A Framework to Identify Greater Sage-grouse Priority Areas and General Areas in Management Zone IV and the Bear Lake Plateau of Southeastern Idaho

September 27, 2011

Paul Makela-Wildlife Biologist and Don Major-Landscape and Fire Ecologist
U.S. Bureau of Land Management
Idaho State Office
Resources and Science Branch
Boise, Idaho

Purpose: In March 2010, U.S. Bureau of Land Management (BLM) Washington Office Instruction Memorandum (IM) 2010-071 (Bureau of Land Management 2010) directed field office managers to implement appropriate conservation actions in priority sage-grouse habitat. "Priority habitat" is defined as "the habitat of highest conservation value relative to maintaining sustainable sage-grouse populations range-wide." Subsequent guidance also directed BLM to identify sage-grouse general habitat areas, comprised of occupied habitat occurring outside of priority areas. The purpose of this paper is 1) to document the background, rationale and processes used in identifying greater sage-grouse (sage-grouse) "Priority Areas" (PAs) and associated "General Areas" (GAs) for Idaho; and, 2) to describe considerations for use of this information in conservation planning. PAs represent high priority sage grouse areas characterized by a combined high male lek attendance, high lek density and high lek connectivity. GAs represent areas of occupied sage-grouse habitats not contained within PAs. GAs may serve as important connectivity corridors between PAs, potential stepping stones (habitat islands) for grouse movements within corridors, or occupied habitats characterized by low lek density. Portions of GAs may also encompass areas with potential data gaps requiring additional evaluation and lek survey efforts.

It should be noted that due to the regional scale of the analysis and nature of the modeling techniques used, PAs and GAs include areas of sage-grouse habitat as well as some inclusions of non-habitat. Consequently, finer-scale habitat information will be necessary to inform local conservation efforts. Many areas of sage-grouse habitat in Idaho are contiguous with habitats in the neighboring states of Utah, Nevada, Oregon, and Montana. Therefore we chose to use the Western Association of Fish and Wildlife Agencies (WAFWA) sage-grouse management zone IV (MZ IV; Figure 1) as the primary analysis boundary, to provide a regional context for the PAs and GAs. While MZ IV encompasses the vast majority of the sage-grouse habitat in Idaho, it excludes habitat in the Bear Lake Plateau area located in the extreme southeastern portion of the state. This area is associated with WAFWA MZ II (Wyoming Basin) and PAs/GAs were therefore identified separately.

In September 2011, we completed the modeling of PAs and GAs. Throughout this effort, many helpful suggestions were provided by sage-grouse experts with the Idaho Department of Fish and Game, Montana Department of Fish, Wildlife, and Parks, Nevada Department of Wildlife,

Oregon Department of Fish and Wildlife, U.S. Geological Survey, U.S. Fish and Wildlife Service and BLM State Offices in Colorado, and Utah, and the BLM National Operations Center.

Background: Other mapping efforts over the past decade have guided sage-grouse conservation planning in Idaho, and provide important context for the current PA modeling effort.

In 2000, Idaho BLM drafted "A Framework to Assist in Making Sensitive Species Habitat Assessments for BLM-Administered Public Lands in Idaho- Sage-grouse" (Sather-Blair et al. 2000). This document, released to field offices via Idaho BLM IM 2000-059 (Bureau of Land Management, 2000) outlined recommended field protocols for assessing sage-grouse habitats and also described a process for mapping sage-grouse habitat and potential restoration areas at the broad scale, to aid in conservation planning in the state. The resulting *Idaho Sage-grouse Habitat Planning Map* has been updated annually since that time, based on expert opinion, remote imagery and wildfire polygons. This map displays only general habitats (e.g., key habitat, perennial and annual grasslands, conifer encroachment and does not reflect the relative importance or priority of those habitat areas with respect to sage-grouse population characteristics.

Additional state and federal agency collaborative mapping efforts in Idaho during the past decade also identified sage-grouse population areas assumed to be "strongholds" and "isolated populations", based on local biological expertise and lek information. This map was briefly utilized by Idaho BLM and conservation partners as a means to identify potentially important population areas. However, this map was never updated from the original version (c.a. 2002) due to a lack of adequate sage-grouse population-level information, and has since been abandoned pending the availability of more suitable and defensible population data and analytical techniques.

In 2006, the Idaho Sage-grouse Advisory Committee (SAC) completed the "*Conservation Plan for the Greater Sage-grouse in Idaho*" (State Plan; Idaho Sage-grouse Advisory Committee 2006), which incorporated recent science and conservation measures into a more comprehensive state-level sage-grouse conservation plan. Recognizing the limitations of the Idaho Sage-grouse Habitat Planning Map, the SAC recommended in a 2009 update to Chapter 6 of the State Plan, that Idaho "continue to explore and review emerging remote-sensing tools and products that would have the capability and accuracy to refine or replace the Sage-grouse Habitat Planning Map." As a follow-up to that recommendation, Idaho BLM and Idaho Department of Fish and Game (IDFG) embarked on a Challenge Cost Share project in 2010 to model sage-grouse general habitat and seasonal habitats. These spatial models (Knetter et al., in progress) are nearing completion, and are anticipated to provide an objective, repeatable and seamless portrayal of habitats across the state.

We initiated the delineation of sage-grouse PAs in 2010, in response to BLM IM 2010-071, and because of the need to effectively focus conservation efforts. To provide a more consistent analytical foundation rangewide and to further promote the mapping of sage-grouse priority areas at the state level, the BLM Washington Office at that time also entered into an Assistance Agreement with the U.S. Fish and Wildlife Service (FWS) to model sage-grouse "breeding bird

density" (BBD; Doherty et al. 2011) at three scales: 1) across the range of the species; 2) by WAFWA sage-grouse management zone; and 3) by individual state, following Doherty et al. (2011). Following delivery of the BBD models in September 2010, we resumed the drafting of PAs for Idaho as described below.

Study Area: Stiver et al. (2006) identified seven "sage-grouse management zones" (Figure 1) within the geographic distribution of the greater sage-grouse, based on sage-grouse populations and subpopulations occurring within seven floristic provinces (Connelly et al. 2004). These zones reflect ecological issues and similarities conducive to more effective and efficient conservation planning.

Idaho is almost entirely within MZ IV with the exception of a small corner of southeastern Idaho. Zone IV also includes portions of southwestern Montana, northwestern Utah, northern Nevada and southeastern Oregon. While Idaho comprises the majority of MZ IV, numerous sage-grouse leks and potentially important habitats and populations/subpopulations occur in proximity to Idaho's border in the adjoining MZ IV states. Therefore, Idaho BLM chose to expand its priority area analysis to incorporate available sage-grouse and habitat information for those adjoining states. This approach has important conservation implications in that it incorporates aspects of interstate population and habitat connectivity that would be overlooked if we limited the scale of analysis to Idaho. A regional approach to sage-grouse conservation planning such as this warrants consideration by other states that are a part of multi-state WAFWA management.

Methods and Results: A primary goal in modeling draft PAs and GAs was to integrate currently available population and habitat data and current modeling techniques into a transparent and repeatable framework. A second goal was to ensure that the draft PAs and GAs were driven by the biology and ecology of sage-grouse. Lek data were acquired, with permission, from state wildlife agencies within MZ IV. For habitat data, BLM Idaho used the BLM currently occupied habitat (COH) model (Durtsche et al. 2009) and assumed for purposes of this analysis that the COH product provides a reasonable portrayal of occupied sage-grouse habitat across the range of the species. Other seamless sage-grouse habitat models were not available however new habitat models can be considered and incorporated into the PA analysis as they become available.

In modeling sage-grouse PAs, BLM Idaho used 1) a Breeding Bird Density (BBD) index of sage-grouse abundance based on male attendance at leks, and 2) lek connectivity to inform the broader spatial distribution of leks. BLM Idaho assumed that BBD adequately informs the PA model as to the relative "importance" of areas with respect to recent breeding bird numbers. Lek connectivity informs the PA model as to the likely, longer-term connectedness between leks, assuming that leks in proximity to one another are more "connected" than those farther apart (Knick and Hanser 2011). Spatial data on sage-grouse late brood-rearing, fall or winter habitats were not readily available, and therefore not included in the model. However, given the buffers (6.4 km and 8.5 km) used in the BBD component and the 18 km window of the lek connectivity analysis, a significant portion of these non-breeding habitats are likely included.

<u>Breeding Bird Density</u>**:** BBD analyses involve ranking leks by attendance (e.g. highest to lowest numbers of males) and summing the number of males until a desired percent-population

threshold is met (e.g., the top 25%, 50%, 75% etc., of the population). With lek locations and abundance being large drivers in the model, BBD results are, by definition, highly correlated with breeding habitat. Incorporation of other important seasonal habitat information (e.g., fall, winter, late brood) when available, will provide additional rigor to the model.

We evaluated two BBD methods: 1) the original Doherty et al. (2011) model which uses a 10-year time period (2001-2010), the most recent average annual maximum lek counts, and a minimum male count =1 to identify high male abundance areas and 2) a modified Doherty version using a more restricted ruleset of a 5 year time period (2006-2010), maximum lek count over the 5-yr period, and minimum male count of 2. This modified ruleset incorporates the assumptions currently used to designate "occupied leks" in Idaho by IDFG. In both methods we followed the Doherty et al. (2010) lek buffering approach. Specifically, leks in the 1-75% BBD percentiles were buffered by 6.4 km (4 miles) to account for a majority of nesting areas and 76-100% BBD percentiles were buffered by 8.5 km (5.3 miles (Doherty et al. 2010 citing Holloran and Anderson 2005), since leks in those classes tend to be farther apart, in lower densities, and potentially in more fragmented habitat.

We compiled 2001 – 2010 male Sage-grouse lek attendance data within MZ IV from state fish and wildlife agencies in Idaho, Nevada, Utah, Oregon, and Montana. A total of 1,655 leks were analyzed to evaluate the original Doherty et al. (2010) method and n=1,481 leks for the modified version (Figure 2). Summary statistics for both datasets were evaluated based on the average and range of male lek counts by lek and the total maximum male lek counts across all leks. While the modified Doherty method identified fewer total leks, the average male counts and total males were highest of the two datasets, better reflecting current populations. In addition, we had concerns with the longer term, ten-year dataset regarding lek location reliability, and variable survey efforts or techniques (i.e., ground vs. aerial) across MZ IV. As a result, we selected the modified Doherty method for the subsequent BBD analysis.

To allow incremental examination of the entire BBD profile, we developed a Python-based model to spatially delineate BBD at 1 percent intervals. We then quantified the amount of greater sage-grouse COH using a modification of Durtsche et al. (2009) at each BBD percent to identify potential patterns or thresholds of COH and non-habitat across the entire BBD profile (Figure 3). The Durtsche et al. (2009) COH map likely underestimates habitat since COH in recent wildfires (since 2006) was omitted from this dataset. Therefore, we used burn severity data from the USGS Monitoring Trends in Burn Severity site (www.mtbs.gov) to update the COH map (Figure 4). Fire polygons (30m pixels) classified as 1=no burn, or 2=low severity were reclassified to the pre-fire landcover type and identified as either COH or not. These areas were then added to the original Durtsche et al. (2009) map. For this exercise, we assumed that areas of low burn severity retained largely the same habitat as before the burn (i.e. patchy burn with small unburned areas). Due to our limited ability to effectively characterize "burn severity" in shrub ecosystems, it is likely that COH in the low severity category is overestimated.

Our results indicate no significant pattern or threshold in COH across the BBD percentage profile (Figure 3). Therefore, we examined two potential thresholds: 1) the BBD 75% value and associated proportion of COH and 2) the associated BBD percent that encompasses 80% of the COH. The 75% BBD captures approximately 60% of the available COH (~40% of available

non-habitat) in MZ IV. The remaining 40% habitat (which occurs outside the 75% BBD) is likely the more fragmented habitat (Doherty et al. 2011). The 90% BBD is required to capture 80% of available COH; however, there is a much higher proportion (70%) of non-habitat included, suggesting that the use of the 90% BBD would lead to overstating priority area boundaries. Since BBD is highly correlated with breeding habitat and the BBD 75% class captures the "top" 75% of males along with 60% of the COH, we recommend that the BBD 75% threshold be used as the "high abundance" (or "population") component of our priority area mapping effort. This threshold provides a meaningful baseline population component for the PA analysis, by conservatively encompassing the least fragmented breeding habitats that are of greatest importance for conservation.

Lek Connectivity: We used the more inclusive Doherty et al. (2010) ruleset (i.e., 10 year timeframe, 1 male minimum) to identify lek points for the lek connectivity analysis. We assumed that this more comprehensive, ten-year dataset would yield a more realistic connectivity extent since the sage-grouse is a relatively long-lived bird, and the modified 5-year dataset may not be sufficient for this purpose. We used a kernel density analysis to create a utilization distribution surface. We modified Hagen (2011) and populated a 1 km grid with lek presence and analyzed kernel density using a neighborhood of 18 km. Knick and Hanser (2011) found an 18 km area to be a reliable connectivity threshold for greater sage-grouse (GSG; i.e., leks within 18 km of one another tend to be more connected than those farther out). The resulting "surface" was used to categorize 2 levels of connectivity: 75% (local connectivity) and 90% (seasonal/migratory connectivity) utilization distributions (Figure 5 A and B). Local lek connectivity (75% utilization contour) appears to encompass the "general" lek distribution patterns across MZ IV; therefore, we recommend that local connectivity be used to represent the "lek connectivity" component of our priority area mapping effort.

The connectivity analysis assumed straight-line distances among lek points. Therefore, similar to the BBD analysis, some areas of non-habitat are encompassed within the resulting polygons. In addition, the connectivity analysis does not account for topography, thus overestimating connectivity results in linear basin and range systems (e.g., the Challis/Salmon area). For example, applying the 18 km connectivity neighborhood to leks occurring within narrow valley bottoms, that average only12 km in width, likely captures some adjacent areas of nonhabitat on nearby steep, timbered or rocky slopes.

MZ IV Sage-grouse *Priority Area* Delineation: For PA delineation, we intersected the 75% breeding density polygons with the 75% utilization local connectivity polygon (Figure 6). Since managers in Idaho are accustomed to using the Idaho Sage-grouse Habitat Planning Map, (Figure 7), for purposes of Idaho context only, displays the polygons overlain on the 2010 version of the habitat map (Bureau of Land Management 2010b).

For each PA polygon within MZ IV, we then assigned a unique alpha identification code and calculated summary statistics. Summary statistics included total polygon area, total number of leks, maximum male attendance, average maximum male attendance and standard deviation, as well as total area and percent of COH within the polygon (Table 1). We used total maximum male attendance to rank the 30 priority area polygons. In aggregate, the PA polygons capture

approximately 94% of the identified MZ IV male lek population. Additional statistics found in Table 1 are reported to help inform future PA and GA (See below) evaluations.

MZ IV Sage-grouse *General Area* Delineation: We used sage grouse population persistence methods (modified Aldridge et al., 2008)) to inform GSG General Area delineations within MZ IV. We evaluated long-term sage-grouse population persistence as a function of sagebrush cover on the landscape. We analyzed sage-grouse population persistence based on the availability of sagebrush within a defined area, under the assumption that the modified COH model served as an adequate representation of sage-grouse habitat/sagebrush within the analysis area. Based on recent lek connectivity work (Knick and Hanser 2011), 18 km was assumed to be an effective distance for characterizing local lek connectivity over most of MZ IV. However, in the linear basin and range systems (e.g., the Challis/Salmon region in Idaho) general valley floor width was less than 18 km (range 8 – 16 km) and could potentially overestimate persistence. Therefore, we selected a smaller 12 km distance to more accurately reflect available area. We used the USGS National Hydrologic Dataset 4th order hydrologic units to identify the linear basin and range systems within MZ IV (Figure 8 A). We resampled the modified 2009 COH model (30m) to 1 km (with an inclusion threshold of 50% COH). The resulting 1 km grid cells (value 1, 0) were then analyzed using a moving window analysis and separate 12 km and 18 km neighborhoods (Figure 8 B). The resulting combined map "surface" was then used to categorize persistence probability. Areas of 25-65% probability represent *Low* sage-grouse population persistence over the long-term, and areas > 65% probability represent *High* sage-grouse population persistence (Aldridge et al. 2008) (Figure 8 B).

We used a persistence threshold of ≥25% to identify the General Area polygons within MZ IV (Figure 8 C). All or portions of certain GA polygons may be important to sage-grouse in terms of connectivity between PA polygons or as refugia in the event of stochastic events in PAs. In some cases, areas are designated as GAs because lek data are lacking due to limited surveys, resulting in BBD or connectivity values that are too low to be captured by the PA model.

Management Zone IV PAs and GAs shown in Figure 9 spatially depict those areas in the MZ IV landscape where sage-grouse conservation efforts might be focused to greater or lesser degrees, depending on management and policy objectives. Given limited resources, conservation efforts generally should focus first on habitats occurring within the PA areas. It must be recognized though, that given the population-centric nature of the PA model and associated analysis buffers, areas of sage-grouse habitat as well as non-habitat are included in those polygons. Consequently, finer-scale habitat information will be necessary at the local, site-specific level. It is also important to recognize that depending on the area of the map or specific PA or GA under consideration, there may be differing management opportunities, strategies, and decision-space for the conservation of sage-grouse. Portions of some PAs or GAs are likely very crucial to local or regional sage-grouse populations or for maintaining connectivity. To identify these areas, additional information is required and is discussed below,

To further refine our understanding of the spatial context of PAs and GAs across MZ IV, and to facilitate discussions of potential management activities within or among these areas, we examined the contribution of a suite of variables to assist in identifying important conservation areas. We combined our continuous persistence, connectivity, and BBD model surfaces to create

a single, composite view of the MZ IV landscape. We combined the full range of persistence probability (1-100%) information with lek connectivity (1-100%) and finally the BBD data (with lek counts normalized from 1-100). The resulting map (Figure 10) displays the full range of surface values to help provide additional spatial context, inform conservation efforts within PA polygons, and to assist in the development of subsequent finer-scale management strategies. In Figure 10, "hotspots" of blue colors indicate those areas of greater relative "importance", to sage-grouse in MZ IV, where the combination of lek connectivity, BBD and population persistence on the landscape appears to be comparatively high relative to other areas of the map.

Priority Area and *General Area* Delineation for the Bear Lake Plateau (MZ II): The Bear Lake Plateau area of extreme southeastern Idaho occurs outside of the MZ IV analysis area discussed above. Due to floristic similarities and a closer association with populations and habitats in adjacent areas within Utah and Wyoming, this portion of Idaho is encompassed by the adjacent Wyoming Basin MZ II. While available sage-grouse population and habitat information for this portion of Idaho are somewhat limited, the area nonetheless contains potentially important sage-grouse habitats and populations that should be considered by conservation planners and managers in Idaho.

Logistical and time limitations precluded us from developing a full MZ II analysis; therefore, we incorporated other available data to develop the PA map for this portion of southeastern Idaho. We examined BBD results (Doherty et al. 2011) for MZ II and Key Habitat data from Idaho's 2010 Sage-grouse Habitat Planning Map. Specifically, we selected the 75% BBD polygons occurring within the Bear Lake Plateau area and merged them with the Idaho Key Habitat data. We then applied a 1 km buffer to the 75% BBD to assist in aggregating the polygons. Any Key Habitat polygons intersecting and extending beyond the 75% BBD polygon were included as part of the final Bear Lake Plateau PA (Figure 11). Remaining key habitat areas not intersected by the 75% BBD and associated 1 km buffer were designated as sage-grouse GAs. Figure 12 displays the full, composite map of MZ IV and Bear Lake Plateau PAs and GAs.

Management Approaches for Consideration: The information presented in this paper should not be construed as policy. It is primarily intended to complement and provide spatial context for interim national BLM sage-grouse policy which is being developed. This information can also provide helpful context for analyses and decisions associated with future project-level work, authorizations, activity planning or land-use planning that may affect sage-grouse or sage-grouse habitat on BLM lands in Idaho. To inform future discussions of possible management actions for the various PAs or GAs (or portions thereof), we suggest considering two general approaches, as a starting point.

Habitat Maintenance Focus: In some areas, the focus of sage-grouse habitat conservation may best be achieved by an effort to *maintain or protect the current extent and health of sagebrush landscapes and sage-grouse population connectivity*. These areas might include PAs or portions of PAs that currently provide relatively important, intact sage-grouse habitat and are therefore important for sustaining sage-grouse populations into the future. Maintenance may also apply to certain GA areas that appear to be important for connectivity between PAs. Examples of management actions could include: 1) the establishment of exclusion zones (for certain types of actions, such as energy development), sage-grouse "conservation areas", Areas of Critical

Environmental Concern, or other protective designations to minimize or reduce anthropogenic impacts; 2) application of more stringent project stipulations or protective buffers; and 3) provide aggressive and proactive approaches to wildfire suppression, establishment of strategic fuel breaks, implementation of juniper/conifer control activities, or other protective or maintenance measures appropriate for the landscape.

Habitat Improvement Focus: In some areas, the focus of sage-grouse habitat conservation may best be achieved by an effort to *restore the extent and ecological health of sagebrush landscapes to improve sage-grouse habitat quality, quantity and population connectivity*. These would be comprised of PAs and/or GAs that currently are constrained due to concerns with habitat quality, fragmentation or other factors that could be ameliorated with restoration activities or other approaches. Management actions could focus on efforts to restore sagebrush and/or the herbaceous components of the habitat, reduce conifer expansion, and protection of restoration investments (i.e., aggressive wildfire suppression).

Future Modeling Opportunities: Given the repeatable and transparent analytical framework described previously, we can readily incorporate other geospatial landscape metrics, threat information, or other data as they become available. For example, we could incorporate information on the Human Footprint (Leu et al. 2008), or Core Patch Size Distribution using Patch Analyst for ArcGIS. Other class or landscape metrics (e.g., habitat connectivity, fragmentation or aggregation indices, edge density, etc.) could also be explored to further characterize the nature and context of our connectivity polygons.

In the near future, we will have the opportunity to incorporate sage-grouse seasonal habitat models currently under development for Idaho and MZ IV by IDFG (Knetter and Svancara, in progress) using a Maximum Entropy (MAXENT) climate envelope characterization of sage-grouse habitat. We anticipate these will be helpful in further informing sage-grouse PAs within MZ IV and at more local scales.

Acknowledgements: Many individuals provided helpful comments during the development of this model and/or review of the draft report. We would like to especially thank the following for their input: Cameron Aldridge (US Geological Survey), Jack Connelly (Idaho Dept. Fish & Game), Shawn Espinosa (Nevada Dept. Wildlife), Christian Hagen (Oregon Dept. Fish & Wildlife), Steve Hanser (US Geological Survey), Nick Hardy (US Fish & Wildlife Service), Don Kemner (Idaho Dept. Fish & Game), Sonya Knetter (Idaho Dept. Fish & Game), Steve Madsen (Utah BLM), Rick Northrup (Montana Dept. Fish, Wildlife, & Parks), Tom Rinkes (Idaho BLM), Frank Quamen (BLM National Operation Center), Robin Sell (Colorado BLM), and Kendra Womack (US Fish & Wildlife Service).

Table 1. Summary statistics for area, lek attributes 2006-2010 and currently occupied habitat (COH) information associated with sage-grouse Priority Areas. Priority areas are sorted by total max male count.

Priority Areas		Lek Attributes							GSG_COH Attributes	
Name	Area (ac)	Total Leks	Total Max Males[1]	Percent Population	PA Cumulative Pop. Percent	MZ IV Cumulative Pop. Percent	Average Males/Lek	StdDev Males/Lek	COH (ac)[2]	COH percent of Priority Area
F	8352472	643	13465	44	44	42	20.94	22.33	5019096	60
L	2818028	222	5041	17	61	57	22.71	21.69	1302065	46
Q	971243	86	3337	11	72	67	38.80	38.32	666358	69
D	557820	50	1252	4	76	71	25.04	25.34	505371	91
J	751950	61	1148	4	**80**	75	18.82	15.00	549389	73
S	579563	28	675	2	82	77	24.11	22.90	297203	51
W	230640	11	462	2	84	78	42.00	38.48	99953	43
K	169149	11	440	1	85	**80**	40.00	30.77	89186	53
AA	453188	30	416	1	87	81	13.87	9.75	248238	55
U	262389	16	368	1	88	82	23.00	15.25	116674	44
C	350231	20	366	1	89	83	18.30	17.28	108716	31
N	453463	29	355	1	**90**	84	12.24	7.83	403624	89
H	242069	14	343	1	91	85	24.50	13.72	118158	49
CC	315480	19	341	1	92	86	17.95	12.45	213992	68
X	273520	12	335	1	94	87	27.92	19.21	200559	73
M	158799	11	237	1	94	88	21.55	14.54	87433	55
P	112608	5	232	1	95	89	46.40	17.74	86369	77
Y	211674	14	220	1	96	**90**	15.71	11.61	106792	50
R	237676	10	190	1	96	90	19.00	12.28	179839	76
O	373690	11	185	1	97	91	16.82	9.55	280991	75
B	260058	11	175	1	98	91	15.91	13.13	250606	96
DD	123281	8	132	<1	98	92	16.50	12.04	59350	48
T	97590	6	115	<1	98	92	19.17	15.97	69129	71
V	114393	3	109	<1	99	92	36.33	43.36	54598	48
A	155665	5	105	<1	99	93	21.00	9.19	113374	73
Z	83132	5	86	<1	99	93	17.20	4.60	37264	45
BB	74241	6	78	<1	100	93	13.00	6.45	28987	39
I	110003	4	54	<1	100	93	13.50	12.97	61389	56
E	32447	2	21	<1	100	93	10.50	2.12	2206	7
G	51471	2	13	<1	100	93	6.50	3.54	17450	34
Total	**18977933**	**1355**	**30296**	--	--	**93.5**	**22.36**	**23.03**	**11374362**	**=60% of MZ4 COH**

[1]Data represents total of max counts 2006-2010 for leks identified using the modified Doherty 2010 method.
[2]Modified Durtsche 2009 GSG Currently Occupied Habitat was resampled from 30m to 90m for computational purposes

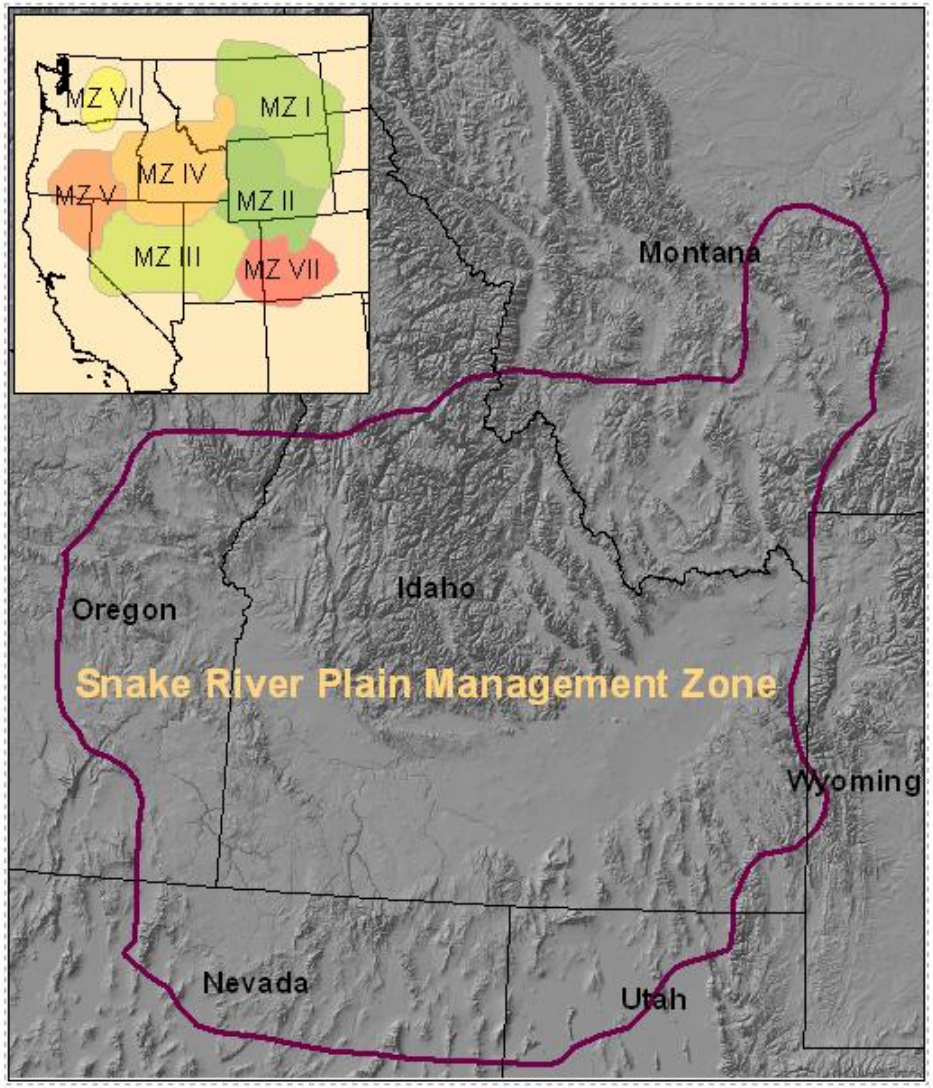


Figure 1. Sage-grouse management zones (Stiver et al. 2006) within the geographic distribution of the greater sage-grouse, based on sage-grouse populations and subpopulations occurring within seven floristic provinces, as described in Connelly et al. (2004). The Management Zone IV analysis area includes portions of southern Idaho, southwestern Montana, northwestern Utah, northern Nevada and southeastern Oregon

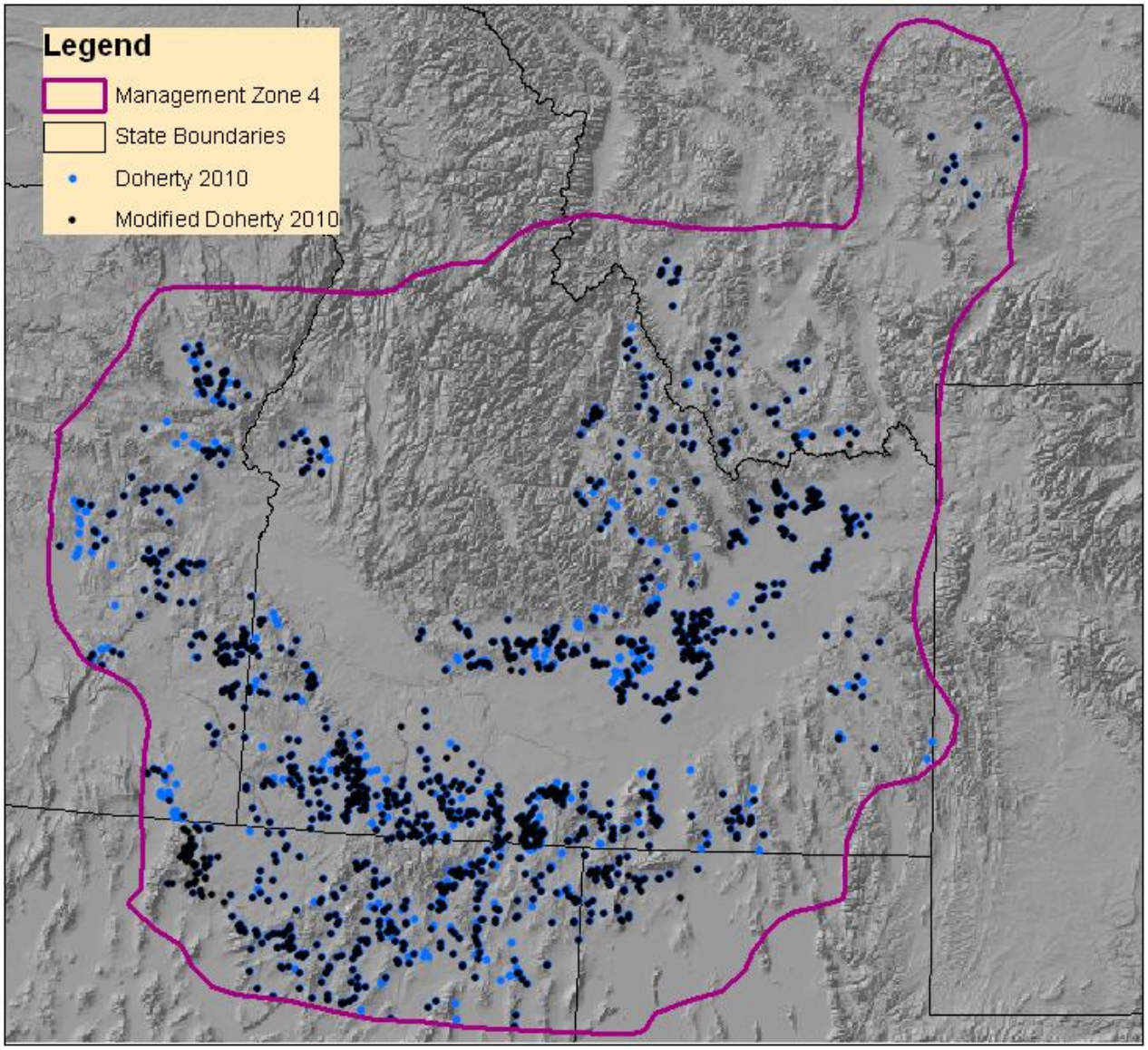
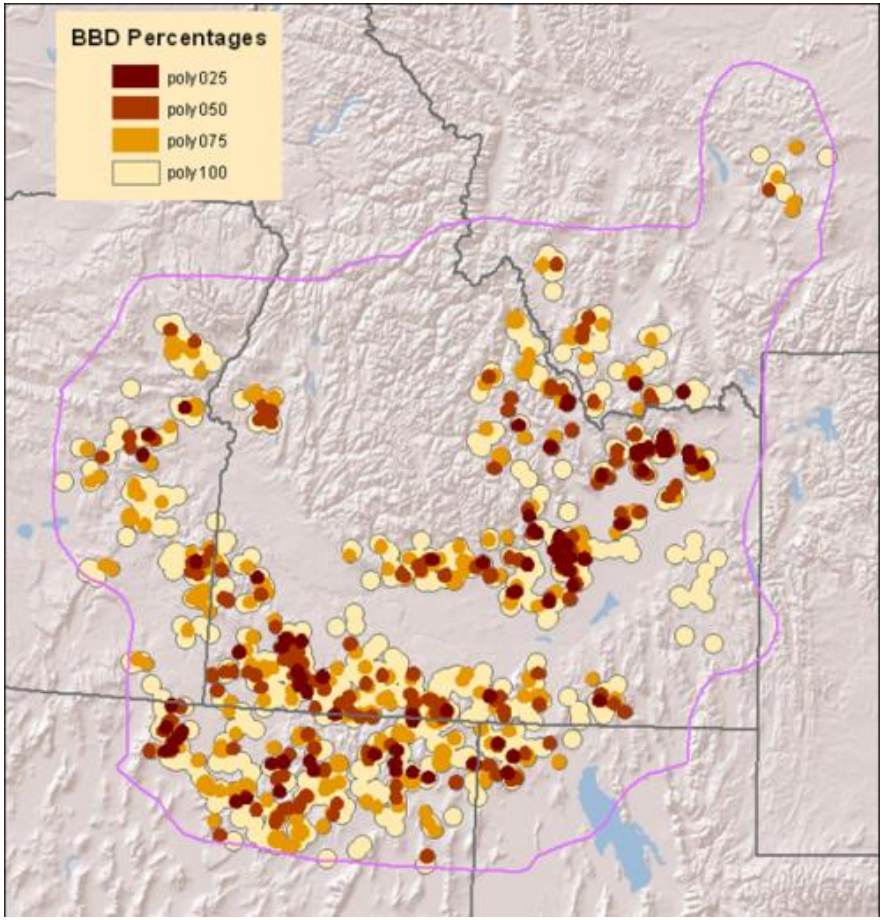
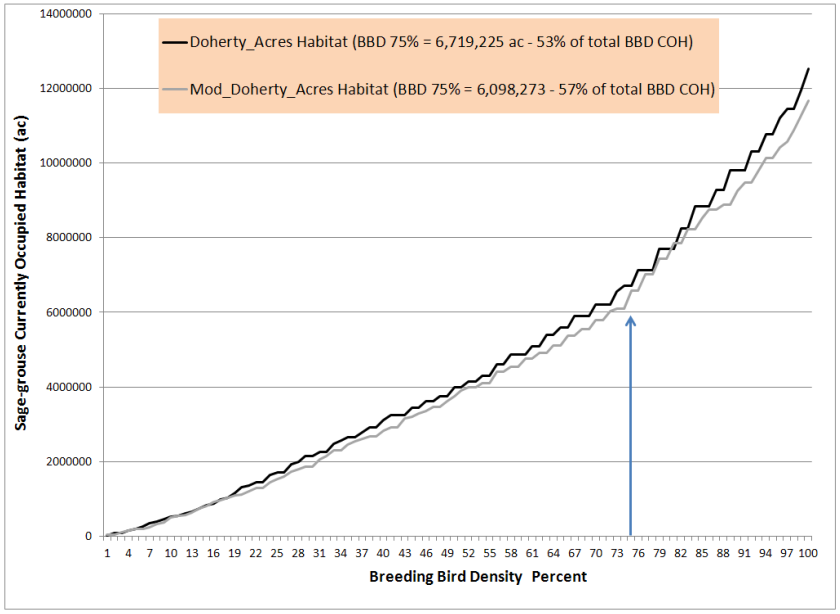


Figure 2. Management zone IV sage-grouse lek location data (2001 – 2010) used to evaluate high male abundance areas using the Doherty 2010 method (n = 1,655 leks; blue symbols) and the modified ruleset version (2006-2010) (n = 1,481 leks; black symbols).





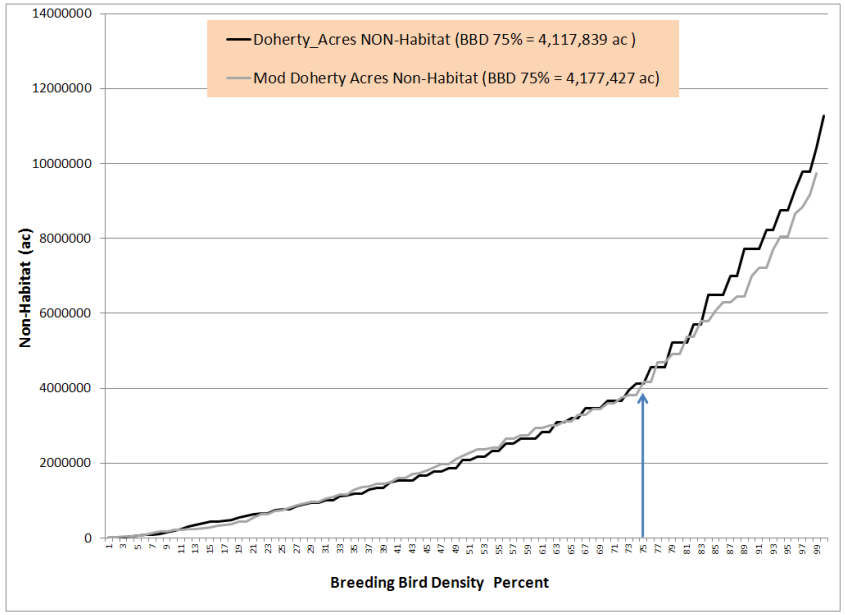


Figure 3. BBD percentiles (left) ranging from dark red to light brown. The dark areas essentially show the "best of the best" areas, based on maximum count data at leks 2006-2010. The darkest areas capture the top 25% of the leks and breeding habitat; darker brown to light brown areas capture 50, 75 and 100% of the data, respectively. The graphs on the right show the relationship between Breeding Bird Density (BBD) percent and acres of currently occupied habitat and non-habitat for the two BBD methods evaluated.

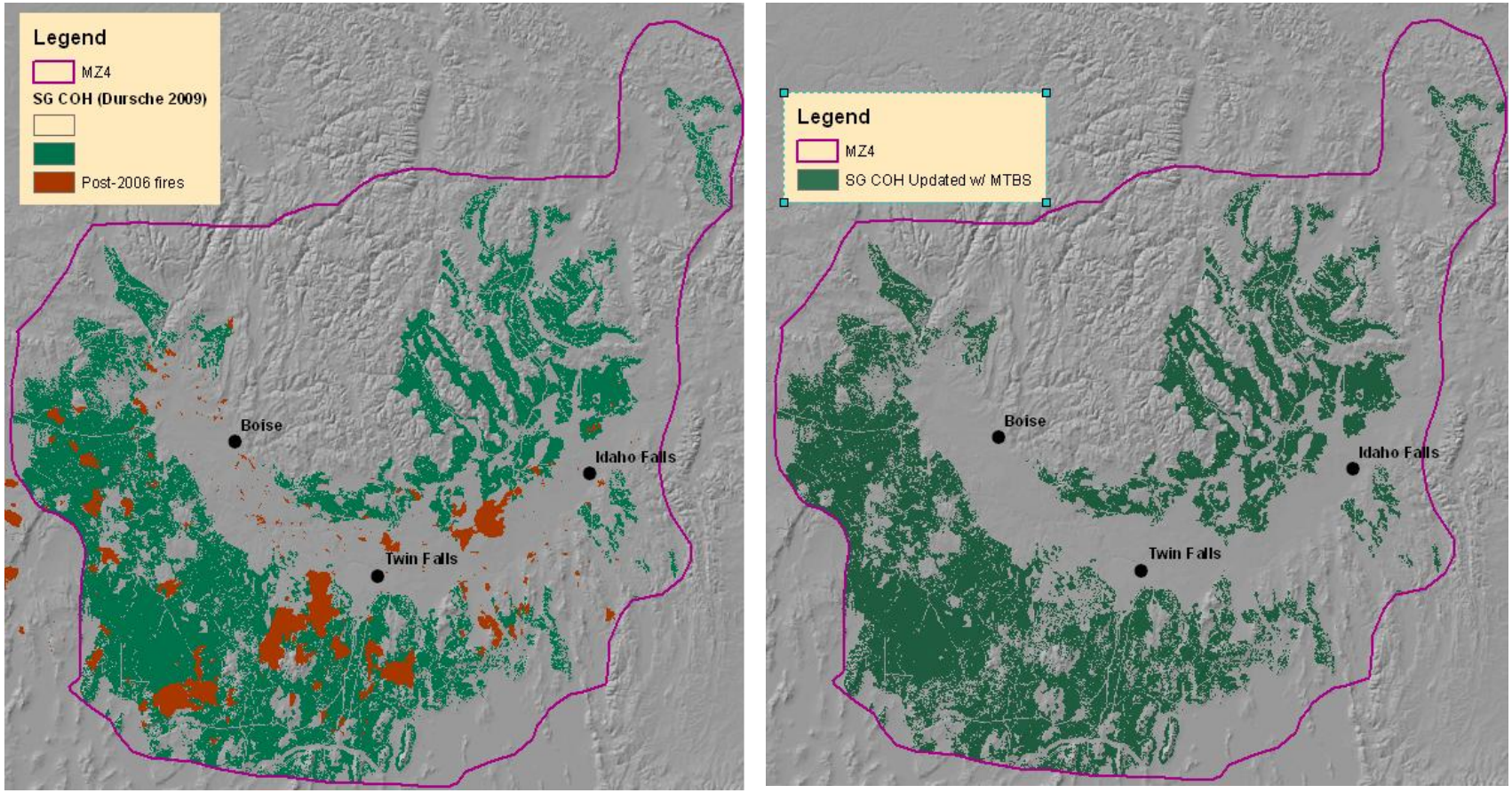
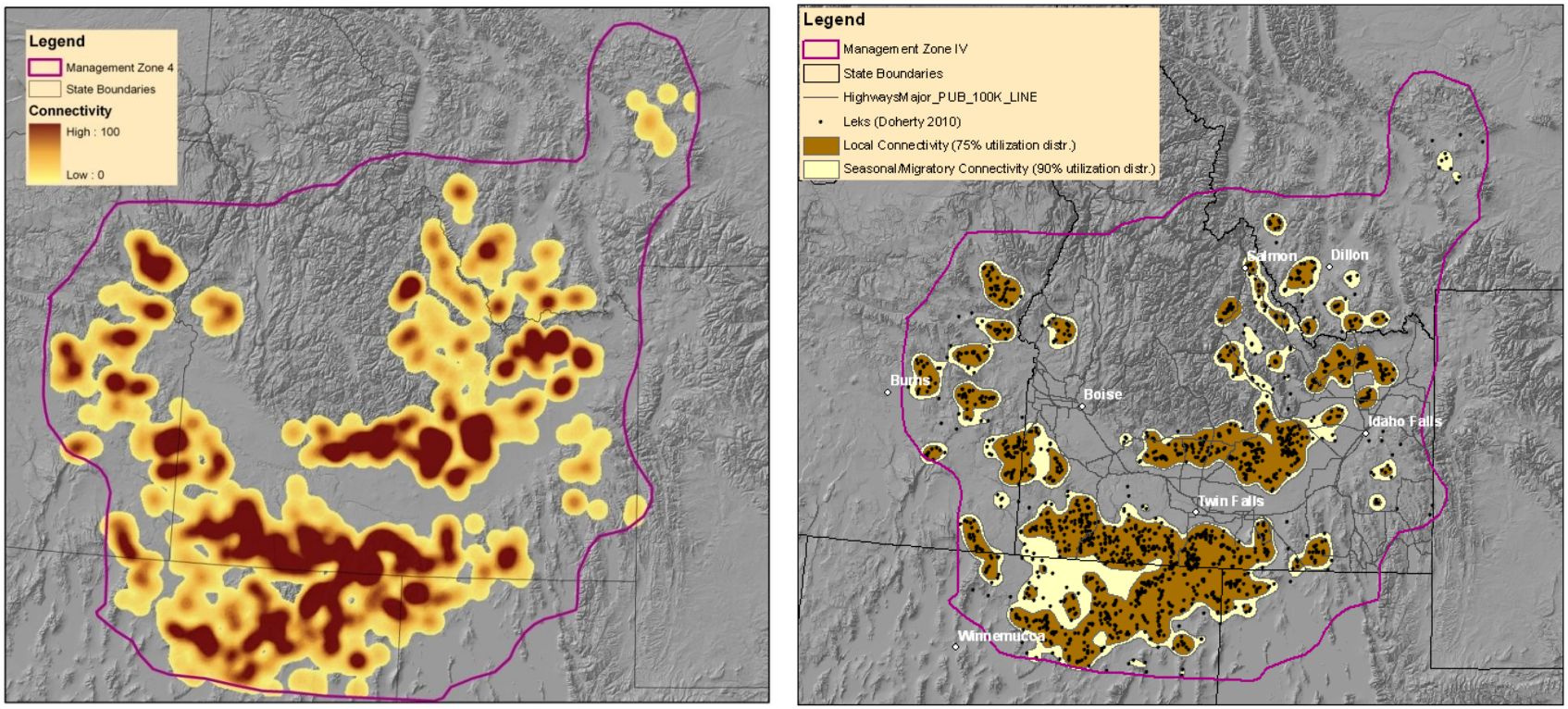


Figure 4. The Durtsche et al. (2009) Greater Sage-grouse Currently Occupied Habitat (COH) map did not include any areas of recent fire (since 2006) (red polygons). Therefore, we used Burn Severity data from USGS Monitoring Trends in Burn Severity (www.mtbs.gov) to update the map. Within fire polygons, areas (30m pixels) classified as 1=no burn, or 2-low severity were reclassified to the pre-fire landcover type and identified as either GSG COH or not. These areas were then added to the original Durtsche et al. 2009 map. Note that due to our limited ability to effectively characterize 'burn severity" in shrub ecosystems, it is likely that we are overestimating COH in the low severity category. But for this exercise, we assumed that areas of low burn severity retained largely the same habitat as before the burn (i.e. patchy burn).



A B

Figure 5. Sage-grouse lek connectivity surface (A). Two utilization levels of connectivity are shown in image B: 75% Local Connectivity (brown) and the larger 90% Regional Connectivity (yellow) (following Hagen 2011).

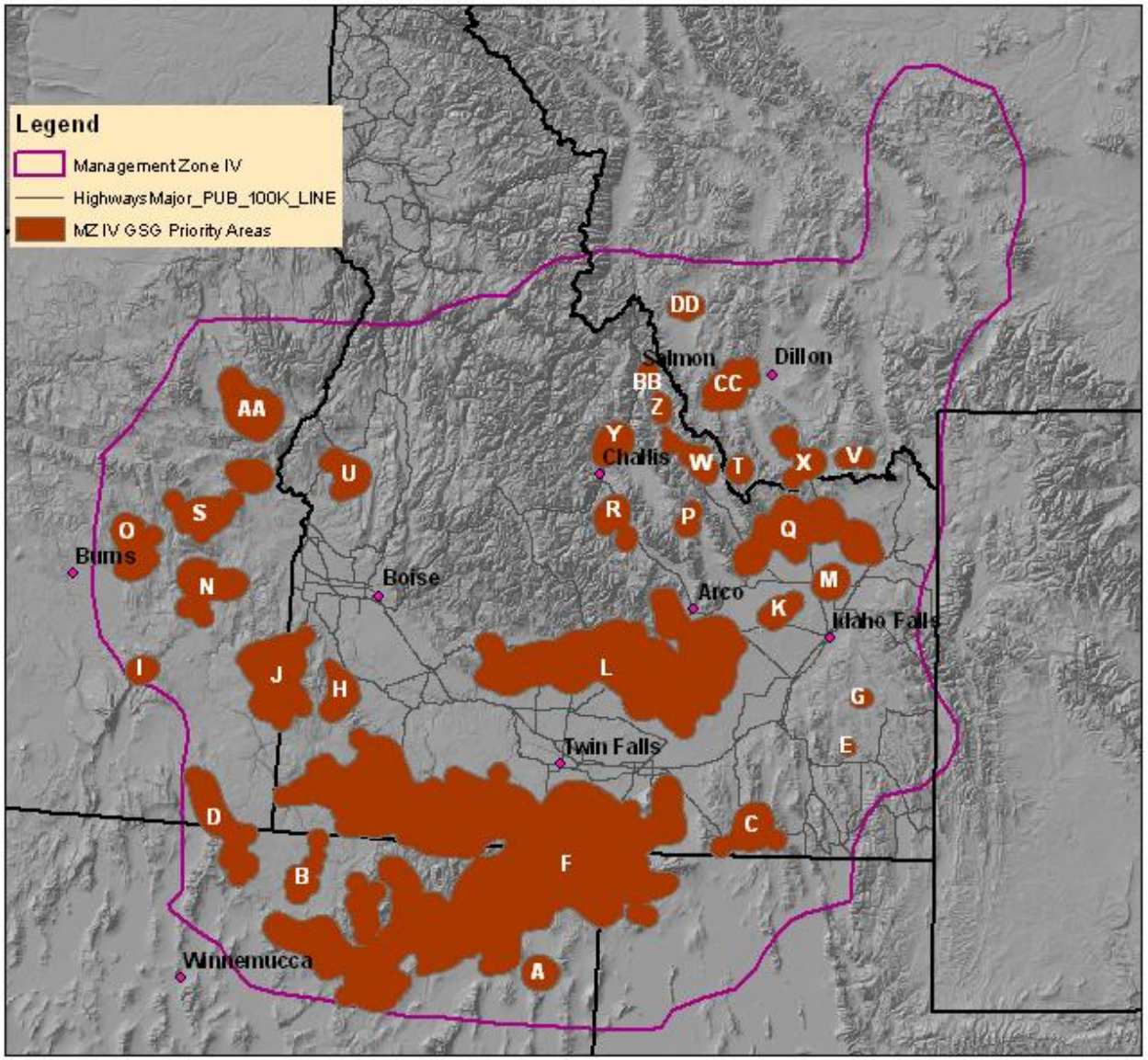


Figure 6. Sage-grouse priority areas delineated in Management Zone IV. Priority areas (red) were delineated by intersecting the 75% connectivity and 75% breeding bird density (BBD) polygons. The letter in each polygon denotes the polygon "name".

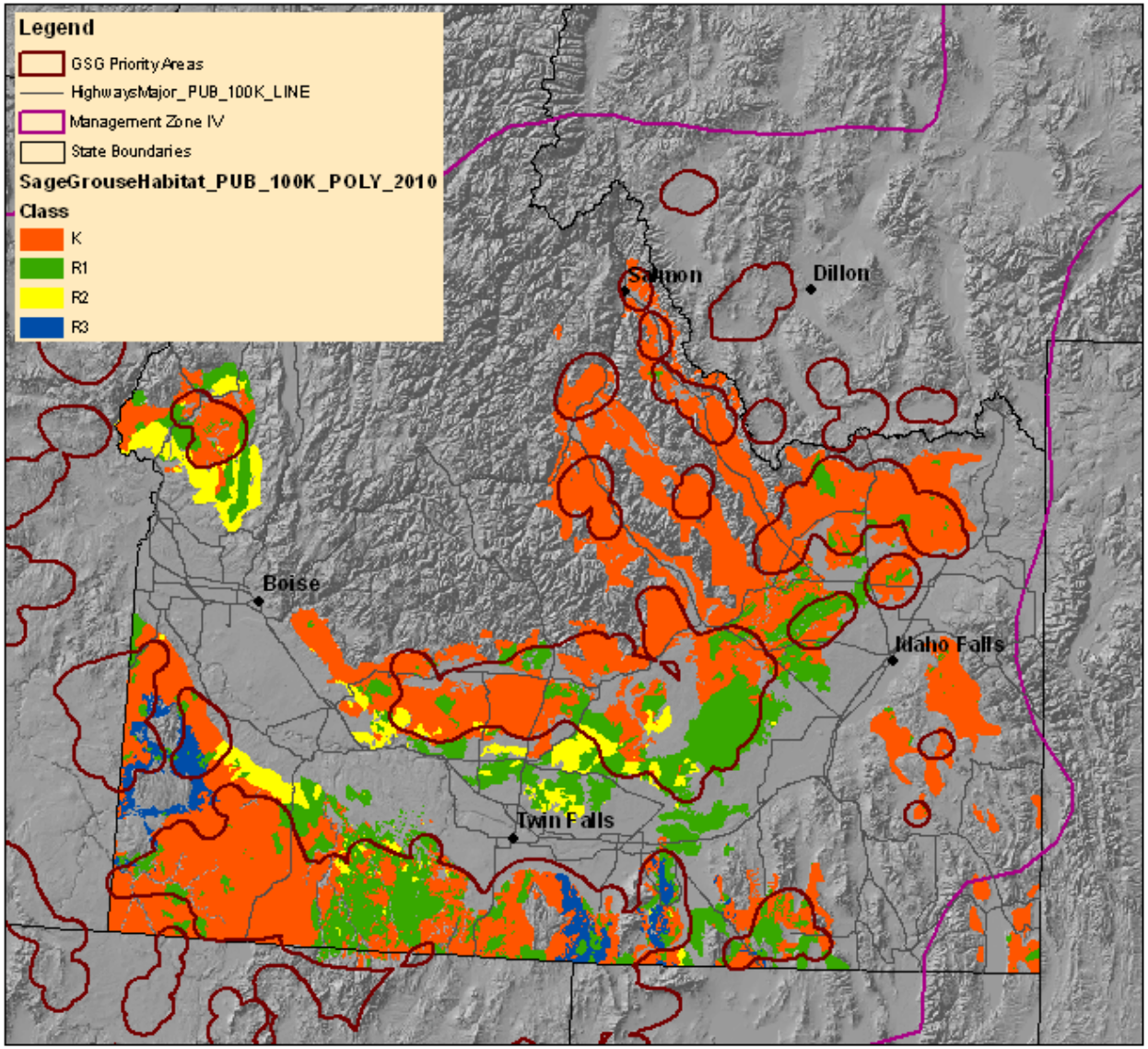
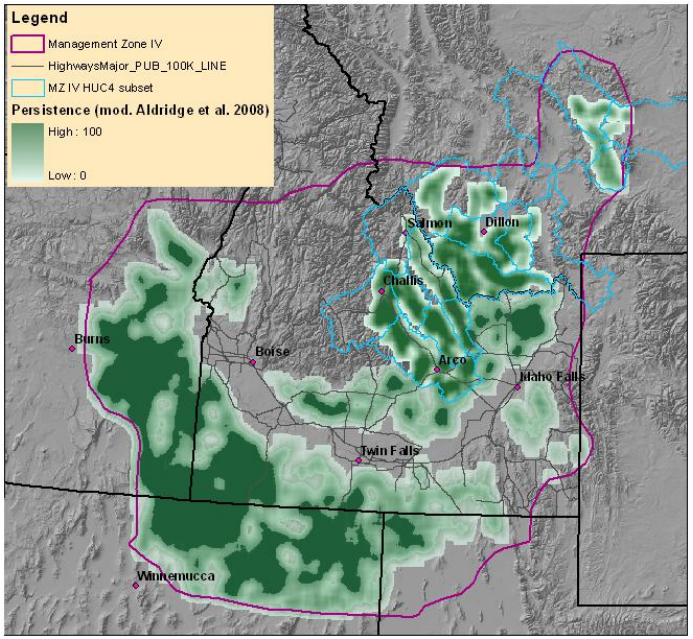
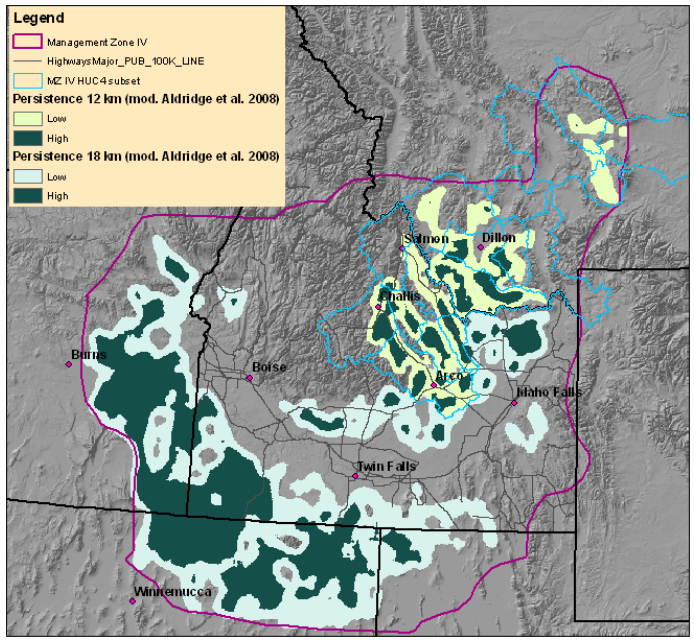


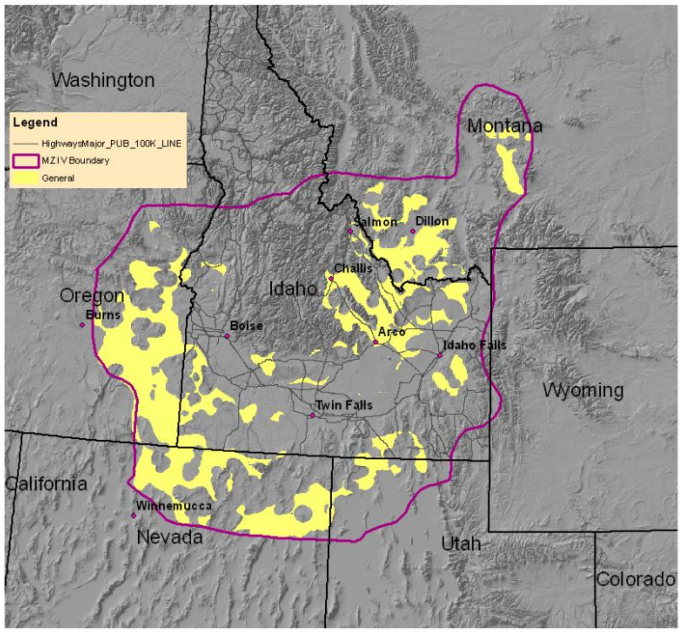
Figure 7. Management zone IV sage-grouse Priority Area (PA) polygons overlain on the 2010 Idaho Sage-grouse Habitat Planning Map. The red areas show key habitat (areas of generally in-tact sagebrush that provide habitat for sage-grouse at some point during the year. The green, yellow, and blue areas respectively show areas of perennial grassland, annual grassland and conifer encroachment restoration potential.



A



B



C

Figure 8. Habitat-based sage-grouse persistence probability surface (modified Aldridge et al. 2008) for management zone IV. (A) Persistence surface represents the relative amount of GSG currently occupied habitat (COH) within an 12 km neighborhood for the identified basin and range subset (combined blue polygons) and 18 km for the remaining portion of management zone IV. (B) Combined Persistence probability categorized as Low (25-65%, light green) and high (>65%, dark green). (C) General Area designations for sage-grouse in management zone IV (data represents persistence value ≥ 25%). Priority Areas have been clipped out of the image.

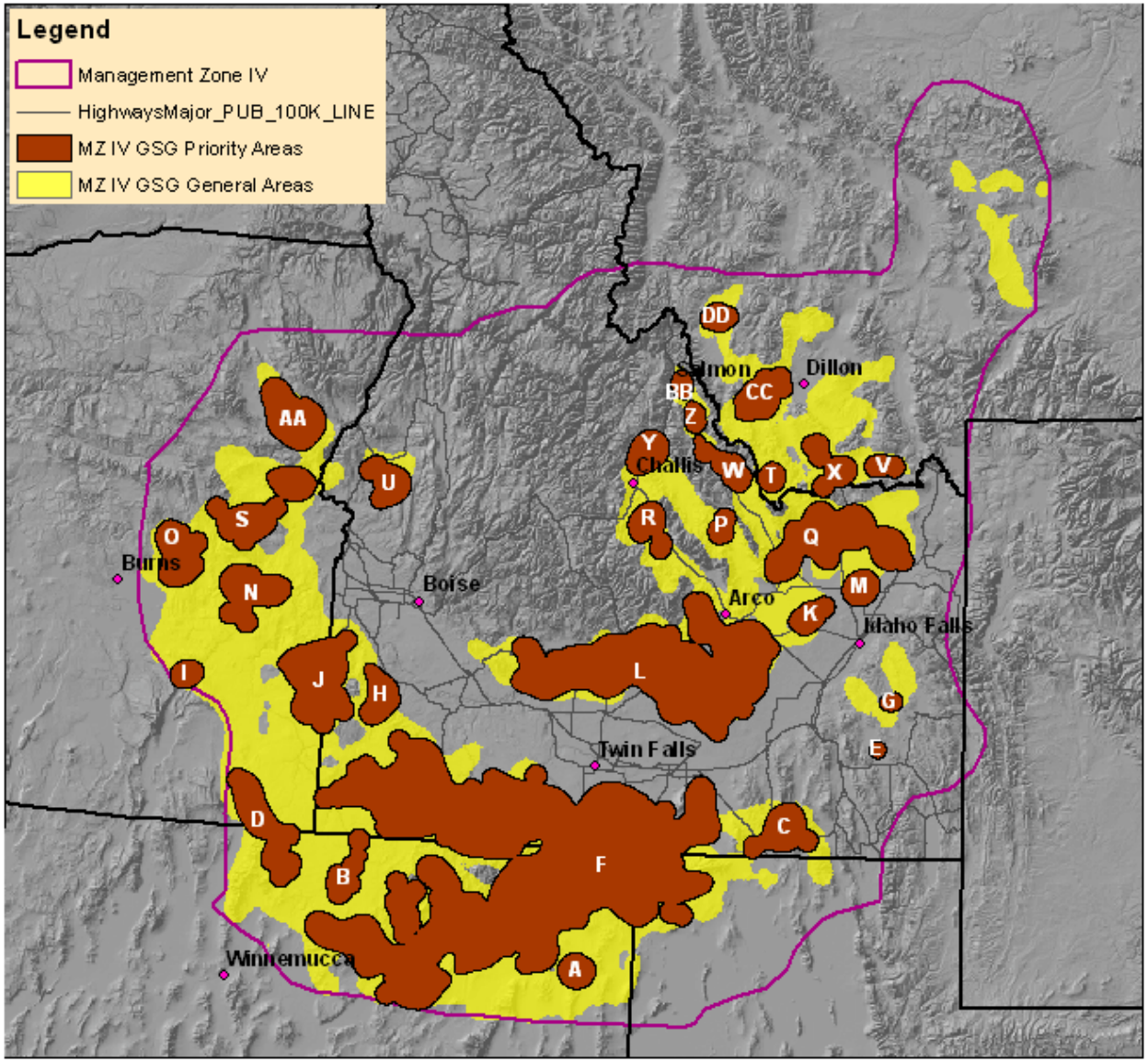


Figure 9. Identified Greater Sage-grouse Priority Areas (PA) and General Areas (GA) in management zone IV.

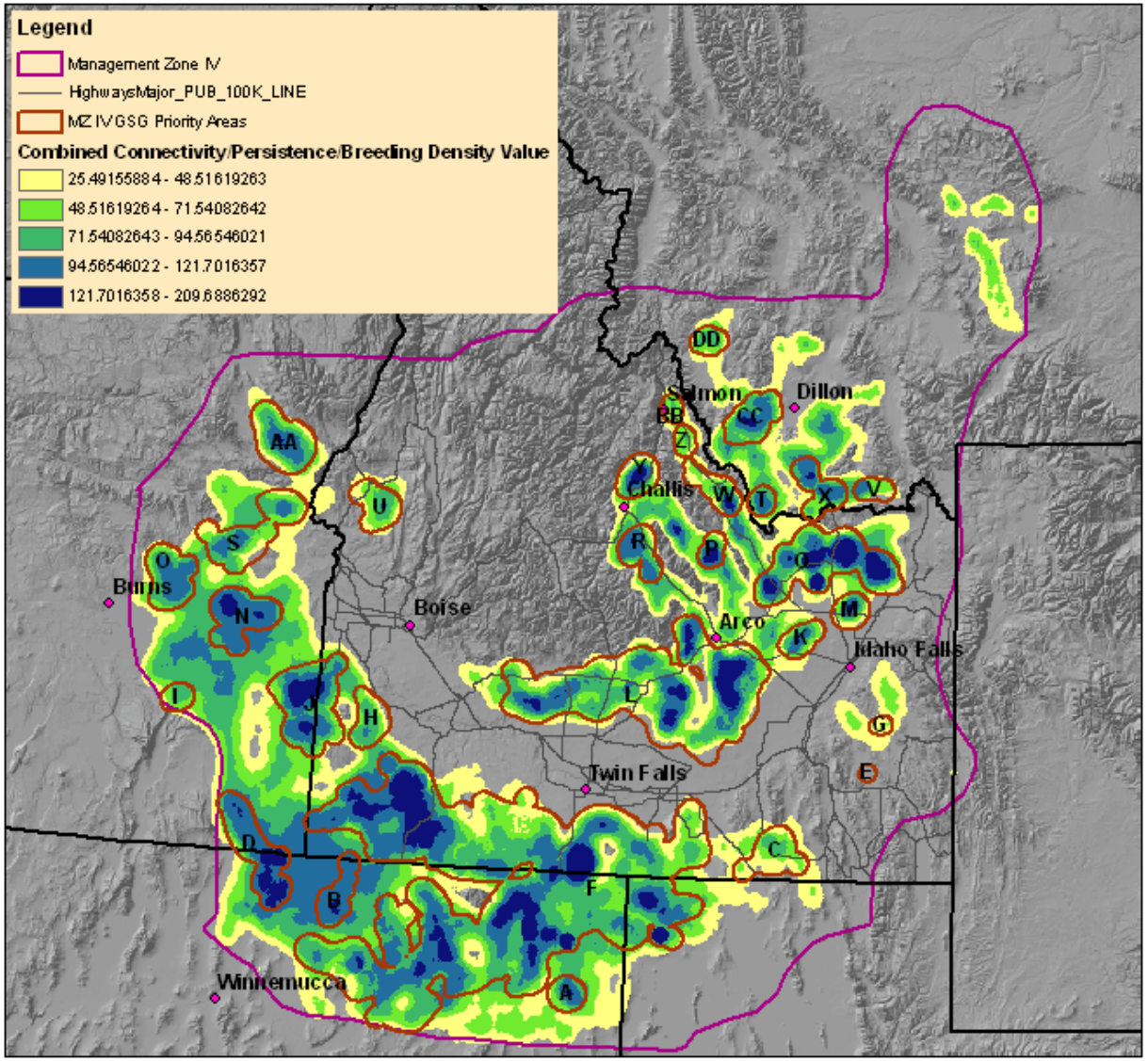


Figure 10. Combined lek connectivity, habitat-based persistence probability, and Breeding Bird Density (BBD) data for MZ IV. Map surface colors indicate Low (light yellow) to High (dark blue) combined value rating for these three factors, overlain by sage-grouse Priority Area (PA) boundaries. Blue to dark blue areas appear to be of high relative importance for conservation and may warrant particular attention during conservation planning efforts.

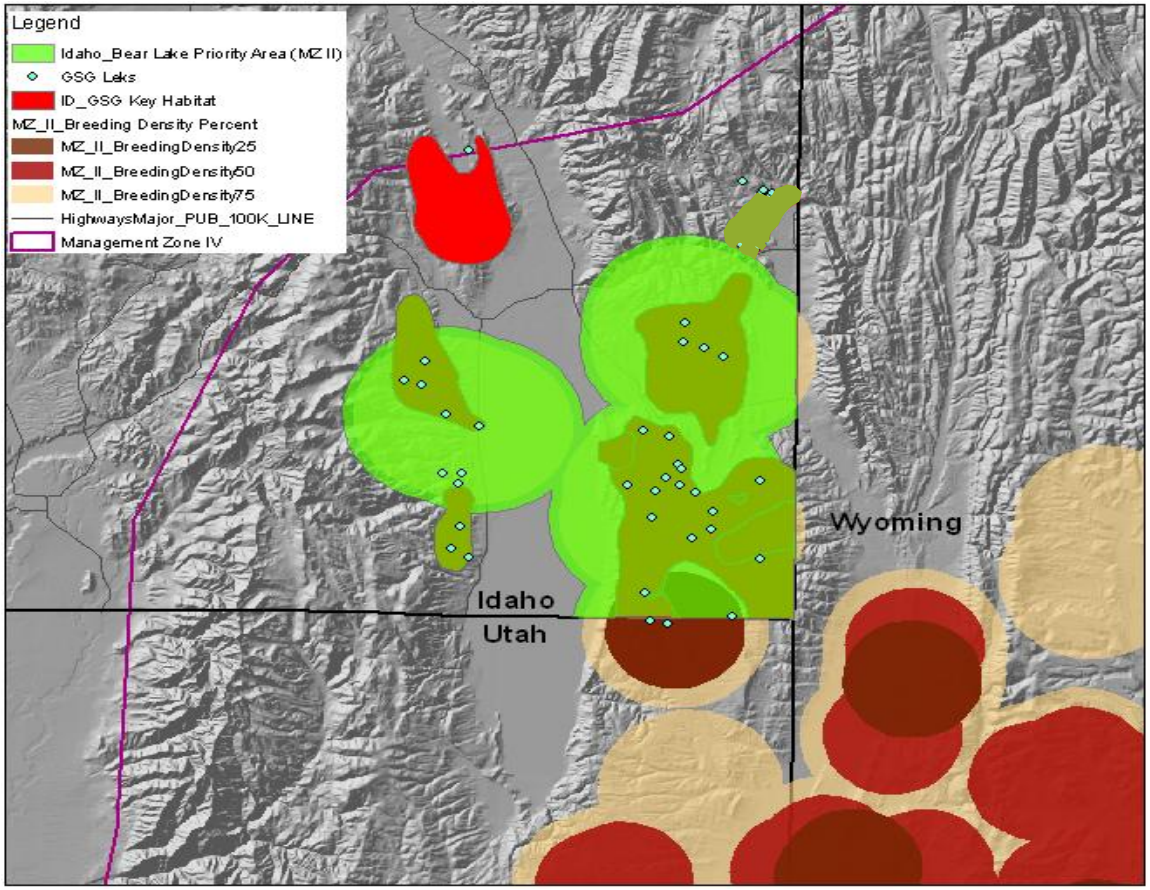


Figure 11. Bear Lake Plateau area (MZ II). Sage-grouse Priority Area (PA) for Idaho is represented by the bright green polygon. Note the 2010 Idaho Key Habitat polygons (shaded red) that are encompassed within the green PA polygon. The colored circles represent Breeding Bird Density results (Doherty et al. 2010) for Management Zone II: 25% BBD (dark red), 50% (red), and 75% (light brown).

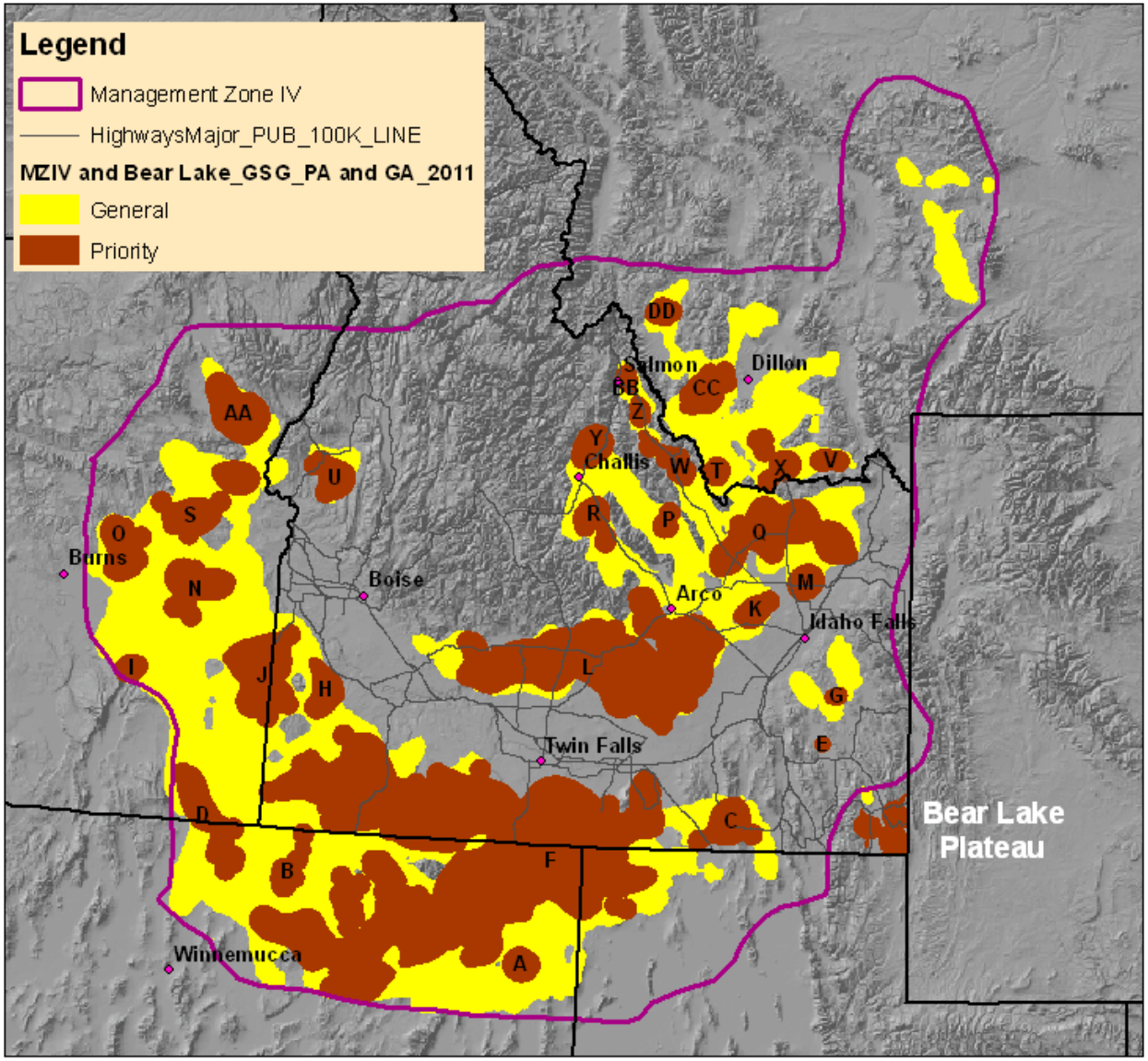


Figure 12. Draft Sage-grouse Priority Area and General Area Designations for Management Zone IV and Idaho – Bear Lake Plateau (MZ II).

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