

2024 Greater Sage-Grouse Population Triggers Analysis



Photo: Rachel Curtis

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Introduction

The Idaho Department of Fish and Game (IDFG) presents results of the 2024 adaptive management population triggers analysis for Greater Sage-Grouse (*Centrocercus urophasianus*; hereafter, sage-grouse) in Idaho. Adaptive management triggers are identified and described in the 2021 Idaho Sage-grouse Management Plan of Executive Order 2022-03 (State of Idaho 2022) and approved in the Bureau of Land Management (BLM) and U.S. Forest Service (USFS) plan amendments for sage-grouse (BLM 2015, USFS 2015), and include both habitat and population triggers. These adaptive management triggers provide a policy mechanism to stabilize habitats and populations on federal lands where a demonstrated significant loss has occurred either over time or unexpectedly.

IDFG calculates two metrics to assess the status of sage-grouse population triggers within the 2015 Priority and Important Habitat Management Areas (PHMA and IHMA) within 4 Conservation Areas (CA) (Figure 1):

- 1) the 3-year average of total maximum number of males counted on leks routes; and
- 2) the average finite rate of change (λ) of maximum males counted on leks over a 3-year period.

Hard population triggers are defined as:

- A 20% decline in the current 3-year average of total maximum number of males counted on lek routes compared to the total maximum number of males counted on routes in 2011 (i.e., 2011 baseline) **and** average finite rate of change significantly below 1.0 within IHMA or PHMA within a CA over the current 3-year period (MD SSS 19, BLM 2015). Significance is defined by 90 percent confidence intervals that do not include 1.0.

Soft population triggers are defined as:

- A 10% decline in the current 3-year average of total maximum number of males counted on lek routes compared to the 2011 baseline **and** average finite rate of change below 1.0 within IHMA or PHMA within a CA over the current 3-year period (MD SSS 20, BLM 2015).

When a soft trigger is tripped, an interagency adaptive management team will evaluate causal factors and recommend additional potential implementation level activities (MD SSS 21, BLM 2015). When a hard trigger is tripped, all PHMA management actions will be applied to the IHMA within that CA and an interagency adaptive management team will evaluate causal factors and recommend additional potential implementation level activities (MD SSS 22, BLM 2015). For a population trigger to be removed, the current 3-year average of total maximum number of males counted on lek routes must return to or exceed 2011 baseline levels within the associated CA (MD SSS 24, BLM 2015).

Methods

The IDFG lek database was updated in 2023 following status designations and definitions described in Cook et al. (2022). Under these definitions not all locations in the database meet the definition of a

verified lek. This does not change how the population analyses are performed but may produce inconsistencies with data reported previously, as some locations no longer meet criteria for inclusion. In addition, the sage-grouse database is continuously under review, so edits and corrections may update previously reported totals. The new status designations and definitions are included in Appendix B.

All verified sage-grouse leks (1,646) in the IDFG database were assigned to the appropriate HMA based on the 2015 sage-grouse habitat management areas (BLM 2015). Thirty-two verified leks fall outside HMAs; thus, the 10-km nesting buffer identified in Appendix B of the 2012 Governor’s Plan (Governor’s Sage-grouse Task Force 2012) was used to assign these leks to the nearest HMA (“HMA by buffer”). One verified lek was >10 km from any mapped Priority, Important, or General habitat, so it was excluded from analyses.

To assess status of population triggers for 2024, lek route counts and finite rate of change were analyzed for each HMA and CA. For a population trigger to trip, both lek route and finite rate of change must meet or exceed the trigger requirements in that year.

Lek Route Analysis

A lek route is a logistical group of leks that are counted on the same morning, often by the same observer(s) (Cook et al. 2022). These leks must be close enough to allow all leks on the route to be counted between 0.5 hours before official sunrise and 1.5 hours after sunrise. Lek routes are counted 3-4 times each spring, typically from late March to early May, depending on elevation. Counts are not conducted during inclement weather (e.g., rain or snow, or winds >15 kph). Observers record the number of males at each lek on each survey day. The maximum number of males on a lek route is the highest number of males counted in total on the route on one survey day.

Some lek routes pass through multiple HMAs. For this analysis, lek routes were assigned to a single HMA based on the HMA assignment of most leks on the route (Appendix A).

The lek route analysis compares the current 3-year average of total maximum number of males on routes in each CA and HMA to the 2011 baseline. Seventy-six lek routes qualified for inclusion in this analysis (Figure 1), which includes 453 verified leks. This represents about 25% of all verified sage-grouse leks in the Idaho lek database. The actual number of leks counted on lek routes may vary among years as new leks are observed on the route. *It is important to note there are no lek routes in West Owyhee IHMA under the 2015 BLM plan amendment (Figure 1).*

$$\% \text{ change} = \left(\frac{\text{Current 3 year average total max males} - \text{2011 total max males}}{\text{2011 total max males}} \right) * 100$$

If the % change declines $\geq 20\%$, then route criteria have been met for a hard population trigger. If the % change declines $> 10\%$, but $< 20\%$, then route criteria have been met for a soft population trigger.

Finite Rate of Change Analysis

The rate of change analysis calculates the average rate of change in maximum lek counts over the current 3-year period (between 2022 and 2024). A stable population is represented by a value of 1.0, a decreasing population will have a value less than 1.0 and an increasing population will have a value greater than 1.0.

Significance for the rate of change was defined by the 90 percent confidence interval (Scheaffer et al. 1986). If the 90 percent confidence interval is less than, and does not include 1.0, then the finite rate of change has declined significantly, and the rate of change criteria has been met for a hard population trigger. The finite rate of change and variance was calculated following Garton et al. (2011).

Leks must have been counted in both 2022 and 2024 and lek count data must meet protocol requirements (i.e., time of day/date and weather conditions). Because the model uses ratios of counts accumulated within a larger area, lek counts may be included for leks that were visited 1 or more times within the season (2 –3 visits are recommended). Aerial survey counts that adhere to survey protocols are also included.

Sample size estimation for rate of change calculations

The 2023 finite rate of change and associated variance was used to determine appropriate sample size by HMA and CA for 2024 lek surveys. The sample size estimation formula for ratios (Scheaffer et al. 1986) was used to estimate the number of leks that need to have counts in both 2022 and 2024 to produce an estimate of the rate of change, +/- 20%.

Leks on routes are counted annually and are automatically included in the rate of change analysis. This may introduce bias to analysis, as leks route leks may be more stable/larger than leks not associated with routes. To ensure an unbiased proportion of other leks (i.e., leks not on lek routes) was also included in the analysis, the sample size estimate was multiplied by the proportion of leks not on routes, to calculate the number of additional leks that should be surveyed. This number was increased in some HMA/CA to ensure ≥ 60% of leks were surveyed. These additional leks were randomly assigned from the available pool.

The objective for 2024 was to count a minimum of 784 Pending Active and Active leks statewide. Of these, 467 were on lek routes and 316 were randomly assigned. Historical, Pending Historical, and Inactive leks (Appendix B) do not contribute to the rate of change analysis because there is no change between years.

Database and other lek monitoring priorities:

In addition to monitoring leks for lek route and rate of change analyses, some leks are surveyed to verify/maintain management status (see Appendix B):

1. Visiting Undetermined (unverified) locations to determine status.
2. Visiting Pending Active or Active leks at least once every 5 years.
3. Revisiting Inactive/Historical/Pending Historical leks every 5–10 years.
4. Visiting leks of special interest (i.e., research projects, post-wildlife response, habitat improvements).

These surveys do not contribute to the rate of change analysis as they are biased (i.e., not selected as a statistical sample of the population).

Results and Discussion

IDFG and state and federal partners (i.e., Governor's Office of Species Conservation, U.S. Fish and Wildlife Service, Bureau of Land Management, U.S Forest Service, Idaho National Laboratory) and community scientists surveyed 1,009 verified leks in 2024: 938 Active or Pending Active leks and 71 Inactive, Pending Historical, or Historical leks (Table 1, Figure 1). Birds were observed at 679 leks. Three Undetermined locations identified in 2023 were verified as Active leks in 2024. Eighteen new Undetermined locations were identified in 2024; these locations will receive follow up visits in 2025 to determine if they meet the definition of a verified lek (at least 2 males in at least 2 years during a 10-year period).

Statewide, male attendance on lek routes (including routes in GHMA) in 2024 was up 37% from 2023 and 49% from 2022 (i.e., current 3-year change). This is reflected in the 2022–2024 rates of change (which includes lek routes and randomly selected leks) where all HMAs had increasing values (i.e., $\lambda > 1.0$) (Table 2). Sage-grouse populations generally experience natural, regular oscillations in abundance over a period of 6–12 years (Fedy and Aldridge, 2011; Fedy and Doherty, 2011; Coates et al., 2021). The baseline year of 2011 used for trigger evaluation occurred within a few years of the low point of an oscillation. Statewide lek counts have been increasing since the most recent low point in 2019/2020. The rate of change can be stable or increasing for successive years, but the 3-year average of total number of maximum males remains below the 2011 baseline (Figure 2). Figure 3 depicts the current 3-year average of total maximum number of males by route in comparison to the 2011 baseline.

No new population triggers were tripped in 2024, and no existing population triggers were untripped.

- Population triggers remain tripped in Desert PHMA, Desert IHMA, Mountain Valleys PHMA, Southern IHMA, West Owyhee PHMA, and West Owyhee IHMA (Table 2).
- Statistical power was not reached for the rate of change analysis in the Southern IHMA (84 leks counted in both 2022 and 2024; 94 needed to produce an estimate of $\lambda \pm 0.20$). However, the current 3-year average of maximum total males on lek routes is below the 2011 baseline, so the hard population trigger remains tripped.
- The West Owyhee IHMA tripped a hard population trigger in 2019, under the 2019 BLM plan amendment (BLM 2019) which moved two lek routes from West Owyhee PHMA to IHMA. The 2019 BLM plan amendment was enjoined in 2019, and HMA lek route assignments reverted to the 2015 plan amendment (BLM 2015). There are no lek routes in West Owyhee IHMA under the 2015 BLM plan amendment; therefore, trigger status has been evaluated only on the rate of change analysis since 2020. The finite rate of change in that area has exceeded 1.0 in recent years; however, the increase was not significant (90% confidence interval included 1.0) so the population trigger remains tripped.
- Mountain Valleys IHMA tripped a soft population trigger in 2019, but not since. Although the lek routes analysis for Mountain Valleys IHMA met hard triggers in 2020–2023 and a soft trigger in 2024, the rate of change analysis for this IHMA exceeded 1.0, therefore a population trigger in IHMA was not tripped.
- Southern PHMA has never tripped a population trigger, likely because the 2011 baseline was four years after the Murphy Complex Fire; this fire significantly impacted a large portion of Southern

PHMA, resulting in lowered sage-grouse counts in subsequent years. The history of population triggers, 2015–2024, is depicted in Table 3.

As per Idaho Governor’s Executive Order 2022-03, the 2015 BLM and USFS ARMPA, an interagency Idaho Adaptive Management Team is directed to evaluate causal factors of tripped soft and hard population triggers and to recommend management actions. A causal factor analysis and management recommendations report was completed for population triggers that had tripped in 2019 or earlier (Desert PHMA and IHMA, Mountain Valleys PHMA, Southern IHMA, and West Owyhee IHMA) (Idaho Adaptive Management Team 2020). West Owyhee PHMA first tripped a hard population trigger in 2020. A causal factor analysis was initiated by the Adaptive Management Team, but a report was not finalized.

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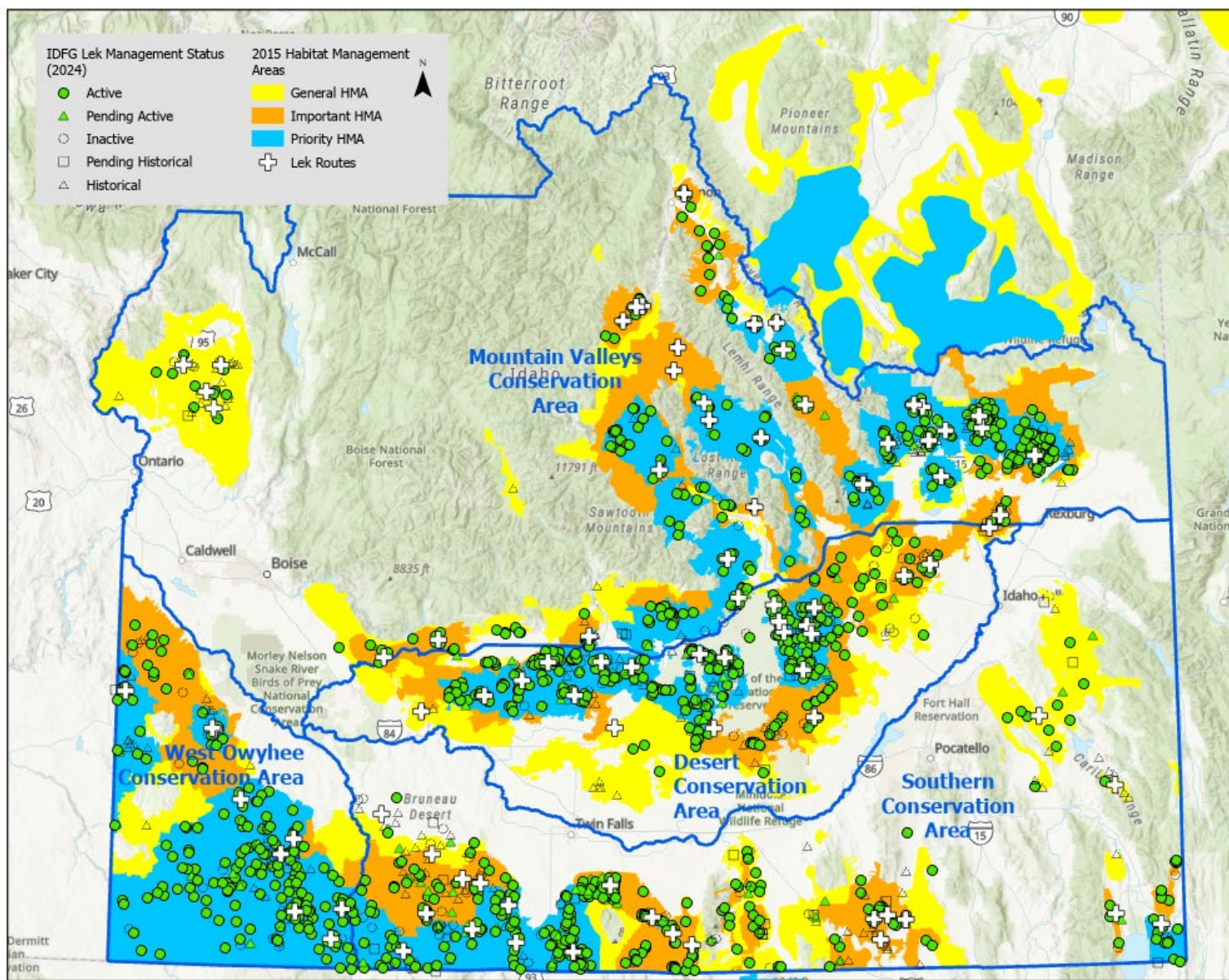


Figure 1. Location of sage-grouse lek routes and verified leks in each Conservation Area and 2015 BLM Habitat Management Area in Idaho.

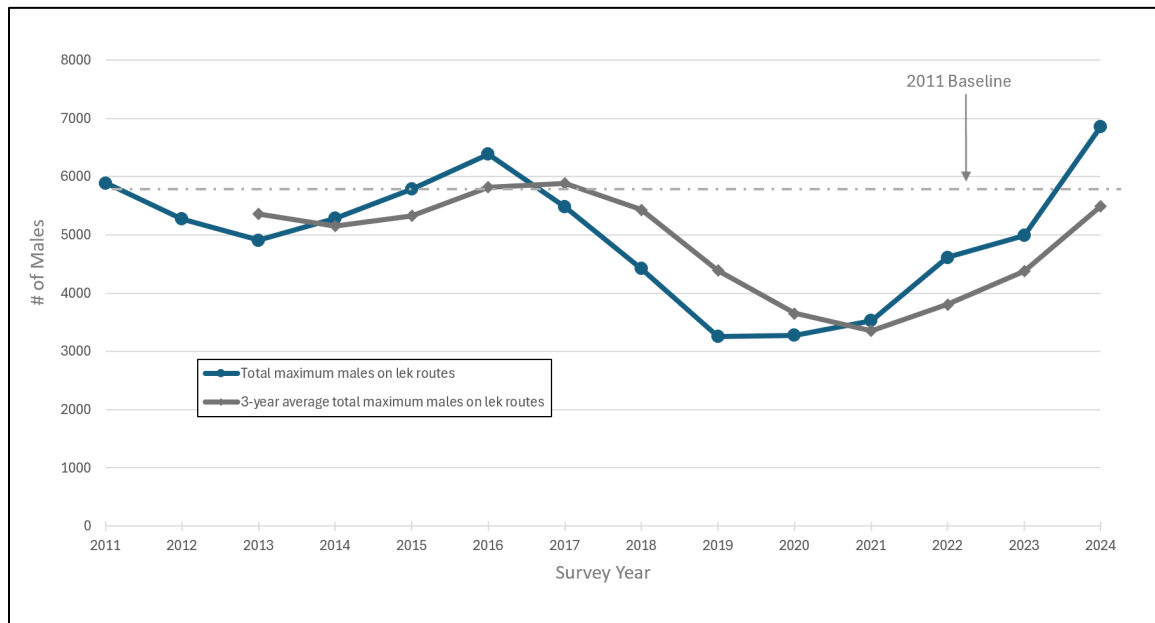


Figure 2. Total maximum number of males on 76 lek routes and 3-year average total maximum number of males on lek routes, in comparison to the 2011 baseline.

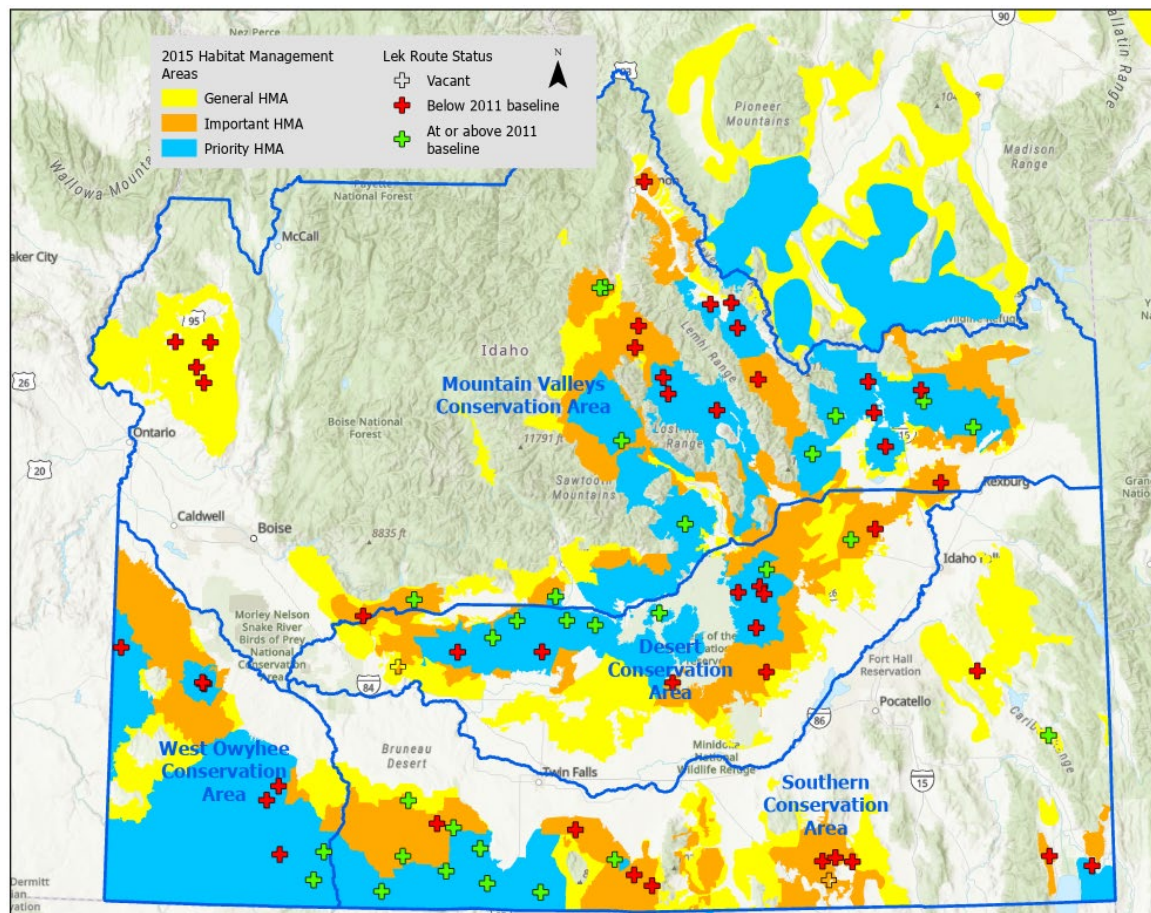


Figure 3. Current 3-year average of total maximum number of males on lek routes in comparison to the 2011 baseline.

Table 1. Estimate of number of Active and Pending Active leks to count by Conservation Area and 2015 BLM Habitat Management Area in Idaho in 2024, statistical sample needed of leks counted in 2022 and 2024 for rate of change estimation, and 2024 survey results.

2015 BLM Conservation Area/HMA ^a	Total Active and Pending Active Leks	Leks on lek routes ^b	Total leks to count 2024 ^c	Leks counted 2024 ^d	Sample size needed of leks counted 2022 & 2024 ^e	Leks counted 2022 & 2024	Statistical power reached
Desert PHMA	248	130	161	176	66	157	Yes
Desert IHMA	70	28	56	58	47	47	Yes
Mountain Valleys PHMA	277	121	167	201	52	182	Yes
Mountain Valleys IHMA	75	36	64	65	54	59	Yes
Southern PHMA	131	43	80	103	55	82	Yes
Southern IHMA	147	50	112	97	94	84	No
West Owyhee PHMA	171	35	103	168	51	148	Yes
West Owyhee IHMA	17	0	16	17	16	17	Yes
Desert GHMA	18	3	3	14			NA
Mountain Valleys GHMA	26	13	13	19			NA
Southern GHMA	35	7	7	19			NA
West Owyhee GHMA	0	0	0	0			NA
Outside HMA (>10km)	1	1	1	1			NA
Statewide	1,216	467	784	938			--

^aHMA= Habitat Management Area, PHMA=Priority Habitat Management Area, IHMA=Important Habitat Management Area, GHMA=General Habitat Management Area. HMA assignments following BLM (2015).

^bFor the finite rate of change analysis, leks on routes are individually assigned to the HMA where they are located (See Appendix A)

^cTotal Active and Pending Active leks on routes and random selection.

^dActive and Pending Active leks on routes and random selection.

^eNumber of leks that needed to be counted in both 2022 and 2024 to produce an estimate of $\lambda \pm 0.20$ (Scheaffer et al. 1986)

Table 2. Lek count history and trigger evaluation for lek routes and finite rate of change (λ) for 2024 by Conservation Area/Habitat Management Area.

Conservation Area/HMA ^a	Total maximum number of males on lek routes														Lek route analysis			Rate of change analysis (λ)		
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Current 3-year avg ^b	Percent change from 2011 ^c	2024 Route trigger ^d	λ 2022 to 2024	90% confidence interval	2024 λ trigger ^e
Desert PHMA	1777	1461	1517	1417	1373	1718	1425	1154	776	643	796	1139	1430	1814	1461	-18%	Soft	1.61	1.389-1.835	No
Desert IHMA	233	236	194	194	190	241	164	138	124	110	98	170	192	229	197	-15%	Soft	1.57	1.214--1.917	No
Mountain Valleys PHMA	1801	1719	1455	1608	1653	1683	1452	1181	862	957	1100	1512	1432	1991	1645	-9%	No	1.33	1.171-1.479	No
Mountain Valleys IHMA	342	290	317	339	390	488	423	383	231	279	253	332	243	451	342	0%	No	1.09	0.869-1.316	No
Southern PHMA	371	354	337	509	699	625	503	441	385	477	522	577	656	966	733	+98%	No	1.43	1.171-1.679	No
Southern IHMA	572	516	454	587	555	613	532	435	325	320	333	438	474	647	519	-9%	No	1.30	0.898-1.699	No
West Owyhee PHMA	700	600	562	566	841	948	933	638	502	450	368	407	556	734	566	-19%	Soft	1.42	1.267-1.565	No
West Owyhee IHMA ^f	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.51	0.918-2.10	No

^aHMA= Habitat Management Area; PHMA=Priority Habitat Management Area, IHMA=Important Habitat Management Area, GHMA=General Habitat Management Area. HMA assignments following BLM (2015).

^bCurrent 3-year average, spans years 2022-2024.

^cPercent change in current 3-year average from 2011 total.

^dFor a route trigger to trip, current 3-year average must be a decrease of 10% (soft trigger) or 20% (hard trigger) from the 2011 baseline.

^eFor a rate of change (λ) trigger to trip, the 90% confidence interval would be less than and not include 1.0.

^fNo lek routes in West Owyhee IHMA under BLM (2015); thus, a trigger is evaluated only on the rate of change (λ) analysis.

Table 3. History of population triggers^a in Idaho, 2015–2024. Hard triggers remain tripped until the counts on lek routes return to the 2011 baseline.

Conservation Area/HMA ^b	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Desert PHMA	None	None	None	Soft	Hard	Hard	Hard	Tripped ^c	Tripped	Tripped
Desert IHMA	None	None	None	Hard	Hard	Hard	Hard	Tripped	Tripped	Tripped
Mountain Valleys PHMA	None	None	None	Hard	Hard	Hard	Tripped	Tripped	Tripped	Tripped
Mountain Valleys IHMA	None	None	None	Operational ^d	Soft/ Operational	Operational	Operational	Operational	Operational	Operational
Southern PHMA	None	None	None	None	None	None	None	None	None	None
Southern IHMA	None	None	None	None	Hard	Hard	Tripped	Tripped	Tripped	Tripped
West Owyhee PHMA	None	None	None	None	None	Hard	Tripped	Tripped	Tripped	Tripped
West Owyhee IHMA	None	None	None	None	Hard ^e	λ trigger ^f	Tripped	Tripped	Tripped	Tripped

^aFor a population trigger to trip, both lek route and rate of change (λ) must meet the trigger requirements in that year.

^bHMA= Habitat Management Area; PHMA=Priority Habitat Management Area, IHMA=Important Habitat Management Area, GHMA=General Habitat Management Area.

^cOnce a hard trigger is “tripped”, it remains tripped until the current 3-year average of males on lek routes to return to or exceed the 2011 baseline.

^d“Operational” indicates temporary application of all PHMA management actions to the IHMA within a Conservation Area where the PHMA has met a hard trigger (MD SSS 22, BLM 2015).

^eUnder BLM (2019), 2 leks routes were moved from West Owyhee PHMA to IHMA and hard trigger criteria were met in 2019.

^fFollowing enjoinderment of BLM (2019), HMA lek assignments reverted to BLM (2015). No lek routes in West Owyhee IHMA under BLM (2015); thus, a trigger is evaluated only on the rate of change (λ) analysis. “ λ trigger” indicates the rate of change was significantly below 1.0.

Appendix A. Lek Routes

Lek routes used in the population triggers analysis^a and Habitat Management Area assignments (HMA).

Lek Route	Conservation Area	2015 BLM HMA	Notes
Antelope Creek	Mountain Valleys	Priority	
Antelope Pocket	Southern	Priority	Most of route in Priority
Big Desert #1	Desert	Priority	
Big Desert #3	Desert	Priority	Most of route in Priority
Big Desert #5	Desert	Priority	
Big Jack's Creek	West Owyhee	Priority	
Birch Creek	Southern	Important	
Blair Trail	Desert	Important	
Bliss-Hill City Road	Desert	Priority	
Bloomington	Southern	Important	
Brown's Bench	Southern	Priority	
Brown's Creek	West Owyhee	Priority	
Carlson Cabin	Mountain Valleys	Priority	
Cottonwood Ridge	Southern	Important	7 leks in Important, 5 in Priority
Cow Creek	West Owyhee	Priority	
Crane Creek	Mountain Valleys	General	
Crooked Creek	Mountain Valleys	Priority	
Crow's Nest-Clover	Southern	Important	4 leks in Important, 1 in General, 4 outside of HMA
Curlew East	Southern	Important	1 lek outside HM
Curlew North	Southern	Important	2 leks outside HMA
Curlew South	Southern	Important	2 leks outside HMA
Curlew West	Southern	Important	
Dishpan	Southern	Priority	
Dry Creek	Southern	Important	
Dry Gulch	Mountain Valleys	Important	
EIU Sheep Creek	Southern	Priority	2 leks in Priority, 1 in Important
Fingers Butte	Desert	Priority	11 leks in Priority, 2 in Important
Fir Grove	Desert	Priority	
Grassy Hills	Southern	Priority	
INL/Tractor Flat	Desert	Important	1 lek in General
Jacoby	Mountain Valleys	Priority	
Kinyon	Southern	Important	
Leadore East	Mountain Valleys	Priority	
Leadore West	Mountain Valleys	Priority	1 lek outside HMA

Lek Route	Conservation Area	2015 BLM HMA	Notes
Lidy	Mountain Valleys	Priority	3 leks outside HMA
Lincoln/Minidoka	Desert	Priority	1 lek in General
Little Hat Creek	Mountain Valleys	Important	
Little Lost	Mountain Valleys	Priority	
Little Sagehen Flat	Mountain Valleys	Important	
Lower Birch Creek	Mountain Valleys	Priority	
Lower Lemhi	Mountain Valleys	Important	
Lower Pahsimeroi East	Mountain Valleys	Important	
Lower Pahsimeroi West	Mountain Valleys	Important	
Macon Flat	Desert	Priority	
Medicine Lodge	Mountain Valleys	Priority	1 lek outside HMA
Middle Mountain	Southern	Important	
Midvale Hill	Mountain Valleys	General	
Monday Gulch	Mountain Valleys	General	
Moore's Flat	Mountain Valleys	Important	
North Shoshone	Desert	Priority	
Oreana	West Owyhee	Priority	
Paddleford Flat	Desert	Priority	1 lek outside HMA
Picabo	Desert	Priority	1 lek outside HMA
Plano	Mountain Valleys	Important	
Red Road	Mountain Valleys	Priority	3 leks in Important, 7 in Priority
Rock Creek	Mountain Valleys	Priority	11 leks in Priority, 1 in Important, 1 in General, 1 outside HMA
Rocky Knoll	West Owyhee	Priority	
Roland Road	West Owyhee	Priority	
Roseworth	Southern	Important	7 leks in Important, 2 in Priority
RWMC/INL	Desert	Priority	5 leks in Priority, 3 in Important
Sheep Creek	West Owyhee	Priority	
Sheep Station	Mountain Valleys	Priority	
Shoshone Basin	Southern	Priority	
Slug Creek	Southern	General	
Soulen Center	Mountain Valleys	General	
South Big Desert	Desert	Important	
Stible Road	Desert	Important	
Sunday Creek	Southern	General	
Table Butte	Mountain Valleys	Priority	
Timmerman	Desert	Priority	
Upper Big Lost	Mountain Valleys	Priority	

Lek Route	Conservation Area	2015 BLM HMA	Notes
Upper Birch Creek	Mountain Valleys	Important	
Upper Lemhi	Mountain Valleys	Priority	
Upper Pahsimeroi	Mountain Valleys	Priority	
Wickahoney	West Owyhee	Priority	
Yellow Sign Road	Southern	Important	

^aTwo lek routes (Spring Gulch and Winter Camp) were not surveyed in 2011 and are not included.

Appendix B. Status Designations and Definitions for Idaho Sage-Grouse Leks (2024)

Definitions (from Cook et al. 2022):

Lek – A lek is a traditional location where at least 2 males congregate during at least 2 springs within a 10-year period to perform their strutting display and opportunistically breed with females. Although males are territorial on leks and occupy an area, not a point, the representative location for the lek is the estimated or calculated center of the display activity. The ‘lek’ is the standard reporting and analysis unit for evaluating population status and long-term trends. Because males may alter their display locations within and between years (for numerous possible reasons), these multiple locations ‘within’ the lek have been referred to as “sub-leks”, “satellite leks”, “alternative leks”, or “temporary leks”. The location provided for the overall ‘lek’ should represent the dominant, largest, and/or most recent annual activity center. The lek identifier is the critical piece of data to remain consistent over time, the location can shift over time.

Lek Route – A logistical group of leks that are counted on the same morning, often by the same observer(s).

Management Status

- **Active** – A lek that has at least 2 males counted during two or more years within the past 10 years.
- **Inactive** – A lek at which all observations within the past 10 years have been less than 2 males and that had at least 2 males recorded during a lek count between 11 and 20 years ago.
- **Pending Active** – A lek with one observation of at least 2 males in the last 10 years and at least one observation of at least 2 males more than 10 years ago. This status captures leks insufficiently monitored to classify as Active, Inactive, or Historical but contains a more recent observation than Pending Historical.
- **Pending Historical** – A lek with insufficient observations in the last 10 years to classify as Active, Inactive, Historical, or Pending Active. This requires one observation of at least 2 males recorded 11 to 20 years ago and may include at least one observation of at least 2 males more than 20 years ago.
- **Historical** – A lek at which all observations within the last 20 years have been less than 2 males but previously met the definition of a lek (Cook et al. 2022).
- **Undetermined** – A location where males are displaying that has not been documented in multiple years and does not meet the definition of a lek. Sage-grouse may spontaneously display in an alternate location that is not maintained through time; undetermined locations should be verified in subsequent breeding seasons.

Literature Cited:

Cook, Avery A., Pat A. Deibert, Shawn P. Espinosa, Ann Moser, Leslie Schreiber, Michael A. Schroeder. 2022. Greater Sage-grouse Range-wide Population Monitoring Guidelines Part A: Standards for Collection and Reporting of Greater Sage-grouse Lek Count Data. WAFWA Sage- and Columbian Sharp-tailed Grouse Technical Team, Boise, Idaho.

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