Environmental
& Statistical
Consultants

Greater Sage-Grouse Reproductive Habitat Selection and Survival in Response to Wind Energy Infrastructure

Chad LeBeau[1]
Greg D. Johnson[1], Matthew J. Holloran[2, 4], Jeffrey L. Beck[3], Ryan M. Nielson[1], Mandy E. Kauffman[1], Eli J. Rodemaker[2, 5], and Trent L. McDonald[1]

[1]Western EcoSystems Technology, Inc., 415 W. 17th St., Cheyenne, WY 82001
[2]Wyoming Wildlife Consultants, LLC, P.O. Box 893, Pinedale, WY 82941
[3]University of Wyoming Department of Ecosystem Science and Management, 1000 East University Ave, Laramie WY 82071

[4]Currently at Operational Conservation, LLC, 1612 Laporte Ave., Fort Collins, CO 80521
[5]Currently at Image Spatial Consulting, LLC, 552 North Cedar Street, Laramie, WY 82072

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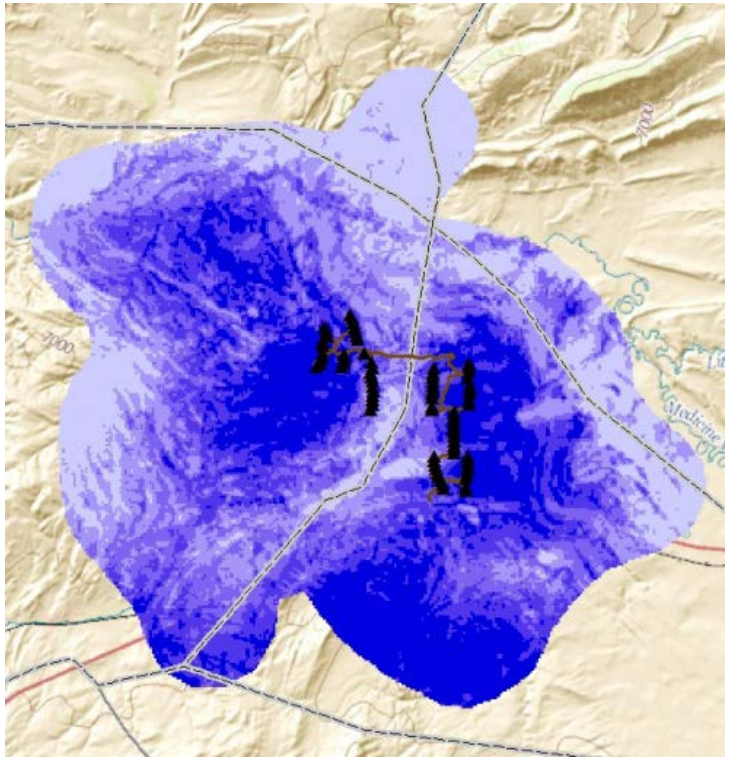
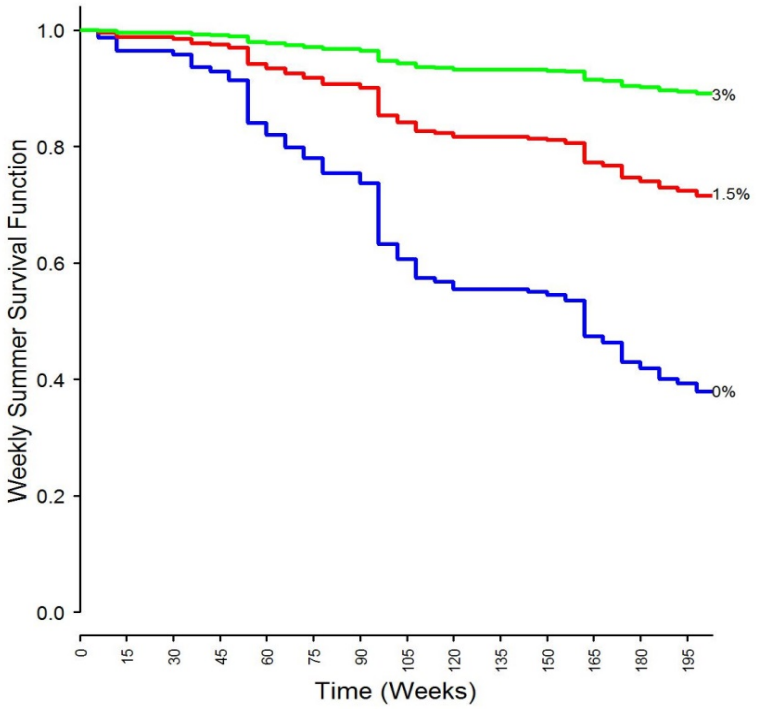
Study Purpose - Wind Energy Infrastructure

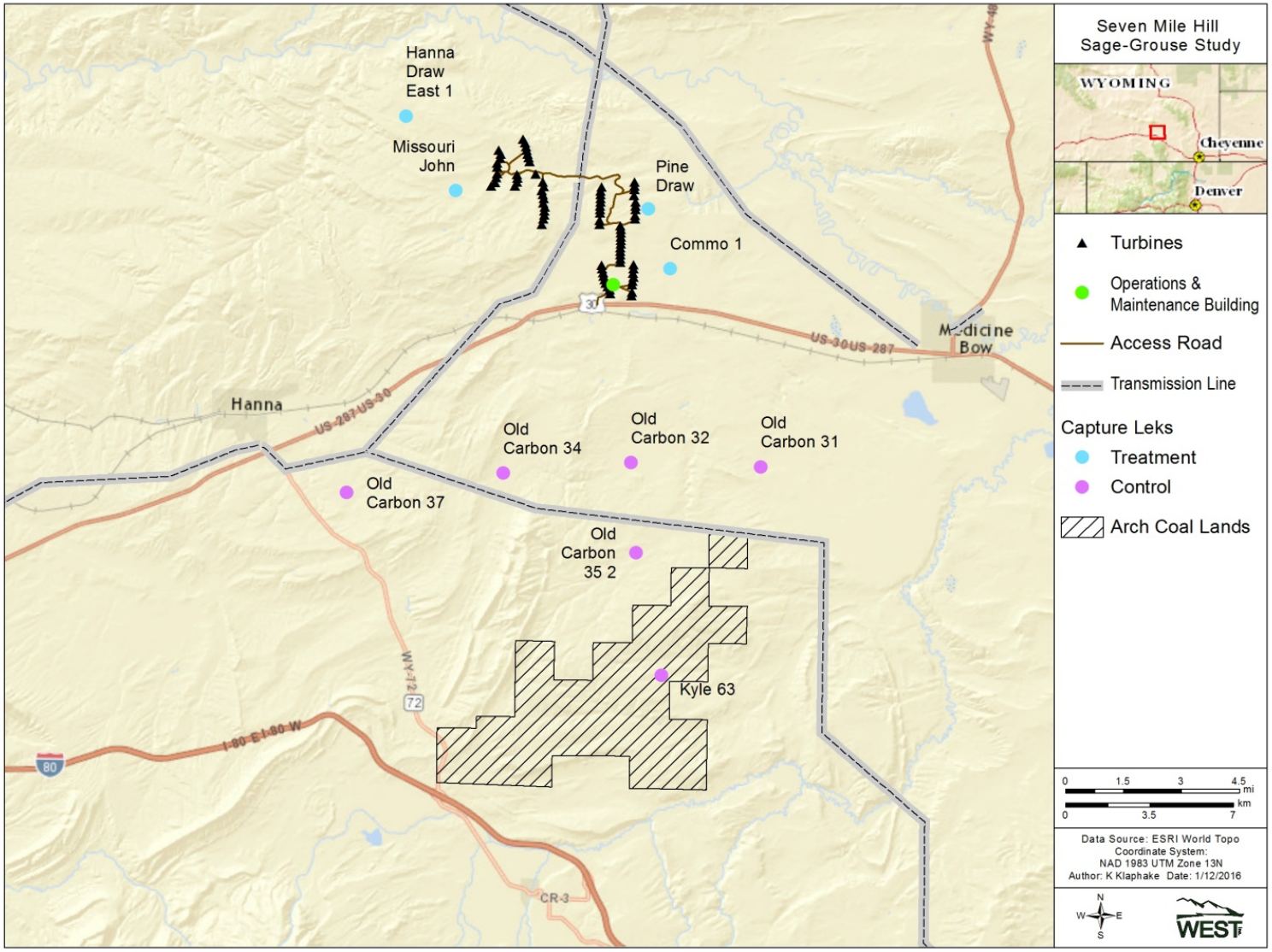
Sage-Grouse Habitat Selection



Sage-Grouse Survival



Study Area

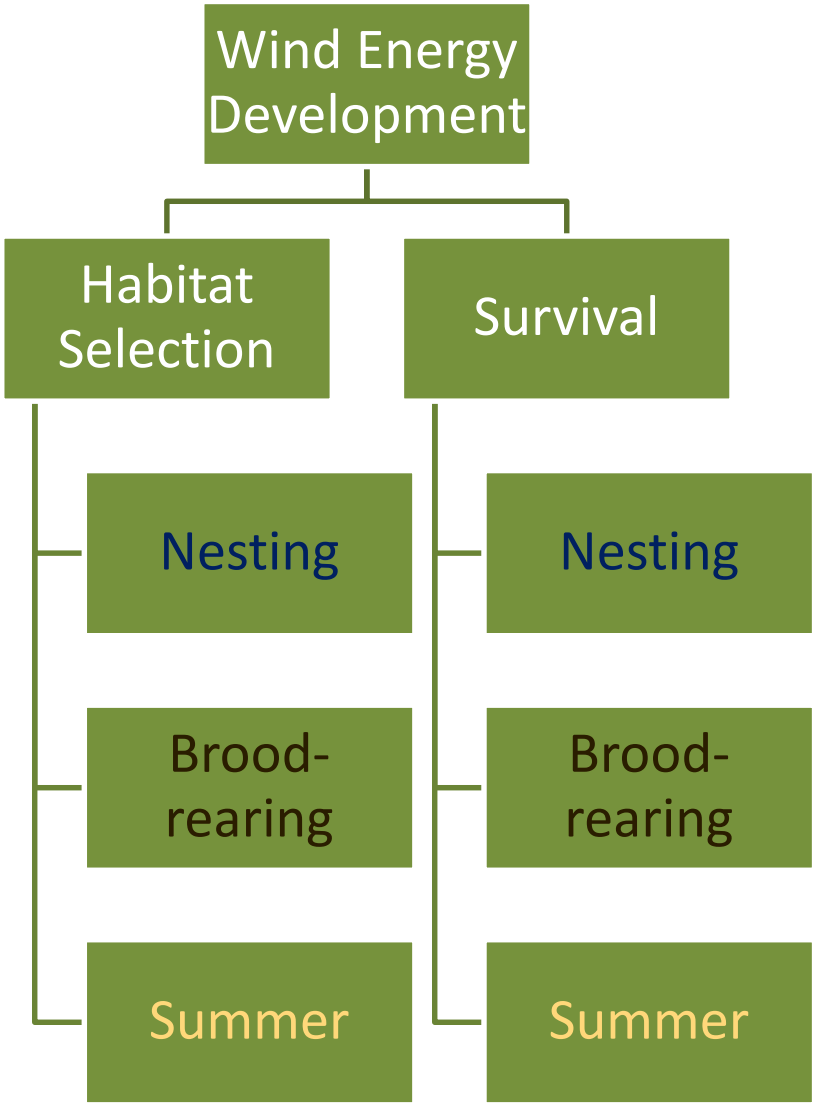

Hanna Draw East 1
Missouri John
Pine Draw
Commo 1
Medicine Bow
Hanna
Old Carbon 34
Old Carbon 32
Old Carbon 31
Old Carbon 37
Old Carbon 35 2
Kyle 63
US-30US-287
US-287US-30
I-80 E I-80 W
WY-72
CR-3
Seven Mile Hill Sage-Grouse Study
WYOMING
Cheyenne
Denver
Turbines
Operations & Maintenance Building
Access Road
Transmission Line
Capture Leks
Treatment
Control
Arch Coal Lands
0 1.5 3 4.5 mi
0 3.5 7 km
Data Source: ESRI World Topo
Coordinate System:
NAD 1983 UTM Zone 13N
Author: K Klaphake Date: 1/12/2016
N
W
E
S
WEST

Study Area

Field Methods

- Study 2009 – 2014
- Captured 346 (160 treatment; 186 control)
- 22-g necklace-mounted VHF radio transmitter (666 days)

Study Outline



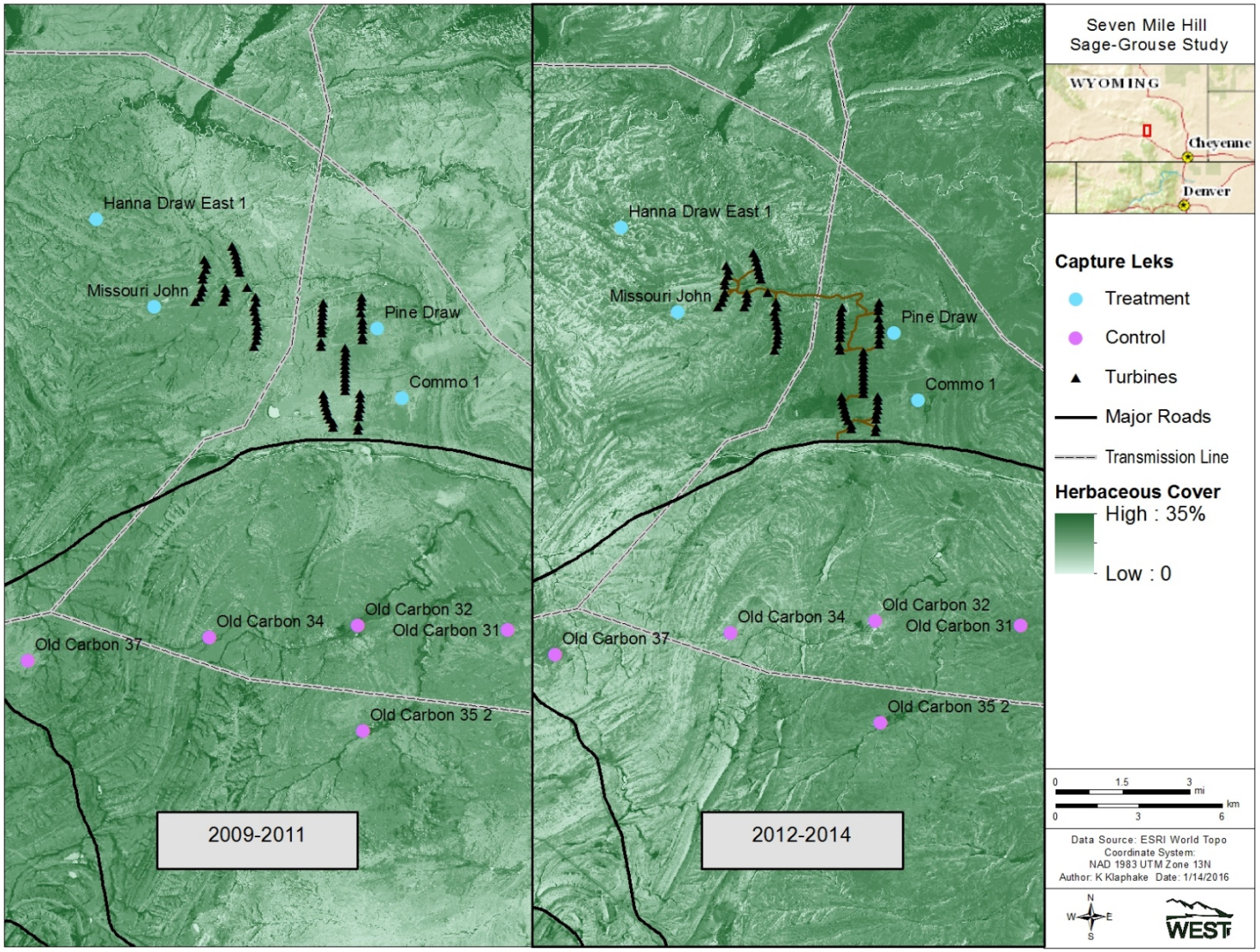
Covariate Data

Anthropogenic infrastructure
Distance to Major Roads
Distance to Transmission Line
Distance to Turbines
Proportion of Disturbance

Environmental
Terrain ruggedness
Distance to capture lek
Avian predator density
Elevation
Compound Topographic Index (CTI)
Topographic Position Index (TPI)

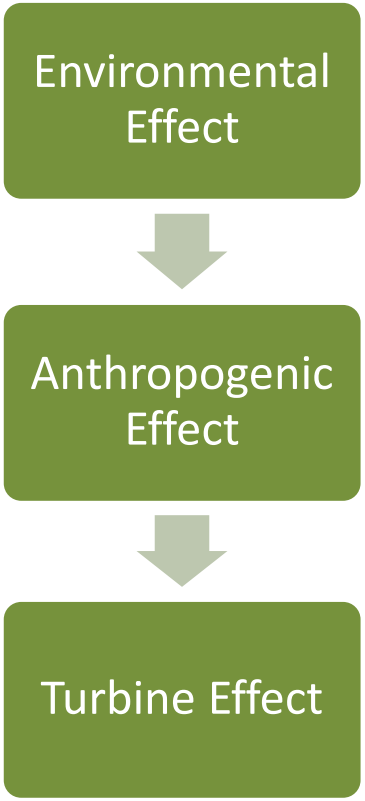
Vegetation
Bare ground
Big sagebrush
Herbaceous
Litter
Sagebrush
Shrub
Shrub height
Meadow
Distance to Meadow
Slope
Wyoming big sagebrush

Covariate Data – Herbaceous Cover



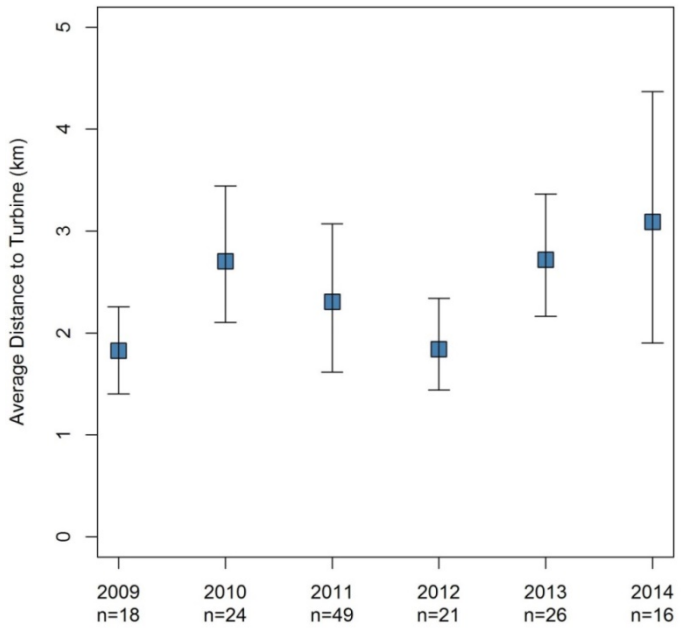
Analysis Methods

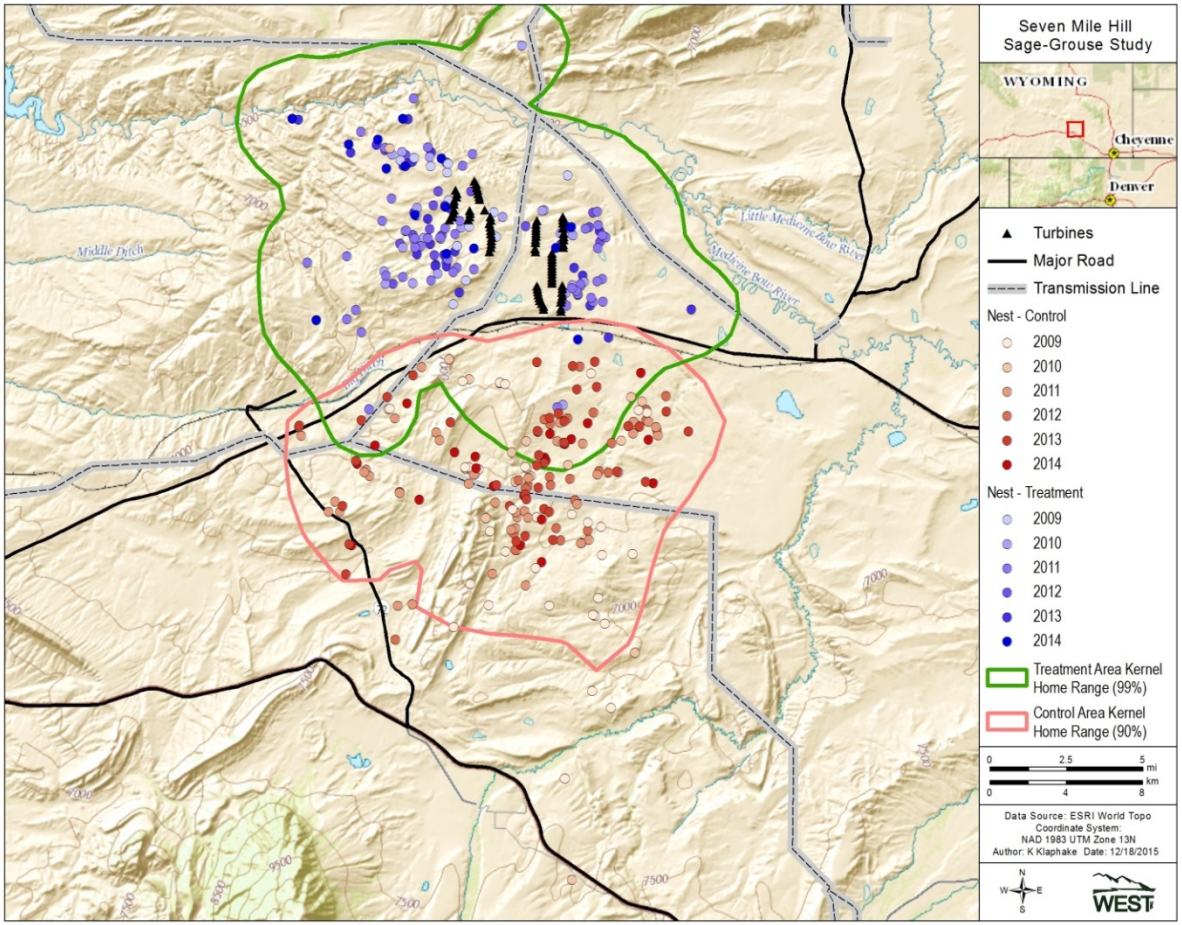
Habitat Selection and Survival



Habitat Selection

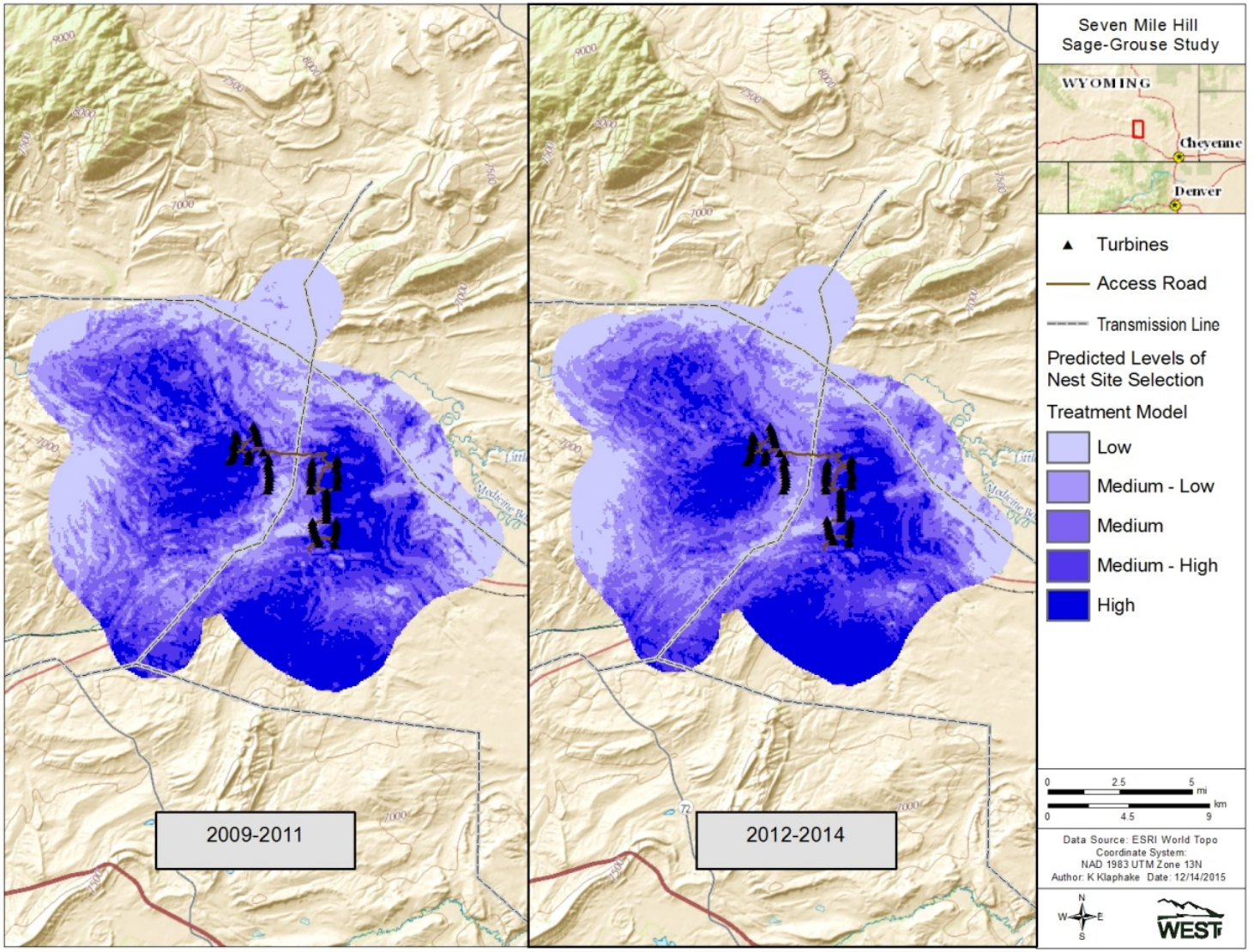
Results – Nest Site Selection



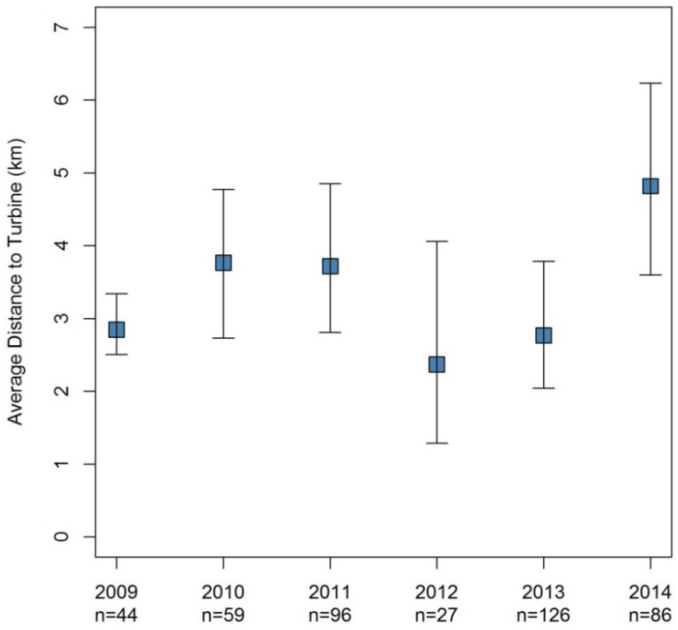


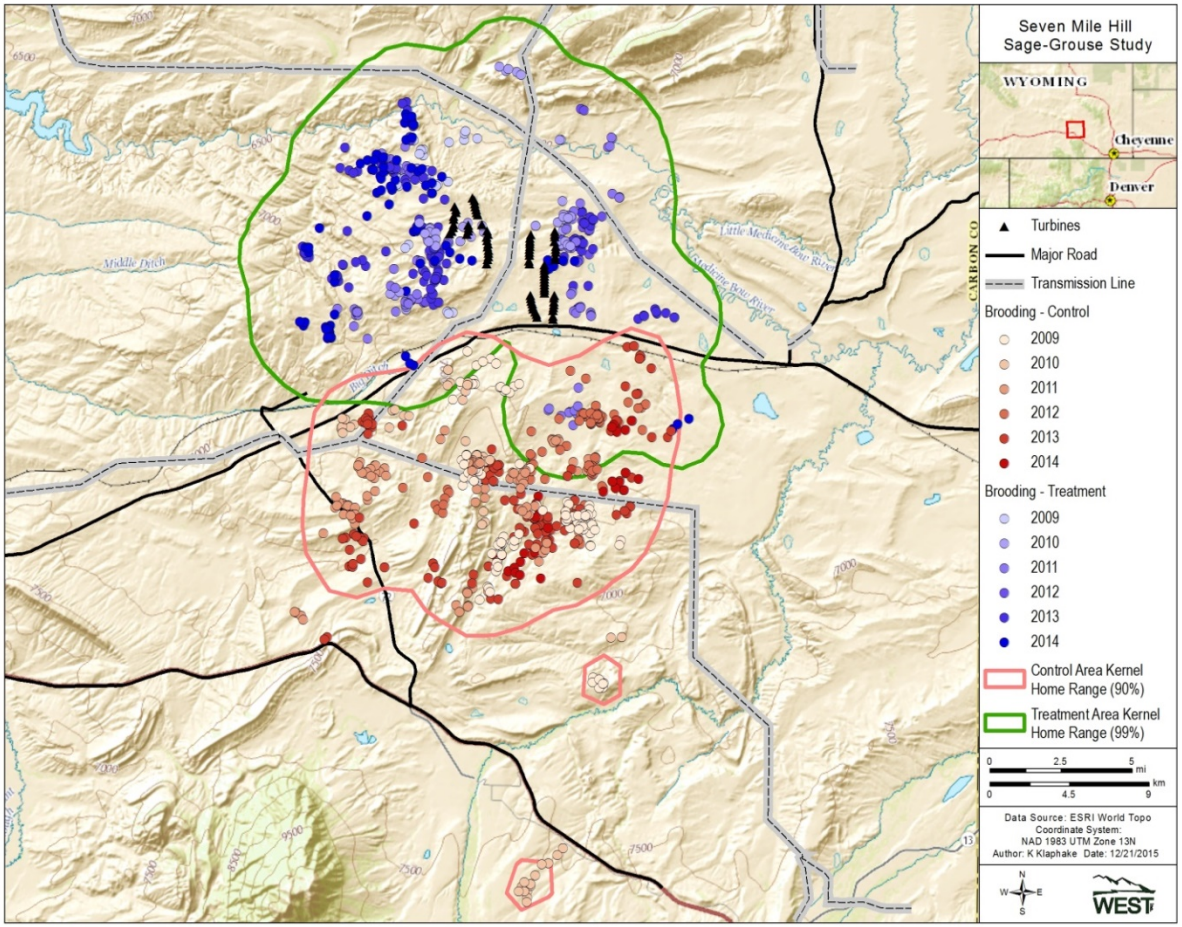
Results – Nest Site Selection

Final Model
Distance to lek of capture (-)
Bare ground (-)
Litter (+)
Wyoming big sagebrush (+)
Distance to Transmission Line (+)
(Distance to Transmission Line)^2 (-)



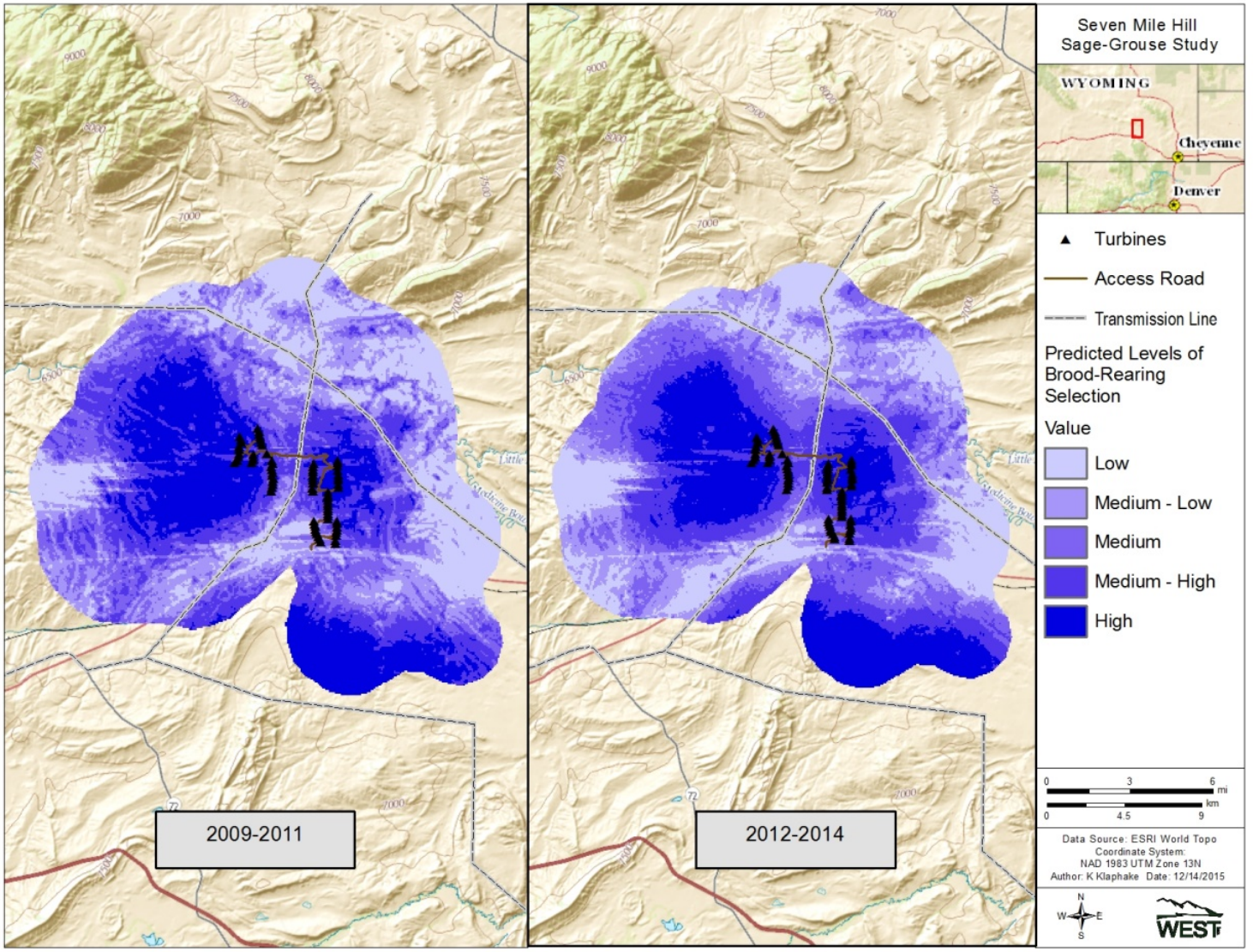
Results – Brood-Rearing Habitat Selection



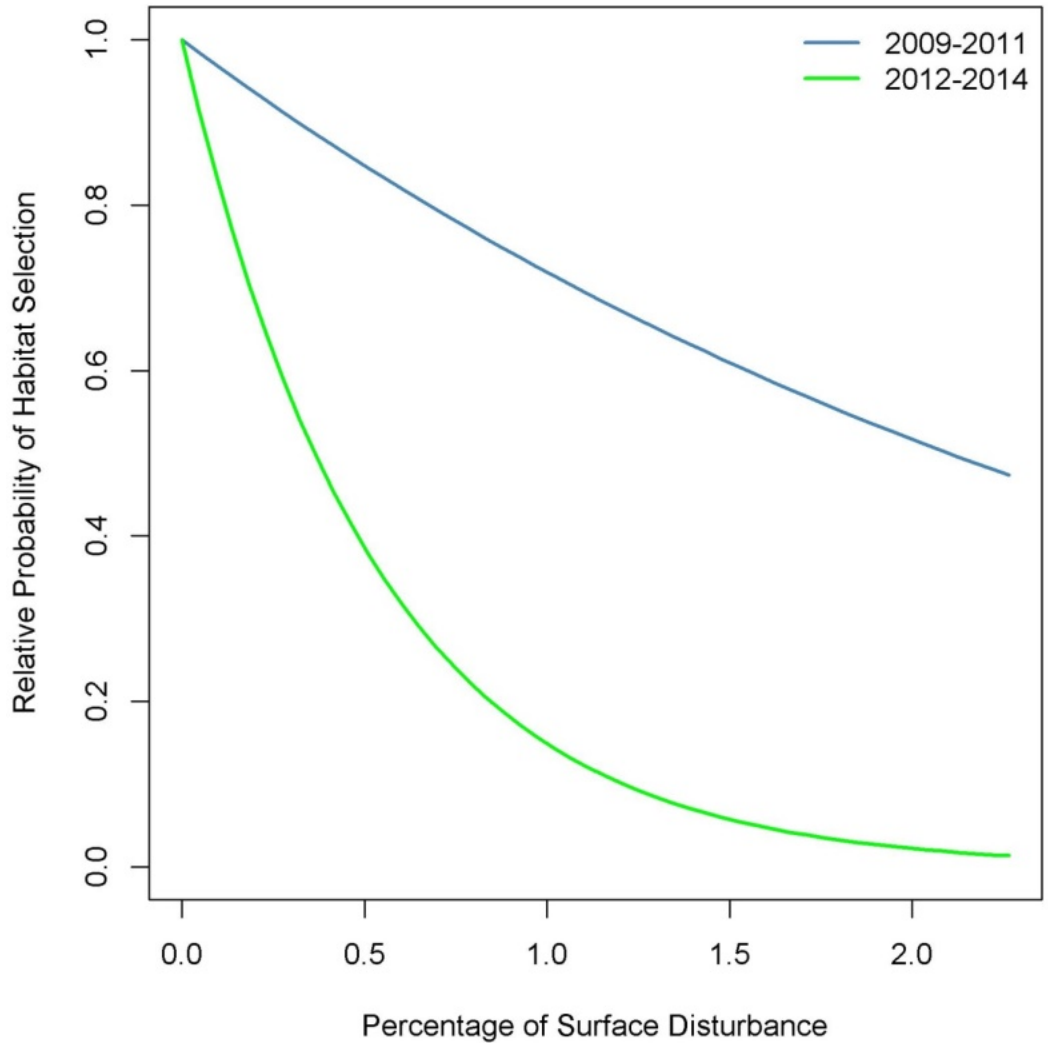


Results – Brood-Rearing Habitat Selection

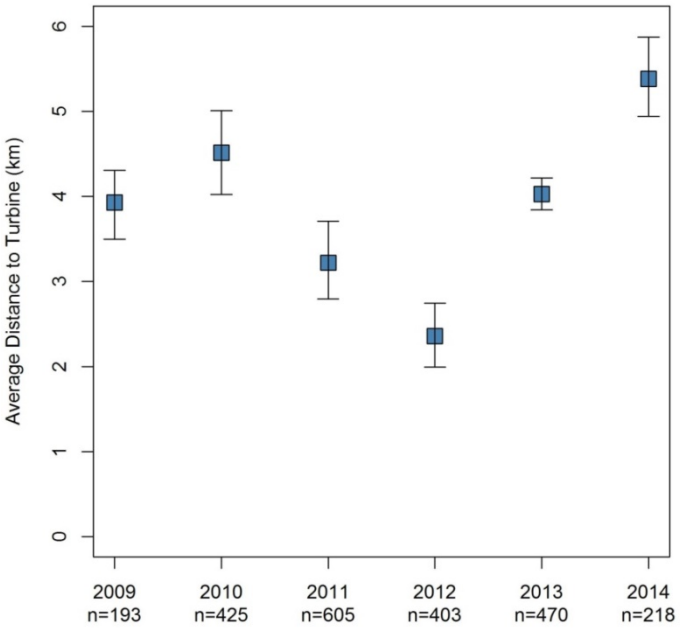
Final Model
Distance to lek of capture (-)
Wyoming big sagebrush (+)
Elevation (+)
Bare ground (-)
SD shrub height (-)
Distance to transmission line (+)
(Distance to Transmission Line)^2 (-)
Distance to major roads (+)
(Distance to major roads)^2 (-)
Percent of SWEF surface disturbance (-)

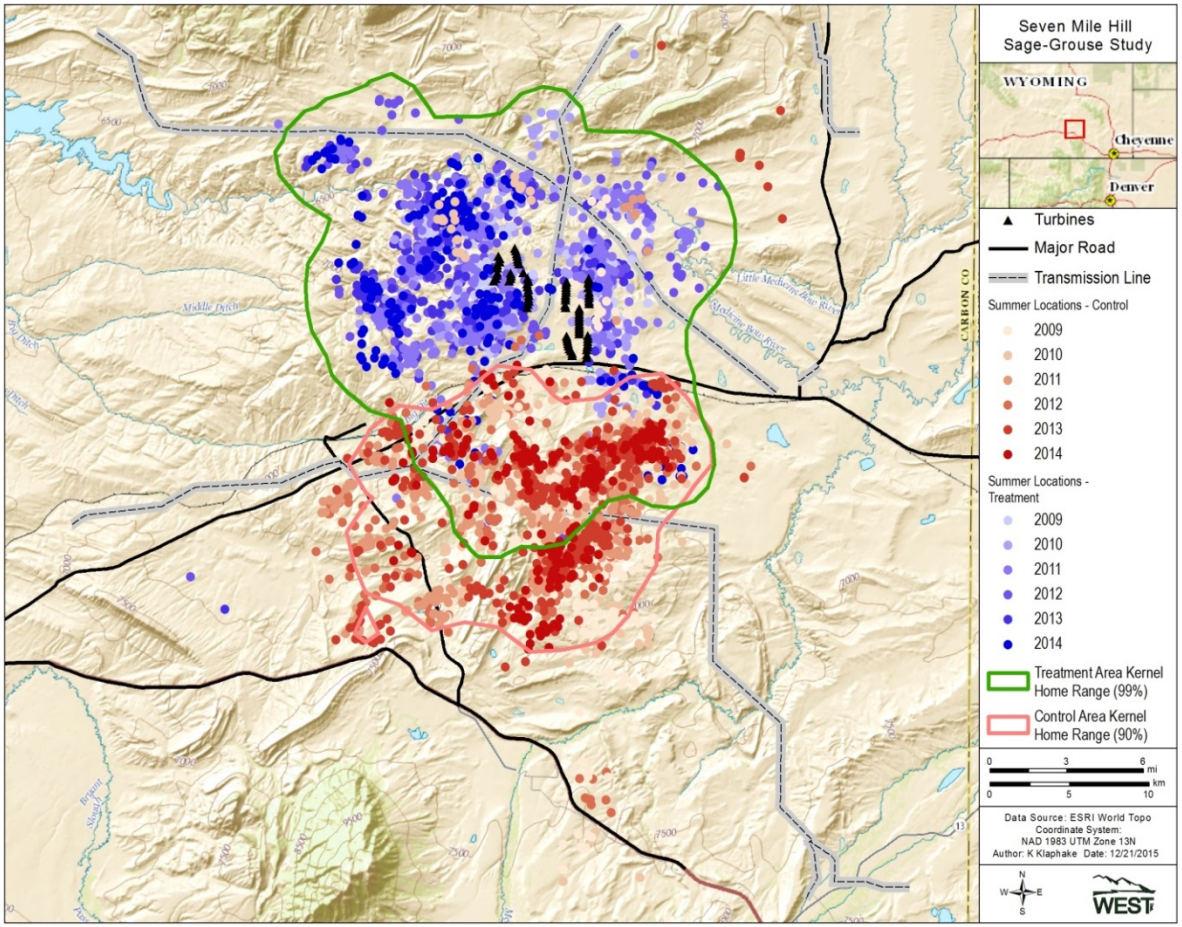


Results – Brood-Rearing Habitat Selection



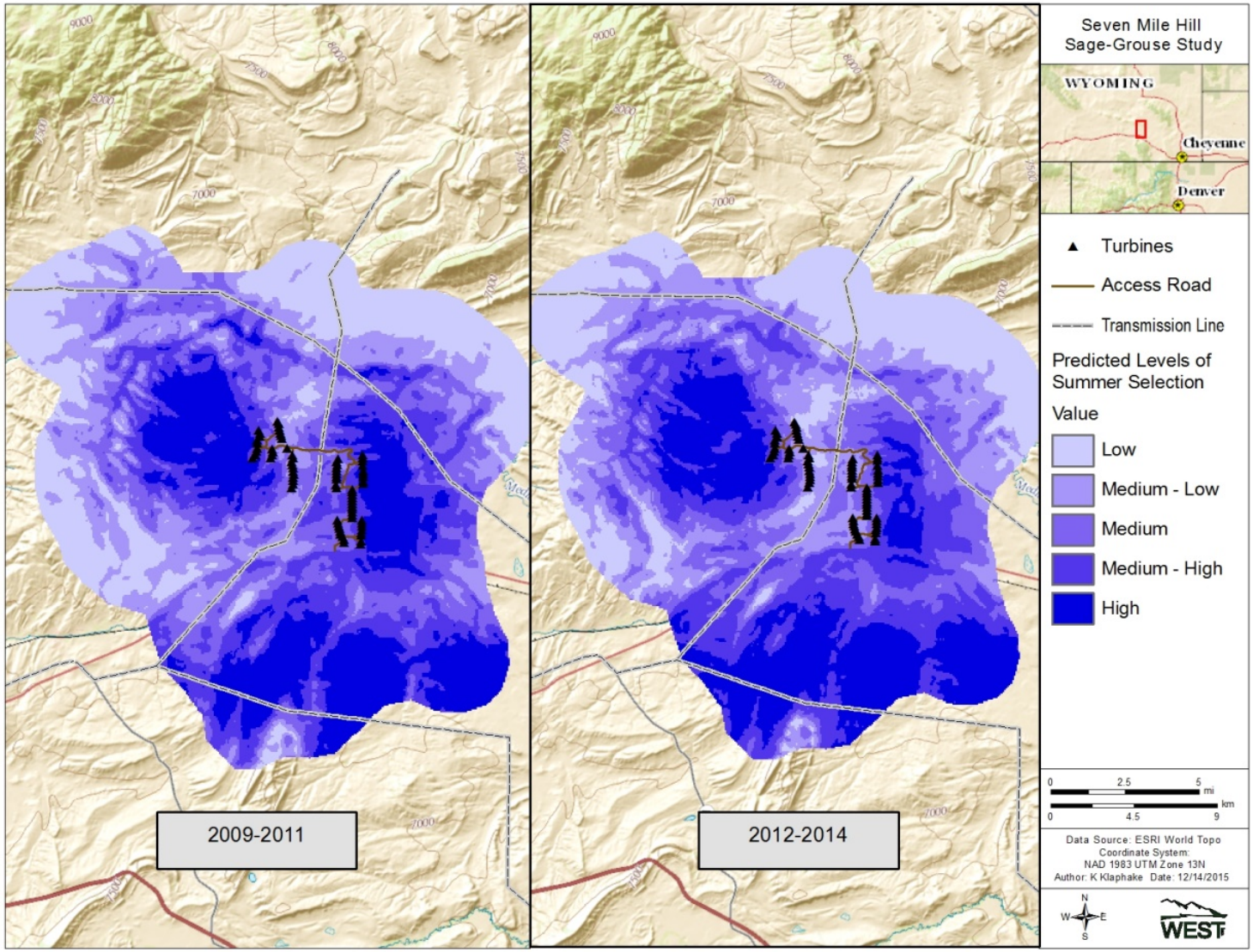
Results – Summer Habitat Selection





Results – Summer Habitat Selection

Final Model
Distance to lek of capture (-)
Herbaceous (-)
TPI (-)
Shrub SD (+)
Slope (-)
Distance to major roads (+)
Percentage of SWEF Disturbance (-)



Discussion – Habitat Selection

- Turbine locations did not affect nest site selection patterns
- Females shifted selection patterns during the brood-rearing and summer period away from turbines
- Density of turbines was more important than proximity

Habitat Selection	Turbine Effect
Nest	No Effect
Brood-Rearing	Negative Effect (1.2 km)
Summer	Negative Effect (1.2 km)

Survival

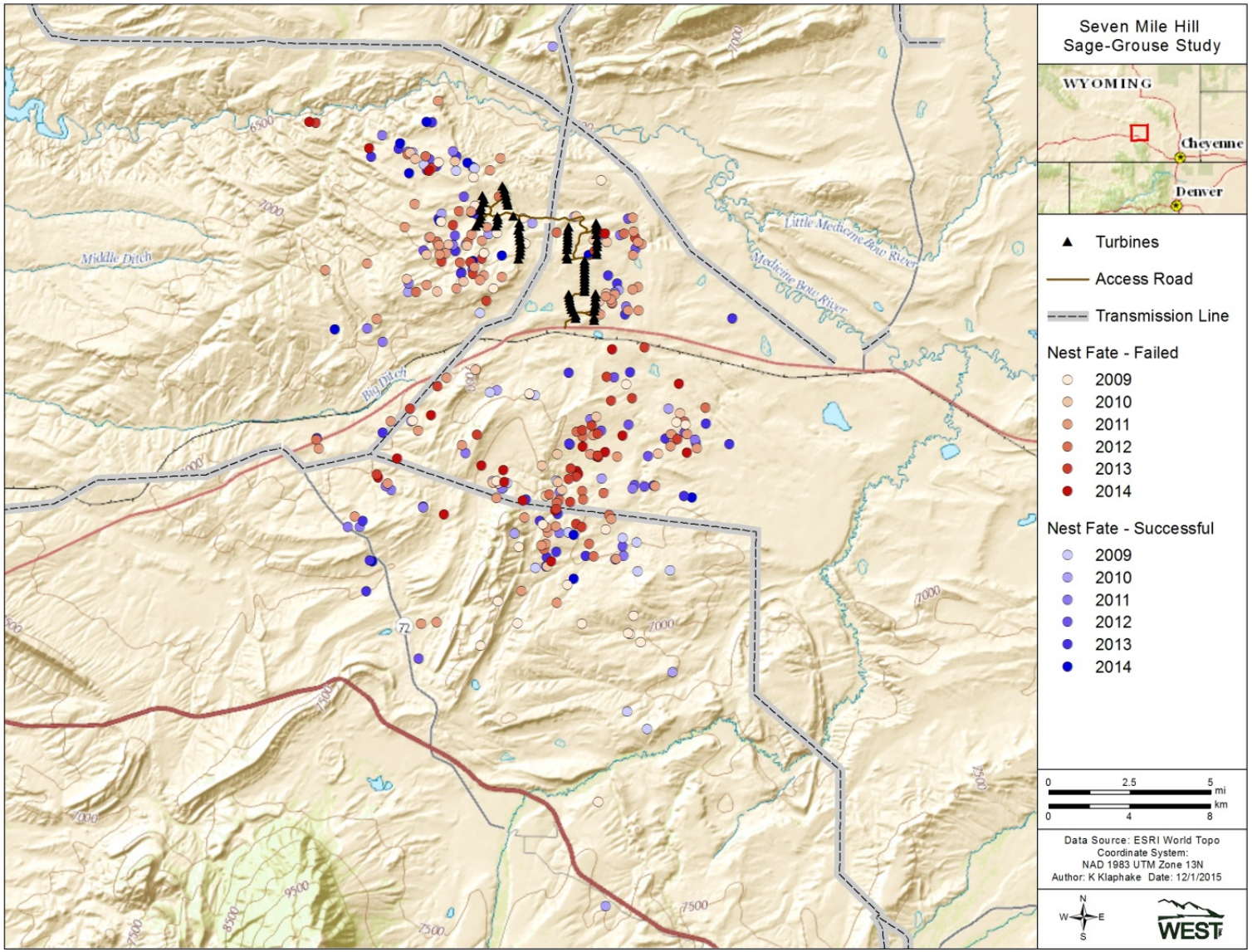
Analysis Methods – Survival

- Combined all data
- Cox Proportional Hazards
- Nest Survival – 28 days
- Brood Survival – 37 days post hatch
- Female Survival – Capture through October
- Random effect of leks

Results – Nest Survival

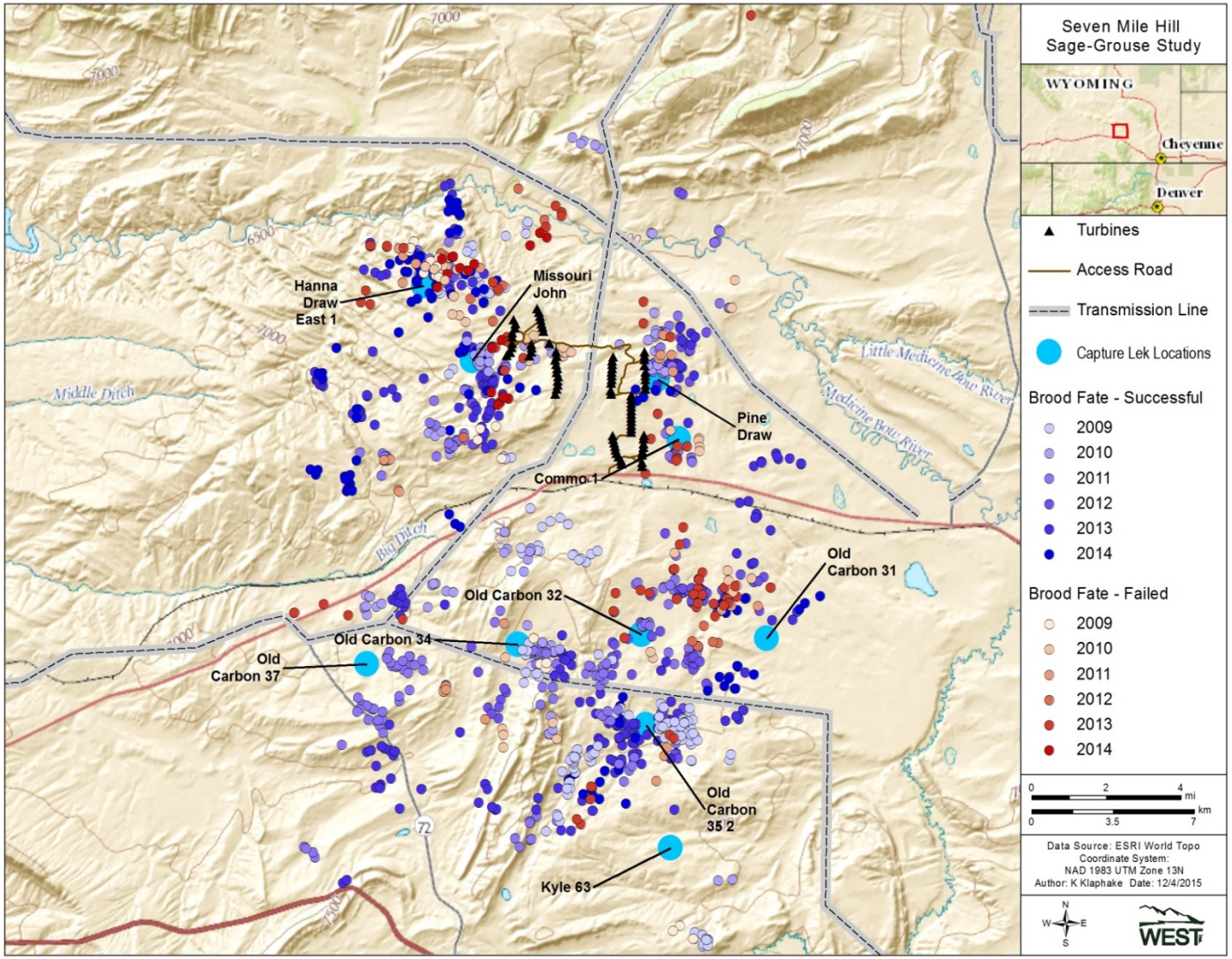
Final Model

- Shrub SD (-)
- TPI (-)
- Distance to major roads (+)
- (Distance to major roads)^2 (-)
- Distance to transmission line (+)



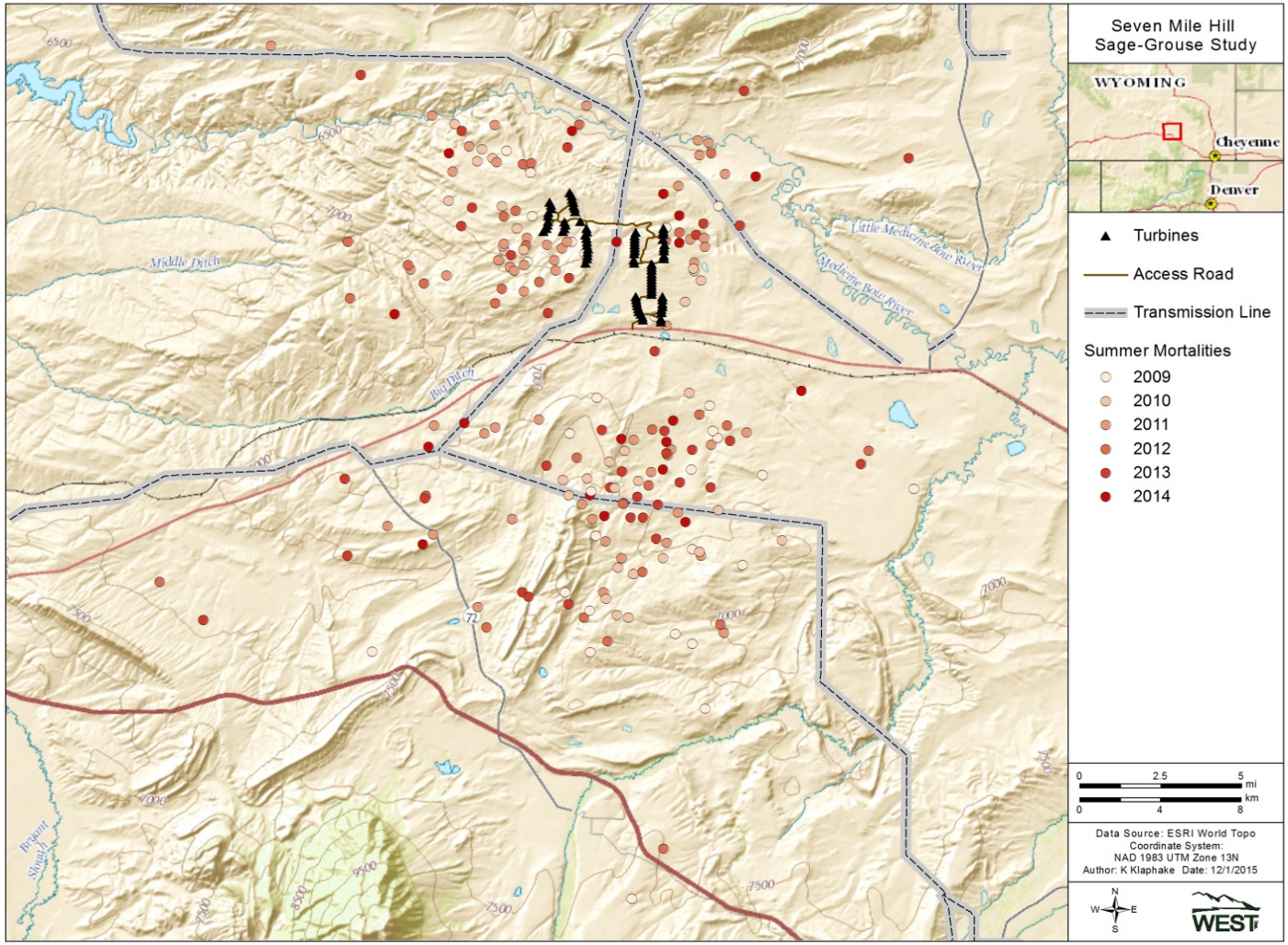
Results – Brood-Rearing Survival

Final Model
Terrain Ruggedness (-)
TPI (-)
Distance to Capture Lek (+)
Distance to Major Roads (+)
Distance to Transmission line (+)
Distance to Transmission line^2 (-)

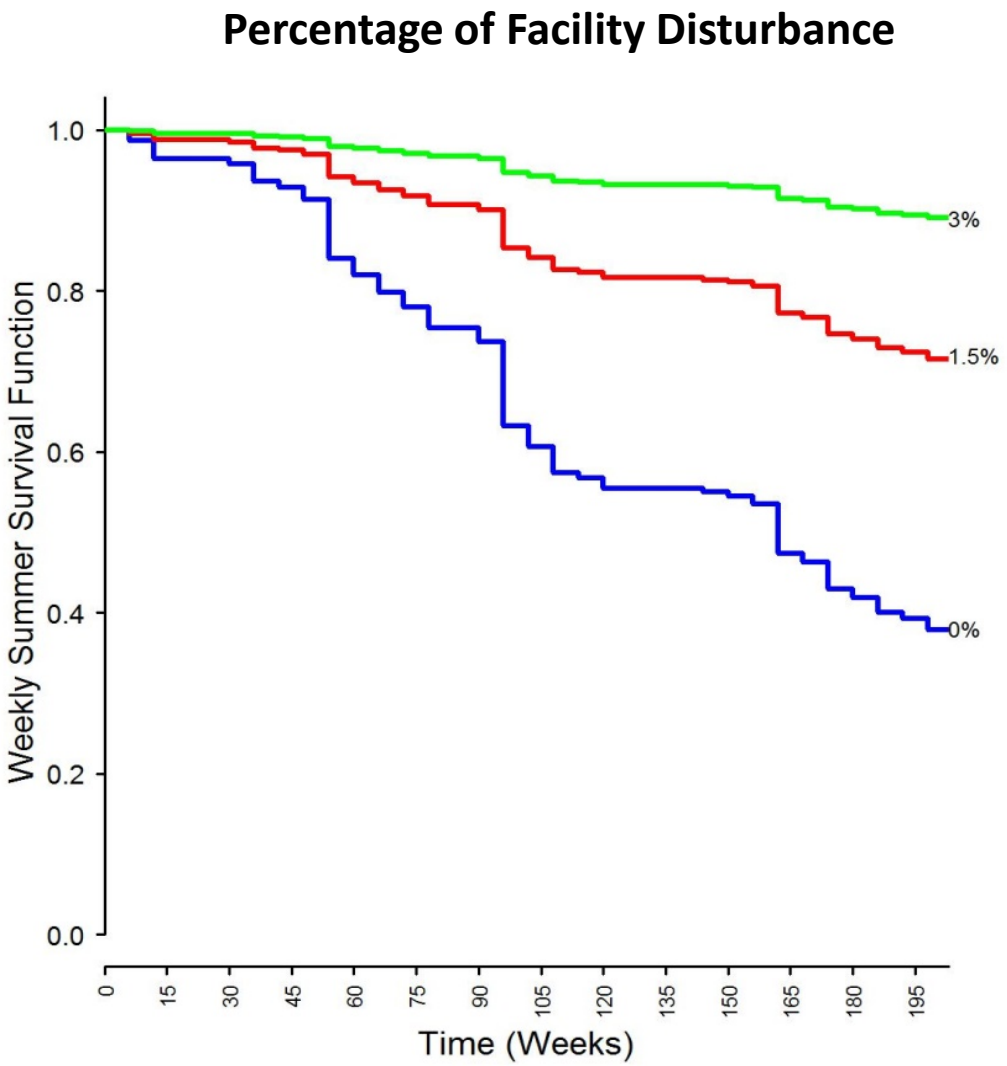


Results – Summer Female Survival

Final Model
Bare ground (+)
CTI (-)
Herbaceous (+)
Terrain Ruggedness (+)
TPI (-)
Distance to Capture Lek (+)
Percentage of Disturbance (+)



Results – Summer Female Survival



Discussion – Survival

- Nest and brood survival not impacted by turbines

- Observed a positive effect of percentage of disturbance on female survival

Survival	Turbine Effect
Nest	No Effect
Brood-Rearing	No Effect
Female	Positive Effect

Conclusion

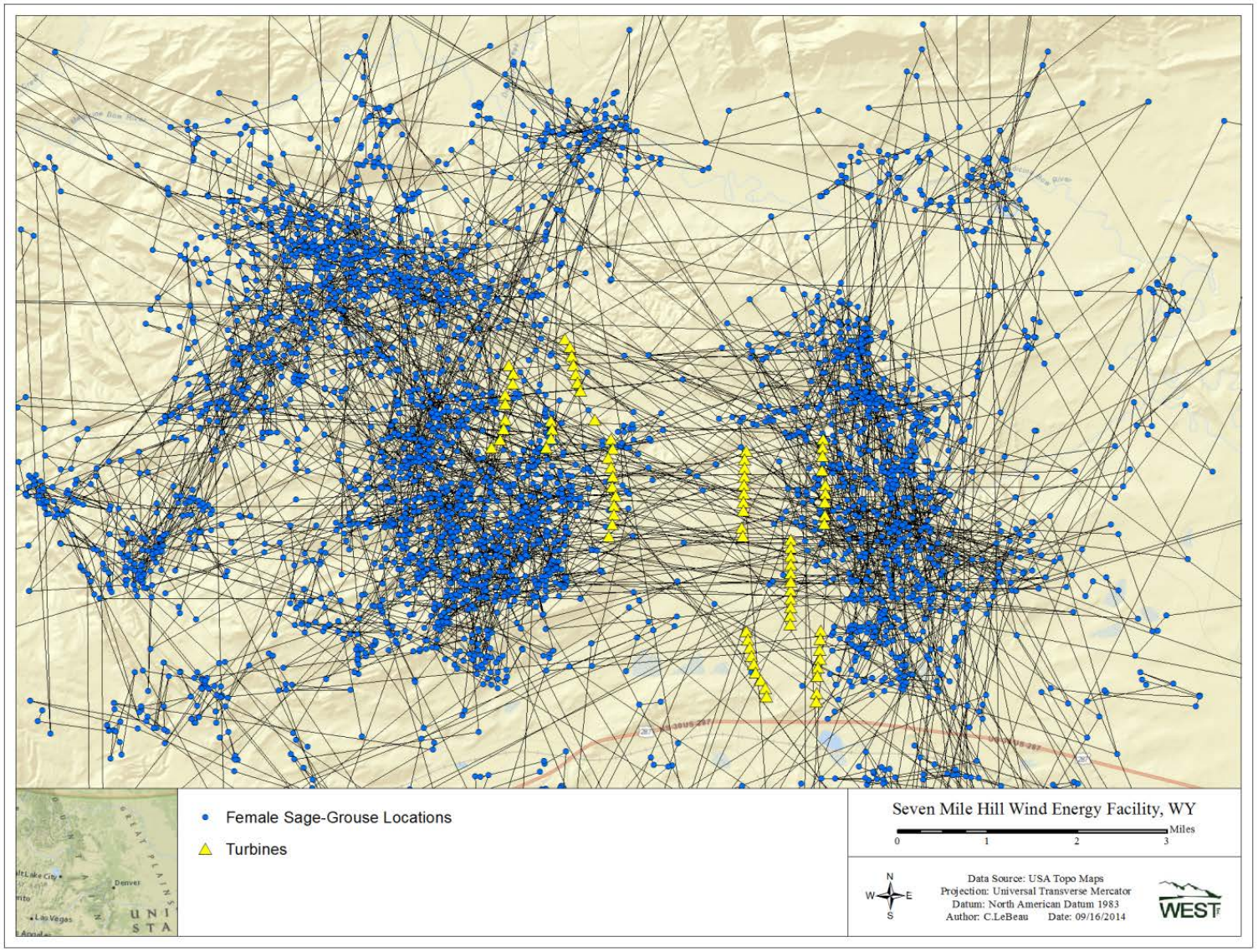
Analysis	Nesting period	Brood-rearing Period	Summer Period	Study Period
Habitat Selection	**No** Turbine Effect	**Negative** Turbine Effect to 1.2 km	**Negative** Turbine Effect to 1.2 km	**NA**
Survival	**No** Turbine Effect	**No** Turbine Effect	**NA**	**Positive** Turbine Effect

Management Recommendations

- Important to note the results are based the characteristics of the studied sage-grouse population

- We recommend facilities with a similar disturbance footprint to our facility (0.7% within 1.20 km of the facility) be placed 1.20 km from any occupied nesting, brood-rearing, or summer habitats.

Next Steps


Female Sage-Grouse Locations
Turbines
Seven Mile Hill Wind Energy Facility, WY
Miles
0
1
2
3
N
W
E
S
Data Source: USA Topo Maps
Projection: Universal Transverse Mercator
Datum: North American Datum 1983
Author: C.LeBeau Date: 09/16/2014
WEST

west-inc.com

cwlebeau@west-inc.com

Corporate Headquarters

415 West 17th Street, Suite 200, Cheyenne, WY 82001
307.634.1756