Factors influencing the Ecology of Greater Sage-Grouse in the Bear Lake Plateau and Valley, Idaho-Utah

Photo by Tom Prestby

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Ecology of Greater Sage-grouse

- Breeding Behavior

Lekking

Brood Rearing

Nesting

- Survival

Habitat Use

Nesting

Brood Rearing

Winter

Photo by Rachel Curtis

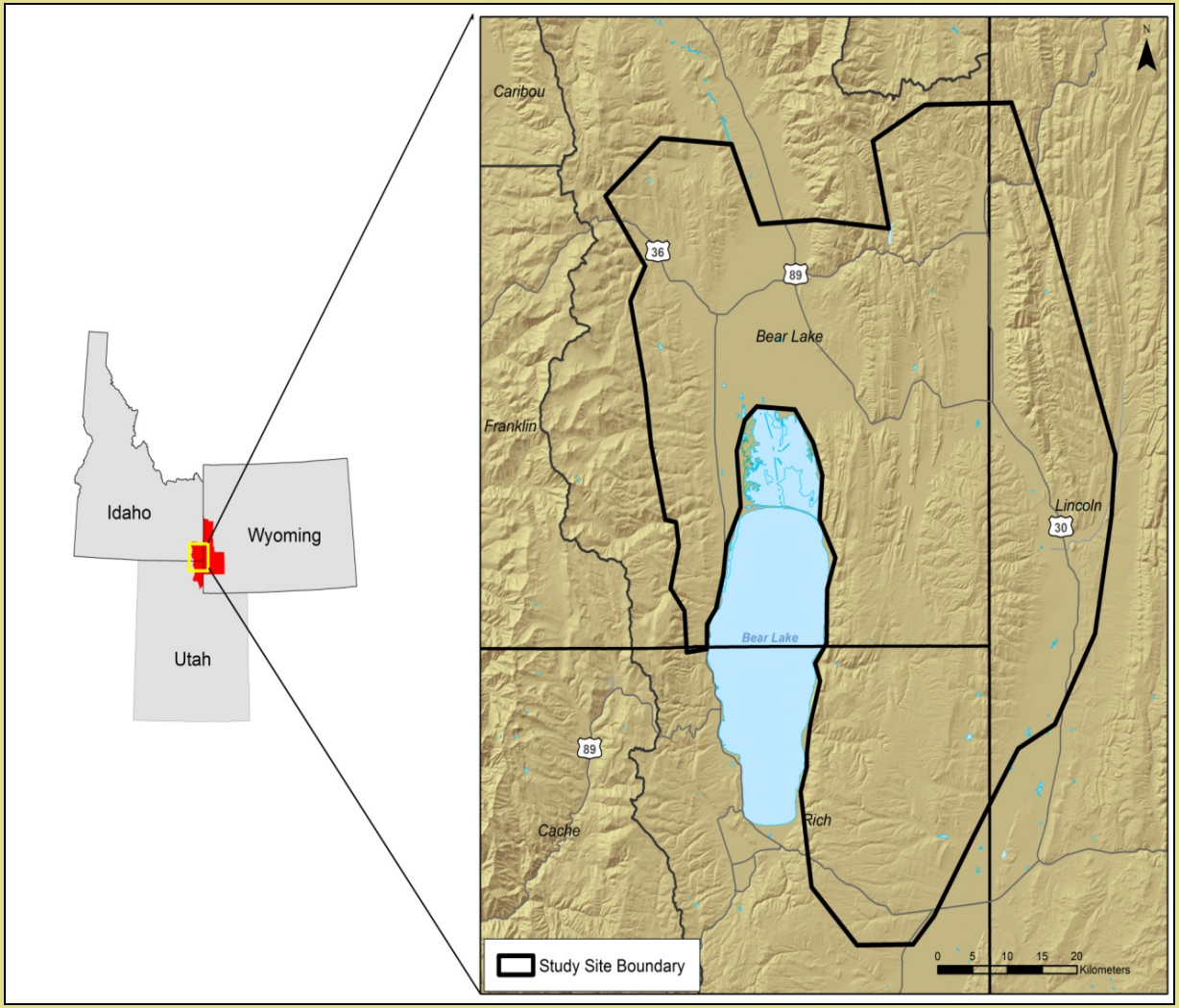
Threats to sage-grouse

Inadequacy of Regulatory Mechanisms

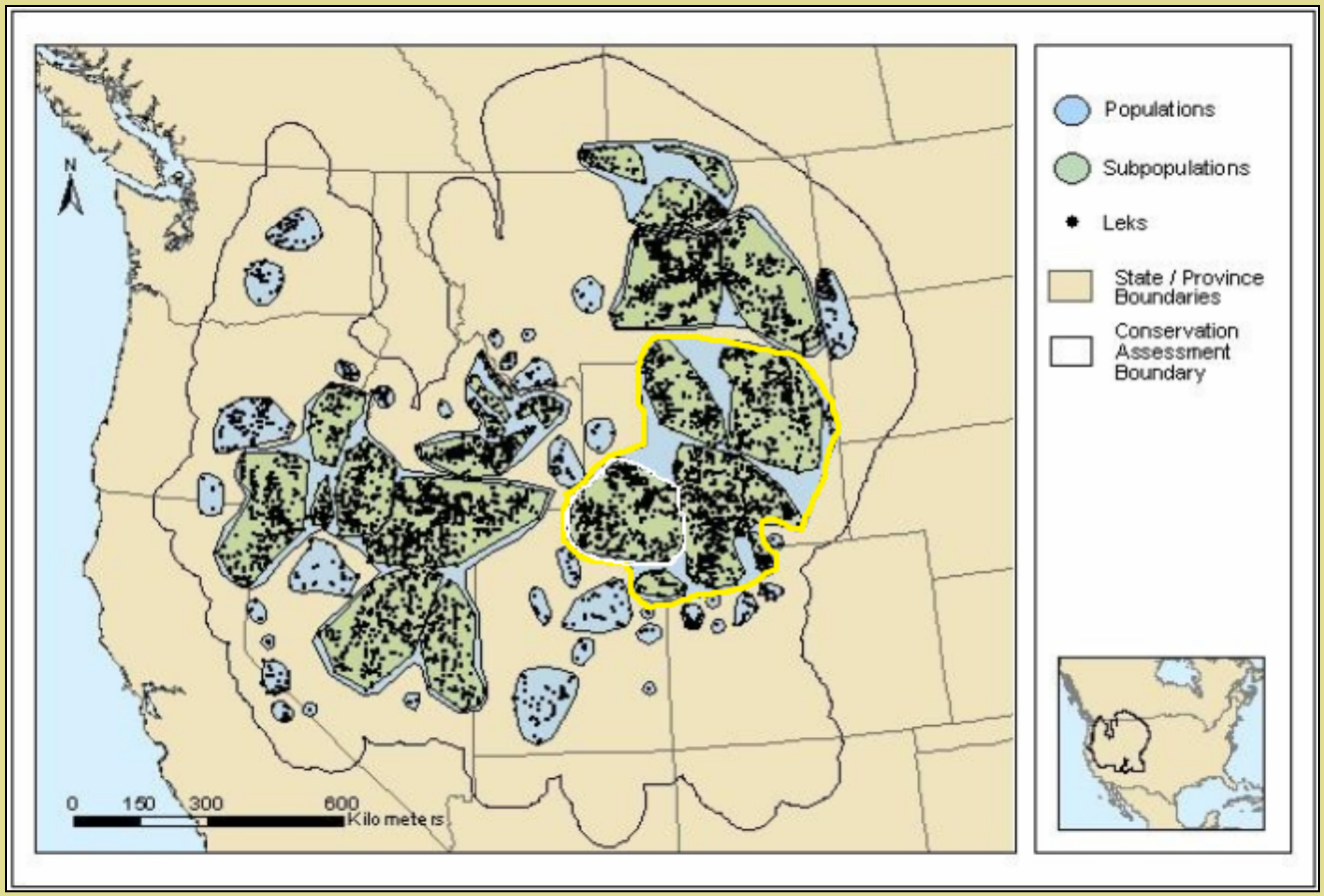
Greater Sage-Grouse Conservation Plan for
Nevada and Eastern California

First Edition – June 30, 2004

Bear Lake Plateau and Valley Study Area



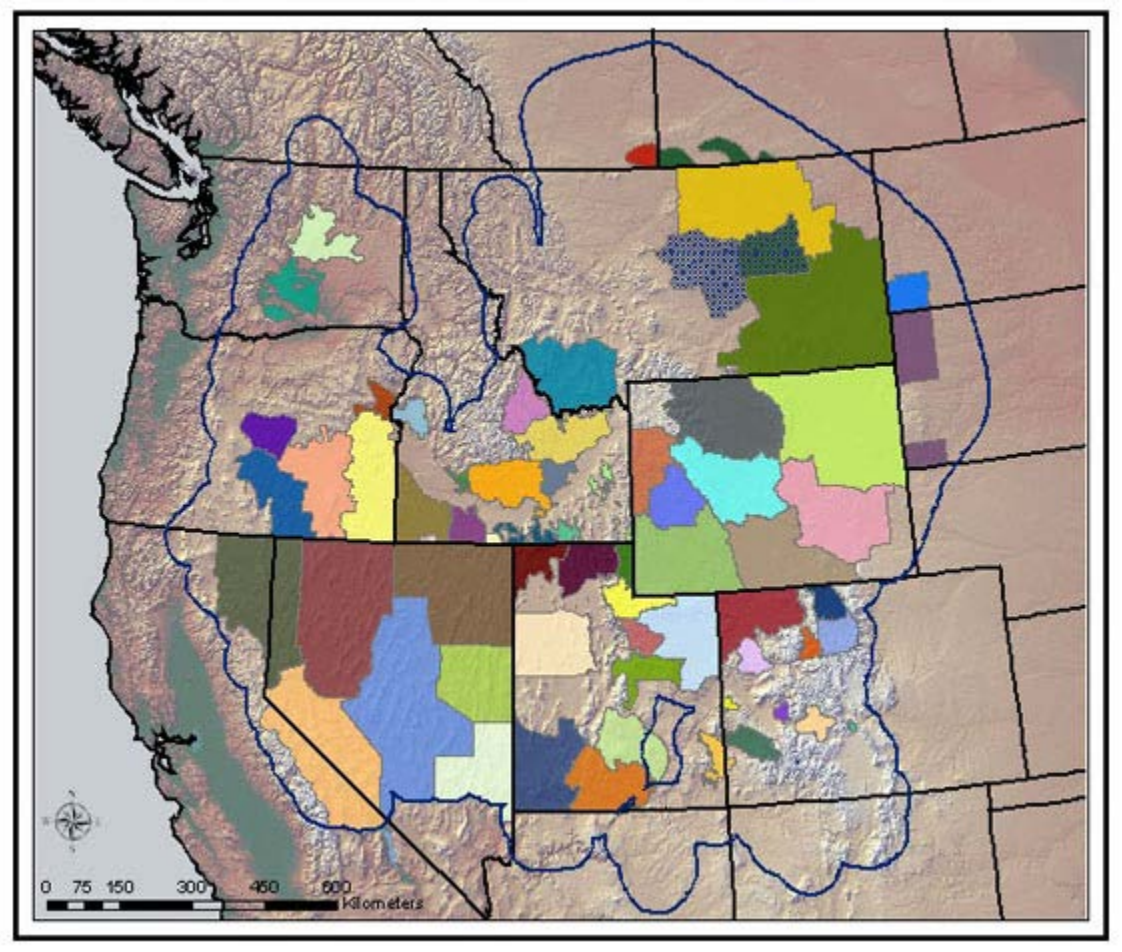
Sage-grouse around Bear Lake inhabit the western edge of the Wyoming Basin Population



Adapted from Connelly et al. 2004

Management Differences Between ID, UT, WY

- Hunting
- Monitoring
- Habitat conservation
- Local working groups often do not span state boundaries



Objectives

1. Document Ecology of sage-grouse populations in the Bear Lake Valley and Plateau
   - Lek Counts
   - Population vital rates
     - Nesting and Brood Success
     - Survival
   - Home Range Delineation

2. Seasonal distribution and habitat-use patterns
   - Habitat fragmentation by natural and anthropogenic land-use
   - Habitat selection models using Maxent

Ecology of Sage-grouse on the BLPV

Photo by Rachel Curtis

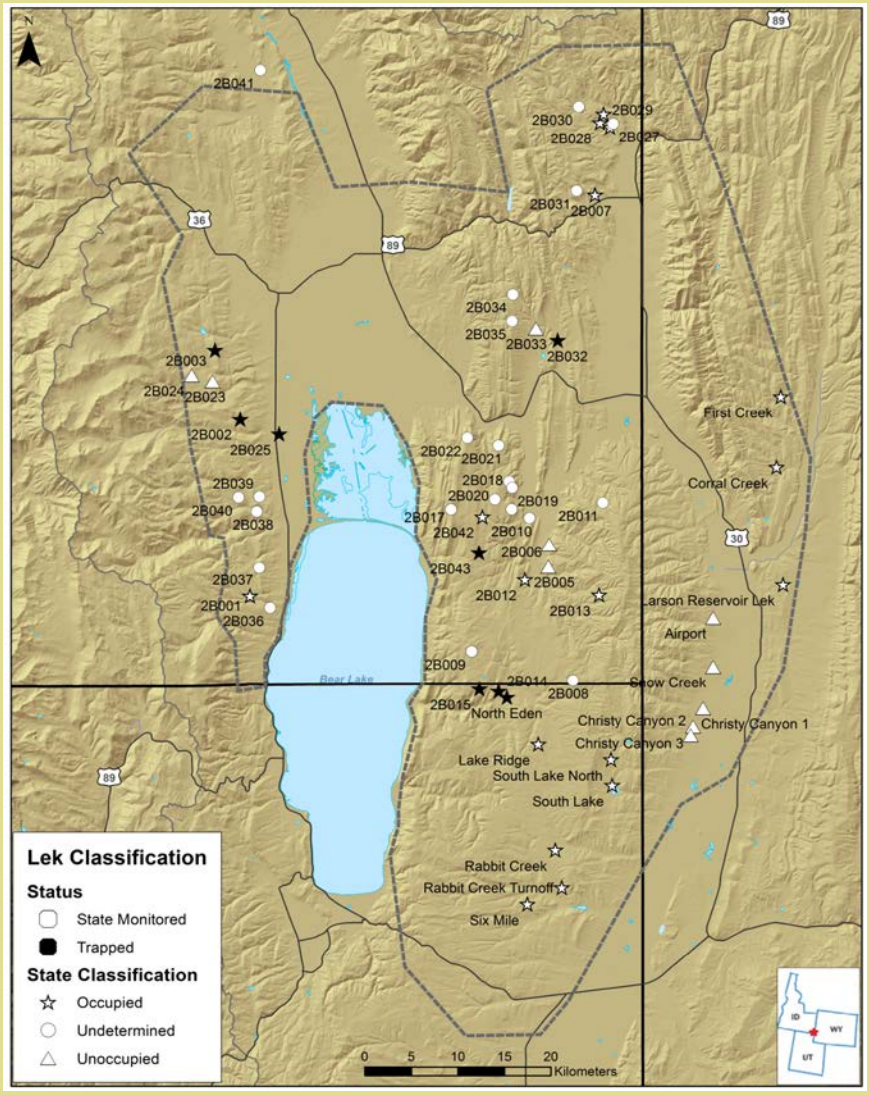
Photo by Rachel Curtis

Photo by Melissa Fellin

Methods- Lek Counts

- State Agencies monitor leks in the area
- Not all leks were counted using standard protocols

Photo by Rachel Curtis



Methods- Radio Telemetry

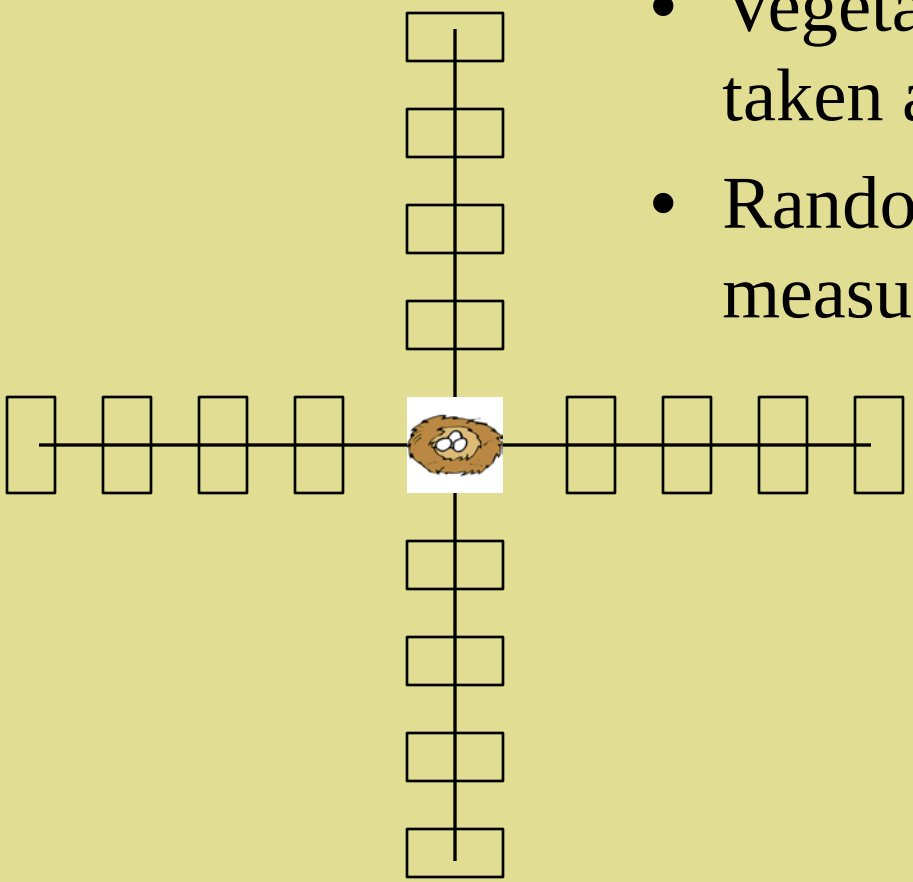
61 Females
100 Males

-ATS
-Sirtrack
-Wildlife Materials
-American Wildlife Enterprises

Methods- Nesting Success

- Mayfield maximum likelihood estimator for ragged monitoring data
- Confidence intervals calculated using the Delta Method
- Covariates were assessed for nest success
- Models were ranked using AIC corrected for small sample size

Methods- Vegetation Monitoring



- Vegetation Measurements were taken at nest and brood sites
- Random sites were also measured

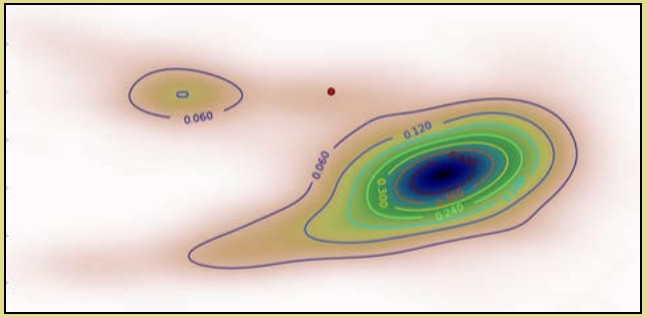
Methods- Survival

- Mayfield maximum likelihood estimator for ragged monitoring data
- Covariates were assessed for survival
  - Sex, Age, Year, Month, Season, Capture Lek
- Confidence intervals calculated using the Delta Method
- Models were ranked using AIC

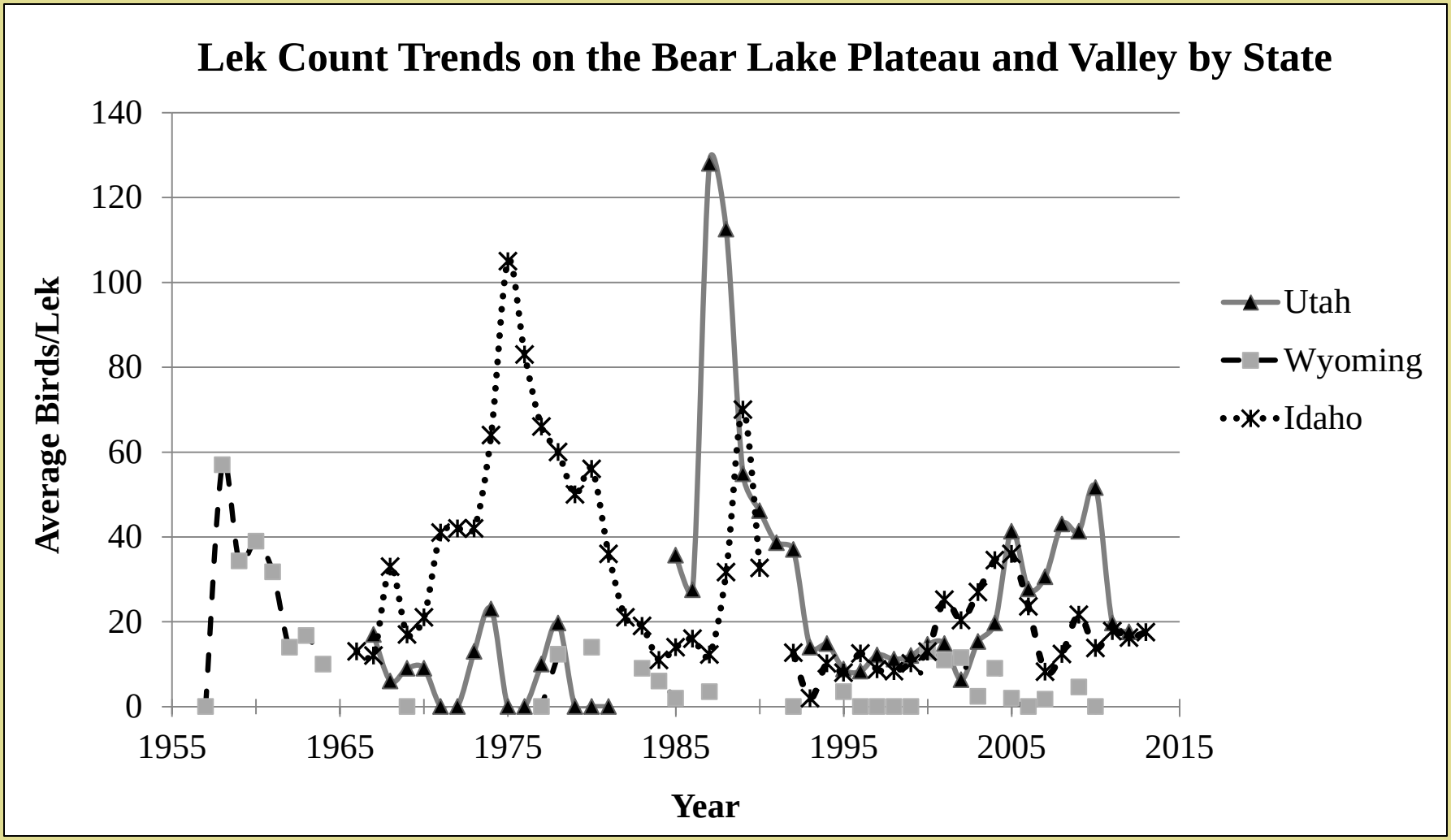
Methods- Movement and Home Ranges

- Movements
  - Migratory Status
  - Distance to capture lek
  - Distance to nearest lek

- Home Range
  - Kernel Density Estimator



Results- Lek Trends



Results- Nest Success Analysis

Model	Parameters	AIC*c*	Δ AIC*c*	Weight
Robel In	2	130.4242	0	0.11599
Distance to Structure	2	130.8589	0.43469	0.09333
Null	1	131.416	0.99184	0.07064
Year	2	131.4383	1.01412	0.06986
Litter Percentage	2	131.6405	1.21632	0.06314
Aspect	2	131.9829	1.55869	0.5321
Distance to Fence	2	132.424	1.99979	0.04268

Results- Nest Success

- 28 nesting attempts recorded
  - 2011 eleven nests
  - 2012 seventeen nests
- Daily Survival Rate
  - 95.9% (SE=0.94%)
- Probability of success from laying to hatch (36 days)
  - 22.3% (95% Confidence Level = 6.9 – 37.8%)

Photo by Rachel Curtis

Results- Brood Success Observations

- 10 successful nesting attempts recorded
  - 2011 three successful nests
    - 1 brood observed post 14 days
  - 2012 seven successful nests
    - 6 broods with at least 1 chick to 50 days

Results- Nest Vegetation

- 80% of nests were located under big sagebrush
- Visual Observation Readings were higher at nest sites (43.7 cm verses 23.5 cm)
- Center shrub diameter was higher at nest sites (118.9 cm verses 66.4 cm)
- Slightly higher forb levels at nest sites

	Nest (n= 26)		Random (n= 21)	
	$\bar{x}$	*se*	$\bar{x}$	*se*
Aspect	164.5	(32.0)	159.0	(43.7)
Slope	9.4	(3.4)	9.7	(3.6)
Cover %				
Shrub	28.6	(5.9)	21.7	(6.9)
Artemisia spp.	25.4	(5.2)	15.7	(4.8)
Forb	17.5	(4.1)	12.1	(3.6)
Grass	14.1	(2.5)	18.9	(2.8)
Bare Ground	20.4	(5.3)	15.1	(3.5)
Litter	30.4	(4.9)	35.0	(6.1)
Rock	8.3	(4.3)	8.2	(3.9)
Cover Height(cm)				
Shrub	37.2	(6.3)	33.9	(6.3)
Artemisia spp.	40.1	(7.4)	35.5	(6.1)
Forb	7.0	(1.1)	6.5	(1.1)
Grass	16.3	(1.9)	20.0	(3.1)
Nest Shrub				
Height (cm)	64.2	(10.6)	49.8	(12.7)
Diameter (cm)	118.9	(20.4)	66.4	(14.7)
Robel In (dm)	43.7	(7.6)	23.5	(8.7)

(SE) Standard error found in parenthesis

Results- Brood Vegetation

- Brood sites were located on more level slopes than random sites
- Forb levels were lower than recommended forb composition at brood sites

	Brood (n=24)		Random (n= 9)*	
	$\bar{x}$	*se*	$\bar{x}$	*se*
Aspect	154.5	(46.5)	164.5	(70.4)
Slope	3.8	(1.4)	12.4	(6.8)
VOR (dm)	27.5	(7.3)	17.8	(11.1)
Cover %				
Shrub	23.3	(6.4)	28.3	(10.0)
Artemisia spp.	21.0	(5.9)	28.3	(13.8)
Forb	11.3	(2.7)	13.3	(6.1)
Grass	16.9	(3.0)	13.1	(4.0)
Bare Ground	15.2	(3.5)	16.5	(3.3)
Litter	38.9	(4.8)	32.0	(6.7)
Rock	5.5	(3.6)	9.3	(4.2)
Cover Height (cm)				
Shrub	37.2	(9.7)	36.4	(13.8)
Artemisia spp.	35.9	(9.6)	39.2	(18.1)
Forb	9.0	(2.9)	6.1	(2.3)
Grass	21.9	(3.8)	16.6	(2.5)

** In the pilot year, unmarked broods were observed and vegetation was recorded, but due to time constraints, not all random matched locations were measured*

(SE) Standard error found in parenthesis

Results- Survival Analysis

Model	Parameters	AIC	Δ AIC	Weight
Season + Capture Area	8	319.2146	0	0.1822
Season + Age	5	319.2988	0.0843	0.1746
Season	4	319.72	0.5054	0.1415
Capture Area + Individual Year	8	319.7214	0.5068	0.1414
Season+ Individual Year	7	320.784	1.5694	0.0831
Season+ Sex	5	321.0984	1.8836	0.071

Results- Survival Analysis

- Seasonal survival estimates
  - Spring = 84.7% (95% CL= 78.5 – 89.4%)
  - Summer = 79.3% (95% CL= 71.3 – 85.6%)
  - Fall = 94.3% (95% CL= 87.1 – 97.6%)
  - Winter = 83.4% (95% CL= n/a)

Results- Movement and Home Ranges

- Partially migratory population
  - Most common migration was to a unique winter range
- Average annual home range was 100.7 km^2
- Larger male annual home ranges
  - 131.8 km^2 verses 59.4 km^2
- Larger yearling annual home ranges
  - 138.5 km^2 verses 85.7 km^2

Observations of Note

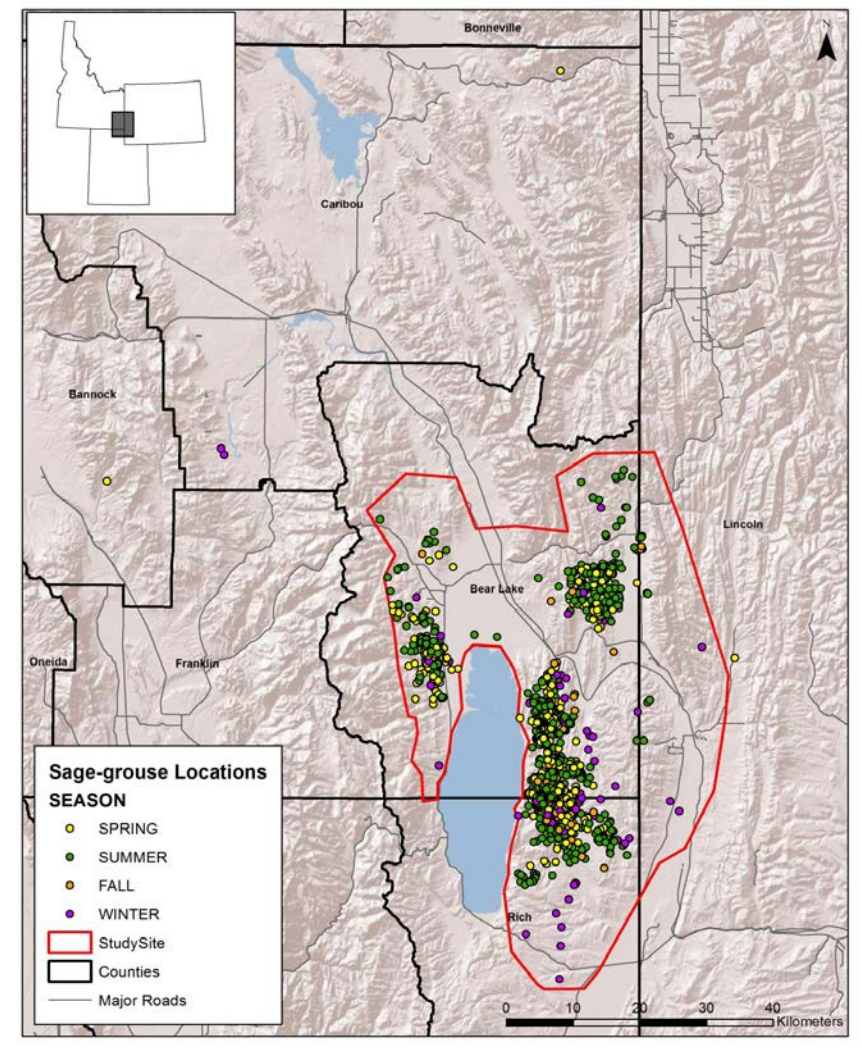
- Nest survival rates are lower than averages recorded across the range
- Low clutch sizes are likely due to recorded renest attempts
- Hens used sagebrush with greater diameter and higher nest bowl VOR than random sites
- Many forbs noted in other studies were found in brood rearing sites on the BLPV

Observations of Note

- Highest seasonal survival rates occurred in the Fall
- Migration did not appear to affect annual survival
- Individuals were found to utilize habitat in all three states
- Extreme movements were observed, and BLPV may be important for genetic dispersal
- Males had larger home ranges than females

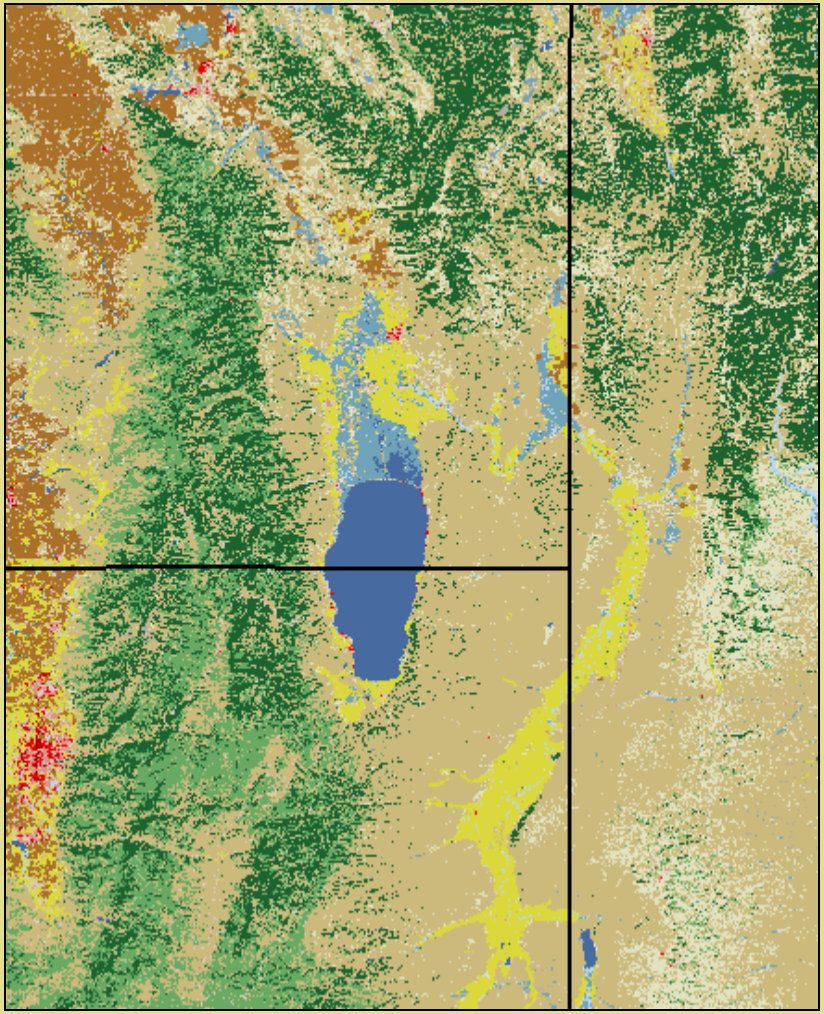
Habitat Selection of Sage-grouse on BLPV

Recorded Locations



Methods- Fragmentation

- National Land Cover Data Set
  - Shrub lands
  - Grassland/herbaceous cover
- Patch Area
- Length of Edge
- Perimeter-area ratio
- Number of disjunct core areas

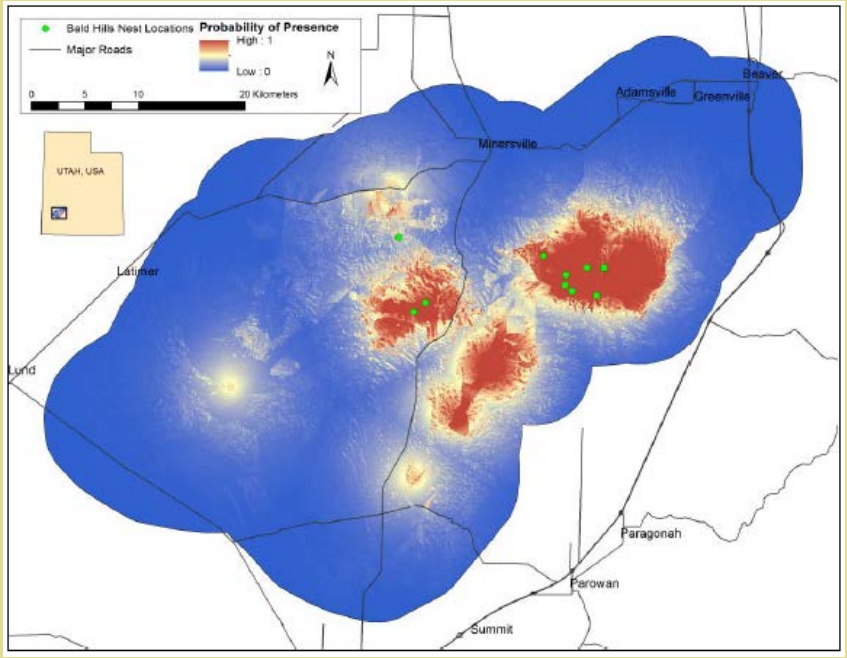


Methods- Habitat Selection Model

- Maxent Model
  - Presence only data
  - Calculates the distribution probability
  - Output prediction values between 0 and 1

$$q_\lambda(x) = \frac{e^{\lambda \cdot f(x)}}{z_\lambda}$$

Burnett, A. C. 2013. Modeling habitat use of a fringe greater sage-grouse population at multiple spatial scales.



Methods- Habitat Selection Model

- Maxent Model
  - Models with training data then uses test data to assess model
  - Model performance was evaluated using a Receiver Operating Characteristic

Smith, A.B. 2012. An introduction to best practices in species distribution modeling

AUC ranges from 0 to 1

AUC "rules of thumb" (debatable):

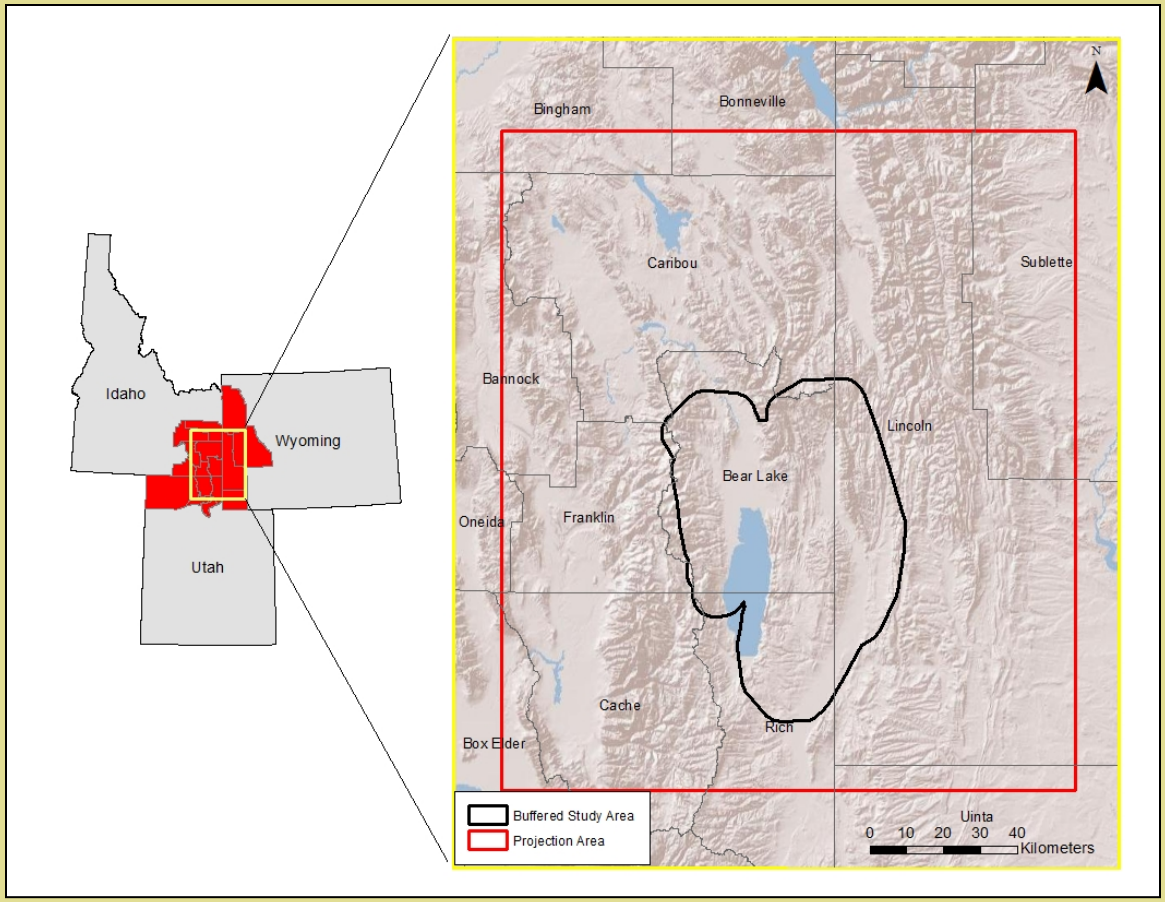
1 to 0.9 "excellent"
0.9 to 0.8 "good"
0.8 to 0.7 "fair"
0.5 to 0.7 "poor"
0 to 0.5 "perverse" (less accurate than a random guess!)

Range is >0 to <1 if random "absences" are used instead of real absences, so these rules of thumb won't apply!

No authoritative citation for this, but everyone cites Swets (1988 Measuring the accuracy of diagnostic systems. Science 240:1285-1293), though he doesn't actually pose this breakdown of values.

Methods- Habitat Selection Model

- Landscape of Interest

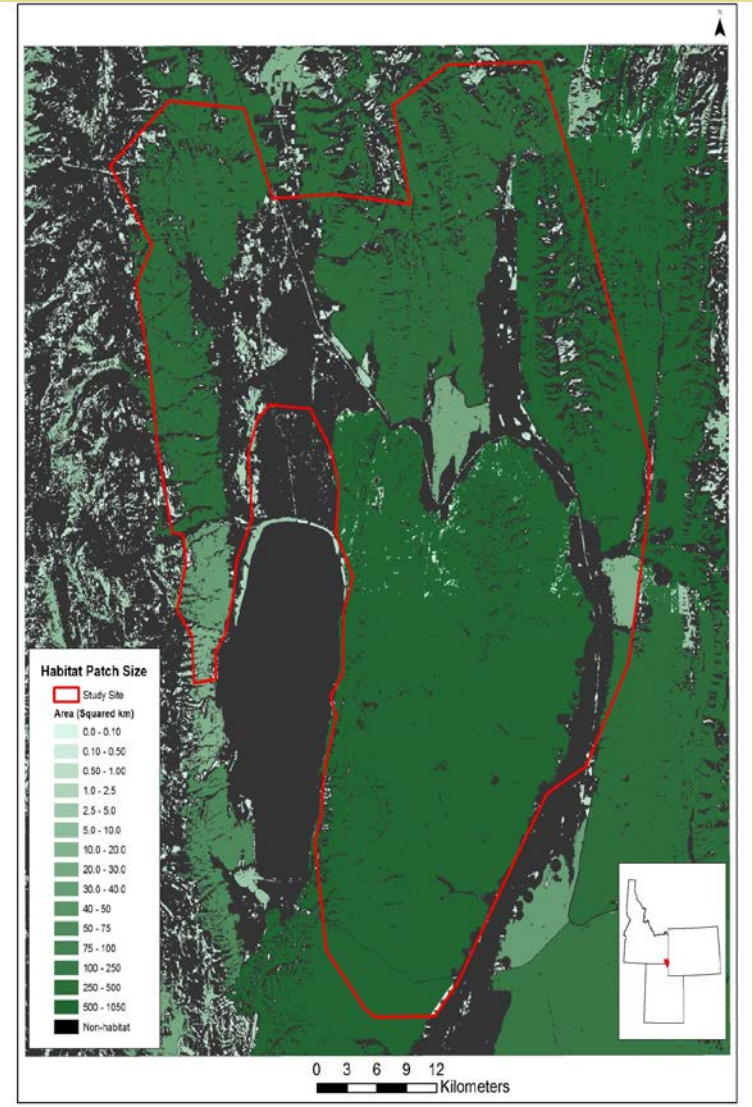


Methods- Habitat Selection Model

Predictor Rasters

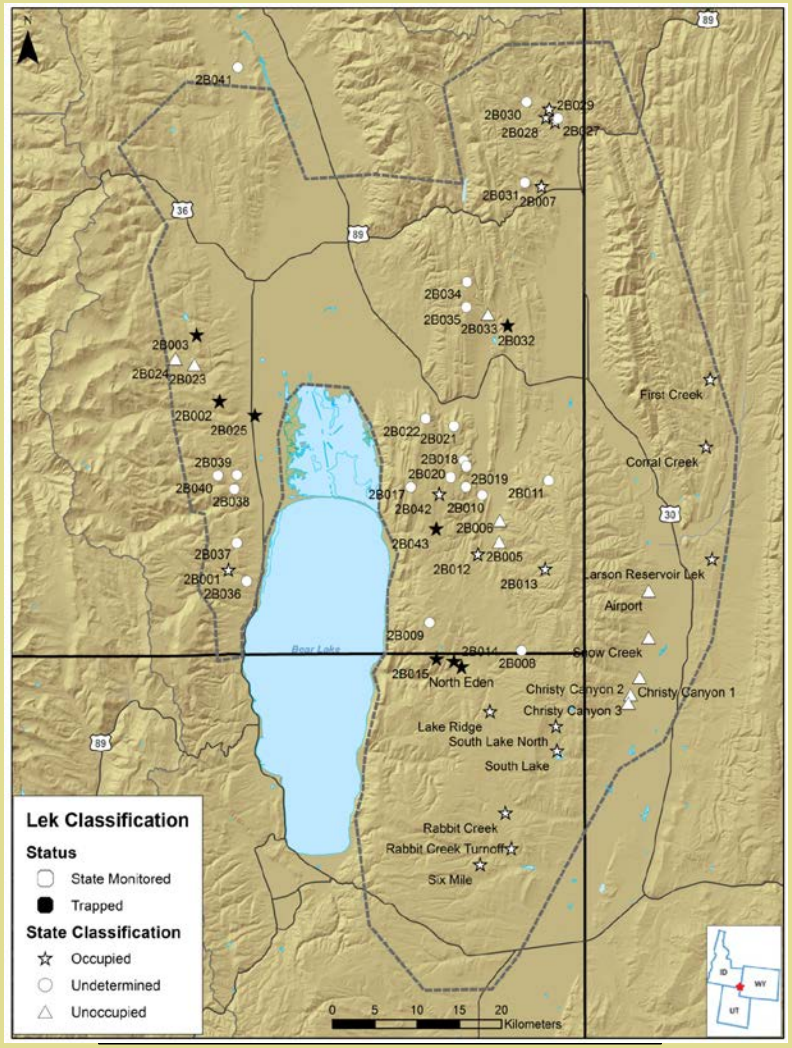
- Environmental Variables
  - Elevation
  - Slope
  - Aspect
  - GAP Canopy Cover
  - Soil Type
  - Distance to Edge
- Anthropogenic Variables
  - Distance to Primary Road
  - Distance to Secondary Road
  - Distance to Development
  - Distance to Transmission Line
  - Distance to Structure

Results- Fragmentation



- Average patch size
  - 0.34 km^2
- Average edge per patch
  - 1.41 km
- Edge-area ratio
  - 107:1
- Four main core areas

Results- Fragmentation



- Lek Comparison
  - Proportion of habitat surround lek
    - 2B002 = 40.7%
    - 2B003 = 44.0%
    - 2B025 = 37.2%
    - 2B032 = 68.8%
    - 2B042 = 70.9%
    - 2B043 = 72.4%
    - North Eden = 89.8%

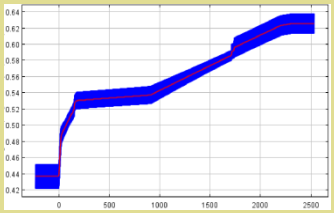
Results- Habitat Selection

Annual sage-grouse habitat selection model Test AUC = 0.889

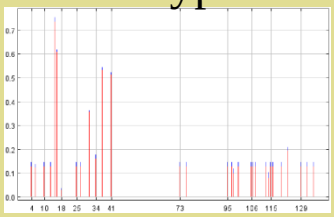
Top Variable Response Curves

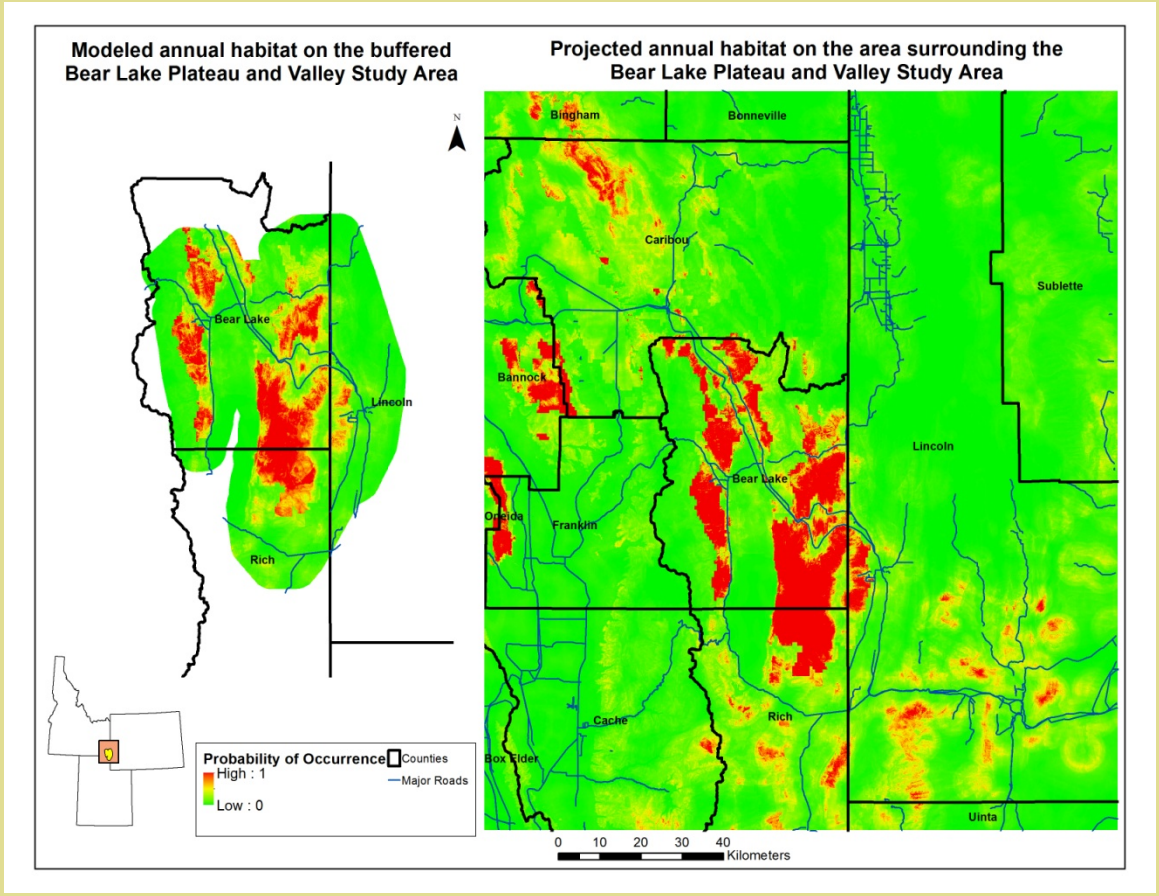
Distance to Major Road

Distance to Habitat Edge



Soil Type





Results- Habitat Selection

Spring

- AUC=0.933
- Top Contributing Variables
  - Distance to major road
  - Distance to vertical structure
  - Distance to habitat edge

Summer

- AUC=0.917
- Top Contributing Variables
  - Distance to major road
  - Distance to habitat edge
  - Soil type

Fall

- AUC=0.946
- Top Contributing Variables
  - Distance to major road
  - Distance to habitat edge
  - Distance to vertical structure

Winter

- AUC=0.833
- Top Contributing Variables
  - Distance to major road
  - Soil type
  - Distance to habitat edge

Results- Habitat Selection

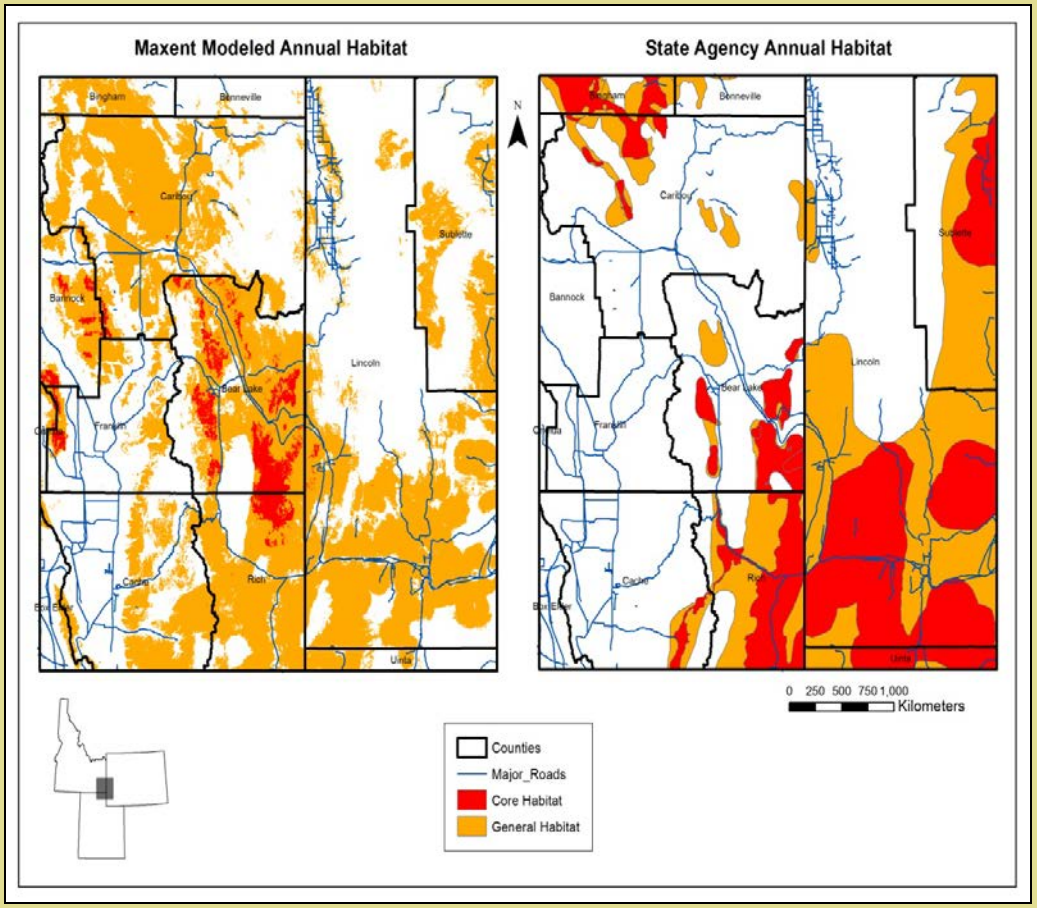
Nest habitat selection

- AUC=0.931
- Top Contributing Variables
  - Distance to habitat edge
  - Distance to major road
  - Soil type

Brood habitat selection

- AUC=0.968
- Top Contributing Variables
  - Distance to minor road
  - Soil type
  - Distance to major road

Results- State Habitat Comparison



- State defined habitats encompassed much larger areas than Maxent modeled habitat

Observations of Note

- Both natural and anthropogenic fragmentation occurred on the BLPV
- Bear Lake State Park and Bear Lake NWR may serve as movement corridors between leks on the east and west sides of Bear Lake
- Maxent models depended largely on avoidance of major roads, soil types, distance to edge, and distance to vertical structure

Observations of Note

- Interior habitat patches could be a limiting factor on the BLPV
- State defined habitat encompassed a much greater area than Maxent predictions
  - This likely could be due to the lower rank of land cover in the model

Conclusions

- Sage-grouse monitored during this study had vital rates that fell within population wide estimate
- Nest survival rates are lower than averages recorded across the range
- Winter seasonal survival rates may be lower due to increased snow levels on BLPV
- Not all BLPV sage-grouse were migratory
- Individuals were found to utilize habitat in all three states
- Extreme movements were observed, and BLPV may be important for genetic dispersal

Conclusions

- Habitat loss and fragmentation varied across the BLPV
- Movement corridors should be protected for migration and dispersal
- Seasonal habitats had a large amount of overlap
  - Variables of highest importance
    - Distance to major roads, soil types, distance to edge, and distance to vertical structure
- Interior habitat patches could be a limiting factor on the BLPV

Management Implications

- Additional monitoring should occur to determine the effect of vital rates on population dynamics
- Conservation of habitat at large landscape scales would benefit sage-grouse populations
- Further habitat fragmentation should be mitigated to protect populations in the area
- Connectivity habitat should be protected for migratory and dispersal movements
- Target construction of new tall towers

Management Implications

- Microhabitat conservation could also be important for BLPV sage-grouse
- Enhancing areas of high sagebrush canopy close to leks may increase nest success
- Increased forb production could improve brooding success
- **A tri-state management plan should be created for conservation of important habitats in the area**

Acknowledgements

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-Dr. John Connelly
-Dr. John Bissonette

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Questions