GREATER SAGE-GROUSE SEASONAL HABITAT MODELS, RESPONSE TO JUNIPER REDUCTION AND EFFECTS OF CAPTURE BEHAVIOR ON VITAL RATES, IN NORTHWEST UTAH

Thesis Defense – April 6, 2015

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Multiple Paper Format

1. Background
2. A Greater Sage-Grouse Habitat Suitability Model For Box Elder County, UT
3. Factors Influencing Greater Sage-Grouse use of Conifer Reduction Treatments: Implications for Range-Wide Conservation
4. Greater Sage-Grouse Behavior and Condition During Capture And Handling Relative To Survival And Reproductive Success
5. Conclusions

Basic Ecology

- Sagebrush Obligates
  - Nest
  - Brood Rearing
  - Non-breeding
  - Winter

Basic Ecology

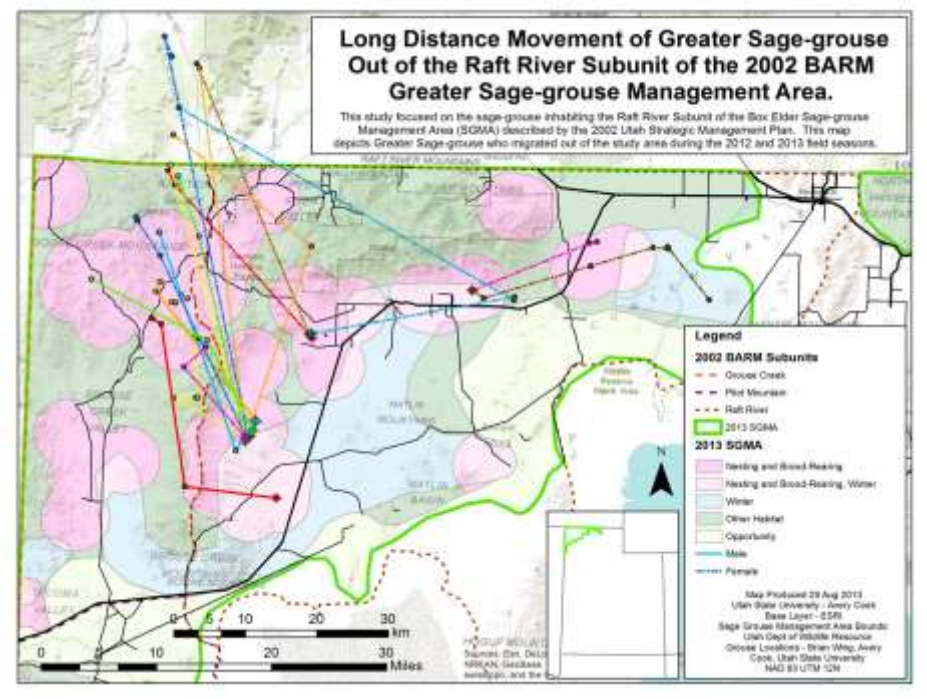
- Sagebrush Obligates
- Lek Breeding Behavior
  - Feb-April
  - Open areas in Sagebrush
  - Males and Females may visit multiple leks
  - Hens generally nest in vicinity of leks, in UT 90% within 5 km

Basic Ecology

- Sagebrush Obligates
- Lek Breeding Behavior
- Low Reproductive Output
  - Average 7 eggs/clutch
  - 15-85% nest success
  - 12-80% brood success
  - High Annual Survival

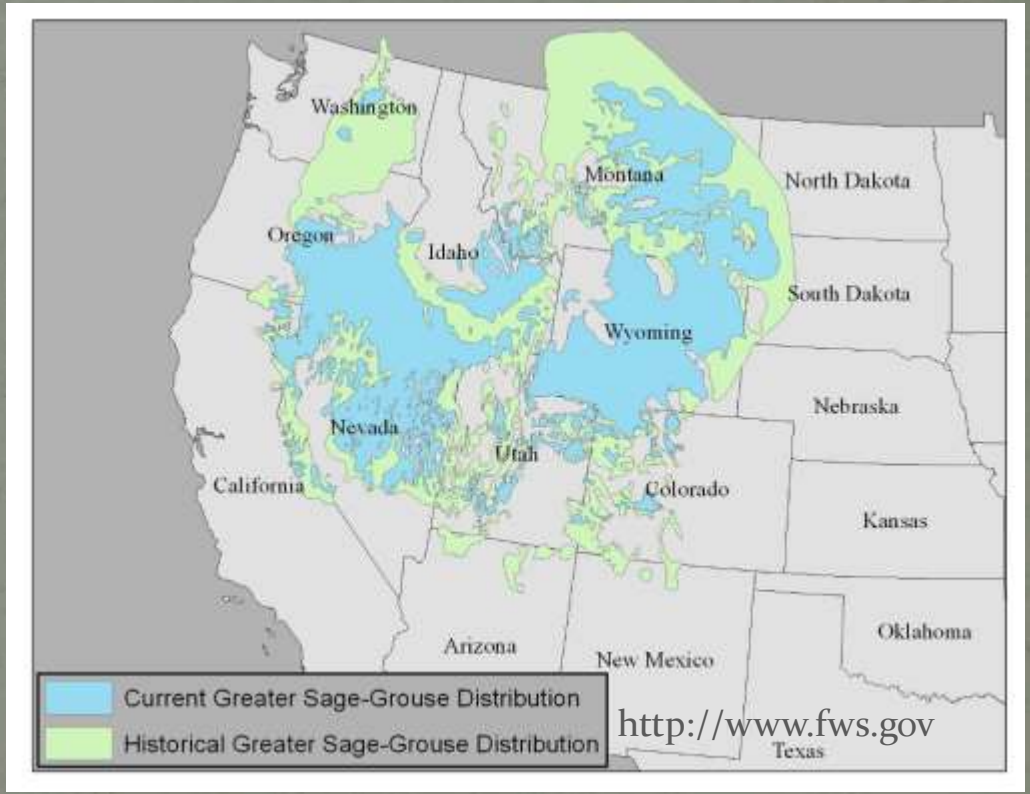
Basic Ecology

- Sagebrush Obligates
- Lek Breeding Behavior
- Low Reproductive Output
- Large Seasonal Range



Sage-Grouse: What's the BIG Deal?

1. Landscape Species
   - Sagebrush obligate
   - Does not adapt well to habitat change

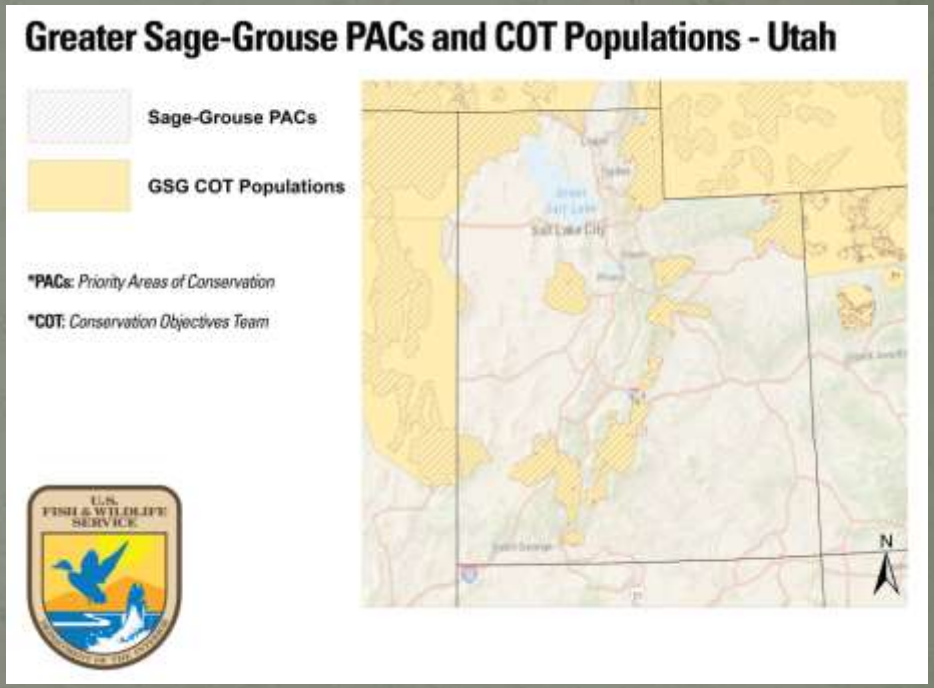


Sage-Grouse: What's the BIG Deal?

1. Landscape Species
2. Range Reduction
   - Pre-settlement
     1,200,000 km²
   - Year 2000
     668,000 km²
   - Utah – 41% of historic habitats

Sage-Grouse: What's the BIG Deal?

1. Landscape Species
2. Range Reduction
3. Petitioned for Listing
   - Multiple listing petitions since 1999
   - Court ordered decision Sept 2015



Sage-Grouse: What's the BIG Deal?

1. Landscape Species
2. Range Reduction
3. Petitioned for Listing
4. Unprecedented Conservation Work

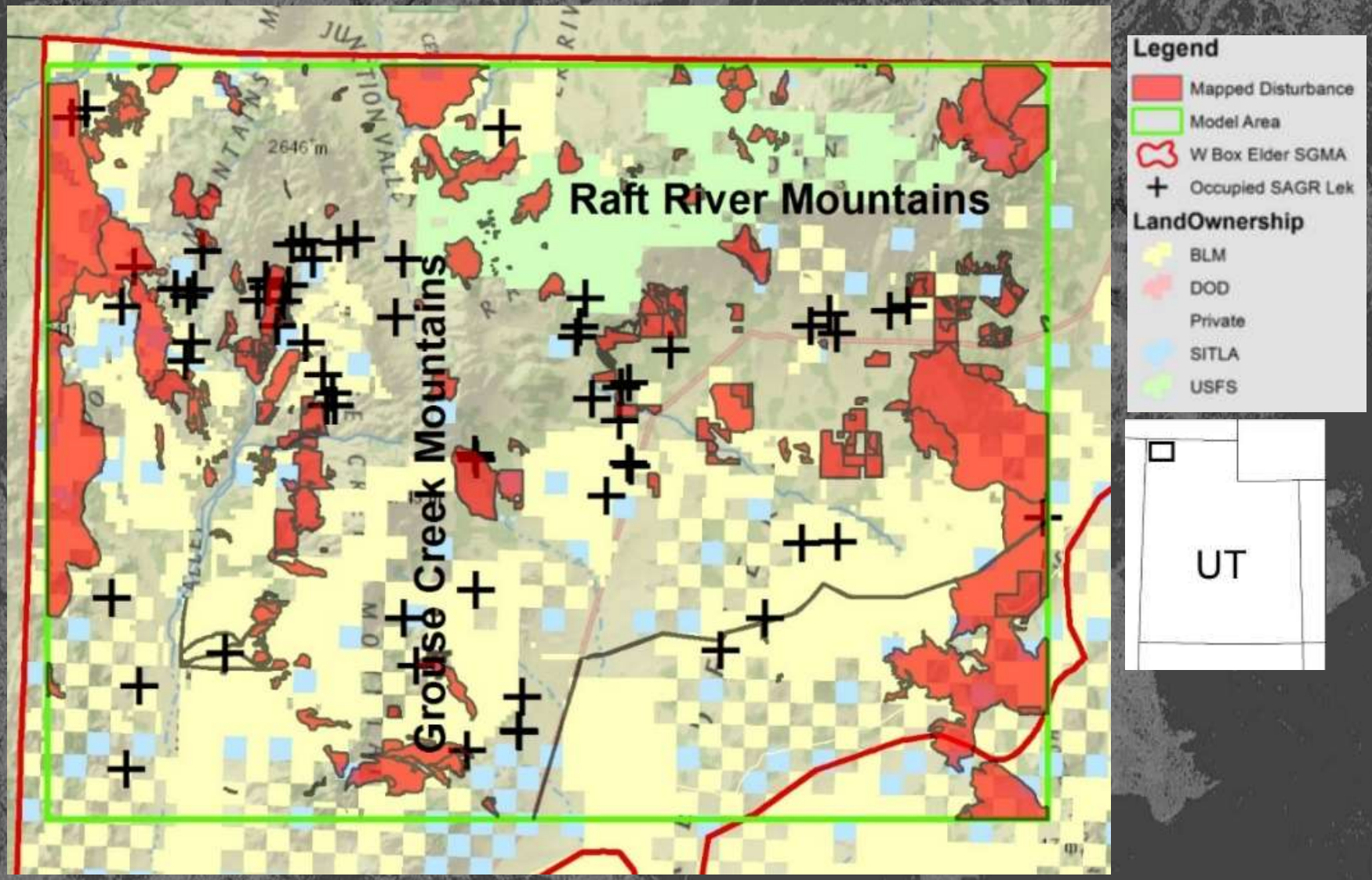
Chapter 2

A GREATER SAGE-GROUSE HABITAT SUITABILITY MODEL FOR BOX ELDER COUNTY, UT

Study Objectives

- Identify past and present vegetation disturbances within the study area.
- Model influence of past vegetation disturbance on current sage-grouse distribution.
- Identify seasonal sage-grouse habitat in the Box Elder SGMA.

Study Area


Raft River Mountains
Grouse Creek Mountains
2646 m
Legend
Mapped Disturbance
Model Area
W Box Elder SGMA
Occupied SAGR Lek
LandOwnership
BLM
DOD
Private
SITLA
USFS
UT

Methods

- VHF Radio Telemetry
  - 68 F, 55 M Capture 2012, 2013
  - Located 2-3 times/week (F), 1 time/week (M)
  - Additional Locations from 2005-2011 USU Projects

Methods

- Vegetation Disturbance
  - Landsat 5,8 Images from 1987-2013
  - Normalized using COST method
  - Derived NDVI images
  - Change detection via image differencing
- Additional Vegetation Disturbance
  - Utah WRI Project Data
  - GeoMAC Fire Perimeters
  - LANDFIRE Disturbance
  - Visual Examination of NAIP, Google Earth Imagery

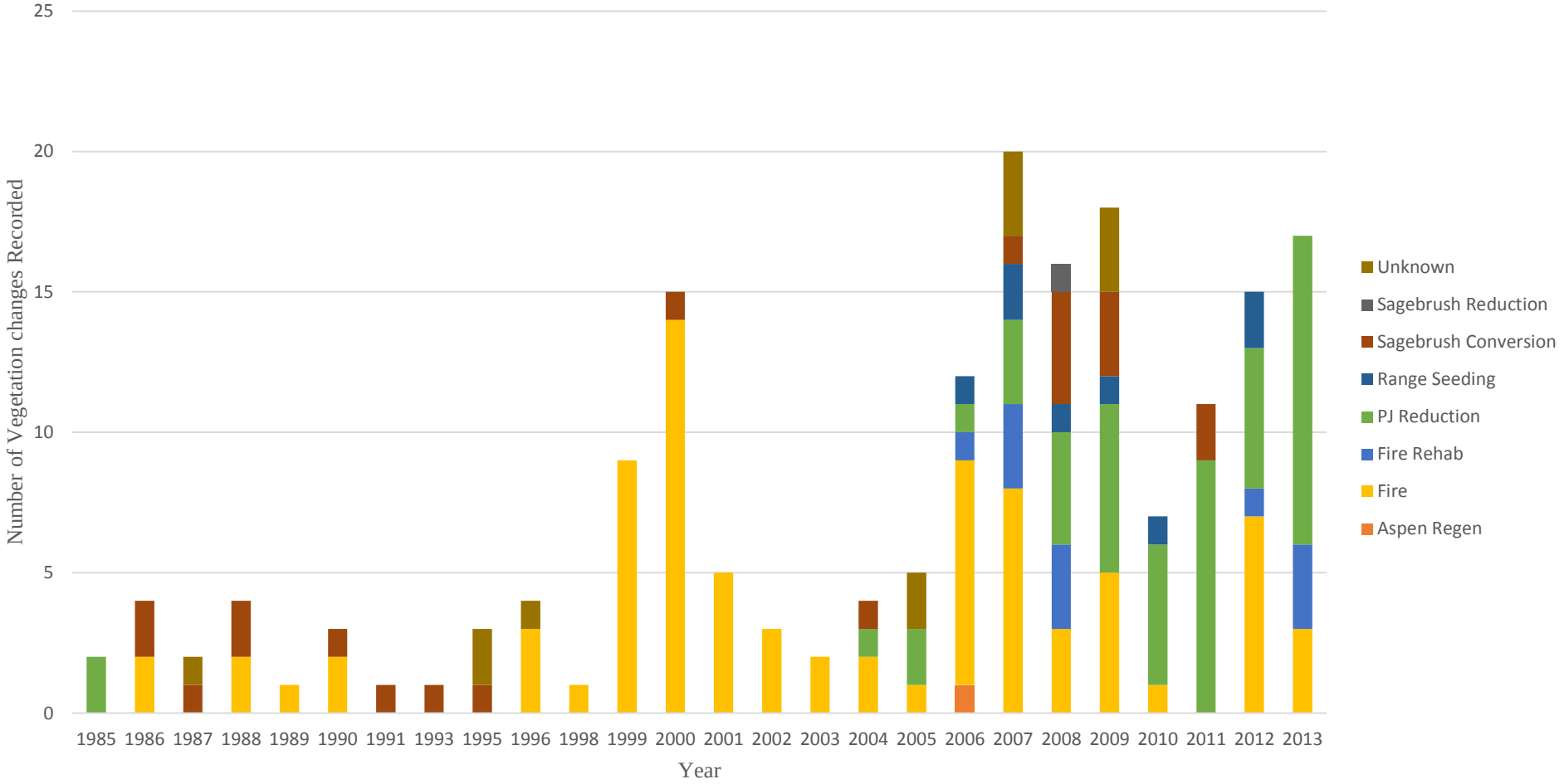
Methods

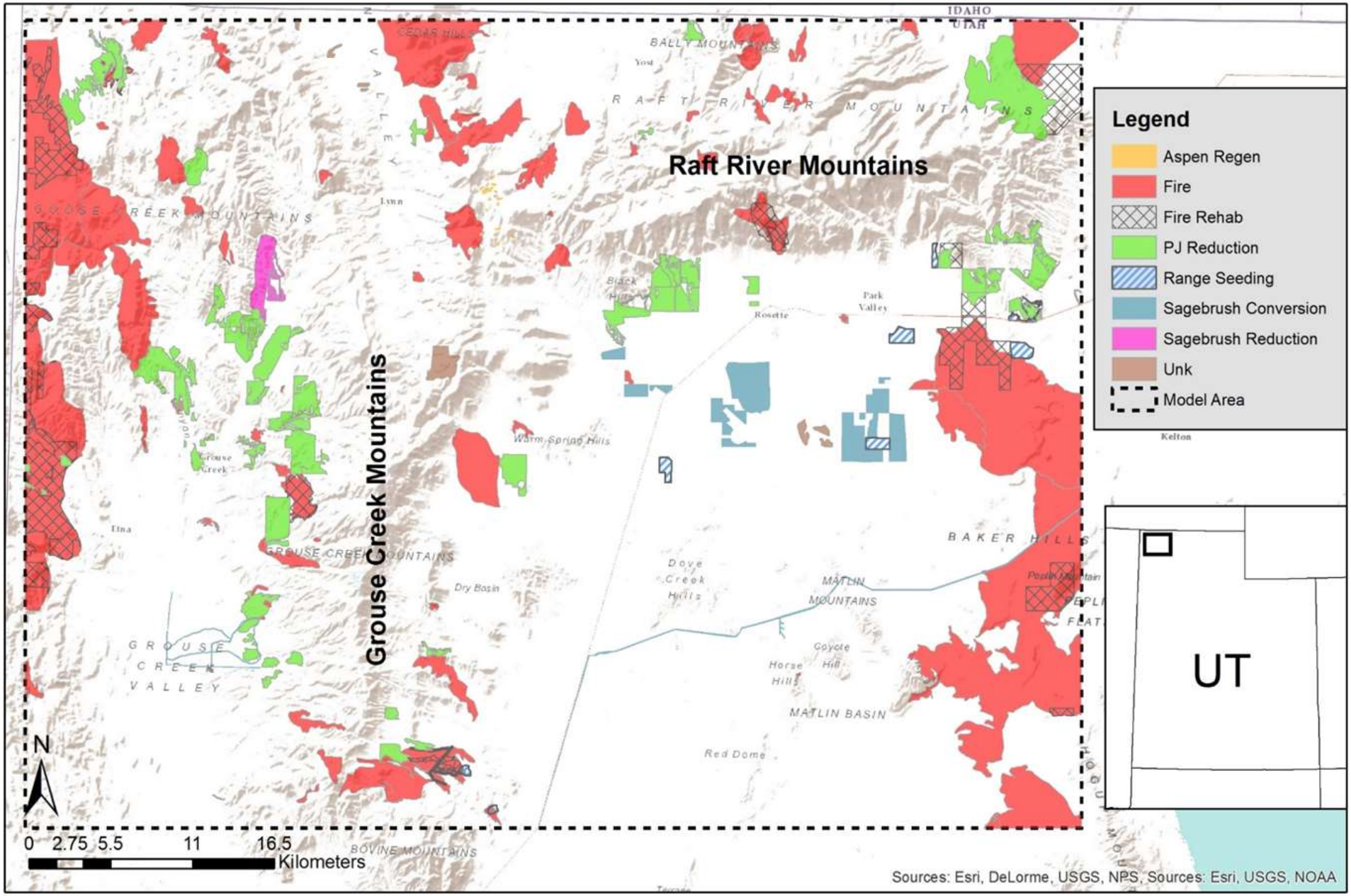
- Model Inputs
  - Disturbance
  - NDVI
  - LANDFIRE Existing Vegetation Type
  - LANDFIRE Existing Vegetation Cover
  - LANDFIRE Existing Vegetation Height
  - LANDFIRE Biophysical Setting
  - Distance to Major (>25 mph), Minor (≤25 mph) Roads
  - Elevation
  - Aspect
  - Slope

Methods

- Modeling
  - Random Forest via ModelMap R Package
  - 10:1 Pesudo-absence to presence location ratio
- Vegetation Disturbance
  - Most Recent Telemetry Data Only (2012-2013)
  - Many Disturbances Occurred 2005-2011
  - Subset Disturbance to Fire, PJ Reduction, All Habitat Projects, All Disturbance
- Habitat Use
  - All Telemetry Data
  - Seasonal Models

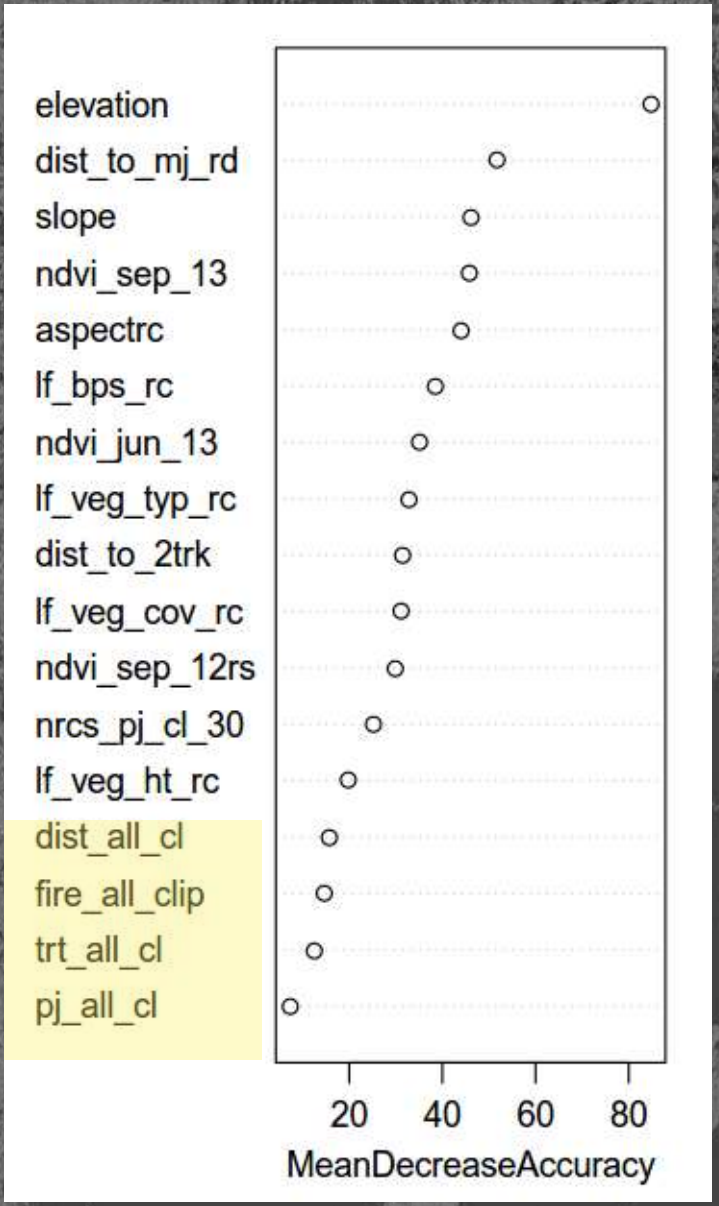
Results


25
20
15
10
5
0
Number of Vegetation changes Recorded
1985 1986 1987 1988 1989 1990 1991 1993 1995 1996 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Year
Unknown
Sagebrush Reduction
Sagebrush Conversion
Range Seeding
PJ Reduction
Fire Rehab
Fire
Aspen Regen


Raft River Mountains
Grouse Creek Mountains
Legend
Aspen Regen
Fire
Fire Rehab
PJ Reduction
Range Seeding
Sagebrush Conversion
Sagebrush Reduction
Unk
Model Area
UT
N
0 2.75 5.5 11 16.5
Kilometers
Sources: Esri, DeLorme, USGS, NPS, Sources: Esri, USGS, NOAA

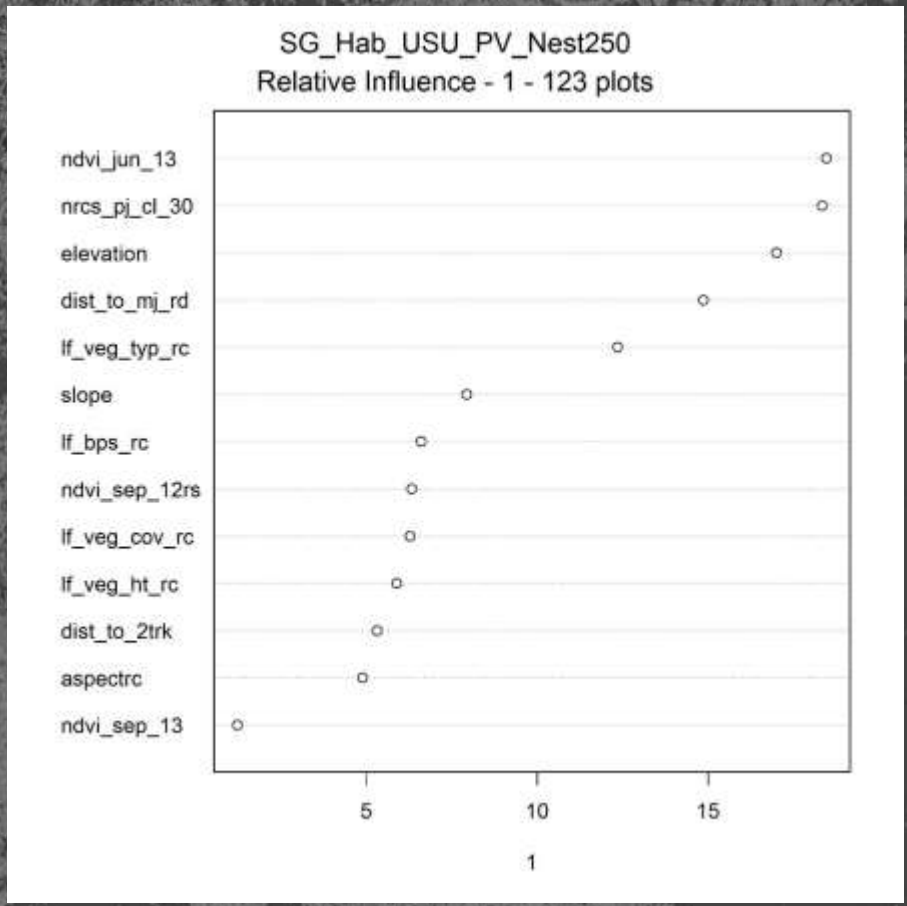
Results

- Recorded vegetation disturbance had low influence on modeled SAGR distribution

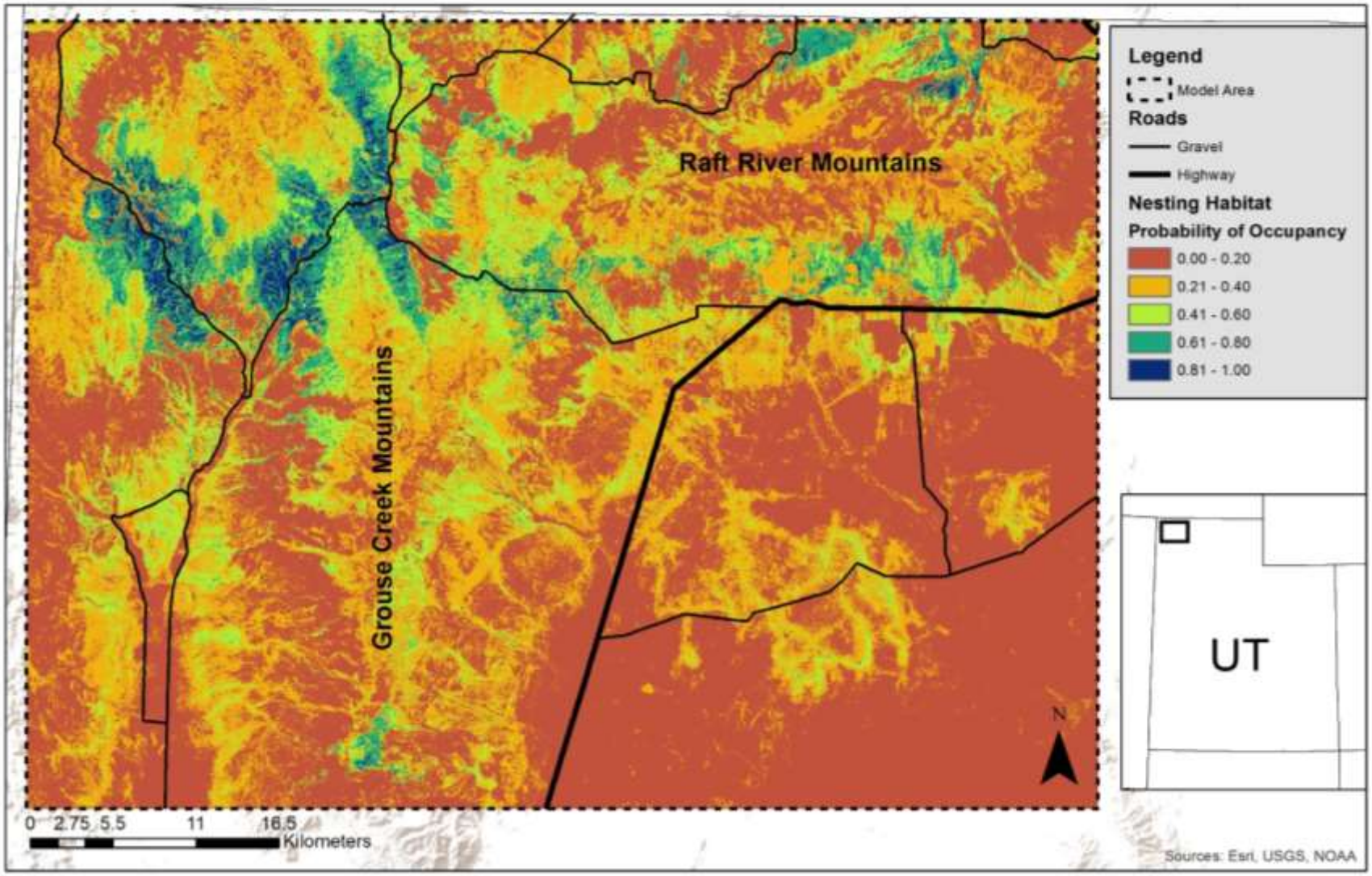


Results - Nest

	2005-2013		
	N	AUC	Accuracy
Non-Breeding	1838	0.90	85.40%
Lek	284	0.92	75.70%
Early Summer	1001	0.91	85.00%
Late Summer	388	0.92	74.70%
Winter	158	0.85	67.70%
Nest	123	0.87	62.60%
Brood	1129	0.95	86.30%
Total	3090		

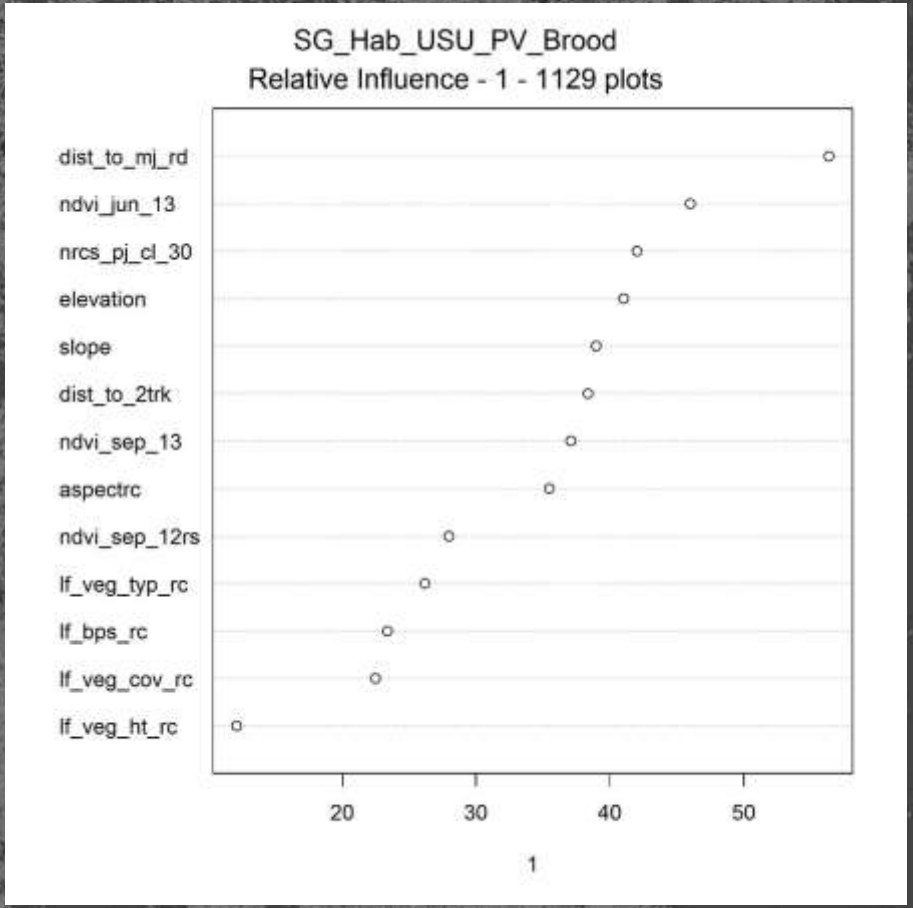


Results - Nest

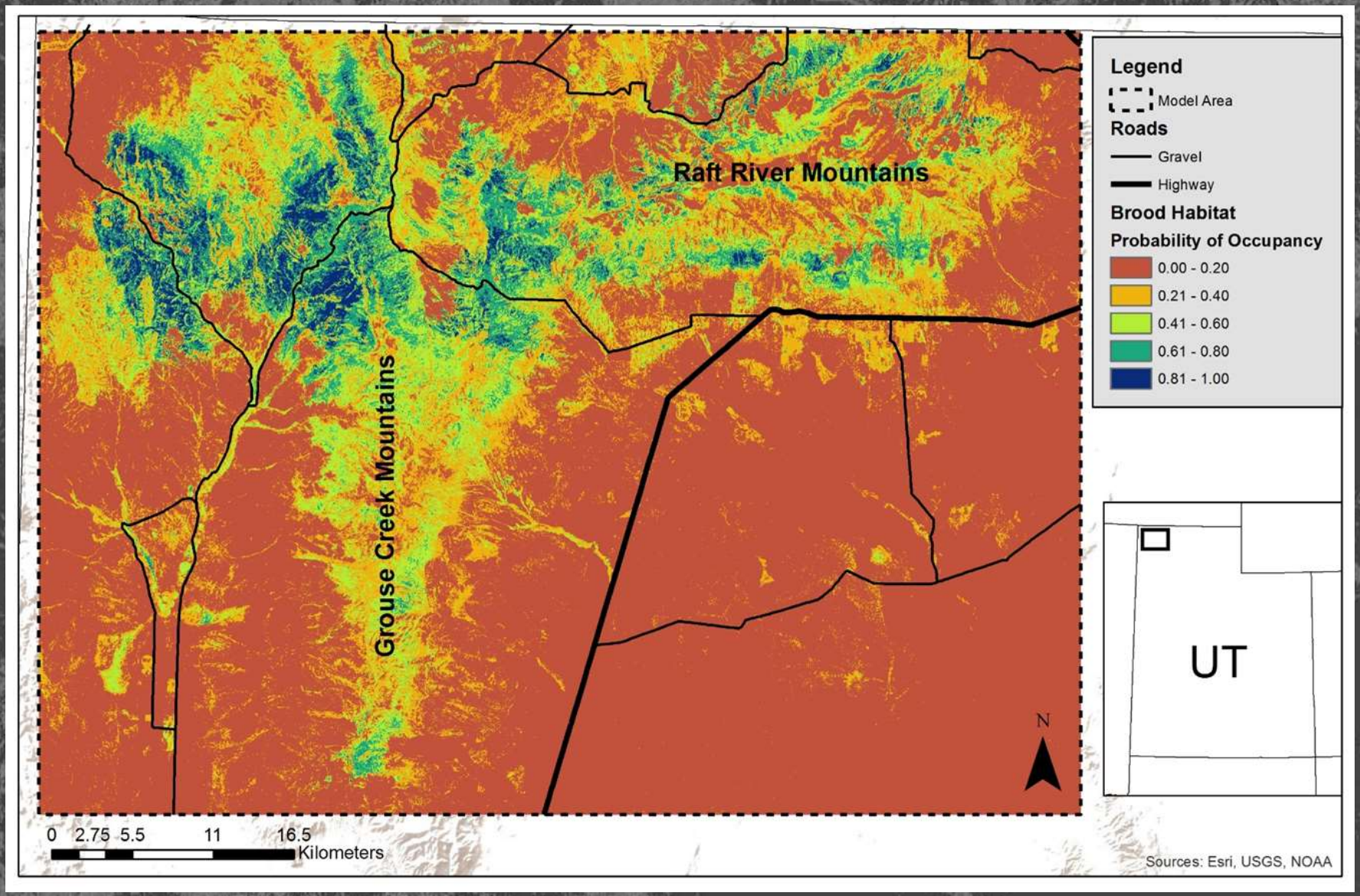


Results - Brood

	2005-2013		
	N	AOC	Accuracy
Non-Breeding	1838	0.90	85.40%
Lek	284	0.92	75.70%
Early Summer	1001	0.91	85.00%
Late Summer	388	0.92	74.70%
Winter	158	0.85	67.70%
Nest	123	0.87	62.60%
Brood	1129	0.95	86.30%
Total	3090		



Results - Brood



Results – Early Summer

All Locations other than Nest and Brood, from April 16 to June 30.

	2005-2013		
	N	AUC	Accuracy
Non-Breeding	1838	0.90	85.40%
Lek	284	0.92	75.70%
Early Summer	1001	0.91	85.00%
Late Summer	388	0.92	74.70%
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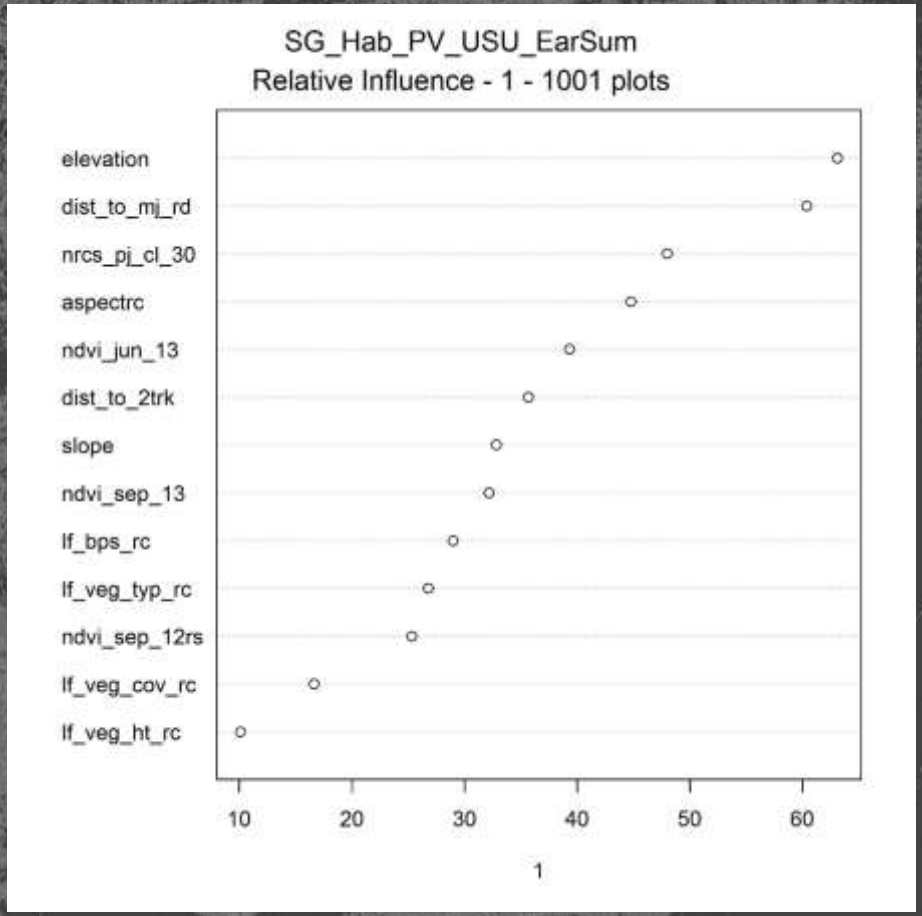
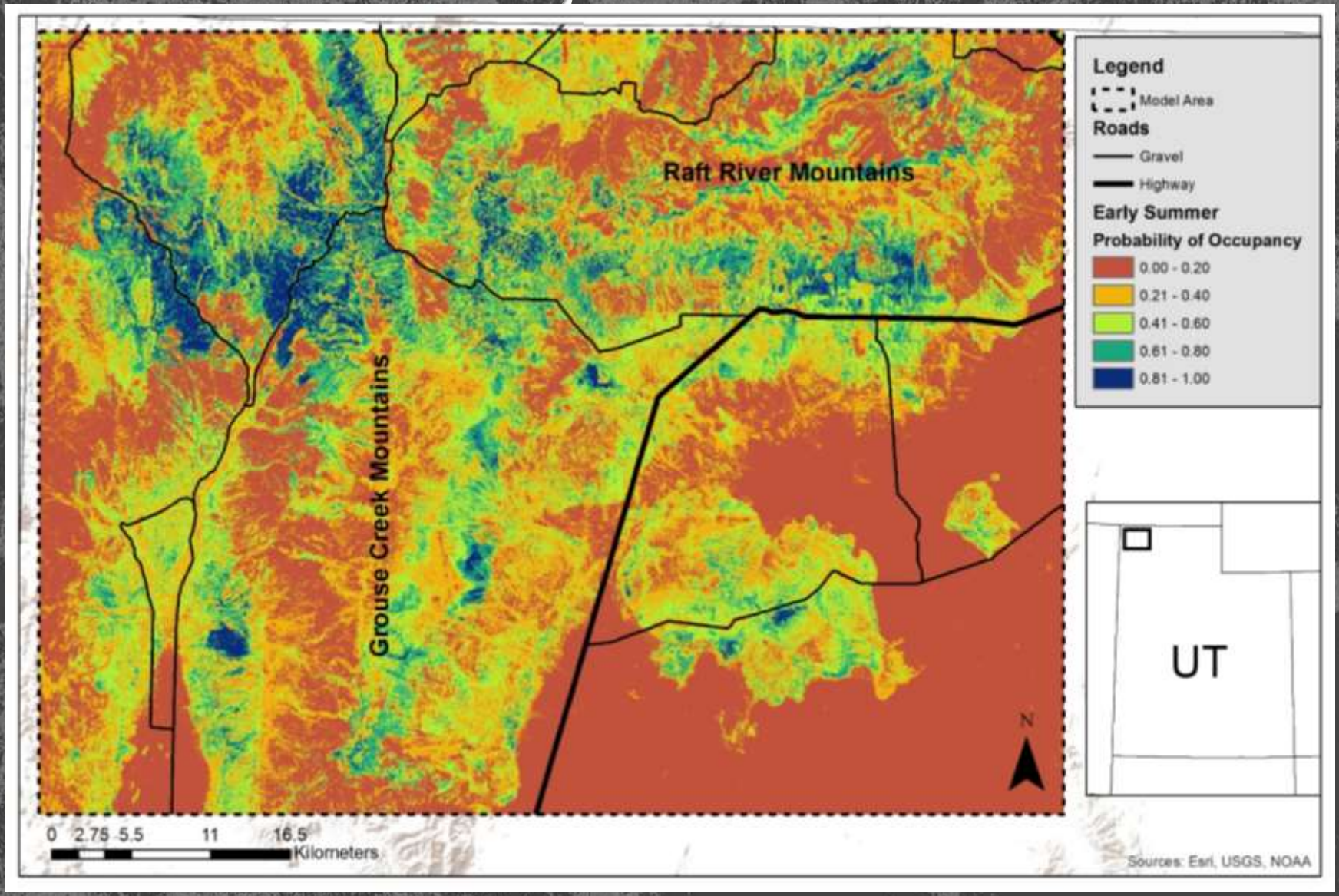


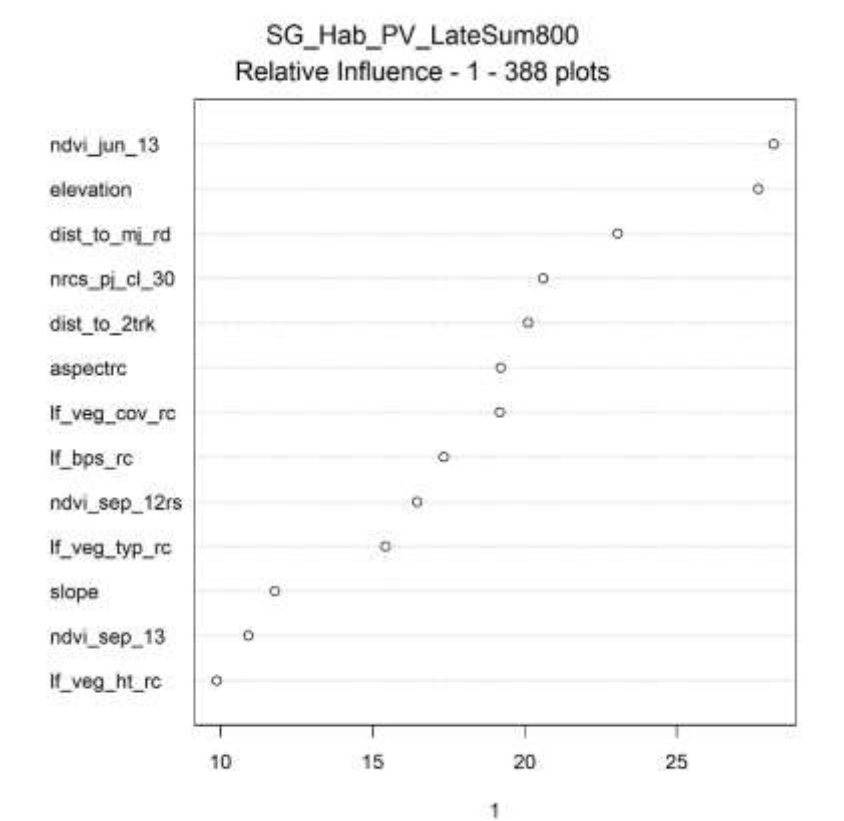
Results – Early Summer



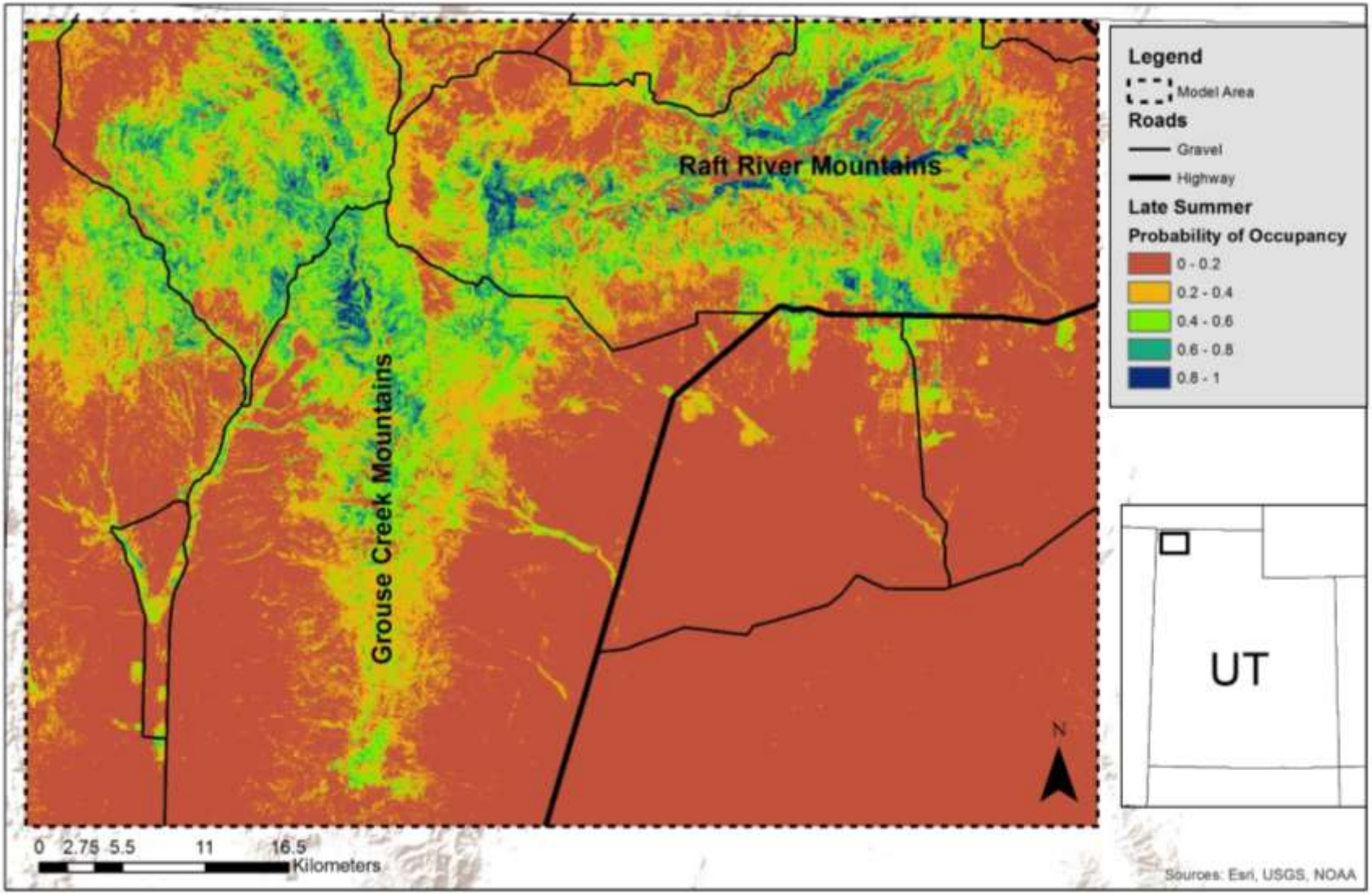
Results – Late Summer

All Locations other than Nest and Brood, from July 1 to Sept 30.

	2005-2013		
	N	AUC	Accuracy
Non-Breeding	1838	0.90	85.40%
Lek	284	0.92	75.70%
Early Summer	1001	0.91	85.00%
Late Summer	388	0.92	74.70%
Winter	158	0.85	67.70%
Nest	123	0.87	62.60%
Brood	1129	0.95	86.30%
Total	3090		



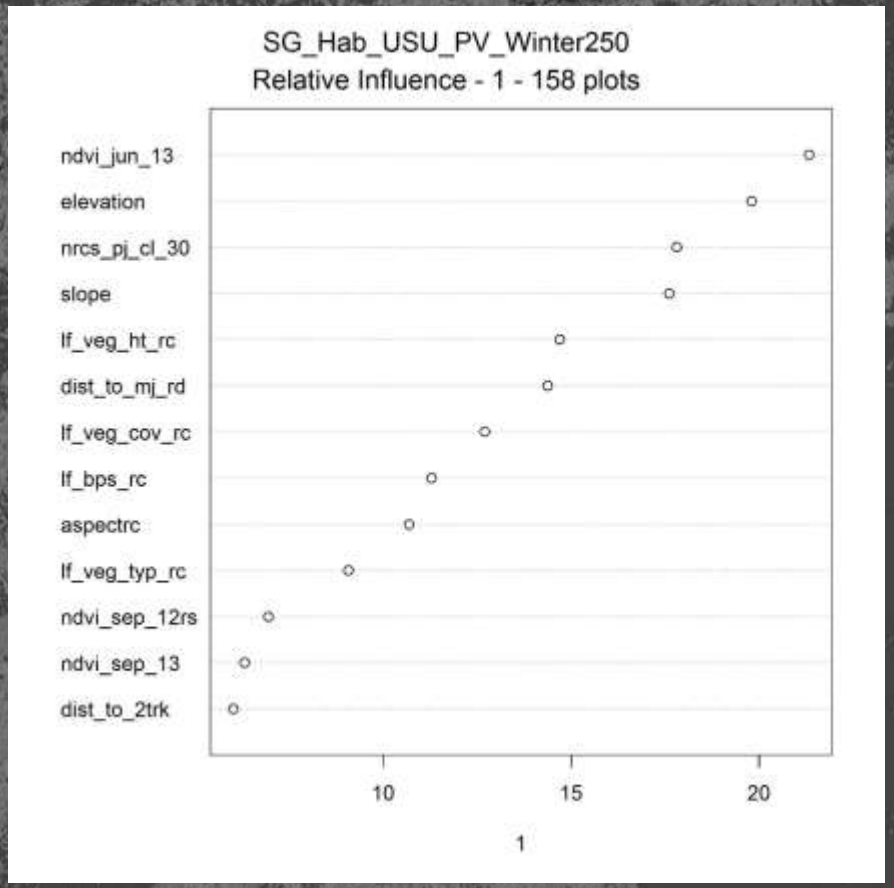
Results – Late Summer



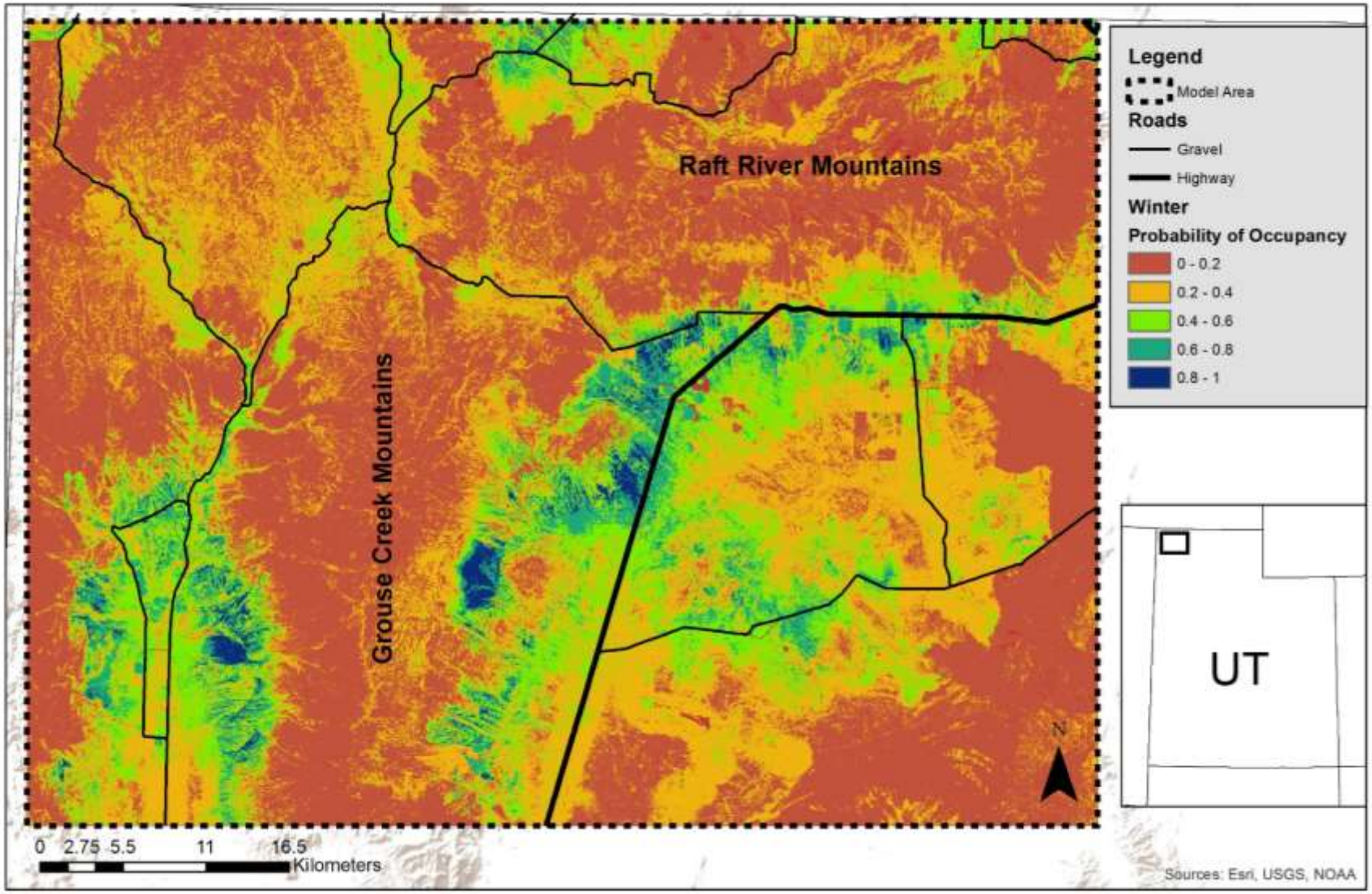
Results – Winter

All Locations from October 1 to February 14.

	2005-2013		
	N	AUC	Accuracy
Non-Breeding	1838	0.90	85.40%
Lek	284	0.92	75.70%
Early Summer	1001	0.91	85.00%
Late Summer	388	0.92	74.70%
Winter	158	0.85	67.70%
Nest	123	0.87	62.60%
Brood	1129	0.95	86.30%
Total	3090		



Results – Winter



Results – Lekking Period

All Locations other than Nest and Brood, from Feb 15 to April 15.

	2005-2013		
	N	AUC	Accuracy
Non-Breeding	1838	0.90	85.40%
Lek	284	0.92	75.70%
Early Summer	1001	0.91	85.00%
Late Summer	388	0.92	74.70%
Winter	158	0.85	67.70%
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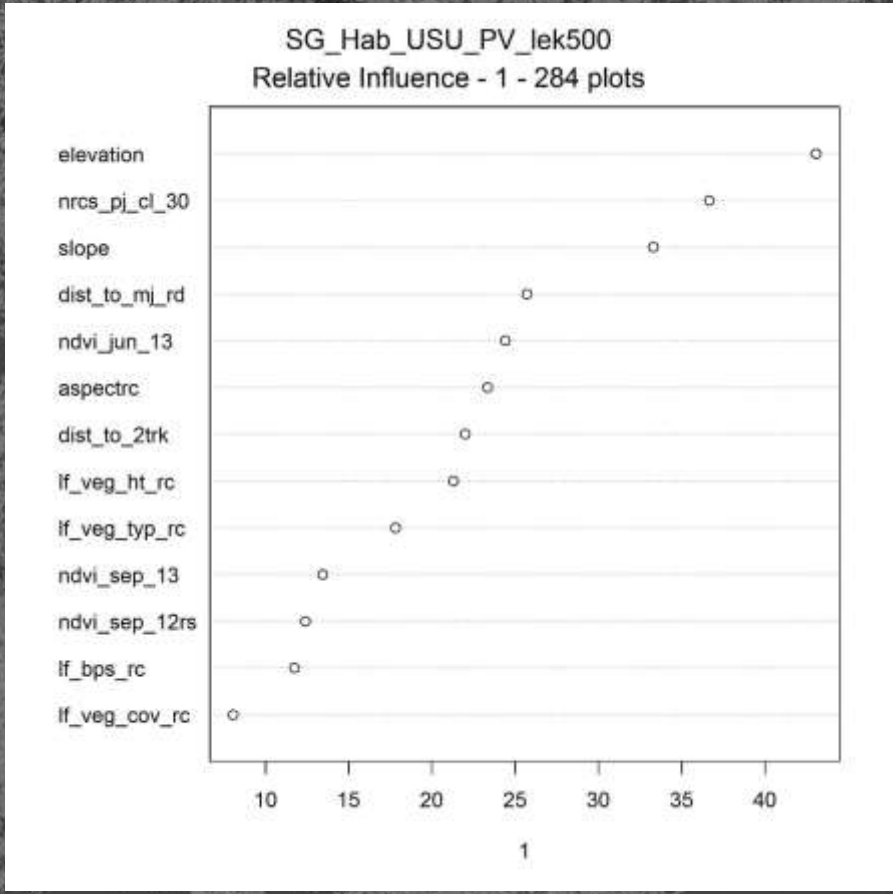
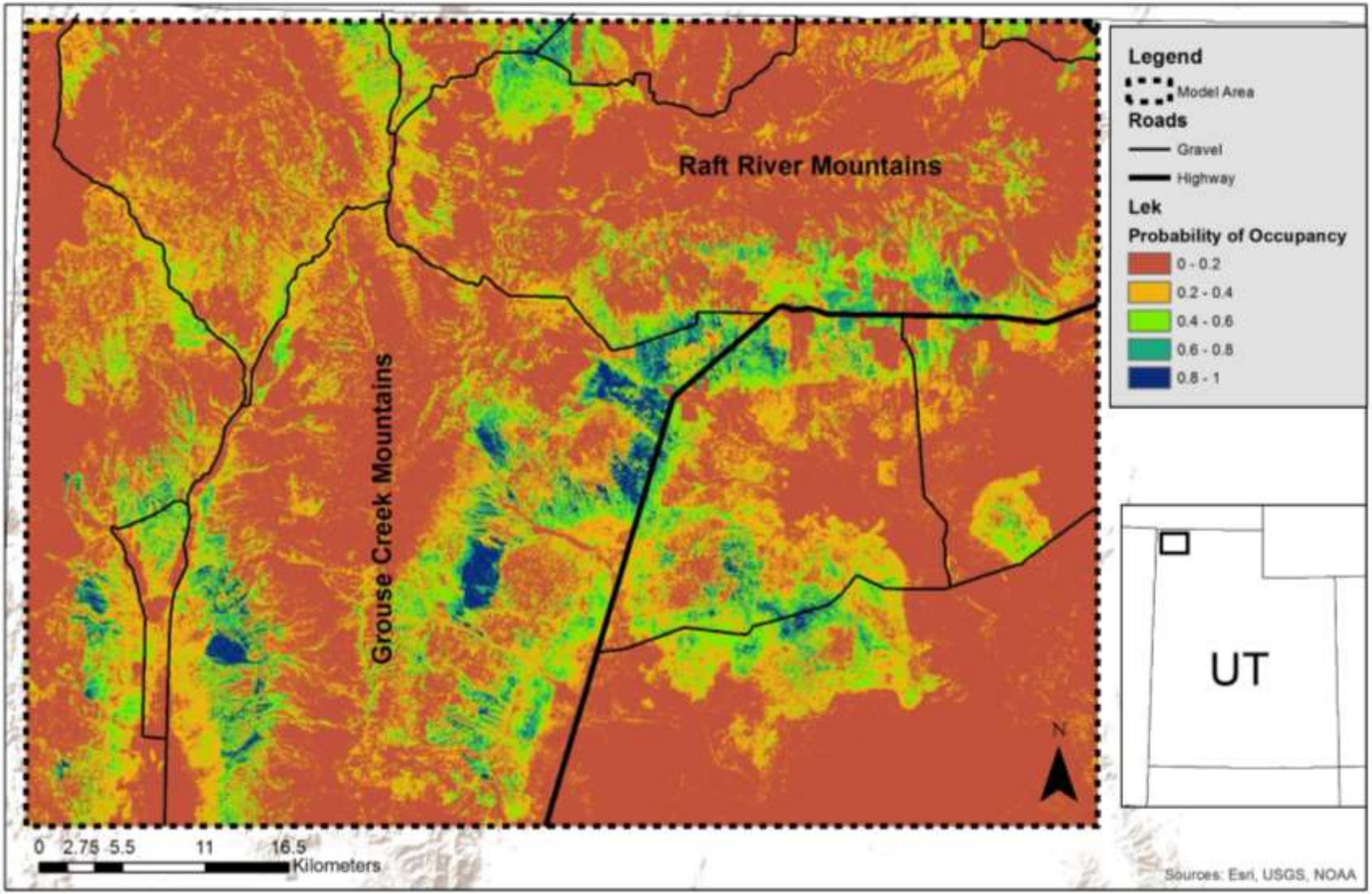
Brood	1129	0.95	86.30%
Total	3090		



Results - Lek


Raft River Mountains
Grouse Creek Mountains
Legend
Model Area
Roads
Gravel
Highway
Lek
Probability of Occupancy
0 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1
UT
N
0 2.75 5.5 11 16.5
Kilometers
Sources: Esri, USGS, NOAA

Results – All Non-Breeding

All Locations other than Nest and Brood.

	2005-2013		
	N	AUC	Accuracy
Non-Breeding	1838	0.90	85.40%
Lek	284	0.92	75.70%
Early Summer	1001	0.91	85.00%
Late Summer	388	0.92	74.70%
Winter	158	0.85	67.70%
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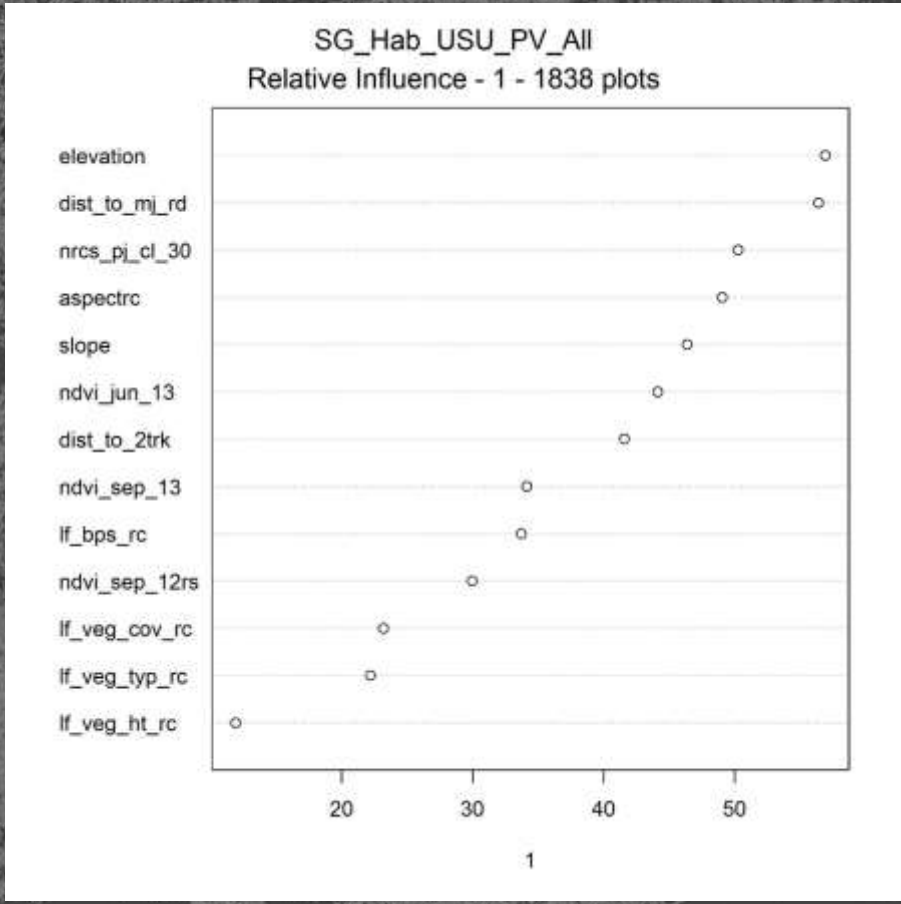
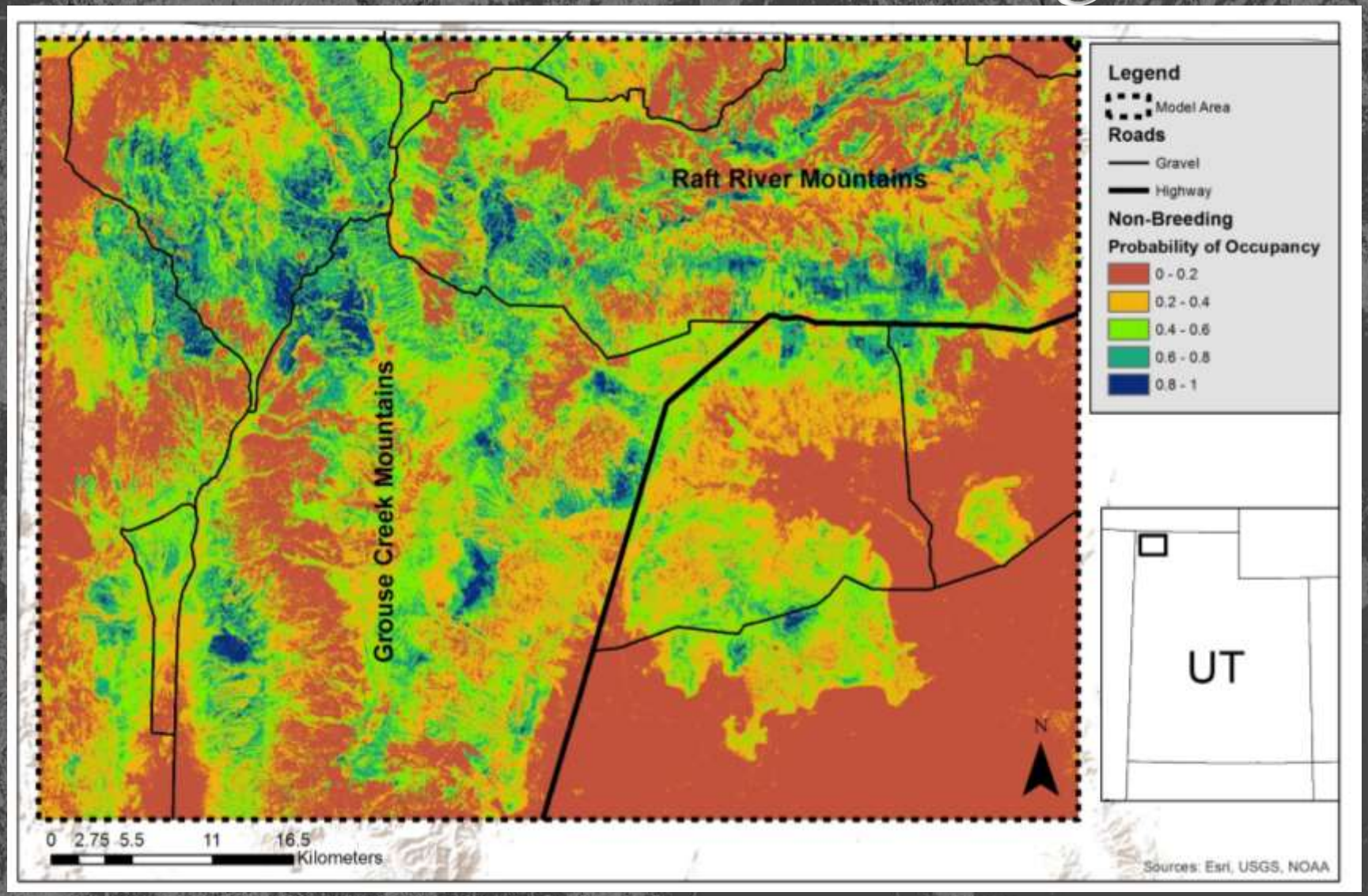
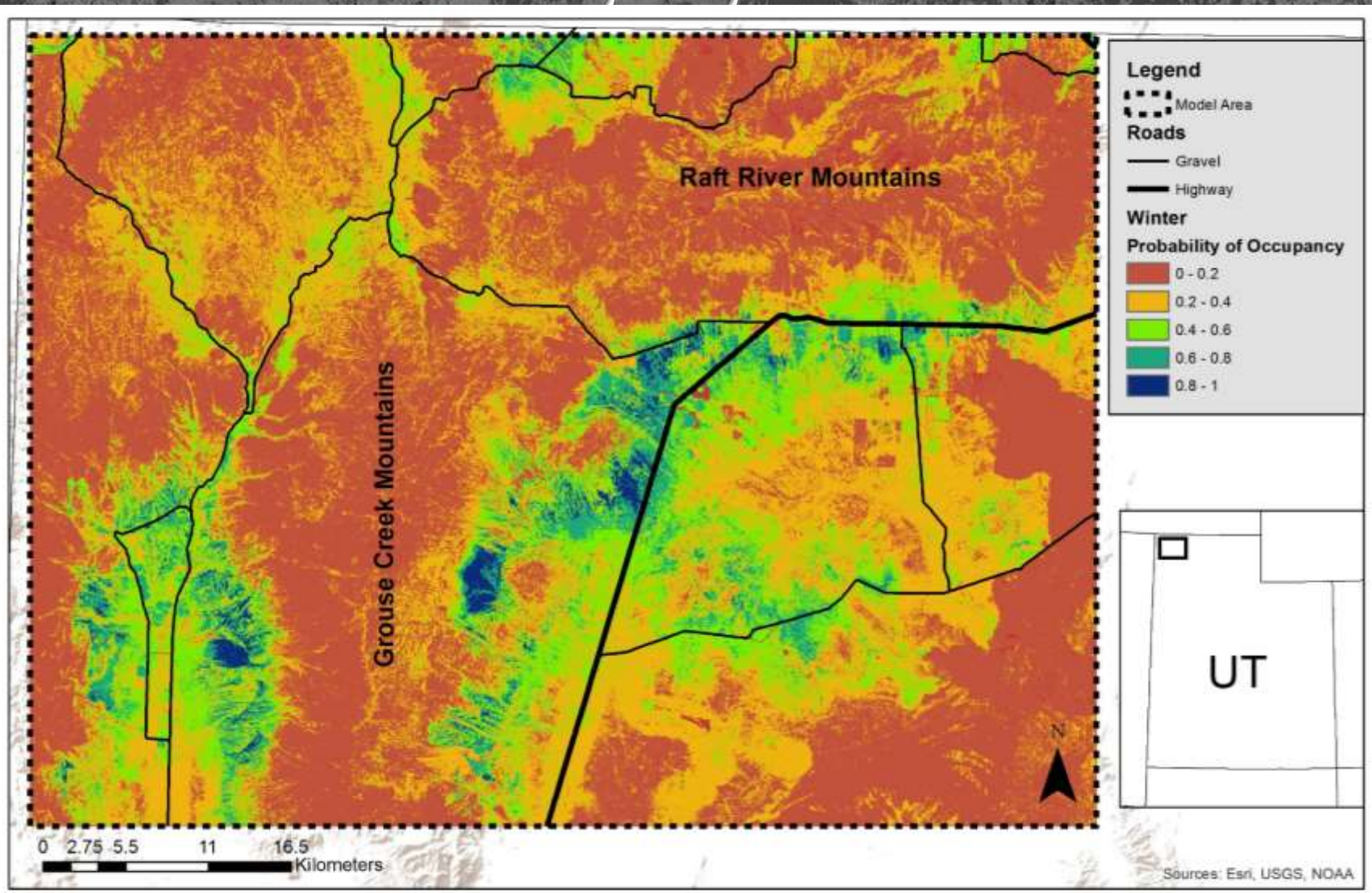
Total	3090		



Results – All Non-breeding

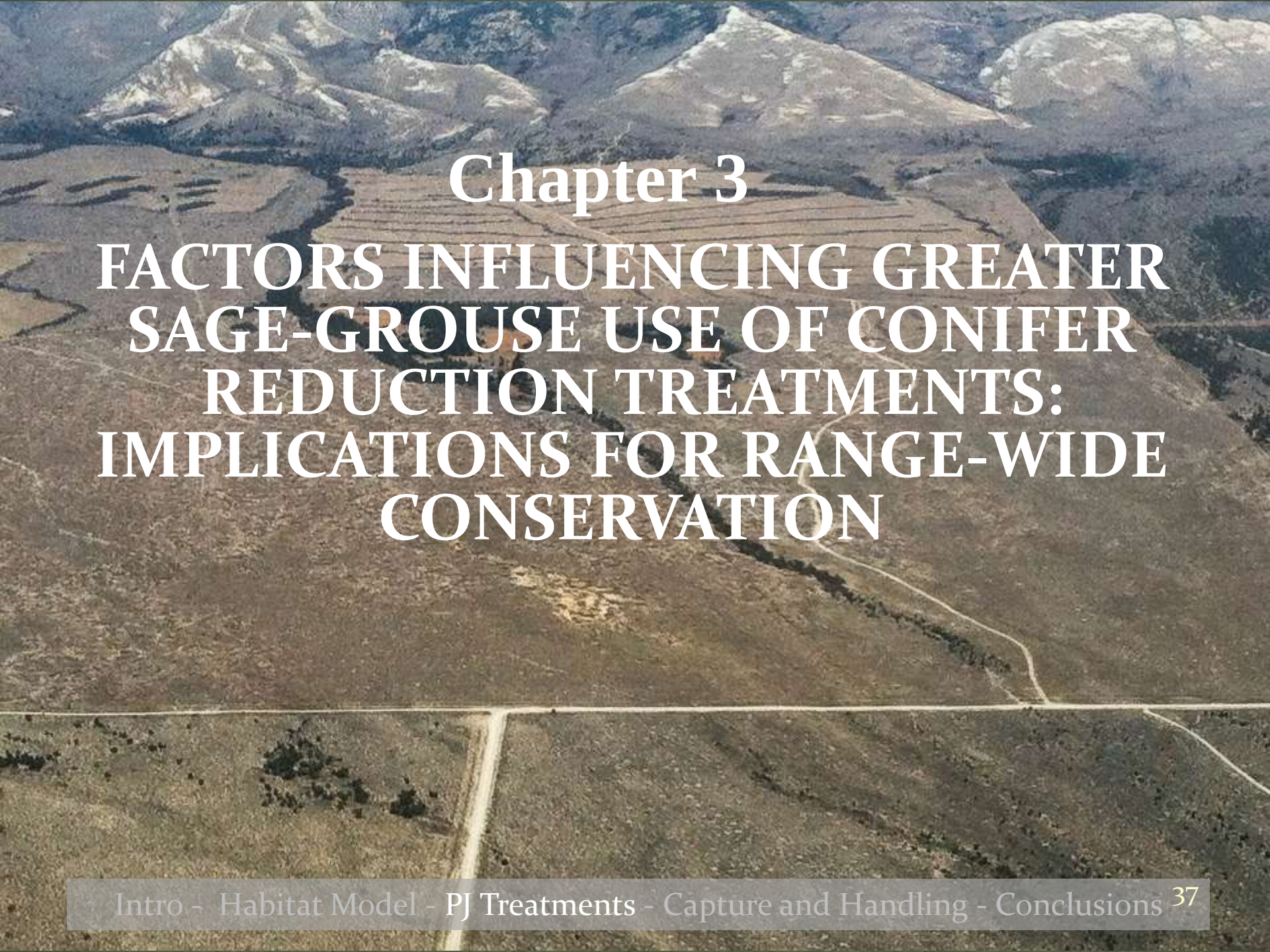


Results – Yearly Cycle



Conclusions

- Random Forest machine learning methods are an effective method of building SAGR habitat models
- Refined seasonal habitat mapping
- Additional information to help prioritize sage-grouse habitat improvement projects
- Lack of predictive power of mapped habitat disturbance should not be interpreted to mean disturbance does not impact sage-grouse



Chapter 3

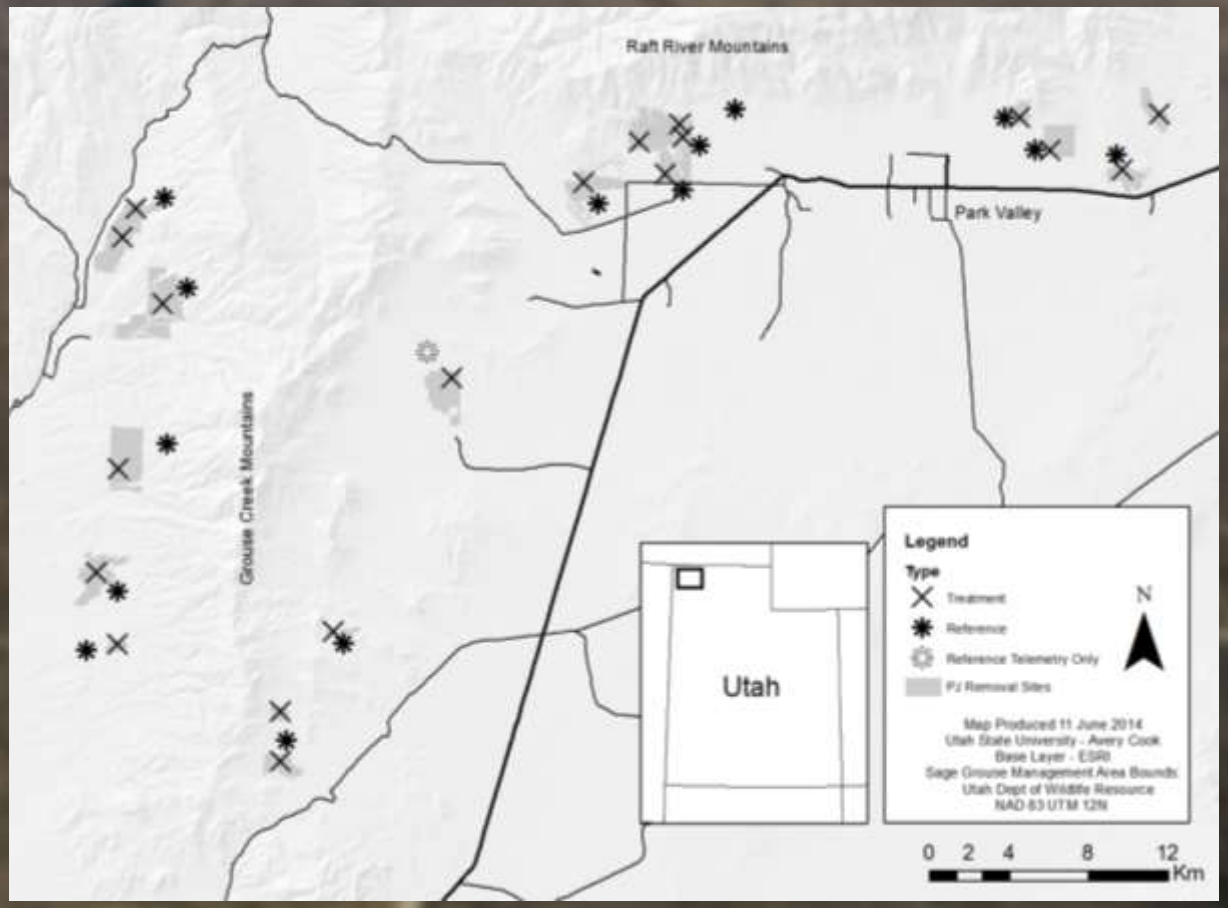
FACTORS INFLUENCING GREATER SAGE-GROUSE USE OF CONIFER REDUCTION TREATMENTS: IMPLICATIONS FOR RANGE-WIDE CONSERVATION

Objectives

- PJ encroachment is a major source of sage-grouse habitat loss, but also a major opportunity for restoration projects.
- Determine if sage-grouse were using pinyon-juniper reduction treatments in west Box Elder County, UT.
  - Pellet survey (2400 m transect/plot)
  - Radio Telemetry
- Investigate habitat characteristics associated with sage-grouse detection or non-detection on pinyon-juniper reduction treatments.

Study Area

- West Box Elder County in NW Utah.
- 19 PJ treatments and 14 adjacent reference plots.



Methods

- Evaluated with pellet surveys and telemetry
  - If a pellet was found = detection
  - If a bird was found = detection
- Grouped by detection/non-detection, Control/Reference
  - Tested for difference in habitat va ps using bootstrapped t-tests.

Variables Examined

Treatment and Reference Plots

- Compared between plots:
  - Detection/non-detection.
  - Treatment/reference.
- Percent Canopy Cover
  - Grass/Forb
  - Tree/Shrub
    - Small Sage (low and black)
    - Big Sage (big sage all subspecies)
- Vegetation Height
- Dominant Species
- Percent Litter

Variables Examined

Treatment Plots Only

- Compared between detection/not-detection plots
- LANDFIRE 2010 Existing Vegetation Type
  - Buffered to 40 m, 500 m, 1000 m, 2000 m
  - Extracted percent composition for PJ, Sagebrush, mesic, urban, other vegetation groups within each buffer
- Distance to water features
  - Streams, Lakes, Springs
- Distance to Nearest Occupied Lek
- Age of treatment
- Treatment Size
- Cow pie density

Results

- Sage-grouse use detected in 12 of 19 treatments and 7 of 14 reference plots.
- Positive relationship between detection in treatment and nearest reference plot (P=0.018)
- Positive relationship between SAGR use and mesic landcover at a 1000 m scale (P=0.048)
- Negative relationship between SAGR and PJ landcover at 500 m and 1000 m scales (P=0.056, P=0.048)
- Shrub cover was greater on plots where SAGR were detected (P=0.039)

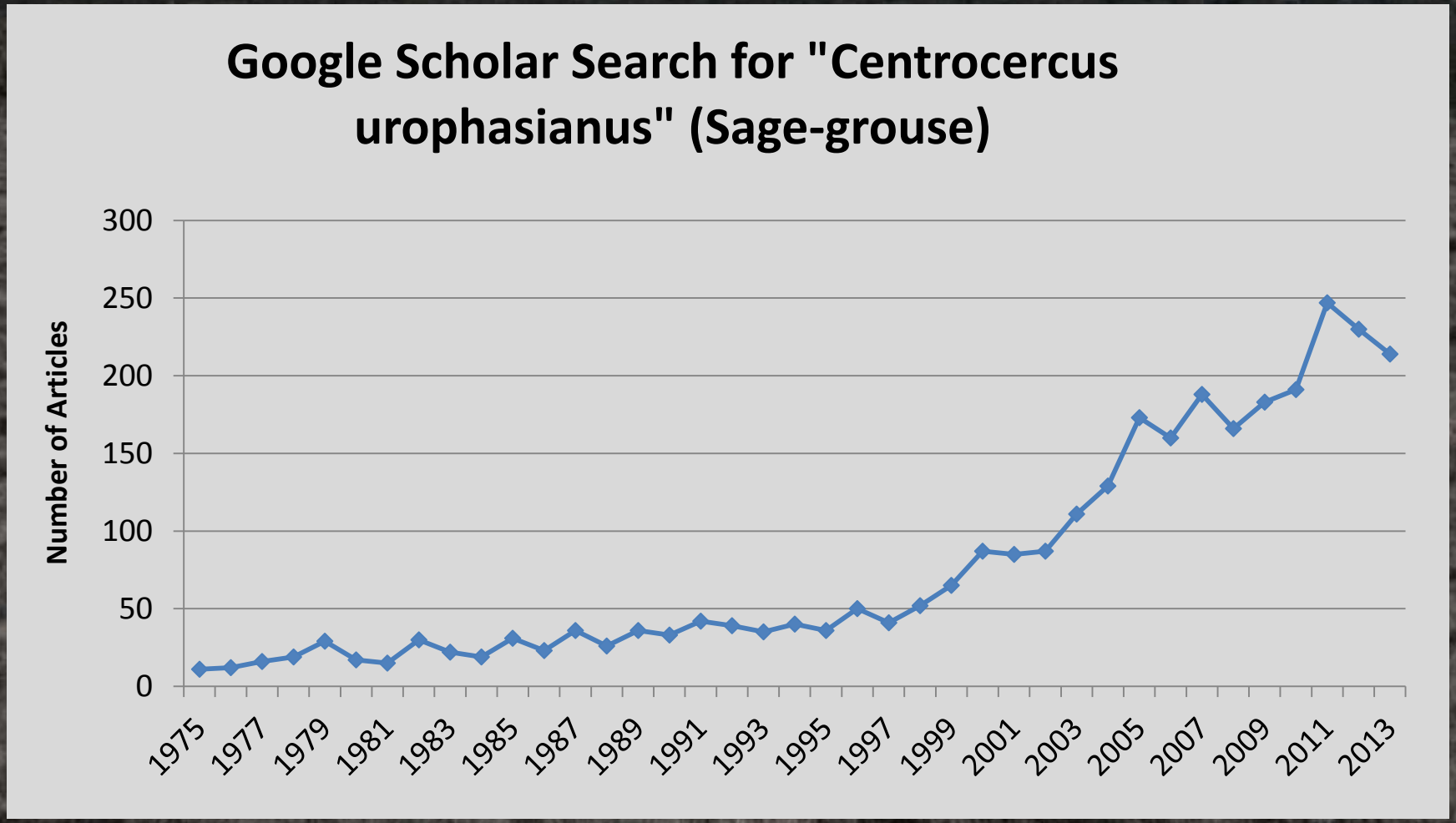
Research and Management Implications:

- Treatments are used by sage-grouse and increase habitat and usable space.
- Placement of treatments.
  - In proximity to occupied habitat
  - In areas with maximal mesic habitat
  - In areas with minimal surrounding PJ cover
- Did not document effect on population vital rates, only that sage-grouse are found in treatment areas.

Chapter 4

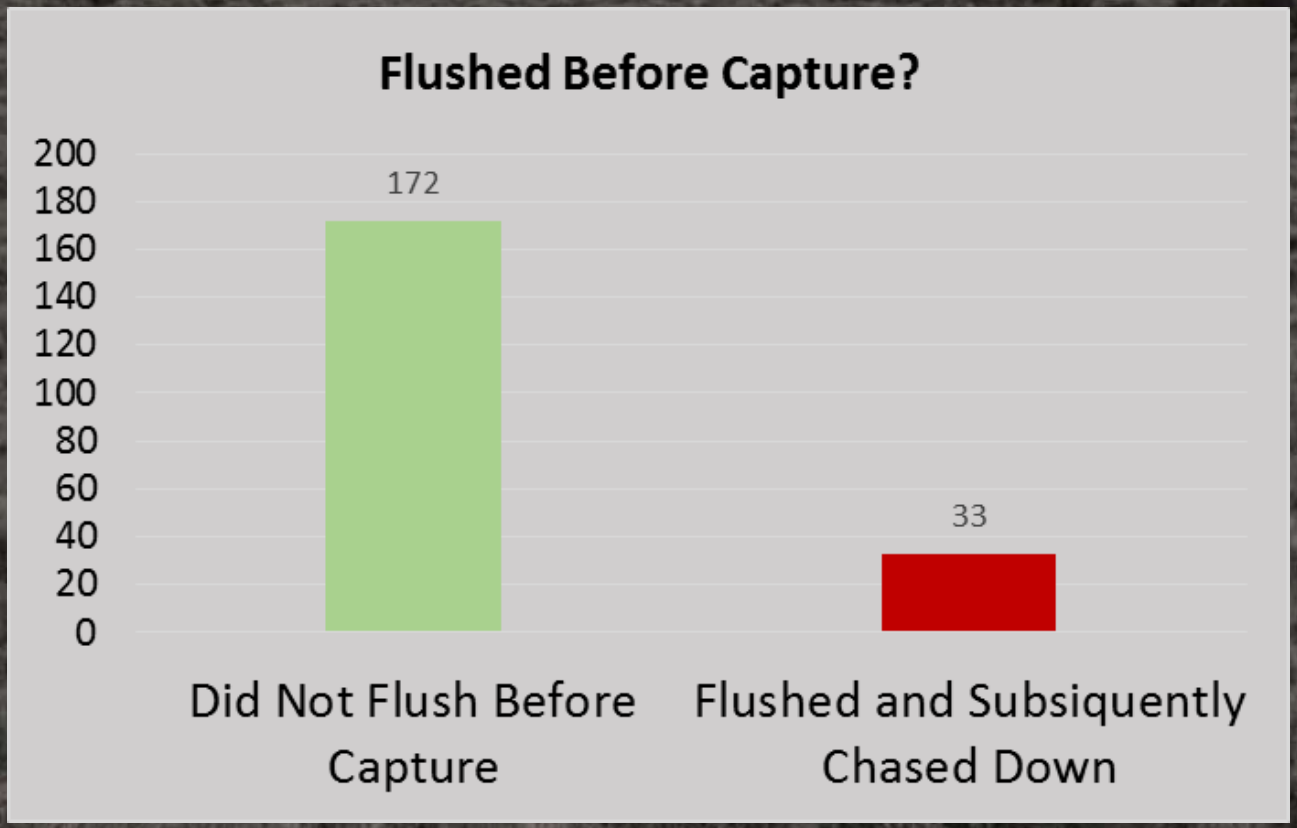
GREATER SAGE-GROUSE BEHAVIOR AND CONDITION DURING CAPTURE AND HANDLING RELATIVE TO SURVIVAL AND REPRODUCTIVE SUCCESS

We trap a lot of sage-grouse



But which birds do we catch…

- Generally, the ones that don't fly away.



Does our sample population accurately reflect the study population?

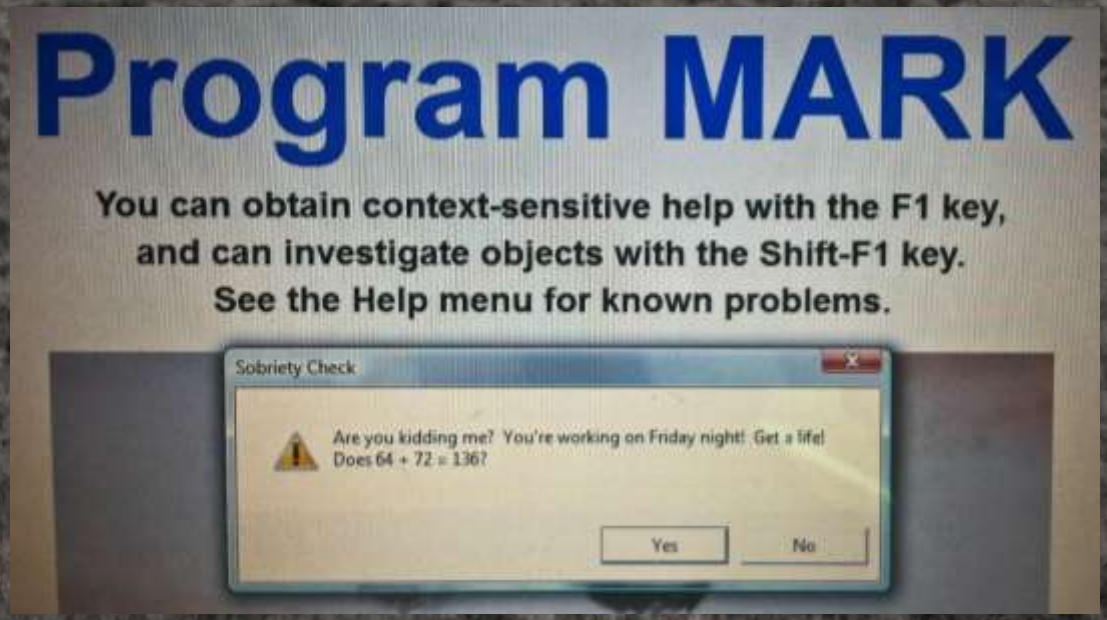
- Are the birds that flush before we reach them also better at surviving during other life stages?
- Do differences in capture and handling impact vital rates?
- If so is there a detectable difference in:
  - Nest Survival?
  - Brood Survival?
  - Annual Survival?

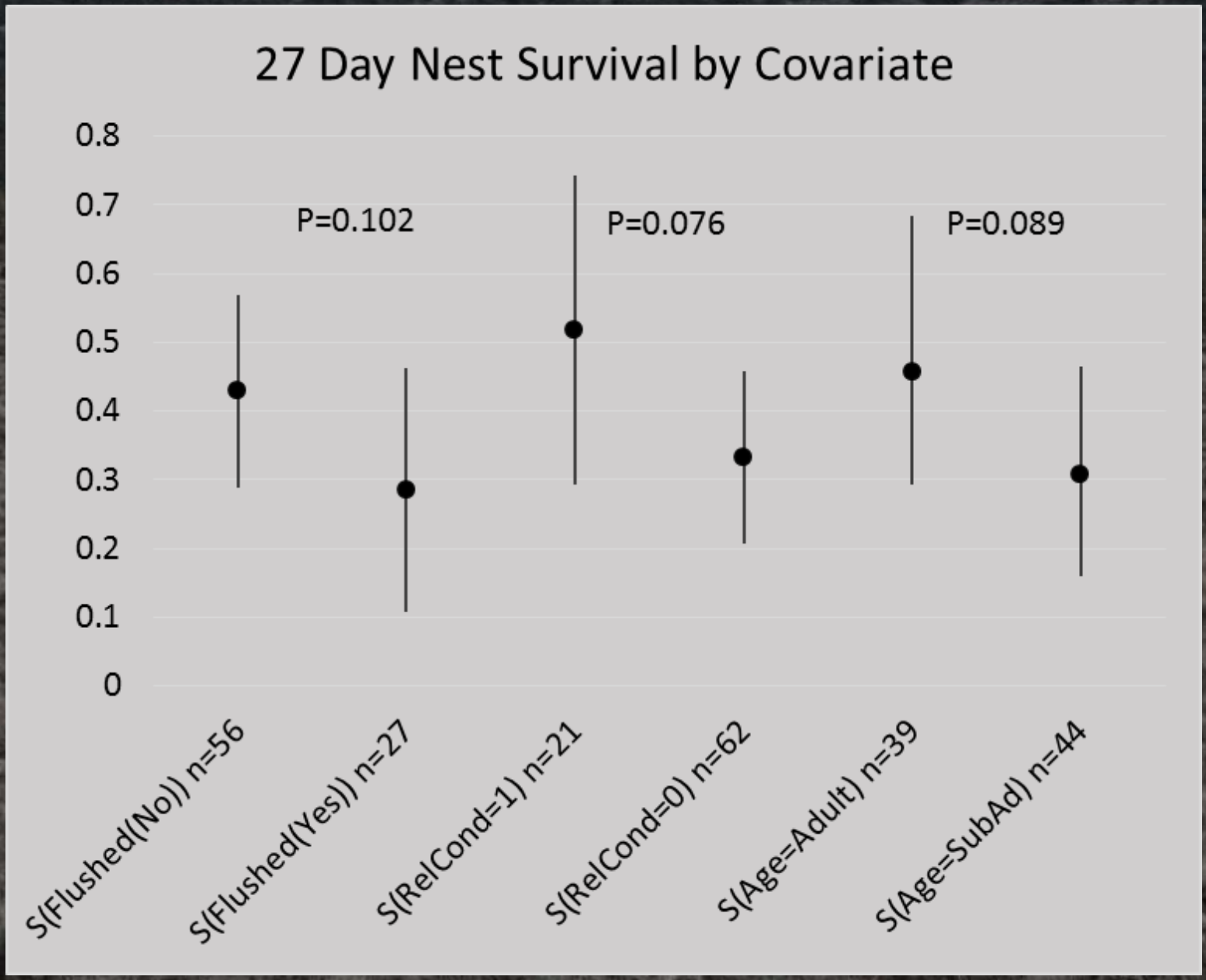
Methods:

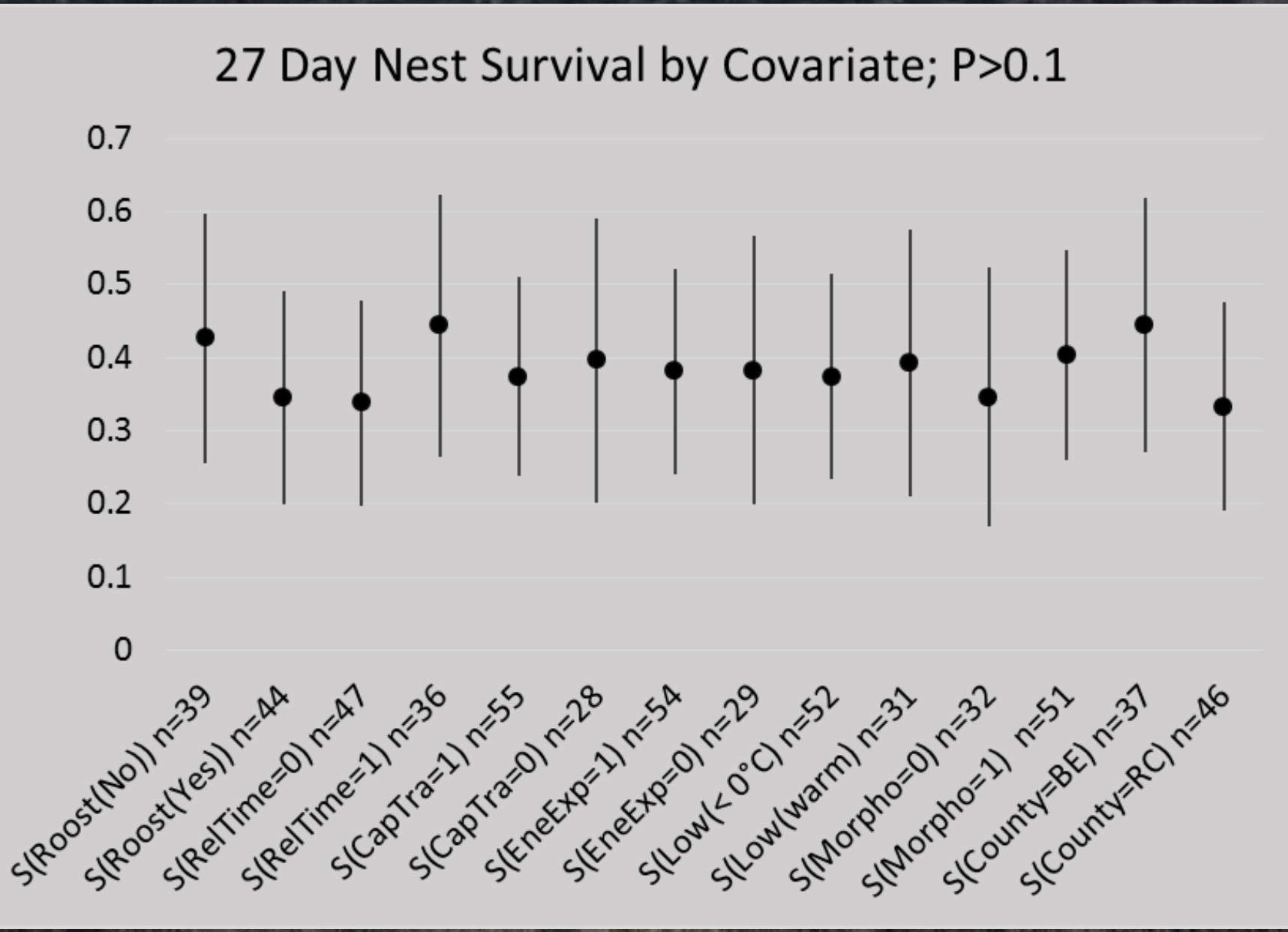
- Captured 205 sage-grouse on two study sites to equip birds with VHF radio collars
- Evaluated Each Capture for:
  - Previously Flushed (times flushed before capt
  - Capture Trauma (did we damage the bird)
  - Energy Expended (extreme struggle to totally calm)
  - Release Condition (signs of stress)
  - Handling Time
  - Roost Pile
  - 2 groups: Morphometrics Taken/ Not Taken (i.e. put in a weighing bag, etc.)
  - Netter/Processer

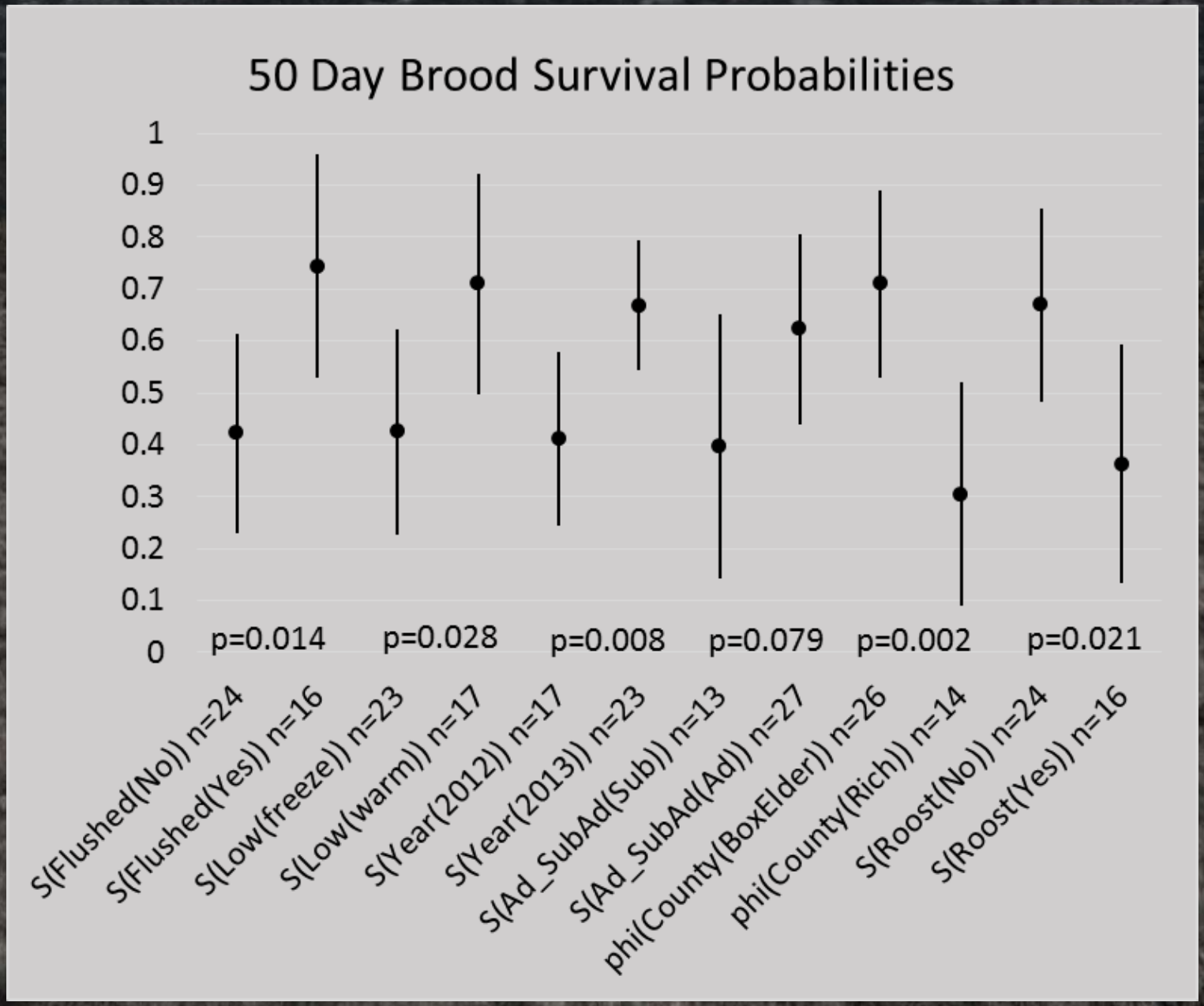
Methods:

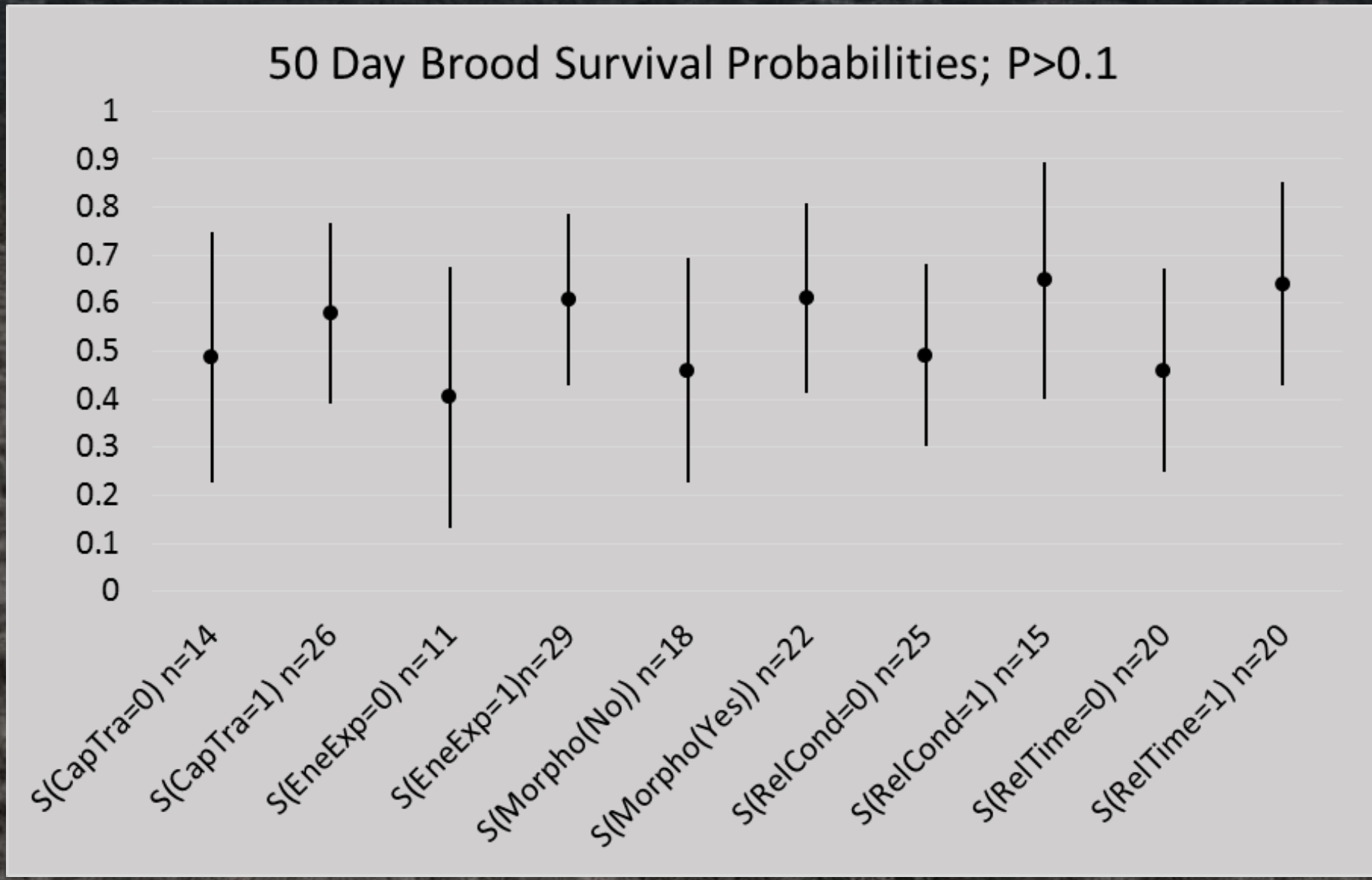
- Monitored grouse for 2 years
- Modeled vital rates in Program MARK
  - Nest models for nest and brood survival
    - 27 day, 35 day nest survival
    - 50 day brood survival
  - Known fate model for annual survival

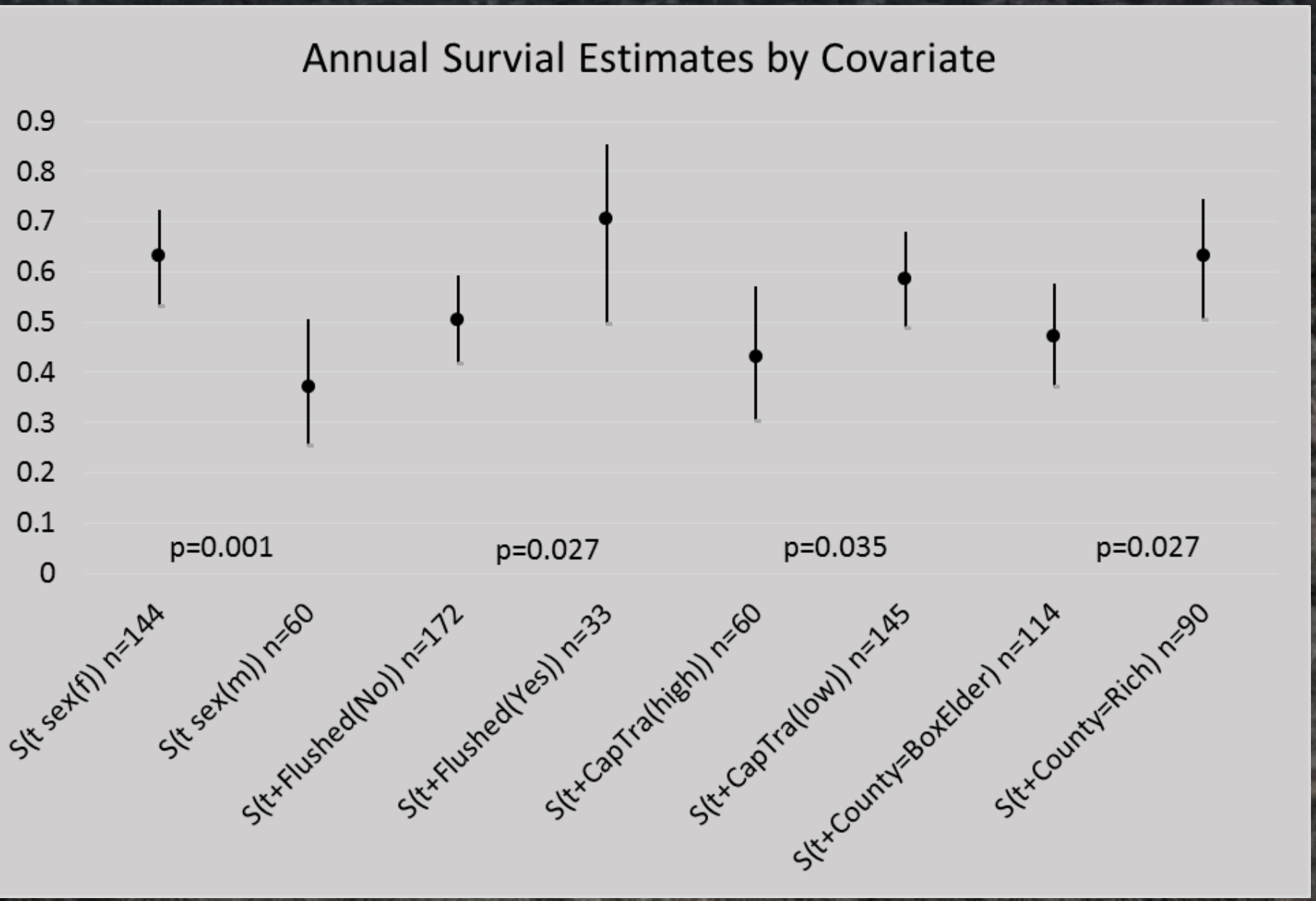


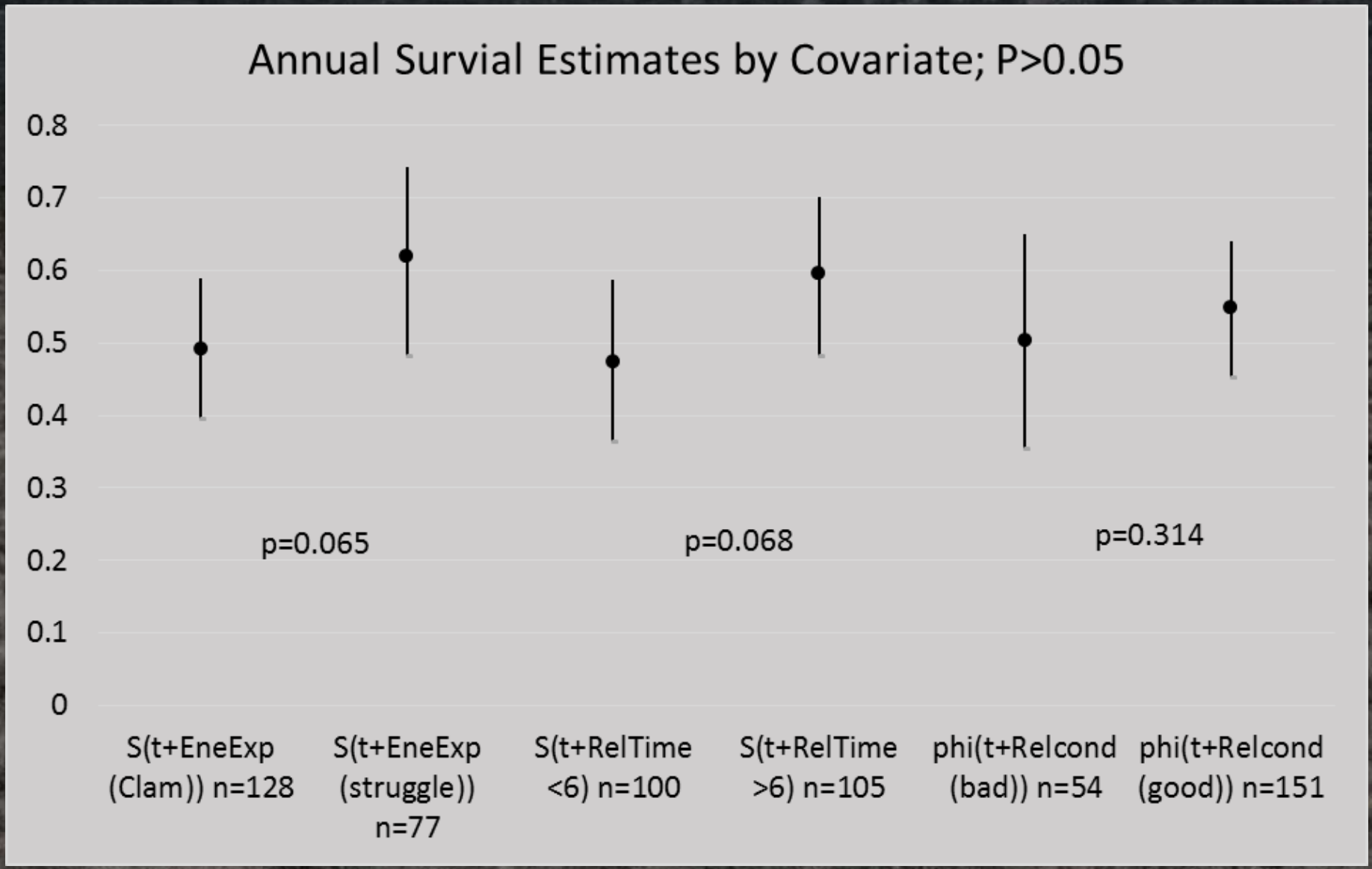

27 Day Nest Survival by Covariate
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
P=0.102
P=0.076
P=0.089
S(Flushed(No)) n=56
S(Flushed(Yes)) n=27
S(RelCond=1) n=21
S(RelCond=0) n=62
S(Age=Adult) n=39
S(Age=SubAd) n=44


27 Day Nest Survival by Covariate; P>0.1
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
S(Roost(No)) n=39
S(Roost(Yes)) n=44
S(RelTime=0) n=47
S(RelTime=1) n=36
S(CapTra=1) n=55
S(CapTra=0) n=28
S(EneExp=1) n=54
S(EneExp=0) n=29
S(Low(< 0°C) n=52
S(Low(warm) n=31
S(Morpho=0) n=32
S(Morpho=1) n=51
S(County=BE) n=37
S(County=RC) n=46


50 Day Brood Survival Probabilities
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
p=0.014
p=0.028
p=0.008
p=0.079
p=0.002
p=0.021
S(Flushed(No)) n=24
S(Flushed(Yes)) n=16
S(Low(freeze)) n=23
S(Low(warm)) n=17
S(Year(2012)) n=17
S(Year(2013)) n=23
S(Ad_SubAd(Sub)) n=13
S(Ad_SubAd(Ad)) n=27
phi(County(BoxElder)) n=26
phi(County(Rich)) n=14
S(Roost(No)) n=24
S(Roost(Yes)) n=16


50 Day Brood Survival Probabilities; P>0.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
S(CapTra=0) n=14
S(CapTra=1) n=26
S(EneExp=0) n=11
S(EneExp=1)n=29
S(Morpho(No)) n=18
S(Morpho(Yes)) n=22
S(RelCond=0) n=25
S(RelCond=1) n=15
S(RelTime=0) n=20
S(RelTime=1) n=20


Annual Survial Estimates by Covariate
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
p=0.001
p=0.027
p=0.035
p=0.027
S(t sex(f)) n=144
S(t sex(m)) n=60
S(t+Flushed(No)) n=172
S(t+Flushed(Yes)) n=33
S(t+CapTra(high)) n=60
S(t+CapTra(low)) n=145
S(t+County=BoxElder) n=114
S(t+County=Rich) n=90


Annual Survial Estimates by Covariate; P>0.05
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
p=0.065
p=0.068
p=0.314
S(t+EneExp (Clam)) n=128
S(t+EneExp (struggle)) n=77
S(t+RelTime <6) n=100
S(t+RelTime >6) n=105
phi(t+Relcond (bad)) n=54
phi(t+Relcond (good)) n=151

Summary

- Little difference seen in nest survival
- Birds that are more jumpy:
  - Have higher annual survival
  - Have higher brood survival
- Physical trauma during capture has the potential to impact long term survival
- Males have lower annual survival relative to females
- There is considerable variation in survival and reproductive success between study sites

Research and Management Implications

- We may have biased survival rates for SAGR as a result of capturing a population that is not representative of the study population.
  - But it would bias survival low
  - Should be considered when designing studies and reporting vital rates
- Does it matter?
  - Still have a downward population trend, and lek counts are used for population trend data
  - Habitat is still limiting
  - We can still compare areas, all likely have the same bias
- Increased handling time is likely not a significant factor in survival issues related some marking techniques.

Conclusions

- PJ Reduction is a valid strategy for increasing habitat quantity/ usable space available to SAGR.
- Placement of PJ reduction projects impacts SAGR use of projects.
- SAGR behavior that is correlated with survival and reproductive success may also impact capture success leading to biased study populations.
- Impact of localized vegetation change is difficult to detect over large spatial and temporal scales.

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- Fellow Grad students within the Messmer lab.
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