Potential Effects of Oil & Gas Development on Mule Deer in Western North Dakota

Jesse Kolar
University of Missouri

Dr. Joshua Millspaugh
University of Montana

Bruce Stillings
ND Game and Fish Department

Brett Skelly
West Virginia University

Chris Hansen
University of Montana

Dr. Christopher Rota
West Virginia University

Contributors

Authors

Jesse Kolar - North Dakota Game and Fish Dept.
Dr. Joshua Millspaugh - University of Montana
Bruce Stillings - North Dakota Game and Fish Dept.
Chris Hansen - University of Montana
Dr. Colter Chitwood - University of Montana
Dr. Chris Rota - West Virginia University
Brett Skelly - West Virginia University

Advisory Committee:

Kent Reierson - Crowley Fleck/Sportsman
Donna Williams - Conoco Phillips
Chuck Anderson - Colorado DNR
Brent Brannan - ND Oil and Gas Research Program

Objectives

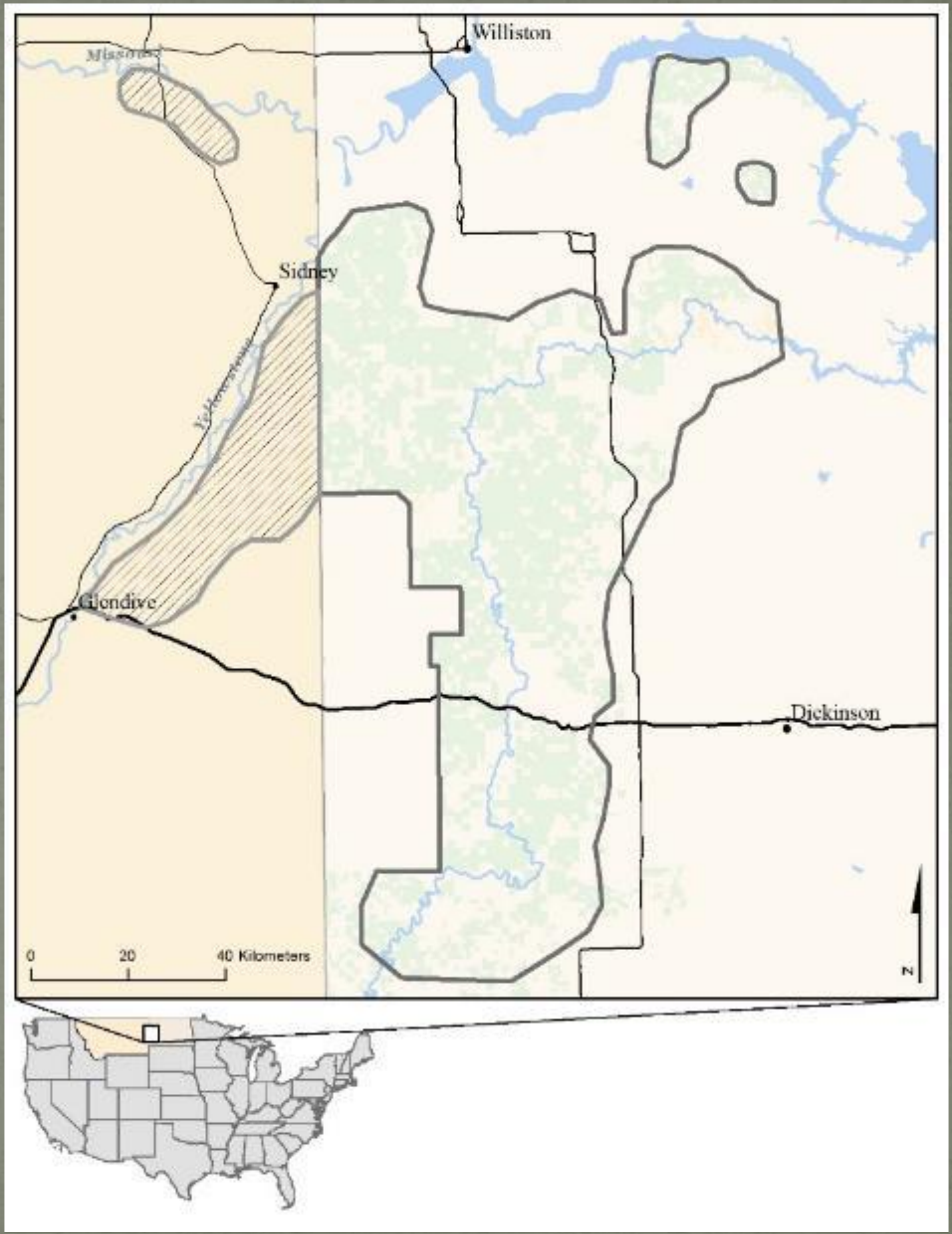
Investigate potential effects of O&G on:

Resource Selection
Movements
Physiological stress

Survival
Abundance

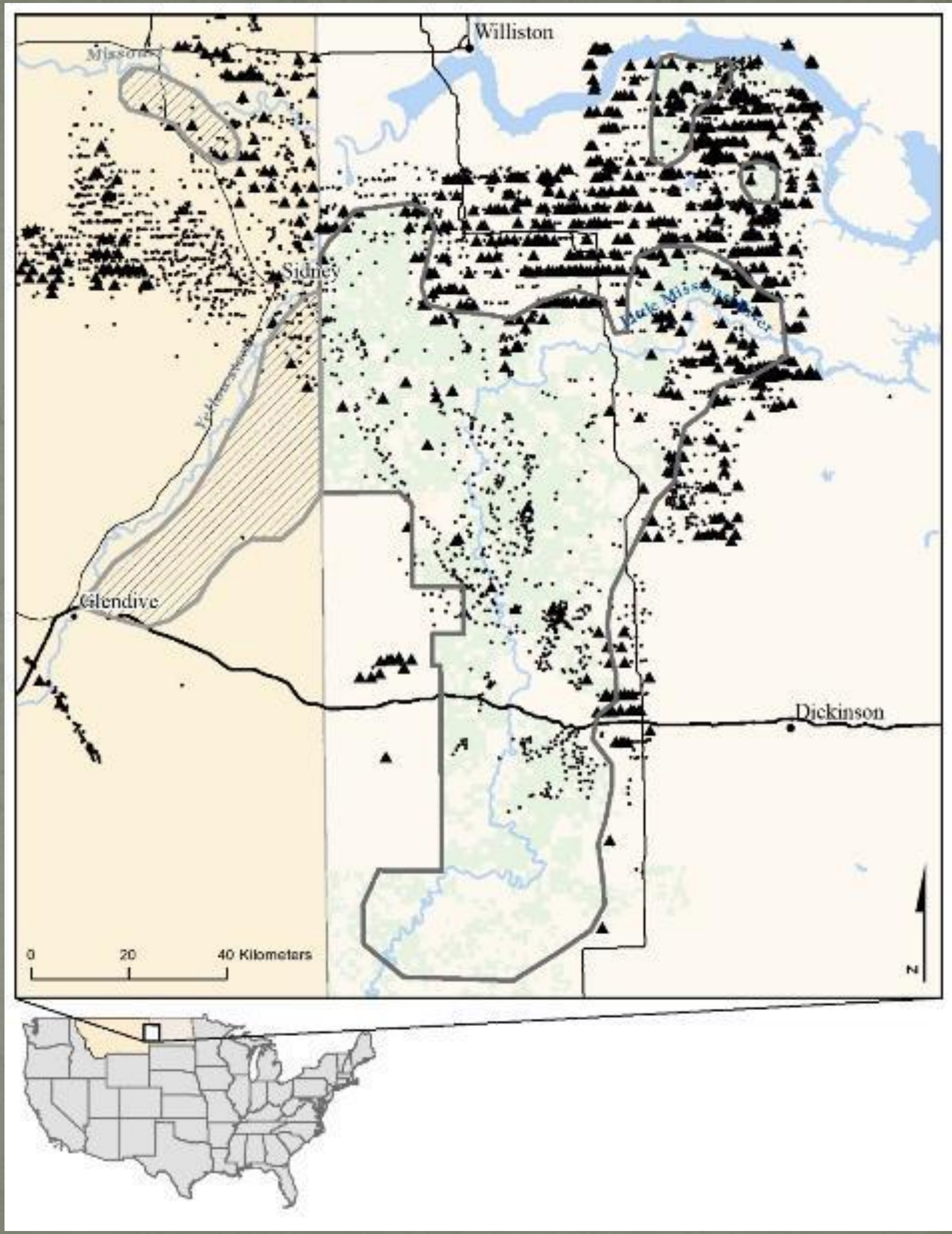
Study Area

Study area map showing North Dakota study area primarily focused on the Little Missouri National Grasslands, and the Montana addition (cross-hatch).

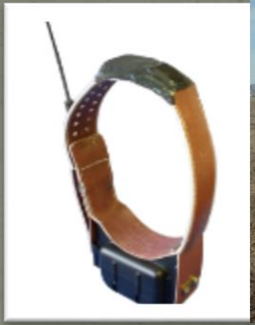


Study Area

Map of drilling rigs and active well pads overlaid on study area (ND Industrial Commission, Department of Mineral Resources, Oil and Gas Division Feb 2013)



Iridium GPS Collars



VHF Radio	GPS	Iridium transmitter	Activity Sensor*	Battery Pack
Used to manually locate deer in the field	Acquired locations every 5 hours	Satellite cell phone transmitted GPS fixes every 4 days, and mortality notifications in real time	Detected physical movement of the collar	Adult collars lasted up to 4.5 years Fawn collars lasted up to 2 years.

*When activity sensors failed to detect movement for 6 hours, collars went into a mortality mode and transmitted hourly, real-time GPS locations.

Capture Summary

Year	ND (MT)		
	Does	Fawns	Total
2012	60	30	90
2013	16 (20)	30 (20)	46 (40)
2014	25 (10)	46 (23)	71 (33)
Total	**101 (30)**	**106 (43)**	**207 (73)**

Chapter 1
Resource Selection

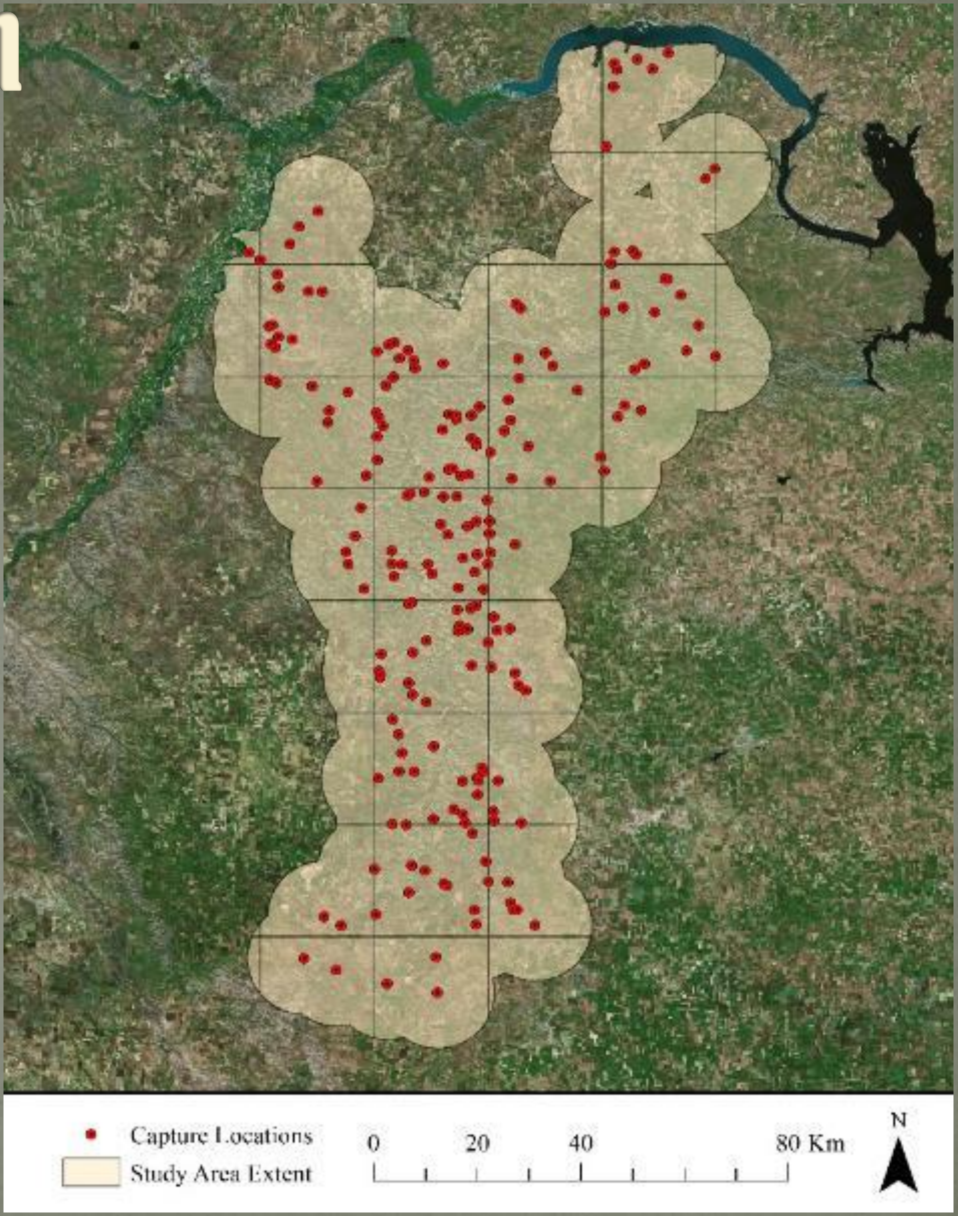
Resource Selection

We used discrete choice models to compare used deer locations to randomly sampled “available” locations.

Available = average of the maximum distances moved (11 km)

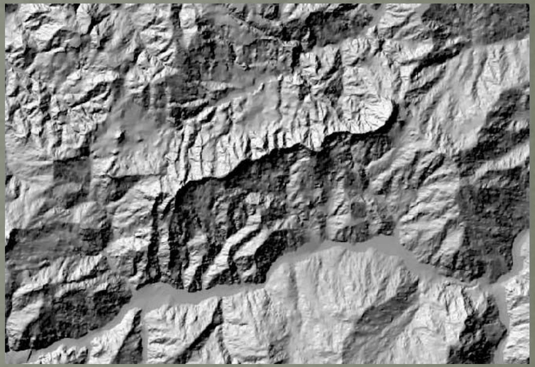
We overlaid a 22 km grid over the available polygon and generated 5 random points for every used point within the available grid

We used the available buffer to distribute 2,157,905 random points that were considered available to radio-marked deer, and compared these to 431,581 used deer locations.



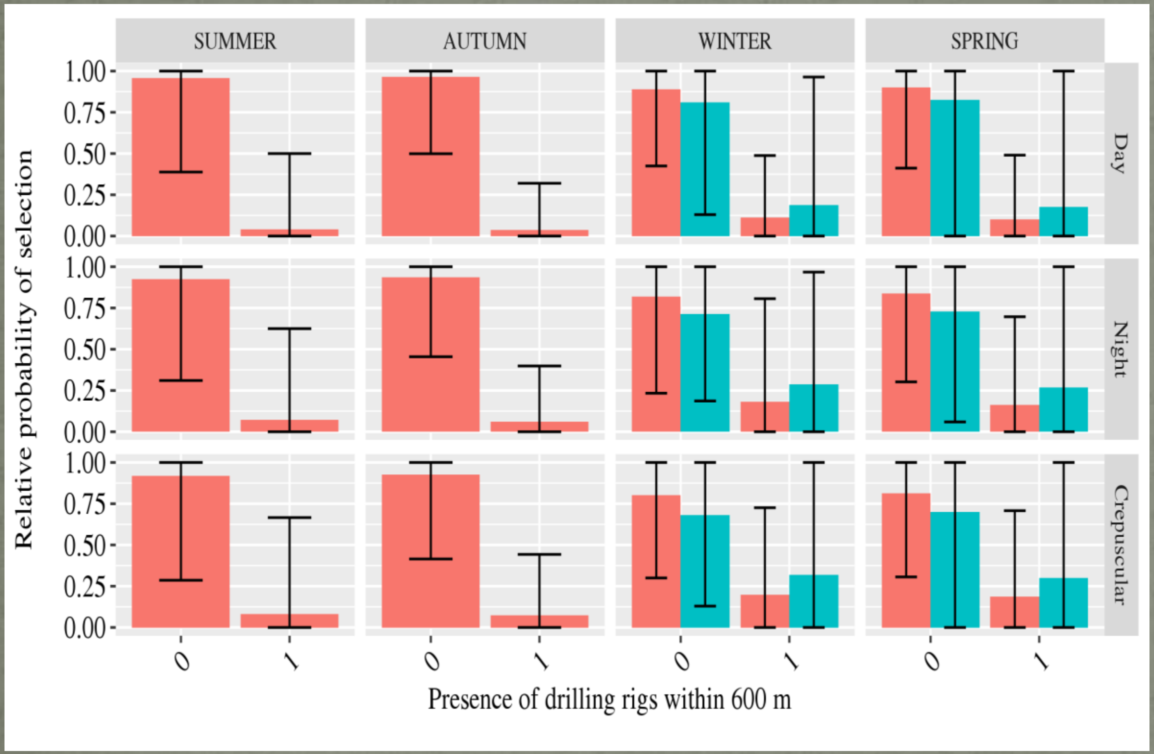
Resource Selection

Hypothesis	Models[a]
Vegetation	Null
	Vegetation Class (wooded, shrub, grass, hay, legume, crop, or barren)
	Distance from wooded edge
	Interspersion Juxtaposition Index (IJI)
	NDVI (vegetation greenness)
Topography	Null
	Northness (sine of aspect)
	Slope (%)
	Ruggedness
	Landforms (ridge or head of draw, mid to upper slope, lower slope, valley, flat)
Anthropogenic Development	Null
	Distance to nearest road
	Road density within 2 km
	Density of active well pads (900 m)
	Presence of drilling rig (600 m and 2500 m)
(Interactions)	Age (fawn, adult)
	Season: summer (Jun – Sep), autumn (Oct – Nov), winter (Dec – Mar) and spring (Apr – May)
	Time of Day (day, night, crepuscular: +/- 2 hours sunrise or sunset)



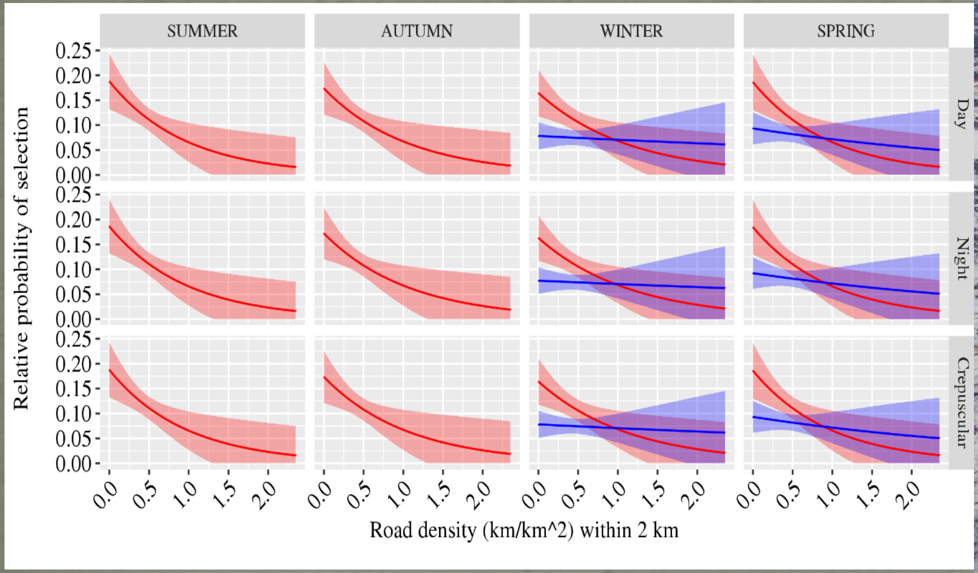
Resource Selection - Results

1) Areas were 22 times more likely to be selected when they did not have a drilling rig within 600 m.



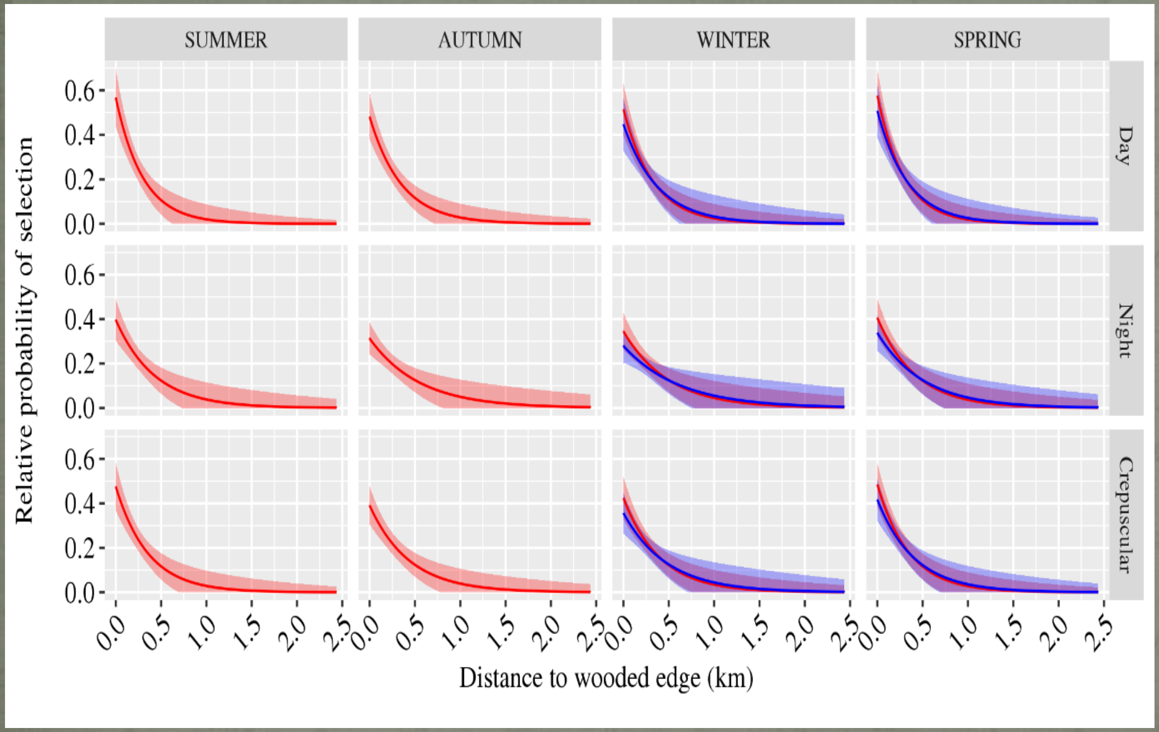
Resource Selection - Results

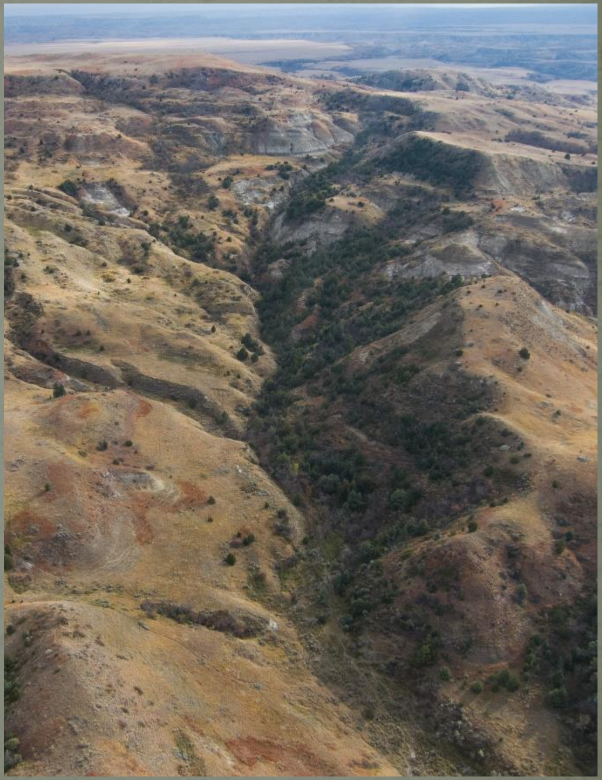
Road densities negatively influenced mule deer selection, but the relationship was less pronounced than presence of a drilling rig within 600 m and was more pronounced for adults than fawns.



Resource Selection - Results

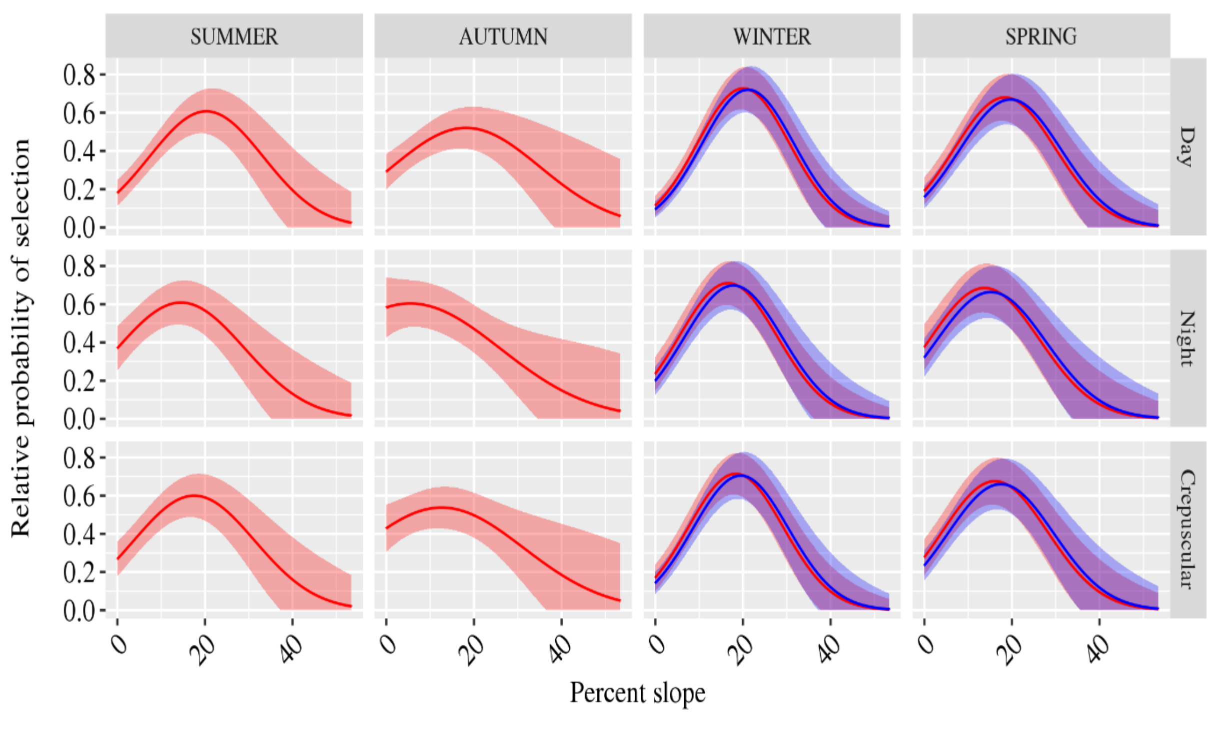
4) Vegetation and topographic features were the main drivers of mule deer selection if rigs were not present. Mule deer used wooded and shrub vegetation types and avoided crops during the day, and were more likely to use open vegetation types (hay and legumes) during night and crepuscular hours





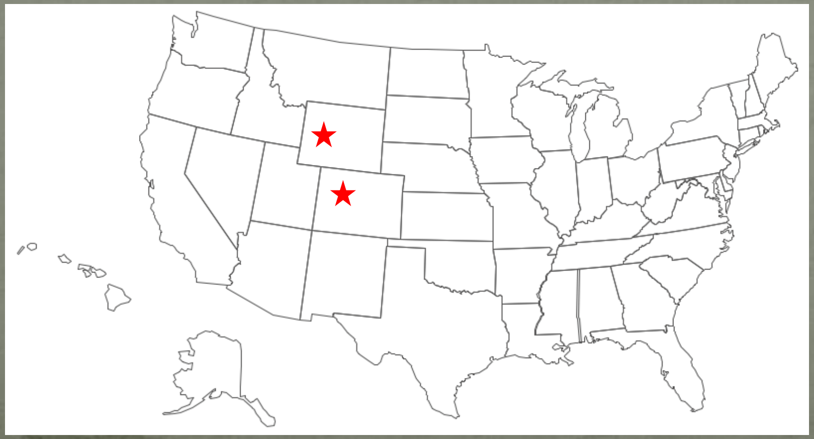
Resource Selection - Results

5) Ridges, upper draws and slopes were used more than other topographic features. Similarly, mule deer selected areas with moderate ruggedness and slope.



Resource Selection - Discussion

- Avoidance of drilling rigs at 600 m is consistent with the Piceance Basin of Colorado (up to 800m), but less than Pinedale Anticline of western Wyoming (avoidance up to 1.5 km). We documented avoidance in all seasons (vs. winter only in WY and CO).
- We possibly observed lower levels of avoidance due to: increased topographic relief, taller vegetative cover, or acclimatization (>35 years).
- Unlike findings from Colorado or Wyoming, we did not find significant avoidance of well pads at any distance
- Natural features were selected as we predicted, and follow closely to the primary mule deer range delineated by the NDGF.

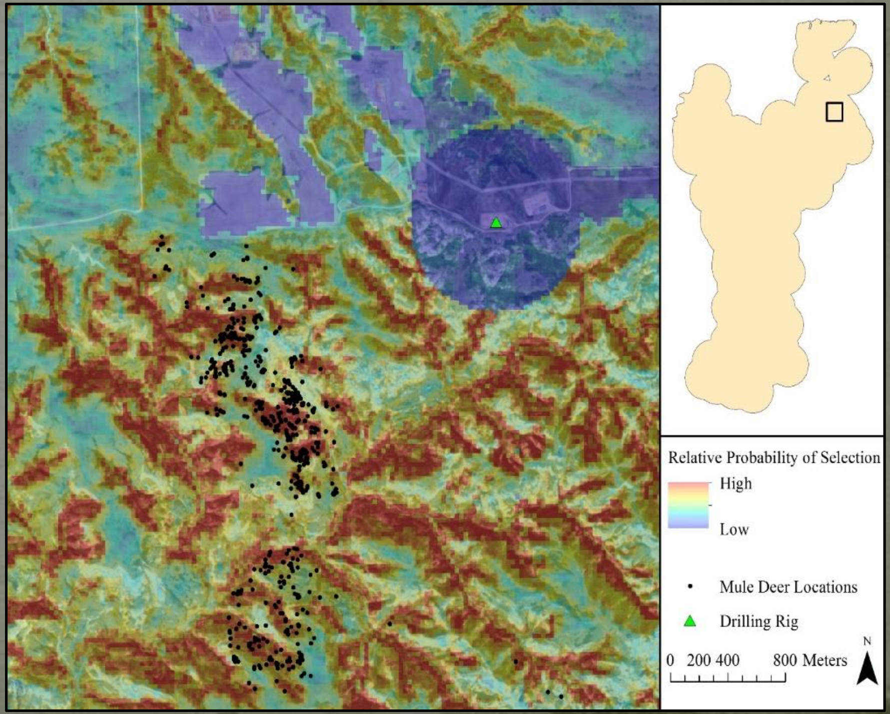


Resource Selection – Management Implications

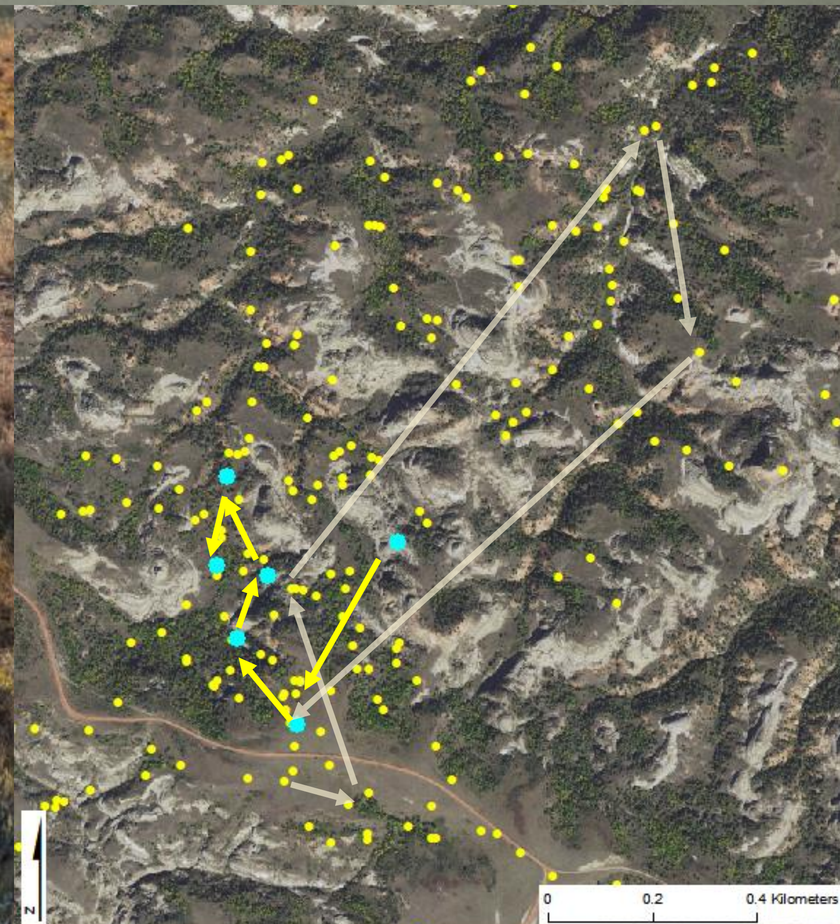
- The two most critical times for deer are fawning/fawn rearing (Jun – Sep) and winter survival (Dec – Mar). It is unlikely drilling can be avoided during these periods. It would benefit mule deer to minimize the density of rigs in an area because each rig negatively affects 1.13 km^2 during the drilling phase.

- We recommend that new development features are near existing roads, because areas with increased road densities are less likely to be used by mule deer.

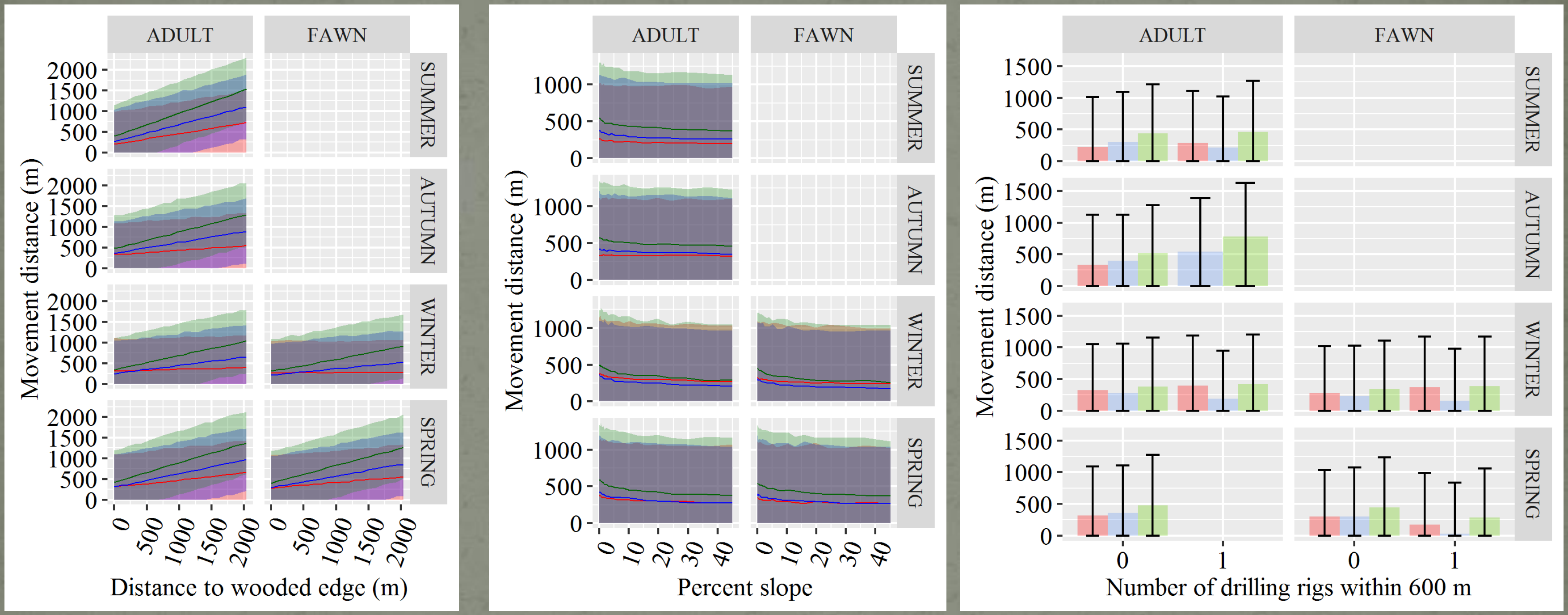
- In primary mule deer range, we suggest that infrastructure should be placed in flatter (<10% slopes), open areas when possible, minimum of > 0.6 km from wooded draws (ideally > 1.1 km).



Chapter 2
Movements



Movements - Results



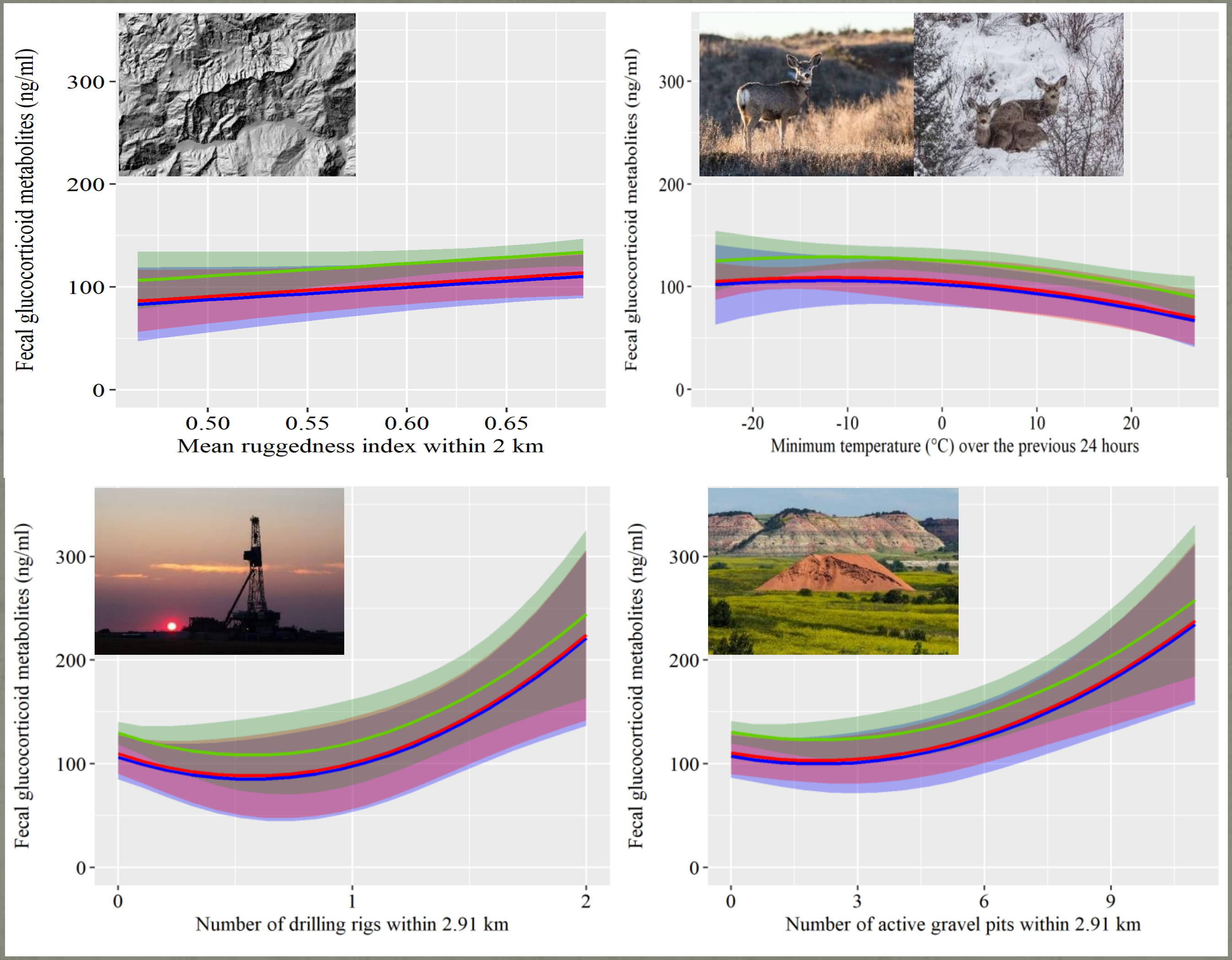
Plots of movement distance predicted by Distance to Wooded Edge, Percent Slope, and Presence of a drilling rig within 600 m for adults and fawns during each season and each time of day (day: red, night: blue, crepuscular: green).

Chapter 3
Physiological Stress

Physiological Stress

- We collected fecal samples during each capture (Dec or Feb).
- We homogenized and froze fecal samples and sent them to the University of Missouri wildlife physiology lab, where they were analyzed for stress hormone concentration, specifically, fecal corticosterone metabolites (FGM).
- We modelled FGM concentration using predictors similar to previous chapters (Table 4.)

Physiological Stress - Results



Physiological Stress - Discussion

- Only high traffic forms of energy infrastructure (drilling rigs and gravel pits) correlated with higher levels of stress, which supports previous research that found that deer may acclimate to low levels of predictable disturbance (well pads, roads, etc.).

- Human factors overrode natural climate factors such as temperature, but both affected mule deer physiological stress levels.

Physiological Stress - Discussion

- The elevated FGMs that we found indicated that mule deer initiated a coping mechanism. It only becomes deleterious to the animal when an animal is unable to eliminate the stressor in the environment, and the inability to cope leads to chronic stress which can have multiple negative effects



Physiological Stress – Management Implications

- Our recommendation for drilling rigs, gravel pits (and potentially other high-traffic forms of development) would be to minimize overlap with areas most likely to be used by mule deer, and to minimize disturbance during sensitive seasons (June - fawning and Dec-Mar - winter survival).

- FGMs could be a useful method, partnered with other metrics, for passively examining stress levels of wildlife in areas with anthropogenic development. Experimental manipulations, in conjunction with year-round sampling, particularly of the same individuals would more fully allow cause and effect relationships to be determined.

Chapter 4
Survival

Survival

- "Mortality" notification after >6 hours inactivity
- We arrived at most mortalities within 24 hours
- Field investigations and formal necropsies
- Cause of mortality
- Factors affecting survival

Survival - Results

From 203 collared deer, 86 mortality events, we concluded:

1) Adult mule deer annual survival probability was 85.6%.
2) Juvenile mule deer overwinter survival (Dec – May) was 67.7%*.
3) Lowest survival for adults and juveniles was during the winter.

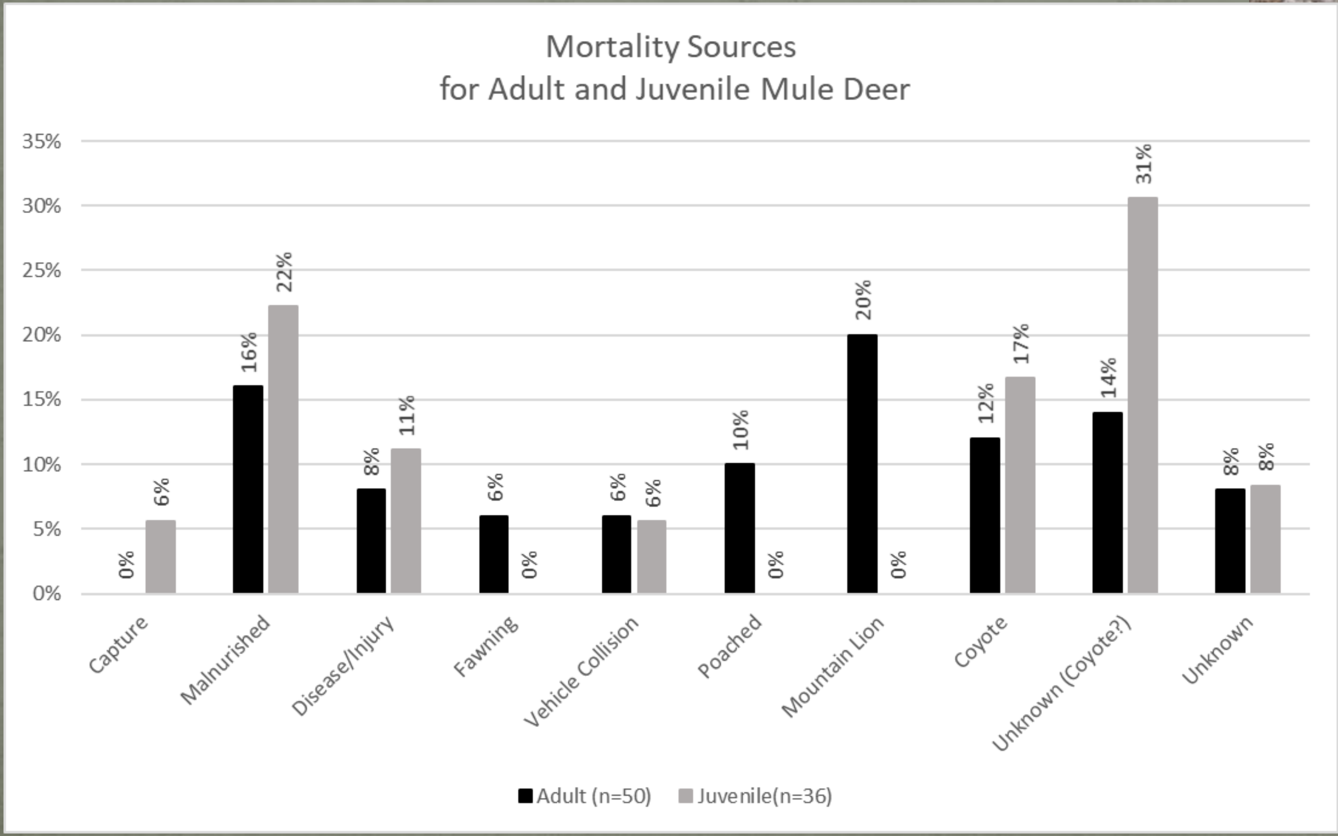
*We could not calculate juvenile annual survival because they were captured as 6-month-old deer.

		Survival Rate	Lower 95% CI	Upper 95% CI
Adult	**Annual**	**85.9%**	75.3%	92.8%
	Winter	93.0%	86.6%	96.8%
	Spring	97.0%	94.0%	98.7%
	Summer	96.3%	92.3%	98.5%
	Autumn	98.9%	97.0%	99.7%
Juvenile	**Post-winter (Dec - June)**	**67.7%**	49.3%	81.8%
	Winter	75.9%	60.5%	87.1%
	Spring	88.9%	79.7%	94.7%

Survival - Results

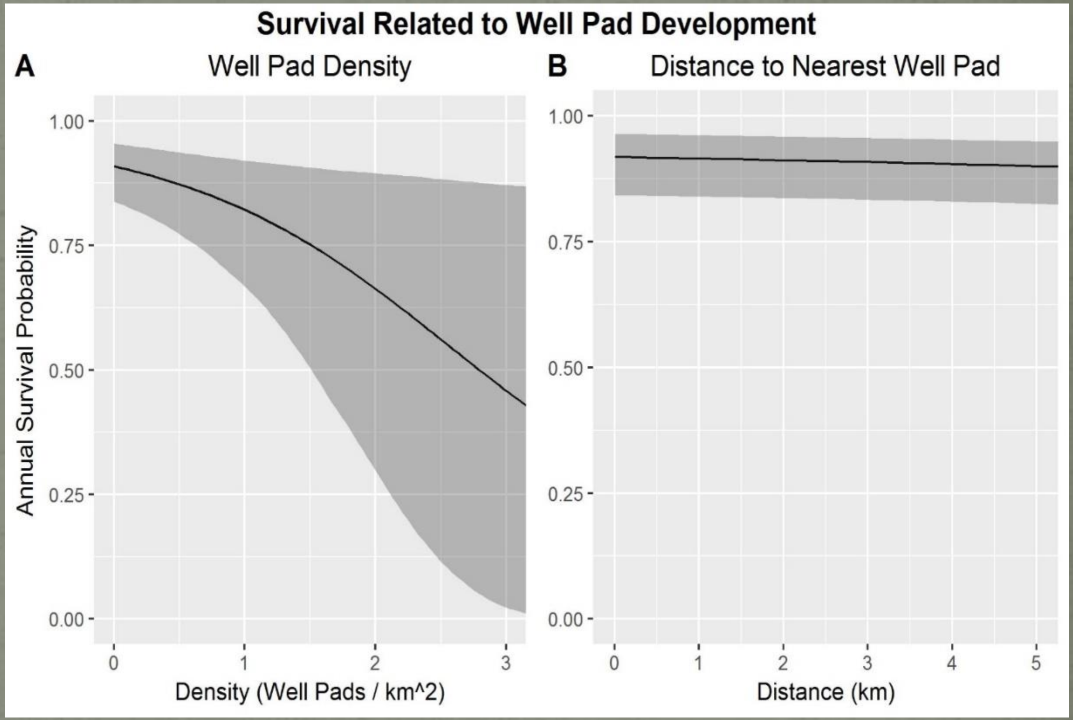
We used data from 203 collared mule deer and observed 86 mortality events.

We documented several sources of mortality as shown in Figure 15.



Survival - Results

The most significant factor other than season and age was: well pad density. Survival decreased by 24% when well pad density increased from 0 to 5 well pads/mi^2.



Survival - Discussion

- Female adult survival and fawn recruitment are the two most important demographic parameters that affect population growth rates in mule deer.

- Our results suggest that female adult survival rates were consistent with average survival rates from other studies (0.84-0.85). However, there were not antlerless hunting seasons during our study.

Survival - Discussion

- We did not detect high rates of vehicle-killed mule deer, but we avoided highways and interstate during capture to avoid chasing deer near high traffic areas. (Note: 2/4 deer that used areas crossing Hwy 85 were hit by vehicles).

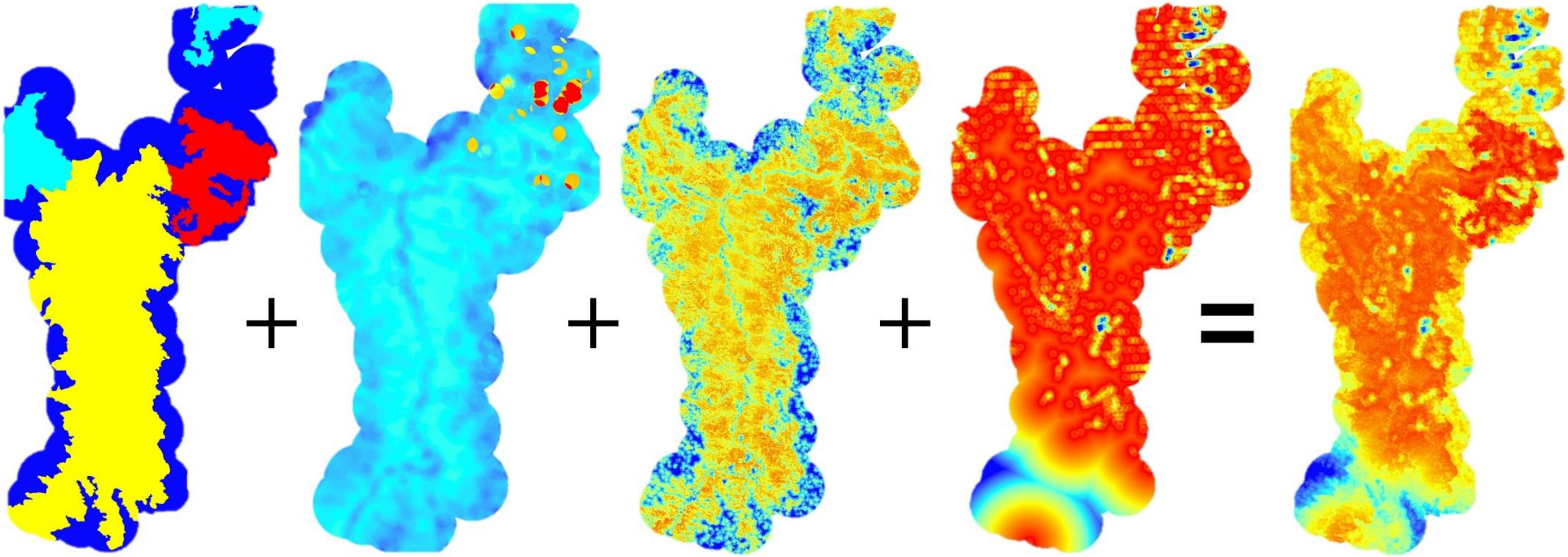
Survival – Management Implications

- Well pad density significantly influenced survival probabilities, and areas with 1 well pad/km^2 had 10% lower probability of survival than areas without well pads.

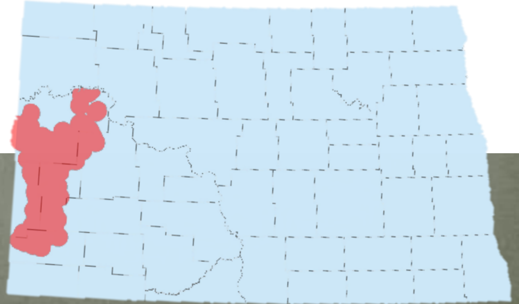
- In areas where many wells will be produced, it would be best for mule deer if multiple wells were produced per well pad to minimize well pad density.

- Our conclusions on mule deer survival provide further evidence for the benefit drilling multiple wells per well pad, which coincides with current best management practices.

Risk Assessment



Abundance Stress Resource Selection Survival Risk



Wrap up




Resource Selection

- Rigs within 600 m and road density negatively affected the probability that a mule deer would select an area.
- The most preferred areas had moderate slopes (10-30%), in upper portions of draws, nearer to wooded edges.

Physiological Stress

- Rigs and gravel pits were correlated with increased physiological stress.

Survival

- Mule deer survival was negatively correlated with well pad density.

Acknowledgments

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Mule Deer Foundation

Questions?

Jesse Kolar: jlkolar@nd.gov