - pp.972-974; Bates & Davies 2014 REM67(4):412; Cagney et al 2010 UWyo Coop Extention Report; Beck and Mitchell 2000 WSB28(4):993; Vavra 2005 REM58(2):128; Wambolt and Payne 1986; -- also consider evidence from GPC: Winder et al. (2014) Ecosph; McNew et al. (2014) ConsBio; GPC and LPC: Pruett et al. (2008, ConsBio)	Some info available in: Connelly et al. 2000, Connelly et al. 2004, Johnson et al. (2011; SAB No.38). Add'l sources: Wallestad and Schladweiler (1974, JWM38); Stevens et al. 2012 (WSB & JWM); Taylor et al. 2012 (JWM76)	

	Surface Disturbance, immediate and cumulative: lost & altered habitat distribution & condition + activities (lead to aversion)		Linear features - esp. roads: habitat distrib., condit. & fragment. + aversion/displacement (due to noise)	Energy - esp. Oil & Gas - Development: habitat degradation; Indirct: aversion/displacement (noise & activity)	Tall structures. Direct: predation, Indirect: behavioral avoidance	Low structures (fences) - direct effect: injury/death	Activities affecting behavior (without habitat damage +/-): avoidance/stress
Recommended value(s) with brief, specific commentary	**DENSITY:** 1pad/2.6km^2 (mi^2) has some impact (lowest limit) **->** 8pads/2.6km^2 (mi^2) exceeds tolerance; Min. (0% develop) is desirable **->** 25% footprint within 3.2km and 1 well within 350m **->** >= 40% development footprint within 3.2km buffer CAUSED measurable decline. **DISTANCE:** 3.2km (often used/recommended), 6.4km (4mi) identified in Colo.Plan; effects approach zero btwn. 5-10km (~7km), activity & noise specified so seasonal limites/closures related to use (spr/sum/wintr) may be effective (Holloran & Anderson 2005);	Minimize treated/disturbed areas: maintain sagebrush canopy >25% within 30km area (around lek and across/around key habitat areas). Small (<60m diam/width) treatments may create good foraging conditions for sage-grouse broods. Decisions…should be based on quantitative knowledge of vegetative conditions over and entire population's seasonal range. Generally, the treatment…should be…least disruptive to the vegetation community and has the most rapid recover time."	min. 400m - but source audiblity (type/volume) and visibility could dictate effect area/distance (both are linked to terrain and cover)	Most habitat development impacts have been assessed in reference to Oil & Gas development (so see entries for "DENSITY" and "DISTANCE" for key discusssion). 1-12 wells per 32.2km^2 (12.4 sq.mi.) [approaches the] threshold (Doherty et al. 2010); 1pad/2.6km2 (mi2) has some impact (lowest limit) -> 8pads/2.6km2 (mi2) exceeds tolerance (Holloran & Anderson 2005)	min. 400m - but source audiblity (type/volume) and visibility could dictate effect area/distance (both are linked to terrain and cover). 1-5km fitness effects (nest/brood failure; LeBeau 2014) - 100m avoidance (LPC, GPC; Pruett 08)	Mark or remove fences within (2km (1.2mi.) on flat/rolling terrain (Stevens et al. 2012a,b)	min. 400m - but source audiblity (type/volume) and visibility could dictate effect area/distance (both are linked to terrain and cover).
Lit. Review (ranges in effect sizes and/or discussion)	>= 40% development footprint within 3.2km buffer OR 25% footprint within 3.2km and 1 well within 350m CAUSED measurable decline (**Naugle et al. 2011**); 1pad/2.6km2 (mi2) has some impact (lowest limit) - 8pads/2.6km2 (1mi2) exceeds tolerance threshold (max. develop to minimize impact lies below this value); Naugle et al, 2011, p.495-501) - many studies but values in SAB volume capture/summarize key info. (Table 20.2 provides additional references). **Colorado Greater Sage-Grouse Conservation Plan** (2008): (a) map sagebrush with >10% cover (do not count herbaceous, burns, trts., Agr., urban, or industrial "inclusions") (b) ID leks [or other seasonal hab.?] (c) sage cover within 4-20km of core habitats (leks, broods) has important potential (d) buffer sage habitats in range of 4km (non-migr. pops) - 20km (suggested common for many pops. based on female mvmts.). [~7km (4.34mi) might be defensible intermediate; **Holloran and Anderson (2005)** - key figure reproduced in SAB volume (fig 20.5) - measured effects approached zero around 7km.] (e) ID winter habitats within 20km (or pop. specified migr. distance) of leks based on sage cover (15-40%), height (20-40cm), and topography (S & W exposures, draws with Basin sage, exposed ridges) (f) implement seasonal closures and density limits in/around winter habitats.	Beneficial effects or trts. are questionable - maintain sagebrush canopy >25% within 30km area (around lek and across/around key habitat areas). Extent areas (min/max) are not clearly established - detrimental effects on lek & brood-rearing habitats have been described. Key references include: Beck et al. (2012 REM65), (Connelly et al. (2000, p972), Enyeart (1956), Higby (1969), Peterson (1970), Wallestad (1975). Small (<60m diam/width) treatments may create good foraging conditions for sage-grouse broods (esp. in Mtn. sagebrush) (Beck et al. 2012 REM65). "…herbicide application to blocks of sagebrush rangeland resulted in major declines in sage-grouse breeding populations (Enyeart 1956, Higby 1969, Peterson 1970, Wallestad 1975)." (Connelly et al. 2000, p972) "Activities responsible for the loss or degradation of sagebrush habitats also may be used to restore these habitats. Including: prescribed fire, grazing, herbicides and mechanical treatments. Decisions…should be based on quantitative knowledge of vegetative conditions over and entire population's seasonal range. Generally, the treatment…should be…least disruptive to the vegetation community and has the most rapid recover time." (Connelly et al. 2000, p.975) "…results suggest 2 considerations for managers considering burning or mowing to enhance Wyoming big sagebrush for sage-grouse in arid habitat… " (1) burning never resulted in adequate height or canopy cover for breeding habitat, and mowing only resulted in adequate sagebrush heights some of the time (1 of 2 yrs in this study on an arid site). And (2) if untreated communities do not meet minimum guidelines, consider consequences of sagebrush-reduction on those conditions and reconsider... practices such as grazing management or other approaches without active treatment [may be most effective]. (Hess and Beck 2012 WildSocBullp.92) --Davies et al. 2011 also endorsing caution in application. Conduct treatments only "in areas with large contiguous stands of sagebrush (Beck and Mitchell 2000, Connelly et al 2000, Dahlgren et al 2006)."	avoid leks & nesting areas (distance = audible range, 400m-2km?)	Direct impacts within 3acre area (radius: 38yd., 35m); Indirect influence to 19km (11.8mi.); "Clustering well locations enabled a few small leks to remain active inside of developments." (Doherty et al. 2010). Key consideration, besides footprint and impacts on habitat condition and predation potential, is the effect of intermittent noise on behavior (avoidance). In addition to evidence from "inclusive" studies (on distance/density effects) - work by Blickley et al (2012) provides essential insights into noise effects. A precise distance effect for noise has not been determined, but likely varies depending on the source (equipment, vehicles, others) and the terrain.	avoid leks & nesting areas (distance = audible range, 400m-2km?). Direct (min): 3 acres (35m/38yrd radius) -> 1km -10km in nesting habitats (e.g., within 3.2km of lek); GPC/LPC avoided powerlines by 100m and reduced crossing (use) of those corridors Indirect effects: 6.9km (4.3mi; predation)out to 19km (11.8mi) as with O&G (invasives/preds.)	Fences within 2km of active leks, flat/rolling terrain are implicated, solution is marking/removal. Need better info on Corvid and Raptor foraging, use of poles/towers and behavioral response of GRSG.	avoid leks & nesting areas (distance = audible range, 400m-2km?)

Rocky Mountain States ***** Note: Buffers are not applied in many areas due to the entire management area/habitat may already protected by allocation.***

*** All distances provided are miles from known GRSG leks**

Color headers represent conceptual and/or practical groupings >>	Habitat Area/ Extent/ Distribution Impacts	Habitat Area/ Extent/ Distribution Impacts	Habitat Area/Condition Modification	Linear habitat mods.; fragmentation/habitat mods. + behavior effects (noise)	Oil & Gas Development - habitat mods.; behavior effects (noise)	Oil & Gas Development - habitat mods.; behavior effects (noise)	Oil & Gas Development - habitat mods.; behavior effects (noise)	Oil & Gas Development - habitat mods.; behavior effects (noise)	Habitat Area/Extent/Distribution Impacts + Noise (behavior effects)
LUP categories >>	**Surface disturbing activities ***	**Prohibit or minimize sage brush removal or cutting ***	**Vegetation Treatments**	**Upgrading/ new roads/trails**	**Fluids (Closed) ***	**Fluids (NSO)**	**Fluids (CSU/TL)**	**Fluids –Geospatial exploration (TL)**	**Mineral Development**
Wyoming ADPPs	Core: 0.6-mile lek[r] Non-Core: 0.25-mile lek Connectivity: 0.6-mile lek [r]$_{2}$	Core: see below$_{19}$ Non-Core: see below $_{19}$ Connectivity: see below [19]	Core: see below$_{19}$ Non-Core: see below$_{19}$ Connectivity: see below$_{19}$	Core: see below$_{21}$ Non-Core: see below$_{21}$ Connectivity: see below$_{21}$	Core: no SG specific Non-Core: no SG specific Connectivity: no SG specific	Core: 0.6-mile lek [r]$_{20}$ Non-Core: 0.25 mile lek Connectivity: 0.6-mile lek [r]$_{20}$	Core: all (5.3 miles)[s] Non-Core: 2-mile lek Connectivity: 4-mile lek	Core: all (5.3 miles)[s] Non-Core: 2-mile lek Connectivity: 4-mile lek	Core: 0.6-mile lek [r]$_{20}$ Non-Core: .25-mile lek Connectivity: 0.6-mile lek [r]$_{20}$
Montana ADPPs$_{17}$	Priority: General: Restoration:	Priority: General: Restoration:	Priority: General: Restoration:	Priority: General: Restoration:	Priority: General: Restoration:	Core : General: 0.6[m] Restore:	Core : - General: 2$_{18}$ Restore: -	Priority: General: Restoration:	Priority: General: Restoration:
Idaho/SW MT ADPP (MT portion)	None	None	None	None	None	Core : General: 0.6 Restore:	Core : - General: 2 Restore: -	Core : - General: 4 Restore: -	
NW Colorado ADPPs	Priority:2[nop] General: 2[nop]	Priority	Priority[q]	Priority[q]	Priority:1$_{1}$[nop] General: 1$_{1}$[nop]	Priority:4$_{2}$[nop] General: 2$_{2}$[nop]	Priority:4$_{3}$[nop] General: 4$_{3}$[nop]	Priority:4$_{3}$[nop] General: 4$_{3}$[nop]	Priority:2$_{5}$[q] General: 2$_{5}$[q]

Rocky Mountain States ***** Note: Buffers are not applied in many areas due to the entire management area/habitat may already protected by allocation.***

*** All distances provided are miles from known GRSG leks**

Color headers represent conceptual and/or practical groupings >>	Wind, Solar - tall structures, roads, infrastructure: Habitat Mods. + Behavior effects	Wind, Solar - tall structures, roads, infrastructure: Habitat Mods. + Behavior effects	Tall structures - predation + behavior mods.	Low structures (fences) - direct effect: injury/death	Low structures (non-fence, e.g. wells, ditches, etc)	Activities affecting behavior (without habitat damage +/-)	Activities affecting behavior (without habitat damage +/-)
LUP categories >>	**Exclude Renewable Development**	**Avoid Renewable Development**	**Above ground structures**	**Fence Removal /Marking**	**Rangeland Structures**	**Disruptive recreational events**	**Repeated or sustained behavioral disturbance**
Wyoming ADPPs	Core: 0.6-mile lek $^{r}_{20}$ Non-Core: 0.25-mile lek Connectivity: 0.6-mile lek $^{r}_{20}$	Core: all (5.3 miles)^{s} Non-Core: 0.25-mile lek Connectivity: 0.6-mile lek $^{r}_{20}$	Core: 0.6-mile lek $^{r}_{20}$ Non-Core: .25-mile lek Connectivity: 0.6-mile lek $^{r}_{20}$	Core: all (5.3 miles)^{s} Non-Core: all habitat Connectivity: all habitat	Core: 0.6-mile lek $^{r}_{20}$ Non-Core: .25-mile lek Connectivity: all habitat	Core: 0.6-mile lek $^{r}_{20}$ Non-Core: 0.25-mile lek Connectivity: 0.6-mile lek $^{r}_{20}$	Core: all (5.3 miles)^{s} Non-Core: 2-mile lek Connectivity: 4-mile lek
Montana ADPPs$_{17}$	Priority: General: Restoration:	Priority: General: Restoration:	Priority: General: Restoration:	Priority: General: Restoration:	Priority: General: Restoration:	Priority: General: Restoration:	Priority: General: Restoration:
Idaho/SW MT ADPP (MT portion)	Core : - General: 1 Restore: -	None	None	None	None	None	None
NW Colorado ADPPs	Priority^{q}	Priority^{q}	Priority: 1_{4}^{q} General: 1_{4}^{q}	Priority^{q}	Priority^{q}	Priority^{q}	None

Numeric Footnotes for Fig1 RM and Fig2 GB (State providing in parentheses)
1- (OR) Only applies to new anthropogenic disturbances
2- (NV) 4 mile buffer for all surface disturbing activities (during life cycle periods, except within existing designated corridors) & 1 mile buffer from seeps, springs and wet meadows within brood-rearing habitat (year round)
3- (UT) Only applies to development associated with existing fluid mineral leases.
4- (OR) For fluid mineral development
5- (ID) Exclude/Avoid solar energy development only.
6- (ID) Do not schedule disruptive recreational events (e.g., motorized races) during the lekking season.
7- (OR) 3 mile buffer only applies to the issuance of future special recreation permits; the 4 mile buffer only applies to the issuance of motorized/ race SRPs
8- (OR) Only applies to upgrading primitive roads.
9- (NV) Only applies to the to concentrated turn-out locations for livestock
10- (ID) Do not construct new paved or high volume traffic gravel roads.
11- (NV) 2 mile buffer only applies to domestic sheep use and bedding areas, and herder camps
12- (OR) Includes juniper cutting and vegetation management activities that are timing-sensitive for maximum effectiveness
13- (NV) .62mile buffer for Lek Security-Tree cover/Proximity of trees: Less than 4 percent landscape canopy cover and 3.2 miles for nesting security-Tree cover/Proximity of trees: No tall structures
14- (UT) Reduce conifer, where technically feasible, to less than 5 percent canopy cover, with preference for complete removal
15- (UT) Applies only to ROWs, mineral materials permits, non-energy leasables, appurtenant sub-surface coal mine facilities, surface coal mines (or facilities), or locatable mineral (where claimant agrees) developments
16- (ID) No repeated or sustained behavioral disturbance (e.g., visual, noise, etc.) to lekking birds from 6:00 pm to 9:00 am in Core/Important areas and to be avoided in General habitat areas.
17 - (MT) We address impacts to sage-grouse in our priority and general habitat regardless of how close the activity is to a lek. This approach is accomplished through the use of our activity screening and project specific analysis based on the location of the project within our priority habitat and the nature and type of expected impacts to sage-grouse and sage-grouse habitat.
18 - Numerous studies. Management decision to protect only a portion of nesting hens and limit threats from the primary threat BLM manages (oil and gas development) in general habitat resulted in the 2 mile distance.
19 - (WY) All sagebrush removal and cutting activities in addition to all vegetation treatments are evaluated to determine whether they constitute a disturbance. If they do, restrictions pertaining to surface disturbing activities (not allowed within .6-mile/.25-mile/.6-mile leks, all core/2-mile lek/4-mile lek timing limitations, and 5% disturbance cap in core restrictions) apply.
20 - (WY) Some existing literature exists recommending greater NSO buffers around for all surface disturbing activities. However, these recommendations do not consider concurrent restrictions on the density of disturbances or disruptive activities. The 0.6-mile NSO for all surface disturbing activities in Core Areas is only one component of the collective strategy to protect breeding activities.
21 - (WY) Within Core and Connectivity Areas, new BLM Local and Collector Roads (as defined in the BLM Goldbook and BLM Handbook H-8342 [Travel and Transportation Handbook]) are not allowed within 1.9-miles of the perimeter of leksc. Within Core Areas, new BLM Resource Roads (as defined in the BLM Goldbook and BLM Handbook H-8342 [Travel and Transportation Handbook]) are not allowed within 0.6-miles of the perimeter of leks.

Alphabet Footnotes for Fig1 RM and Fig2 GB - Scientific References provided from LMP revisions
a. State of Colorado GRSG Conservation Plan (ver.2) - origin, definition and history of the "4mile rule" (well written and referenced report)
b. Connelly et al. (2000) Wildlife Society Bulletin vol.28
c. Christiansen (2009) Project Report; Stevens (2011) Thesis (2 pubs in 2012, see below; paper recommends a buffer of “at least 0.6 miles not 1.25 miles); NRCS (2012) SGI Report
d. Stevens, et al. (2012) Wildlife Society Bulletin. 36:297-303; Stevens et al. (2012) Journal of Wildlife Management. 76:1370-1380
e. IDswMT biology team
f. Connelly et al. (2000) Wildlife Society Bulletin; Gillan et al. (2013): Do not allow transmission line construction - avoid in General habitats, and do not allow in breeding habitats. (source?)
ff. Johnson et al. (2011) (SABNo.38, Chpt. 17)
g. Patricelli et al. (2012) - (source?)
h. 2011 MS Thesis (source?)
i. Connelly et al. 2011, chpt. XX; Blomberg et al.(2013) JWM 77(8):1583-1592, investigated nesting and fall mortality rates using radiomarked birds
j. Peterson (1980); Autenrieth (1981); Giesen (1995); Graham and McConnell (2004); Graham and Jones (2005); Hagen (2011); NTT (2011) p.20-21
k. Connelly et al. (2000) - foundational paper; Stiver et al. (in press) - not reviewed; Baruch-Mordo et al. (2013), a modeling intensive approach that provides valuable insights into the effects of juniper encorachment on leks and population.
l. Coates et al. (2013) JWM 77(8):1598-1609, recommended surface use buffer btwn. 5.0km and 7.5km based on modelilng of BiState DPS
m. This buffer is intended to protect breeding activities at the lek. The 0.6 mile buffer is based upon Wallestad and Schladweiler (1974), who, working with radio-equipped males in Montana, found that 76% of movements during the breeding period occurred within 1 kilometer (0.6 mile) of leks and Schoenberg (1982) found that male daily movements averaged 0.6 miles in CO.
n. Walker, et al (2006), "Persistence of 110 leks was positively influenced by the proportion of sagebrush habitat within 6.4 km of the lek…"
o. Holloran [and Anderson] (2005) (or 2005 Thesis?) -- Nest distributions were spatially related to lek location within 3 and 5 km of a lek, and a 5-km buffer included 64% of the nests. There was no relationship between lek size and lek-to-nest distance. (Thesis 2005) - Declines in the number of displaying males were positively correlated with decreased distance from leks to gas-field-related sources of disturbance, increased levels of development surrounding leks, increased traffic volumes within 3 km of leks, and increased potential for greater noise intensity at leks.
p. Naugle, et al 2011 (SABNo.38, Chpt. 20) - combination of ag. And energy resulted in highest linear road density - fragmentation to 1km2 habitat patches.
q. National Technical Team Report (2011), not technical research, however it represents the collective input and wisdom of experts, managers and planners; it should be regarded as a solid foundation for applications, includes regionally specific discussions of s-g, habitats and threats, and includes some references in support.

r. The .6 mile buffer is based upon Wallestad and Schladweiler (1974) , who, working with radio-equipped males in Montana, found that 76% of movements during the breeding period occurred within 1-kilomenter (0.6 miles) of leks. These findings have also been supported by Ellis et al. (1987), Carr (1967), Rothenmaier (1979), Emmons (1980) and Schoenberg (1982).

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(UT): Walker et al. (2007) Greater sage-grouse population response to energy development and habitat loss. JWM71(8):2644-2654; cited p.2651; Holloran (2005) p.57-90 - Thesis.

Great Basin States ***** Note: Many buffers are not applied due to the fact that the entire GRSG management area/habitat may already protected by a land use plan allocation.***

*** All distances provided are miles from known GRSG leks**

Color headers represent conceptual and/or practical groupings >>	Habitat Area/ Extent/ Distribution Impacts	Habitat Area/ Extent/ Distribution Impacts	Habitat Area/Condition Modification	Linear habitat mods.; fragmentation/habitat mods. + behavior effects (noise)	Oil & Gas Development - habitat mods.; behavior effects (noise)	Oil & Gas Development - habitat mods.; behavior effects (noise)	Oil & Gas Development - habitat mods.; behavior effects (noise)	Oil & Gas Development - habitat mods.; behavior effects (noise)	Habitat Area/ Extent/ Distribution Impacts + Noise (behavior effects)
LUP categories >>	**Surface disturbing activities ***	**Prohibit or minimize sage brush removal or cutting ***	**Vegetation Treatments**	**Upgrading/ new roads/trails**	**Fluids (Closed) ***	**Fluids (NSO)**	**Fluids (CSU/TL)**	**Fluids –Geospatial exploration (TL)**	**Mineral Development**
Oregon ADPP	PPMA: $1_{1\ (new\ only)}$ PGMA: $1_{1\ (new\ only)}$	PPMA: 4 PGMA: 4	PPMA: 4_{12} PGMA: 4_{12}	PPMA: 4_{8} PGMA: 4_{8}	None	PPMA: - PGMA: 1_{4}	None	None	None
Nevada/NE CA ADPP	PPMA: $4^{j}{}_{2}$ & 1mi around seeps/springs [i] PGMA: $4^{j}{}_{2}$ & 1mi around seeps/springs [i]	N/A: sagebrush removal is not permitted within PPMA/PGMA	PPMA: 0.6 [k]/3.2 [l] $_{13}$ PGMA: 0.6 [k] /3.2 [l] $_{13}$	PPMA: $4^{j}{}_{2}$ ($_{9}$ is N/A) PGMA: $4^{j}{}_{2}$ ($_{9}$ is N/A) None permitted within PPMA/PGMA except for valid existing rights.$_{9}$	None	PPMA:N/A PGMA: $4^{j}{}_{2}$	N/A	PPMA/PGMA: $4^{j}{}_{2}$	PPMA/PGMA-$4^{j}{}_{2}$ 4 mile buffer except for locatables
Utah ADPP	PPMA: 1_{15} PGMA: 0	None	PPMA: 0.6_{14} PGMA: 0.6_{14}	None	PPMA: 4_{3} PGMA: survey req. @ 4	PPMA: 4_{3} PGMA: survey req. @ 4	None	None	PPMA: 1 PGMA: 0
Idaho/SW MT ADPP (Idaho portion)	Core: 2^{b} Important: 2^{b} General: 2^{b}	Core: 0.6^{a} Important: 0.6^{a} General: 0.6^{a}	None	Core: 0.8_{10} Important: 0.8_{10} General: -	None	None	None	None	Core: 0.8^{g} Important: 0.8^{g} General: -
Idaho/SW MT ADPP (MT portion)	None	None	None	None	None	Core : General: 0.6 Restore:	Core : - General: 2 Restore: -	Core : - General: 4 Restore: -	

Great Basin States ***** Note: Many buffers are not applied due to the fact that the entire GRSG management area/habitat may already protected by a land use plan allocation.***

*** All distances provided are miles from known GRSG leks**

Color headers represent conceptual and/or practical groupings >>	Wind, Solar - tall structures, roads, infrastructure: Habitat Mods. + Behavior effects	Wind, Solar - tall structures, roads, infrastructure: Habitat Mods. + Behavior effects	Tall structures - predation + behavior mods.	Low structures (fences) - direct effect: injury/death	Low structures (non-fence, e.g. wells, ditches, etc)	Activities affecting behavior (without habitat damage +/-)	Activities affecting behavior (without habitat damage +/-)
LUP categories >>	**Exclude Renewable Development**	**Avoid Renewable Development**	**Above ground structures**	**Fence Removal /Marking**	**Rangeland Structures**	**Disruptive recreational events**	**Repeated or sustained behavioral disturbance**
Oregon ADPP	None	None	None	PPMA: 1.2 PGMA: 1.2	PPMA: 1 PGMA:1	PPMA: 3-4[7] PGMA: 3-4[7]	None
Nevada/NE CA ADPP	PPMA/PGMA is closed to Wind/Solar	PPMA/PGMA is closed to Wind/Solar	PPMA:0.6[k]/3.2[l][13] PGMA:0.6[k]/3.2[l][13]	PPMA: 1.25[c] PGMA: 1.25[c]	PPMA:1[i]/2[11]/ 4[j][2] PGMA:1[i]/2[11]/4[j][2]	N/A: events are only permitted if they have neutral or beneficial effects in PPMA/PGMA	PPMA/PGMA-4[j][2]
Utah ADPP	None	None		PPMA: 1.2[d] PGMA: 1.2[d]		None	None
Idaho/SW MT ADPP (Idaho portion)	Core: - Important: 2[5] General: -	Core: - Important: 2[5] General: -	Core: 3[f] (no new poles/towers unless public safety) Important: 3[f] (no new poles/towers unless public safety) General: -	None	Core: 0.6[e] Important: 0.6[e] General: 0.6[e]	Core: - 2[6] Important: 2[6] General: -	Core: 0.2[h] / 16 Important: 0.2[h] / 16 General: 0.2[h] / 16
Idaho/SW MT ADPP (MT portion)	Core : - General: 1 Restore: -	None	None	None	None	None	None

Numeric Footnotes for Fig1 RM and Fig2 GB (State providing in parentheses)
1- (OR) Only applies to new anthropogenic disturbances
2- (NV) 4 mile buffer for all surface disturbing activities (during life cycle periods, except within existing designated corridors) & 1 mile buffer from seeps, springs and wet meadows within brood-rearing habitat (year round)
3- (UT) Only applies to development associated with existing fluid mineral leases.
4- (OR) For fluid mineral development
5- (ID) Exclude/Avoid solar energy development only.
6- (ID) Do not schedule disruptive recreational events (e.g., motorized races) during the lekking season.
7- (OR) 3 mile buffer only applies to the issuance of future special recreation permits; the 4 mile buffer only applies to the issuance of motorized/ race SRPs
8- (OR) Only applies to upgrading primitive roads.
9- (NV) Only applies to the to concentrated turn-out locations for livestock
10- (ID) Do not construct new paved or high volume traffic gravel roads.
11- (NV) 2 mile buffer only applies to domestic sheep use and bedding areas, and herder camps
12- (OR) Includes juniper cutting and vegetation management activities that are timing-sensitive for maximum effectiveness
13- (NV) .62mile buffer for Lek Security-Tree cover/Proximity of trees: Less than 4 percent landscape canopy cover and 3.2 miles for nesting security-Tree cover/Proximity of trees: No tall structures
14- (UT) Reduce conifer, where technically feasible, to less than 5 percent canopy cover, with preference for complete removal
15- (UT) Applies only to ROWs, mineral materials permits, non-energy leasables, appurtenant sub-surface coal mine facilities, surface coal mines (or facilities), or locatable mineral (where claimant agrees) developments
16- (ID) No repeated or sustained behavioral disturbance (e.g., visual, noise, etc.) to lekking birds from 6:00 pm to 9:00 am in Core/Important areas and to be avoided in General habitat areas.
17 - (MT) We address impacts to sage-grouse in our priority and general habitat regardless of how close the activity is to a lek. This approach is accomplished through the use of our activity screening and project specific analysis based on the location of the project within our priority habitat and the nature and type of expected impacts to sage-grouse and sage-grouse habitat.
18 - Numerous studies. Management decision to protect only a portion of nesting hens and limit threats from the primary threat BLM manages (oil and gas development) in general habitat resulted in the 2 mile distance.
19 - (WY) All sagebrush removal and cutting activities in addition to all vegetation treatments are evaluated to determine whether they constitute a disturbance. If they do, restrictions pertaining to surface disturbing activities (not allowed within .6-mile/.25-mile/.6-mile leks, all core/2-mile lek/4-mile lek timing limitations, and 5% disturbance cap in core restrictions) apply.
20 - (WY) Some existing literature exists recommending greater NSO buffers around for all surface disturbing activities. However, these recommendations do not consider concurrent restrictions on the density of disturbances or disruptive activities. The 0.6-mile NSO for all surface disturbing activities in Core Areas is only one component of the collective strategy to protect breeding activities.
21 - (WY) Within Core and Connectivity Areas, new BLM Local and Collector Roads (as defined in the BLM Goldbook and BLM Handbook H-8342 [Travel and Transportation Handbook]) are not allowed within 1.9-miles of the perimeter of leksc. Within Core Areas, new BLM Resource Roads (as defined in the BLM Goldbook and BLM Handbook H-8342 [Travel and Transportation Handbook]) are not allowed within 0.6-miles of the perimeter of leks.

Alphabet Footnotes for Fig1 RM and Fig2 GB - Scientific References provided from LMP revisions

a. State of Colorado GRSG Conservation Plan (ver.2) - origin, definition and history of the "4mile rule" (well written and referenced report)

b. Connelly et al. (2000) Wildlife Society Bulletin vol.28

c. Christiansen (2009) Project Report; Stevens (2011) Thesis (2 pubs in 2012, see below; paper recommends a buffer of "at least 0.6 miles not 1.25 miles); NRCS (2012) SGI Report

d. Stevens, et al. (2012) Wildlife Society Bulletin. 36:297-303; Stevens et al. (2012) Journal of Wildlife Management. 76:1370-1380

e. IDswMT biology team

f. Connelly et al. (2000) Wildlife Society Bulletin; Gillan et al. (2013): Do not allow transmission line construction - avoid in General habitats, and do not allow in breeding habitats. (source?)

ff. Johnson et al. (2011) (SABNo.38, Chpt. 17)

g. Patricelli et al. (2012) - (source?)

h. 2011 MS Thesis (source?)

i. Connelly et al. 2011, chpt. XX; Blomberg et al.(2013) JWM 77(8):1583-1592, investigated nesting and fall mortality rates using radiomarked birds

j. Peterson (1980); Autenrieth (1981); Giesen (1995); Graham and McConnell (2004); Graham and Jones (2005); Hagen (2011); NTT (2011) p.20-21

k. Connelly et al. (2000) - foundational paper; Stiver et al. (in press) - not reviewed; Baruch-Mordo et al. (2013), a modeling intensive approach that provides valuable insights into the effects of juniper encorachment on leks and population.

l. Coates et al. (2013) JWM 77(8):1598-1609, recommended surface use buffer btwn. 5.0km and 7.5km based on modelilng of BiState DPS

m. This buffer is intended to protect breeding activities at the lek. The 0.6 mile buffer is based upon Wallestad and Schladweiler (1974), who, working with radio-equipped males in Montana, found that 76% of movements during the breeding period occurred within 1 kilometer (0.6 mile) of leks and Schoenberg (1982) found that male daily movements averaged 0.6 miles in CO.

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Important comments and discussion from Field and State Office and Planners and Managers regarding use and adaptation of research findings and historic uses for sagebrush habitat and sage-grouse population management
Johnson et al (2011) chapter in the SAB volume, is the most recent and most comprehensive assessment adddressing all surface disturbances combined. Not all disturbances are equal, but we have to cross-tabulate/estimate to arrive at these values.
Aldridge et al (2008) considered/assessed multiple influences (correlative) and used these to predict (logistic reg.) historic vs. currently occupied habitat rangewide - human density (census)*, ag. area (% cropland)*, road length/distance to road, number of recent droughts*, sagebrush habitat (% in 31km radius)* and proximity to range-margins (peripherality)* were implicated.
Although rangewide compilation of precise acreage and locations of historic treatments does not exist, recent estimates suggest more than 4,000 km2 (988,400 acres) were treated within these States between 1997 and 2006 (617,750 acres [2,500 km2] of prescribed burns; 346,000 acres [1,400 km2] of mechanical fuel treatments; and 154,700 acres [626 km2] of mechanical habitat treatments). This results in an estimate of more than 8.15 million acres (33,000 km2) treated (approaching 12 percent of sage-grouse habitat area based on mean values and a data-limited estimate of a highly variable activity). Vegetation manipulations were more prominent during the post-war (WWII) era, circa 1940–60, making this extrapolation based on modern treatment areas a conservative estimate.
Rangeland management, incl. livestock, has the potential for a strong influence on habitat conditions - each season, with variability in utilization and effects each year due to differences in climate and productivity. BMPs should address timing of rotations and standing residuals (veg.) to promote range health and habitat values (e.g., Bates & Davies 2014 REM67(4):412; Cagney et al 2010 UWyo Coop Extention Report; Beck and Mitchell 2000 WSB28(4):993; Vavra 2005 REM58(2):128)
Connelly et al 2004 section 3-10 "Nesting" -- while distances traveled from lek to nest areas vary among studies and regions (2.7km - 7.8km) and Braun (77) indicated a mean of 3.2km - Lyon and Anderson (03) documented behavioral effect of disturbed leks with mvmt to nest 2.1km without disturbance doubling to 4.1km with disturbances in proximity to lek (within 3km) and a decrease in nest initiation from 86% (undist) to 65% (w/dist). Multiple studies provided evidence of distances traveled in different regions, but role of habitat condition/disturbance was not explicitly addressed.
Connelly et al 2000 p972-974 discuss treatments, fire and related habitat disturbances. They cite multiple studies that found detrimental effects on GRSG populations, and a few that found no neg. effects; importantly, despite expectations (and observations) that disturbances in mountain sagebrush recover more quickly than arid sagebrush communities - sage canopy cover did not respond with suitable habitat conditions 14 years post fire (Nelle et al 2000) - so treatments in mountain sage communities, as well as steppe and GB sagebr, should be planned and implemented with great caution due to potential for negative impacts in the near term - landscape context and availablity of "intact" sagebrush stands in the area and available for utilization will be important.
The origins of 0.6 miles distance for buffering leks (in Wyoming, and likely similar in other states) is an amalgamation of ecological NSO, timing and pratcial limitations - - practical implementation of NSO (implcating all sagebrush habitat) -- will implicate vast landscapes of BLM lands in Wyo. - this level of exclusion will affect the multiple-use purpose of BLM lands in Wyo. -- therefore, practical regional limitations are needed to maintain true multiple use implications AND protect GRSG. [Full consideration should include] a demonstration using GIS assessment of Land ownership and 0.6,. 1.0 and 2.0 mile buffers [for example, in Wyoming] -- what is affected/implicated versus available for multiple land-use? [This analysis should also recognize lands "protected" as PrelimPriority/Core versus PrelimGeneral and if/when/how buffers will/will not apply in each. Summarize/present using combo of maps and tables.]
It is important to remember that our management decisions may be different than the science finding, but that doesn't mean the results didn't inform management decision. It is important to consider, "how the information science provided can be used to make management decisions," during this process. I keep hearing that the "best available science" is going to give us the answers, when in fact science is giving us [part of the] information we then use to make our management decisions. It is important for [management for grouse conservation] to move beyond the idea that a lek centric approach (just because the lek is the measurement basis for impacts in many of our research studies) is the only or best approach to sage-grouse management, and that science will tell us what the magic distance is for lek buffers that will solve all [habitat and population management] problems.
There is a long history of using guidelines or stipulations within a 1/4-mile buffer around leks to protect sage-grouse from adverse impacts of human activities. We have been unable to document any scientific literature that served as the basis for the establishment of this buffer, and new data suggest that this buffer size is inadequate to prevent impacts to breeding populations (Walker et al. 2007a). The buffers we recommend for unmapped seasonal habitats (following the “History of the 1/4-mile Buffer”) are based on actual data on GrSG habitat use.
Keep in mind, Utah PPMA is 100% NSO for unleased areas. The 4-mile buffer only applies to existing leases, and is only to be applied if the first condition (complete avoidance) isn’t possible. If complete avoidance of PPMA is not possible for existing leases, the next tier is to avoid areas within 4-miles of a lek. If that is not possible, it is to place in the most distal portion of the lease from the lek. Showing a 4-mile NSO for fluid minerals does not capture these specifics. All areas within 1 mile of a lek that is located in PPMA, whether habitat or not, has been included in PPMA. This is to ameliorate any indirect noise impacts from projects that would have been located outside PPMA, but near leks. We haven’t cited anything in the EIS to justify the 1 mile. The main purpose for the 1-mile, however, is protection of the lek, and not a focus on the nesting habitat. It is also critical to take the 1-mile buffer as a component with the other protections. By itself, a 1 mile closure wouldn’t provide sufficient protection. Combined with everything else, it provides certainty for protection near leks, while complimenting other protective measures for the remainder of PPMA.
This was recommended by our local USFWS office. The following is their explanation: “Our FR notice proposed rule (75 FR 13946) states, "Walker et al. (2007a, p. 2651) reported negative impacts on lek attendance of coal-bed methane development within 0.8km (0.5 mi) and 3.2 km (2 mi) of a lek, and Holloran (2005, pp. 57-60) observed that the influence of producing well sites and haul roads on lek attendance extended to at least 3 km (2 mi)." Looking further at Walker et al. (2007), they also conclude that natural gas development within 3-5 km (2-3 mi) of an active greater sage-grouse lek will lead to dramatic declines in breeding populations; energy development within 6.2 km (4 mi) of leks decreased male attendance at leks. So, it appears that there are impacts on leks from structures/activities anywhere from 0.5 mi to 4 mi. Connelly et al. 2000 noted that for migratory populations of grouse, breeding habitats should br protected within 18km of the leks (11miles) (p.978); ...hopefully our 5% disturbancece cap would take care of this...
From the ColoConsPlan: "Breeding Habitat and Summer-Fall Habitat - If these seasonal habitats are not mapped and field-validated, they should be designated by 2 concentric circles around active leks (Fig. B-1). The first circle has a radius of 0.6 miles (“Lek Habitat” portion of the Breeding Habitat), and the second has a radius of 4.0 miles, which encompasses the nesting and early-brood-rearing habitat and summer–fall habitat (Fig. B-1). Generally, breeding habitat is considered to be [i.e., estimated using] sagebrush communities within the 4-mile radius. Summer-fall habitat includes sagebrush communities, wet meadows, and agricultural fields within the 4-mile radius. On federal lands, the 0.6 mile radius area around a lek in breeding habitat could be defined as an area of No Surface Occupancy (NSO) or Avoidance Area (AA). Every possible opportunity to avoid or minimize the impact should be exhausted to prevent development in this area, but allowances are provided in these guidelines. The 4-mile radius is not an NSO or AA. It is an area of consideration where the disturbance guidelines should be applied when, and if, possible."

	Surface Disturbance, immediate and cumulative: lost & altered habitat distribution & condition + activities (lead to aversion)		Linear features - esp. roads: habitat distrib., condit. & fragment. + aversion/displacement (due to noise)	Energy - esp. Oil & Gas - Development: habitat degradation; Indirct: aversion/displacement (noise & activity)	Tall structures. Direct: predation, Indirect: behavioral avoidance	Low structures (fences) - direct effect: injury/death	Activities affecting behavior (without habitat damage +/-): avoidance/stress
Recommended value(s) with brief, specific commentary	**DENSITY:** 1pad/2.6km^2 (mi^2) has some impact (lowest limit) **->** 8pads/2.6km^2 (mi^2) exceeds tolerance; Min. (0% develop) is desirable **->** 25% footprint within 3.2km and 1 well within 350m **->** >= 40% development footprint within 3.2km buffer correlated with measurable decline. **DISTANCE:** 3.2km (often used/recommended), 6.4km (4mi) identified in Colo.Plan; effects approach zero btwn. 5-10km (~7km), activity & noise specified so seasonal limites/closures related to use (spr/sum/wintr) may be effective (Holloran & Anderson 2005);	Minimize treated/disturbed areas: maintain sagebrush canopy >25% within 30km area (around lek and across/around key habitat areas). Small (<60m diam/width) treatments may create good foraging conditions for sage-grouse broods. Decisions…should be based on quantitative knowledge of vegetative conditions over and entire population's seasonal range. Generally, the treatment...should be...least disruptive to the vegetation community and has the most rapid recover time."	min. 400m - but source audiblity (type/volume) and visibility could dictate effect area/distance (both are linked to terrain and cover)	Most habitat development impacts have been assessed in reference to Oil & Gas development (so see entries for "DENSITY" and "DISTANCE" for key discusssion). 1-12 wells per 32.2km^2 (12.4 sq.mi.) [approaches the] threshold (Doherty et al. 2010); 1pad/2.6km2 (mi2) has some impact (lowest limit) -> 8pads/2.6km2 (mi2) exceeds tolerance (Holloran & Anderson 2005)	min. 400m - but source audiblity (type/volume) and visibility could dictate effect area/distance (both are linked to terrain and cover). 1-5km fitness effects (nest/brood failure; LeBeau 2014) - 100m avoidance (LPC, GPC; Pruett 08)	Mark or remove fences within (2km (1.2mi.) on flat/rolling terrain (Stevens et al. 2012a,b)	min. 400m - but source audiblity (type/volume) and visibility could dictate effect area/distance (both are linked to terrain and cover).
Lit. Review (ranges in effect sizes and/or discussion)	>= 40% development footprint within 3.2km buffer OR 25% footprint within 3.2km and 1 well within 350m CAUSED measurable decline (**Naugle et al. 2011**); 1pad/2.6km2 (mi2) has some impact (lowest limit) - 8pads/2.6km2 (1mi2) exceeds tolerance threshold (max. develop to minimize impact lies below this value); Naugle et al, 2011, p.495-501) - many studies but values in SAB volume capture/summarize key info. (Table 20.2 provides additional references). **Colorado Greater Sage-Grouse Conservation Plan** (2008): (a) map sagebrush with >10% cover (do not count herbaceous, burns, trts., Agr., urban, or industrial "inclusions") (b) ID leks [or other seasonal hab.?] (c) sage cover within 4-20km of core habitats (leks, broods) has important potential (d) buffer sage habitats in range of 4km (non-migr. pops) - 20km (suggested common for many pops. based on female mvmts.). [~7km (4.34mi) might be defensible intermediate; **Holloran and Anderson (2005)** - key figure reproduced in SAB volume (fig 20.5) - measured effects approached zero around 7km.] (e) ID winter habitats within 20km (or pop. specified migr. distance) of leks based on sage cover (15-40%), height (20-40cm), and topography (S & W exposures, draws with Basin sage, exposed ridges) (f) implement seasonal closures and density limits in/around winter habitats.	Beneficial effects or trts. are questionable - maintain sagebrush canopy >25% within 30km area (around lek and across/around key habitat areas). Extent areas (min/max) are not clearly established - detrimental effects on lek & brood-rearing habitats have been described. Key references include: Beck et al. (2012 REM65), (Connelly et al. (2000, p972), Enyeart (1956), Higby (1969), Peterson (1970), Wallestad (1975). Small (<60m diam/width) treatments may create good foraging conditions for sage-grouse broods (esp. in Mtn. sagebrush) (Beck et al. 2012 REM65). "…herbicide application to blocks of sagebrush rangeland resulted in major declines in sage-grouse breeding populations (Enyeart 1956, Higby 1969, Peterson 1970, Wallestad 1975)." (Connelly et al. 2000, p972) "Activities responsible for the loss or degradation of sagebrush habitats also may be used to restore these habitats. Including: prescribed fire, grazing, herbicides and mechanical treatments. Decisions…should be based on quantitative knowledge of vegetative conditions over and entire population's seasonal range. Generally, the treatment...should be...least disruptive to the vegetation community and has the most rapid recover time." (Connelly et al. 2000, p.975) "...results suggest 2 considerations for managers considering burning or mowing to enhance Wyoming big sagebrush for sage-grouse in arid habitat... " (1) burning never resulted in adequate height or canopy cover for breeding habitat, and mowing only resulted in adequate sagebrush heights some of the time (1 of 2 yrs in this study on an arid site). And (2) if untreated communities do not meet minimum guidelines, consider consequences of sagebrush-reduction on those conditions and reconsider... practices such as grazing management or other approaches without active treatment [may be most effective]. (Hess and Beck 2012 WildSocBullp.92) --Davies et al. 2011 also endorsing caution in application. Conduct treatments only "in areas with large contiguous stands of sagebrush (Beck and Mitchell 2000, Connelly et al 2000, Dahlgren et al 2006)."	avoid leks & nesting areas (distance = audible range, 400m-2km?)	Direct impacts within 3acre area (radius: 38yd., 35m); Indirect influence to 19km (11.8mi.); "Clustering well locations enabled a few small leks to remain active inside of developments." (Doherty et al. 2010). Key consideration, besides footprint and impacts on habitat condition and predation potential, is the effect of intermittent noise on behavior (avoidance). In addition to evidence from "inclusive" studies (on distance/density effects) - work by Blickley et al (2012) provides essential insights into noise effects. A precise distance effect for noise has not been determined, but likely varies depending on the source (equipment, vehicles, others) and the terrain.	avoid leks & nesting areas (distance = audible range, 400m-2km?). Direct (min): 3 acres (35m/38yrd radius) -> 1km -10km in nesting habitats (e.g., within 3.2km of lek); GPC/LPC avoided powerlines by 100m and reduced crossing (use) of those corridors Indirect effects: 6.9km (4.3mi; predation)out to 19km (11.8mi) as with O&G (invasives/preds.)	Fences within 2km of active leks, flat/rolling terrain are implicated, solution is marking/removal. Need better info on Corvid and Raptor foraging, use of poles/towers and behavioral response of GRSG.	avoid leks & nesting areas (distance = audible range, 400m-2km?)

Surface Disturbance, immediate and cumulative: lost & altered habitat distribution & condition + activities (lead to aversion)	Habitat Area/Condition Modification	Habitat Area, Extent & Distribution: Habitat Value/ Condition Impacts + Noise (behavior effects use)	Linear habitat mods.: fragmentation/ habitat mods. + behavior effects (noise)
		Vegetation Treatments	**Roads and Trails**
			not addressed (no new construction unless pub. Safety...?)
		Incomplete - this info not requested or compiled at this time…	not addressed
			not addressed (no new construction unless pub. Safety...?)
		Incomplete - this info not requested or compiled at this time…	not addressed
			not addressed (no new construction unless pub. Safety...?)
PPMA is 100% NSO for unleased areas. The 4-mile buffer only applies to existing leases, and is only to be applied if the first condition (complete avoidance) isn't possible. If complete avoidance of PPMA is not possible for existing leases, the next tier is to avoid areas within 4-miles of a lek. If that is not possible, it is to place in the most distal portion of the lease from the lek. If that is not possible, it is to place in the most distal portion of the lease from the lek. Showing a 4-mile NSO for fluid minerals does not capture any of these specifics.		Require vegetation treatments conducted within 0.6 miles of a lek to include an objective of reducing conifer, where technically feasible, to less than 5 percent canopy cover, with preference for complete removal.	not addressed

Surface Disturbance, immediate and cumulative: lost & altered habitat distribution & condition + activities (lead to aversion)	Habitat Area/Condition Modification	Habitat Area, Extent & Distribution: Habitat Value/ Condition Impacts + Noise (behavior effects use)	Linear habitat mods.: fragmentation/ habitat mods. + behavior effects (noise)
		Vegetation Treatments	**Roads and Trails**
			not addressed (no new construction unless pub. Safety...?)
		Incomplete - this info not requested or compiled at this time…	not addressed

Surface Disturbance, immediate and cumulative: lost & altered habitat distribution & condition + activities (lead to aversion)	Habitat Area/Condition Modification	Habitat Area, Extent & Distribution: Habitat Value/ Condition Impacts + Noise (behavior effects use)	Linear habitat mods.: fragmentation/ habitat mods. + behavior effects (noise)
		Vegetation Treatments	**Roads and Trails**
			not addressed (no new construction unless pub. Safety...?)
		Incomplete - this info not requested or compiled at this time…	not addressed
			not addressed (no new construction unless pub. Safety...?)
		Incomplete - this info not requested or compiled at this time…	not addressed
			not addressed (no new construction unless pub. Safety...?)
		Incomplete - this info not requested or compiled at this time…	not addressed
			Avoid - No new roads within 1mi of lek
considered to be [i.e., estimated using] sagebrush communities within the 4-mile radius. Summer-fall habitat includes sagebrush communities, wet meadows, and agricultural fields within the 4-mile radius. **On federal lands, the 0.6 mile radius area around a lek in breeding habitat could be defined as an area of No Surface Occupancy (NSO) or Avoidance Area (AA)**. Every possible opportunity to avoid or			Avoid - No new roads within 1mi of lek

Industrial Development - habitat mods.; behavior effects (noise)	Industrial Development - habitat mods.; behavior effects (noise)	Industrial Development - habitat mods.; behavior effects (noise)	Wind, Solar - tall structures, roads, infrastructure: Habitat Mods. + Behavior effects	Wind, Solar - tall structures, roads, infrastructure: Habitat Mods. + Behavior effects	Tall structures - predation + behavior mods.
Fluids	**Non-energy Leasables**	**Mineral Development**	**Solar**	**Wind**	**Transmission lines, Pipelines (Major ROW)**
Priority/Core: NSO General: Open with Moderate constraints[13]	Priority/Core: Closed General: Open	Priority/Core: Closed General: Open	Priority/Core: Excluded General: Avoid (& buffer?)	Priority/Core: Excluded General: Avoid (& buffer?)	Priority/Core: Avoid (& buffer?) General: Avoid (& buffer?)
Priority/Core: NSO General: NSO	Priority/Core: Closed General: Closed	Priority/Core: Closed General: Closed	Priority/Core: Excluded General: Excluded	Priority/Core: Excluded General: Excluded	Priority/Core: Avoid (& buffer?) General: Avoid (& buffer?)
Priority/Core: NSO General: Open with Standard Constraints	Priority/Core: Closed General: Open	Priority/Core: Closed General: Open	Priority/Core: Excluded General: Excluded	Priority/Core: Excluded General: Open	Priority/Core: Avoid (& buffer?) General: Open
Development associated with existing fluid mineral leases overlapping PPMA, will place development outside of PPMAs. If the lease is entirely within PPMAs, if feasible, place development at least 4-miles from occupied leks. If this is not technically feasible, locate infrastructure in areas that will minimize habitat loss.	No new ROWs, mineral materials permits, non-energy leasables, appurtenant sub-surface coal mine facilities, surface coal mines (or facilities), or locatable mineral (where claimant agrees) developments within 1-mile of an occupied lek in PPMA				

Industrial Development - habitat mods.; behavior effects (noise)	Industrial Development - habitat mods.; behavior effects (noise)	Industrial Development - habitat mods.; behavior effects (noise)	Wind, Solar - tall structures, roads, infrastructure: Habitat Mods. + Behavior effects	Wind, Solar - tall structures, roads, infrastructure: Habitat Mods. + Behavior effects	Tall structures - predation + behavior mods.
Fluids	**Non-energy Leasables**	**Mineral Development**	**Solar**	**Wind**	**Transmission lines, Pipelines (Major ROW)**
Priority/Core: NSO (Imp - NSO) General: Open with Moderate constraints	Priority/Core: Closed (Imp - Open) General: Open	Priority/Core: Closed (Imp - Open) General: Open	Priority/Core: Exclusion (Imp - Avoid.) General: Open (Imp - Open)	Priority/Core: Exclusion (Imp - Avoid.) General: Open (Imp - Open)	Priority/Core: Avoid (Imp - Avoid) General: Open

Industrial Development - habitat mods.; behavior effects (noise)	Industrial Development - habitat mods.; behavior effects (noise)	Industrial Development - habitat mods.; behavior effects (noise)	Wind, Solar - tall structures, roads, infrastructure: Habitat Mods. + Behavior effects	Wind, Solar - tall structures, roads, infrastructure: Habitat Mods. + Behavior effects	Tall structures - predation + behavior mods.
Fluids	**Non-energy Leasables**	**Mineral Development**	**Solar**	**Wind**	**Transmission lines, Pipelines (Major ROW)**
Priority/Core: NSO (Imp - NSO) General: Open with Moderate constraints	Priority/Core: Closed (Imp - Open) General: Open	Priority/Core: Closed (Imp - Open) General: Open	Priority/Core: Exclusion (Imp - Avoid.) General: Open (Imp - Open)	Priority/Core: Exclusion (Imp - Avoid.) General: Open (Imp - Open)	Priority/Core: Avoid (Imp - Avoid) General: Open
Priority/Core: Open with major/moderate constraints [8] General: Open with standard/moderate constraints	Priority/Core: Open [9] General: Open	Priority/Core: Open General: Open	Priority/Core: NA (no solar) General: NA no solar	Priority/Core: Avoid [7] (Excl. in 1 FO; buffer?) General: Open	Priority/Core: Avoid (& buffer?) General: Open
Priority/Core: NSO [3] General: Open with Moderate constraints	Priority/Core: Closed [2] General: Open [2]	Priority/Core: Open [1] General: Open	Priority/Core: Exclude General: Avoid (& buffer?)	Priority/Core: Exclude General: Avoid (& buffer?)	Priority/Core: Avoid (& buffer?0 General: Open [5] (Avoid. In 1 FO; buffer?)
Priority/Core: NSO [10] General: Open with Moderate constraints [10]	Priority/Core: Closed General: Open	Priority/Core: Open [11] General: Open	Priority/Core: Excluded General: Avoid (& buffer?)	Priority/Core: Excluded General: Avoid (& buffer?)	Priority/Core: Avoid (& buffer?0 General: Open [12]

Tall structures - predation + behavior mods.	Low structures (fences, wells, ditches, row crops, etc.)	Activities affecting behavior (without habitat damage +/-)
Other Infrastructure (Minor ROW)	**Rangeland Infrastructure**	**Disruptive occasional and repeated events**
Priority/Core: Avoid (& buffer?) General: Open	Priority/Core: ? General: ?	Priority/Core: ? General: ?
Priority/Core: Avoid (& buffer?) General: Avoid (& buffer?)	Priority/Core: General:	Priority/Core: General:
Priority/Core: Avoid (& buffer?) General: Open	Remove, modify or mark fences in high risk areas (within 1.2mi of lek) + terrain	

Tall structures - predation + behavior mods.	Low structures (fences, wells, ditches, row crops, etc.)	Activities affecting behavior (without habitat damage +/-)
Other Infrastructure (Minor ROW)	**Rangeland Infrastructure**	**Disruptive occasional and repeated events**
Priority/Core: Avoid (Imp - Avoid) General: Open	Priority/Core: General:	Priority/Core: General:

Tall structures - predation + behavior mods.	Low structures (fences, wells, ditches, row crops, etc.)	Activities affecting behavior (without habitat damage +/-)
Other Infrastructure (Minor ROW)	**Rangeland Infrastructure**	**Disruptive occasional and repeated events**
Priority/Core: Avoid (Imp - Avoid) General: Open	Priority/Core: General:	Priority/Core: General:
Priority/Core: Avoid (&buffer?0 General: Open	Priority/Core: General:	Priority/Core: General:
Priority/Core: Avoid (& buffer?) General: Open (Avoid. In 1 FO; buffer?)	Priority/Core: General:	Priority/Core: General:
Priority/Core: Avoid (& buffer?) General: Open	Priority/Core: General:	Priority/Core: General:

Appendix 4: USGS OFR 2013-1098 **Density assesments and relations (non-distance/buffer)**

Threat or Issue	Location	Comparison	Covariate Investigated	Spatial Scale(s) Investigated	Sage-Grouse Response	Comment	Source
Agricultural Conversion	Wyoming, Montana, and Colorado	Lek count comparison	Proportion of land area converted from sagebrush	Variable scales surrounding leks	Conversion of ≥16% of sagebrush-dominated area around leks correlated with a 50 to 100% decline in male lek occupancy	Review of several studies	Swenson, 1987
Agricultural Conversion	Historic range	Currently occupied compared to unoccupied	Proportion of land area in cropland	2,975 km^2 around random points	Cropland exceeding 25% associated with extirpated range		Aldridge, 2008
Agricultural Conversion	Historic range	Currently occupied compared to unoccupied	Proportion of land area in cropland	1,018 km^2 around random points	Sagebrush cover <27% associated with extirpated range	Extirpated range had 3 times more area in agriculture compared to occupied range	Wisdom, 2011
Agricultural Conversion	Montana	Lek count comparison	Proportion of land area in cropland	202 km^2 of study area	Conversion of 30% of sagebrush-dominated habitat patches resulted in 73% decline in number of breeding males on leks	Habitats converted were used by sage-grouse predominantly in winter	Swenson, 1987
Agricultural Conversion	Current range	Lek count comparison	Proportion of land area in cropland	5 km (79 km^2) and 18 km (1,018 km^2) buffers of leks	Decline in lek trends to 2.5% of the area within 5 km or 1.5% of the area within 18 km of leks was cropland	Lek counts stabilized as percent cropland increased beyond these proportions; few leks occurred in areas where proportion of agricultural land exceeded 50%	Johnson, 2011
Infrastructure — Roads	Montana, Canada	Comparison of occurrence of large (>25 males) vs. small leks	Length of road (road density)	3.2-km buffer of leks	Probability of occurrence of large lek approached 0% as the length of road exceeded 100 km		Tack, 2009
Infrastructure — Roads	Colorado	Lek count comparison	Traffic volumes	Unspecified	Increased traffic (coal mine road upgrade) correlated with 94% decline in number of sage-grouse over a 5-year period on leks <2 km from road		Remington and Braun, 1991
Infrastructure — Roads	Wyoming	Lek count comparison	Traffic volumes	3-km buffer of leks	Decline in lek counts positively correlated with increased traffic volumes	Vehicle activity on roads when grouse present on leks had greater influence on male lek attendance compared to roads with no vehicle activity during this period	Holloran, 2005

Threat or Issue	Location	Comparison	Covariate Investigated	Spatial Scale(s) Investigated	Sage-Grouse Response	Comment	Source
Infrastructure — Roads	Wyoming	Females breeding on impacted vs. unimpacted leks; nest site selection	Impacted leks within 3 km of road	N/A (study area)	Females from impacted leks: had 24% lower probability of initiating a nest; moved twice as far from lek to nest; were less likely to initiate nests in consecutive years compared to females from non-impacted leks		Lyon, 2003
Infrastructure — Power Lines	Wyoming	Lek activity comparison	Distance to power line; Proportion of land area within 350 m of power line	Multiple buffers to 6.4 km (129 km^2) of leks	Probability of an active lek decreased with closer proximity to poles and increasing proportion of area within 350 m of power line within 6.4 km of lek		Walker, 2007
Infrastructure—Transmission Lines	Wyoming	Sage-grouse female nesting and brood-rearing (early and late) occurrence	Distance to transmission line	N/A (study area)	Sage-grouse avoided brood-rearing habitats within 4.7 km of transmission line		LeBeau, 2012
Infrastructure — Fences	Idaho	Collision occurrence	Lek size; Distance to lek; Topography; Fence density	2.5-km buffer of leks	Probability of collision higher in areas with (1) increased fence density; (2) decreased distance to nearest lek; (3) increased lek size; (4) lower topographic ruggedness	Collisions more common on fences constructed of steel t-posts and/or with large distances between posts (decreased visibility)	Stevens, 2011, Stevens, 2012
Energy development—Natural gas	Eastern range of species	Lek count comparison	Well pad densities	3.2-km buffer of leks	Well pad densities exceeding 1 pad/mi^2 (section) negatively influence number of sage-grouse on leks	Review of several studies	Naugle, 2011
Energy development—Natural gas	Wyoming	Lek count comparison	Well pad densities	8.5-km buffer of leks	Impacts to the number of sage-grouse on leks found at well pad densities >0.4 to 0.8 well pads/km^2 (0.15 to 0.3 pads/section)	Common well pad densities of 1.5 and 3.1 pads/km^2 (4 and 8 pads/section) associated with lek count declines ranging from 13–74% and 77–79%, respectively	Harju, 2010
Energy development—Natural gas	Wyoming	Lek activity comparison	Well pad densities	1-km buffer of leks	0% probability of lek occurrence when well pad densities exceeded 6.5 pads/mi^2 (section)		Hess, 2012

Threat or Issue	Location	Comparison	Covariate Investigated	Spatial Scale(s) Investigated	Sage-Grouse Response	Comment	Source
Energy development—Natural gas	Montana, Canada	Comparison of occurrence of large (>25 males) vs. small leks	Well pad densities	12.3-km buffer of leks	Large leks did not occur in areas where well pad densities exceeded 2.5 pad/mi^2 (section)		Tack, 2009
Energy development—Natural gas	Wyoming	Lek count comparison	Distance to well pads (pad presence (1) vs. absence (0) within buffers of leks)	Multiple buffers to 4.8 km of leks	Well pads within smaller buffers (<1.6–2 km) around leks associated with 35–76% fewer sage-grouse on leks compared to leks with no well pads within these buffers	Leks that had at least 1 well pad within 0.4 km had 35 to 92% fewer sage-grouse compared to leks with no well pads within this buffer	Harju, 2010
Energy development—Natural gas	Eastern range of species	Lek count comparison	Distance to well pads	N/A (study area)	Impacts to the number of males on leks were most severe when infrastructure occurred near leks; impacts remained discernible out to distances of 6.2 to 6.4 km	Review of several studies	Naugle, 2011
Energy development—Natural gas	Wyoming	Sage-grouse female nesting occurrence	Distance to well pads	N/A (study area)	Yearling females avoided nesting within 950 m of well pads		Holloran, 2010
Energy development—Natural gas	Wyoming	Sage-grouse female nesting and brood-rearing (early and late) occurrence	Distance to well pads; proportion of buffer disturbed by gas development activities	Multiple buffers to 1.26 km (5 km^2) of seasonally selected sites	Females avoided nesting and brood-rearing in areas with increased numbers of visible wells within a 1-km^2 area; females avoided sites when the proportion of a 5-km^2 area disturbed by gas development exceeded 8%		Kirol, 2012
Energy development—Natural gas	Wyoming	Sage-grouse chicks survival	Proportion of buffer disturbed by gas development activities	Multiple buffers to 1.26 km (5 km^2) of seasonally selected sites	Chick survival decreased when the proportion of a 1-km^2 area disturbed by gas development exceeded 4%		Kirol, 2012
Energy development—Natural gas	Canada	Sage-grouse chicks survival	Well pad densities	Multiple buffers to 1 km (3 km^2) of seasonally selected sites	Chick survival decreased with increasing numbers of visible wells within 1 km of brood-rearing locations		Aldridge and Boyce, 2007

Threat or Issue	Location	Comparison	Covariate Investigated	Spatial Scale(s) Investigated	Sage-Grouse Response	Comment	Source
Habitat Fragmentation	Idaho	Movement patterns		N/A (study area)	Sage-grouse used an annual range of at least 2,764 km^2		Leonard, 2000
Habitat Fragmentation	Historic range	Currently occupied compared to unoccupied	Proportion of land area in cropland	1,018 km^2 around random points	Sagebrush patch size in occupied range averaged 4,173 ha		Wisdom, 2011
Habitat Fragmentation	Idaho, Wyoming	Movement patterns		N/A (study area)	Sagebrush patch sizes >4,000 ha required for successful reproduction and over-winter survival		Leonard, 2000, Walker, 2007
Habitat Fragmentation	Wyoming	Movement patterns		N/A (study area)	314-km^2 area necessary to maintain breeding habitat around a single lek		Doherty, 2008