

How can breeding stage-specific estimates of home range size of female Lesser Prairie-Chickens aid conservation efforts?

Bram H.F. Verheijen¹, Chris K.J. Gulick¹, John D. Kraft¹, Jonathan D. Lautenbach¹, Joseph M. Lautenbach¹, Reid T. Plumb¹, Samantha G. Robinson¹, Daniel S. Sullins¹, and David A. Haukos^{1,2}

¹ Kansas Cooperative Fish and Wildlife Research Unit, Kansas State University, ² U.S. Geological Survey



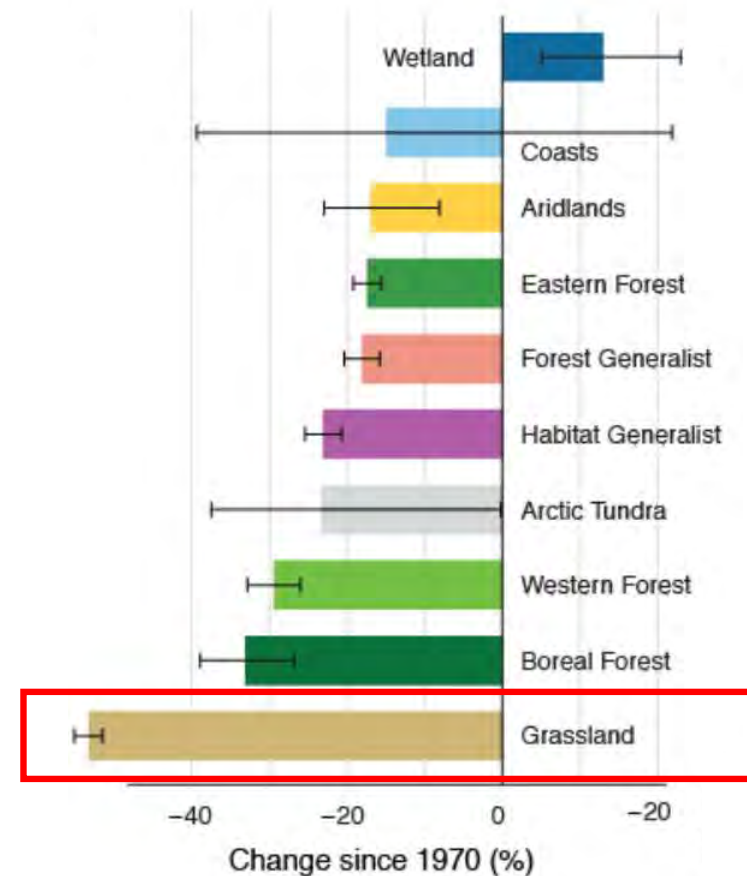
Large-scale Declines in Grassland Ecosystems!

- Grassland ecosystems in the US have seen large-scale declines since European settlement.
- Land-use change and agricultural intensification have led to **habitat loss** and **fragmentation** for many wildlife species.



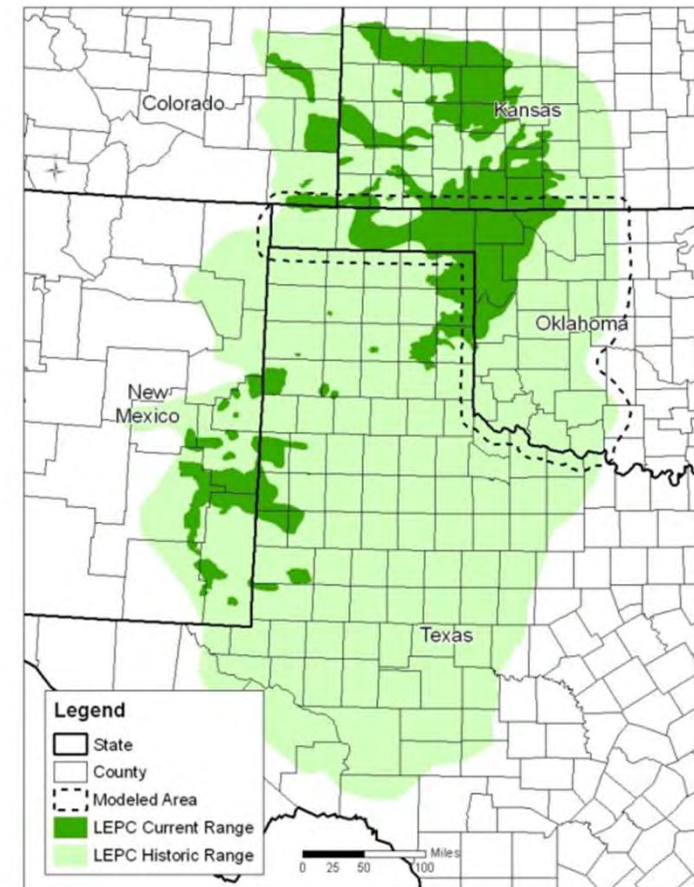
Large-scale Declines in Grassland Ecosystems!

- Grassland ecosystems in the US have seen large-scale declines since European settlement.
- Land-use change and agricultural intensification have led to habitat loss and fragmentation for many wildlife species.
- **Rosenberg et al. (2019)**
- ~ 3 billion birds were lost since 1970 in US and Canada
- Grassland birds have seen the largest declines (53%)



Lesser Prairie-Chickens (*Tympanuchus pallidicinctus*)

- Lesser Prairie-Chickens have been especially affected by habitat loss and fragmentation.
- Range and population numbers have declined by ~90%.
- In recent years: Have been listed, were delisted, but are still of conservation concern!



Management of Lesser Prairie-Chickens is Complex

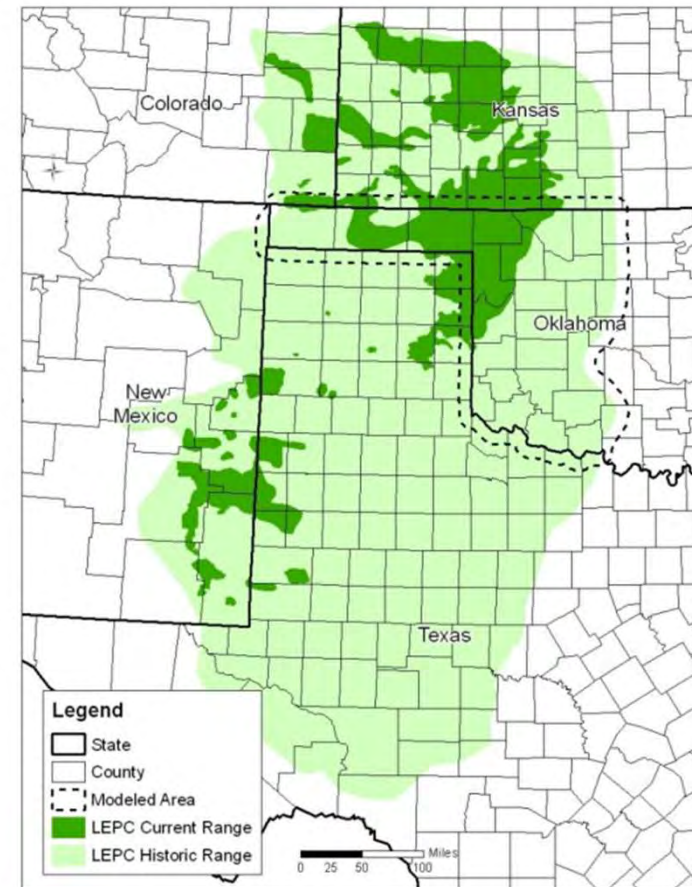
- Habitat needs vary greatly among the lekking, nesting, brooding, and post-breeding stages of the breeding season.
- Movements and space use of females during these stages remain relatively unclear.



Breeding stage-specific estimates of home range size could help managers to determine the minimum patch size and spatial distribution of breeding habitat on the landscape.

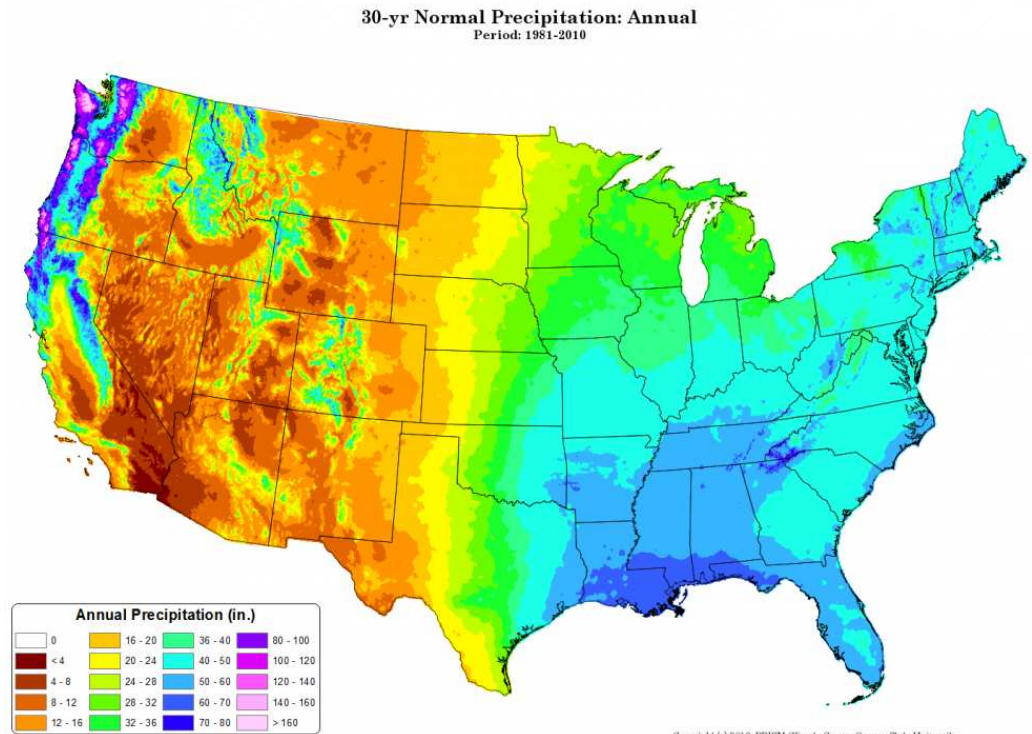
Management of Lesser Prairie-Chickens is Complex

- Moreover, the degree of fragmentation of remaining tracts of native grasslands varies throughout the LEPC range.
- Landscape fragmentation could force females to increase their movements and space use.



Management of Lesser Prairie-Chickens is Complex

- Similarly, grassland landscapes experience large spatiotemporal variation in annual precipitation and temperatures.
- Drought conditions could increase home range sizes by decreasing habitat quality.
- Or, drought conditions could restrict the amount of habitat available on the landscape, thereby restricting home range sizes of Lesser Prairie-Chickens.



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Research Questions

- 1) What is the home range size of female Lesser Prairie-Chickens during the breeding season?
- 2) Does home range size vary among the lekking, nesting, brooding, and post-breeding stages?
- 3) Does home range size vary with local extent of habitat fragmentation?
- 4) Does home range size vary with annual precipitation?

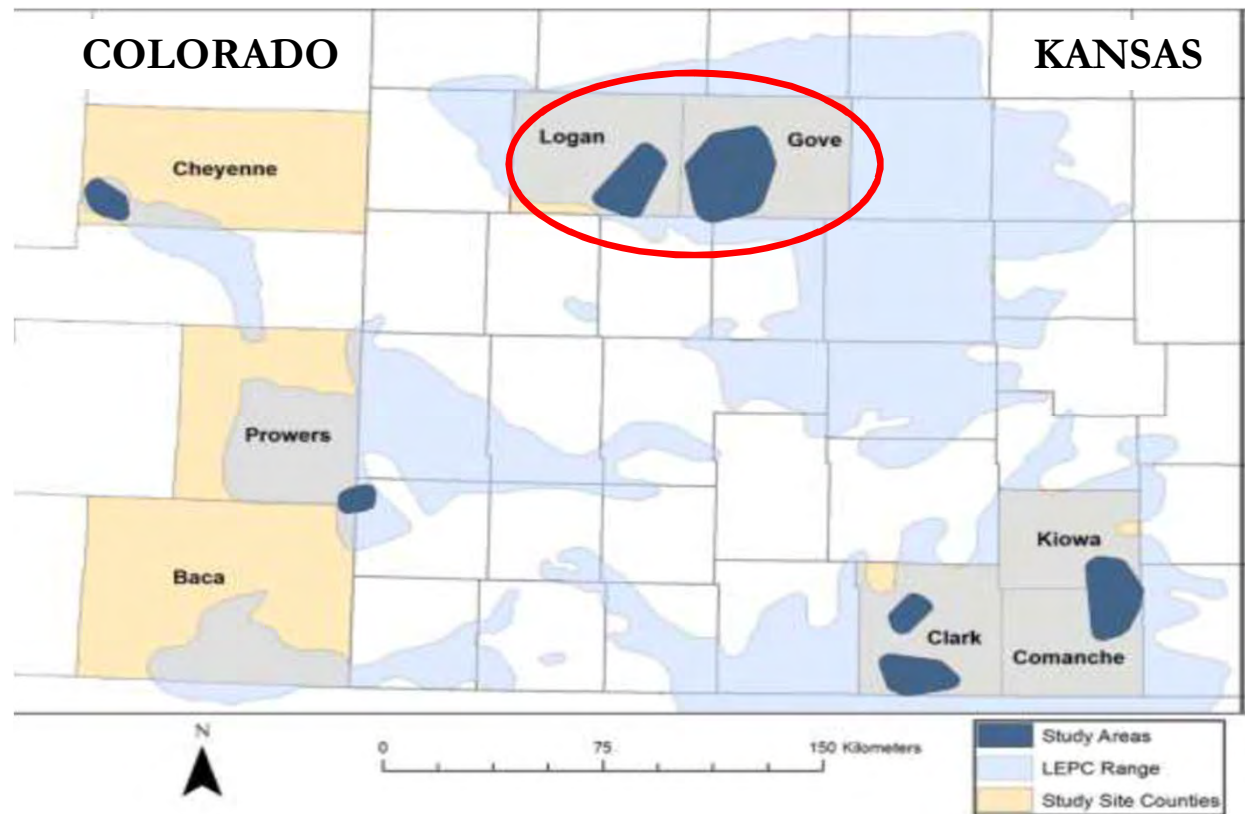


Trapping Female Lesser Prairie-Chickens at 4 Sites

- 4 sites in KS and CO, representing 3 of the 4 occupied ecoregions.

Northwest (2013 – 2015)

- Short-grass Prairie/CRP Mosaic
- Relatively fragmented landscape
- ~54% grassland (>60% with CRP)



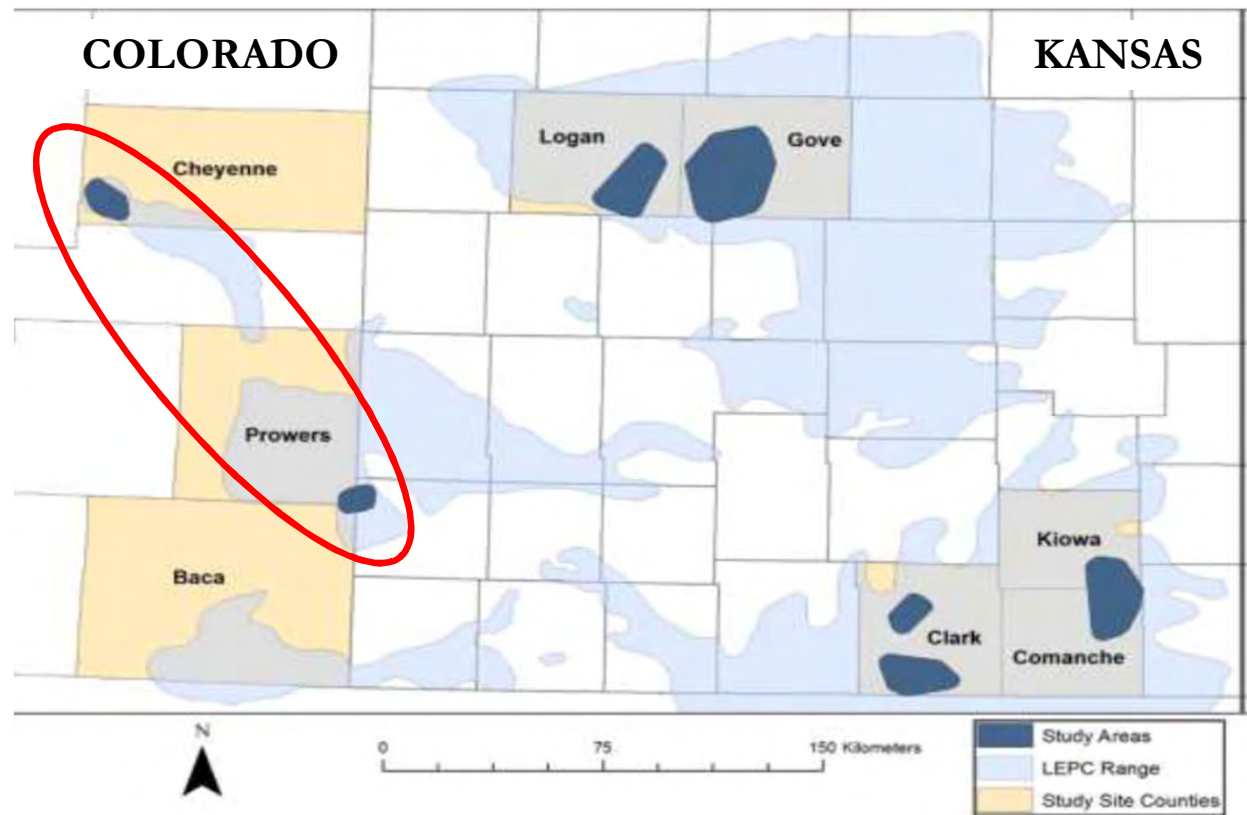
JWM: Robinson et al. (2018)

Trapping Female Lesser Prairie-Chickens at 4 Sites

- 4 sites in KS and CO, representing 3 of the 4 occupied ecoregions.

Colorado (2013 – 2015)

- Sand Sagebrush Prairie
- Fragmentation comparable to Northwest site.
- Lowest annual precipitation



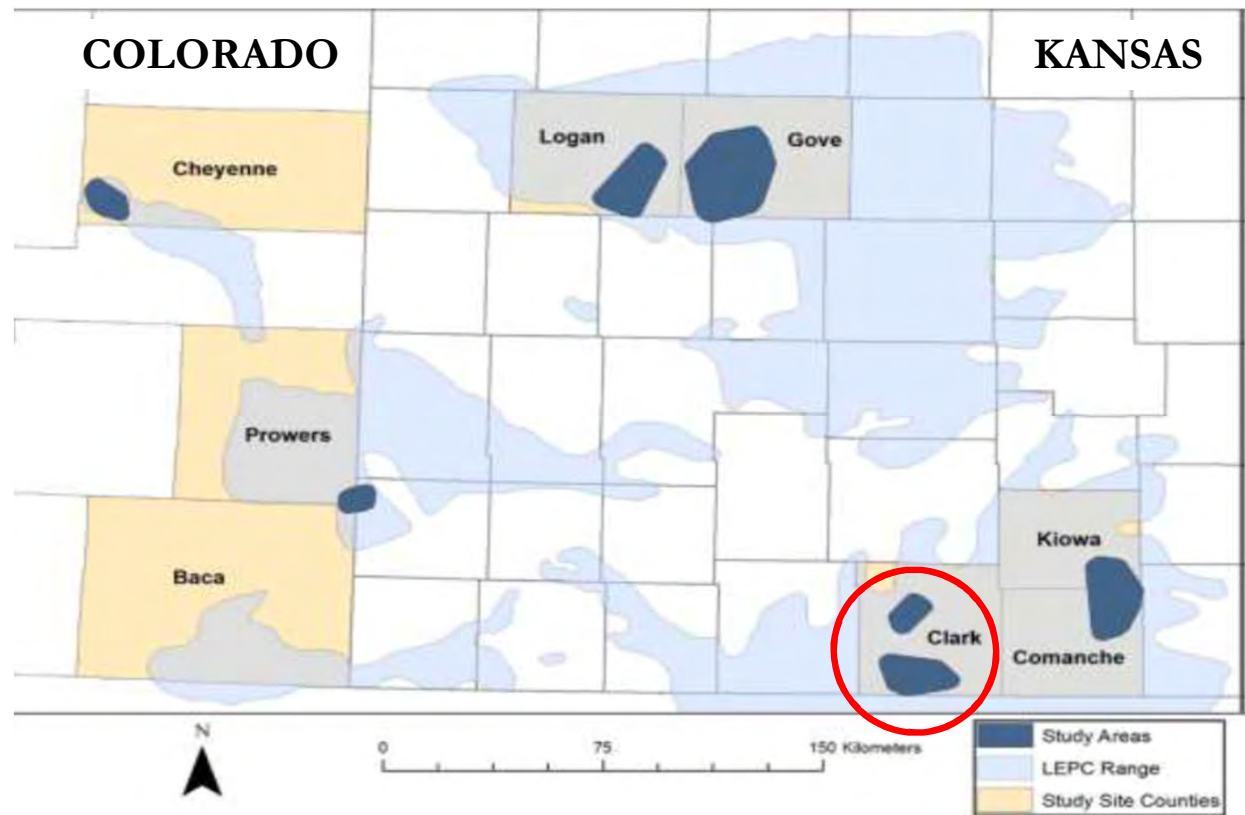
JWM: Robinson et al. (2018)

Trapping Female Lesser Prairie-Chickens at 4 Sites

- 4 sites in KS and CO, representing 3 of the 4 occupied ecoregions.

Ashland/Clark (2013 – 2015)

- Mixed-grass Prairie
- Less fragmented than Northwest and Colorado sites
- ~ 77% grassland



JWM: Robinson et al. (2018)

Trapping Female Lesser Prairie-Chickens at 4 Sites

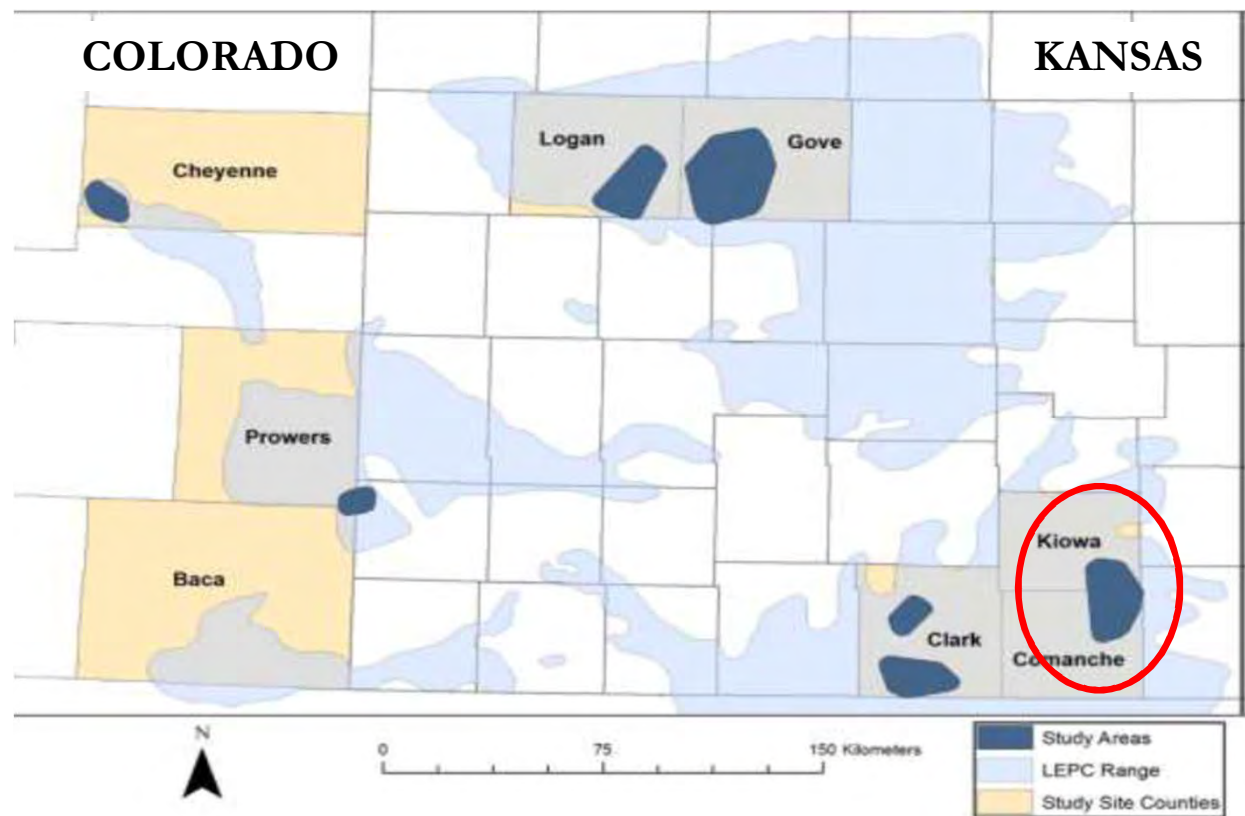
- 4 sites in KS and CO, representing 3 of the 4 occupied ecoregions.

Red Hills (2013 – 2018)

- Mixed-grass Prairie
- Less fragmented than Northwest and Colorado sites
- ~ 87% grassland
- Highest annual precipitation

2013 drier than 2014 and 2015

JWM: Robinson et al. (2018)



Trapping Female Lesser Prairie-Chickens at 4 Sites



- We captured female Lesser Prairie-Chickens at leks using walk-in traps and drop nets.
- We then outfitted females with either a VHF or GPS satellite transmitter.



2-3 locations/week



8-10 locations/day

Separating Locations in Four Breeding Stages

- Limited locations to the breeding season:
March 15 – September 15
- Further split locations in four separate categories based on collected nesting data of individual hens



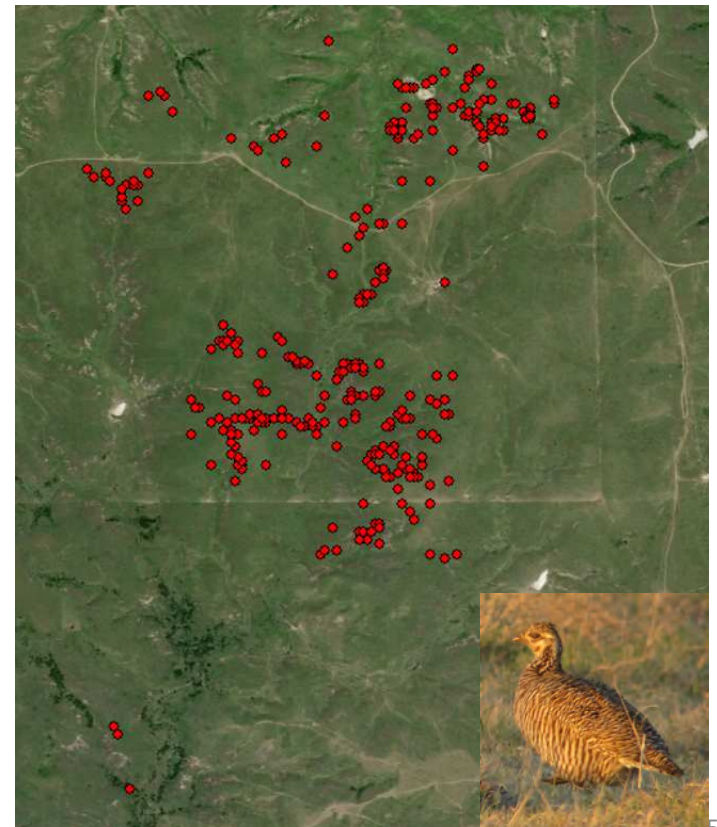
Estimating Home Range Sizes

VHF-birds

- Kernel Density Estimators
- ≥ 30 unique locations/bird \sim 10-week period

Satellite-birds

- Brownian Bridge Movement Models
- ≥ 100 unique locations/bird \sim 2-week period
- Visually determined location of initial HR (≥ 2 weeks without large movements).
- Removed large-dispersal movements (> 5 km from center).

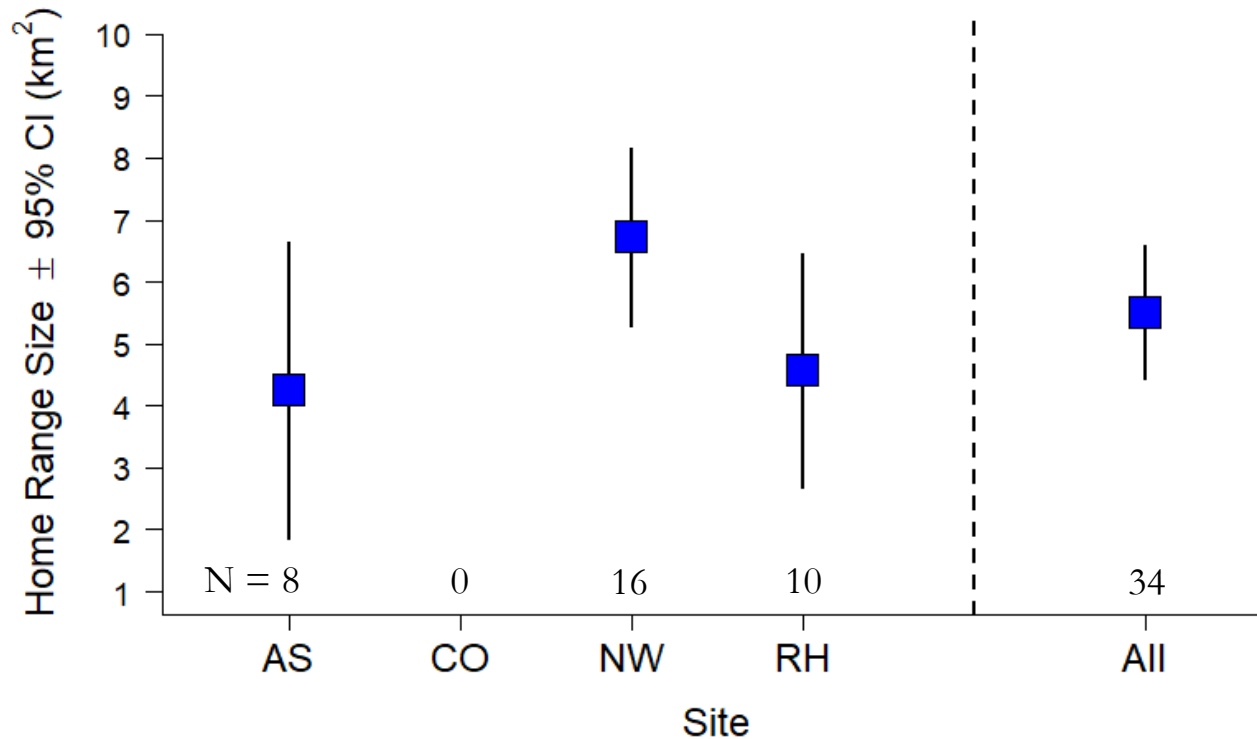


AND THIS IS WHAT WE FOUND...



VHF - Home Ranges Tend to be Largest at Northwest

VHF - Whole Breeding Season



- Mean home range size is: $5.51 \pm 0.55 \text{ km}^2$ ($551 \pm 55 \text{ ha}$)

- Tends to be largest at Northwest

- SDs are comparable among sites

Coefficient of Variation

- AS: 76.0%

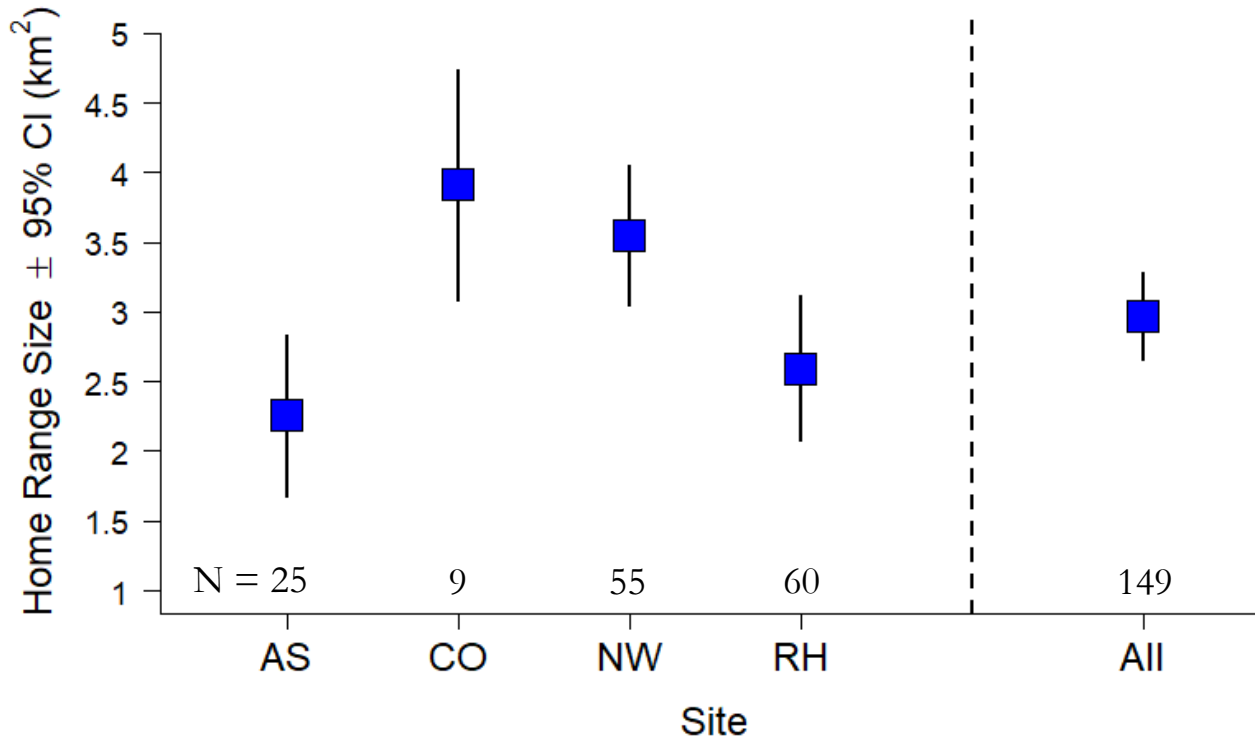
- NW: 42.3%

- RH: 66.5%

- **All: 58.4%**

GPS - Home Ranges are Largest at CO and NW Sites

GPS SAT - Whole Breeding Season



- Mean home range size is: $2.97 \pm 0.16 \text{ km}^2$ ($297 \pm 16 \text{ ha}$)

- Largest at CO and NW sites

- Most variable at NW and RH sites

Coefficient of Variation

- AS: 65.2%

- CO: 32.5%

- NW: 54.1%

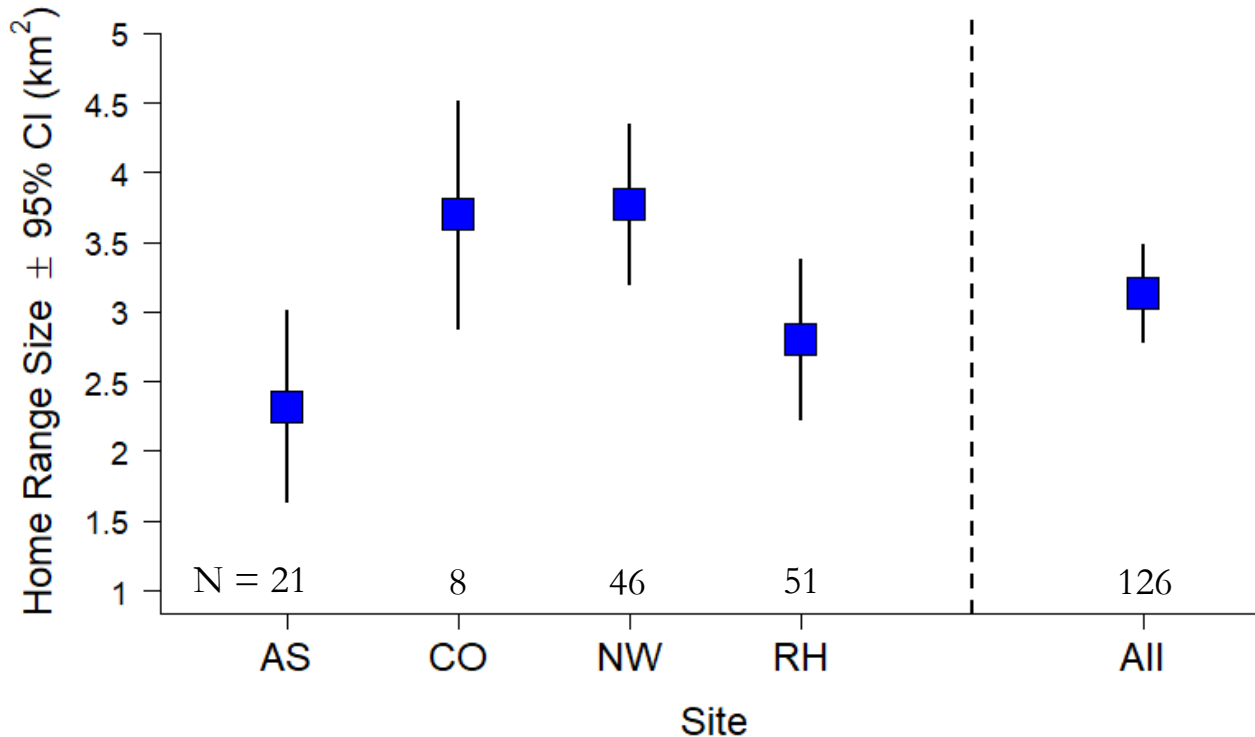
- RH: 78.9%

- **All: 65.4%**

Lekking – Similar to Whole Breeding Season



GPS SAT – Lekking Period



- Mean home range size is: $3.13 \pm 0.18 \text{ km}^2$ ($313 \pm 18 \text{ ha}$)
- HR sizes larger at NW vs. AS site
- Most variable at NW and RH sites

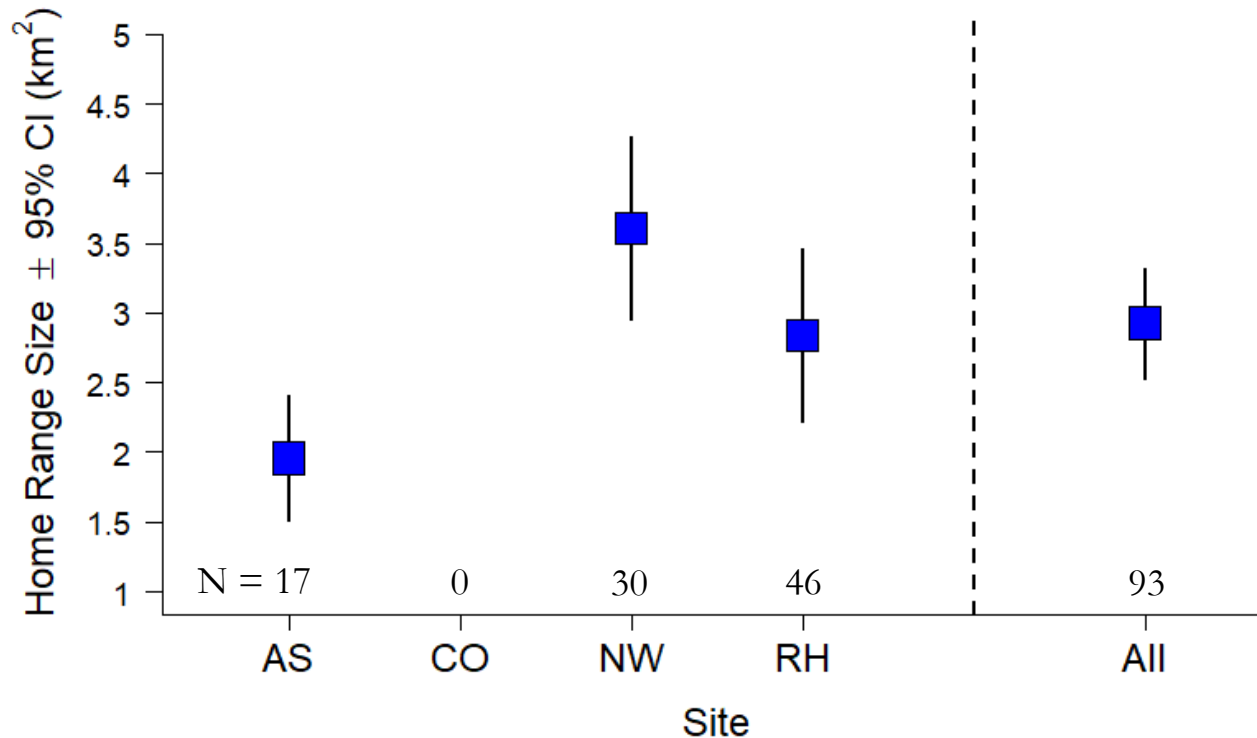
Coefficient of Variation

- AS: 68.6%
- CO: 31.9%
- NW: 52.8%
- RH: 75.2%
- **All: 63.9%**

Nesting – Similar to Whole Breeding Season



GPS SAT – Nesting Period



- Mean home range size is: $2.93 \pm 0.20 \text{ km}^2$ ($293 \pm 20 \text{ ha}$)
- HR sizes larger at NW vs. AS site
- Most variable at NW and RH sites

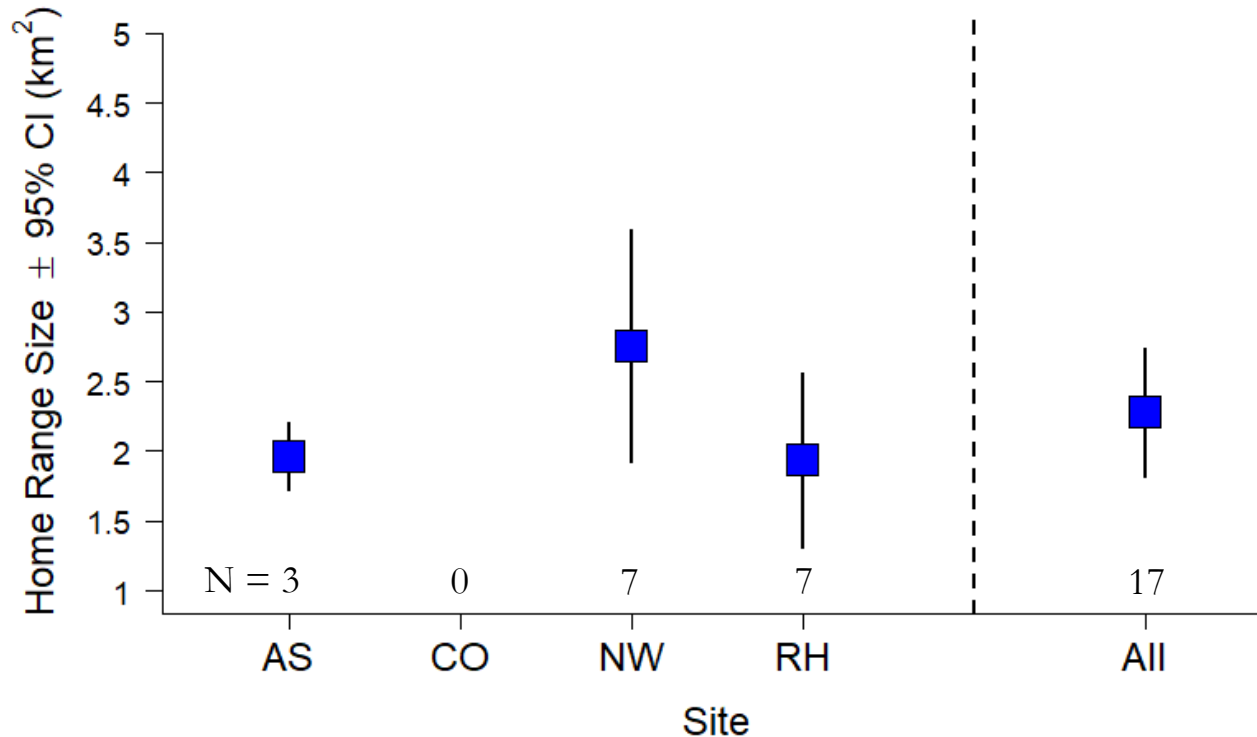
Coefficient of Variation

- AS: 48.6%
- NW: 50.6%
- RH: 75.7%
- **All: 66.6%**

Brooding – Smaller than Other Breeding Periods



GPS SAT – Brooding Period



- Mean home range size is: $2.28 \pm 0.23 \text{ km}^2$ ($228 \pm 23 \text{ ha}$)

- Low sample sizes

- Lower HR sizes than other breeding periods

- **Coefficient of Variation**

- AS: 11.0%

- NW: 41.0%

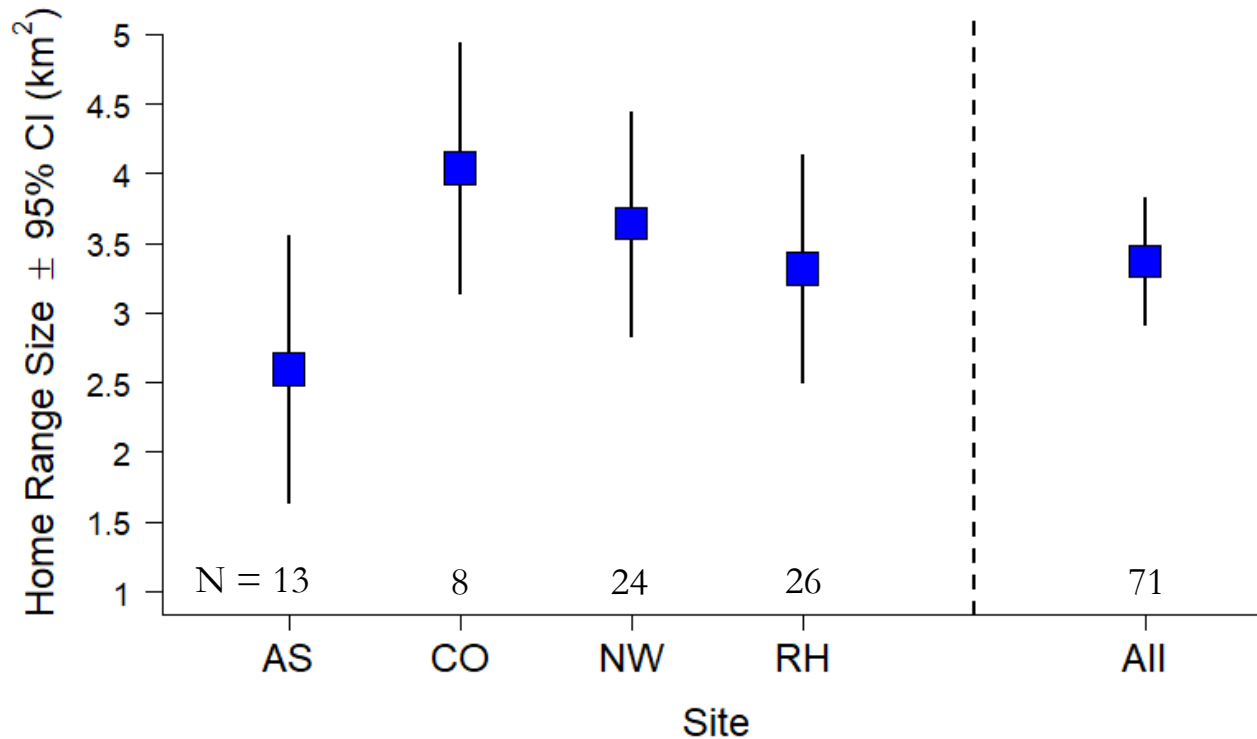
- RH: 43.9%

- **All: 42.2%**

Post-breeding – Similar to Whole Season



GPS SAT – Post-breeding Period



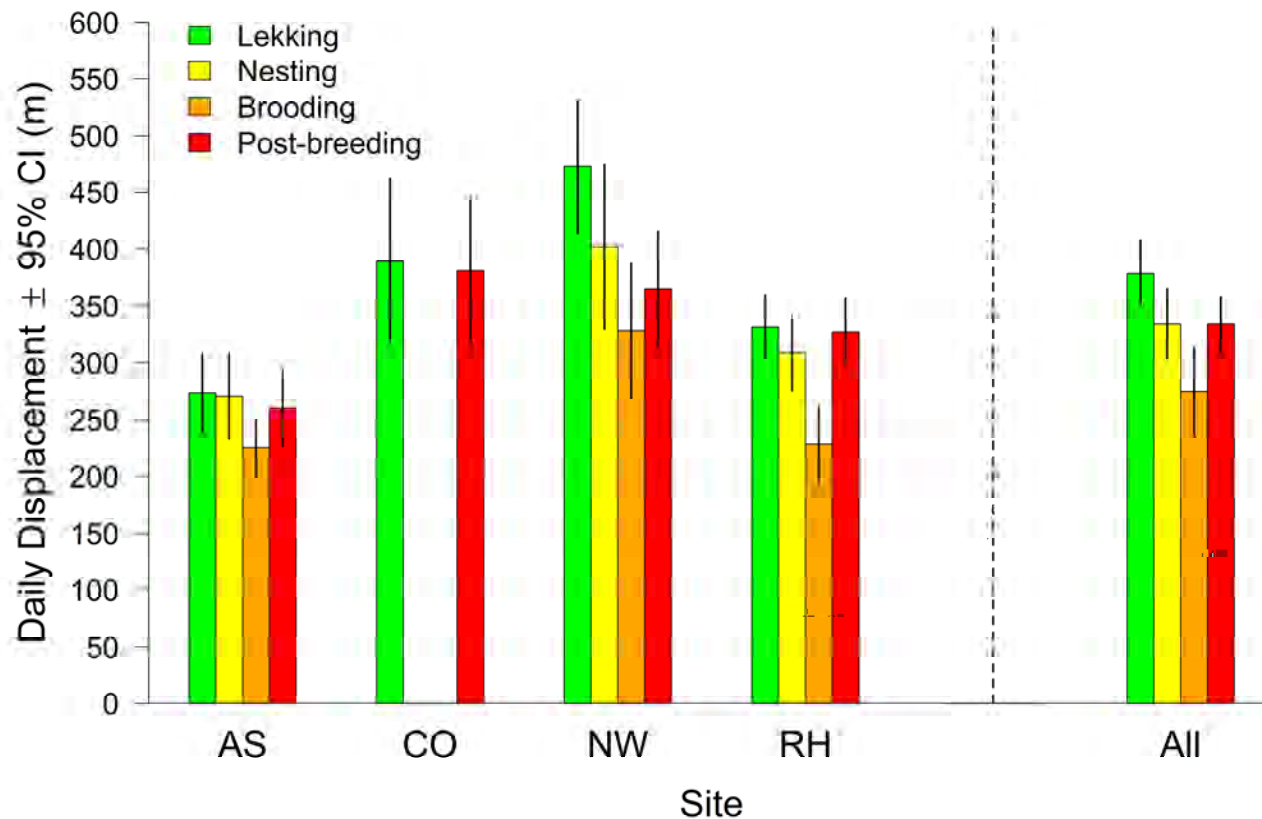
- Mean home range size is: $3.38 \pm 0.23 \text{ km}^2$ ($338 \pm 23 \text{ ha}$)

- Tend to be larger than other breeding periods
- Tend to be lowest at AS site.

- Coefficient of Variation

- AS: 68.2%
- CO: 31.3%
- NW: 55.3%
- RH: 64.0%
- **All: 58.0%**

Similar Patterns in Mean Daily Displacement



Mean daily displacement for whole breeding season

| | |
|-------------|----------------|
| Ashland: | 281.0 ± 16.0 m |
| Colorado: | 397.1 ± 33.4 m |
| North West: | 468.5 ± 29.4 m |
| Red Hills | 319.5 ± 13.8 m |
| All sites: | 374.8 ± 14.3 m |

- Largest and most variable at NW site
- Highest in lekking stage and NOT in post-breeding stage!

So, what did we find!?! ---



- HR sizes of VHF-birds were $\sim 2x$ larger than GPS-birds
 - However, KDE vs. BBMM, and lower number of points for VHF: 34 birds (≥ 30 pts) vs. 149 birds (≥ 100 pts).
- Larger variation in HR size among sites vs. years.
- 2013 – 2015: Site differences in HR size might differ among years, but sample sizes did not allow for a site/year interaction.
- HR sizes were (or tended to be) largest at our Northwest and Colorado sites during the lekking, nesting, brooding, and the entire breeding season.
- Mean Daily Displacement was (or tended to be) also largest at our Northwest and Colorado sites. However, were largest during lekking and NOT during post-breeding stage!

Home Range Size vs. Breeding Season Survival

- Landscapes in Colorado and Northwestern Kansas are more fragmented than at our other sites
- Also estimated female adult survival during the breeding season for the same sites/years

Female survival varied by study site:

- Highest at Ashland site in south-central Kansas: 0.63 ± 0.08 SE.
- Lowest at Northwest Kansas site: 0.41 ± 0.13 SE.
- Lowest survival at site where birds have largest home ranges.
- Could (the need for) increased space-use come at a cost?



Robinson et al. (In preparation)

Females Can't Move Far During Brooding

- HR sizes of VHF-birds were $\sim 2\times$ larger than GPS-birds
 - However, KDE vs. BBMM, and lower number of points for VHF: 34 birds (≥ 30 pts) vs. 149 birds (≥ 100 pts).
- Larger variation in HR size among sites vs. years.
- 2013 – 2015: Site differences in HR size might differ among years, but sample sizes did not allow for a site/year interaction.
- HR sizes were (or tended to be) largest at our Northwest and Colorado sites during the lekking, nesting, brooding, and the entire breeding season.
- HR sizes and daily displacement were smallest during the brooding period.
 - Sample size for brooding was 17 birds across all sites and years...



VHF-Home Ranges Smaller in Sand Shinnery Oak Prairie?

- Estimates of home range sizes from Sand Shinnery Oak Prairie in Texas and New Mexico:
 - **Whole Breeding Season**
 671 ± 538 SD ha (TX; N = 38)¹
 - **Pre-nesting/Lekking**
 231 ± 80 SE ha (NM; N = 23)²
 231 ± 41 SE ha (NM; N = 40)³
 - **Nesting**
 92 ± 18 SE ha (NM; N = 23)²
 92 ± 3 SE ha (NM; N = 12)³
 - **Brooding**
 119 ± 234 SE ha (NM; N = 3)³
 - **Post-nesting**
 119 ± 459 SE ha (NM; N = 23)²
 73 ± 15 SE ha (NM; N = 19)³
 - Animal movement more restricted in highly fragmented landscape?

¹ Borsdorf (2013), ² Candelaria (1979), ³ Riley et al. (1994)

LEPC Use More Space During Nonbreeding Season

- Estimates of home range size in nonbreeding seasons at same sites and years (GPS data):
 - **All sites: 997 ± 145 ha ($N = 72$)⁰**
 - Ashland: 1372 ± 210 SE ha ($N = 18$)⁰
 - Northwest: 757 ± 219 SE ha ($N = 30$)⁰
 - Red Hills: 1018 ± 295 SE ha ($N = 24$)⁰
- Home range sizes smallest in most fragmented NW site!
- **Estimates are variable in Sand Shinnery Oak Prairie in Texas and New Mexico:**
 - $282 - 761$ ha ($\pm 50 - 452$ SE; TX; $N = 12$)¹
 - 504 ± 35 SE ha (TX; $N = 5$)²



⁰ Robinson et al. 2018, ¹ Kukal (2010), ² Pirius (2011)

Management Implications

- Breeding stage-specific estimates of movements and space use of Lesser Prairie-Chickens could help managers to:
 - 1) Determine the spatial distribution of breeding habitat on the landscape.
 - 2) Estimate the minimum habitat patch sizes for specific breeding stages.
- Large variation among **sites and ecoregions**, and between **breeding and nonbreeding season** makes site-specific estimates of breeding season home range size necessary.

Maintaining large home range sizes in fragmented landscapes could potentially have **consequences for adult survival** of female Lesser Prairie-Chickens!



Acknowledgements



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- All Technicians

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- Jonathan Reitz
- Mindy Rice

Photo Credit

- Jonathan Lautenbach
- John Kraft
- Reid Plumb



Thank you for your attention!

Home Range Size – Result Tables



Results – VHF: Whole Breeding Season (34/37 shown)

| Site | 2013 | 2014 | 2015 | Total |
|------------|-------|-------|------|-------|
| Ashland | . | 3 | 5 | 8 |
| North West | 1 | 10 | 5 | 16 |
| Red Hills | 5 (6) | 5 (7) | . | 10 |
| Total | 6 | 18 | 10 | 34 |

| Site | 2013 | 2014 | 2015 | Overall |
|------------|-------------------|-------------------|-------------------|-------------------|
| Ashland | . | 2.704 ± 0.762 | 5.188 ± 1.636 | 4.257 ± 1.143 |
| North West | 9.154 ± 0 | 6.274 ± 0.915 | 7.150 ± 1.217 | 6.728 ± 0.711 |
| Red Hills | 5.408 ± 1.619 | 3.743 ± 1.097 | . | 4.576 ± 0.963 |
| Overall | 6.033 ± 1.462 | 4.976 ± 0.707 | 6.169 ± 1.123 | 5.513 ± 0.552 |

Results – GPS: Whole Breeding Season – 149/157 shown

| Site | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Total |
|------------|------|------|------|------|------|------|-------|
| Ashland | 0 | 16 | 9 | 0 | 0 | 0 | 25 |
| Colorado | 5 | 1 | 3 | 0 | 0 | 0 | 9 |
| North West | 28 | 19 | 8 | 0 | 0 | 0 | 55 |
| Red Hills | 12 | 12 | 10 | 14 | 8 | 4 | 60 |
| Total | 45 | 48 | 30 | 14 | 8 | 4 | 149 |

| Site | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Overall |
|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Ashland | . | 2.50 ± 0.41 | 1.82 ± 0.35 | . | . | . | 2.26 ± 0.29 |
| Colorado | 3.86 ± 0.32 | 1.42 | 4.83 ± 0.59 | . | . | . | 3.91 ± 0.42 |
| North West | 3.63 ± 0.33 | 2.79 ± 0.33 | 5.08 ± 0.95 | . | . | . | 3.55 ± 0.26 |
| Red Hills | 2.56 ± 0.48 | 3.94 ± 0.85 | 2.07 ± 0.34 | 2.31 ± 0.57 | 2.31 ± 0.60 | 1.55 ± 0.32 | 2.59 ± 0.26 |
| Overall | 3.37 ± 0.25 | 2.95 ± 0.29 | 3.07 ± 0.40 | 2.31 ± 0.57 | 2.31 ± 0.60 | 1.55 ± 0.32 | 2.97 ± 0.16 |

Results – GPS: Lekking period – 126/133 shown

| Site | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Total |
|--------------|-----------|-----------|-----------|-----------|----------|----------|------------|
| Ashland | 0 | 13 | 8 | 0 | 0 | 0 | 21 |
| Colorado | 5 | 1 | 2 | 0 | 0 | 0 | 8 |
| North West | 25 | 13 | 8 | 0 | 0 | 0 | 46 |
| Red Hills | 12 | 11 | 5 | 13 | 6 | 4 | 51 |
| Total | 42 | 38 | 23 | 13 | 6 | 4 | 126 |

| Site | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Overall |
|----------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| Ashland | . | 2.60 ± 0.50 | 1.88 ± 0.40 | . | . | . | 2.32 ± 0.35 |
| Colorado | 3.86 ± 0.32 | 1.42 | 4.45 ± 0.77 | . | . | . | 3.70 ± 0.42 |
| North West | 3.71 ± 0.35 | 3.08 ± 0.44 | 5.08 ± 0.95 | . | . | . | 3.77 ± 0.29 |
| Red Hills | 2.56 ± 0.48 | 4.25 ± 0.87 | 2.21 ± 0.40 | 2.41 ± 0.60 | 2.82 ± 0.67 | 1.55 ± 0.32 | 2.80 ± 0.30 |
| Overall | 3.40 ± 0.27 | 3.21 ± 0.35 | 3.29 ± 0.47 | 2.41 ± 0.60 | 2.82 ± 0.67 | 1.55 ± 0.32 | 3.13 ± 0.18 |

Results – GPS: Nesting period – 93/98 shown

| Site | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Total |
|------------|------|------|------|------|------|------|-------|
| Ashland | 0 | 9 | 8 | 0 | 0 | 0 | 17 |
| Colorado | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| North West | 13 | 11 | 6 | 0 | 0 | 0 | 30 |
| Red Hills | 10 | 12 | 7 | 8 | 6 | 3 | 46 |
| Total | 23 | 32 | 21 | 8 | 6 | 3 | 93 |

| Site | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Overall |
|------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Ashland | . | 2.04 ± 0.28 | 1.87 ± 0.40 | . | . | . | 1.96 ± 0.23 |
| Colorado | . | . | . | . | . | . | . |
| North West | 3.30 ± 0.30 | 2.95 ± 0.40 | 5.49 ± 1.12 | . | . | . | 3.61 ± 0.33 |
| Red Hills | 2.77 ± 0.55 | 3.94 ± 0.85 | 2.33 ± 0.45 | 2.35 ± 0.79 | 2.73 ± 0.72 | 1.43 ± 0.43 | 2.84 ± 0.32 |
| Overall | 3.07 ± 0.29 | 3.06 ± 0.37 | 3.06 ± 0.50 | 2.35 ± 0.79 | 2.73 ± 0.72 | 1.43 ± 0.43 | 2.93 ± 0.20 |

Results – GPS: Brooding period – 17/19 shown

| Site | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Total |
|------------|------|------|------|------|------|------|-------|
| Ashland | 0 | 2 | 1 | 0 | 0 | 0 | 3 |
| Colorado | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| North West | 1 | 6 | 0 | 0 | 0 | 0 | 7 |
| Red Hills | 2 | 1 | 3 | 1 | 0 | 0 | 7 |
| Total | 3 | 9 | 4 | 1 | 0 | 0 | 17 |

| Site | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Overall |
|------------|-----------------|-----------------|-----------------|------|------|------|-----------------|
| Ashland | . | 1.92 ± 0.20 | 2.05 | . | . | . | 1.97 ± 0.12 |
| Colorado | . | . | . | . | . | . | . |
| North West | 1.81 | 2.91 ± 0.47 | . | . | . | . | 2.76 ± 0.43 |
| Red Hills | 2.38 ± 0.07 | 2.31 | 1.78 ± 0.72 | 1.14 | . | . | 1.94 ± 0.32 |
| Overall | 2.19 ± 0.19 | 2.63 ± 0.34 | 1.85 ± 0.51 | 1.14 | . | . | 2.28 ± 0.23 |

Results – GPS: Postbreeding period – 71/74 shown

| Site | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Total |
|--------------|-----------|-----------|-----------|----------|----------|----------|-----------|
| Ashland | 0 | 10 | 3 | 0 | 0 | 0 | 13 |
| Colorado | 4 | 1 | 3 | 0 | 0 | 0 | 8 |
| North West | 12 | 7 | 5 | 0 | 0 | 0 | 24 |
| Red Hills | 5 | 4 | 5 | 6 | 4 | 2 | 26 |
| Total | 21 | 22 | 16 | 6 | 4 | 2 | 71 |

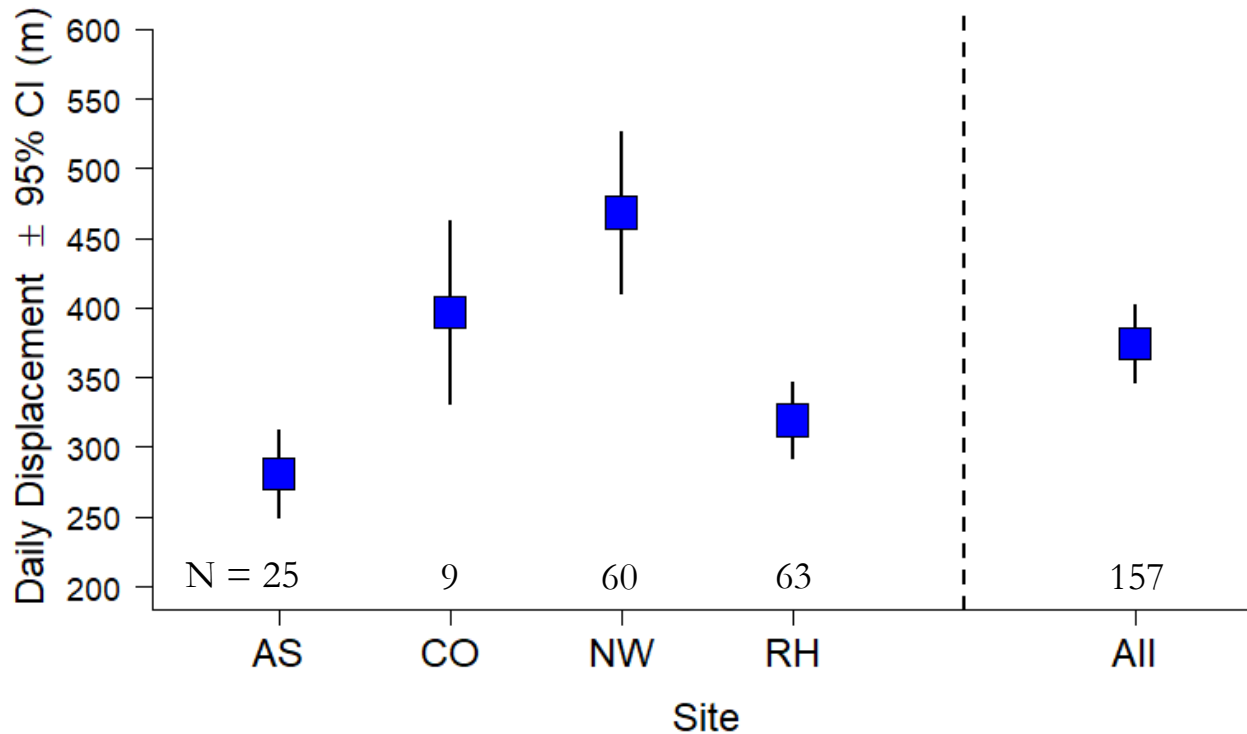
| Site | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | Overall |
|----------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Ashland | . | 2.88 ± 0.57 | 1.65 ± 0.91 | . | . | . | 2.60 ± 0.49 |
| Colorado | 4.10 ± 0.27 | 1.42 | 4.83 ± 0.59 | . | . | . | 4.14 ± 0.46 |
| North West | 3.04 ± 0.26 | 2.69 ± 0.54 | 6.42 ± 1.06 | . | . | . | 3.64 ± 0.41 |
| Red Hills | 2.25 ± 0.52 | 5.77 ± 1.32 | 2.45 ± 0.58 | 3.66 ± 1.06 | 3.70 ± 0.59 | 1.50 ± 0.42 | 3.32 ± 0.42 |
| Overall | 3.05 ± 0.23 | 3.28 ± 0.45 | 3.99 ± 0.63 | 3.66 ± 1.06 | 3.70 ± 0.59 | 1.50 ± 0.42 | 3.38 ± 0.23 |

Average Daily Displacement – Figures



GPS – Daily Displacement – Whole Breeding Season

GPS SAT - Whole Breeding Season



- Mean daily displacement is: 374.8 ± 14.3 m

- Largest at CO and NW sites

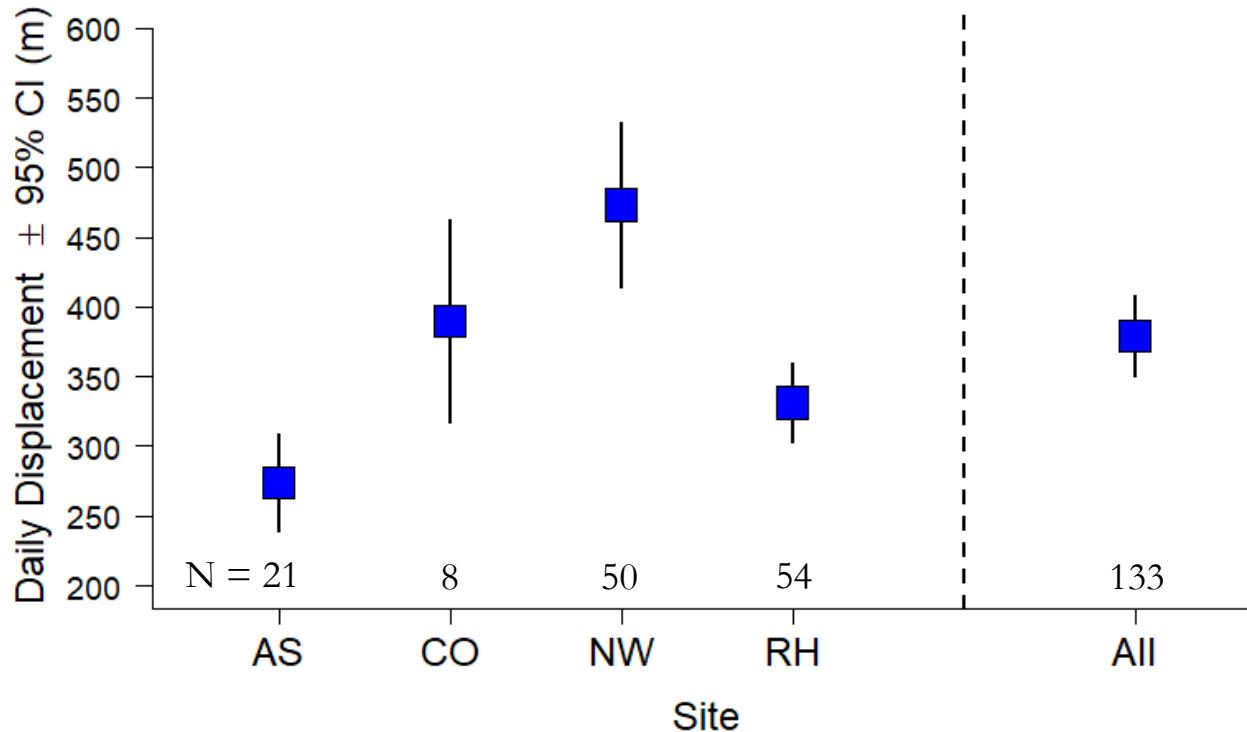
- Most variable at NW and RH sites

Coefficient of Variation

- AS: 65.2%
- CO: 32.5%
- NW: 54.1%
- RH: 78.9%
- **All: 65.4%**

GPS – Daily Displacement – Lekking

GPS SAT – Lekking Period



- Mean daily displacement is: 379.2 \pm 14.8 m

- DD larger at NW vs. AS site
- Most variable at NW and RH sites
- Larger than other breeding periods

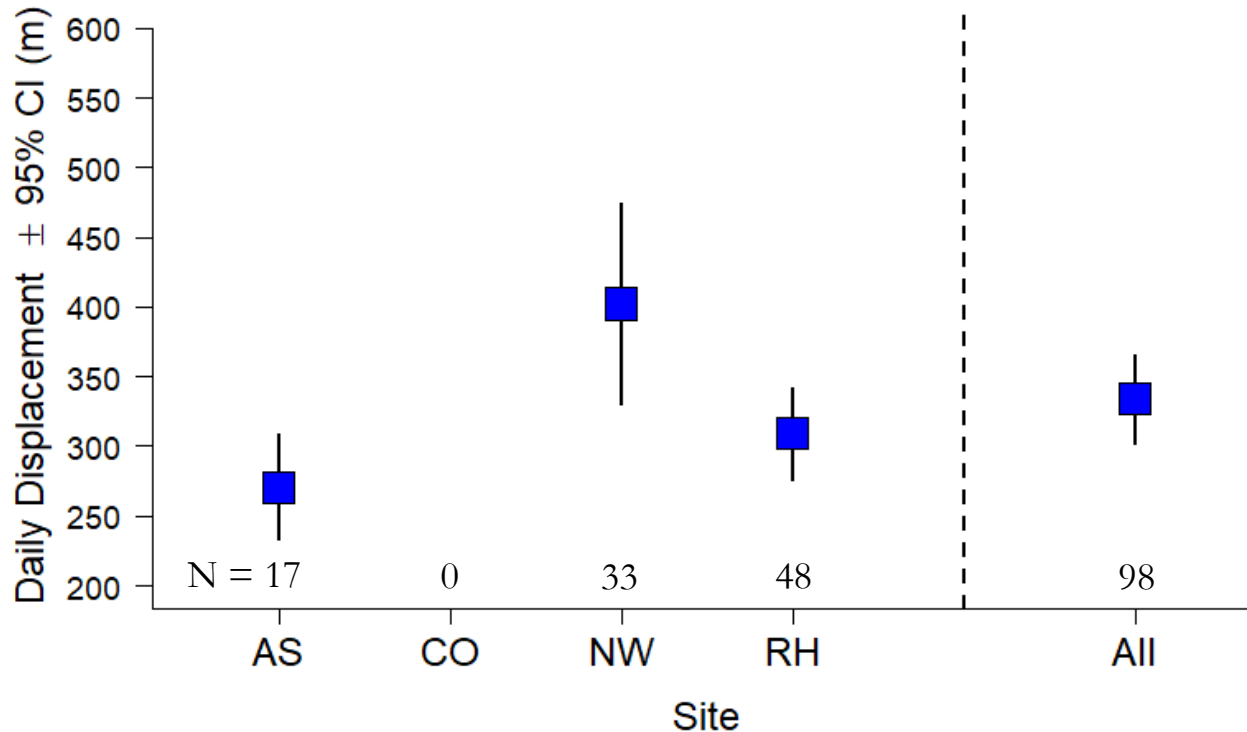
Coefficient of Variation

- AS: 68.6%
- CO: 31.9%
- NW: 52.8%
- RH: 75.2%
- All: 63.9%



GPS – Daily Displacement – Nesting

GPS SAT – Nesting Period



- Mean daily displacement is: 333.8 \pm 16.1 m

- DD larger at NW vs. AS site

- Most variable at NW and RH sites

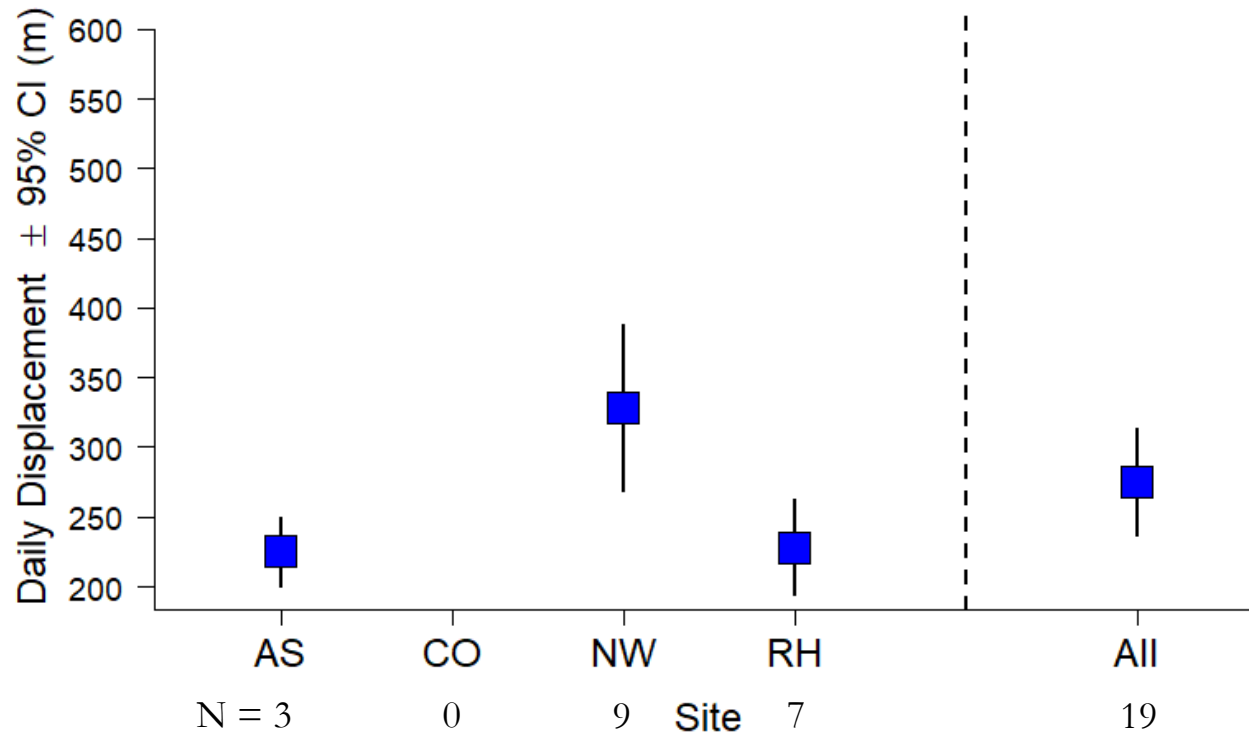
Coefficient of Variation

- AS: 48.6%
- NW: 50.6%
- RH: 75.7%
- **All: 66.6%**



GPS – Daily Displacement – Brooding

GPS SAT – Brooding Period



- Mean daily displacement is: 275.1 \pm 19.4 m

- Low sample sizes

- Lower daily displacement than other breeding periods

- **Coefficient of Variation**

- AS: 11.0%

- NW: 41.0%

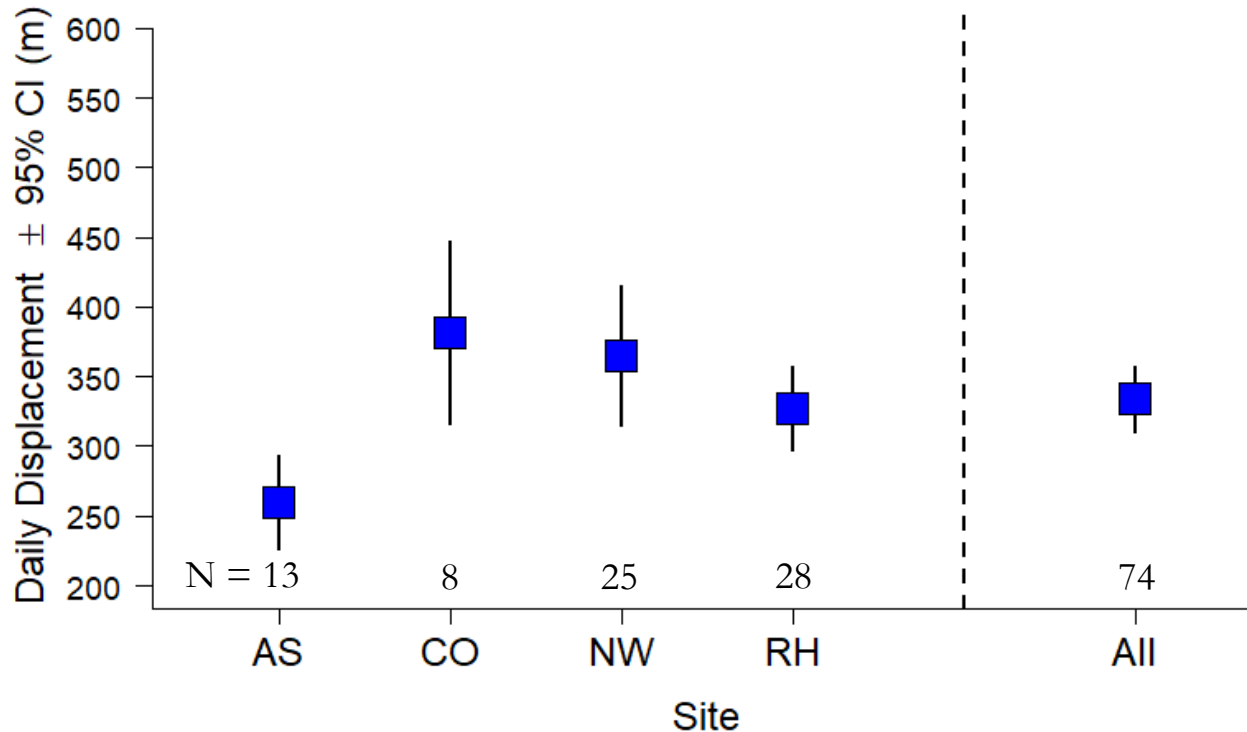
- RH: 43.9%

- **All: 42.2%**



GPS – Daily Displacement – Post-breeding

GPS SAT – Post-breeding Period



- Mean daily displacement is: 334.0 \pm 12.2 m

- Tend to be lowest at AS site.

- **Coefficient of Variation**

- AS: 68.2%

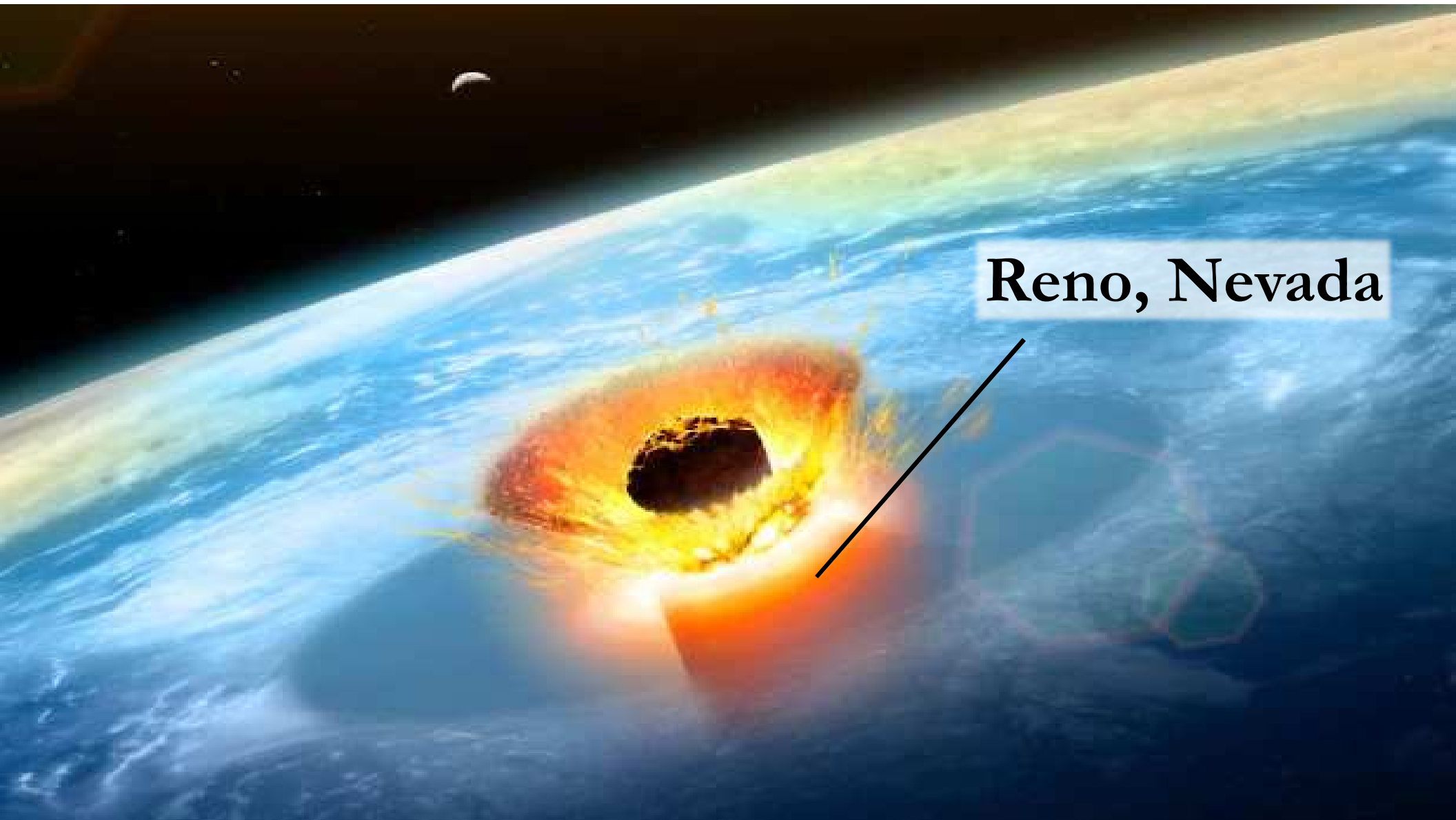
- CO: 31.3%

- NW: 55.3%

- RH: 64.0%

- **All: 58.0%**





Reno, Nevada