Denbury

Greater Sage-Grouse Lek Monitoring Along the Cedar Creek Anticline

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June 2013

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NYSE: DNR
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Background

- Lek count surveys conducted 2007-2013
- Surveys funded by oil/gas companies, but were voluntary—not required by state or federal agencies
- Known sage-grouse lek locations were provided by MTFWP, BLM, and NDGFD
- Surveyed all known and unconfirmed leks within 2 miles of project area
- Project area determined by lease area or unit boundaries from funding companies
- Surveys funded by:
  - 2007-2008: Fidelity Exploration & Production
  - 2009-2011: Fidelity E&P and Encore (jointly)
  - 2012-2013: Denbury (acquired Encore)

Main Objectives

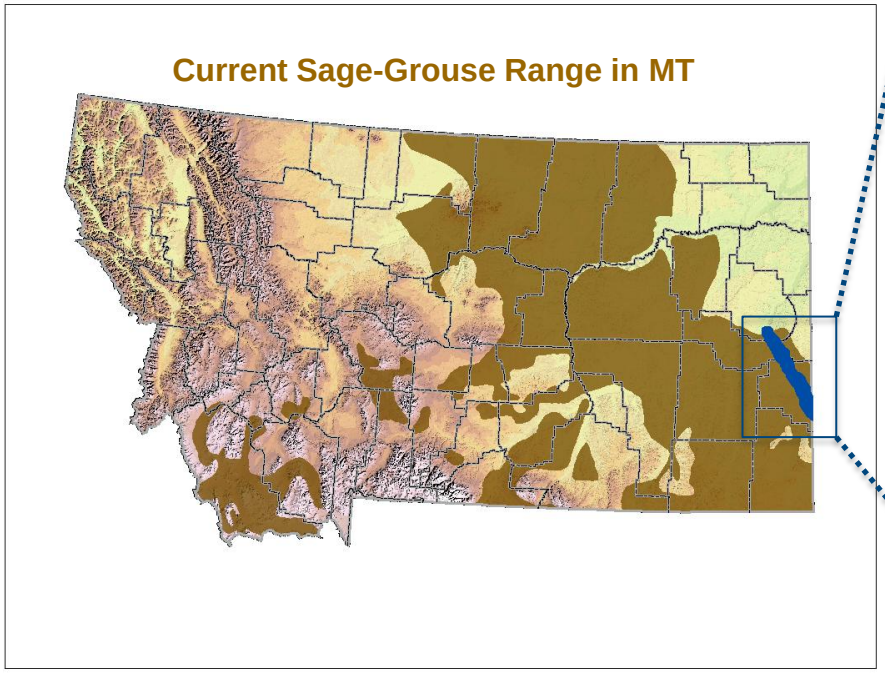
- **Compliance and Monitoring**
  - Provide information on annual lek status
  - Document male lek attendance and annual changes
  - Ensure lek locations are up-to-date and accurate
  - Search for new or previously-undocumented leks

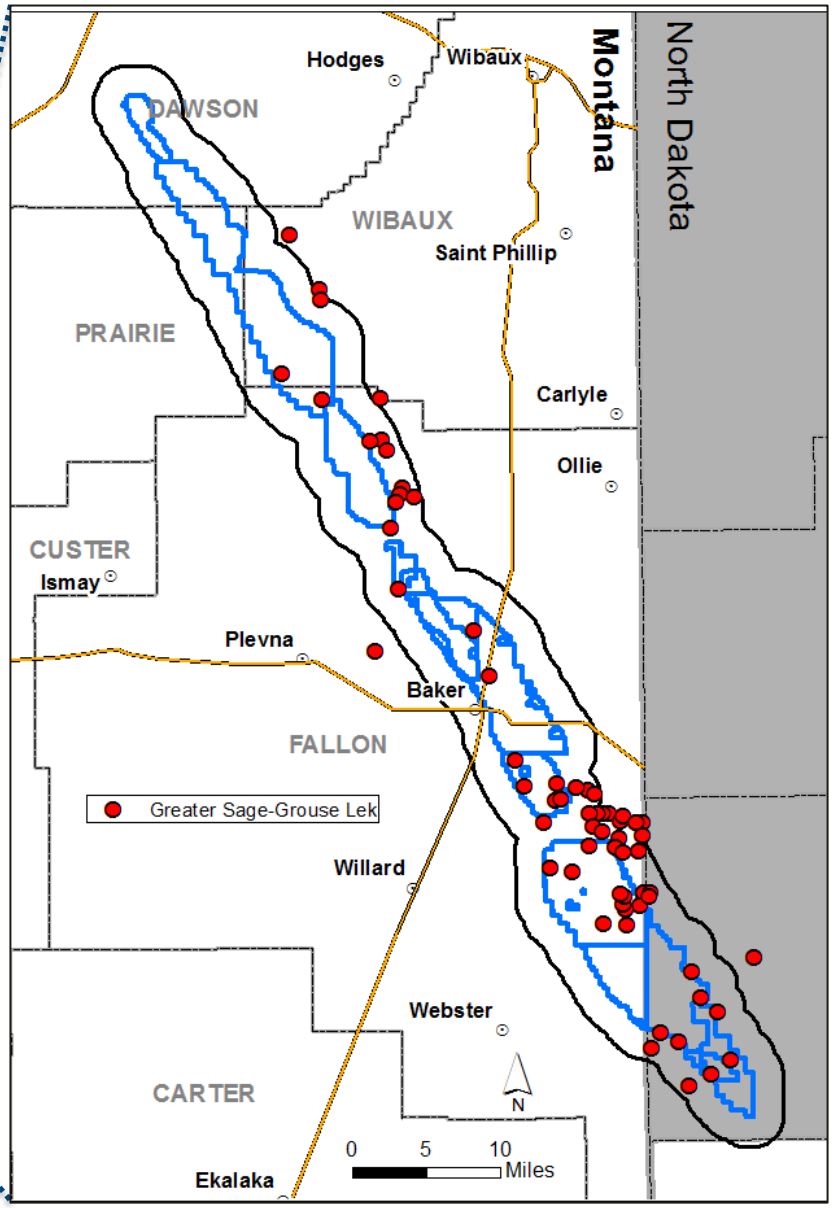
Scope of Presentation

- Only data collected by HWA are included
  - 2007-2013 (7 years)
- Represents a preliminary non-statistical assessment of trends in sage-grouse male lek attendance and lek persistence
- Several important landscape features not considered for this presentation (i.e., vegetation, topography, wind farms, overhead power lines, roads, etc.)
- More comprehensive analyses are planned for the near future

Project Area: Cedar Creek Anticline

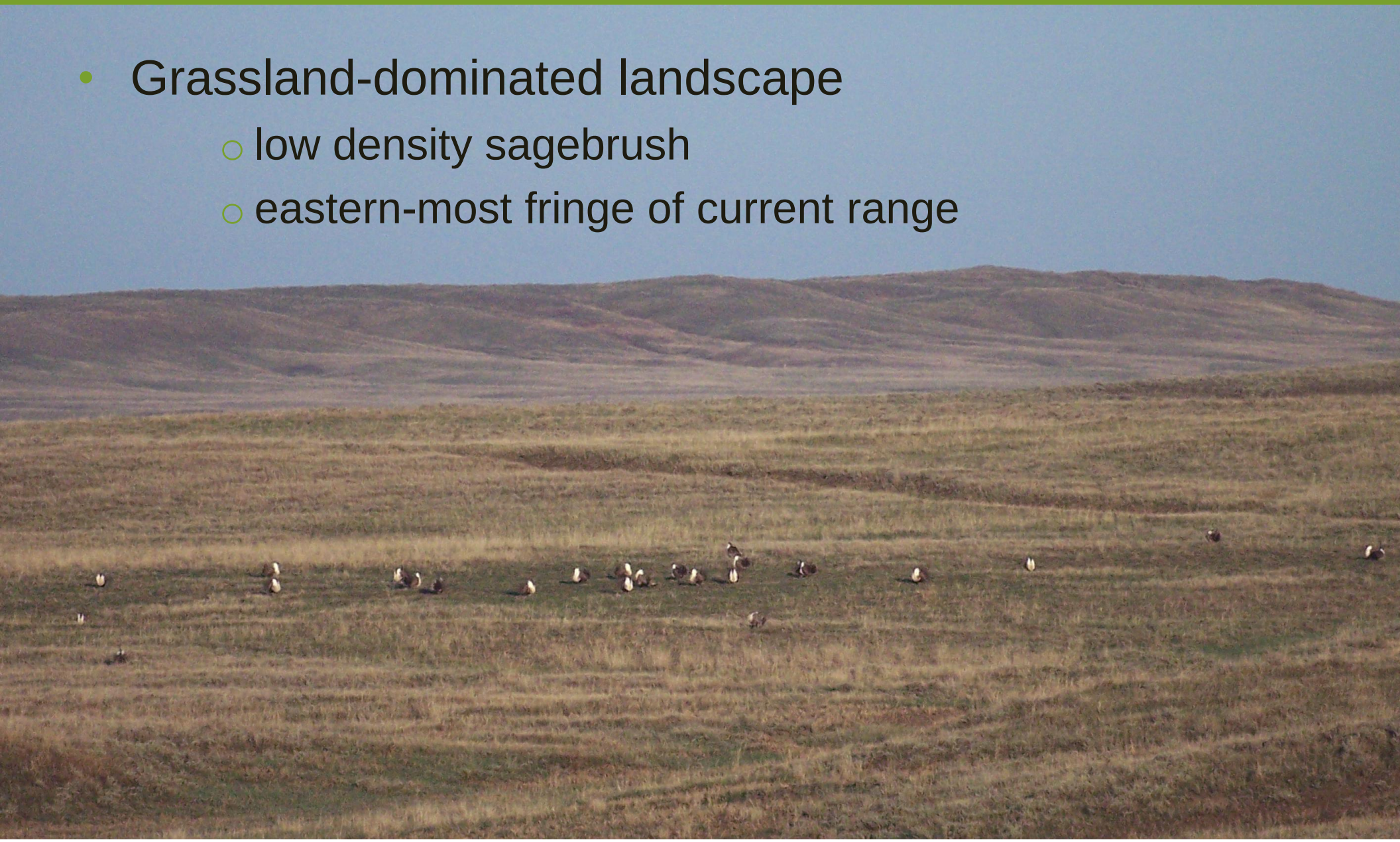
- Surveys limited to leks in Montana and a few along the border with North Dakota
  - Leks in North Dakota surveyed by NDGFD



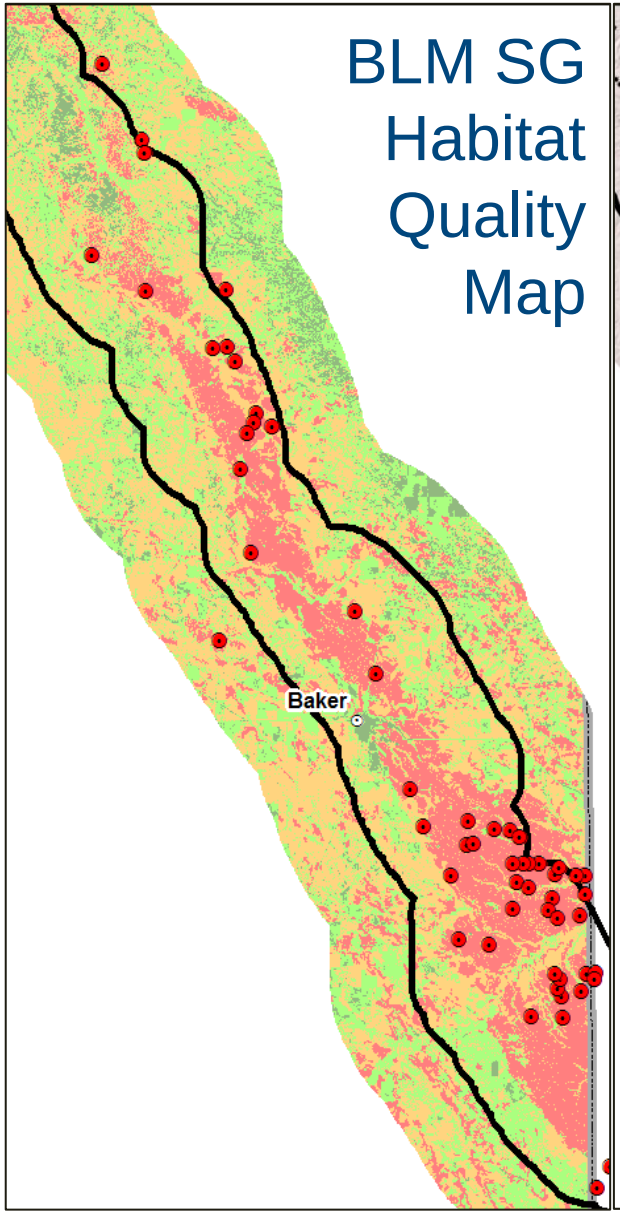


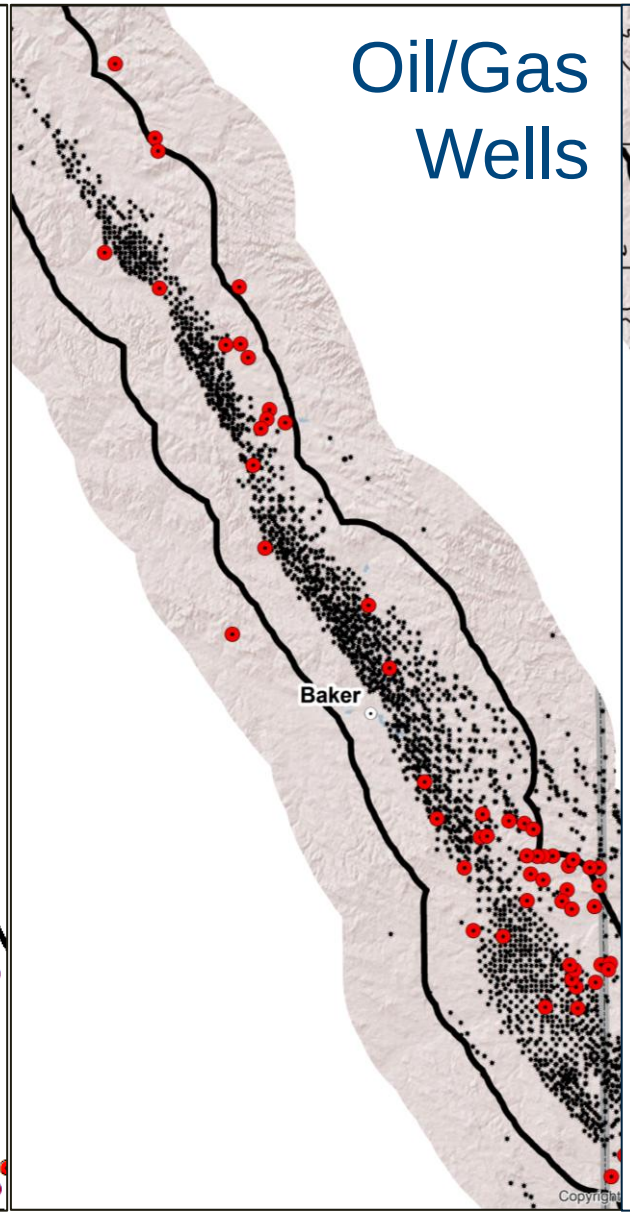
Example of Typical Lek Location

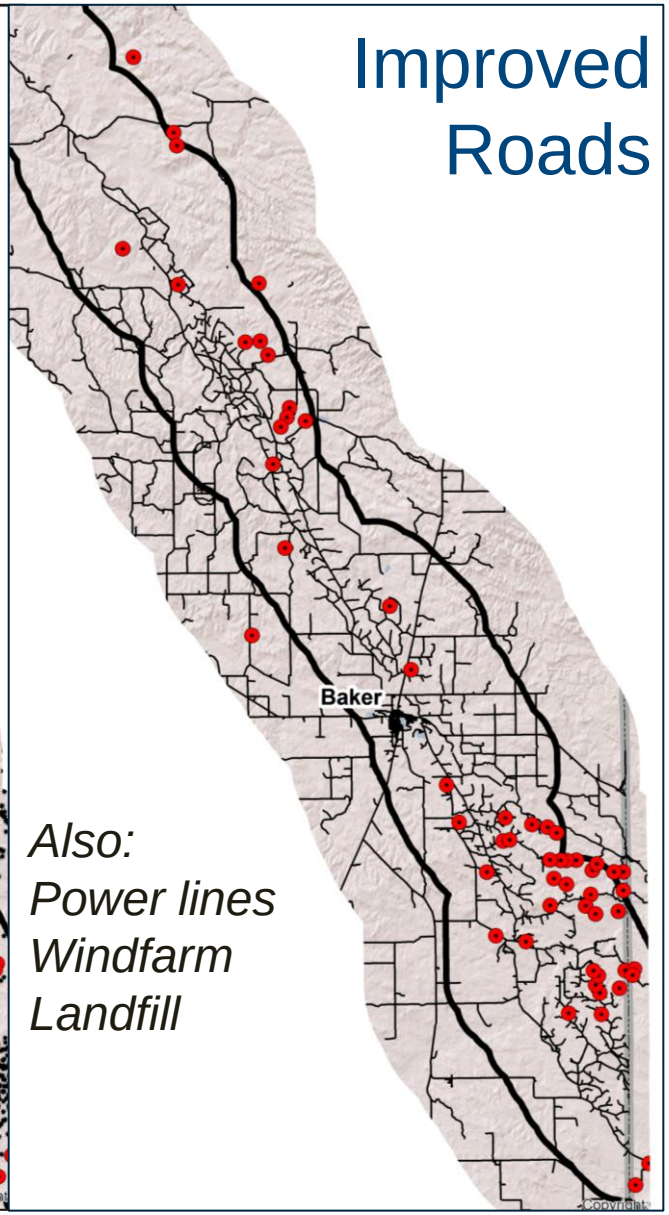
- Grassland-dominated landscape
  - low density sagebrush
  - eastern-most fringe of current range



Landscape Features of Project Area





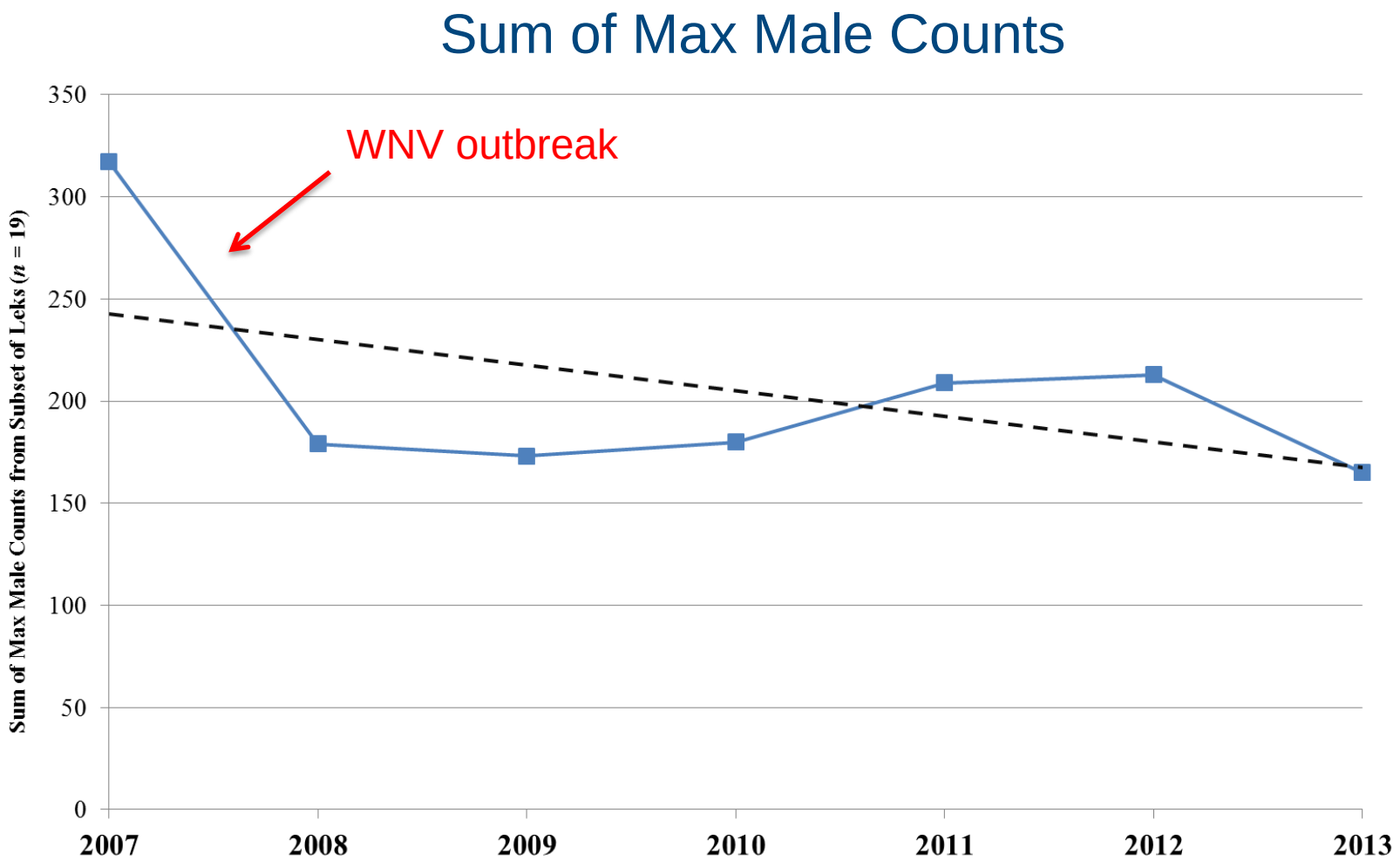


RESULTS: Sage-Grouse Lek Counts

Parameter	2007	2008	2009	2010	2011	2012	2013	Mean
Leks counted	37	38	42	44	44	44	44	**42**
Males/lek	8.92	5.18	5.29	5.14	5.57	6.00	4.55	**5.81**
Active leks	21	22	21	22	22	23	22	**21.86**
% active leks	57	58	50	50	50	52	50	**52.42**
Males/active lek	15.71	8.95	10.57	10.27	11.14	11.48	9.09	**11.03**
Population Growth Rate*	**--**	**0.565**	**0.966**	**1.040**	**1.161**	**1.019**	**0.775**	**0.92**

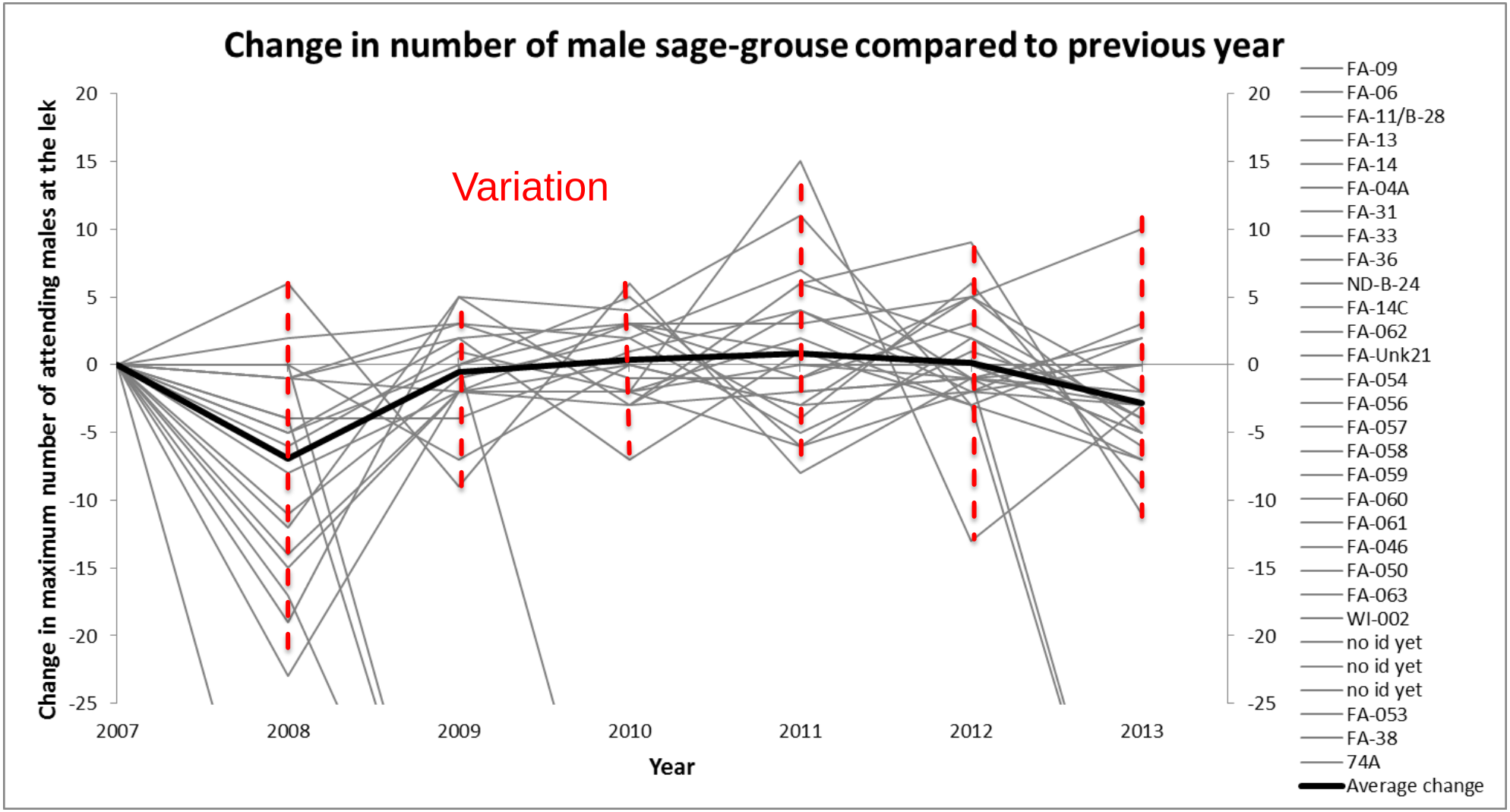
** Calculated using subset of leks (n = 19), all active in 2007 and surveyed annually since.*

Trends: Overall Sage-Grouse Lek Attendance



- Index based on subset of (*n* =19) leks, all of which were active during the 1st year of monitoring and have been surveyed consistently each year since.

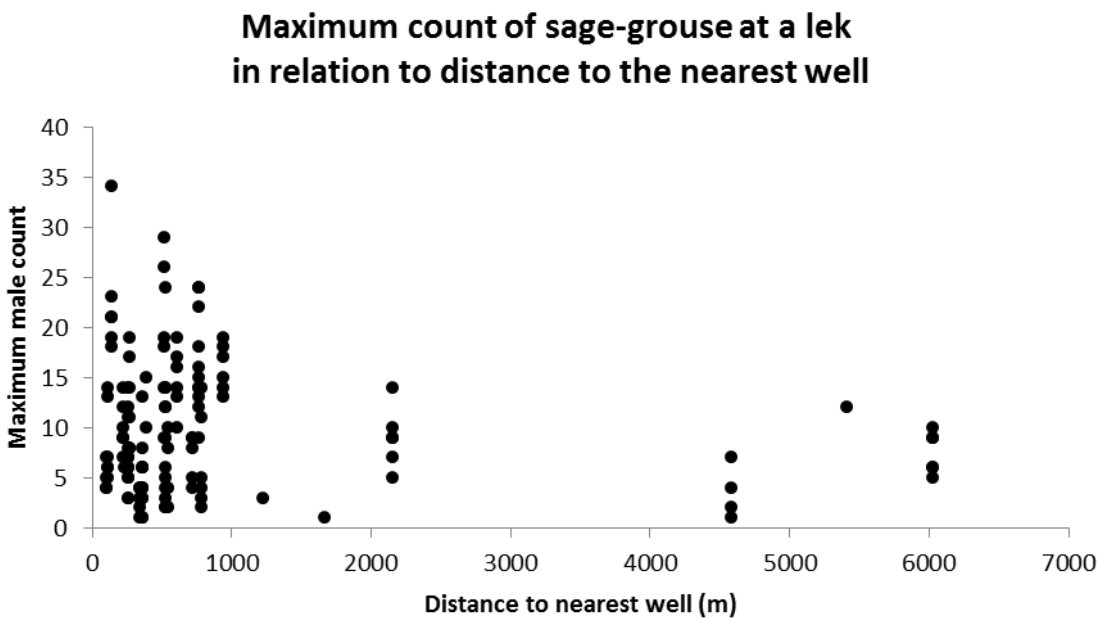
Trends: Collective Patterns and Variation

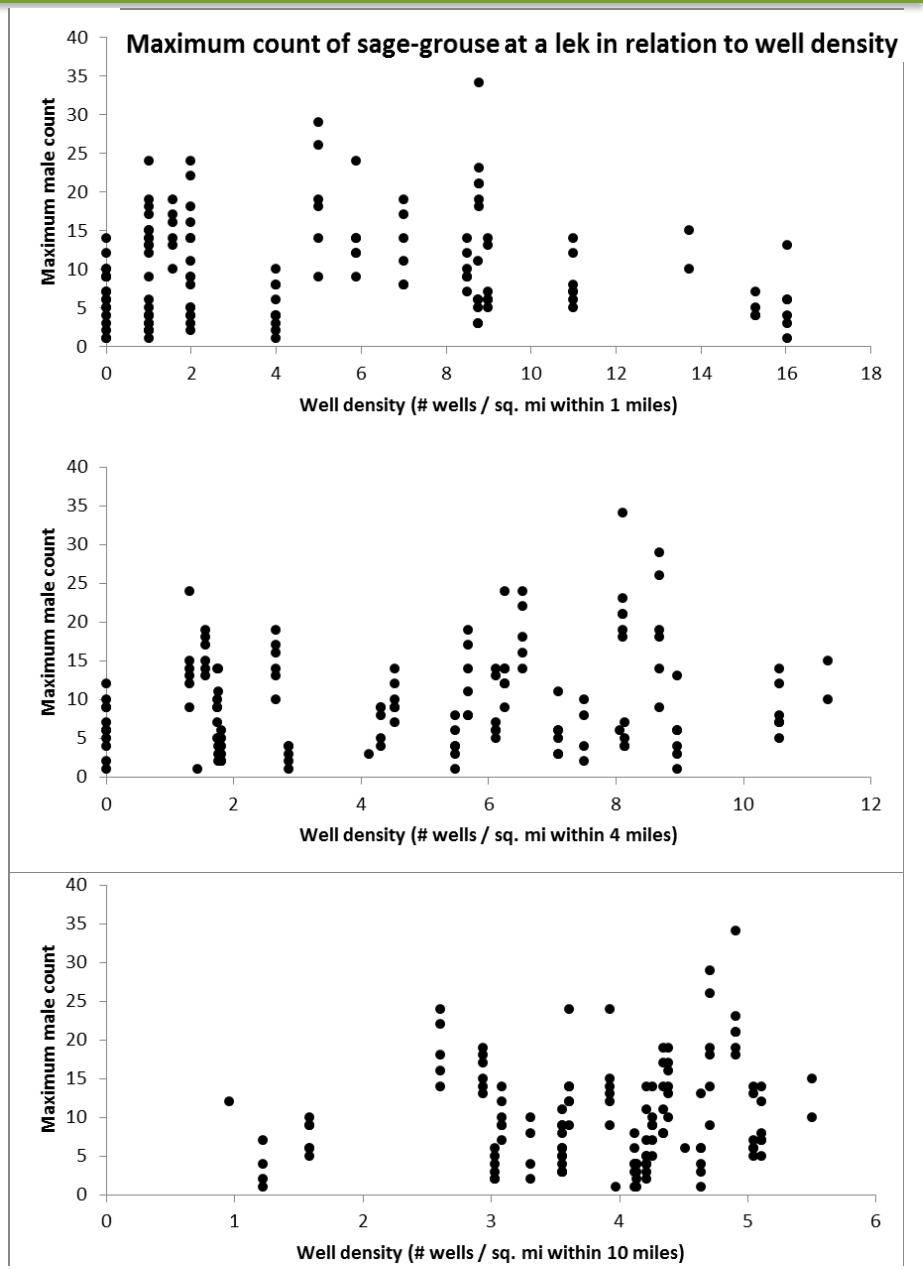


- All changes are relative to 2007 counts, so 2007 numbers are standardized to zero for comparative purposes

Abundance In Relation to Oil/Gas Wells

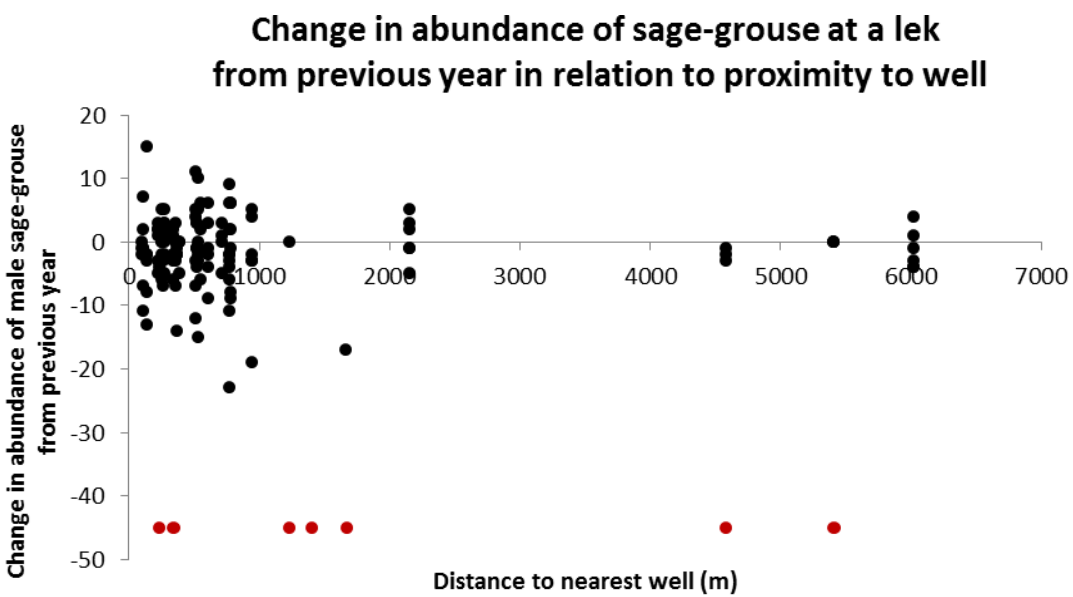
- Max male count relative to the proximity to and density of oil/gas wells
- Considered well data from 2006 (displayed below) and 2013
- Used scales of 1, 4, and 10 sq. miles for well density
  - **No apparent pattern regarding abundance in relation to oil/gas features at these scales**

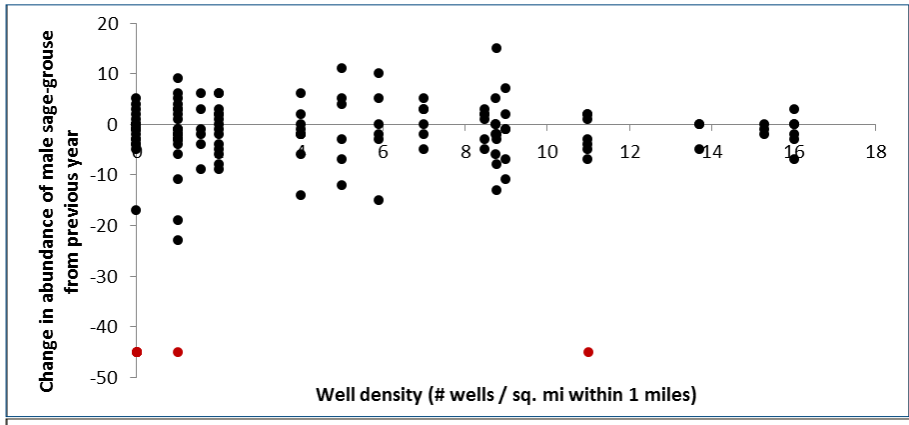


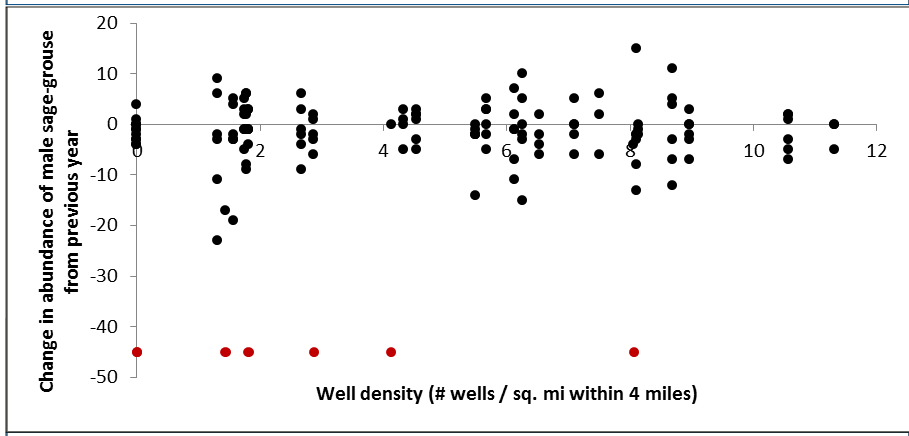


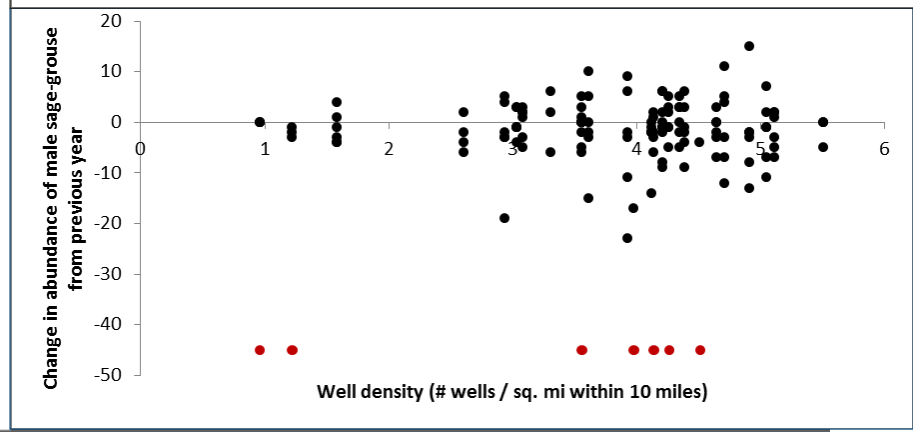
Change in Abundance in Relation to Oil/Gas Wells

- Change in abundance from the previous year relative to proximity to and density of oil/gas wells
- Considered well data from 2006 (displayed below) and 2013
- Used scales of 1, 4, and 10 sq. miles for well density
  - **No apparent relationship between change in abundance and proximity/density of oil/gas features, at these scales**

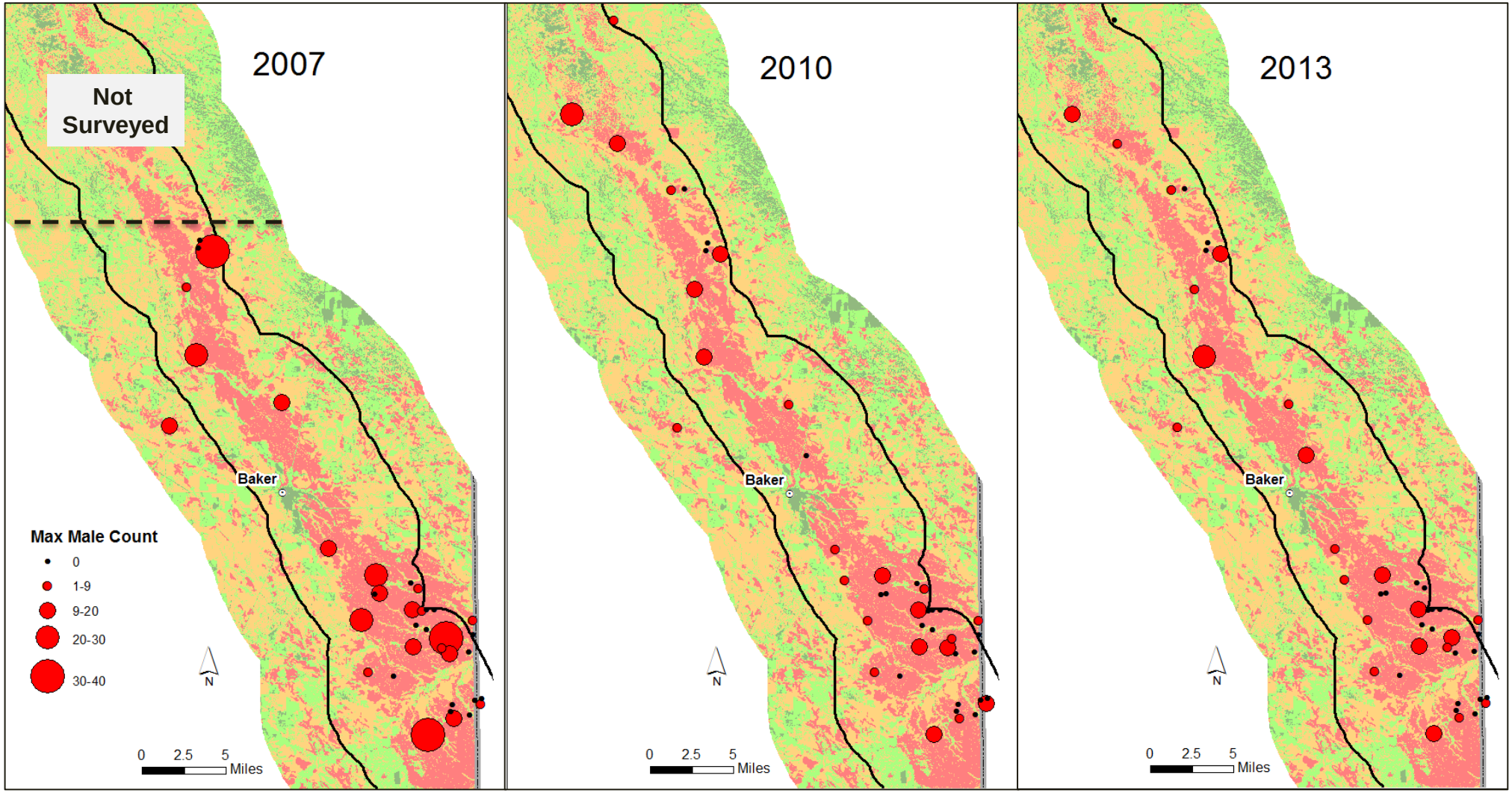








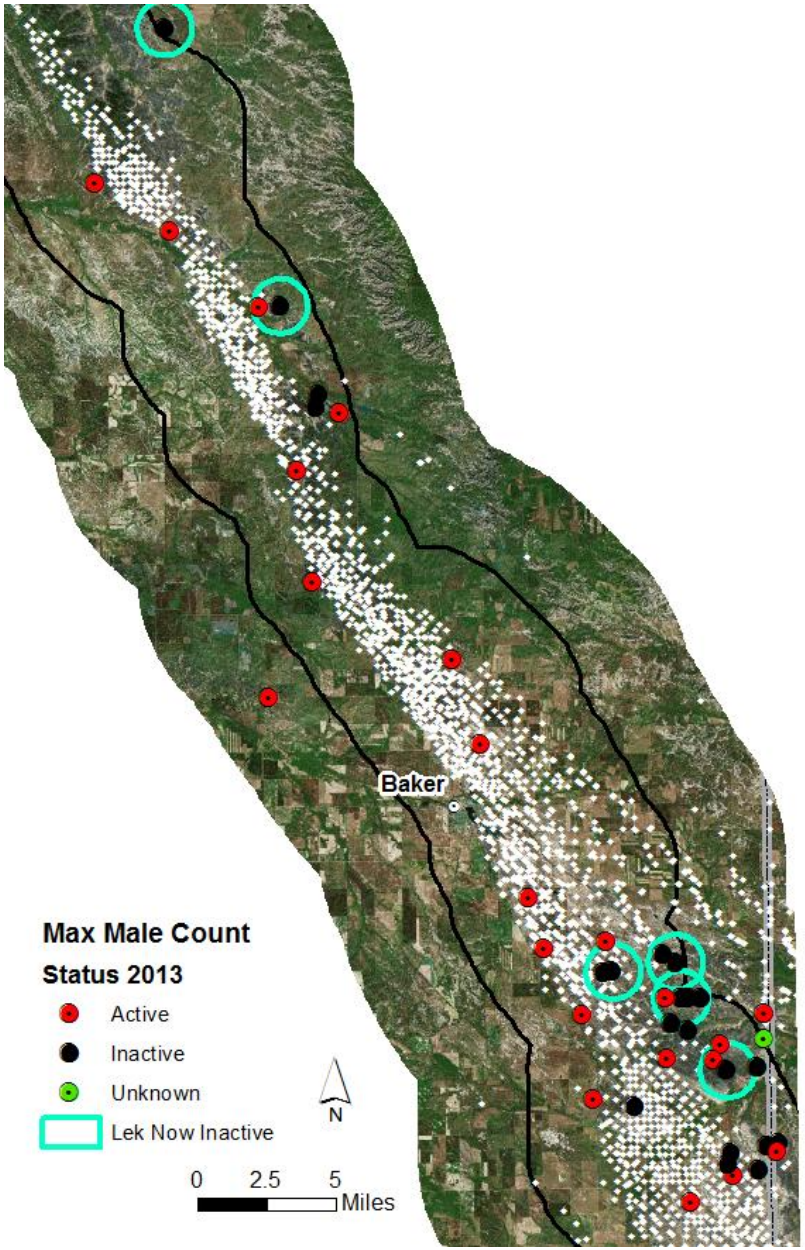
Trends: Spatial Patterns of Male Attendance



Lek Persistence: Spatial Patterns

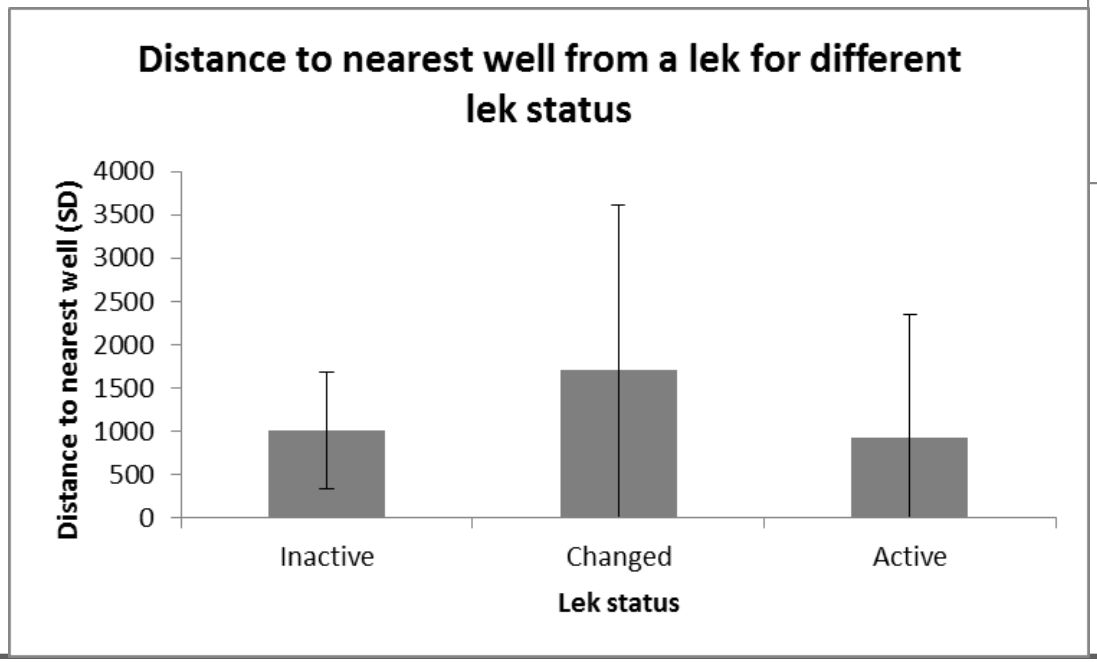
Lek Status Change Categories	2007-2013
# leks active ≥1 yr between 2007-2013	28*
leks remaining active in 2013	22 (78.6%)
previously active leks inactive in 2013	6 (21%)

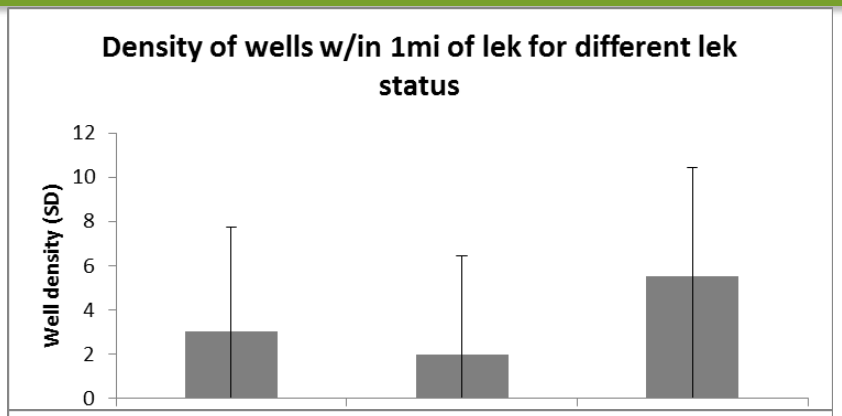
* Includes 15 leks found by HWA or others since 2007

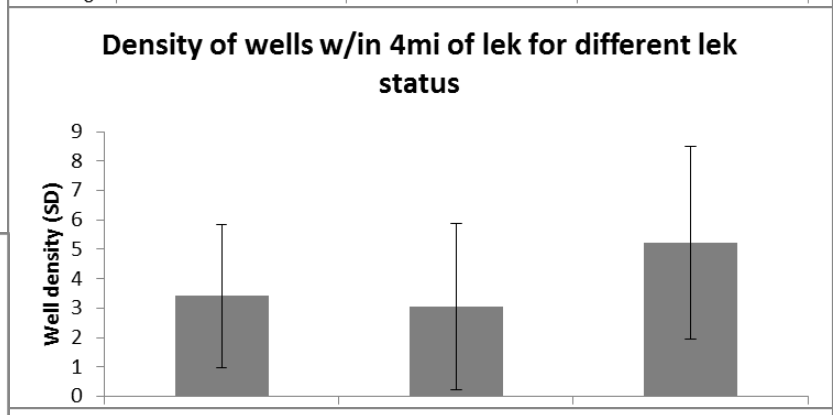


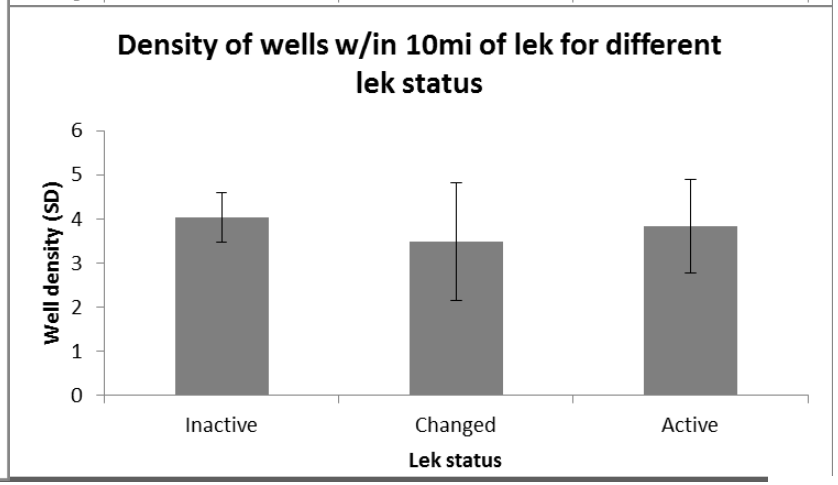
Trends: Lek Status Relative to Oil/Gas Wells

- Comparison of lek status 2007-2013 relative to proximity to and density of oil/gas wells
- Considered well data from 2006 (displayed below) and 2013
- Used scales of 1, 4, and 10 sq. miles for well density
  - **No apparent difference among status categories relative to oil/gas features**
  - **If anything, results are opposite of conventional expectations**









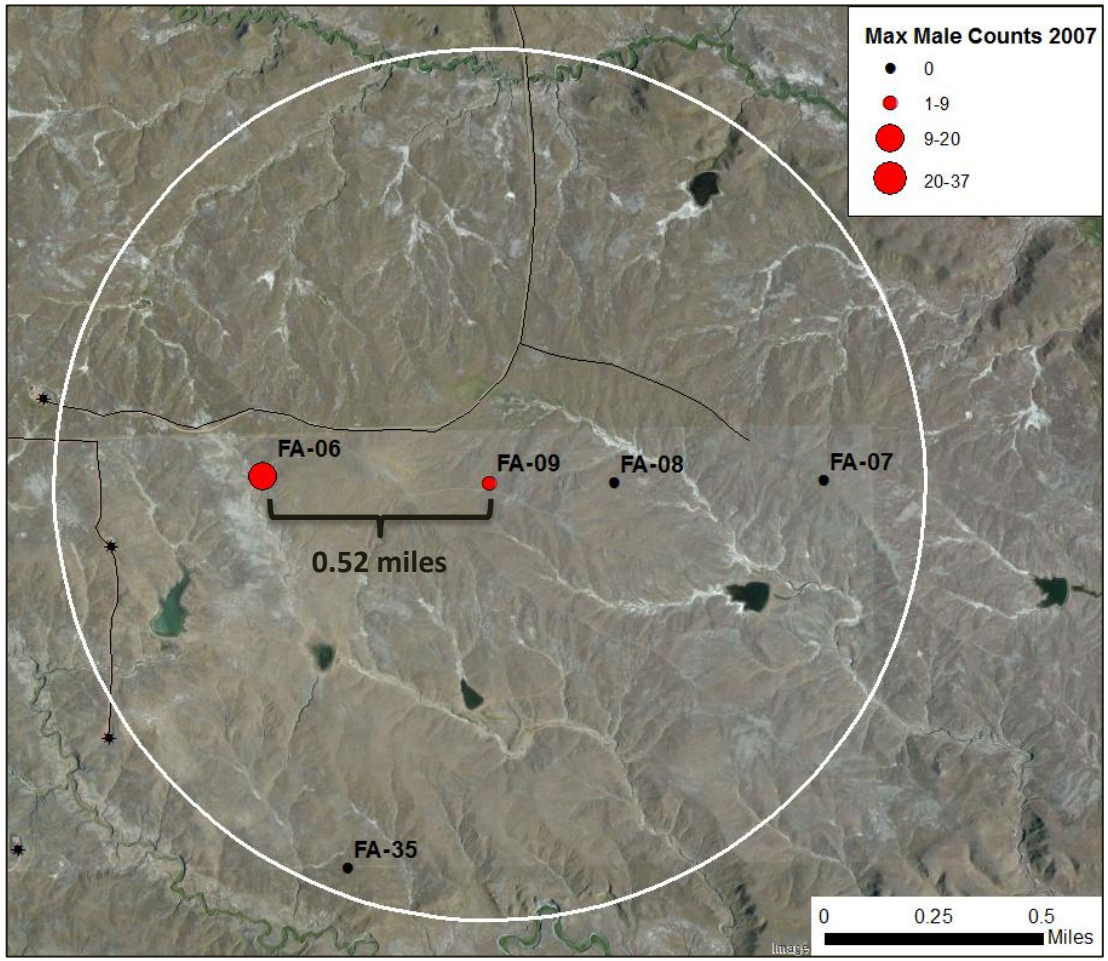
Previously Active Leks That Are Now Inactive—Some Observations

- Not always as clear-cut as it seems
- Of the six previously active leks that are now inactive:
  - 2 are believed to be satellite leks
  - 1 was a very small “new” lek that we believe moved to a different location nearby
  - 2 declined for no obvious reason; one is completely outside the oil/gas development and one is on the edge of low density development
  - 1 was clearly disturbed by a wind farm

Example #1: Lek Status Active→Inactive

Lek ID	2007	2008	2009	2010	2011	2012	2013
FA-09	2	0	0	0	0	0	0

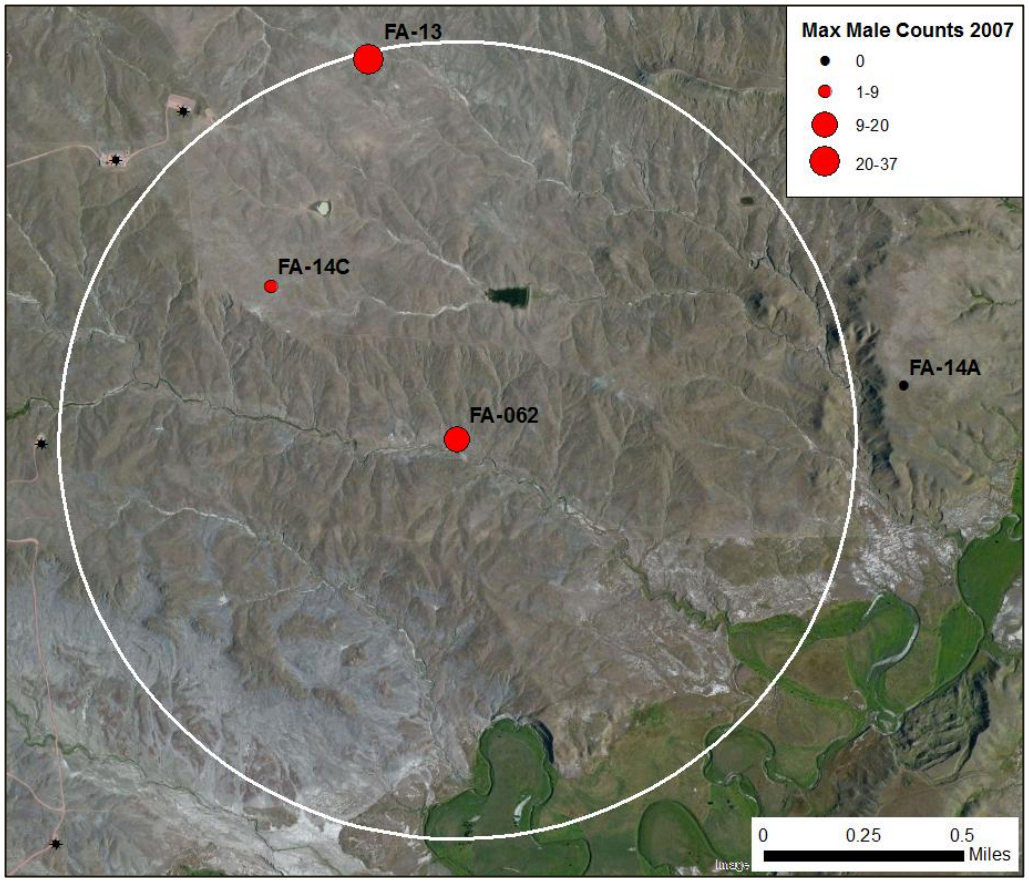
- FA-09
  - MTFWP lek location
  - 2 males on last survey in 2007 only
  - 0.52 miles from established lek
  - One oil/gas well within 1 mile
  - Suspected satellite lek location



Example #2: Lek Status Active→Inactive

Lek ID	2007	2008	2009	2010	2011	2012	2013
FA-062	18	1	0	0	0	0	0

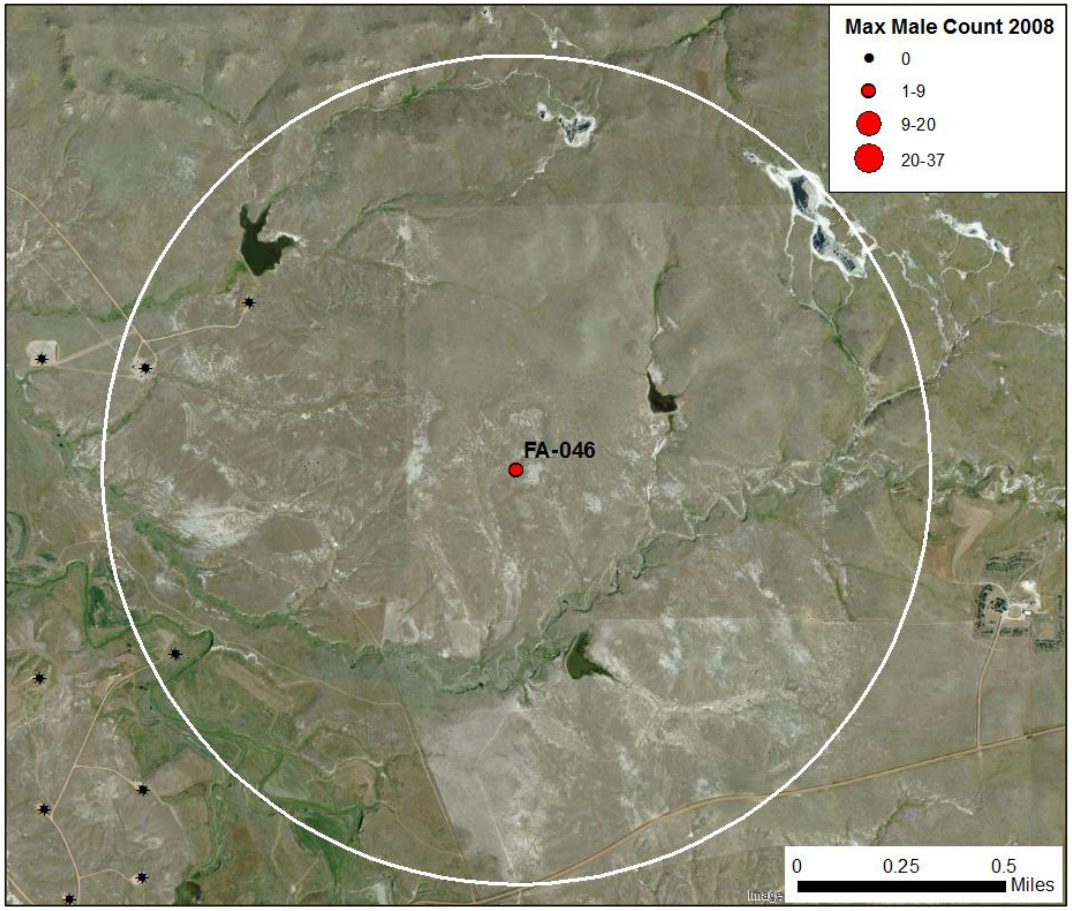
- FA-062
  - BLM “unknown” lek location
  - Confirmed in 2007
  - Males observed flying from FA-13 in direction of FA-062
  - 0 oil/gas wells within 1 mile
  - Suspect lek is part of three-lek complex rather than independent



Example #3: Lek Status Active→Inactive

Lek ID	2007	2008	2009	2010	2011	2012	2013
FA-046	--	3	0	0	0	0	0

- FA-046
  - Reported by other surveyor in 2007
  - Confirmed active with multiple observations of >2 males in 2008, but inactive since 2008.
  - Three oil/gas wells within 1 mile
  - Arguably should not have been listed as confirmed unless active another year



Main Points

1) Using 2007 as a baseline, the population declined ~40% following the outbreak of WNV during the summer of 2007 and has yet to recover to previous levels
2) No obvious relationship detected between declines in male abundance or lek persistence in relation to oil/gas wells during the past seven years
3) To the contrary, active leks tended to be in areas with higher well densities than inactive leks, which is likely a function of extensive overlap between the distribution of sagebrush habitat and the oil/gas resources
4) Trends and patterns from the past 7 years may not be reflective of the years prior to 2007 nor do we know if 2007 is an appropriate baseline.

Main Points (cont.)

5) Even as many leks have declined since 2007, most have persisted even in close proximity to oil/gas wells
6) Disturbance did not appear to be a factor in at least 4 of 6 cases of previously-active leks becoming inactive
7) Clearly more comprehensive statistical analyses are needed, in which multiple natural and anthropogenic features are considered, for identifying the most important factors influencing male lek attendance and persistence

Acknowledgments

Funding:
Denbury and Fidelity Exploration & Production

Data Sharing and Support:
MTFWP, BLM and NDGFD

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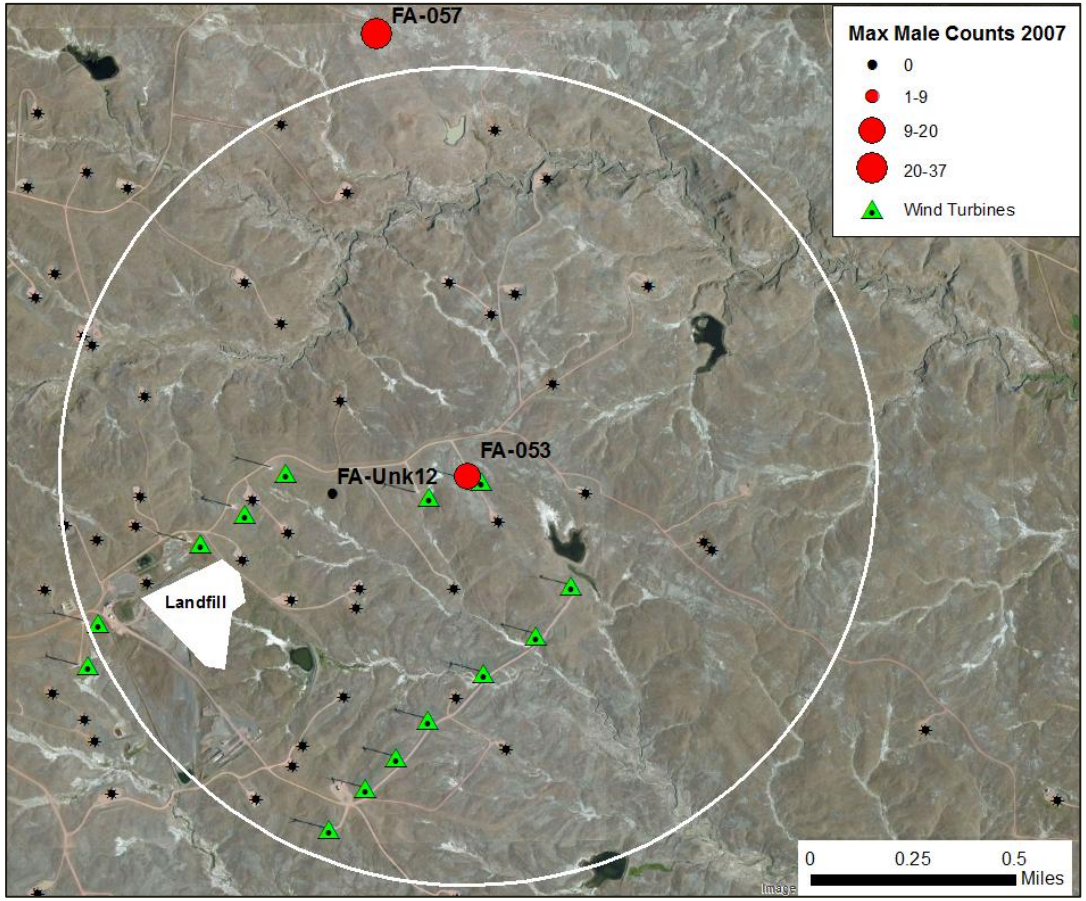
Example #4: Lek Status Active→Inactive

Lek ID	2007	2008	2009	2010	2011	2012	2013
FA-053	10	6	0	0	0	0	0

- FA-053
  - Found in spring 2007
  - Believe this was the new location for FA-Unk12
  - Many oil/gas wells and within 1 mile of landfill
  - Wind farm constructed summer 2007
  - Turbine unknowingly sited on lek location
  - Inactive 2-years post-construction of windfarm