



RESEARCH ARTICLE

The Texas Conservation Plan has not slowed oil and gas well development in dunes sagebrush lizard habitat [version 1; referees: 1 approved with reservations, 1 not approved]

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Abstract

Background: The dunes sagebrush lizard (*Sceloporus arenicolus*) is an imperiled species that is restricted to shinnery oak (*Quercus havardii*) sand dune habitats in southeastern New Mexico and West Texas, USA. This region is also a hotspot of oil and gas development that is a major threat to the species.

Methods: Here we use well data and a natural experiment to test the effectiveness of voluntary conservation agreements for slowing or stopping oil and gas well approval in the lizard’s habitat in New Mexico and Texas.

Results: We show that the Candidate Conservation Agreement (CCA) and CCA with Assurances in New Mexico, both of which contain strong avoidance mechanisms, are associated with a steep decline in oil and gas well approval in the New Mexico portion of the lizard’s range, but not outside the lizard’s range. By contrast, the Texas Conservation Plan (TCP), which does not include mandatory avoidance, is not associated with any decline of oil and gas well approval in the lizard’s Texas range relative to the broader landscape.




Conclusions: These results indicate that the TCP is insufficient to conserve the lizard in Texas, thereby jeopardizing genetic and geographic representation across the range of the species.

Keywords

Endangered Species Act, dunes sagebrush lizard, *Sceloporus arenicolus*, oil and gas development, voluntary conservation, Candidate Conservation Agreement

Open Peer Review

Referee Status:  

	Invited Referees	
	1	2
version 1 published 21 Jun 2018	 report	 report
1 Howard L. Snell  , University of New Mexico, USA		
2 Philip N. Smith , Texas Tech University, USA		

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Author roles: **Malcom J:** Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Project Administration, Resources, Software, Supervision, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Moskwik M:** Conceptualization, Data Curation, Formal Analysis, Methodology, Resources, Software, Validation, Writing – Original Draft Preparation, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

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Introduction

The dunes sagebrush lizard (DSL; *Sceloporus arenicolus*) is an imperiled species whose distribution is restricted to shinners oak (*Quercus havardii*) sand dunes in the Mescalero Sandhills of eastern New Mexico and the Monahans Sandhills of West Texas, USA (Degenhardt *et al.*, 1996; Fitzgerald & Painter, 2009). This area is within the Permian Basin, which is the focus of extensive and intensive oil, gas, and infrastructure development that degrades or destroys the species' habitat (Sias & Snell, 1998; U.S. Fish and Wildlife Service, 2010). The species' perilous conservation status has been recognized since at least 1982, when the U.S. Fish and Wildlife Service (FWS) first established *S. arenicolus* as a candidate for listing under the U.S. Endangered Species Act (ESA) (U.S. Fish and Wildlife Service, 2010). After episodes in and out of candidate status, the FWS proposed to list the species as endangered in 2010 (U.S. Fish and Wildlife Service, 2010). That proposal was withdrawn in 2012, in large part because of voluntary conservation agreements in New Mexico and Texas that the FWS believed offered adequate protections for the species (U.S. Fish and Wildlife Service, 2012).

The agreements for New Mexico and Texas are structured very differently, but both are based on the voluntary conservation component of section 10(a)(1)(A) of the ESA. For non-listed species, these include Candidate Conservation Agreements (CCAs) and CCAs with Assurances (CCAAs; for brevity, we refer to both agreements as the "CCA/As"). CCAs are agreements between FWS and one or more public or private parties that stipulate the actions enrollees will take or will avoid to conserve a species, which may preclude the need for listing under the ESA. CCAAs are similar to CCAs, but apply only to non-federal parties and include assurances that enrollees will not face ESA restrictions beyond those described in the CCAA if the covered species is listed in the future. (Federal agencies are not eligible for CCAAs because they cannot be exempted from the duty to avoid jeopardizing listed species under section 7(a)(2).) Parties in New Mexico drafted a CCA (for federal entities) and complementary CCAA (for non-federal entities) to protect lesser prairie-chicken (*Tympanuchus pallidicinctus*) and *S. arenicolus* habitat in December, 2008. These CCA/As include strong requirements to avoid the lizard's shinners oak sand dune habitats (U.S. Fish and Wildlife Service *et al.*, 2008; U.S. Fish and Wildlife Service and the Center for Excellence in Hazardous Materials Management, 2008), which reflect the practices of the Bureau of Land Management in their Range Management Plan for the species (BLM, 2008). However, the CCA/As also direct oil and gas wells into interstitial habitats (between the large sand dune blowouts that the species uses) that provide connectivity among core dunes habitats.

In contrast to the New Mexico CCA/As, the Texas Conservation Plan (TCP) for the DSL—which is a CCAA with a tailored name—does not include avoidance requirements (Texas Comptroller of Public Accounts, 2011). Instead, the TCP offers only guidance to *attempt* to avoid habitat; there is no requirement for enrollees to avoid developing oil and gas wells in lizard habitat. Even though the same legal instrument

underlies the agreement of each states—section 10(a)(1)(B) of the ESA—the differences in the details means we expect different conservation outcomes for *S. arenicolus*.

The objective of this study was to test whether voluntary conservation agreements for the DSL in New Mexico and Texas may have been effective at reducing oil and gas development in the species' habitat. We hypothesized that the New Mexico CCA/As have produced a noticeable reduction of new oil and gas wells approval in DSL habitat, but that the TCP did not produce such a reduction. Our predictions were:

1. The rate of new well approval through time is approximately the same inside and outside of DSL habitat *before* the CCA/As (2009) (in New Mexico) and *before* the TCP (2012) (in Texas);
2. The rate of new well approval in New Mexico is lower inside of DSL habitat than outside of DSL habitat *after* the CCA/As were adopted; and
3. The rate of new well approval in Texas is not different inside and outside of DSL habitat *after* the TCP was adopted.

Methods

Data identification

We downloaded all oil and gas well data for New Mexico from the state's Oil Conservation Division site on 03 April 2018. The Texas Railroad Commission makes its oil and gas well data available through a separate provider, <http://www.texas-drilling.com/>, from which we downloaded the data on 03 April 2018. We filtered out well approvals that were marked as canceled in the datasets from both states. We defined the range of *S. arenicolus* in New Mexico as the boundaries recognized in 2008, at the time the CCA/As were developed and adopted. We defined the species' range in Texas as the boundaries of the "Hibbitts Map" of suitable habitat (from low to very high quality; Fitzgerald *et al.*, 2011). In New Mexico, the area outside of the species range included oil and gas well data from the Permian basin excluding the 2008 range boundaries. In Texas, the area outside included the five counties (i.e., Andrews, Crane, Ector, Ward, and Winkler) that encompass the species' range, excluding the "Hibbitts Map."

Data analysis

To test our hypotheses and determine the rate of oil and gas well expansion, we counted the number of wells approved each year since 1990 inside and outside of *S. arenicolus* habitat. Because this scenario is an intervention experiment with a before-after-control-impact design, we fit log-link Poisson generalized linear models (McCullagh & Nelder, 1999), with terms for time period and in/out of habitat, for statistical inference. We fit separate linear models, of the form $\text{number_wells} \sim \text{year} + \text{in_CCAA_area}$, for New Mexico and Texas data to plot the trends in/out of habitat and before/after the agreements were approved. All code and the data needed to replicate our results is available in the Open Science Foundation repository at <https://doi.org/10.17605/OSF.IO/HKVSU> (Malcom, 2018).

Results

The well data supported our predictions. We observed that the rate of new well approval was much lower within the DSL habitat than outside of the DSL habitat after the adoption of the CCA/As in New Mexico (Figure 1); however, the rate of new well approvals was no different inside versus outside of DSL habitat after the adoption of the TCP in Texas (Figure 2). The trends visible in the plots are supported by the generalized linear model statistics (Table 1).

Discussion

Conserving the DSL requires protecting its remaining habitat in both New Mexico and Texas: if the species is lost from either state then representation (Shaffer & Stein, 2000)—both in terms of unique genetic contributions (Chan et al., 2009; Chan et al., 2013) and geographical distribution—will be lost. Our analyses indicate that the CCA/As in New Mexico have significantly reduced oil and gas development, one of the most notable direct threats to the DSL and its habitat. In contrast to New Mexico, the data show that the TCP has had no effect on the rate of new well approval inside DSL

habitat in Texas. This research highlights how the details of voluntary conservation agreements, even those authorized under the exact same provision of law, can lead to markedly different outcomes.

The decline in the number of new oil and gas wells approved each year in New Mexico after the CCA/As were adopted reflect the avoidance requirements in those agreements. The number of new wells approved in the DSL's range in New Mexico is not zero since the CCA/As were enacted because the agreements allow well siting in interstitial habitat. While this reduces the direct effects of development, it likely harms connectivity (U.S. Fish and Wildlife Service, 2008) and may have secondary effects on landscape characteristics that influence DSL life history (Ryberg et al., 2015).

Because the TCP does not require avoidance of DSL habitat loss, i.e., there is no mechanism protecting the habitat, we expected to *not* see any effect of the TCP. The data supported our prediction, and even hint that the rate outside DSL habitat decreased faster than inside. Had the State of Texas

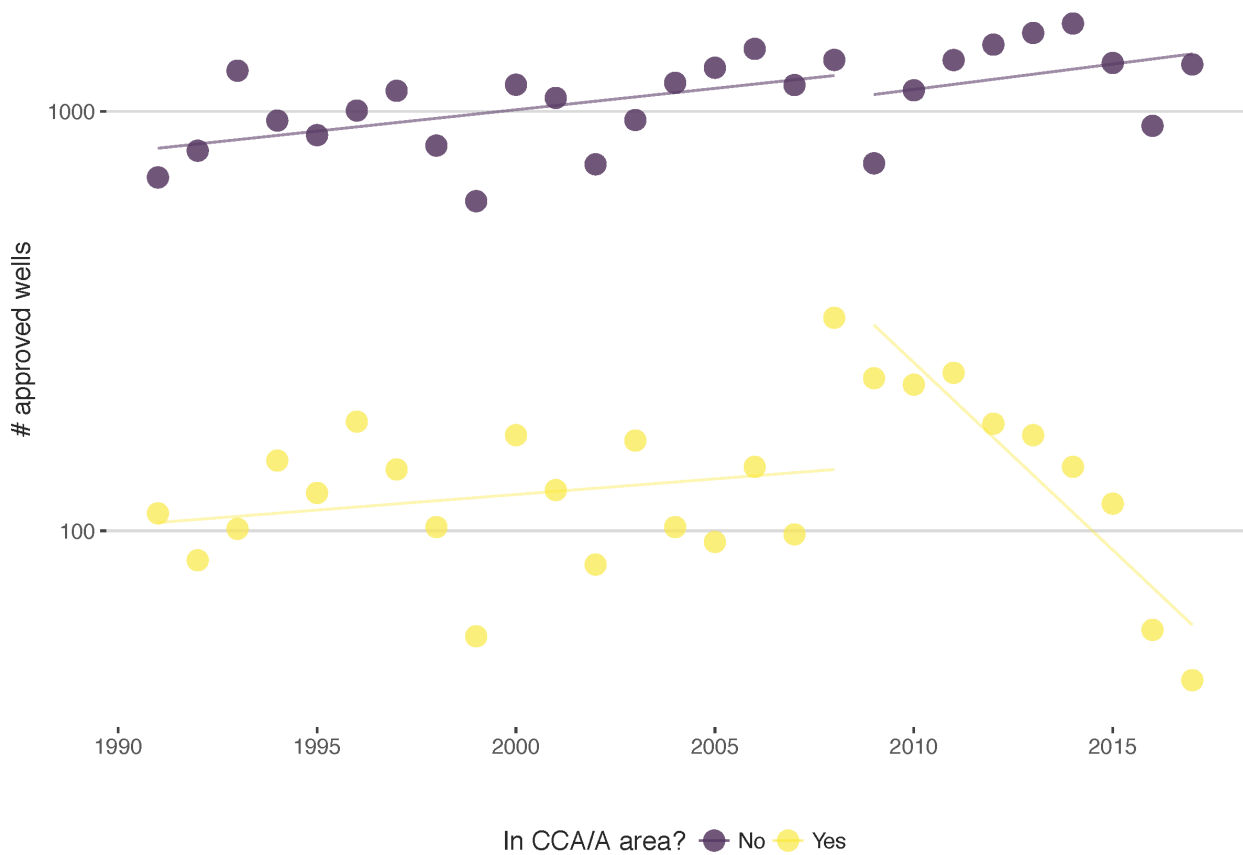


Figure 1. The New Mexico Candidate Conservation Agreement (CCA) and CCA with Assurances (together, CCA/As), which have strong avoidance requirements, result in a rapid decline of new well approvals in dunes sagebrush lizard habitat after their adoption in 2008. The plot shows the number of wells approved by the State of New Mexico per year (dots), inside and outside of the lizard's habitat (yellow and purple, respectively). Fitted lines are from a simple least-squares model of the form $\text{number_wells} \sim \text{year} + \text{in_CCAA_area}$, split by pre- and post-CCA/A. Figure CC-BY Defenders of Wildlife 2018, available at <https://doi.org/10.6084/m9.figshare.6226721> (Malcom & Moskwik, 2018).

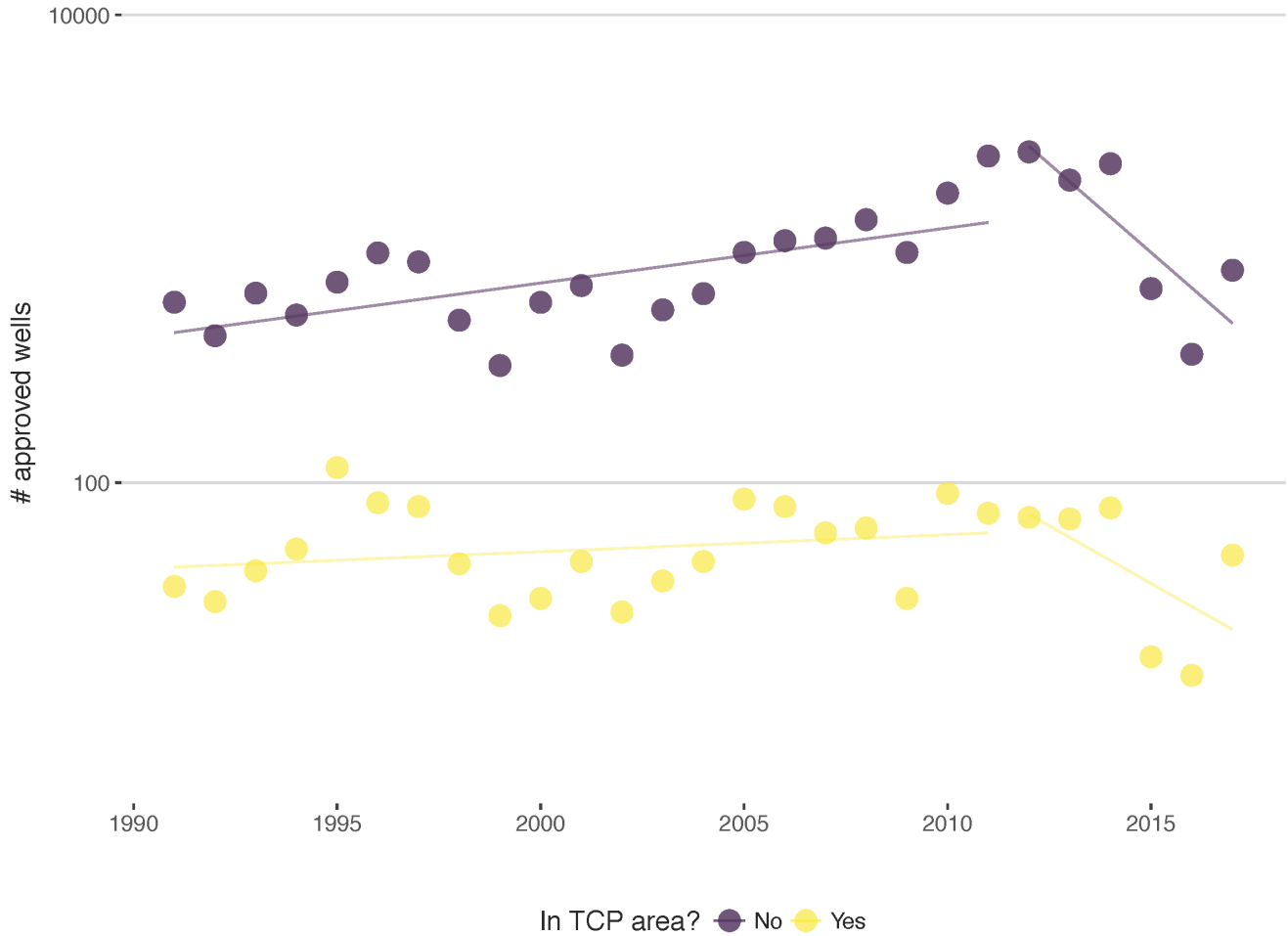


Figure 2. The Texas Conservation Plan (TCP), which lacks strong avoidance requirements, has no apparent effect on new well approvals in dunes sagebrush lizard habitat versus outside of habitat after the TCP was adopted in 2012. The plot shows the number of wells approved by the Texas Railroad Commission per year (dots), inside and outside of the lizard's habitat (yellow and purple, respectively). Fitted lines are from a simple least-squares model of the form $\text{number_wells} \sim \text{year} + \text{in_TCP_area}$, split by pre- and post-TCP. CC-BY Defenders of Wildlife 2018, available at <https://doi.org/10.6084/m9.figshare.6226964.v2> (Malcom & Moskwik, 2018).

Table 1. Parameter estimates for trends in oil and gas well approvals in and outside of *Sceloporus arenicolus* habitat, pre- and post-agreement in New Mexico (2009) and Texas (2012).

State	Time	Parameter	Estimate	se	z	p-value
New Mexico	Pre-agreement	Year	0.024	0.0014	16.5	$<2 \times 10^{-16}$
		Year:in-habitat	0.003	0.0043	0.69	0.487
	Post-agreement	Year	0.023	0.0036	6.22	4.85×10^{-10}
		Year:in-habitat	-0.192	0.0115	-16.7	$<2 \times 10^{-16}$
Texas	Pre-agreement	Year	0.067	0.0013	51.9	$<2 \times 10^{-16}$
		Year:in-habitat	-0.053	0.0050	-10.6	$<2 \times 10^{-16}$
	Post-agreement	Year	-0.322	0.0069	-46.8	$<2 \times 10^{-16}$
		Year:in-habitat	0.127	0.0356	3.56	3.74×10^{-4}

se, standard error.

incorporated strong avoidance requirements of the New Mexico CCA/As into the TCP, then our analysis may have shown that voluntary conservation efforts were sufficient to protect the DSL.

Data availability

In addition to obtaining the data as described in the manuscript, the raw oil and gas well data associated with this article can also be found on OSF: <https://osf.io/hkvsu/> (Malcom, 2018).

Software availability

Software available from: https://github.com/jacob-ogre/DSL_well_approvals.

Archived software at time of publication: <https://osf.io/hkvsu/> (Malcom, 2018).

License: BSD 2-Clause “Simplified” License.

Competing interests

No competing interests were disclosed.

Grant information

The author(s) declared that no grants were involved in supporting this work.

Acknowledgements

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[Publisher Full Text](#)

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[Reference Source](#)

Open Peer Review

Current Referee Status: ? X

Version 1

Referee Report 21 January 2019

<https://doi.org/10.5256/f1000research.16721.r40292>



Philip N. Smith

Department of Environmental Toxicology, Texas Tech University, Lubbock, TX, USA

Introduction

The sentence beginning “After episodes in and out of candidate status,...” is nebulous and uninformative. What are the episodes that are alluded to? In order to provide necessary context, it would appear that those episodes should be described to some extent.

Pertaining to the section describing the Texas CCA/As: a search of the referenced TCP document reveals no specific wording as it is characterized here. No specific language related to “*attempt* to avoid habitat” is included in the referenced document. Why is the word “*attempt*” emphasized in italics? It is not verbatim from the reference. Clearly, there are differences in the NM and TX plans, but this passage characterizes the Texas document as intentionally or tacitly promoting disruptive oil and gas development. Another interpretation of the TCP would be that it allowed greater flexibility to enrollees as to conservation strategies. This section should be revised to more objectively and thoroughly present the differences between the TCP and NM CCA.

Why isn't the objective of the paper to evaluate actual protection of the DSL? That would seem to be a much more direct and appropriate test of the process and allow for comparison of each state's effectiveness in carrying out the process.

As written, outcomes of the predictions (results) appear to be solely affected by the CCA/As; as if no other factors drive oil and gas development approvals. Myriad other factors influence these outcomes, but none are listed here (and should be). This paper lacks acknowledgement and review of mitigating/confounding factors.

Methods

Data Identification

Selection of DSL range and thus lands to be included in these analyses is critical. Justification for the selection procedure, or land masses included in analyses are not well documented in this manuscript. As for the Texas DSL range, the Hibbitts map is somewhat controversial and perhaps not well suited (in its entirety) for these analyses. Habitat designated as “low quality” likely does not and may have never supported viable populations of DSLs. Inclusion of those areas in these analyses is questionable and potentially confounding. What is the reference for the NM DSL range? It is difficult to determine if the authors are comparing apples and apples, or apples and oranges. Detailed maps and much stronger justification for inclusion of land in these analyses would be most helpful.

Data Analysis

This seems like an overly complicated way to evaluate some very simple questions. Why not simply use *Chi-square* analysis to determine application approval rate differences inside and out, before and after? For that matter, is the focus on approval rates or simply the numbers of new wells? The introduction speaks of approval rates, not numbers of new wells. Data presented only depict new wells, not applications that were approved or rejected.

Results

The authors switch back and forth between new well approvals and numbers of new wells. They are not the same. What about wells that were not approved? The figures indicate a reduction in number of wells in NM after implementation of the CCA, and no decrease in areas deemed “outside DSL range”. Clearly the delineation of inside versus outside seriously influences these models. The figure depicting new wells in Texas DLS habitat also show reductions in well development both inside and outside DSL ranges. Why is that? The slopes of these lines are not presented for evaluation. Also, the table of statistics is vague and confusing. What is the term “Year:in-habitat”? Is that an interaction term? Unclear as presented.

With regard to the figure legends: there is insufficient documentation of the “strong avoidance requirements” in the NM plan as well as no substantiation of the “lacks strong avoidance requirements” claims about the TCP. As such, this manuscript appears, to some degree, to lack objectivity.

Discussion

These results indicate that (at best) oil and gas development has slowed in some areas in both states since about 2008. There is no definitive proof that the CCA/As were the cause. This is perhaps simply due to coincidence. These results could also demonstrate how comparing apples to oranges can lead one to whatever conclusion an author wishes to demonstrate. The objectivity and methods of this research are questionable.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

No

Are sufficient details of methods and analysis provided to allow replication by others?

No

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions drawn adequately supported by the results?

No

Competing Interests: No competing interests were disclosed.

Referee Expertise: Ecological risk assessment, toxicology, wildlife

I have read this submission. I believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Referee Report 02 July 2018

<https://doi.org/10.5256/f1000research.16721.r35353>



Howard L. Snell 

Department of Biology , Museum of Southwestern Biology, University of New Mexico, Albuquerque, NM, USA

Article provides a potential analysis of the efficacy of various types of agreements among parties to protect species that could have been listed as endangered by the US Fish & Wildlife Service. A comparison between the pattern of permits issued by New Mexico or Texas within and outside habitat of the Dunes Sagebrush Lizard before and after the agreements were finalized appears to suggest that New Mexico's agreements have a greater effect than those of Texas. That conclusion may be supported, but additional analyses could clarify the actual situation.

Basically, previous research has shown that the effects of oil and gas development on populations of the Dunes Sagebrush Lizard (DSL) vary with the density of wells and their associated infrastructure. However, the current analyses compare total numbers permits for wells and not the densities that would result from those wells if constructed. This may lead to some confusion. Both states permit considerably fewer wells within DSL habitat than outside - both before and after the agreements were finalized. However, without knowing the relative amounts of habitat it is hard to interpret the pattern. Texas appears to permit fewer wells after the agreements - both within and outside DSL habitat, while New Mexico appears to increase permitting outside of DSL habitat after the permits and reduce permitting within. Adjusting the permitting data for area could clarify if differences between the states' patterns exist and, perhaps more importantly, are the apparent differences likely to impact populations of the lizard.

The use of explicit hypotheses and predictions is clear. However, it might appear directed to demonstrate less efficacy in Texas than in New Mexico due to the "one-tailed" nature of the directional predictions. Perhaps broadening the hypotheses and predictions into a "two-tailed" format could increase objectivity. Basically "The agreements of the two states differ. We tested whether or not those differences translate into lower or higher densities of wells in the future".

Finally, if the permit data were adjusted to densities, it should be densities of existing wells and future permitted wells. That could then be compared to the threshold densities proposed by Sias & Snell 1998¹.

References

1. Sias DS, Snell HL: The sand dune lizard *Sceloporus arenicolus* and oil and gas in southwestern New Mexico. Final report of field studies 1995-1997. *New Mexico Department of Game and Fish. Department of Biology, University of New Mexico, Albuquerque, New Mexico*. 1998.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: I and my colleagues performed early research that we and others felt demonstrated negative impacts of oil & gas development on populations of the Dunes Sagebrush Lizard. I wrote what I felt was a strong statement supporting the listing of the Dunes Sagebrush Lizard as endangered back when listing was being considered. I haven't seen anything in the years since that would cause me to alter that statement or my support for listing this species as endangered. I have no doubt that it is actually endangered of becoming extinct due to human activities and I have no doubt that oil & gas development are the most damaging human activities for the lizard currently occurring.

Referee Expertise: Conservation biology, herpetology, functional & evolutionary ecology.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

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