

# Rangelands at Risk: A Geographic Analysis of Sustainability Indicators

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## Introduction

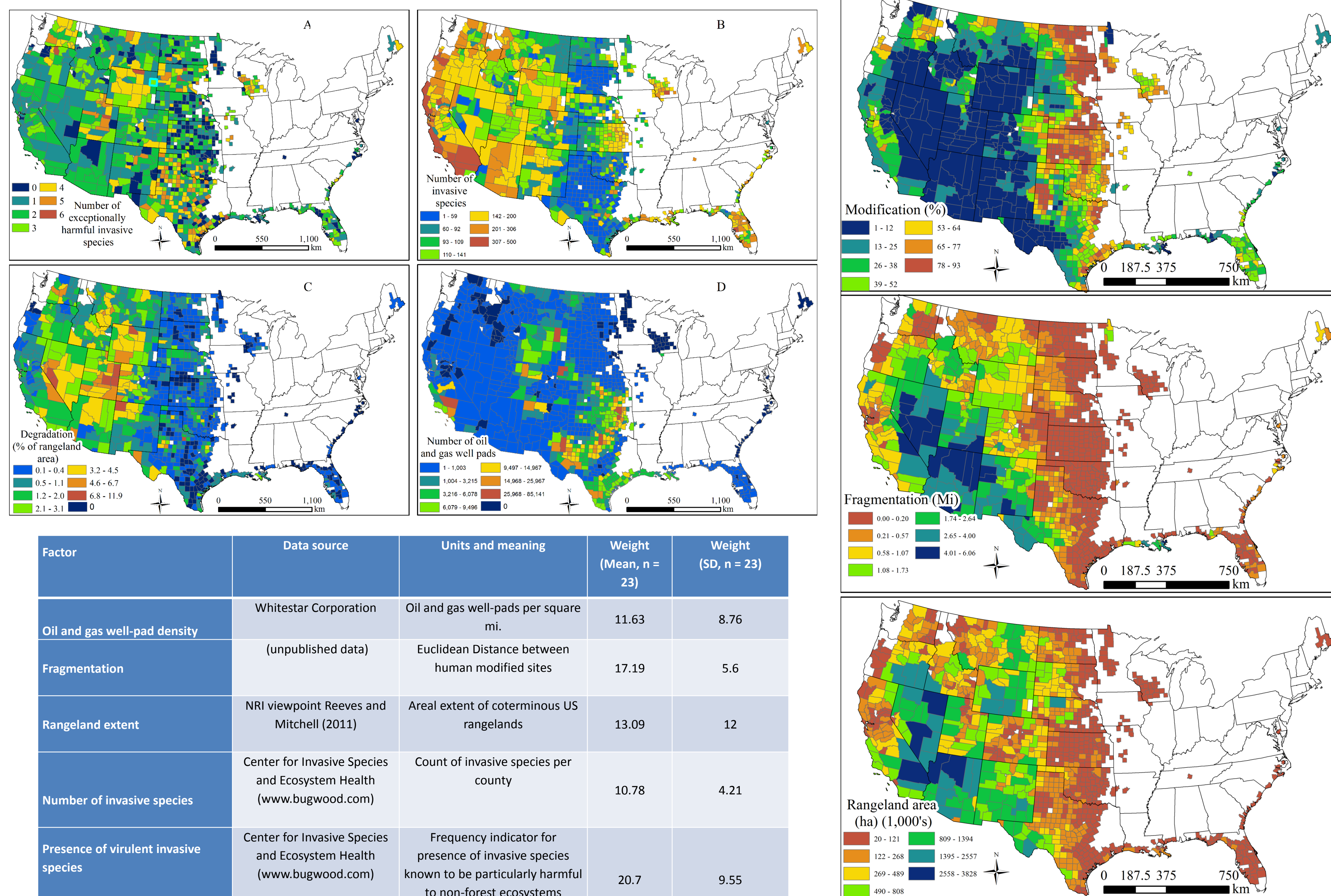
Rangelands produce an array of ecosystem goods and services that link natural capital to economic, social, and legislative frameworks. The sustainability of rangelands, and therefore the goods and services they provide, should be evaluated to improve our understanding of the situation across the U.S. and to guide future expectations and future management of rangelands.

## Methods

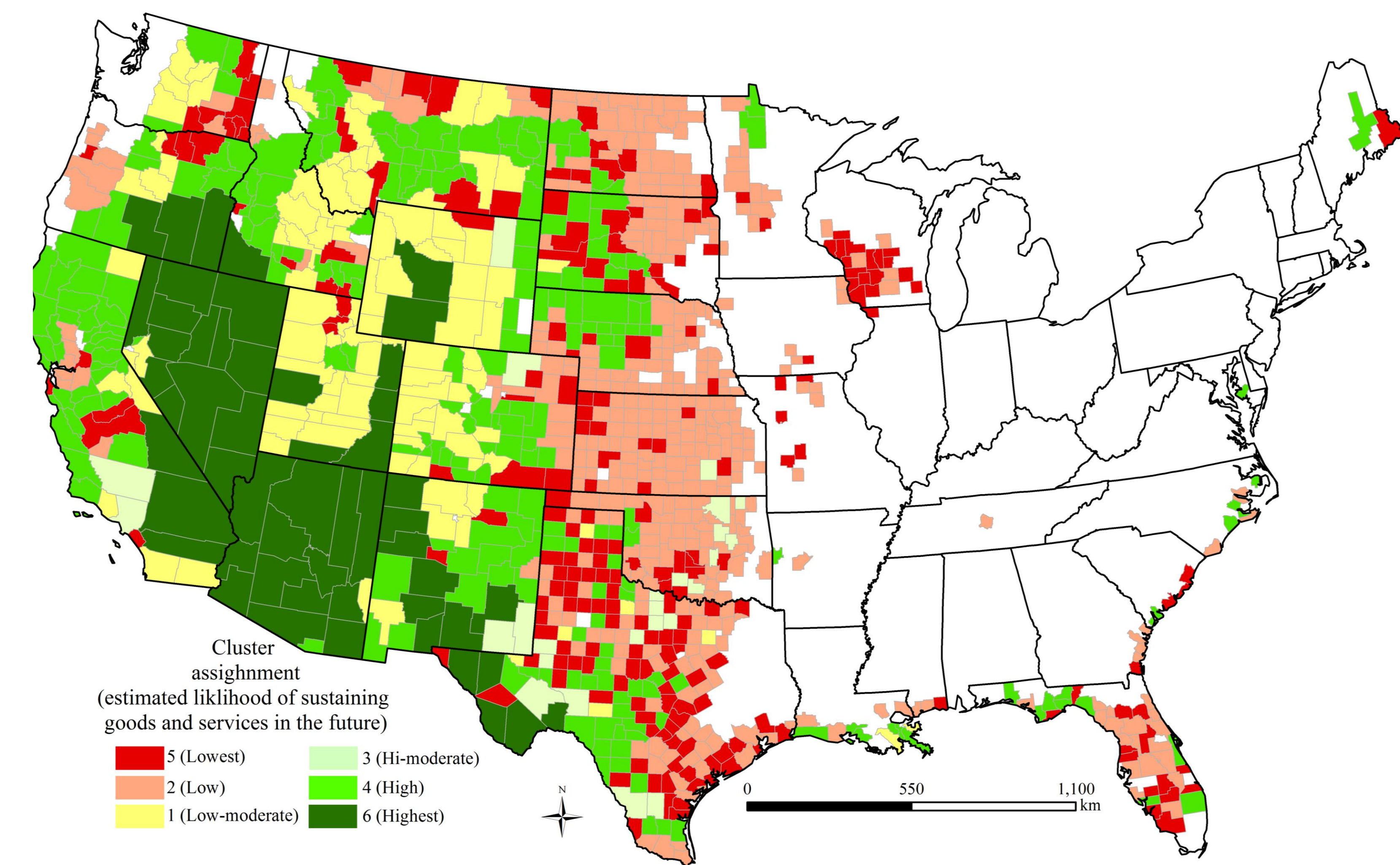
To aid this process, we analysed juxtaposition, extent, and magnitude of seven indicators of rangeland sustainability across the coterminous US. For each county in the coterminous US dominated by rangeland vegetation, indicators evaluated were oil and gas well pad density, rangeland extent, fragmentation, number of invasive species, presence of exceptionally virulent invasive species, proportion of human modification, and proportion of degraded lands. These indicators were linked to sustainability indicators developed by the Sustainable Rangelands Roundtable (SRR) and evaluated using a combination of expert opinion and clustering enabling each county to receive a final sustainability evaluation. This was accomplished using weighted clustering guided by expert opinion.

## Results

Results indicated natural groupings of six clusters representing rangeland sustainability. The southwestern US, interior west, and small parts of the northern Great Plains exhibited the highest composite scores that, in this assessment, indicated the greatest likelihood for maintenance of goods and services in the future. In contrast, rangelands further to the east received lower scores, indicating decreased likelihood of maintenance of goods and services in the future. Counties with lowest scores tended to have low rangeland area, high fragmentation and modification, high numbers of invasive species including those considered especially problematic. These counties were not necessarily characterized by high density of oil and gas development or a high amount of degradation. Across the US extent, 1053 counties were evaluated. 53 counties obtained the highest rating while 153 received the lowest.



Factor	Data source	Units and meaning	Weight (Mean, n = 23)	Weight (SD, n = 23)
Oil and gas well-pad density	Whitestar Corporation	Oil and gas well-pads per square mi.	11.63	8.76
Fragmentation	(unpublished data)	Euclidean Distance between human modified sites	17.19	5.6
Rangeland extent	NRI viewpoint Reeves and Mitchell (2011)	Areal extent of coterminous US rangelands	13.09	12
Number of invasive species	Center for Invasive Species and Ecosystem Health (www.bugwood.com)	Count of invasive species per county	10.78	4.21
Presence of virulent invasive species	Center for Invasive Species and Ecosystem Health (www.bugwood.com)	Frequency indicator for presence of invasive species known to be particularly harmful to non-forest ecosystems	20.7	9.55
Percent of human modified rangeland	(unpublished data)	Extent and magnitude of human modified non-forest lands	13.69	10.08
Proportion of degraded land	(unpublished data)	Proportion in each county of non-agricultural and non-urban vegetated surfaces that are degraded	12.92	9.34



## Discussion

We fulfilled the need expressed by the Sustainable Rangelands Roundtable to provide an evaluation of indicators of situations that threaten the sustained production of ecological goods and services. Spatially explicit data describing the extent and degree of risk associated with rangelands permit development of mitigation strategies enabling improvement of land planning and management strategies.

