CUMULATIVE AND SYNERGISTIC IMPACTS

CHAPTER 29: THREAT ACCUMULATION AND INTERACTION

Cumulative impacts are those factors that act in concert with one another to increase effects, either in a beneficial or negative fashion, to a species or its habitat. Cumulative impacts can result from individually inconsequential, but collectively significant, actions taking place over a period of time. Cumulative impacts may be a total of the effects from multiple actions of the same type (e.g., agricultural conversion) occurring in different locations or it may be a total of the effects from two or more different types of actions (e.g., agricultural conversion and wildfire). We quantified the sum of these impacts by MZ and across all action types for which we had available data. For those actions that lacked a spatial data component, we evaluated them qualitatively. Furthermore, some actions may have impacts (direct and indirect) beyond their direct physical footprint. To account for this, we assigned an area of influence (AOI) to specific threats in instances with scientific literature support. An AOI is an area where direct habitat removal did not occur but the functional utility of the habitat has been lost. This loss of functional utility may be the result of sage-grouse behavioral avoidance or it may result in negative effects on various demographic parameters (e.g., nest survival) when the habitat is used (i.e., sink habitat). Therefore impacts may be measured by the direct footprint of the disturbance and/or may be measured by the direct footprint and the AOI.

As described in the previous ***Impact Analysis*** section, some individual actions are considered in a cumulative fashion depending on the relationship of the action various components. For example, a nonrenewable energy development may consist of a drill site, roads, waste water pits, power lines, human disturbance, and synanthropic predators, all of which have individually been demonstrated to negatively affect sage-grouse ecology. Due to the variation in resolution of available spatial data, we have combined these cumulative impacts and have not deconstructed the individual components. While the results of this analysis are inherently coarse, we consider this a reasonable approach to assessing cumulative impacts given the available spatial data. Nevertheless, consideration should be afforded to the potentially multiple components of an individual action when evaluating the actions overall impact. The individual chapters contained within the Impacts Section above more fully delineate the components of the various actions that can impact sage-grouse.

Some of the individual threats posed to sage-grouse conservation discussed in the ***Impact Analysis*** section often interact in ways more complex than simply additive. The result of these synergistic interactions may be a realized cumulative impact greater than the sum of its respective parts. This can be the result of feedback loops and the multiplicative nature of the two or more factors or the spatial arrangement of disturbances across a landscape. For example, across the range of sage-grouse, improper livestock grazing alone may only affect a portion of sage-grouse habitat. However, improper grazing combined with invasive plants, drought, and wildfire may collectively result in substantial habitat loss, degradation, or fragmentation across large portions of the species' range. Numerous threats are likely acting in concert, both synergistically and cumulatively to further contribute to the challenges faced by sage-grouse in the future.

Synergistic feedbacks between invasive plants and increased fire frequency and size has reduced sagebrush shrub cover and plant diversity and resulted in type conversions from sagebrush communities to non-native grassland landscapes (Miller *et al.* 2011, p. 183). We anticipate the loss of sage-grouse habitat from wildfire to increase due to the intensifying synergistic interactions among fire, people, invasives, and climate change (Miller *et al.* 2011, pp. 179–184). The recent past- and present-day fire regimes across the sage-grouse range have changed with a demonstrated increase in the more xeric Wyoming big sagebrush communities and a decrease across many mountain big sagebrush communities. Both scenarios of altered fire regimes have caused significant losses to sage-grouse habitat through facilitating invasive annual grass encroachment at lower elevation Wyoming big sagebrush sites and conifer expansion at higher elevation mountain big sagebrush sites (Miller *et al.* 2011, pp. 181–184). We also anticipate both of these scenarios to worsen in the face of climate change (Baker 2011, p. 200; Miller *et al.* 2011, p. 183). Predicted changes in temperature, precipitation, and carbon dioxide are all anticipated to influence vegetation dynamics and alter fire patterns resulting in the increasing loss and conversion of sagebrush habitats (Neilson *et al.* 2005, p. 157). Researchers have suggested that future drought simulations may underestimate decade-scale droughts and larger mega-droughts (Ault *et al.*2014, pp. 7545–7548). Further, many climate scientists suggest that in addition to the predicted change in climate toward a warmer and generally wetter Great Basin, variability of interannual and interdecadal wet-dry cycles will increase and likely act in concert with fire, disease, and invasives to further stress the sagebrush ecosystem (Neilson *et al.* 2005, p. 152). Lightning strikes are predicted to increase approximately 50 percent in the twenty-first century (Romps *et al.* 2014, p. 853). The anticipated increase in suitable conditions for wildfire will likely further interact with people and infrastructure. Human-caused fires have reportedly increased and been shown to be correlated with roads (Miller *et al.* 2011, p. 171). The most common human-caused fire starts were from power lines, vehicles, and equipment use (e.g., welding, cutting torches, chainsaws). These were followed by fires caused by railroads, warming/cooking fires, agricultural/debris burning, and fireworks (Havlina *et al.* 2014, pp. 2, 23). Additionally, given the popularity of OHVs and the ready access to lands in the Great Basin, the increasing trend in both fire ignitions by people and loss of habitat will likely continue.

We anticipate the increased amount of land use activities will also have a significant impact on the soils, biological soil crusts, and vegetation of these systems and their ability to recover from the cascading effects created by invasives, fire, and climate change (Belnap *et al.* 2006, p. 73). Invasives are readily dispersed along roads (Forman and Alexander 1998, p. 210; Forman 2000, p. 32; Gelbard and Belnap 2003, p. 426; Knick *et al.* 2003, p. 619; Connelly *et al.* 2004, p. 7–25) and trail corridors and establishment is favored by anthropogenic disturbance and human land use activities and associated infrastructure (Banks and Baker 2011, p. 384). In Wyoming, the abundance and distribution of invasive plants increased with infrastructure, including linear features such as roads (highways, major and minor unpaved thoroughfares, spurs and driveways, and two-tracks), pipelines, transmission lines, and site-specific features, such as active and reclaimed well pads (Manier *et al.* 2011, p. 10). Human developments, such as buildings, may also provide sites for cheatgrass colonization (Banks and Baker, p. 384). These anthropogenic features can facilitate establishment of invasive plants in adjacent sagebrush communities and elsewhere across the landscape, negatively affecting sage-grouse through habitat loss and ecosystem conversion.

Progressive losses of resilience and resistance can result in the crossing of abiotic and biotic thresholds (Beisner *et al.* 2003, pp. 376–382) and may lead to a catastrophic shift in community structure (Scheffer *et al.* 2009, pp. 53–59; Reisner *et al.* 2013, p. 1047). Functional habitat loss is occurring because of long-term loss of sagebrush cover and conversion to nonnative annual grasses (primarily cheatgrass), mainly due to an increase in fire occurrence, intensity, and severity (Miller *et al.* 2011, p. 183). The positive feedback process between cheatgrass and fires facilitates future fires, sagebrush loss, and cheatgrass dominance, resulting in entire landscapes being converted to nonnative annual grasslands (Miller *et al.* 2011, p. 183). Interactions among disturbances and stressors may have cumulative effects (Chambers *et al.* 2014a, pp. 365–368). Invasive annual grasses and noxious perennials continue to expand their range, facilitated by ground disturbances, caused by more frequent and more severe wildfires, overgrazing of native perennial plants by domestic livestock and free-roaming equids, infrastructure, and other anthropogenic activity (Rice and Mack 1990, p. 84; Gelbard and Belnap 2003, p. 420; Zohar *et al.* 2008, p. 23), but disturbance is not required for invasives to spread (Young and Allen 1997, p. 531; Roundy *et al.* 2007, p. 614). Invasions also may occur sequentially, where initial invaders (e.g., cheatgrass) are replaced by new invasive plants (Crawford *et al.* 2004, p. 9; Miller *et al.* 2011, p. 160). Long-term changes in climate that facilitate invasion and establishment by invasive annual grasses further exacerbate the fire regime and accelerate the loss of sagebrush habitats (D’Antonio and Vitousek 1992, pp. 63–87). The effects of disturbance will likely be amplified by greater susceptibility of habitats to burn as well as decreased likelihood for recovery of sagebrush-steppe communities (Miller *et al.* 2011, p. 183).

Concern with habitat loss and fragmentation due to fire and invasive plants has mostly been focused in the western portion of the species’ range. However, climate change may alter the range of invasive plants, potentially expanding this threat into other areas of the species’ range. The establishment of invasive annual grasses will then contribute to increased fire frequency in those areas, further compounding habitat loss and fragmentation. The fire-invasives feedback loop may be promoted by warmer, wetter winters and a subsequent increase in establishment and growth of invasive winter annuals. These cycles may be exacerbated by rising atmospheric carbon dioxide concentrations, nitrogen deposition, and increases in human activities that result in soil surface disturbance and invasion corridors (Chambers *et al.* 2014a, pp. 367–368). Cheatgrass already competes successfully against native perennial grasses because of early maturation, short root systems to collect water in soils, greater seed production, and the ability to respond quickly to resources released during disturbance. Thus, the ability of cheatgrass to compete in sagebrush ecosystems created by enhanced carbon dioxide or changes in the length of the growing season, temperature, or the frequency of wet winters will likely facilitate the establishment of invasive annual grasses and intensify the fire cycle and cheatgrass dominance (D’Antonio and Vitousek 1992, pp. 74–75; Ziska *et al.* 2005, pp. 1330–1331).

Other land uses, including threats associated with recreation activities are often tied with other impacts described in this species report. These associated threats may increase the number of humans or access to recreational areas within sage-grouse habitat. Urbanization and increases in human population centers may increase recreation activities near those urban centers and expand the areas where recreation activities are likely to occur. Recreationalists, such as OHV users, using roads and corridors through sage-grouse habitat may increase disturbance to lekking and nesting activities as well as facilitate the spread of invasives (Patterson 1952, p. vi; Knick *et al*. 2011, p. 219). Increased hunting and recreation may also be facilitated by infrastructure such as roads and trails. Hunting of sage-grouse or other species occurring in sage-grouse habitat, including, but not limited to, pronghorn antelope, mule deer, elk, and upland game birds, may increase human presence in an area and have similar impacts as other recreational activities (e.g., noise, garbage, and/or habitat impacts). Other infrastructure, such as camping areas, restrooms, and visitor centers, would likely increase recreational activities. Contaminants to sage-grouse, such as fuel for OHVs, pet waste, and garbage, are associated with recreational activities. Pesticide use may increase in areas used by humans for recreation, as herbicides may be used in trail maintenance and humans may use insecticides during recreational activities. Predators of sage-grouse may be attracted to areas used by humans for recreational activities and garbage may sustain increased densities of predators in these areas (Bui 2009, p. X). Pets accompanying humans during recreational activities could act as predators to sage-grouse if not under strict control of their owner. Wildfire threats may increase in areas with recreational activities if participants start campfires or use cigarettes in dry conditions and do not properly extinguish them (NWCG 1999, p. 1).

Abundance of red foxes, raccoons, and corvids, which historically were rare in the sagebrush landscape, has increased in association with human-altered landscapes (Johnson and Cassidy 1997, p. 222; Sovada *et al.* 1995, p. 5; Luginbuhl *et al.* 2001, p. 570). Ranches, farms, and housing developments have resulted in the introduction of nonnative predators including domestic dogs and cats into sage-grouse habitats (Connelly *et al.* 2000b, p. 975; Connelly *et al.* 2004, p. 7-24). The addition of these nonnative predators has increased predation on sage-grouse (Hagen 2011, p. 98). Raven abundance has increased as much as 1,500 percent in some areas of western North America since the 1960s, thriving on human-altered landscapes. Local attraction of ravens to nesting females may be facilitated by loss and fragmentation of native shrublands (e.g., infrastructure to support urbanization and energy development; Aldridge and Boyce 2007, p. 522; Bui 2009, p. 32). Anthropogenic structures in the environment increase the abundance of avian predation, particularly in low canopy cover areas, by providing ravens and raptors with hunting perches (Coates 2007, p. 155; Bui 2009, p. 2; Coates *et al.* 2014, p. 352). Development, including oil and gas infrastructure, residential houses, communication towers, power lines, fences, and trees, provide perching and nesting habitat for predatory birds (Dinkins *et al.* 2012, p. 320). Trash, landfills, and road-kill have the potential to subsidize predator food sources, especially ravens (Kristan III *et al.* 2004, p. 250; Coates and Delehanty 2010, p. 244). As more suitable sage-grouse habitat is converted to and impacted by oil fields, agriculture, and other exurban development, sage-grouse nesting and brood-rearing become increasingly spatially restricted (Bui 2009, p. 32). High sage-grouse nest densities, which result from habitat fragmentation or disturbance associated with the presence of edges, fencerows, or trails may increase predation rates because predators can more efficiently locate prey in these environments (Holloran 2005, p. C37; Holloran and Anderson 2005, p. 748).

The incidence of WNv in sage-grouse and its impacts to the species can be exacerbated by other threats across the range, including aspects of habitat loss and degradation, sources of direct mortality, and climate change. Climate change has the potential to increase the incidence and distribution of WNv in the range of sage-grouse through increasing temperatures and precipitation. Human activities can affect the availability and distribution of mosquito breeding habitat, a key limiting factor in the WNv transmission cycle (Zou *et al.* 2006, p. 1035). Anthropogenic water sources, such as ponds and ditches filled by irrigated agriculture, stock tanks and ponds, and discharge ponds from coal-bed natural gas extraction, provide mosquito habitat that would not otherwise exist in the arid sagebrush-steppe habitat that comprises most of the range of sage-grouse (Naugle *et al.* 2004, p. 711; Doherty 2007, pp. 36–37; Zou *et al.* 2006, p. 1039). This expansion of persistent surface water and mosquito breeding habitat can facilitate WNv persistence and its spread across the landscape (Friend *et al.*, 2001, p. 298; Zou *et al.* 2006, p.1040; Walker and Naugle 2011, p. 139).

Diseases that have only density-dependent, regulatory effects on highly connected populations of abundant species can cause the extirpation of small, isolated populations that do not have the numbers or resilience to rebuild themselves following a mortality event (Peterson 2004, p. 38 and references therein). Isolated, small, or genetically depauperate populations of sage-grouse, such as those at the periphery of the species' range or that result from habitat fragmentation likely face the greatest risk from WNv (Walker and Naugle 2011, p. 140). Twenty-seven populations are identified (USFWS 2013a, pp. 16–29). Conversely, larger populations, such as those in the center of the species' range, probably are better able to sustain and recover from WNv outbreaks simply owing to their size and connectivity (Walker and Naugle 2011, p. 140). However, if human impacts to sage-grouse habitat increase in these areas, and connectivity within or among populations is reduced, sage-grouse strongholds (e.g., in southwestern Wyoming and the northern Great Basin) will become fragmented into small, isolated populations that are more vulnerable to extirpation (Knick and Hanser 2011, pp. 404–405).

Mortality from WNv combined with other anthropogenic sources of direct mortality of sage-grouse can raise mortality to levels that result in local, population-level impacts. Recreational hunting or predation by synanthropic predators can have localized population-level impacts when combined with other sources of anthropogenic mortality such as WNv (Stiver *et al.* 2006, p. 2-13). For example, in 2006 and 2007, sage-grouse mortality to WNv in South Dakota was estimated to be between 21 and 63 percent of the monitored population (Kaczor 2008, p.72), compounded by mortality from hunting when regulations were not adjusted accordingly in those years . However, it is important to recognize that although hunting, disease, and predation may have direct effects on some sage-grouse populations, the effects of these factors on rangewide population persistence are relatively small compared to indirect effects on populations by habitat loss and degradation. (Manier *et al.* 2013, p. 23).

The impacts described in this species report may vary in relative importance among MZs but are inclusive and representative of the suite of threats across the species range. Human land use and both natural and anthropogenic disturbance will continue to be the dominant stressors on sagebrush communities and we anticipate their individual and cumulative effects will challenge long-term conservation of sage-grouse populations (Knick *et al.* 2011, pp. 203–204). We acknowledge that the cumulative and synergistic effects of land use changes described in this species report may result in landscape-scale changes across the range of the species or may influence population persistence in some regions within the sage-grouse range. Ultimately, the cumulative impact of these potential stressors, rather than a single factor, will have the most significant influence on the trajectory of sagebrush-steppe ecosystems into the foreseeable future (Knick *et al.* 2011, p. 249).

Below we describe the cumulative impact to sage-grouse and sage-grouse habitat by MZ, derived by summing effects due to variety of threats. We further forecast the potential risk to sage-grouse based on potential future development. Finally, we attempt to quantify the realized risk to sage-grouse in the foreseeable future by discounting cumulative impacts with implemented conservation efforts intended to restore past degradations and regulatory mechanisms intended to limit future development.

Mz I - Northern Great Plains: Management Zone 1 is within the Great Plains floristic province and encompasses the northeastern distribution of sage-grouse (Figure 29-1). This MZ has 12.4 percent of the birds across the range. This MZ has a high percentage of private lands (USFWS 2013, p. 63). The COT Report (USFWS 2013, entire) identified the primary threats for this MZ as habitat loss, fragmentation, and degradation as a result of conversion of native areas to cropland and energy development with its associated infrastructure (USFWS 2013, pp. 16–17; Table 29-1). Sage-grouse populations in this MZ also experienced significant negative population impacts from WNV outbreaks beginning in the early 2000s.

Table 29-1. Extent of existing impacts in MZ I. Missing values do not mean there are no data, but simply that the table is incomplete.

		Occupied Range				Modeled Breeding Distribution			
		Direct		AOI		Direct		AOI	
		Acres	%	Acres	%	Acres	%	Acres	%
Tier 1	Wildfire								
	Invasives	405,051	0.9			53,315	0.5		
	Conifer								
	Ag Conversion								
	Oil&Gas								
Tier 2	Mining								
	Wind	1,167	0.003	278,786	0.6	538	0.005	82,890	0.8
	Solar								
	Geothermal	0	0			0	0		

	Interstates	16,774	0.04	2,752,289	6	1,852	0.02	321,332	3.1
	Federal &State Highways	23,462	0.05	5,812,988	12.6	2,703	0.03	710,754	6.9
	Railroads	4,807	0.01			324	0		
	Power (>115kV)	118,503	0.26	11,193,378	24.3	15,021	0.15	1,576,874	15.3
	Power (<115kV)	221,514	0.48	2,159,307	4.7	26,911	0.26	381,703	3.7
	Comm. Towers	5,699	0.0124			457	0.0044		
	Urban	13,058	0.03	4,335,812	9.4	299	0	352,966	3.4
	Exurban	112,692	0.24			2,983	0.03		
	Urban (other)	10,960	0.02			357	0		
Tier 3	Fences								
Tier 3	Grazing (not meet LHS)	338,496	0.7			140,304	1.4		
Tier 3	Equids (HMA acres)	0	0			0	0		
	Totals	1,272,183	2.7454	26,532,560	57.6	245,064	2.3994	3,426,519	33.2

Figure 29-1. Spatial depiction of cumulative impacts in MZI.

MZ II – Wyoming Basin: Management Zone II is within the Wyoming Basin floristic province and contains the highest abundance of sage-grouse relative to all other MZs (36.8 percent). This MZ contains five separate populations, but is dominated by the expansive Wyoming Basin population. Primary threats identified in the COT Report (USFWS 2013, pp. 17–19) for this MZ include habitat loss, fragmentation, and degradation as a result of energy development with its associated infrastructure (Table 29-2; Figure 29-2).

Table 29-2. Extent of existing impacts in MZ II. Missing values do not mean there are no data, but simply that the table is incomplete.

		Occupied Range				Modeled Breeding Distribution			
		Direct		AOI		Direct		AOI	
		Acres	%	Acres	%	Acres	%	Acres	%
Tier 1	Wildfire								
	Invasives	1,252,889	3.4			306,400	2.6		
	Conifer								
	Ag Conversion								
	Oil&Gas								
Tier 2	Mining								
	Wind	1,407	0.004	315,589	0.9	605	0.005	127,202	1.1
	Solar								
	Geothermal	0	0			0	0		
	Interstate	15,251	0.04	1,967,258	5.3	1,122	0.01	351,168	2.9
	Federal &State Highways	26,317	0.07	6,374,926	17.2	6,962	0.06	1,793,002	15.1
	Railroads	5,130	0.01			686	0.01		
	Power (>115kV)	146,989	0.4	12,579,259	34	46,175	0.39	4,332,616	36.4
	Power (<115kV)	212,198	0.57	2,170,436	5.9	40,558	0.34	453,783	3.8
	Comm. Towers	7,652	0.0207			1,168	0.0098		
	Urban	14,114	0.04	6,429,994	17.4	2,983	0.03	1,111,211	9.3
	Exurban	237,371	0.64			22,827	0.19		
	Urban (other)	14,371	0.04			456	0		
Tier 3	Fences								
	Grazing (not meet LHS)	705,551	1.9			394,283	3.3		
	Equids (HMA acres	4,929,155	13.3			1,530,957	12.9		
	Totals	7,568,395	20.4347	29,837,462	80.7	2,355,182	19.8448	8,168,982	68.6

Figure 29-2. Spatial depiction of cumulative impacts in MZII.

MZ III – Southern Great Basin: Management Zone III is within the Southern Great Basin floristic province. This MZ contains five populations, and includes the Bi-State DPS (which is not discussed further). This MZ is home to approximately 12.2 percent of the entire sage-grouse population. Due to soil type and precipitation, this MZ is the driest of all MZ across the species' range. Therefore, habitat loss due to fire is a predominant threat (Table 29-3; Figure 29-3).

Table 29-3. Extent of existing impacts in MZ III. Missing values do not mean there are no data, but simply that the table is incomplete.

		Occupied Range				Modeled Breeding Distribution			
		Direct		AOI		Direct		AOI	
		Acres	%	Acres	%	Acres	%	Acres	%
Tier 1	Wildfire								
	Invasives	2,070,425	7.2			263,942	3.1		
	Conifer								
	Ag Conversion								
	Oil&Gas								
Tier 2	Mining								
	Wind	328	0.001	87,444	0.3	0	0	5,702	0.1
	Solar								
	Geothermal	6	0.00002			0	0		
	Interstates	6,888	0.02	1,052,355	3.7	396	0	96,415	1.1
	Federal &State Highways	14,142	0.05	3,477,026	12.1	5,534	0.07	1,342,671	15.8
	Railroads	2,072	0.01			284	0		
	Power (>115kV)	109,209	0.38	9,015,016	31.3	32,088	0.38	2,696,396	31.8
	Power (<115kV)	67,524	0.23	2,170,436	5.9	11,676	0.14	453,783	3.8
	Comm. Towers	3,306	0.0115			944	0.0111		
	Urban	5,275	0.02	2,667,817	9.3	856	0.01	803,257	9.5
	Exurban	138,956	0.48			33,757	0.4		
	Urban (other)	5,487	0.02			834	0.01		
Tier 3	Fences								
	Grazing (not meet LHS)	4,338,253	15.1			1,534,250	18.1		
	Equids (HMA acres)	8,434,802	29.3			2,422,530	28.6		
	Totals	15,196,673	52.8	18,470,094	62.6	4,307,091	50.821	5,398,224	62.1

Figure 29-3. Spatial depiction of cumulative impacts in MZIII.

MZ IV – Snake River Plain: The management zone includes sage-grouse in parts of Montana, Utah, Nevada and Oregon, but most of the birds occur in Idaho (Garton *et al.* 2011, p. 340). It is one of the largest areas of connected sage-grouse habitats and supports the largest population of sage-grouse outside of MZ II (30.2 percent of total birds; USFWS 2013, p. 75). Primary threats in this MZ are fire and invasive annual grasses (Table 29-4; Figure 29-4).

Table 29-4. Extent of existing impacts in MZ IV. Missing values do not mean there are no data, but simply that the table is incomplete.

		Occupied Range				Modeled Breeding Distribution			
		Direct		AOI		Direct		AOI	
		Acres	%	Acres	%	Acres	%	Acres	%
Tier 1	Wildfire								
	Invasives	5,316,843	13.8			1,620,418	14		
	Conifer								
	Ag Conversion								
	Oil&Gas								
Tier 2	Mining								
	Wind	555	0.001	123,092	0.3	33	0	8,783	0.1
	Solar								
	Geothermal	6	0.00002			0	0		
	Interstates	11,026	0.03	1,964,764	5.1	2,198	0.02	326,407	2.8
	Federal &State Highways	17,535	0.05	4,434,105	11.5	4,499	0.04	1,187,110	10.3
	Railroads	2,139	0.01			369	0		
	Power (>115kV)	169,224	0.44	13,538,149	35	49,361	0.43	3,952,888	34.2
	Power (<115kV)	92,103	0.24	1,060,411	2.7	18,484	0.16	213,255	1.8
	Comm. Towers	3,032	0.0078			884	0.0077		
	Urban	1,719	0	5,703,315	14.8	736	0.01	1,122,423	9.7
	Exurban	65,578	0.17			9,544	0.08		
	Urban (other)	5,295	0.01			1,148	0.01		
Tier 3	Fences								
	Grazing (not meet LHS)	3,834,539	9.9			1,323,466	11.5		
	Equids (HMA acres)	2,081,815	5.4			332,093	2.9		
	Totals	11,601,409	30.0588	26,823,836	69.4	3,363,233	29.157	6,810,866	58.9

Figure 29-4. Spatial depiction of cumulative impacts in MZIV.

MZ V – Northern Great Basin: This MZ includes sage-grouse in parts of Oregon, Nevada and California (Garton *et al.* 2011, p. 351). The BLM is the primary landowner. This MZ is home to 7.4 percent of the population rangewide, and is considered part of a stronghold of birds in combination with the Snake River Plain to the east (USFWS 2013, p. 80). Primary threats in this MZ include habitat loss due to fire, invasive annual grasses, and conifers (Table 29-5; Figure 29-5).

Table 29-5. Extent of existing impacts in MZ V. Missing values do not mean there are no data, but simply that the table is incomplete.

		Occupied Range				Modeled Breeding Distribution			
		Direct		AOI		Direct		AOI	
		Acres	%	Acres	%	Acres	%	Acres	%
Tier 1	Wildfire								
	Invasives	1,621,426	8.4			233,977	6.8		
	Conifer								
	Ag Conversion								
	Oil&Gas								
Tier 2	Mining								
	Wind	0	0	3,886	0	0	0	0	0
	Solar								
	Geothermal	0	0			0	0		
	Interstates	994	0.01	172,333	0.9	0	0	6,381	0.2
	Federal &State Highways	10,021	0.05	2,437,598	12.6	612	0.02	241,312	7
	Railroads	855	0			0	0		
	Power (>115kV)	73,115	0.38	6,198,588	32	14,343	0.41	1,164,305	33.6
	Power (<115kV)	67,041	0.35	680,063	3.5	4,589	0.13	72,928	2.1
	Comm. Towers	1,792	0.0093			55	0.0016		
	Urban	10,982	0.06	1,705,838	8.8	0	0	71,708	2.1
	Exurban	88,109	0.46			1,603	0.05		
	Urban (other)	6,732	0.03			0	0		
Tier 3	Fences								
	Grazing (not meet LHS)	878,625	4.5			336,887	9.7		
	Equids (HMA acres)	4,507,290	23.3			854,942	24.7		
	Totals	7,266,982	37.54	11,198,306	57.8	1,447,008	41.8116	1,556,634	45

Figure 29-5. Spatial depiction of cumulative impacts in MZV.

MZ VI – Columbia Basin: Management Zone VI is contained entirely within Washington State and is comprised of 4 populations. Two of the populations were extirpated, but sage-grouse have been re-introduced within the last decade with uncertain long-term success (USFWS 2013, pp. 86–87). This MZ has 0.6 percent of the total sage-grouse population. The State of Washington has an active recovery program for sage-grouse, which is listed under state laws. Primary threats to this MZ is small population sizes and agricultural conversion (Table 29-6; Figure 29-6).

Table 29-6. Extent of existing impacts in MZ VI. Missing values do not mean there are no data, but simply that the table is incomplete.

		Occupied Range				Modeled Breeding Distribution			
		Direct		AOI		Direct		AOI	
		Acres	%	Acres	%	Acres	%	Acres	%
Tier 1	Wildfire								
	Invasives	223,789	8.1			68,978	6.3		
	Conifer								
	Ag Conversion								
	Oil&Gas								
Tier 2	Mining								
	Wind	0	0	18,394	0.7	0	0	11,056	1
	Solar								
	Geothermal	0	0			0	0		
	Interstates	1,772	0.06	209,486	7.6	411	0.04	65,167	5.9
	Federal &State Highways	2,450	0.09	666,803	24.2	856	0.08	238,940	21.7
	Railroads	382	0.01			20	0		
	Power (>115kV)	73,115	0.38	6,198,588	32	14,343	0.41	1,164,305	33.6
	Power (<115kV)	67,041	0.35	680,063	3.5	4,589	0.13	72,928	2.1
	Comm. Towers	670	0.0243			158	0.0144		
	Urban	1,065	0.04	630,275	22.9	47	0	98,141	8.9
	Exurban	18,881	0.68			368	0.03		
	Urban (other)	640	0.02			53	0		
Tier 3	Fences								
	Grazing (not meet LHS)								
	Equids (HMA acres)	0	0			0	0		
	Totals	389,805	9.7543	8,403,609	90.9	89,823	7.0044	1,650,537	73.2

Figure 29-6. Spatial depiction of cumulative impacts in MZVI.

MZ VII – Colorado Plateau: This MZ is located in northwest Colorado and consists of two populations. It contains 0.3 percent of the range-wide population. This MZ has no known connectivity with Utah to the west, but appears to have some linkage to MZ II to the north. The primary concern for this MZ is the isolated nature of the populations and energy development (USFWS 2013, pp. 87–88; Table 29-7; Figure 29-7).

Table 29-7. Extent of existing impacts in MZ VII.. Missing values do not mean there are no data, but simply that the table is incomplete.

		Occupied Range				Modeled Breeding Distribution			
		Direct		AOI		Direct		AOI	
		Acres	%	Acres	%	Acres	%	Acres	%
Tier 1	Wildfire								
	Invasives	44,374	3.8			632	0.4		
	Conifer								
	Ag Conversion								
	Oil&Gas								
Tier 2	Mining								
	Wind	0	0	0	0	0	0	0	0
	Solar								
	Geothermal	0	0			0	0		
	Interstates	0	0	6,310	0.5	0	0	256	0.2
	Federal &State Highways	0	0	0	0	0	0	0	0
	Railroads	3	0			0	0		
	Power (>115kV)	1,823	0.15	6,198,588	32	0	0	8,258	5.1
	Power (<115kV)	0	0	128,365	10.9	0	0	2,717	1.7
	Comm. Towers	133	0.0112			21	0.0133		
	Urban	6	0	47,341	4	0	0	3,327	2.1
	Exurban	162	0.01			0	0		
	Urban (other)	2	0			0	0		
Tier 3	Fences								
	Grazing (not meet LHS)								
	Equids (HMA acres)	8,536	0.7			7,269	4.5		
	Totals	55,039	4.6712	6,380,604	47.4	7,922	4.9133	14,558	9.1

322

Figure 29-7. Spatial depiction of cumulative impacts in MZVII.