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VIA U.S. MAIL & ELECTRONIC DELIVERY

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Re: New Information Supplementing CBD's Protest of the April 20, 2016 Oklahoma-Kansas Competitive Oil and Gas Lease Sale

Dear Secretary Jewell, Director Kornze, and Lieutenant General Bostick,

We write to supplement our February 19, 2016 protest urging you not to issue the 11 leases for oil and gas development on more than 2,300 acres in Oklahoma and Kansas that were auctioned by the Bureau of Land Management's ("BLM") New Mexico State Office on April 20, 2016.[1] It is our understanding that BLM has not yet resolved the protest for the April 20, 2016 lease sale, and that the leases cannot be issued until the protest is resolved. In resolving this protest, we request BLM to consider highly significant information concerning (1) our recent petition to list the lesser-prairie chicken as "endangered," and to list the Mixed-Grass Prairie and Shortgrass Prairie/CRP Mosaic combined population as a Distinct Population Segment of lesser prairie-chicken; and (2) the risk of continued oil and gas wastewater injections in Oklahoma and Kansas leading to a major earthquake that could cause significant property damage and/or loss of life or injuries.

[1] BLM has stated it will not issue the leases until all protests have been resolved. The parcels at issue are: NM-201604-001, NM-201604-002, NM-201604-003, NM-201604-004, NM-201604-005, NM-201604-006, NM-201604-007, NM-201604-008, NM-201604-009, NM-201604-010, NM-201604-011

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A. New Information Concerning the Impacts to Lesser Prairie Chicken Must Be Addressed in an EIS

On September 8, 2016, we petitioned the Secretary of the Interior and the U.S. Fish and Wildlife Service ("FWS") to list the lesser prairie-chicken (*Tympanuchus pallidicinctus*) as "endangered" under the U.S. Endangered Species Act (ESA) (16 U.S.C. §§ 1531-1544).[2] We also petitioned the Service to list three Distinct Population Segments ("DPS") of lesser prairie-chicken. The proposed DPS most affected by the sale is the combined Mixed-Grass Prairie and Shortgrass Prairie/CRP Mosaic population,[3] which extends from the northeast panhandle of Texas through central Oklahoma and central Kansas. New information indicating that the Mixed-Grass Prairie and Shortgrass Prairie/CRP Mosaic combined population are a discrete population deserving of protection as an endangered species must be considered in BLM's environmental review of the April 2016 lease sale's impacts on the proposed DPS. Because the lease parcels from the April 2016 lease sale occur in suitable habitat for the proposed DPS, the lease sale could significantly harm this genetically distinct population, which is already at high risk of extinction.

The best available data show that the Mixed-Grass Prairie and Shortgrass Prairie/CRP Mosaic combined population are a distinct population segment. Cushman et al. (2010: 25) argued for organizing the lesser prairie chicken into three distinct and largely mutually-isolated metapopulations,[4] while Oyler-McCance et al. (2016: unnumbered 11) argued that the Sand Sagebrush Prairie and Shinnery Oak Prairie populations are genetically distinct populations, while the MixedGrass prairie and Shortgrass Prairie/CRP Mosaic populations are genetically mixed.[5] Other studies support the discreteness and genetic separation of the Mixed-Grass Priairie and Shortgrass Prairie/CRP Mosaic birds.[6]

[2] We petition for consideration of the populations in these two ecoregions as one DPS, as there is contradictory evidence regarding whether they are genetically or geographically distinct from each other. While we would support separate DPS status for the Mixed-Grass Priairie and Shortgrass Prairie/CRP Mosaic populations, these two populations are closer together geographically (suggesting greater potential for intermixing) and this distinction is not necessary for the purposes of this petition. Taken together, the best available science clearly shows that the Mixed-Grass Prairie and Shortgrass Prairie/CRP Mosiac ecoregional populations, when taken together, are discrete from the Shinnery Oak Prairie and Sand Sage Prairie populations, and also are isolated by distance.

[3] *See* Center for Biological Diversity 2016 map of Mixed-Grass Prairie and Shortgrass Prairie/CRP suitable habitat.

[4] Cushman, S.A., E.L. Landguth, and C.H. Flather. 2010. Climate change and connectivity: Assessing landscape and species vulnerability, Phase 1 Final Report. Great Plains Landscape Conservation Cooperative, 103 pp. Available online at http://www.greatplainslcc.org/PDFs/2010reports/Cushman_GPLCC_phase1_final_report.pdf, site last visited 11/1/16.

[5] Oyler-McCance, S.J., R.W. DeYoung, J.A. Fike, C.A. Hagen, J.A. Johnson, L.C. Larsson, and M.A. Patten. 2016. Rangewide genetic analysis of lesser prairie-chicken reveals population structure, range expansion, and possible introgression. Conserv. Genet. DOI 10.1007/s10592-016-0812-y

[6] Van den Bussche, R.A., S.R. Hoofer, D.A. Wiedenfeld, D.H. Wolfe, and S.K. Sherrod. 2003. Genetic variation within and among fragmented populations of lesser prairiechickens (Tympanuchus pallidicinctus). Molecular Ecol. 12: 681; Hagen, C.A. 2003. A demographic analysis of lesser prairie-chicken populations in southwestern Kansas: Survival, population viability, and habitat use. PhD Dissertation, Kansas State Univ., 2003: 185; Bouzat, J.L., and K. Johnson. 2004. Genetic structure among closely spaced leks in a peripheral population of lesser prairie-chickens. Molecular Ecol. 13: 499-505; Hagen, C.A. 2010. Impacts of Energy Development on Prairie Grouse Ecology: A Research Synthesis. Trans. N. Am. Wildl. Conf. 75: 33; and Pruett, C.L., J.A. Johnson, L.C. Larsson, D.H. Wolfe,

While we would support separate DPS status for the Mixed-Grass Priairie and Shortgrass Prairie/CRP Mosaic populations, these two populations are closer together geographically (suggesting greater potential for intermixing). Taken together, the best available science clearly shows that the Mixed-Grass Prairie and Shortgrass Prairie/CRP Mosiac ecoregional populations, when taken together, are discrete from the Shinnery Oak Prairie and Sand Sage Prairie populations, and also are isolated by distance.

Protection of the proposed Mixed-Grass Priairie and Shortgrass Prairie/CRP Mosaic DPS is highly critical. The Shortgrass Prairie/CRP Mosaic population supports approximately 65% of the remaining birds left in the wild,[7] and when combined with the Mixed-Grass Prairie population, the two populations represent the vast majority of remaining birds. Garton et al. (2016: 61, 66) gives each of these populations relatively low chances of extirpation compared to the remaining two proposed DPSs,[8] and therefore the loss of this combined population would leave the lesser prairie chicken's survival dependent on the smaller populations that inhabit more arid and inhospitable climates where rates of growth and survival are intrinsically lower.[9] As the core of the remaining population of the species with the lowest chance of extinction, the importance of the Mixed-Grass Prairie and Shortgrass Prairie/CRP Mosaic combined populations cannot be disputed.

Listing of the Shortgrass Prairie/CRP Mosaic population as "endangered" is warranted, as the best available data show this population could drop below critical thresholds in the near future, and that significant losses of genetic diversity and habitat have already occurred. The current population in the Mixed-Grass Prairie Ecoregion is estimated at less than 4,000 birds, the second-largest population of lesser prairie chickens.[10] In the Mixed-Grass Prairie ecoregion, Garton et al. (2016: 61) projected a minimal probability of the population dropping below Ne=50, but a 28% chance of the population dropping below Ne=500 within 30 years; at the 100-year timescale, there is a 39% chance of the effective breeding population dropping below 50 birds, and a 75% chance of the population dropping below Ne=500. In addition, estimates of genetic effective population size (Ne) for the Mixed Grass Prairie Ecoregion are low, suggesting that the maintenance of genetic diversity may be compromised for this population.[11] In the Shortgrass Prairie/CRP Mosaic ecoregion, at least 73% of the landscape has been converted to

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and M.A. Patten. 2011. Low effective population size and survivorship in a grassland grouse. Conserv. Genet. 12: 1212.

[7] Dahlgren, D. K., R. D. Rodgers, R. D. Elmore, and M. R. Bain. 2016. Grasslands of Western Kansas, North of the Arkansas River. Stud. Avian Biol. 48:263.

[8] Garton, E.O., C.A. Hagen, G.M. Beauprez, S.C. Kyle, J.C. Pitman, D.D. Schoeling, and W.E. Van pelt. 2016. Population dynamics of the lesser prairie-chicken. Studies in Avian Biol. 48: 61.

[9] *See*, *e.g*. Engle, D.M., and J.D. Kulbeth. 1992. Growth dynamics of crowns of eastern red-cedar at 3 locations in Oklahoma. J. Range Manage. 45: 301-305.

[10] Wolfe, D.H., L.C. Larsson, and M.A. Patten. 2016. The lesser prairie-chicken in the Mixed-Grass Prairie Ecoregion of Oklahoma, Kansas, and Texas. Stud. Avian Biol. 48: 299-314

[11] Corman, K. S. 2011. Conservation and landscape genetics of Texas Lesser Prairie-Chicken: population structure and differentiation, genetic variability, and effective size. M.S. thesis, Texas A&M University-Kingsville, Kingsville, TX; Pruett, C. L., J. A. Johnson, L. C. Larsson, D. H. Wolfe, and M. A. Patten. 2011. Low effective population size constraints rapid demographic evolution in a grassland grouse. Conservation Genetics 12:1205–1214.

cropland, with about 7% currently in the Conservation Reserve Program,[12] which itself is a temporary solution that is subject to returning to tillage agriculture.

As we have stated in our previous letters, habitat loss is a major threat to the lesser prairie chicken ("LPC") in these areas, and fragmentation is ongoing due to various causes including oil and gas development.[13] The Mixed-Grass Prairie and Shortgrass Prairie/CRP Mosaic proposed DPS is impacted by cropland conversion,[14] livestock grazing,[15] herbicide "treatment" of shinnery oak habitats,[16] fencing of small pastures and small pasture size,[17] infrastructure and industrial features,[18] rural sprawl in the form of buildings,[19] energy development,[20] and tree invasion of

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[12] Dahlgren et al. 2016: 262

[13] Samson, F. B., F. L. Knopf, and W. R. Ostlie. 2004. Great Plains ecosystems: past, present, and future. Wildlife Society Bulletin 32:6–15

[14] Copelin, F.F. 1959. Notes regarding the history and current status of the lesser prairie chicken in Oklahoma. Proc. Okla. Acad. Sci. 37: 158-161; Copelin, F.F. 1963. The lesser prairie chicken in Oklahoma. Oklahoma Wildlife Conservation Dept. Tech. Bull. No. 6, 58 pp; Sexson M. L. 1980. Destruction of sandsage prairie in southwest Kansas. Proc. N. A. Prairie Conf. 7: 113-116; Toole, B.E., 2005. Survival, seasonal movements, and cover use by lesser prairie chickens in the Texas panhandle. M.S. Thesis, Texas A&M Univ., 39 pp; Pitman, J.C., C.A. Hagen, R.J. Robel, T.M. Loughin, and R.D. Applegate. 2005. Location and success of lesser prairie-chicken nests in relation to vegetation and human disturbance. J. Wildl. Manage. 69: 1259-1269; Hagen, C.A., J.C. Pitman, B.K. Sandercock, D.H. Wolfe, R.J. Robel, R.D. Applegate, and S.J. Oyler-McCance. 2010. Regional variation in mtDNA of the lesser prairiechicken. Condor 112: 29-37; Robinson, S. 2015. Landscape ecology, survival and space use of lesser prairie-chickens. M.S. Thesis, Kansas State Univ., 123 pp.

[15] Copelin 1959: 159; Jackson, A.S., and R. DeArment. 1963. The lesser prairie chicken in the Texas panhandle. J. Wildl. Manage. 27: 733-737; Collins, S.L. J.A. Bradford, and P.L. Sims. 1987. Succession and fluctuation in Artemesia dominated grassland. Vegetation 73: 89-99; Bidwell, T.G., and A. Peoples. 1991. Habitat management for Oklahoma's prairie chickens. Stillwater, OK: Oklahoma State Cooperative Extension Service, 4 pp; Patten, M.A., D.H. Wolfe, E. Shochat, and S.K. Sherrod. 2005a. Effects of microhabitat and microclimate selection on adult survivorship of the lesser prairie-chicken. J. Wildl. Manage. 69: 1270-1278; Melcher, C.P. 2015. Lesser prairie-chicken. Pp. 163-174 in Southern Great Plans rapid ecoregional assessment – Pre-assessment report. USGS Open File Report 2015-1003, 284 pp., http://dx.doi.org/10.3133/ofr20151003.

[16] Jackson and DeArment 1963: 736, Olawski, C.D. 1987. Effects of shinnery oak control with tebuthiuron on lesser prairiechicken populations. M.S. Thesis, Texas Tech. Univ., 83 pp.; Bell, L.A., S.D. Fuhlendorf, M.A. Patten, D.H. Wolfe, and S.K. Sherrod. 2010. Lesser prairie-chicken hen and brood use on sand shinnery oak. Rangeland Ecol. Manage. 63: 478-486.

[17] Patten, M.A., D.H. Wolfe, E. Shochat, and S.K. Sherrod. 2005b. Habitat fragmentation, rapid evolution and population persistence. Evol. Ecol. Res. 7: 235-249; Wolfe, D.H., M.A. Patten, E. Shochat, C.L. Pruett, and S.K. Sherrod. 2007. Causes and patterns of mortality in lesser prairie-chickens Tympanuchus pallidicinctus and implications for management. Wildl. Biol. 13: 95-104.

[18] Hagen 2003; Robel, R. J., J. A. Harrington Jr., C. A. Hagen, J. C. Pitman, and R. R. Reker. 2004. Effect of energy development and human activity on the use of sand sagebrush habitat by Lesser PrairieChickens in southwestern Kansas. Trans. N. Am. Wildl. Nat. Res. Conf. 69: 251– 266; Pitman et al. 2005: 1259; Hagen, C. A., J. C. Pitman, T. M. Loughin, B. K. Sandercock, R. J. Robel, and R. D. Applegate. 2011. Impacts of anthropogenic features on habitat use by Lesser Prairie Chickens. Pp. 63–75 in B. K. Sandercock, K. Martin, and G. Segelbacher (editors). Ecology, conservation, and management of grouse. Studies in Avian Biology (no. 39), University of California Press, Berkeley, CA; Timmer, J.M. 2012. Relationship of lesser prairie-chicken density to landscape characteristics in Texas. MS Thesis, Texas Tech Univ., 131 pp; Plumb, R.T. 2015. Lesser prairie-chicken movement, space use, survival, and response to anthropogenic structures in Kansas and Colorado. M.S. Thesis, Kansas State Univ., 116 pp.; Lautenbach, J.M. 2015. Lesser prairie-chicken reproductive success, habitat selection, and response to trees. M.S. Thesis, Kansas State Univ., 142 pp.

[19] Pitman et al. 2005: 1267

[20] Dusang, D. 2011. Impacts of energy development on the lesser prairie-chicken ecology and management. M.S. Thesis, Univ. of Oklahoma, 71 pp; Jarnevich, C.S., and M.K. Laubhan. 2011. Balancing energy development and

grassland habitats.[21] Over 50% of the southern mixed-grass prairie has already been lost.[22] While much of the mixed-grass prairie was severely fragmented by homesteading over a century ago, fragmentation is ongoing due to oil and gas development, wind power development, transmission lines, highways, and expansion of invasive plants such as eastern red-cedar (Juniperus virginiana).[23] Oil and gas well densities in the Mixed Grass Prairie Ecoregion already average 4 to 12 wellsites per square mile,[24] and additional development is ongoing. Density of fences, which result in collision mortalities, in the Mixed Grass Prairie Ecoregion can reach as much as 8.8 linear miles of fencing per square mile of habitat, and 6 miles of fencing per square mile is prevalent.[25] New oil and gas development would exacerbate existing habitat fragmentation, adversely affecting this highly sensitive and important proposed DPS.

BLM must consider the effects of the 11 leases on the Mixed-Grass Prairie and Shortgrass Prairie/CRP Mosaic proposed DPS, and not simply on the lesser prairie-chicken generally. Because several of these lease parcels (parcels 1-4, 7, and 9) overlap with or lie near "focal areas," important habitat to this DPS could be lost if leasing were allowed on these parcels. Focal areas are those identified by the states as areas of greatest importance to the species where conservation efforts should be focused and development avoided "to the maximum extent possible."[26] But the EA does not even consider alternatives to leasing within these areas. Because of the severe threat that leasing poses to this population, BLM must refrain from issuing the leases sold in the April 2016 lease sale and prepare an Environmental Impact Statement ("EIS").

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conservation: A method utilizing species distribution models. Envtl. Manage. 47: 930; Hagen et al. 2011: 73; Ungerer, J., and C.A. Hagen. 2012. Status of lesser prairie-chickens: A review of threats and conservation actions. Unpbl. PowerPoint presentation, USDA NRCS; Hovick, T.J., R.D. Elmore, D.K. Dahlgren, S.D. Fuhlendorf, and D.M. Engle. 2014. Evidence of negative effects of anthropogenic structures on wildlife: A review of grouse survival and behaviour. J. Appl. Ecol. 51: 1680-1689.

[21] Drake, B., and P. Todd. 2002. A strategy for control and utilization of invasive juniper species in Oklahoma. Final Report of the "Redcedar Task Force." Oklahoma City, OK: Oklahoma Dept. of Agriculture, Food and Forestry, 54 pp.

[22] Samson, F. B., F. L. Knopf, and W. R. Ostlie. 2004. Great Plains ecosystems: past, present, and future. Wildlife Society Bulletin 32:6–15

[23] Wolfe, D.H., L.C. Larsson, and M.A. Patten. 2016. The lesser prairie-chicken in the Mixed-Grass Prairie Ecoregion of Oklahoma, Kansas, and Texas. Stud. Avian Biol. 48: 299

[24] *Id*. at 302.

[25] *Id*. at 305.

[26] Van Pelt, W.E., et al., The Lesser Prairie-Chicken Range-wide Conservation Plan, Western Association of Fish and Wildlife Agencies, 69, 73 (2013), available at http://www.wafwa.org/Documents%20and%20Settings/37/Site%20Documents/Initiatives/Lesser%20Prairie%20Chicken/2013LPCRWPfinalfor4drule12092013.pdf ("Focal areas will only be effective if conservation efforts can be concentrated in these areas, and if development can be avoided to the maximum extent possible. Focal areas should ensure a persistent and well-distributed population into the future."). While we disagree that the "focal area" concept as provided in the Rangewide Plan is sufficient to conserve lesser prairie-chickens and the Service has found the Plan insufficient to avoid an ESA listing, the proposed lease sales run counter to even the minimal measures in the Plan.

B. New Information Concerning Earthquakes Must Be Addressed and Analyzed in BLM's NEPA Review

Since the April 2016 lease sale, new information regarding the risk of underground oil and gas wastewater disposal on inducing earthquakes has emerged. Despite measures by the Oklahoma Corporation Commission's Oil and Gas Division (OCC) to reduce wastewater injections overall, several studies and experts have noted that the risk of a major earthquake still exists. Moreover, continued wastewater injections and numerous small earthquakes could result in a large earthquake that could cause extensive property damage and human injury or even loss of life. BLM must address the cumulative effect that new oil and gas development could have in contributing to the increased risk of earthquakes.

On September 3, 2016 a 5.8 earthquake occurred in the Pawnee area – the largest recorded quake to hit the state—prompting Oklahoma's governor to declare a state of emergency.[27] The early-morning earthquake injured one person and damaged 14 buildings[28]; the consequences could have been much worse if the epicenter had been closer to population centers and happened in the middle of the day.[29] According to scientists, the Pawnee quake was likely linked to the previous clusters of earthquakes that have struck to the south and west, from the outskirts of Oklahoma City to the Kansas border.[30] Numerous studies have linked those earthquakes to a large increase in waste disposal occurring from 2011 to 2015.[31]

An earthquake of this magnitude was not unexpected. Experts predicted that wastewater injections would lead to a rise in larger earthquakes, which recent earthquake activity in 2016 has confirmed.[32] In 2016, Oklahoma recorded two quakes "in the 5 range": the September Pawnee

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[27] Lee, Mike, Oklahoma Quake Was a Record-Setter, and Anger is Still High. E&E Energy Wire. (September 8, 2016), available at http://www.eenews.net/energywire/stories/1060042493/ ("Lee 2016").

[28] Fieldstadt, Elisha & AP, State of Emergency Declared in Oklahoma After Magnitude 5.6 Earthquake, NBC News, http://www.nbcnews.com/news/us-news/state-emergency-declared-oklahoma-after-magnitude-5-6-earthquake-n642676.

[29] Wines, Michael, Geologist Sees Clues, and Further Dangers, in Puzzle of Oklahoma's Earthquake, New York Times (Sept. 6, 2016) ("Oklahoma got very lucky in that the epicenter of this quake was functionally in the middle of nowhere. And it happened in the early morning. If you'd stuck it underneath a town at a different time of day, when people were on the sidewalks, you would have had a much greater problem.") ("Halihan Interview 2016").

[30] *Id*.

[31] *See, e.g.*, McNamara, D.E., et al., Earthquake Hypocenters and Focal Mechanisms in Central Oklahoma Reveal a Complex System of Reactive Subsurface Strike-Slip Faulting, faulting, *Geophys. Res. Lett.*, 42, 2742–2749, doi:10.1002/2014GL062730 (April 23, 2015) ("McNamara 2015"); *and* Keranen, Katie et al., Potentially Induced Earthquakes in Oklahoma, USA: Links Between Wastewater Injection and the 2011 Mw5.7 Earthquake Sequence, Geology doi:10.1130/G34045.1 (March 26, 2013) ("Keranen 2013"); F. R. Walsh, M. D. Zoback, Oklahoma's recent earthquakes and saltwater disposal. Sci. Adv. 1, e1500195 (2015); Keranen 2013; McNamara 2015; *see also* Oklahoma Geological Survey Summary Statement on Oklahoma Seismicity (April 21, 2015) ("The rate of magnitude 3+ earthquakes has increased from 1 ½ per year prior to 2008 to the current average rate of 2 ½ per day, a rate that is approximately 600 times the historical background. The Oklahoma Geological Survey (OGS) considers it very likely that the majority of recent earthquakes, particularly those in central and north-central Oklahoma, are triggered by the injection of produced water in disposal wells.") (emphasis added).

[32] Fox, Keaton, Oklahoma's record-tying quake was predicted, more expected, Fox25 (Sept. 5, 2016), available at http://okcfox.com/news/local/oklahomas-record-tying-quake-was-predicted-more-expected ("Fox 2016").

earthquake noted above, and a 5.1 magnitude earthquake near Fairvview on February 13.[33] These comprise half of all earthquakes equal to or greater than 5.0 magnitude in Oklahoma's history. The two others were a 5.6 earthquake near Prague in 2011 and a 5.5 near Yukon in 1952.[34] This pattern reflects an increasing trend of larger earthquakes: "In 2016, while the total number of earthquakes is down, the larger, more damaging earthquakes make up a large percentage of those types of quakes in history."[35] Of earthquakes magnitude 4.0 or higher, 20 percent of those (17 earthquakes) were recorded in 2016.[36] The only year with a higher number of 4.0 or greater quakes was 2015, which had 29.[37] Overall energy released from earthquakes has tripled over time, even as the number of earthquakes has declined.[38]

Experts have also noted that large earthquakes are likely to follow a series of smaller earthquakes, suggesting that wastewater injections can cumulatively lead to larger seismic events. For example, after two earthquakes of 4.7 and 4.8 magnitude struck rural northern Oklahoma earlier this year, one news report noted:

> The two quakes followed a series of smaller ones last week that peeled brick facades, toppled columns and caused a power failure in Edmond, an upscale Oklahoma City suburb. Some experts said those quakes hinted at the possibility of a larger shock.
>
> "I do think there's a really strong chance that Oklahoma will receive some strong shaking," said Daniel McNamara, a research geophysicist at the National Earthquake Information Center in Colorado, who has followed the state's quakes.[39]

Experts predict that earthquake activity will continue to rise and larger quakes can continue to be expected, despite declines in wastewater injections:

> "[Pawnee] indicates to me that the earthquake rate is continuing to rise even with the decrease in injection volumes over the year," [USGS seismologist] McNamara said.
>
> McNamara said he has attempted to estimate the size and length of all the faults in Oklahoma to come up with an idea of how much energy could remain and how long it may take to dissipate.

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33 *Id*.
34 *Id*.
35 *Id*.
36 *Id*.
37 *Id*.
38 *Id*.
39 Wines, Michael, Earthquakes in Oklahoma Raise Fears of a Big One, New York Times (Jan. 7, 2016), available at http://www.nytimes.com/2016/01/08/us/earthquakes-in-oklahoma-raise-fears-of-a-big-one.html?action=click&contentCollection=U.S.&module=RelatedCoverage&region=Marginalia&pgtype=article ("Wines 2016").

> "It could be up 10 to 100 years. We don't know—even if they shut down everything today," McNamara said.

Jeremy Boak, director of the Oklahoma Geological Survey, said he would be surprised if it took 100 years, but he expects it to be a "long time" before Oklahoma gets back to its historical average of two 3.0 earthquakes a year.[40] He is more interested in how long it will take to get back to 2012 levels (35 magnitude-3.0s), before seismicity took a terrific leap skyward.[41]

In other words, "even though the rash of earthquakes in Oklahoma has subsided somewhat since its peak last year, the size of the latest tremor makes it more likely that a similar-sized event will happen in the future, according to state and federal geologists. The smaller quakes are likely to continue, too, even though their numbers have tapered off since state regulators started limiting the amount of wastewater injection last year."[42] Similarly, the director of Oklahoma Geological Survey, has warned that there could be more large quakes like the record breaking September 3 magnitude 5.8 temblor that hit Pawnee.[43] Thus, future injections, combined with past injections, could have far-reaching consequences into the future.

Cumulative pressure increase from injection may also trigger swarms of earthquakes on faults located tens of kilometers or more from injection wells.[44] In the Fort Worth Basin in Texas, for example, the cumulative number of earthquakes having magnitudes of 3 or more increased roughly exponentially, since 2008, with discrete increases associated with individual earthquake sequences.[45] In other words, small earthquakes may be precursors to large earthquakes or swarms. Many North Texas earthquake sequences consist of swarms of small earthquakes. The published investigations of all these sequences concluded that it was plausible or probable that they were induced by increased subsurface fluid pressures associated with the

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[40] Jones, Corey, Record quake renews concerns of even stronger tremblors in Oklahoma, Tulsa World (Sept. 4, 2016), available at http://www.tulsaworld.com/homepagelatest/record-quake-renews-concerns-of-even-stronger-temblors-in-oklahoma/article_f4e03860-9a1b-5bce-8b41-e93f99cbc443.html ("Jones 2016")

[41] Jones 2016; Lee 2016 ("'Even if all the wells were shut down, there's still energy in the system,' Daniel McNamara, a researcher with the U.S. Geological Survey, told reporters at a meeting of scientists in Norman."); Fox 2016 ("Large earthquakes typically beget large earthquakes, said USGS seismologist Daniel McNamara. "There will certainly be large M4 aftershocks associated with the M5.6," McNamara said by email from his office in Colorado.") ; Wines, Michael, Oklahoma Puts Limits on Oil and Gas Wells to Fight Quakes, New York Times, available at http://www.nytimes.com/2016/03/08/us/oklahoma-earthquakes-oil-gas-wells.html?hp&action=click&pgtype=Homepage&clickSource=story-heading&module=second-column-region&region=top-news&WT.nav=top-news&_r=0 (deputy chief of USGS man-made earthquake program noting "You really can't rule out the possibility of a larger earthquake.") ("Wines 2016").

[42] Lee 2016.

[43] Soraghan, Mike, Fewer Disposal Wells to Close in Oklahoma From Quake. E&E Energy Wire. (September 13, 2016), ,available at http://www.eenews.net/energywire/stories/1060042721/search?keyword=pawnee ("'We see a continued possibility of an equal or larger-sized earthquake' in the state's sizable quake zone, said Jeremy Boak, director of the Oklahoma Geological Survey.")

[44] Hornbach, M.J., Jones, M., Scales, M., DeShon, H.R., Beatrice Magnani, M., Frohlich, C., Stump, B., Hayward, C., Layton, M., Ellenburger wastewater injection and seismicity in North Texas, *Physics of the Earth and Planetary Interiors* (2016), doi: http://dx.doi.org/10.1016/j.pepi.2016.06.012

[45] *Id*. (Cumulative pressure increase across the basin may trigger earthquakes on faults located tens of kilometers or more from injection wells, and this process may have triggered the Irving-Dallas earthquake sequence).

injection of wastewater.[46] A new study suggests far-field pressurization from clustered, high-rate wells greater than 12 km from an earthquake sequence in Fairview, Oklahoma (of five earthquakes with Mw 4.4 or larger) induced these earthquakes, and points to the far-reaching impact of wastewater injection.[47]

Accordingly, it is highly likely that new oil and gas development, and increased wastewater injection associated with new development, would cumulatively increase the risk of increased earthquake activity, and larger quakes. Oklahoma experienced 905 earthquakes (of magnitude 3 or greater) in 2015 alone,[48] a 55% increase over 2014,[49] up from an average of about 2 earthquakes a year prior to 2009, while earthquake rates in 2016 are on track to exceed 2014 levels.[50] The sheer volume of earthquake activity therefore suggests that continued injections would exacerbate the risk of a larger earthquake, despite measures to reduce wastewater injections overall. And as we have previously noted, several of the parcels are in areas that have a high risk of damage from an earthquake, or are near wastewater wells associated with earthquake activity.[51] For example, one parcel is extremely close to Fairview,[52] which was the epicenter of Oklahoma's fourth largest earthquake (5.1 magnitude) in February.

These risks are all the more significant, given uncertainties in where damaging earthquakes are most likely to occur and how to reduce these risks. For example, the Pawnee earthquake resulted from activation of a previously unknown fault in an area where regulators had not previously ordered cutbacks in wastewater injection.[53] Regulators therefore do not appear to have much of a handle on where wastewater disposal is likely to result in earthquake activity. Even the USGS's 2016 forecast for where damage from induced earthquakes is most likely to occur is based only on *past* activity patterns, rather than an evaluation of areas with geological characteristics or faults most susceptible to induced seismicity.[54]

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[46] *Id*.

[47] Yeck, W. L., M. Weingarten, H. M. Benz, D. E. McNamara, E. A. Bergman, R. B. Herrmann, J. L. Rubinstein, and P. S. Earle (2016), Far-field pressurization likely caused one of the largest injection induced earthquakes by reactivating a large preexisting basement fault structure, Geophys. Res. Lett., 43, 10,198–10,207, doi:10.1002/2016GL070861.

[48] Oklahoma Geological Survey, Earthquakes in Oklahoma What We Know, available at http://earthquakes.ok.gov/what-we-know/ (Accessed September 26, 2016).

[49] *Id*.

[50] *Id*.

[51] CBD Letter re Man-made earthquake risks connected to April 20, 2016 Oil and Gas Lease Auction (May 9, 2016) and exhibits attached thereto.

[52] *Id*.

[53] Jones 2016 (noting fault causing Pawnee quake was "undiscovered"); Soraghan, Mike, EPA orders shutdown of disposal wells after Okla. quake, E&E News (Sept. 7, 2016), available at http://www.eenews.net/energywire/2016/09/07/stories/1060042410 ("EPA has not announced any [restrictions] concerning disposal wells in Osage [County] before now.").

[54] USGS, 2016 One-Year Seismic Hazard Forecast for the Central and Eastern United States from Induced and Natural Earthquakes, Open-File Report 2016–1035, 12 (2016) , available at http://pubs.usgs.gov/of/2016/1035/ofr20161035.pdf ("Our assessment of induced earthquake hazard was dependent on the assumption that past earthquake rates will remain constant over the next year of the forecast. While this assumption will not hold for areas of injection over long periods, recent studies…indicate that assessing earthquake rates observed over short time windows of a year or less are currently the best method available for forecasting the next year's rate of induced earthquakes. This model, however, does not account for increased, reduced, or new induced activity in 2016.").

Moreover, while the state has targeted wastewater injections in areas with high levels of seismic activity, earthquakes of magnitude 5.0 or greater have mysteriously occurred on the outskirts of these areas, according to Jeremy Boak, director of the Oklahoma Geological Survey:

> Boak noted an apparent oddity in that Oklahoma's three magnitude-5.0s since 2011 have occurred on the fringe — not in the heart — of seismic activity. He said he is unsure what that means seismically.
>
> "It may mean nothing, but I'm intrigued by it," Boak said.[55]

Dr. Todd Halihan, a geologist at Oklahoma State University recently noted the need for "large-scale studies" to understand how and where earthquakes occur:

> We're generating earthquakes, but we still haven't done the large-scale studies we need to do to understand how to manage them. We can keep monitoring seismicity and mess with injection volumes, but unless we get boreholes at depth and really study what's happening, this problem is going to continue.[56]

Experts and regulators thus have much to learn in where earthquakes may be triggered, what risk factors may contribute to the activation of a larger quake, and how to manage these risks. It is therefore entirely possible that the next large earthquake could be triggered by wastewater injections in an area not previously on the radar of state and federal agencies. These significant knowledge gaps compel the preparation of an EIS. *See* 40 C.F.R. § 1508.27 (Consideration of whether action "significantly" affects environments involves evaluating "degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.").

BLM cannot pass on its NEPA obligations by assuming these problems will be taken care of by the Oklahoma Corporation Commission. While the OCC is the state's regulatory agency charged with overseeing Oklahoma's oil and gas industry, BLM nevertheless has a duty to perform a thorough analysis of foreseeable environmental impacts of its leasing decision, subject to the public's review and input, prior to leasing public lands for oil and gas development. BLM may take into account any regulatory controls in its analysis of foreseeable impacts, but cannot arbitrarily claim that no significant impacts would result simply because another agency regulates underground injection wells.

Moreover, OCC has largely proven ineffective in preventing earthquakes from underground oil and gas injections. Rather than conducting the necessary studies to gain a handle on which areas are seismically at risk, OCC is largely relying on reactive measures by directing operators to cutback wastewater disposal when a large earthquake occurs.[57] And so-called "proactive" measures simply restrict the volume of wastewater injections allowed, rather than

[55] Jones 2016.
[56] Halihan Interview 2016.
[57] *See id*. (expert noting "we need to be proactive instead of reactive").

requiring a permanent shutdown of wells.[58] Even these "directives" issued by the OCC are requests for voluntary action and not mandatory.[59] Operators may therefore continue injecting wastewaters until OCC completes a formal process to order shut down of injection wells.

Shockingly, in BLM's Environmental Assessment for the next April 2017 lease sale of Oklahoma and Texas parcels, BLM continues to omit this glaring issue from public review, ignoring the potential for significant impacts from oil and gas production on Oklahoma and Texas parcels. BLM has yet to acknowledge, let alone conduct the required analysis of, impacts relating to induced seismicity. The EA for the April 2017 lease sale limits its analysis to the potential for induced seismic events to cause water contamination, and ignores the potential for wastewater injections to cumulatively increase the risk of a large earthquake, and the associated risk to homes, public infrastructure, and human lives. Given that earthquakes occur at much shallower depth in Oklahoma than in other states, such as California or Alaska, earthquakes of the same magnitude have a greater potential for shaking and damage in Oklahoma than in other states.[60] If BLM's treatment of seismic activity in the draft EA is any indication of how it plans to respond to the issues raised in our protest of the April 2016 lease sale, this analysis falls woefully short of the analysis and disclosure required under NEPA.

Conclusion

For the aforementioned reasons, we urge the Secretary and BLM to halt issuance of all of the April 20 auctioned leases, and for the Army Corps to withdrawn its consent to new leasing. Please let us know if you have any questions, and thank you for considering our concerns.

Sincerely,

My-Linh Le
Legal Fellow
Center for Biological Diversity

Wendy Park
Senior Attorney
Center for Biological Diversity

David Brown
Chair
Oklahoma Chapter Sierra Club

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[58] *See* Wertz, Joe, Oklahoma Oil Regulator Issues New Restrictions after Earthquake—Updated, KGOU.org (Aug. 24, 2016), available at http://kgou.org/post/oklahoma-oil-regulator-issues-new-restrictions-after-earthquakes-updated-0 (listing directives issued by OCC through August 2016).

[59] *See, e.g.*, Monies, Paul, Oklahoma Regulators Issue Expanded Disposal Well Directive for Earthquakes, The Oklahoman (Feb. 17, 2016), available at http://www.emergencymgmt.com/disaster/Oklahoma-regulators-issue-expanded-disposal-well-directive-for-earthquakes.html?flipboard=yes (noting "voluntary" directive requesting operators to reduce saltwater injections); Soraghan, Mike, SandRidge defies Okla. directive to close 6 wells, E&E News (Dec. 21, 2015), available at http://www.eenews.net/stories/1060029814 ("The OCC 'directives' are voluntary, but if a company refuses, OCC staff can take formal legal action against the company.").

[60] Halihan Interview 2016.

List of References

Bell, L.A. et al., Lesser prairie-chicken hen and brood use on sand shinnery oak, 63 Rangeland Ecol. Manage. 478 (2010)

Bidwell, T.G., and A. Peoples, Habitat management for Oklahoma's prairie chickens, Stillwater, OK: Oklahoma State Cooperative Extension Service, 4 pp (1991)

Bouzat, J.L., and K. Johnson, Genetic structure among closely spaced leks in a peripheral population of lesser prairie-chickens, 13 Molecular Ecol. 499 (2004)

Center for Biological Diversity, Letter and exhibits from Wendy Park, CBD Senior Attorney to Sally Jewell, Secretary of the Department of the Interior re: Man-made earthquake risks connected to April 20, 2016 Oil and Gas Lease Auction (May 9, 2016)

Collins, S.L. et al., Succession and fluctuation in Artemesia dominated grassland, 73 Vegetation 89 (1987)

Copelin, F.F., The lesser prairie chicken in Oklahoma, Oklahoma Wildlife Conservation Dept. Tech. Bull. No. 6, 58 pp. (1968)

Copelin, F.F.,Notes regarding the history and current status of the lesser prairie chicken in Oklahoma, 37 Proc. Okla. Acad. Sci. 158 (1959)

Corman, K. S., Conservation and landscape genetics of Texas Lesser Prairie-Chicken: population structure and differentiation, genetic variability, and effective size. M.S. thesis, Texas A&M University-Kingsville, Kingsville, TX (2011)

Dahlgren, D. K. et al., Grasslands of Western Kansas, North of the Arkansas River, 48 Stud. Avian Biol. 263 (2016)

Dusang, D., Impacts of energy development on the lesser prairie-chicken ecology and management, M.S. Thesis, Univ. of Oklahoma, 71 pp (2011)

Engle, D.M., and J.D. Kulbeth, Growth dynamics of crowns of eastern red-cedar at 3 locations in Oklahoma, 45 J. Range Manage. 301 (1992)

Fieldstadt, Elisha & AP, State of Emergency Declared in Oklahoma After Magnitude 5.6 Earthquake, NBC News (Sep 4, 2016), http://www.nbcnews.com/news/us-news/state-emergency-declared-oklahoma-after-magnitude-5-6-earthquake-n642676.

Fox, Keaton, Oklahoma's record-tying quake was predicted, more expected, Fox25 (Sept. 5, 2016),http://okcfox.com/news/local/oklahomas-record-tying-quake-was-predicted-more-expected

Garton, E.O. et al., Population dynamics of the lesser prairie-chicken, 48 Studies in Avian Biol. 61 (2016)

Hagen, C. A. et al., Impacts of anthropogenic features on habitat use by Lesser PrairieChickens. Pp. 63–75 in B. K. Sandercock, K. Martin, and G. Segelbacher (editors). Ecology, conservation, and management of grouse. Studies in Avian Biology (no. 39), University of California Press, Berkeley, CA (2011)

Hagen, C.A. et al., Regional variation in mtDNA of the lesser prairiechicken, 112 Condor 29 (2010)

Hagen, C.A., A demographic analysis of lesser prairie-chicken populations in southwestern Kansas: Survival, population viability, and habitat use, PhD Dissertation, Kansas State Univ., 2003: 185 (2003)

Hagen, C.A., Impacts of Energy Development on Prairie Grouse Ecology: A Research Synthesis, 75 Trans. N. Am. Wildl. Conf. 33 (2010)

Hovick, T.J. et al., Evidence of negative effects of anthropogenic structures on wildlife: A review of grouse survival and behaviour, 51 J. Appl. Ecol. 1680 (2014)

Jackson, A.S., and R. DeArment, The lesser prairie chicken in the Texas panhandle, 27 J. Wildl. Manage. 733 (1963)

Jarnevich, C.S., and M.K. Laubhan, Balancing energy development and conservation: A method utilizing species distribution models, 47 Envtl. Manage. 930 (2011)

Jones, Corey, Record quake renews concerns of even stronger tremblors in Oklahoma, Tulsa World (Sept. 4, 2016)

Keranen, Katie et al., Potentially Induced Earthquakes in Oklahoma, USA: Links Between Wastewater Injection and the 2011 Mw5.7 Earthquake Sequence, Geology online publication, doi:10.1130/G34045.1 (March 26, 2013)

Lautenbach, J.M., Lesser prairie-chicken reproductive success, habitat selection, and response to trees. M.S. Thesis, Kansas State Univ., 142 pp.(2015)

Lee, Mike, Oklahoma Quake Was a Record-Setter, and Anger is Still High, E&E Energy Wire (September 8, 2016)

McNamara, D.E., et al., Earthquake Hypocenters and Focal Mechanisms in Central Oklahoma Reveal a Complex System of Reactive Subsurface Strike-Slip Faulting, faulting, 42 Geophys. Res. Lett.2742–2749, doi:10.1002/2014GL062730 (2015)

Melcher, C.P., Lesser prairie-chicken. Pp. 163-174 in Southern Great Plans rapid ecoregional assessment – Pre-assessment report. USGS Open File Report 2015-1003, 284 pp. (2015) http://dx.doi.org/10.3133/ofr20151003.

Monies, Paul, Oklahoma Regulators Issue Expanded Disposal Well Directive for Earthquakes, The Oklahoman (Feb. 17, 2016)

Oklahoma Geological Survey, Summary Statement on Oklahoma Seismicity (April 21, 2015)

Oklahoma Geological Survey, webpage: Earthquakes in Oklahoma What We Know, http://earthquakes.ok.gov/what-we-know/ (Accessed September 26, 2016).

Olawski, C.D., Effects of shinnery oak control with tebuthiuron on lesser prairiechicken populations. M.S. Thesis, Texas Tech. Univ., 83 pp. (1987)

Oyler-McCance, S.J. et al., Rangewide genetic analysis of lesser prairie-chicken reveals population structure, range expansion, and possible introgression, Conserv. Genet. DOI 10.1007/s10592-016-0812-y (2016)

Patten, M.A. et al., Effects of microhabitat and microclimate selection on adult survivorship of the lesser prairie-chicken, 69 J. Wildl. Manage.1270 (2005a)

Patten, M.A. et al., Habitat fragmentation, rapid evolution and population persistence, 7 Evol. Ecol. Res. 235 (2005b)

Pitman, J.C. et al., Location and success of lesser prairie-chicken nests in relation to vegetation and human disturbance, 69 J. Wildl. Manage. 1259 (2005)

Plumb, R.T., Lesser prairie-chicken movement, space use, survival, and response to anthropogenic structures in Kansas and Colorado. M.S. Thesis, Kansas State Univ., 116 pp (2015)

Pruett, C. L. et al., Low effective population size constraints rapid demographic evolution in a grassland grouse, 12 Conservation Genetics 1205 (2011)

Robel, R. J. et al., Effect of energy development and human activity on the use of sand sagebrush habitat by Lesser PrairieChickens in southwestern Kansas, 69 Trans. N. Am. Wildl. Nat. Res. Conf. 251 (2004)

Robinson, S., Landscape ecology, survival and space use of lesser prairie-chickens, M.S. Thesis, Kansas State Univ., 123 pp. (2015)

Samson, F. B. et al., Great Plains ecosystems: past, present, and future, 32 Wildlife Society Bulletin 6 (2004)

Sexson M. L., Destruction of sandsage prairie in southwest Kansas, 7 Proc. N. A. Prairie Conf. 113 (1980)

Soraghan, Mike, EPA orders shutdown of disposal wells after Okla. quake, E&E News (Sept. 7, 2016), http://www.eenews.net/energywire/2016/09/07/stories/1060042410

Soraghan, Mike, Fewer Disposal Wells to Close in Oklahoma From Quake. E&E Energy Wire. (September 13, 2016) http://www.eenews.net/energywire/stories/1060042721/search?keyword=pawnee

Soraghan, Mike, SandRidge defies Okla. directive to close 6 wells, E&E News (Dec. 21, 2015) http://www.eenews.net/stories/1060029814

Timmer, J.M., Relationship of lesser prairie-chicken density to landscape characteristics in Texas. MS Thesis, Texas Tech Univ., 131 pp (2012)

Toole, B.E., Survival, seasonal movements, and cover use by lesser prairie chickens in the Texas panhandle. M.S. Thesis, Texas A&M Univ., 39 pp (2005)

U.S. Geologic Survey, 2016 One-Year Seismic Hazard Forecast for the Central and Eastern United States from Induced and Natural Earthquakes, Open-File Report 2016–1035 (2016)

Ungerer, J., and C.A. Hagen, Status of lesser prairie-chickens: A review of threats and conservation actions, Unpbl. PowerPoint presentation, USDA NRCS (2012)

Van den Bussche, R.A. et al., Genetic variation within and among fragmented populations of lesser prairiechickens (Tympanuchus pallidicinctus, 681 Molecular Ecol. 12 (2003)

Van Pelt, W.E., et al., The Lesser Prairie-Chicken Range-wide Conservation Plan, Western Association of Fish and Wildlife Agencies (2013)

Wertz, Joe, Oklahoma Oil Regulator Issues New Restrictions after Earthquake—Updated, KGOU.org (Aug. 24, 2016), http://kgou.org/post/oklahoma-oil-regulator-issues-new-restrictions-after-earthquakes-updated-0

Wines, Michael, Earthquakes in Oklahoma Raise Fears of a Big One, New York Times (Jan. 7, 2016)

Wines, Michael, Geologist Sees Clues, and Further Dangers, in Puzzle of Oklahoma's Earthquake, New York Times (Sept. 6, 2016)

Wines, Michael, Oklahoma Puts Limits on Oil and Gas Wells to Fight Quakes, New York Times (Mar 7, 2016)

Wolfe, D.H. et al., Causes and patterns of mortality in lesser prairie-chickens Tympanuchus pallidicinctus and implications for management, 13 Wildl. Biol. 95 (2007)

Wolfe, D.H. et al., The lesser prairie-chicken in the Mixed-Grass Prairie Ecoregion of Oklahoma, Kansas, and Texas, 48 Stud. Avian Biol. 299 (2016)