2013

BLM Burns District, Greater Sage-Grouse Fence Collision Analysis

Produced by The Nature Conservancy in partial fulfillment of BLM Cooperative Agreement No. L12AC20615, 2012.
8/26/2013

The Nature Conservancy
Protecting nature. Preserving life.

Contents

Burns BLM District, Greater Sage-Grouse Fence Collision Analysis

Executive Summary

Significant sage-grouse mortality may be caused by collision with livestock fences. Building on work done by Stevens et al. (2012), the Natural Resource Conservation Service and other partners, an analysis of fence collision risk in the Burns District has been completed by the Bureau of Land Management (BLM) Oregon and The Nature Conservancy of Oregon. In BLM's Burns District, our work estimates that there are approximately 52 miles of fence that present a high collision risk in close proximity to important sage-grouse leks. Fortunately, scientific evidence suggests that this risk can be mitigated by visibly marking fences. This report and associated data enables strategic investment of resources by BLM staff and can foster cooperation with other landowners and conservation partners to address the highest priority fences. Information presented in this report should be coupled with additional local knowledge (e.g. overall lek size, adjacent vegetation structure, population risk status, etc.) when determining the allocation of resources to alleviate sage-grouse fence collision risks.

Principle contacts:

Michael Schindel
Director of Conservation Information Systems
The Nature Conservancy
mschindel@tnc.org
(503) 802-8122

Jay Kerby
Southeast Oregon Project Manager
The Nature Conservancy
jkerby@tnc.org
(541) 573-8928

Introduction

In 2010, the US Fish and Wildlife Service (USFWS) ruled that sage-grouse (*Centrocercus urophasianus*) are "warranted but precluded" for protection under the Endangered Species Act. The Service will review this decision in 2015 (USFWS 2010). The primary causes of sage-grouse population decline are fragmentation and loss of sagebrush habitats (USFWS 2010). Factors that are contributing to this loss and fragmentation may include invasive species, wildfire, and anthropogenic development, among others (USFWS 2013). In the interim, state and federal agencies, non-governmental organizations, and private entities have invested significant resources to mitigate threats to sage-grouse. Investments have included on-the-ground conservation actions (e.g. the Natural Resource Conservation Service's Sage-Grouse Initiative), policy and planning efforts (e.g. the Bureau of Land Management's range-wide Resource Management Plan revisions, Oregon's SageCon and All Lands/All Threats plan), and targeted research to answer important management questions.

Wildlife collisions with anthropogenic structures are a global issue and the phenomenon is particularly acute for birds (Martin 2011). Mortality among grouse species due to collision with fences is well-documented in Europe (e.g. Baines and Summers 1997) and the North American prairie. In Oklahoma, 40 percent of Lesser prairie-chicken (*Tympanuchus pallidicinctus*) mortalities were attributed to fence collision (Wolfe et al. 2007). Recent research in Idaho has measured fence-collision at 0.64 sage-grouse strikes/mile (Stevens 2011). However, associated research from Idaho rangelands suggest that the threat posed by livestock fences may be diminished up to 83% after making fences in high-risk areas visible to flying sage-grouse (Stevens et al. 2012a). The effectiveness of this practice is likely dependent on proximity to leks, local sage-grouse abundance and topography (Stevens et al. 2012a, Stevens et al. 2012b).

Because livestock fences are ubiquitous throughout much of the sage-grouse's range, the Natural Resource Conservation Service (NRCS) partnered, through the Conservation Effects Assessment Project, with scientists at the University of Montana and the University of Idaho to develop a predictive tool for estimating fence collision risk. The original outputs of this Fence Collision Risk Tool utilized active sage-grouse leks (as of 2007), and a terrain ruggedness index developed from 30 meter digital elevation models (DEM, Riley et al. 1999) to predict high collision risk areas (Stevens et al. *in press*). The Fence Collision Risk Tool and an associated user's guide (Naugle et al. 2012) were released in 2012.

In fall of 2012, the Oregon state office of the Bureau of Land Management (BLM) and The Nature Conservancy (TNC) of Oregon completed a 5-year assistance agreement, to "*advance BLM strategic priorities in Eastern Oregon, including sage-grouse planning and conservation*" (Cooperative Agreement No. L12AC20615, 2012). The first objective of this cooperative agreement was to refine and update NRCS's Fence Collision Risk Tool for use in Oregon, using the Burns BLM District as a pilot study area. Specifically, BLM and TNC cooperatively completed the following tasks:

- Objective 1: Evaluate whether or not the Fence Collision Risk Tool would be improved by using a 10 meter, rather than 30 meter, Digital Elevation Model (DEM).
- Objective 2: Update the Fence Collision Risk Tool for application in Oregon, using the most up-to-date (2012) sage-grouse lek information from Oregon Department of Fish and Wildlife (ODFW, *personal communication*).
- Objective 3: Perform an intersection of BLM fence data with data from the Fence Collision Risk Tool, to identify potential fences for marking, relocation or removal, as feasible.
- Objective 4: Prioritize leks and associated fences to allow land managers to mitigate the threats posed by highest risk fences near the most active leks.

This document reports the results and findings of the analyses listed above.

Objective 1: Evaluate whether or not the Fence Collision Risk Tool would be improved by using a 10 meter, rather than 30 meter, DEM

In the initial project planning, Burns BLM GIS staff expressed concern regarding the differences in terrain between Idaho, where the collision risk model was parameterized, and the subtle topography of the Burns District. It was suggested that a possible solution might be to run the model with 10m DEM data, which might improve the delineation of small terrain features over the 30m data. Therefore, the BLM requested that TNC investigate the feasibility of running the model with 10 meter Digital Elevation Model (DEM) data.

There are two possible ways the 10m DEM could be used; the modeling steps could be performed on the raw 10m data, or the 10m DEMs could be resampled to 30m to use as inputs for the subsequent modeling steps. Both methods were investigated in support of this project. More details on these comparisons can be found in **Appendix 1: Details of 10m vs. 30m DEM**.

TNC downloaded the most current 10 meter DEM data from the National Elevation Dataset, served from the National Map viewer (http://viewer.nationalmap.gov/viewer/). These data were tiled for the entire Burns District.

Our first test used 10m DEMs as inputs to the risk model. The collision risk model requires a roughness index, calculated from the user supplied DEM, as an input. Compared to outputs using the 30m DEMs, the risk estimates from the 10m DEMs were inflated. This was confounding, as we expected the estimated risk to decrease with the improved resolution of fine terrain features. Further investigation revealed that the both the underlying roughness measure and the model coefficients Stevens calculated for the collision risk model were both scaled to 30m data. It is likely that these coefficients do not scale properly with the 10m DEM.

Our second test compared results from the native 30m DEM to a 10m DEM resampled to 30 meters. Generally, the collision risk outputs from these two DEMs were quite similar. This result was in line with our expectations, as both the 10m and 30m DEMs for SE Oregon are derived from the same source material using the same process. However, the similarity of the two outputs, particularly in low-relief landscapes where most leks occur, suggests that credible outputs can be generated from either source. Interestingly, our research did confirm that the USGS does resample the 10m to derive their 30m product. The differences between the 30m DEM we derived from 10m DEMs and the native USGS 30m DEM, are due to different interpolation methods, not differences in the source data.

The model produces a continuous range of values, from just over 0.0 to a maximum near 3.0. These continuous values were broken into three risk categories by the NRCS – *Low Risk* (0.0 – 0.49), *Moderate Risk* (0.5 – 0.99), and *High Risk* (≥1.0). However, neither the forthcoming Wildlife Society Bulletin manuscript (Stevens et al. *in press*) describing the development of the risk model, nor the guidance document, *Applying Fence Collision Risk Model to Local Data* (Naugle et al. 2012), specify values for these break points. This suggests these values are somewhat fungible. As the range of collision risk values within Oregon was smaller than the range-wide model produced by NRCS, we adjusted our breakpoints downward so the proportions of the high, medium and low risk categories within the leks better matched those of the NRCS model. Our final breakpoints were: *Low Risk* (0.0 – 0.33), *Moderate Risk* (0.34 – 0.66), and *High Risk* (≥.67). Looking at the subset of high priority leks, these breakpoints resulted in 12% of the lek area in the high risk category (vs. 11% in the NRCS model), 23% in the moderate category (vs. 20% in the NRCS model), and 66% in the low risk category (vs. 68% in the NRCS model).

Conclusions

Objective completed. The similarity of outputs generated from the native 30 m DEM and the 30m DEM derived from resampling 10m data (particularly in low-relief landscapes where most leks occur) suggests that credible outputs can be generated from either source. However, since the USGS also produces their 30m DEM from the 10m DEM, we recommend using the NED 30m DEM for these analyses. However, we used the 30m DEMs created from resampling the 10m NED for the Burns BLM District analysis per their express request.

Objective 2: Update the Fence Collision Risk Tool for application in Oregon, using the most up-to-date (2012) lek information from Oregon Department of Fish and Wildlife

In creating these data we generally followed the methodology as outlined in the NRCS document "Applying the Sage-Grouse Fence Collision Risk Tool to Reduce Bird Strikes" (Naugle et al. 2012). The following is a description of the processing steps involved.

We obtained 2012 lek data from BLM (with ODFW permission) and used these data to complete a revised layer of fence collision risk. These data had been substantially updated since the 2007 version used in the NRCS collision risk model. Those updates, both tabular and spatial, included:

- A datum shift, which portrayed a subset of SE Oregon leks 300 meters from their actual location, had been rectified.
- The lek "Status" attribute had been updated to reflect field surveys made between 2007 and 2012. The "Status" attribute was used to prioritize the leks per Objective 4.

The leks were prioritized into three groups; high, moderate, and low. This prioritization was created to facilitate efficiencies in fence management activities such as marking, moving or removing fences. Three lek group layers were created, one for each of the lek priority groups. The leks from each of three priority groups were buffered to 3 kms, and these buffers were used to clip the 30m DEM data (as described in Objective 1) for the subsequent geoprocessing steps.

We executed the Terrain Ruggedness Index aml (TRI.aml) within ArcInfo Workstation using the clipped 30m DEM. This aml calculates the difference in elevation between a central cell and its eight orthogonal neighbors. These differences are squared, summed and averaged. The final index value imputed to each cell is the square root of that average, which corresponds to the average elevation change between any point on a grid and its surrounding area. 0-80 m is considered to represent a level terrain surface, 81-116 m represents nearly level surface, 117-161 m a slightly rugged surface, 162-239 m an intermediately rugged surface, 240-497 m a moderately rugged, 498-958 m a highly rugged, 959-5000 m an extremely rugged surface.

The Euclidean distance tool was then used to measure the distance (in meters) from every pixel to the nearest lek. This output was then used in conjunction with the terrain ruggedness raster in the maximum-likelihood estimator (MLE) to estimate the total collision risk over a breeding season. The MLE of total collision risk over a lekking season (assuming a 78 day lekking season) = 78*exp(-3.3254377759 - 0.2504710567*TRI - 0.0006119843*distance). The result of this process was the collision risk raster. This method was executed independently for each of lek priority groups.

Conclusions

Objective completed.

Objective 3: Perform an intersection of BLM fence data with data from the Fence Collision Risk Tool, to identify potential fences for marking, relocation or removal, as feasible.

Fence data were obtained from the Burns District BLM GIS staff to ensure the most up-to-date fence information would be used. Using the risk model outputs from Objective 2, the fences were classified into their appropriate risk categories (e.g., Figure 1).

All fences were classified relative to each lek buffer they intersected. In some cases, multiple lek buffers overlapped. As a result, many fence segments were prioritized more than once. The ramifications of this are more fully explained under Objective 4.

Conclusions

Objective completed.

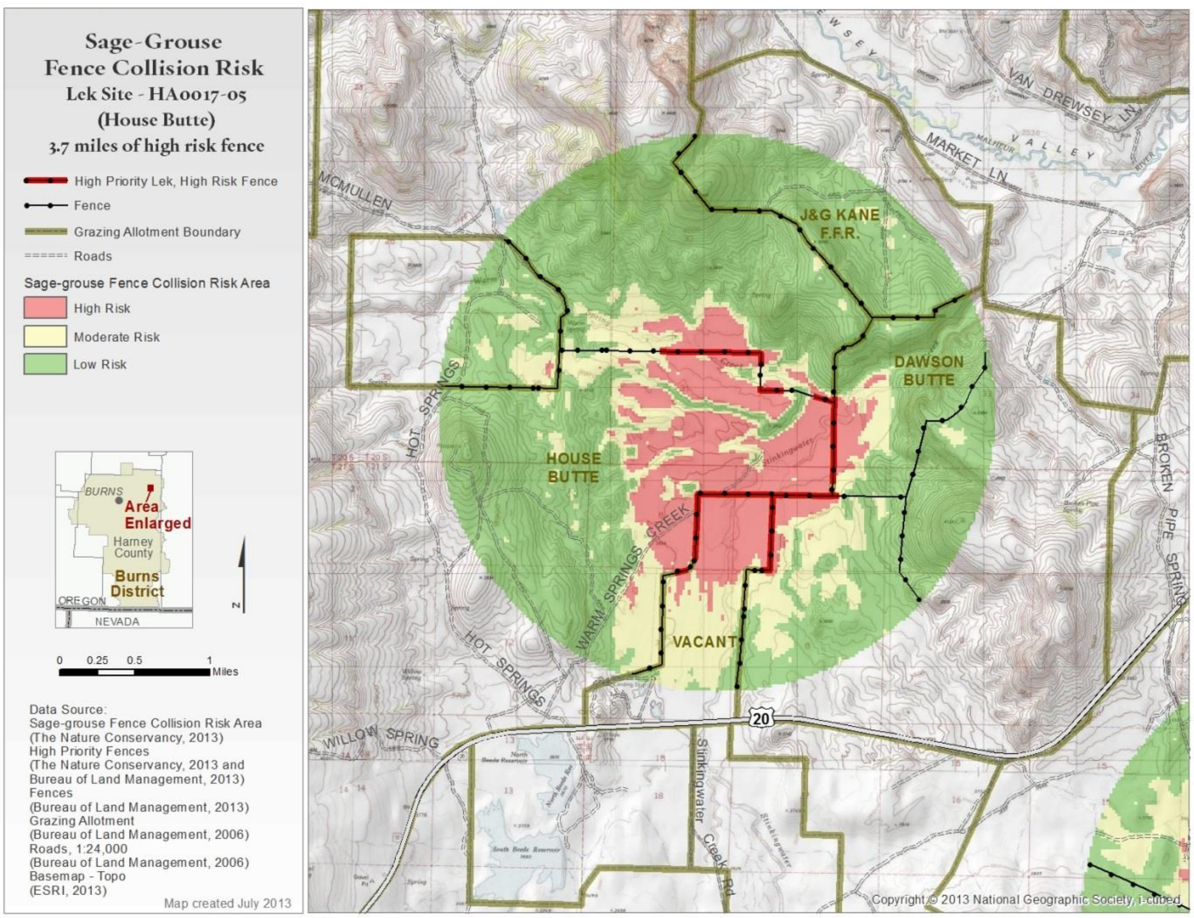


Figure 1: Fence risk attribution map for the House Butte lek. This map, as well as maps for nine other high priority leks with the greatest length of high risk fences, are included in Appendix 3.

Objective 4: Prioritize leks and associated fences to allow land managers to mitigate the threats posed by the most dangerous fences near the most active leks.

Lek data were broken into high, medium and low priority groups (Figure 2) by BLM and TNC staff[1]. Leks excluded from prioritization, and therefore not included in the collision risk model, included those with "Historic" and "Unknown" statuses. Once the fences had been categorized by collision risk, the lek prioritization was used to create an ordinal ranking of fence marking priority, from most to least urgent, across the Burns BLM District. Maps were then created for the top ten high priority leks with the greatest fence miles in the high and moderate collision risk classes. These maps are included in Appendix 3; "Maps of sage grouse fence collision risk".

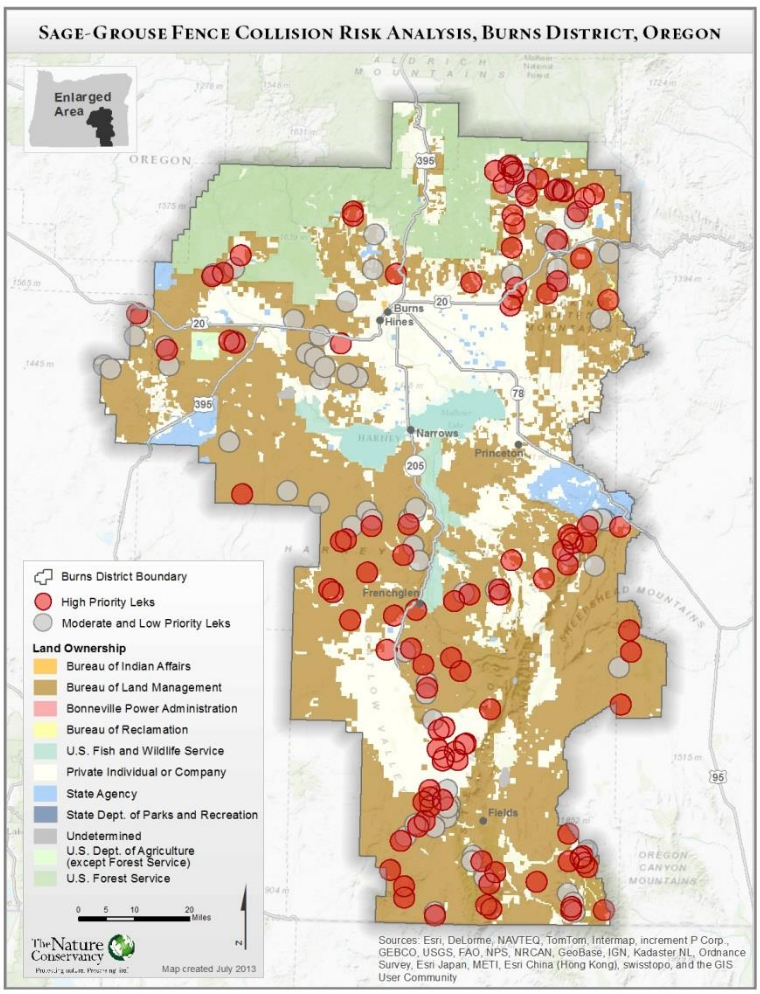


Figure 2: Sage-grouse leks in the Burns BLM District classified into high and moderate/low priorities.

[1] See Appendix 2: Lek prioritization criteria

As each lek was analyzed independently, and some overlaps occurred in the 3 km buffers applied to the leks, some fences were prioritized more than once. In total, 868 actual miles of fence are within the leks analyzed as part of this project (Table 1). The mileage totals in Table 1 do not include any overlaps; each fence was only counted as part of the highest class it occurred in. For example, a fence in the middle of a lek complex was identified as high risk for one lek and moderate risk for the adjacent lek. Assuming both leks are high priority leks, that fence would only be counted as part of the high collision risk group.

Table 1: Miles of fence in the Burns BLM District sorted by collision risk and lek priority.

Lek Group	***Collision Risk***	***Fence Miles***
High Priority	*High*	*51.8*
High Priority	*Low*	*457.4*
High Priority	*Moderate*	*103.0*
Moderate Priority	*High*	*3.5*
Moderate Priority	*Low*	*58.0*
Moderate Priority	*Moderate*	*10.6*
Low Priority	*High*	*21.9*
Low Priority	*Low*	*117.4*
Low Priority	*Moderate*	*43.9*

Conclusions

Objective completed. Based on the preceding steps, we recommend that Burns District BLM staff consider implementing measures to mitigate sage-grouse fence collision risk on the highest priority leks with the most high-risk fence miles.

Supplementary Recommendations

Further strategic refinement to reduce sage-grouse fence collisions

Through this analysis, we have identified 52 miles of high collision risk fence adjacent to high priority leks in the Burns BLM District. However, even this targeted subset of fences within the Burns BLM District will require considerable effort to address potential threats. We recommend that Burns BLM District consider the following criteria to further refine a strategic approach to addressing fence collision risk:

- Target fences near high population sage-grouse leks: research evidence suggests that the frequency of sage-grouse fence coincides with lek population (Stevens et al. *in press*)
- Consider targeting fences near leks with high levels of other infrastructure related risk factors.
- Consider surrounding vegetation. Expert review suggests that plant community attributes such as shrub height or presence of trees may alter sage-grouse flight trajectories and thus reduce likelihood of fence collision.
- Consider further prioritizing fences that are in close proximity to sage-grouse concentration factors such as water sources in addition to lekking grounds.
- Seek opportunities to highlight stakeholder collaboration to achieve sage-grouse conservation: building multi-partner working relationships is essential to sage-grouse conservation efforts.

Collaboration & Outreach

Successful mitigation of sage-grouse fence collision risk across Oregon landscapes will require coordinated efforts and resources from multiple sources and stakeholders, including landowners, other government agencies, and other non-governmental organizations. We recommend, at minimum, that TNC and BLM cooperatively engage the following strategic partners to share the results of this report:

- Allotment grazing permit holders
- ODFW Sage-grouse Coordinator & ODFW Local Implementation Teams
- Oregon Division of State Lands
- USFWS Partners for Fish & Wildlife Program and USFWS Refuge managers
- NRCS Sage-grouse Initiative staff
- Organizations with volunteerism capacity including, but not limited to, TNC, Boy/Girl Scouts of America, Audubon Society, and hunter/sportsmen associations.
- The SageCon Partnership

Acknowledgements
The authors of this report would like to recognize Matt Obradovich (BLM), Pam Keller (BLM), Stacy Fenton (BLM), Autumn Larkins (ODFW), Jeremy Maestas (NRCS), and Jeff Evans (TNC) for their contributions.

Citations

Arbia, G. 1989. Spatial data configuration in the statistical analysis of regional economic and related problems. Dordrecht: Kluwer Academic Publishers.

Baines D. and R. Summers. 1997. Assessment of bird collisions with deer fences in Scottish forests. Journal of Applied Ecology 34: 941-948.

Fotheringham, A. S. and D.W.S. Wong. 1991. The modifiable areal unit problem in multivariate statistical analysis. Environment and Planning A 23(7):1025-1044.

Fotheringham, A.S., C. Brunsdon and M. Charlton. 2000. Quantitative Geography: Perspectives on Spatial Data Analysis. Thousand Oaks: Sage Publications.

Gehlke, C. and H. Biehl. 1934. Certain effects of grouping upon the size of the correlation coefficient in census tract material. Journal of the American Statistical Association Supplement 29:169-170.

Gotway, C. and L. Young. 2002. Combining Incompatible Spatial Data. Journal of the American Statistical Association 97: 632-648.

Martin, G. 2011. Understanding bird collisions with man-made objects: a sensory ecology approach. Ibis 153:239-254.

Naugle, D., B. S. Stevens, and T. Griffiths. 2012. Applying the sage-grouse fence collision risk tool to reduce bird strikes. U.S. Department of Agriculture, Natural Resources Conservation Service Conservation Effects Assessment Project (CEAP) Conservation Insight.

Olea, R.A. 1991. Geostatistical Glossary and Multilingual Dictionary. New York: Oxford University Press.

Openshaw, S. 1984. The Modifiable Areal Unit Problem. Norwich: Geo Books.

Riley, S., S. DeGloria, and R. Elliot. 1999. A terrain ruggedness index that quantifies topographic heterogeneity. Intermountain Journal of Sciences 5:23–27.

Stevens, B. 2011. Impacts of fences on greater sage-grouse in Idaho: collision, mitigation and spatial ecology. Thesis, University of Idaho, Moscow.

Stevens, B., K. Reese, J. Connelly, and D. Musil. 2012a. Greater sage-grouse and fences: Does marking reduce collisions? Wildlife Society Bulletin 36:297-303.

Stevens, B., J. Connelly, and K. Reese. 2012b. Multi-scale assessment of greater sage-grouse fence collision as a function of site and broad scale factors. Journal of Wildlife Management 76:1370-1380.

Stevens, B. D. Naugle, B. Dennis, J. Connelly, T. Griffiths, and K. Reese. *In press*. Mapping sage-grouse fence-collision risk: spatially-explicit models for targeting conservation implementation. Wildlife Society Bulletin.

U.S. Fish and Wildlife Service. 2010. 12-month finding for petitions to list the greater sage-grouse (*Centrocercus urophasianus*) as threatened or endangered; Proposed rule. 75 Federal Register 13910.

U.S. Fish and Wildlife Service. 2013. Greater sage-grouse (*Centrocercus urophasianus*) conservation objectives: Final report. U.S. Fish and Wildlife Service, Denver, CO. February 2013.

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. Wildlife Biology 13 Supplement 1: 95-104.

Appendix 1: Details of 10m vs. 30m DEM

10m DEMs as Model Input

Our first line of inquiry used the raw 10m DEMs as inputs to the modeling process. Outputs from the 10m data were somewhat counter-intuitive. Sage grouse have more fence collisions in areas with low-relief. We had therefore expected outputs from the model using 10 m DEM data to show less risk, as more relief should be captured at the finer scale. This did not seem to be the case, as exhibited by the 10m outputs (Figure 3). Internal review by TNC geospatial ecologists attributed these differences in model outputs to a *change of support problem* (COSP)

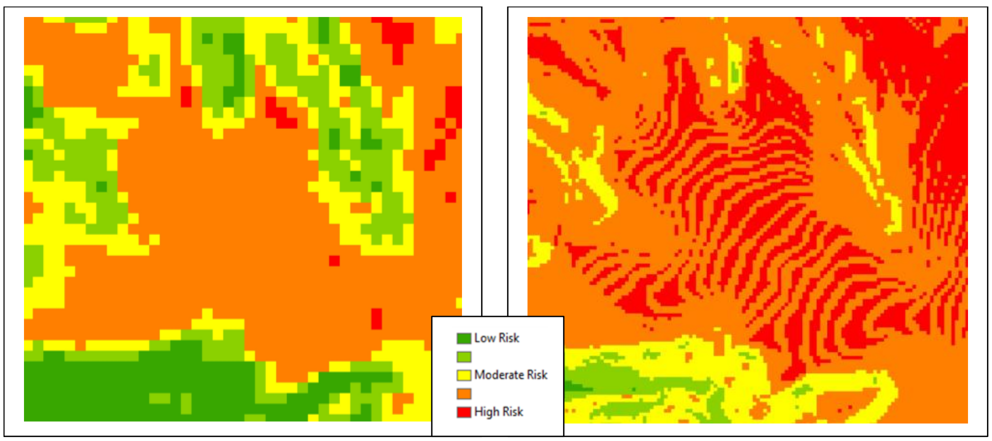


Figure 3: 30 m model outputs vs. 10 m outputs. The left panel shows an extract of the model output generated from 30m data. The right panel is the same area calculated from 10m data. Both datasets are portrayed with the same color ramp and breaks. Note the terracing artifacts in the 10m output, as well as the increased risk values.

(Jeffrey Evans 2013, *personal communication*).

This class of problem was first discovered in 1934 during analyses of census tract data (Gehlke and Biehl 1934). The researchers noted that statistical measures based upon aggregations of point-based data, such as population density, were radically affected by the choice of polygonal aggregation units. This was later described more fully by Openshaw (1984), who dubbed the issue *The Modifiable Areal Unit Problem*.

"Whereas census data are collected for essentially non-modifiable entities (people, households) they are reported for arbitrary and modifiable areal units (enumeration Districts, wards, local authorities). The principal criteria used in the definition of these units are the operational requirements of the census, local political considerations, and government administration. As a result none of these census areas have any intrinsic geographical meaning. Yet it is possible, indeed very likely, that the results of any subsequent analyses depend on these definitions. If the

areal units or zones are arbitrary and modifiable, then the value of any work based upon them must be in some doubt and may not possess any validity independent of the units which are being studied."

There are two fundamental components of the modifiable aerial unit problem (Fotheringham and Wong 1991. Fotheringham et al. 2000.):

1. *The scale effect*: different results can be obtained from the same statistical analysis at different levels of spatial resolution.
2. *The zoning effect*: different results can be obtained owing to the regrouping of zones at a given scale.

In geostatistics, several types of the modifiable aerial unit problem have been identified, which are collectively called *change of support problems.* "Support" describes the size or volume of a measured entity within each data value, and also the shape, size and spatial orientation of the regions associated with those measurements (Olea 1991). Changing the support of a variable creates a new variable with different statistical and spatial properties. The "problem" arises in attempting to understand how the spatial variation from the first variable relates to that of the second (Gotway and Young, 2002).

In our collision risk model case, the COSP is created during the interpolation from 30m to 10m data. The estimated supported scale of DEM's created by complex linear interpolation from USGS quad map contours is approximately 30m. By interpolating to a higher resolution (the scale effect), the statistical properties of the resulting 10m DEMs are altered, introducing a contour bias into the model (Jeffrey Evans, 2013, *personal communication*). Compounding this problem further, both the underlying roughness measure and the model coefficients Stevens calculated for his risk model were all scaled to 30m data. It is quite possible that the additional variance introduced by the contour bias does not scale correctly with these coefficients.

Conclusions: 10 Meter DEMs as Model Inputs

Though it would take complex statistical analysis to quantify these issues, it can be inferred from the outputs that the 10m data is reducing the values of the roughness index (smoothing) that are passed to the risk model. This has the effect of inflating the risk estimates. Additionally, the underlying roughness measure and the model coefficients Stevens calculated for his risk model were all scaled to 30m data. It is quite possible that the additional variance introduced by the contour bias does not scale correctly with these coefficients. **We therefore recommend that this model only be run with 30m DEM inputs.**

10m DEMs Resampled to 30m

Our next test involved resampling 10m DEMs to 30m and using that resampled product as the input to the collision risk model.

The tiled 10m DEM for the project area was resampled to 30m using the bilinear interpolation resampling method. This method causes some smoothing, but avoids the problem of creating output values that are beyond the range of the input values, which sometimes occurs with the cubic convolution resampling method. The native 30m DEM was used as the snap raster to allow direct comparison.

Comparing the native 30m with the 10m resampled version did reveal some differences. Calculating the raw difference between the two products showed a mean pixel by pixel difference of 2.47 meters across the study area. Breaking the Burns District into 3 slope categories, 0 – 6º, 6 – 18º and > 18º showed that the biggest differences occurred in the steeper portions of the study area. The mean difference in the 0 – 6º slope class was only 1.1 meters, rising to 4.1 in the moderate slope category, and 9.4 meters in the > 18º slope category.

Comparing the leks to the slope categories, 24 (only one of which is 'Active') of the 223 lek locations occurred in the 6 – 18º slope category, with the remainder falling in the 0 – 6º slope class. Given that collision risk decreases with increasing topographic complexity, it seems unlikely that these small differences in the two DEM products would impact the model results significantly.

The respective outputs of the fence collision model exhibited correspondingly modest differences. Looking at the subset of high priority leks, the number of high risk miles increased 5.3% with the 10m resampled data, the moderate risk fence miles increased by 4.14%, and the low risk fence miles decreased by 1.7%. Of the ten high priority leks with the greatest number of high risk fence miles identified with the native 30m DEM, nine remained using the 10m resampled DEM. Between the two versions of the model, the ordinal ranking of those nine did not change more than 2 positions.

Given that the two DEM products are slightly different, the question arises which is more accurate? Features depicted in the 10m DEM appear more finely detailed, but this is not related to accuracy, but is rather a function of resolution. Accuracy is how closely a measurement reflects the "true" value, whereas resolution relates to how finely a measurement can be made. However, accuracy can only be determined if there is some basis to differentiate true measurements from those which are not true.

The metadata created by the USGS for the National Elevation Dataset is the place to look for information on the currency and relative accuracies of their various DEM products. As the USGS is actively collecting and incorporating new, more accurate, source data into their DEM products, we advise visiting their website before performing any analysis requiring DEM inputs (http://ned.usgs.gov/downloads.asp). The 'NED Release Notes' are very helpful, as are the spatial metadata which contain a suite of attributes related to each individual USGS quadrangle.

Roughly half the coterminous United States have DEMs derived from source material gathered since 1980, and about a third of the country has DEMs derived from data collected by LiDAR or other active sensors. Unfortunately, SE Oregon is not within these zones. Both the 10 and 30m DEM products for SE Oregon are derived from the same source information and are created with the same process, complex linear interpolation from USGS quad map contours, often including hydrography (LT4X).

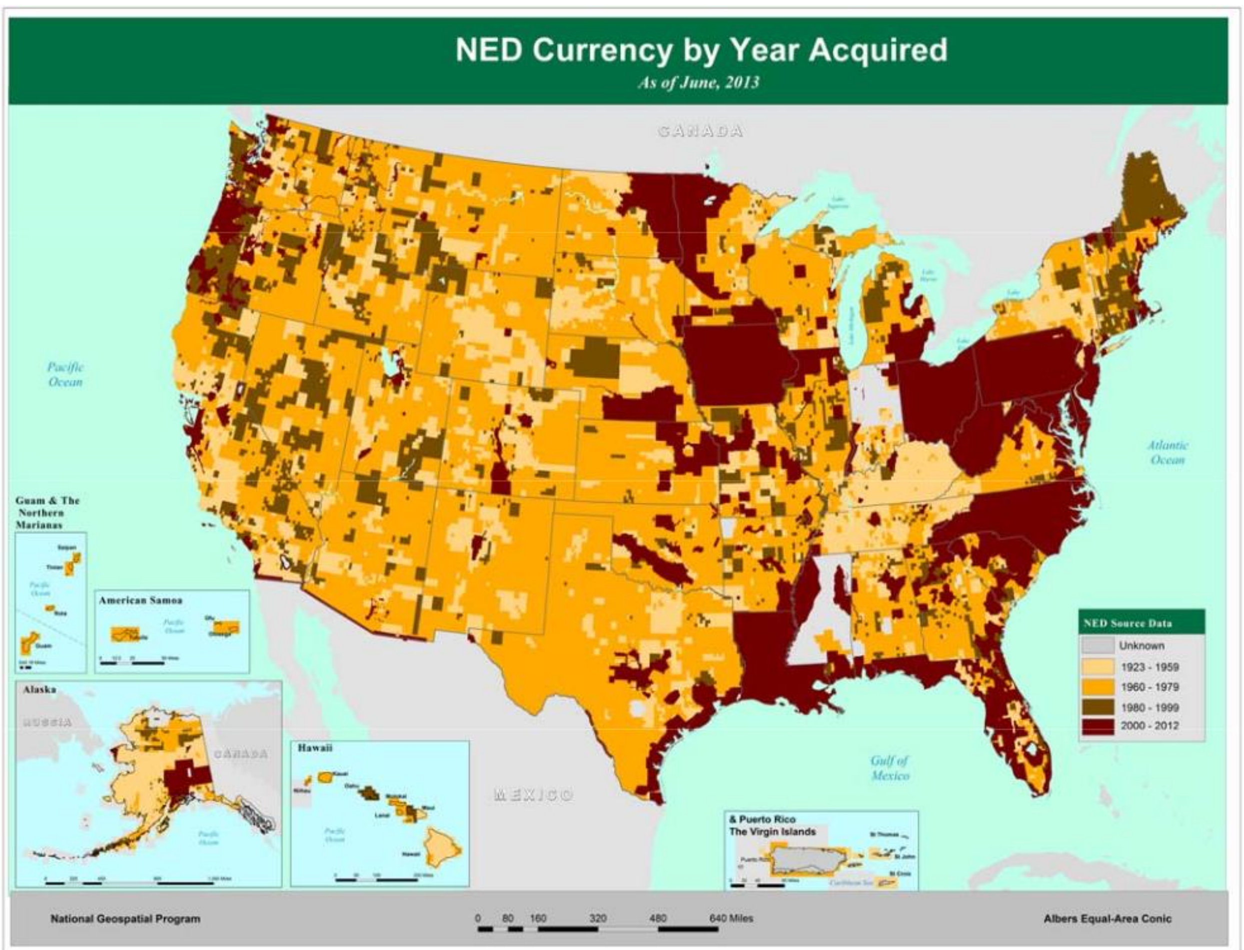


Figure 4: Snapshot of NED data currency, taken from the 6/2013 release notes

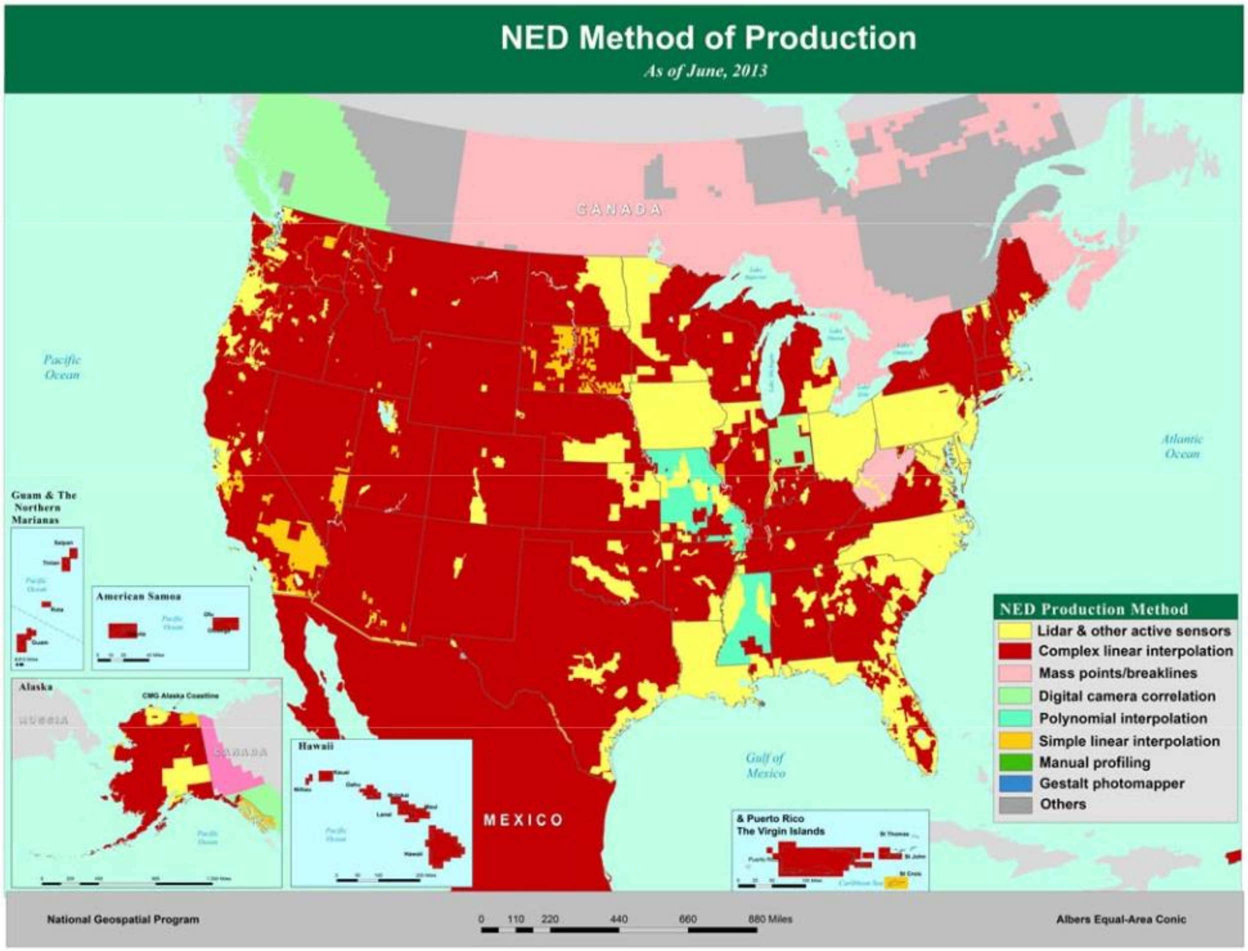


Figure 5: Snapshot of NED production methods, taken from the 6/2013 release notes

The USGS uses the best single resolution dataset for all products. This is why the spatial metadata for the 30m and 10m DEM products only reference the 10m resolution DEM (Gayla Evans, personal communication 7/29/2013). Where there is 10m source data, the USGS downscales it to produce their 30m product. Where there is LiDAR source data, it is downscaled to produce 10m and 30m DEMs. The differences we detected between our 10m resample and the native 30m USGS DEM are caused by the interpolation method itself, not from differences in the source data.

None of these facts suggest that either product is more accurate than the other. To make such a determination would require accuracy assessment values for both products. Unfortunately, accuracy assessment values are not available for the 30m DEM we derived from resampling 10m (1/3 arc second) data.

Conclusions: 10 Meter DEMs Resampled to 30M

Given the similarity of outputs generated from the native 30 m DEM and the 30m DEM derived from resampling 10m data (particularly in low-relief landscapes where most leks occur) we believe that credible outputs can be generated from either source. However, since the USGS produces their 30m DEMs in SE Oregon from the 10m DEM product, we recommend using the NED 30m DEM for future analysis.

Appendix 2: Lek prioritization criteria

TNC and Burns BLM District staff determined that the best course of action for parsing out the fence risk modeling would be to group the leks into several categories based on 1) their status (as defined in the ORLEKS attribute table) and 2) their type (e.g. part of a complex or not). We classified leks into the following 3 groups:

Group 1 Leks: High priority

All leks with status =

- "Active" **OR**
- "Occupied" **OR**
- "Occupied-Pending[2]"

Group 2 Leks: Moderate priority

Leks with status = "Unoccupied Pending" **IF** the following 2 statements are both **TRUE**

1. It's part of a complex **AND**
2. One of the other leks in the complex has a status of "active" **OR** "occupied" **OR** "occupied-pending."

Explanation: In the ORLEKS attribute table, the field ODFW_SITE_ID is a unique identifier. If leks are a part of a complex, there will be multiple leks with the same SITE but different IDs (starting at 1 and going up). Some leks exist as a complex of associated points that may be used periodically or regularly by grouse, thus the status of individual leks within a complex may vary depending on ODFW's sampling effort and detection of birds. Thus, we desired to identify leks that may have periodic occupation by sage-grouse because they are part of a lek complex. Two examples are provided below.

Example 1: ODFW_SITE_ID = HA0066-01, HA0066-02, HA0066-03

These three leks are all part of the Williams Dripp complex, but 2 are "occupied-pending" and 1 is "unoccupied pending." Using the criteria laid out above, HA0066-01 is categorized as a Group 2 lek: moderate priority because it's associated with 2 occupied leks in a complex, even though its status is "unoccupied pending." HA0066-02 and HA0066-03 are both categorized as Group 1 leks: high priority because their status is "occupied-pending."

[2] We identified one lek with a status of "Occupied-Pneding." We assumed that was a typo and corrected it for the purposes of this analysis.

Example 2: ODFW_SITE_ID = HA0067-01, HA0067-02

Both of these leks in the Battle Mountain complex are "unoccupied pending," thus we would put these in Group 3.

Group 3 Leks: Low priority

Leks with status =

- "unoccupied pending" leks **NOT** part of a complex
- "unoccupied"

Leks not mapped, modeled, or otherwise included in this exercise

Leks with status =

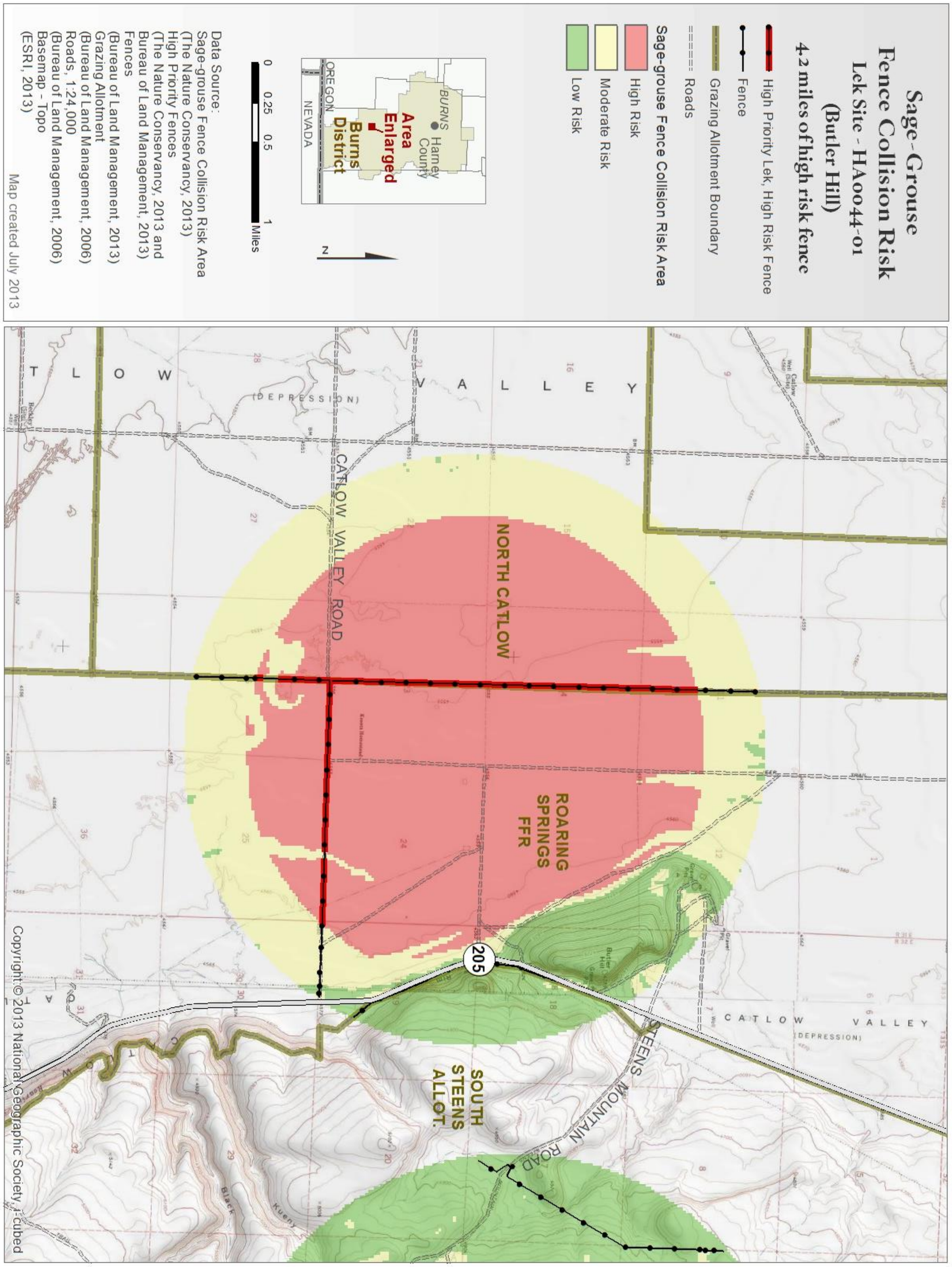
- "historic"
- "unknown"

Appendix 3: Maps of sage grouse fence collision risk

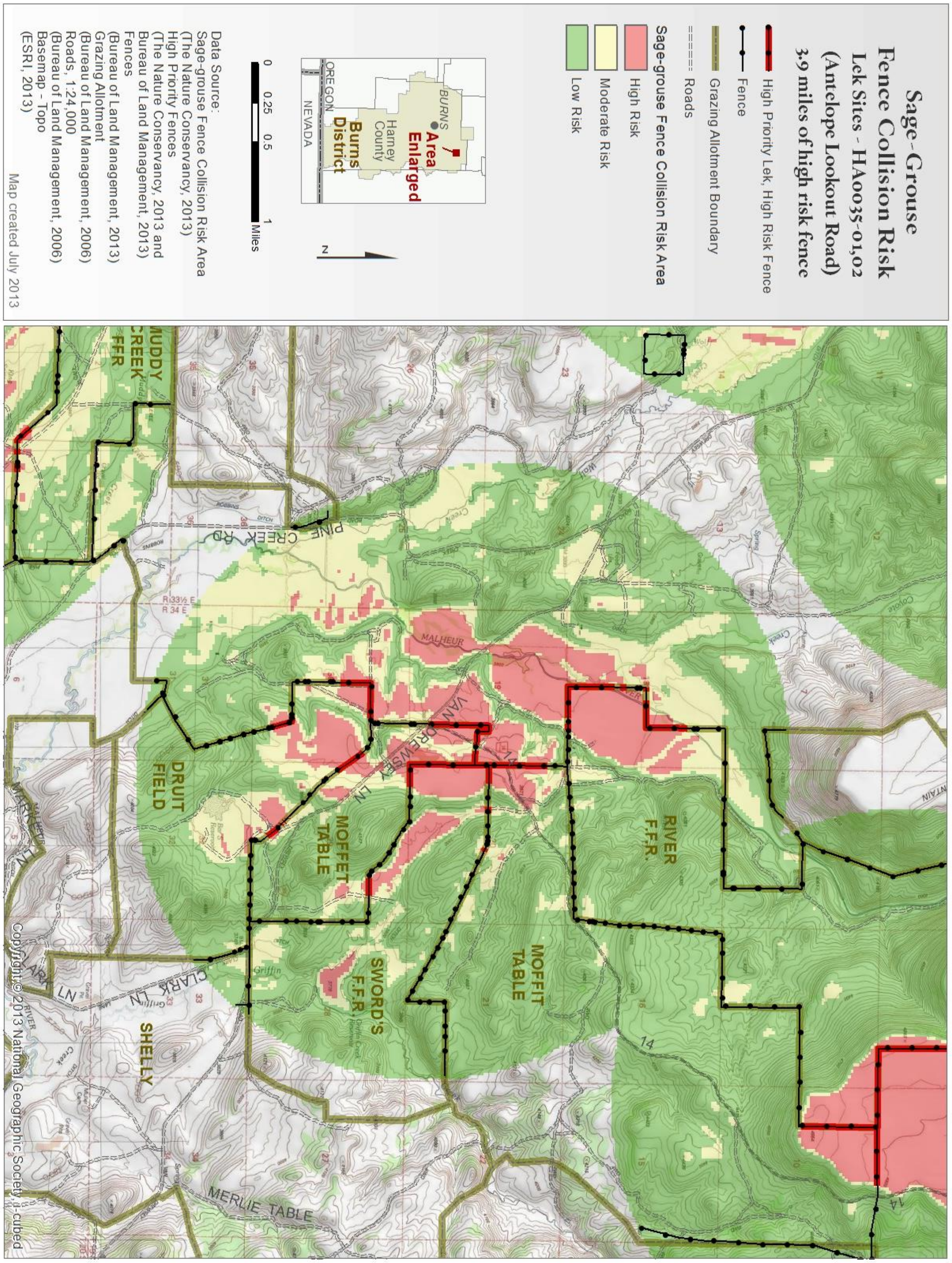
The maps prepared for the ten high priority sage-grouse leks with greatest amounts of high risk fence (totaling 27 miles) are included in the pages that follow. Additionally, an mxd file will be provided with the spatial data, which will have each of these geographies bookmarked with the lek name. Additional maps and tabular data can be exported from this mxd as needed.

Note: Two leks have been combined into a single map (as the 5th map in this series) as their buffers were overlapping.

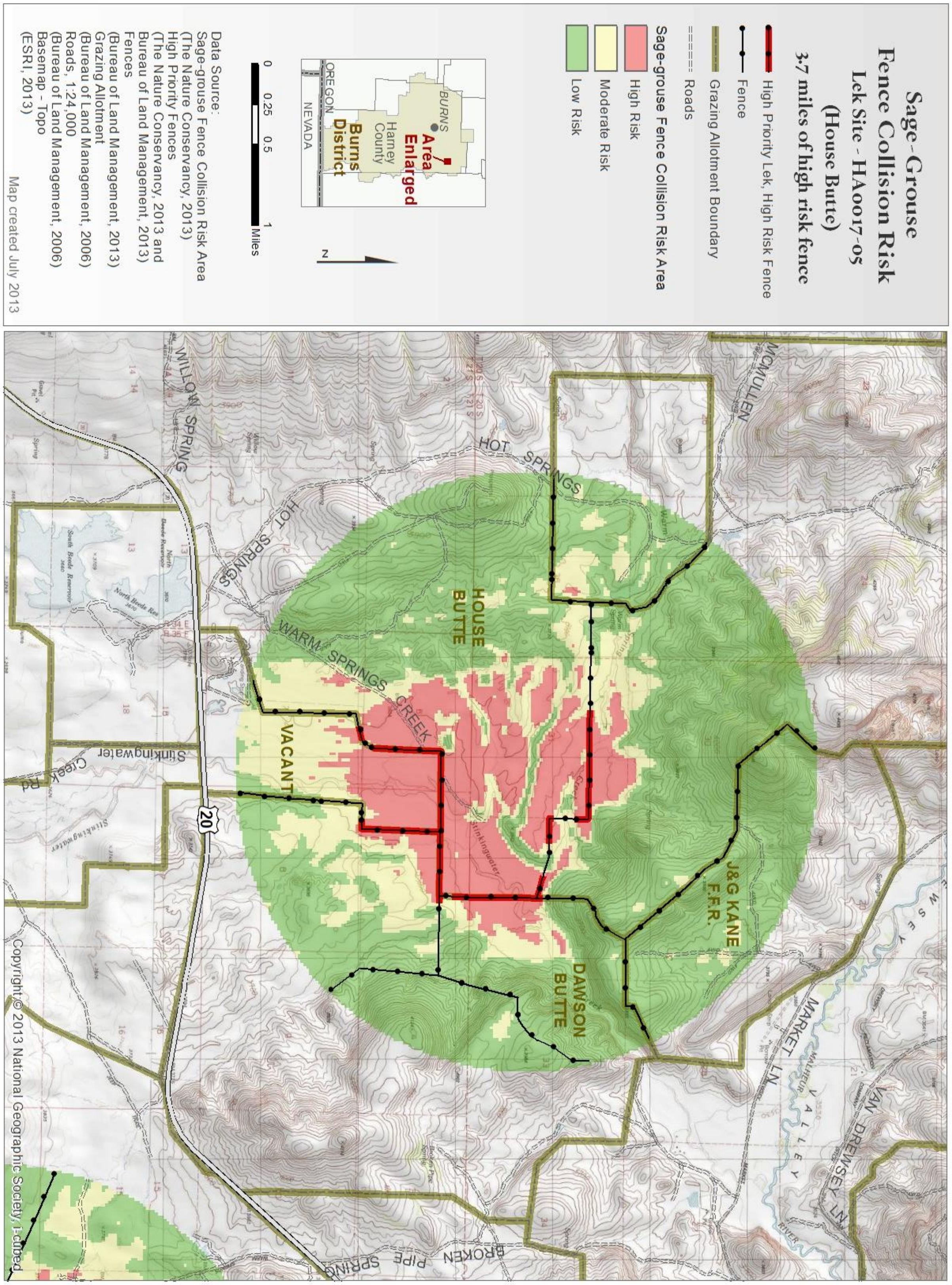
Map 1


Sage-Grouse
Fence Collision Risk
Lek Site - HA0044-01
(Butler Hill)
4.2 miles of high risk fence
High Priority Lek, High Risk Fence
Fence
Grazing Allotment Boundary
Roads
Sage-grouse Fence Collision Risk Area
High Risk
Moderate Risk
Low Risk
BURNS
Harney County
Area Enlarged
Burns District
OREGON
NEVADA
0 0.25 0.5 1 Miles
N
Data Source:
Sage-grouse Fence Collision Risk Area
(The Nature Conservancy, 2013)
High Priority Fences
(The Nature Conservancy, 2013 and
Bureau of Land Management, 2013)
Fences
(Bureau of Land Management, 2013)
Grazing Allotment
(Bureau of Land Management, 2006)
Roads, 1:24,000
(Bureau of Land Management, 2006)
Basemap - Topo
(ESRI, 2013)
Map created July 2013
NORTH CATLOW
CATLOW VALLEY ROAD
ROARING SPRINGS FFR
SOUTH STEENS ALLOT.
STEENS MOUNTAIN ROAD
205
CATLOW VALLEY
(DEPRESSION)
Copyright:© 2013 National Geographic Society, i-cubed

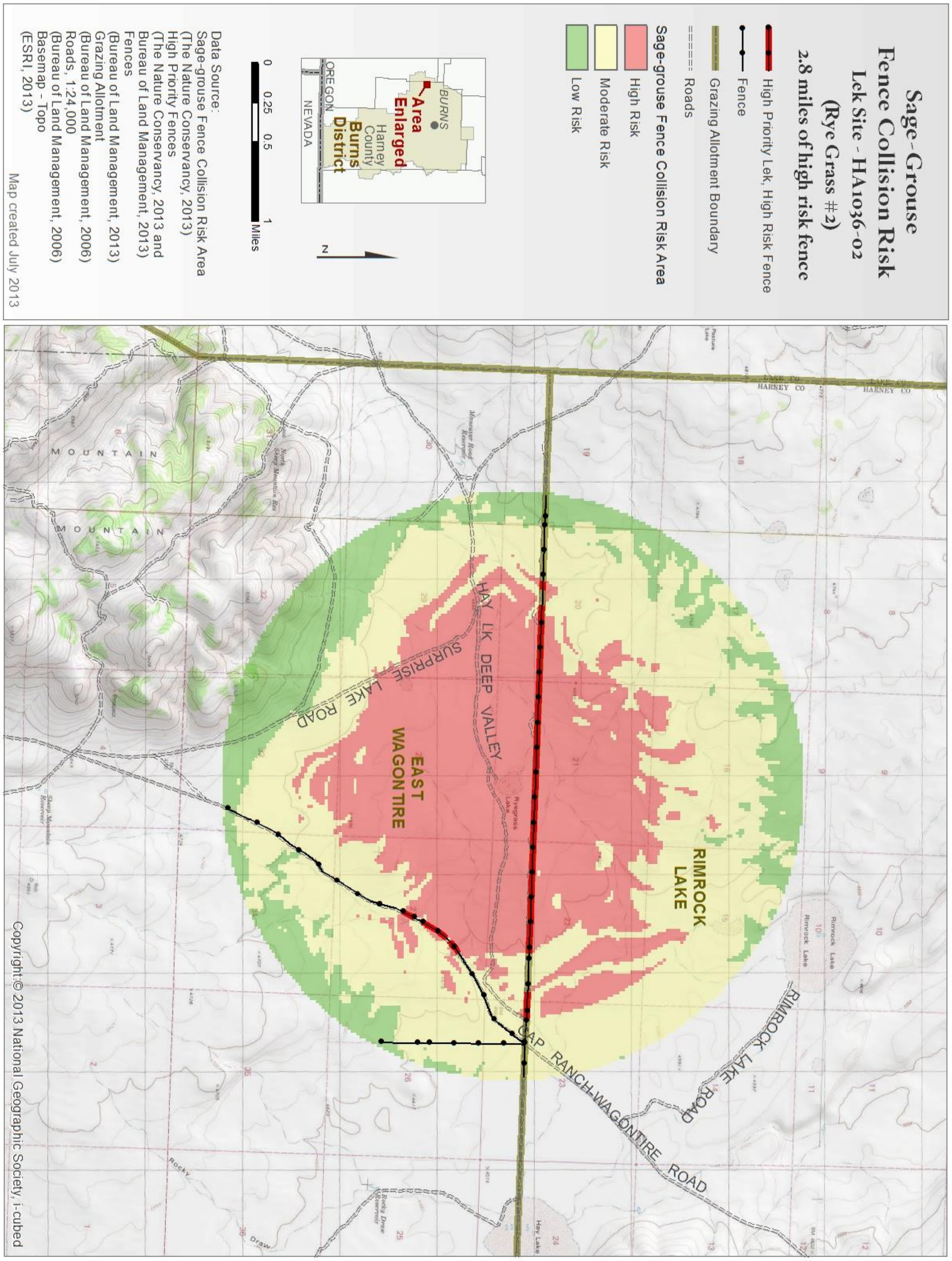
Map 2


Sage-Grouse
Fence Collision Risk
Lek Sites - HA0035-01,02
(Antelope Lookout Road)
3.9 miles of high risk fence
High Priority Lek, High Risk Fence
Fence
Grazing Allotment Boundary
Roads
Sage-grouse Fence Collision Risk Area
High Risk
Moderate Risk
Low Risk
BURNS
Area Enlarged
Harney County
Burns District
OREGON
NEVADA
0 0.25 0.5 1 Miles
N
Data Source:
Sage-grouse Fence Collision Risk Area
(The Nature Conservancy, 2013)
High Priority Fences
(The Nature Conservancy, 2013 and
Bureau of Land Management, 2013)
Fences
(Bureau of Land Management, 2013)
Grazing Allotment
(Bureau of Land Management, 2006)
Roads, 1:24,000
(Bureau of Land Management, 2006)
Basemap - Topo
(ESRI, 2013)
Map created July 2013
MUDDY CREEK FFR
PINE CREEK RD
MALHEUR
VAN DREWSEY LN
RIVER F.F.R.
DRUIT FIELD
MOFFET TABLE
MOFFIT TABLE
SWORD'S F.F.R.
CLARK LN
SHELLY
MERLIE TABLE
Copyright:© 2013 National Geographic Society, i-cubed

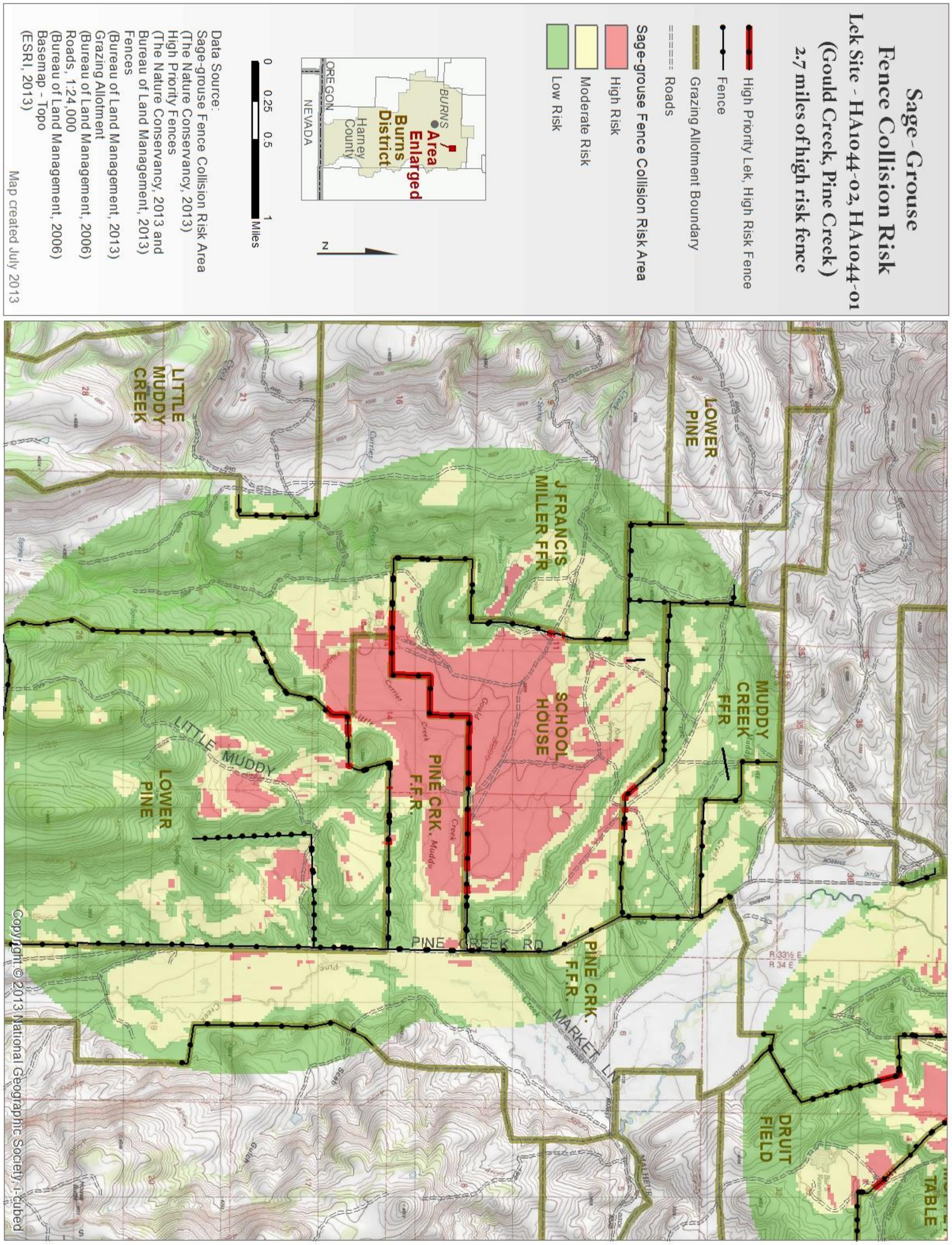
Map 3


Sage-Grouse Fence Collision Risk
Lek Site - HA0017-05
(House Butte)
3.7 miles of high risk fence
High Priority Lek, High Risk Fence
Fence
Grazing Allotment Boundary
Roads
Sage-grouse Fence Collision Risk Area
High Risk
Moderate Risk
Low Risk
BURNS
Area Enlarged
Harney County
Burns District
OREGON
NEVADA
N
0 0.25 0.5 1 Miles
Data Source:
Sage-grouse Fence Collision Risk Area (The Nature Conservancy, 2013)
High Priority Fences (The Nature Conservancy, 2013 and Bureau of Land Management, 2013)
Fences (Bureau of Land Management, 2013)
Grazing Allotment (Bureau of Land Management, 2006)
Roads, 1:24,000 (Bureau of Land Management, 2006)
Basemap - Topo (ESRI, 2013)
Map created July 2013
HOUSE BUTTE
VACANT
J&G KANE F.F.R.
DAWSON BUTTE
WARM SPRINGS CREEK
HOT SPRINGS
WILLOW SPRING
MCMULLEN
MARKET LN
VAN DREWSEY LN
BROKEN PIPE SPRING
Stinkingwater Creek Rd
20
Copyright © 2013 National Geographic Society, i-cubed

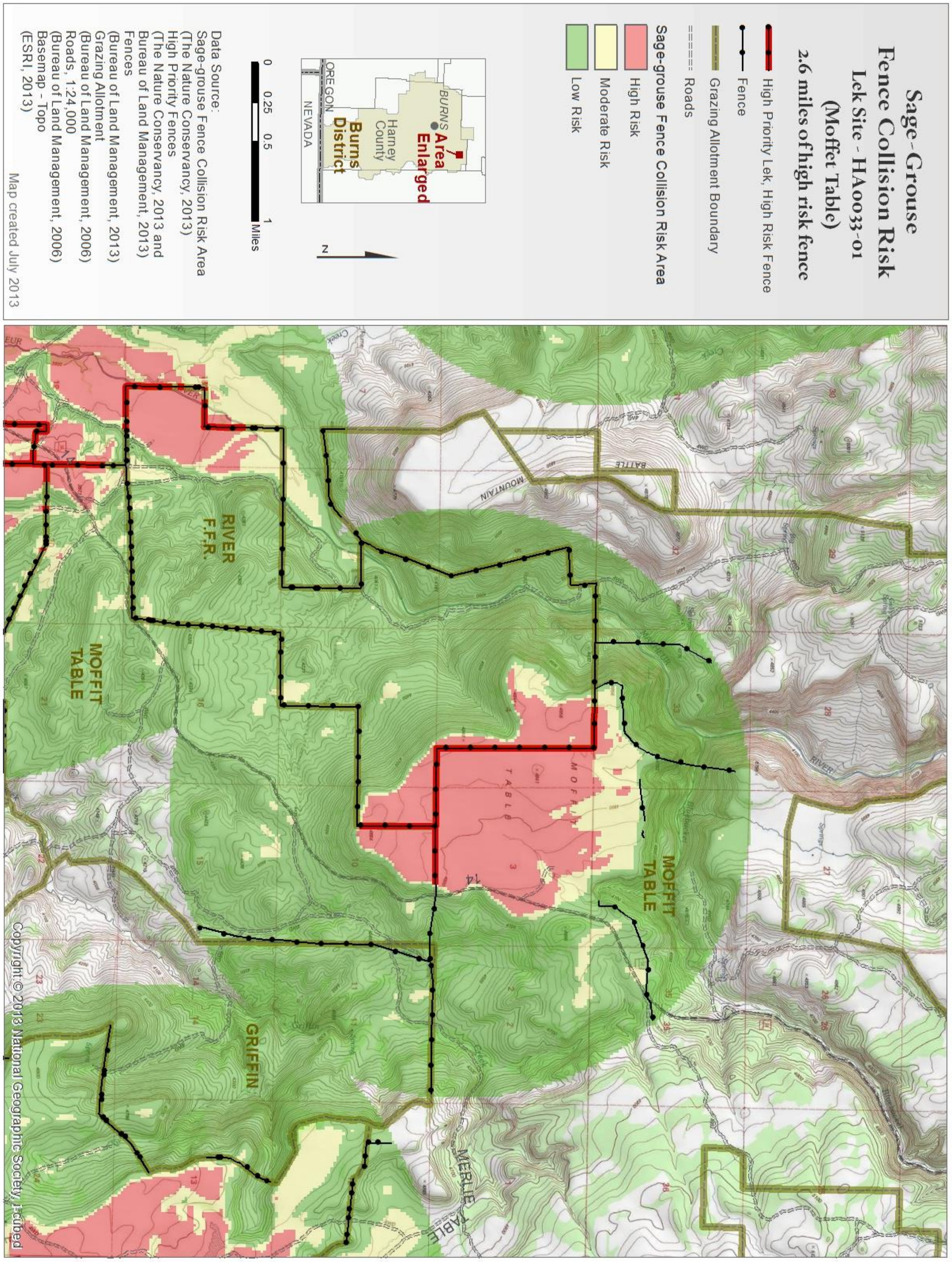
Map 4


Sage-Grouse
Fence Collision Risk
Lek Site - HA1036-02
(Rye Grass #2)
2.8 miles of high risk fence
High Priority Lek, High Risk Fence
Fence
Grazing Allotment Boundary
Roads
Sage-grouse Fence Collision Risk Area
High Risk
Moderate Risk
Low Risk
BURNS
Area Enlarged
Harney County
Burns District
OREGON
NEVADA
0 0.25 0.5 1 Miles
N
Data Source:
Sage-grouse Fence Collision Risk Area
(The Nature Conservancy, 2013)
High Priority Fences
(The Nature Conservancy, 2013 and
Bureau of Land Management, 2013)
Fences
(Bureau of Land Management, 2013)
Grazing Allotment
(Bureau of Land Management, 2006)
Roads, 1:24,000
(Bureau of Land Management, 2006)
Basemap - Topo
(ESRI, 2013)
Map created July 2013
RIMROCK LAKE
EAST WAGON TIRE
HAY LK DEEP VALLEY
SURPRISE LAKE ROAD
RIMROCK LAKE ROAD
CAP RANCH-WAGONTIRE ROAD
MOUNTAIN
Copyright © 2013 National Geographic Society, i-cubed

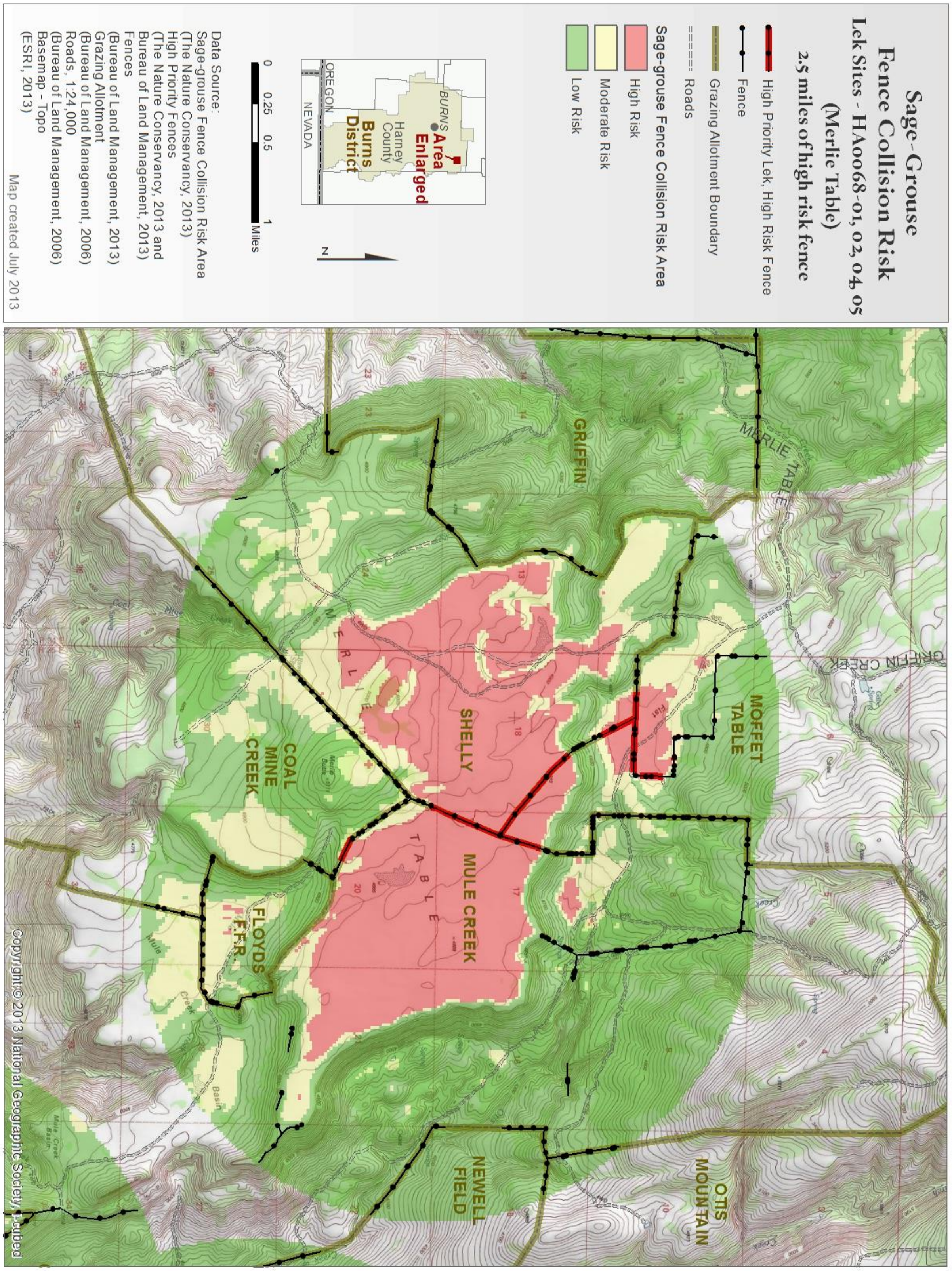
Map 5


Sage-Grouse
Fence Collision Risk
Lek Site - HA1044-02, HA1044-01
(Gould Creek, Pine Creek)
2.7 miles of high risk fence
High Priority Lek, High Risk Fence
Fence
Grazing Allotment Boundary
Roads
Sage-grouse Fence Collision Risk Area
High Risk
Moderate Risk
Low Risk
BURNS
Area Enlarged
Burns District
Harney County
OREGON
NEVADA
0 0.25 0.5 1 Miles
N
Data Source:
Sage-grouse Fence Collision Risk Area
(The Nature Conservancy, 2013)
High Priority Fences
(The Nature Conservancy, 2013 and
Bureau of Land Management, 2013)
Fences
(Bureau of Land Management, 2013)
Grazing Allotment
(Bureau of Land Management, 2006)
Roads, 1:24,000
(Bureau of Land Management, 2006)
Basemap - Topo
(ESRI, 2013)
Map created July 2013
LOWER PINE
J FRANCIS MILLER FFR
LITTLE MUDDY CREEK
MUDDY CREEK FFR
SCHOOL HOUSE
PINE CRK. F.F.R.
LITTLE MUDDY
LOWER PINE
PINE CREEK RD
PINE CRK. F.F.R.
MARKET LN
DRUIT FIELD
TABLE
Copyright: © 2013 National Geographic Society, i-cubed

Map 6

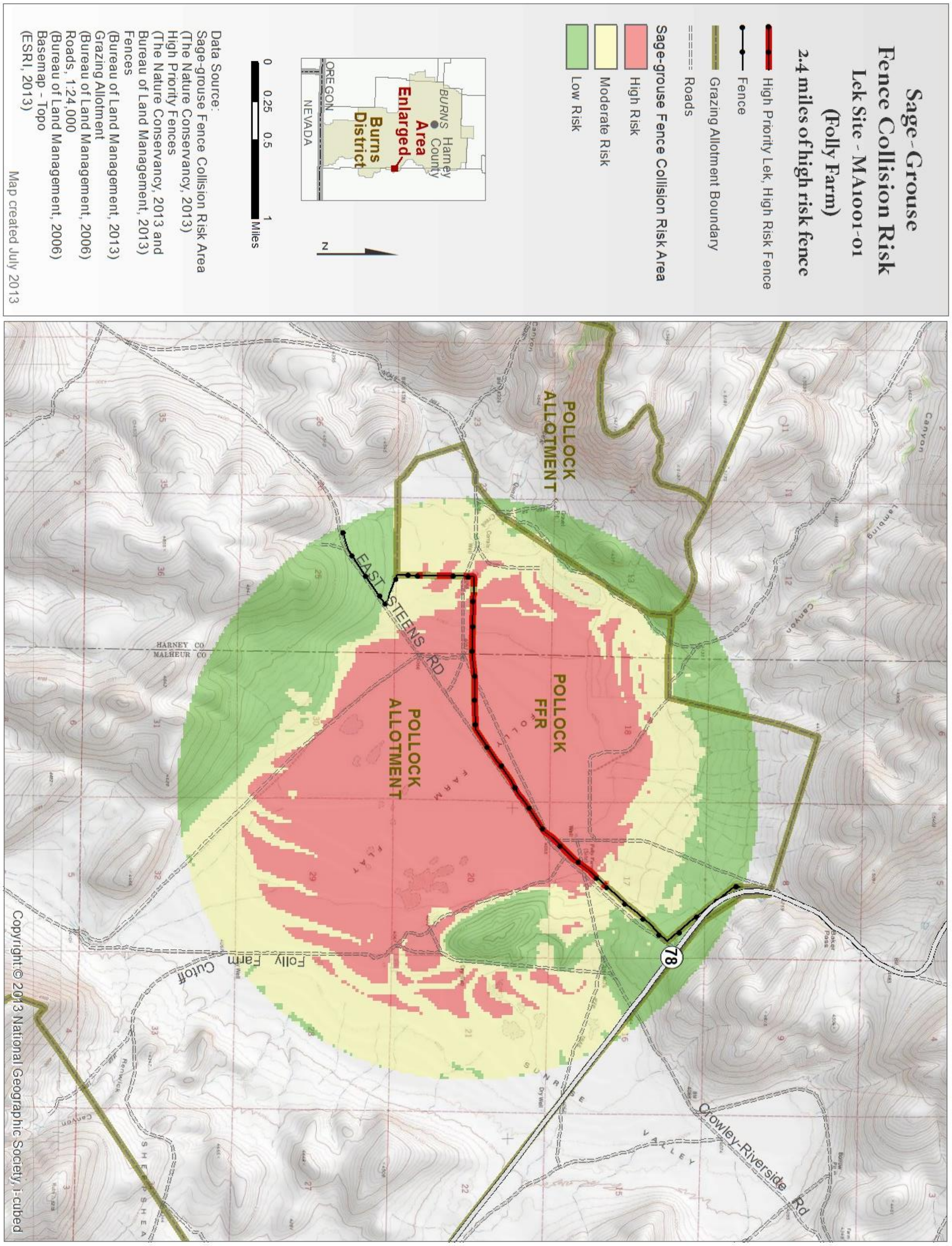

Sage-Grouse
Fence Collision Risk
Lek Site - HA0033-01
(Moffet Table)
2.6 miles of high risk fence
High Priority Lek, High Risk Fence
Fence
Grazing Allotment Boundary
Roads
Sage-grouse Fence Collision Risk Area
High Risk
Moderate Risk
Low Risk
BURNS
Area Enlarged
Harney County
Burns District
OREGON
NEVADA
0 0.25 0.5 1 Miles
N
Data Source:
Sage-grouse Fence Collision Risk Area
(The Nature Conservancy, 2013)
High Priority Fences
(The Nature Conservancy, 2013 and
Bureau of Land Management, 2013)
Fences
(Bureau of Land Management, 2013)
Grazing Allotment
(Bureau of Land Management, 2006)
Roads, 1:24,000
(Bureau of Land Management, 2006)
Basemap - Topo
(ESRI, 2013)
Map created July 2013
RIVER F.F.R.
MOFFIT TABLE
MOFFIT TABLE
GRIFFIN
MERLIE TABLE
BATTLE MOUNTAIN
Copyright:© 2013 National Geographic Society, i-cubed

Map 7

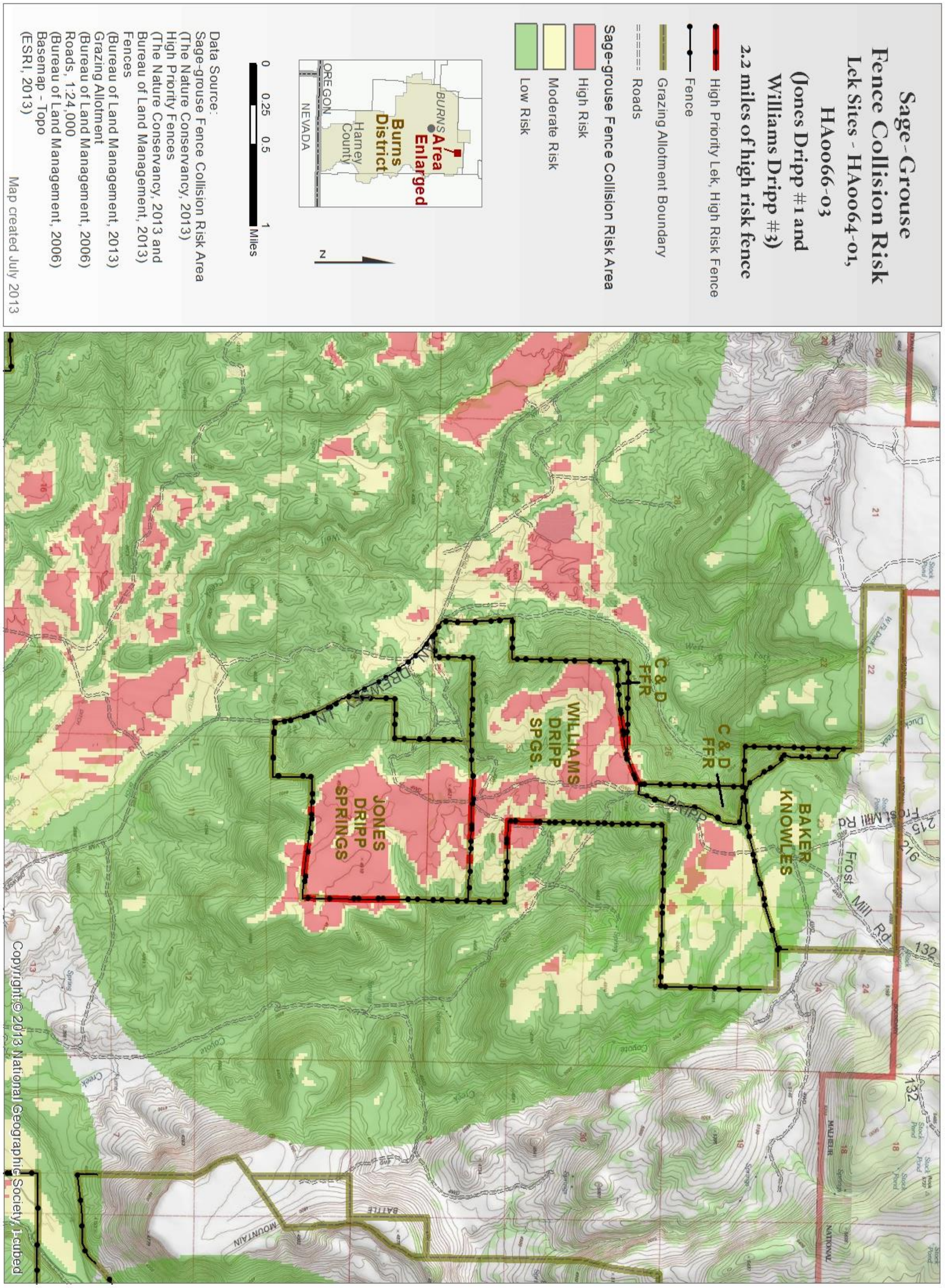


Sage-Grouse
Fence Collision Risk
Lek Sites - HA0068-01, 02, 04, 05
(Merlie Table)
2.5 miles of high risk fence
High Priority Lek, High Risk Fence
Fence
Grazing Allotment Boundary
Roads
Sage-grouse Fence Collision Risk Area
High Risk
Moderate Risk
Low Risk
BURNS
Area Enlarged
Harney County
Burns District
OREGON
NEVADA
N
0 0.25 0.5 1 Miles
Data Source:
Sage-grouse Fence Collision Risk Area
(The Nature Conservancy, 2013)
High Priority Fences
(The Nature Conservancy, 2013 and
Bureau of Land Management, 2013)
Fences
(Bureau of Land Management, 2013)
Grazing Allotment
(Bureau of Land Management, 2006)
Roads, 1:24,000
(Bureau of Land Management, 2006)
Basemap - Topo
(ESRI, 2013)
Map created July 2013
GRIFFIN
MERLIE TABLE
GRIFFIN CREEK
MOFFET TABLE
SHELLY
COAL MINE CREEK
MULE CREEK
FLOYDS F.F.R.
NEWELL FIELD
OTIS MOUNTAIN
Copyright:© 2013 National Geographic Society, i-cubed

Map 8


Sage-Grouse
Fence Collision Risk
Lek Site - MA1001-01
(Folly Farm)
2.4 miles of high risk fence
High Priority Lek, High Risk Fence
Fence
Grazing Allotment Boundary
Roads
Sage-grouse Fence Collision Risk Area
High Risk
Moderate Risk
Low Risk
BURNS
Harney County
Area Enlarged
Burns District
OREGON
NEVADA
0 0.25 0.5 1 Miles
N
Data Source:
Sage-grouse Fence Collision Risk Area
(The Nature Conservancy, 2013)
High Priority Fences
(The Nature Conservancy, 2013 and
Bureau of Land Management, 2013)
Fences
(Bureau of Land Management, 2013)
Grazing Allotment
(Bureau of Land Management, 2006)
Roads, 1:24,000
(Bureau of Land Management, 2006)
Basemap - Topo
(ESRI, 2013)
Map created July 2013
POLLOCK ALLOTMENT
POLLOCK FFR
POLLOCK ALLOTMENT
EAST STEENS RD
HARNEY CO
MALHEUR CO
78
Folly Farm Cutoff
Crowley-Riverside Rd
Copyright:© 2013 National Geographic Society, i-cubed

Map 9


Sage-Grouse Fence Collision Risk
Lek Sites - HA0064-01, HA0066-03
(Jones Dripp #1 and Williams Dripp #3)
2.2 miles of high risk fence
High Priority Lek, High Risk Fence
Fence
Grazing Allotment Boundary
Roads
Sage-grouse Fence Collision Risk Area
High Risk
Moderate Risk
Low Risk
BURNS
Area Enlarged
Burns District
Harney County
OREGON
NEVADA
N
0 0.25 0.5 1 Miles
Data Source:
Sage-grouse Fence Collision Risk Area (The Nature Conservancy, 2013)
High Priority Fences (The Nature Conservancy, 2013 and Bureau of Land Management, 2013)
Fences (Bureau of Land Management, 2013)
Grazing Allotment (Bureau of Land Management, 2006)
Roads, 1:24,000 (Bureau of Land Management, 2006)
Basemap - Topo (ESRI, 2013)
Map created July 2013
BAKER KNOWLES
C & D FFR
WILLIAMS DRIPP SPGS.
JONES DRIPP SPRINGS
Frost Mill Rd
Copyright:© 2013 National Geographic Society, i-cubed