

*“Science affects the way we think together.”*

Lewis Thomas

## Sage-Grouse on the Edge: Understanding and Managing Western Landscapes for Their Survival

*“Conservation of our natural resources and their proper use constitute the fundamental problem which underlies almost every other problem of our national life.”*

—Theodore Roosevelt

With its spiky tail feathers, luxuriant ruff resembling fur more than plumage, and a mating dance unique in the avian world, the greater sage-grouse is an icon of North American sagebrush landscapes. But these birds, which once ranged across 17 states and parts of Canada, have undergone dramatic declines during the last several decades. By some estimates, their overall population has plummeted from about 1.1 million before Euro-American settlement to about 142,000 today—a decrease of more than 80 percent.

Nearly a third of that loss has occurred since 1985. Sage-grouse currently inhabit about 56 percent of their historical range, with populations in Washington, Oregon, Idaho, Montana, North Dakota, Eastern California, Nevada, Utah, Colorado, South Dakota, Wyoming, and the Canadian Provinces of Alberta and Saskatchewan.

Although local trends vary—with sage-grouse numbers holding steady in some areas and losing ground rapidly in others—the species’ future has become a growing concern for wildlife biologists, land managers, and a host of conservation organizations. The situation



G. Kramer

*As sagebrush habitat declines, so do sage-grouse populations. Scientists have identified the amount of sagebrush coverage needed to support sage-grouse in a given area.*

has prompted numerous legal actions under the Endangered Species Act (ESA). In 2010, the U.S. Fish and Wildlife Service (USFWS) determined that although the greater sage-grouse warrants ESA protection, the need to address other species facing more immediate extinction threats precludes listing it at this time.

“Species like the sage-grouse that have been so wide-ranging and historically abundant often are taken for granted,” says Michael Wisdom, a research wildlife biologist with the Pacific Northwest Research Station, based in La Grande, Oregon. “It may seem that with

### IN SUMMARY

*Populations of greater sage-grouse have declined dramatically across their North American range for many decades in response to harmful effects of a variety of human activities and land uses, prompting legal actions to protect the species under the Endangered Species Act. To evaluate the impacts of land use and habitat changes on sage-grouse, Michael Wisdom, a research wildlife biologist, and his colleagues used novel landscape modeling methods to carry out a comprehensive, rangewide analysis that considered 22 environmental factors in areas currently inhabited by sage-grouse compared to areas where the species is locally extinct. The researchers identified threshold values for the amount of sagebrush critical to sage-grouse persistence, addressing a key question about the species’ habitat requirements.*

*The assessment also revealed the potentially negative impacts of tall-tower structures on sage-grouse occurrence. The findings highlighted the urgency of integrating efforts among public agencies and private landowners at all resource management levels to counter the cumulative and synergistic threats to sage-grouse conservation. In combination with related studies, this research has expanded the scientific knowledge base for resource managers and other decisionmakers concerned with designing and implementing landscape strategies for sage-grouse recovery.*

tens of thousands of these birds remaining, the situation is good. But the cumulative, harmful effects of a variety of human activities and land uses have exacted a heavy toll on populations and their habitat. And once habitat and populations become fragmented, downward spirals can occur suddenly.”

To shed light on this subject, Wisdom and colleagues conducted a novel range-wide analysis of the landscape factors—natural and human induced—potentially affecting the birds’ habitat and population levels. One of the most comprehensive landscape assessments ever conducted for a terrestrial species, it demonstrated the interplay among an array of environmental dynamics across some 125 million acres. The analysis was a fundamental part of a larger body of research that the USFWS used in making its 2010 ruling. Recently published as a scientific monograph, this compendium offers the most authoritative basis for sage-grouse conservation and habitat management.

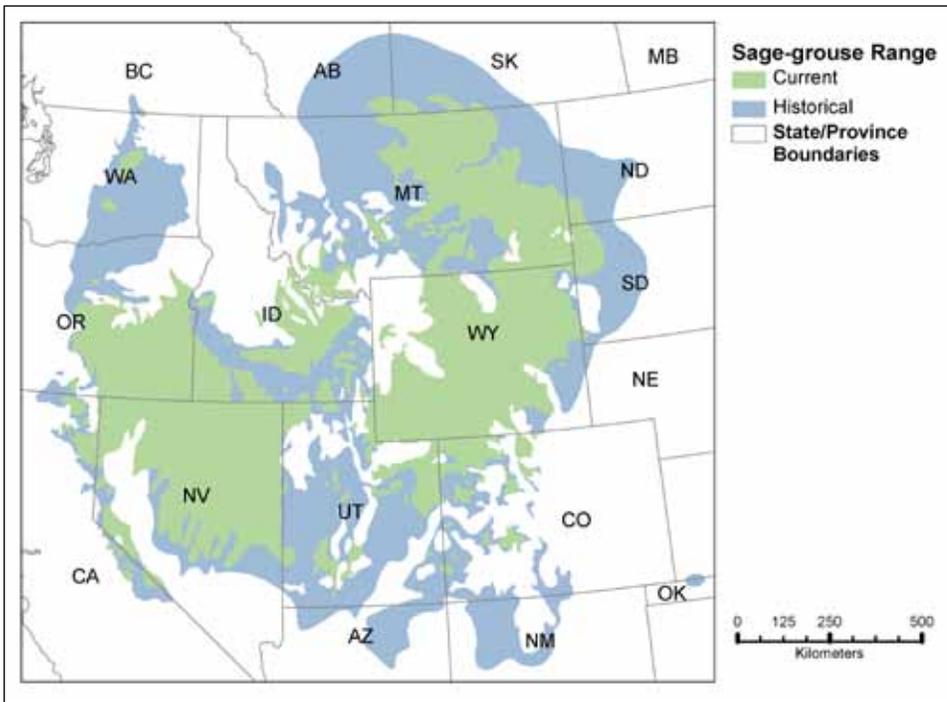
KEY FINDINGS	
<ul style="list-style-type: none"> <li>• The persistence of sage-grouse populations strongly depends on the amount of sagebrush across a landscape. When managing landscapes 250,000 acres or larger, a minimum of 50 percent of area in sagebrush cover appears to be required for long-term survival of a population, whereas less than 27 percent area in sagebrush cover portends a high risk for local extinction.</li> </ul>	
<ul style="list-style-type: none"> <li>• Compared to areas currently occupied by sage-grouse, zones where their populations are locally extinct are found mainly at lower elevations, closer to power lines and communication towers, and on private land. Areas of local sage-grouse extinction largely correspond with fragmented habitat and the edges of the current range.</li> </ul>	
<ul style="list-style-type: none"> <li>• Sage-grouse habitats are very sensitive to human disturbances, which are accelerating habitat declines across vast expanses of the species’ range. Key threats in the western portion of sage-grouse range include the pervasive spread of invasive plants and associated changes in wildfire regimes.</li> </ul>	
<ul style="list-style-type: none"> <li>• In the eastern portion of sage-grouse range, the proliferation of oil and gas development negatively affects huge areas of habitat far beyond actual development sites.</li> </ul>	
<ul style="list-style-type: none"> <li>• Conventional management approaches to maintaining and restoring vulnerable habitats have not succeeded.</li> </ul>	

## SAGE-GROUSE RANGE, PAST AND PRESENT

**T**easing out the reasons for sage-grouse population losses requires knowledge of where they once thrived and how conditions there compare with areas still supporting the species. Wisdom’s team began with maps of historical and current sage-grouse range, compiled in 2004. They selected 375 (out of more than 1,300) historical sage-

grouse locations; 239 were in areas of current (occupied) range, and 136 were in extirpated (formerly occupied) range. Around each location they mapped a circular area of roughly 250,000 acres. The circles served as sampling units for analyzing and comparing the conditions for 22 environmental variables likely to differ between occupied and extirpated areas.

“Nine variables were biological measures, such as total area of sagebrush, patch size, and density,” Wisdom explains. “Five were abiotic, including precipitation, elevation, and soil characteristics. The other eight variables were related to human activities, such as agriculture, population density, and the presence of roads and other developments.”



Current sage-grouse habitat is about 56 percent of what it was before Euro-American settlement of the American West.

The researchers collected spatial data on each of these environmental features across sage-grouse range. Because continuous “layers” of data were necessary for the analysis, two potentially significant factors—livestock grazing and energy extraction—could not be included. “Unfortunately there are no consistently accurate measures of grazing across sage-grouse range,” Wisdom says, “and the collection of spatial data hasn’t kept up with the rapid expansion of energy development activities since the early 2000s across sage-grouse range. However, other studies complementary to ours have used accurate spatial data to evaluate energy development impacts in smaller sections of the range.”

All this detailed information was used to design several experimental computer models that tested different combinations of variables to determine which ones best differentiated between occupied and extirpated range. Creating a model that accurately reflected current conditions “on the ground” provided a tool for predicting places where sage-grouse might be at risk for local extinction and areas where habitat and populations are stable.

## CULPRITS FOR EXTIRPATION

The modeling revealed five prime indicators for the presence or absence of sage-grouse: the amount of sagebrush, elevation, proximity to transmission lines and to cellular towers, and landownership. “We found that areas of extirpation had less sagebrush, were at lower elevations, were situated closer to power transmission lines and to communication towers, and were privately owned,” Wisdom says. More often than not, extirpated areas corresponded with fragmented habitat or the periphery of sage-grouse range, where environmental conditions are changing most rapidly.

Although it may seem obvious that the overall amount of sagebrush cover is the strongest predictor of sage-grouse habitation, Wisdom says that “up to the point of this analysis, many public-interest groups questioned, in court and elsewhere, whether these birds are true sagebrush obligates. Our work established clearly that without adequate sagebrush, they will not persist.” Similar to previous studies, the results showed that in landscape areas of 250,000 acres or larger, an area with at least 50 percent sagebrush cover is likely to support sage-grouse. When sagebrush coverage is less than 27 percent, sage-grouse are absent. “Fortunately, federal and state agencies now can access accurate maps of sagebrush cover to estimate these threshold values, and such assessments are underway in some areas,” he notes.

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M. Wisdom

*Areas where sage-grouse have been extirpated have less sagebrush and tend to be at lower elevation, a likely proxy for human development, and closer to power lines and communication towers.*

Sagebrush prevalence is closely tied to elevation, which represents a suite of conditions that contribute to quality habitat, Wisdom explains. “Sagebrush habitats at higher elevations receive more precipitation and thus have more vibrant native plant communities and better resistance to invasive exotic plants. Also, these areas have less human activity and development, and if it does occur, the land is more resilient to the effects.” In contrast, at lower elevations, former expanses of sagebrush have succumbed to widespread change, such as conversion to livestock forage, agriculture, urban development, and natural resource extraction. And, invasive plants—particularly cheatgrass, a rapid colonizer of disturbed zones that easily outcompetes slower-growing sagebrush—thrive in warmer, drier areas that characterize lower elevations.

The team was surprised at the relatively high significance of power transmission lines and communication towers. “This is an emerging line of research, and we weren’t sure what our analysis would show, but clearly the distance to these tall structures helps explain sage-grouse occurrence.” Sage-grouse are more likely to be found as distance from power lines and communication towers increases. “Without the inclusion of these data, the modeling is less accurate,” Wisdom says.

It’s plausible that sage-grouse would be shy of structures so foreign to the environment in which they evolved. And although sage-grouse aren’t known as champion fliers, at times they do take to the sky, resulting in lethal encounters with towers and lines. “Studies have documented 5- to 10-mile migrations in some populations that shift habitat use seasonally between different ele-

vation zones. But overall we don’t know much about these behavioral patterns or the birds’ migratory pathways,” Wisdom notes.

Still, given the fairly small percentage of land occupied by transmission lines and cell towers, the mechanism for their negative effects remains obscure. “It could be that tall towers are proxies for concentrated human land use or clusters of environmental conditions we didn’t directly measure. Once you have roads into these sites, for example, all kinds of opportunities open up for other disturbances—water development for livestock, the spread of exotic plants, human-caused wildfires, and so on. Individually the effects of these lines and towers don’t seem dramatic, but over decades they can be cumulative and synergistic,” Wisdom says. It’s also possible that electromagnetic radiation from transmission lines are affecting sage-grouse, as studies have demonstrated harmful effects—particularly reproductive ones—in other avian species using areas close to power lines.

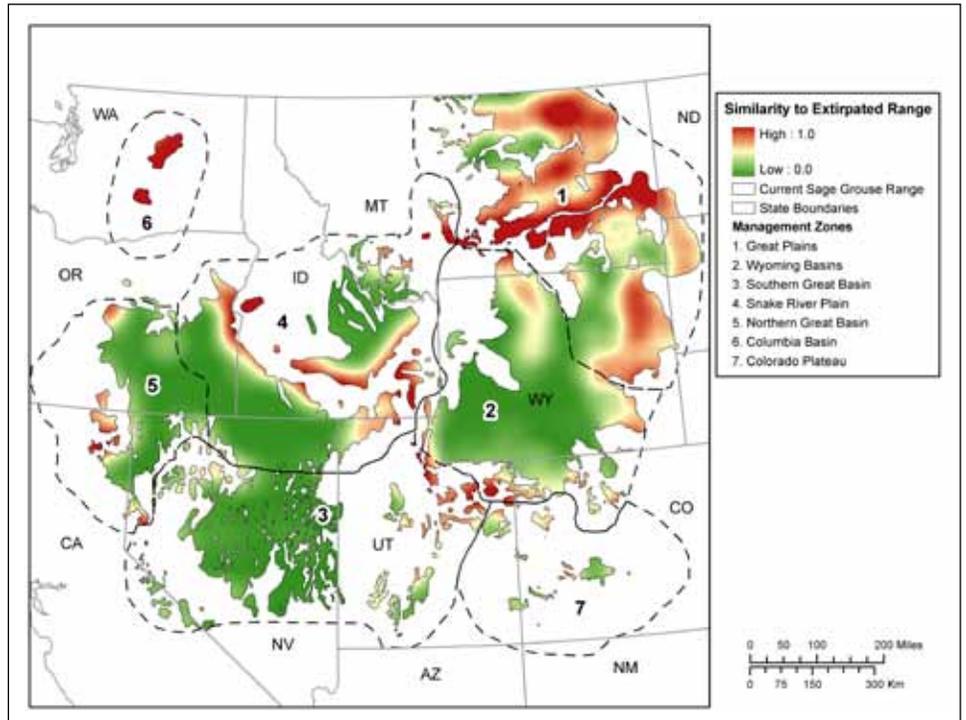
The proliferation of tall towers is one of the fastest growing sources of human disturbance in the West. Some places reportedly offering the highest potential for wind energy development coincide with some of the best remaining sage-grouse habitat. As well, plans abound for amplifying and expanding electric grids and saturating the region with cell phone coverage. “If we’re going to seriously address the range-wide conservation of sage-grouse, it’s crucial that we consider these structures in both research and management,” Wisdom says. As a member of a national working group on tall towers, he serves as a technical authority on sage-grouse relations with transmission lines, communication towers, and other intrusive structures.

# MANAGING FOR ENDURING SAGE-GROUSE POPULATIONS

The greatest losses in sage-grouse numbers and habitat have occurred on private land, where the most sweeping land use changes have taken place. With nearly 40 percent of remaining sage-grouse habitat privately held, private landowners have an important role to play in conserving the species. “Some landowners have initiated very effective habitat management efforts on their own—for example, sustainable livestock grazing systems that maintain sagebrush cover and native bunchgrasses,” Wisdom notes. Additional opportunities exist for public-private partnerships under a program developed by the USDA Natural Resources Conservation Service to manage and improve sage-grouse habitat across the species’ range.

Most of the currently occupied habitat, however, is on public land—50 percent managed by the Bureau of Land Management and 9 percent managed by the Forest Service—and this means what happens on the public portion of sage-grouse range likely will determine the species’ fate. Successful management for sage-grouse conservation will also benefit nearly 50 other animal species found in sage-grouse range, Wisdom adds.

The challenges of responding to sage-grouse needs and addressing threats to its survival on a range-wide scale are enormous. But it’s clear to Wisdom that the situation demands a change in course, as conventional management efforts have met with little or no success. “Take recent attempts to reestablish native grasses and sagebrush after wildfires in areas formerly occupied by cheatgrass, for example.



The most vulnerable sage-grouse habitat is shown in red; green areas are the least vulnerable. This output comes from a model that evaluated environmental similarities between current sage-grouse habitat and areas where the species no longer exists.

Reseeding needs to happen quickly to keep cheatgrass from recolonizing, but it also should be timed with rainfall, which is sparse and unpredictable, so the chances are slim for all the right conditions to come together,” he says.

Given financial limitations, Wisdom believes that using agency resources to modify land uses to maintain sage-grouse-friendly condi-

tions where they still exist may be more effective than trying to repair ruined habitat. “We’ve ignored factors associated with land uses and human activities that by themselves don’t seem so detrimental but in combinations have cumulative, synergistic effects,” Wisdom explains. “Immense changes have taken place across a huge species range that spans innumerable land ownerships and agency administrative boundaries. The situation calls for integrative management to improve conditions. Management actions are implemented locally, but they must fit appropriately into a well-considered, overarching plan to maximize their effectiveness. That’s probably the greatest challenge in terms of research and management.”

The kind of holistic landscape analysis Wisdom’s team performed is especially helpful in providing the “big picture” needed for understanding large-scale processes and environmental patterns affecting the species. And it can be applied on smaller, local scales. For example, resource managers will be able to use the models developed for the analysis to test the effects of actions they are considering for a given area. “It may take some time for the necessary technology transfer to happen,” Wisdom says, but that’s the aim of science-management partnerships: to adapt tools used for research to more specific management situations.”



Sagebrush habitats at higher elevations receive more precipitation, which helps the native plant communities be more resistant to invasive exotic plants.

M. Wisdom

The analysis also produced maps that can be used to identify sage-grouse strongholds—large areas of intact habitat where habitats and populations appear stable. Two extensive strongholds have been identified. One lies in the western part of the range, encompassing parts of Oregon, Nevada, and Idaho; the other spans nearly half of Wyoming. “These are key areas for focused management,” Wisdom says. “By concentrating on the specific threats that pose the highest risk in each stronghold, we have a good shot at sustaining sage-grouse populations over the long term. In the western strongholds, this means minimizing all human disturbances that facilitate the spread of invasive annual grasses. In eastern strongholds, new mitigation methods are required to ensure the maintenance of very large tracts of sagebrush habitats and minimize the negative effects of human activities and land uses—particularly widespread energy development.”

Wisdom acknowledges that this kind of “triage” strategy—which favors channeling resources to population strongholds in favor of other areas where sage-grouse are seriously threatened—is controversial. But agency budgets are far too limited for mounting intensive management programs across sage-grouse range, he says, and priorities must be set. “It’s a difficult issue that must be discussed and dealt with objectively, and we need to study the tradeoffs between different management proposals.”

The road ahead for the sage-grouse will doubtless continue to be a bumpy one, but Wisdom’s research and the other monograph studies have added considerably to the knowledge needed for conserving the species. Since the 2010 USFWS decision, these findings have been used in county, state, and federal planning activities across western North America. The federal Departments of the Interior and Agriculture have committed to adopting new

## FOR FURTHER READING

Wisdom, M.J.; Meinke, C.W.; Knick, S.T.; Schroeder, M.J. 2011. Factors associated with extirpation of sage-grouse. *Studies in Avian Biology Monograph*. 38: 451–472.

Miller, R.F.; Knick, S.T.; Pyke, D.A.; Meinke, C.W.; Hanser, S.E.; Wisdom, M.J. 2011. Sagebrush habitats: primary characteristics and key disrupters to long-term conservation. *Studies in Avian Biology Monograph*. 38: 145–184.

 <b>LAND MANAGEMENT IMPLICATIONS</b> 
<ul style="list-style-type: none"> <li>Reversing the ongoing losses in sage-grouse populations and habitats across their range will require planning and coordination among public agencies and private landowners. Opportunities exist for local management to be integrated with overarching landscape strategies.</li> </ul>
<ul style="list-style-type: none"> <li>Focusing management efforts on sage-grouse strongholds, where populations and habitats remain robust, is likely the most effective strategy for long-term conservation of the species. This will require concerted efforts to address specific threats posing the highest risks in different areas of the range.</li> </ul>
<ul style="list-style-type: none"> <li>Preserving vulnerable areas currently occupied by sage-grouse calls for adaptive management strategies, including research to design, implement, and evaluate the effectiveness of restoration management.</li> </ul>
<ul style="list-style-type: none"> <li>Through integrated management, the synergistic effects of detrimental human activities affecting sage-grouse habitats and populations can be reduced. Implementing holistic landscape strategies can help ameliorate effects from tall-tower structures and other disturbances that have not yet been addressed in a cohesive way.</li> </ul>

multiagency strategies for landscape management related to sage-grouse, and the USDA Natural Resources Conservation Service is using the monograph to guide the development of regional and national strategies for private land management of sage-grouse habitats.

*“Much of the damage inflicted on land is quite invisible to laymen. An ecologist must either harden his shell and make believe that the consequences of science are none of his business, or he must be the doctor who sees the marks of death in a community that believes itself well and does not want to be told otherwise.”*

—Aldo Leopold



N. Hedges

*The Washington ground squirrel is one of about 50 other species that would benefit from sagebrush habitat conservation.*

Knick, S.T.; Hanser, S.E.; Miller, R.F.; Pyke, D.A.; Wisdom, M.J. [et al.]. 2011. Ecological influence and pathways of land use in sagebrush. *Studies in Avian Biology Monograph*. 38: 203–251.

Connelly, J.W.; Braun, C.E.; Knick, S.T.; Baker, W.L.; Beever, E.A. [et al.]. 2011. Conservation of greater sage-grouse: a synthesis of current trends and future management. *Studies in Avian Biology Monograph*. 38: 549–563.

Connelly, J.W.; Hagan, C.A.; Schroeder, M.A. Characteristics and dynamics of greater sage-grouse populations. *Studies in Avian Biology Monograph*. 38: 53–68.

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