Spatially predicting impacts of anthropogenic nightlight and noise on wildlife habitat integrity across the contiguous United States

NASA Ecological Forecasting 2017-2021

End-user: National Park Service

Project Team:

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Utah State: David Stoner (co-PI)

NASA MSFC: Andrew Molthan (co-PI), Lori Schultz

NPS: Kurt Fristrup, Sharolyn Anderson

Artificial light at night as a new threat to pollination

Eva Knop[1], Leana Zoller[1], Remo Ryser[1], Christopher Gerpe[1], Maurin Hörler[1] & Colin Fontaine[2]

Current Biology

Low Levels of Artificial Light at Night Strengthen Top-Down Control in Insect Food Web

Highlights

- Artificial light at night, at varying intensities, is globally widespread
- Intensity of artificial light determines the community response in an insect food web
- Impacts of artificial light on interactions between species may be very common

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In Brief

Conservation Physiology

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SEB

Research article

Artificial light at night disturbs the activity and energy allocation of the common toad during the breeding period

Morgane Touzot[1,*], Loïc Teulier[1], Thierry Lengagne[1], Jean Secondi[1], Marc Théry[2], Paul-Antoine Libourel[3], Ludovic Guillard[1] and Nathalie Mondy[1]

Cascading effects of artificial light at night: resource-mediated control of herbivores in a grassland ecosystem

Jonathan Bennie, Thomas W. Davies, David Cruse, Richard Inger and Kevin J. Gaston

Environment and Sustainability Institute, University of Exeter, Penryn TR10 9FE, UK

Artificial Light at Night Affects Organism Flux across Ecosystem Boundaries and Drives Community Structure in the Recipient Ecosystem

Alessandro Manfrin[1,2,3†], Gabriel Singer[1], Stefano Larsen[4,5], Nadine Weiß[1,2], Roy H. A. van Grunsven[1], Nina-Sophie Weiß[1,2], Stefanie Wohlfahrt[1,2], Michael T. Monaghan[1†] and Franz Hölker[1†]

Project Goal

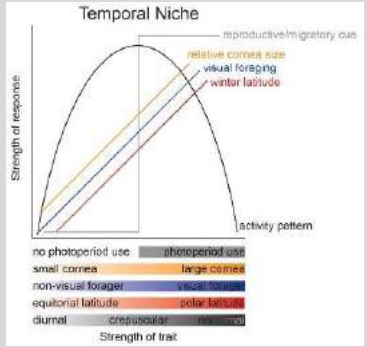
- Incorporate NASA data on nightlight (VIIRS DNB) in decision-support tools for the NPS to identify and mitigate effects of anthropogenic sensory stimuli on wildlife habitats across the Park system.

Using NASA resources to better inform wildlife conservation

Traits

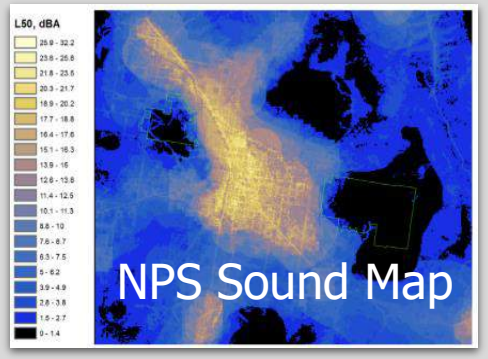
Literature

Expert survey

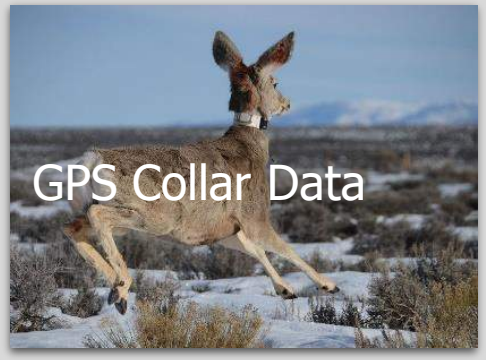


Empirical Data

Remotely-sensed



Field

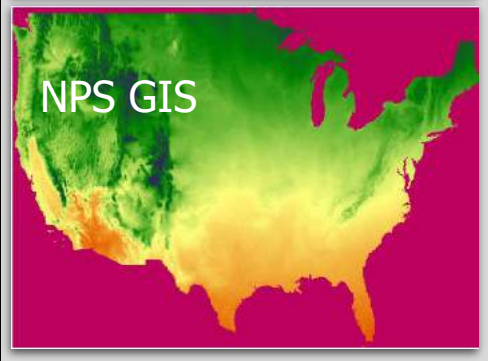


Spatial Analysis

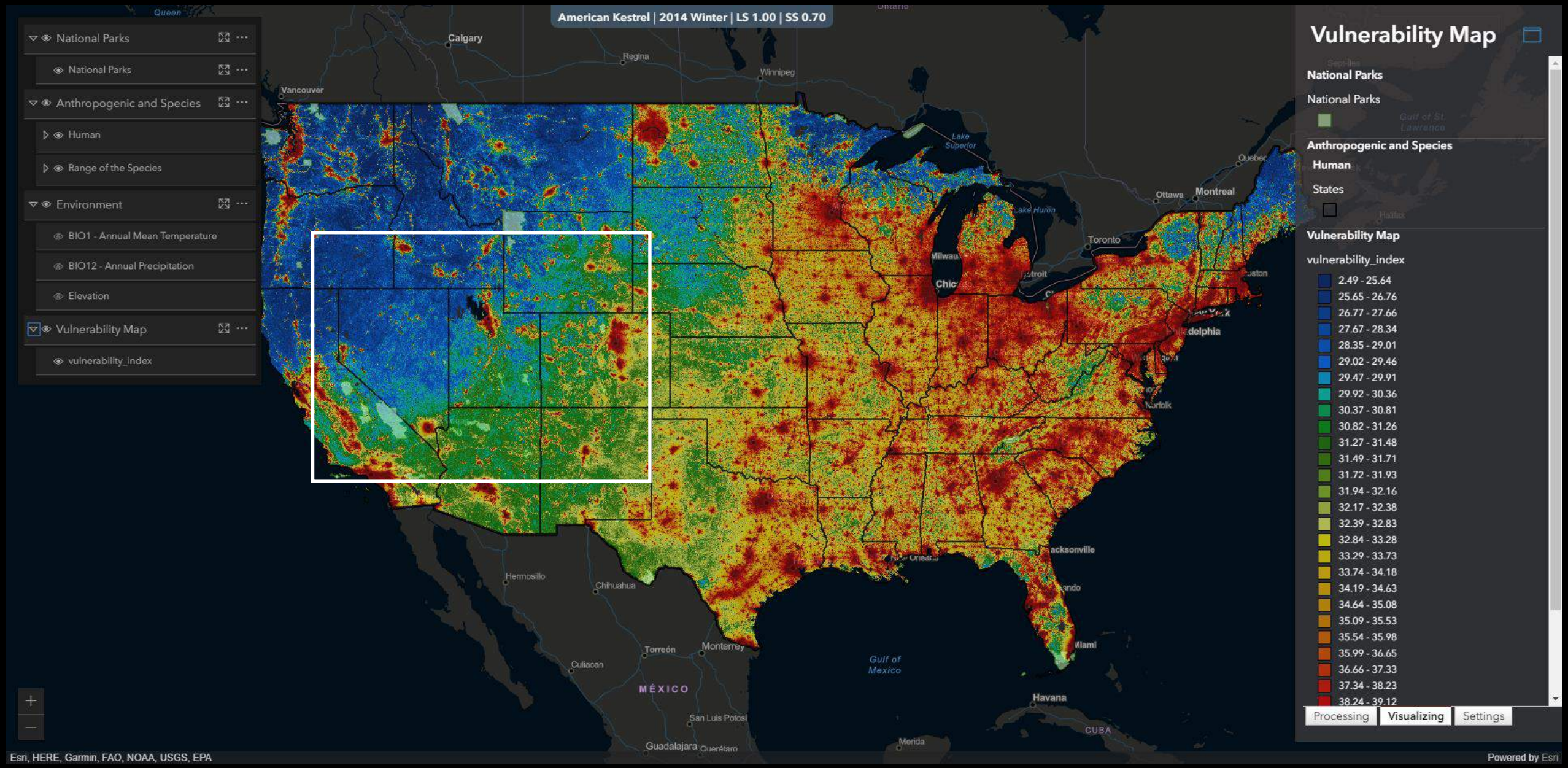
1. Integrated Step Selection Functions
2. Resource Selection Functions
3. Species Distribution Modeling
4. Vulnerability Mapping

Spatial Planning

Geospatial Framework



Vulnerability mapping web application (vms.boisestate.edu)

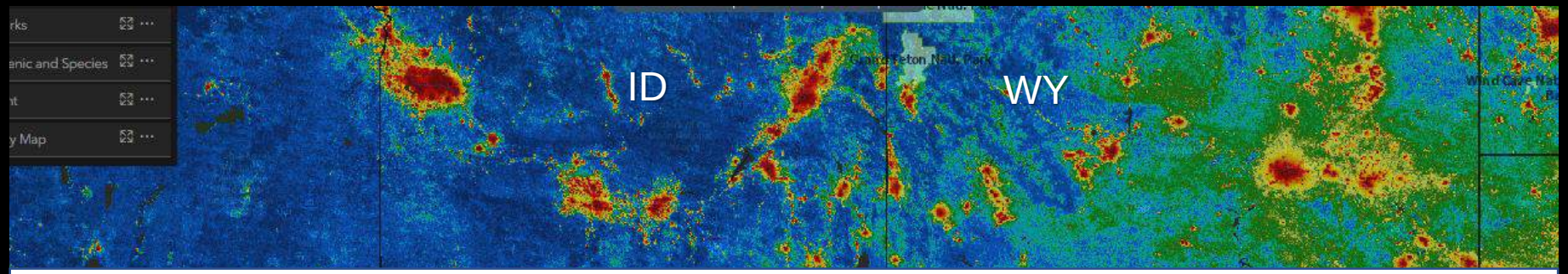


Predator-Prey Ecology in the Great Basin & Colorado Plateau

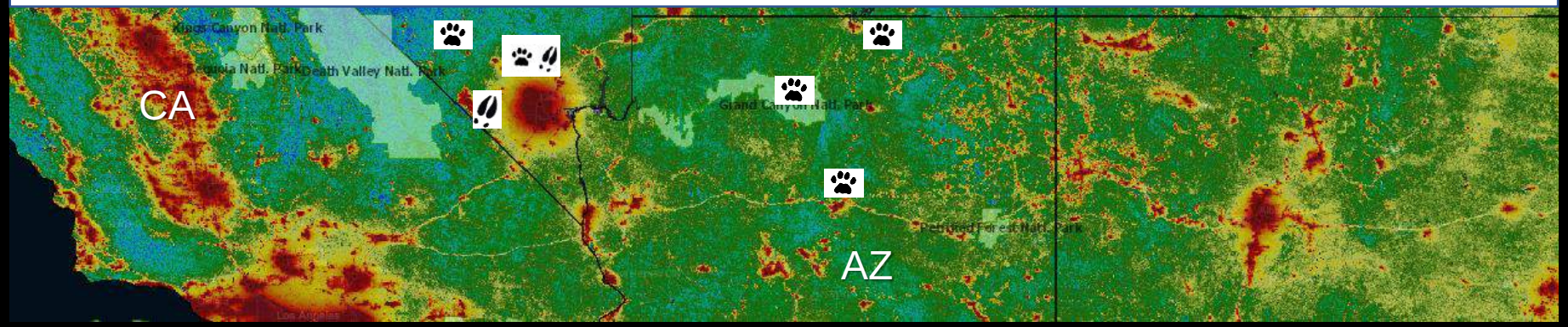
1,629 cache sites
2001-2018

110 individuals
~210 k locations
2001-2017

468 individuals
~1.18 million locations
1999-2018

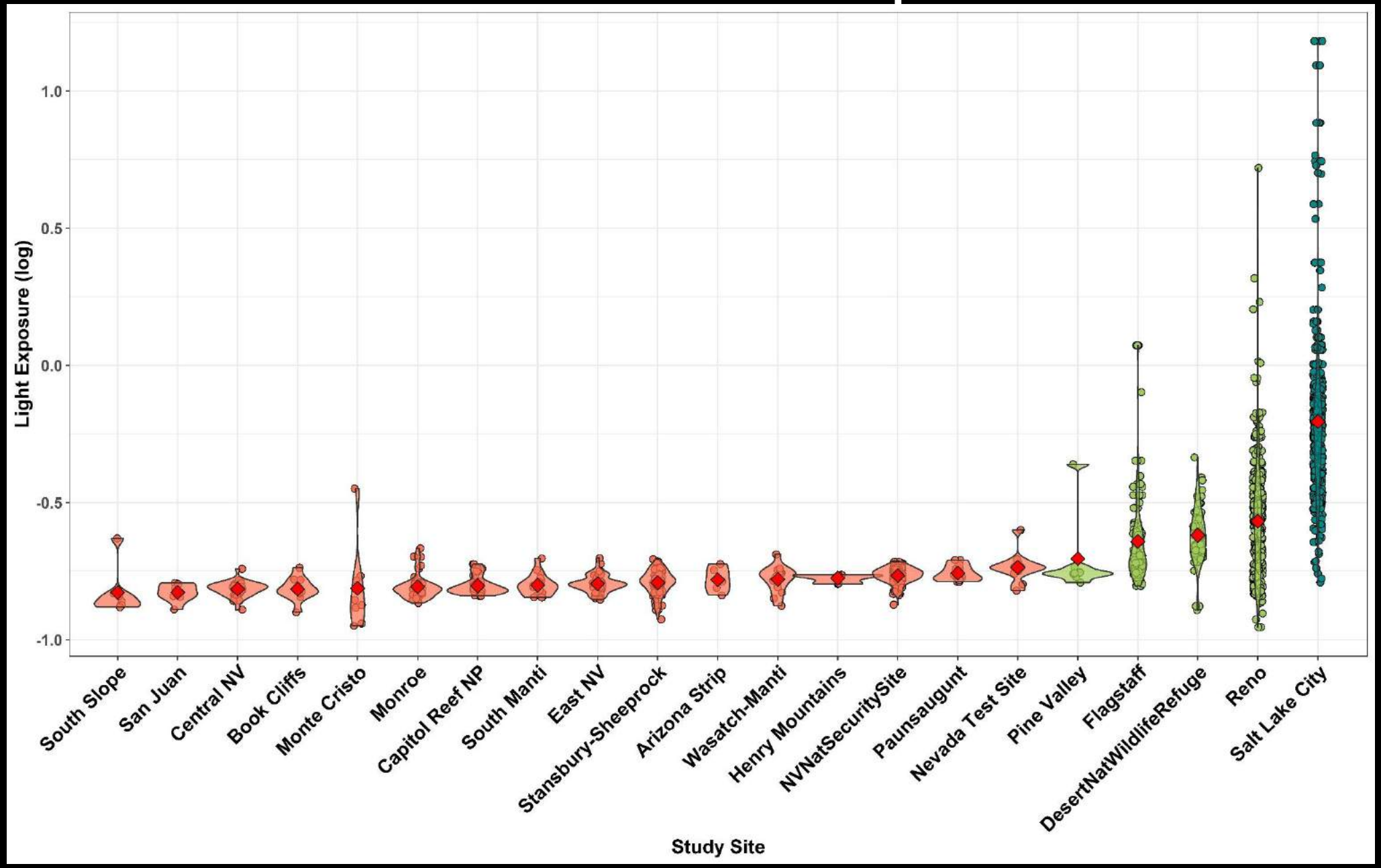


1. How does anthropogenic nightlight affect predation risk?
2. How does anthropogenic nightlight affect animal movements and habitat selection?



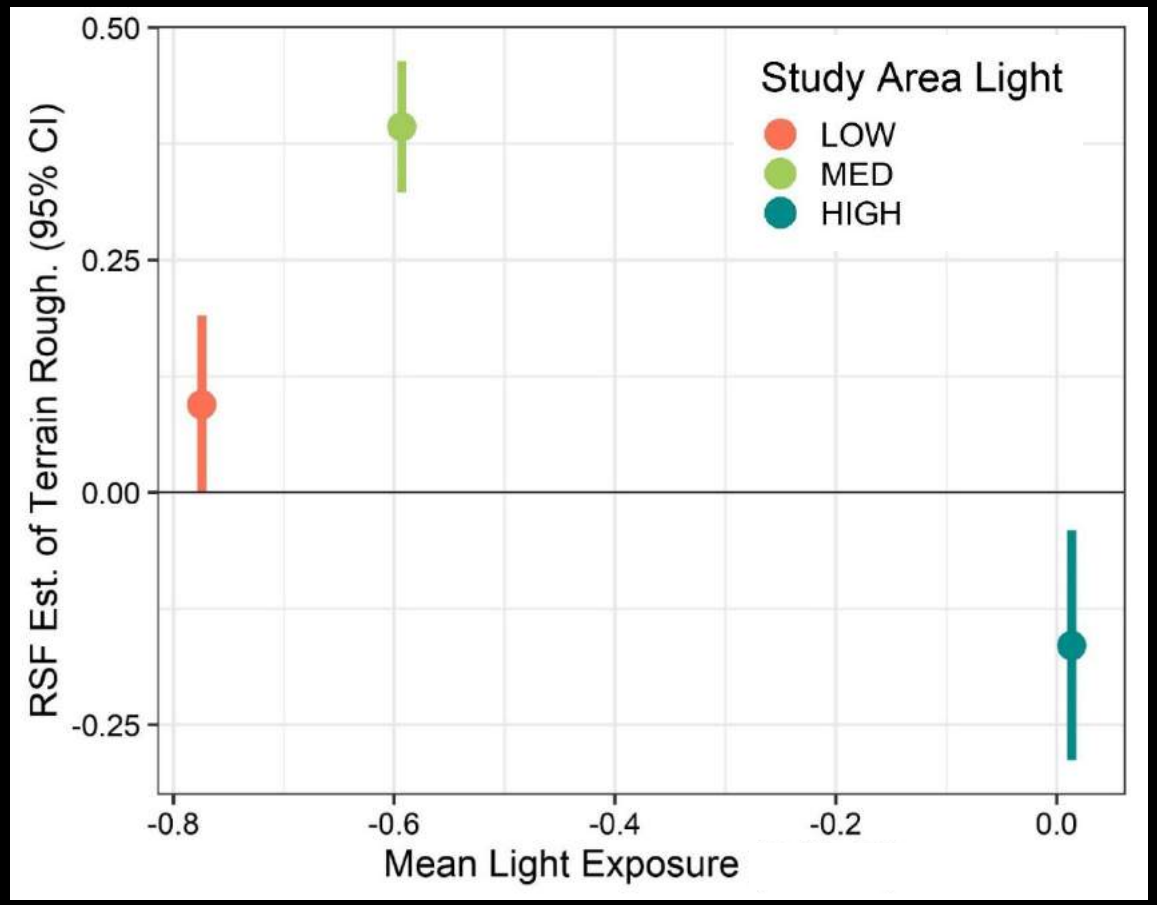
Landscape of Fear

How does ALAN influence predation risk?

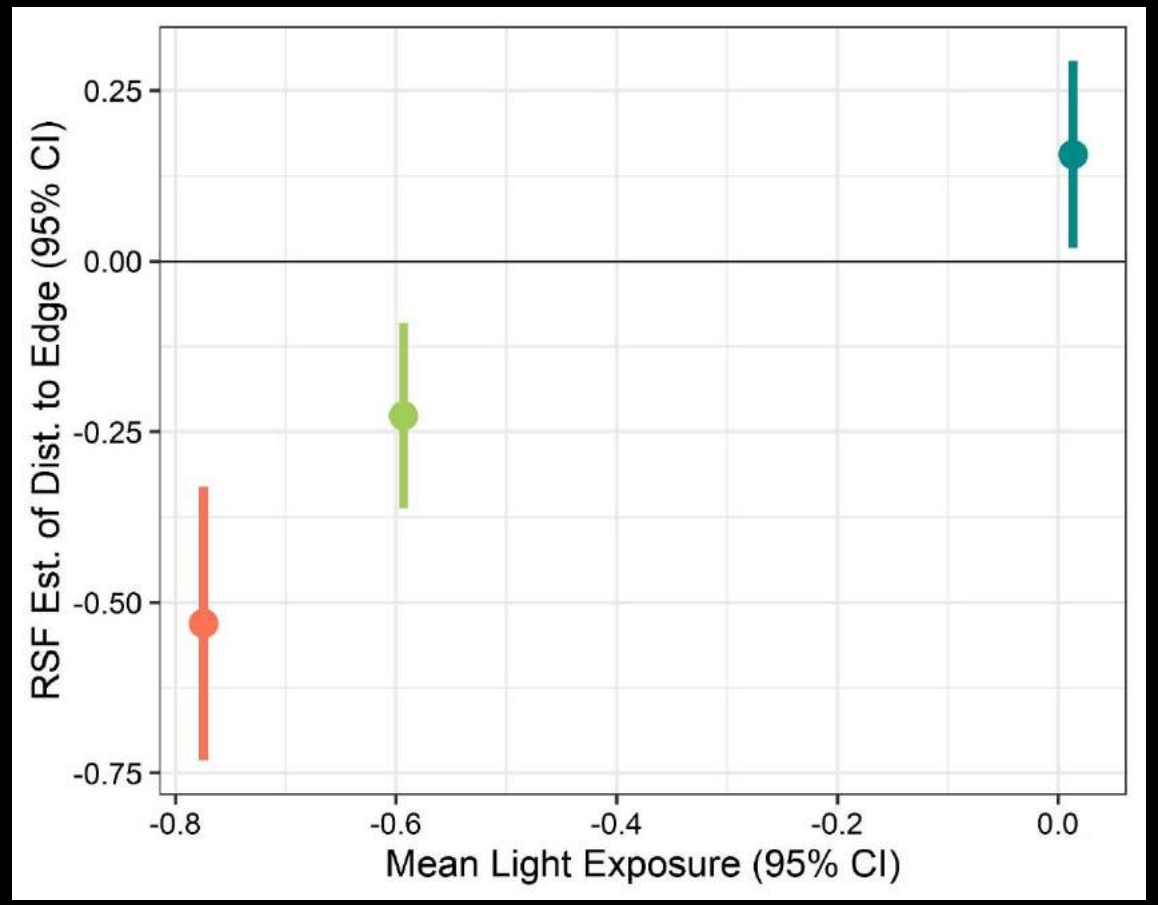


How does ALAN influence predation risk?

Terrain Roughness

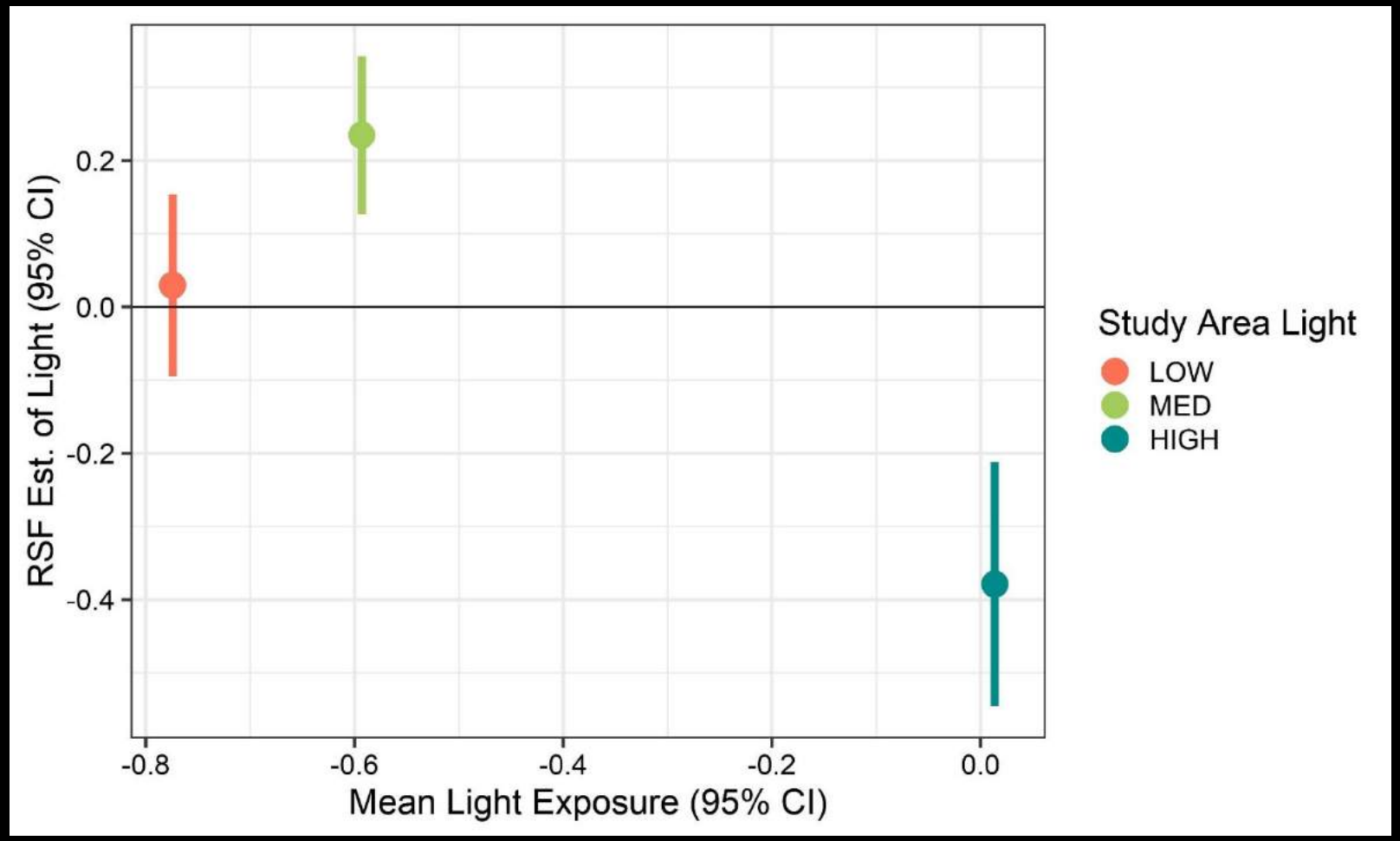


Distance to Forest Edge



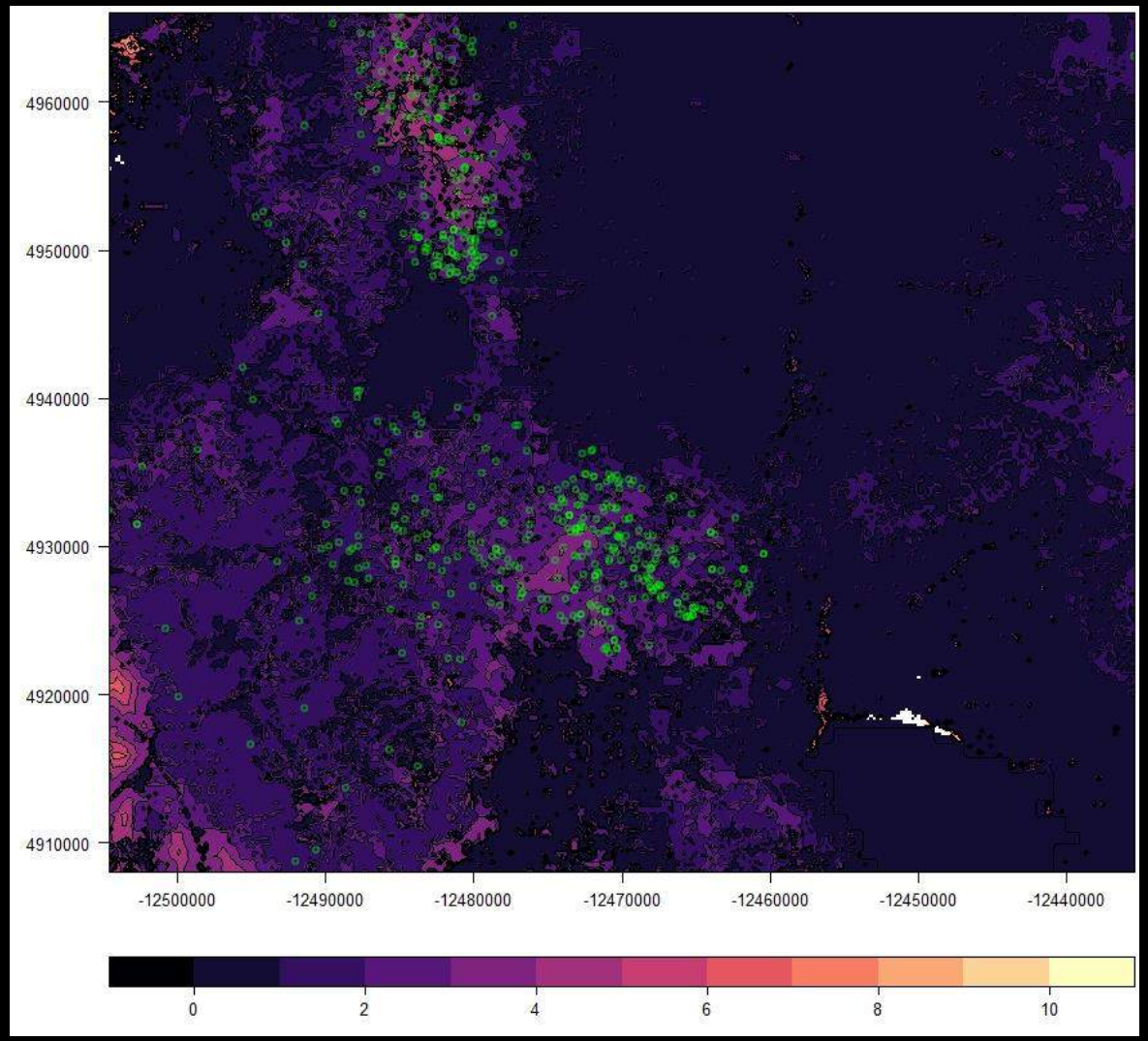
How does ALAN influence predation risk?

Artificial Nightlight

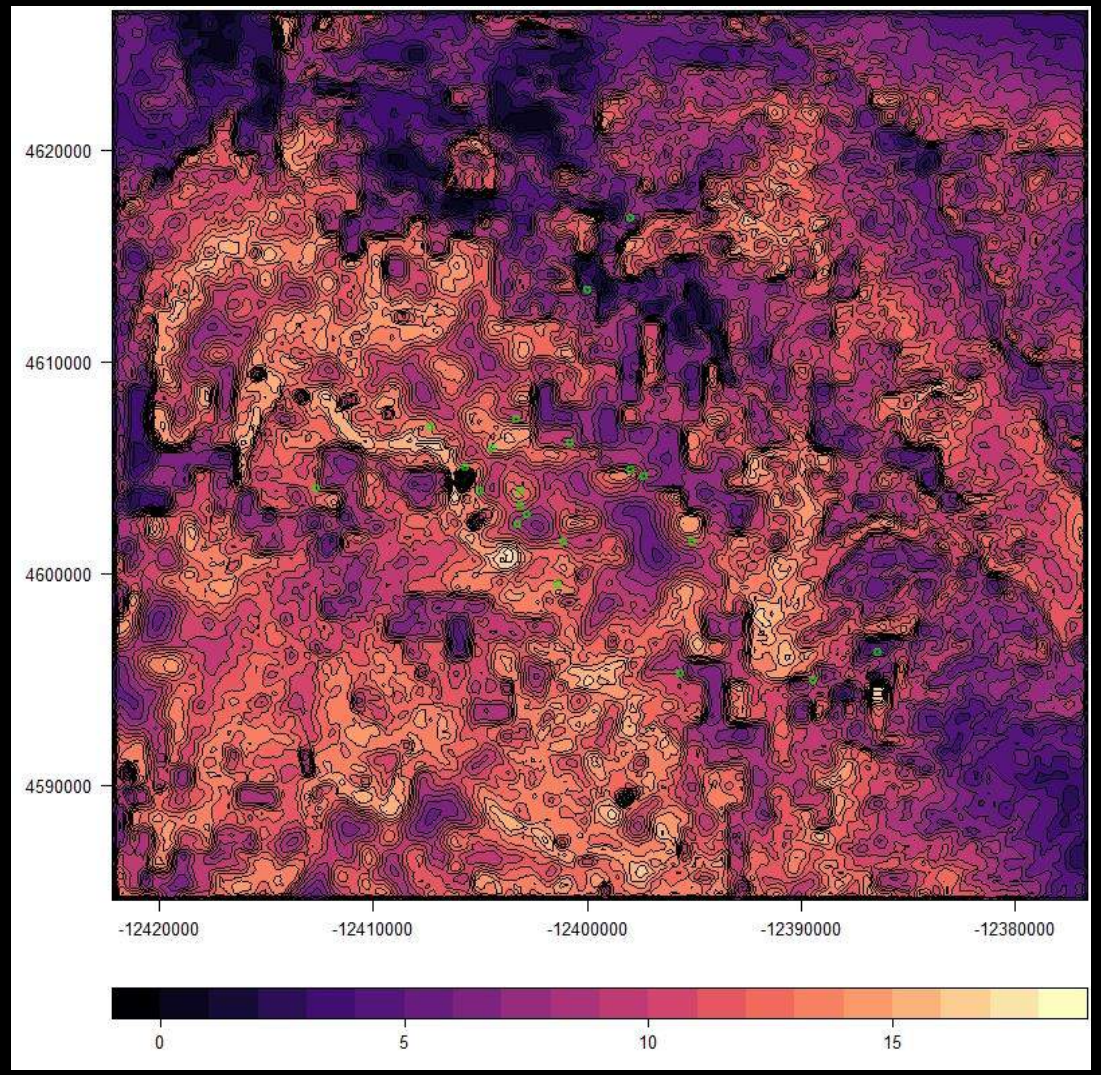


Spatial Prediction of Predation Risk

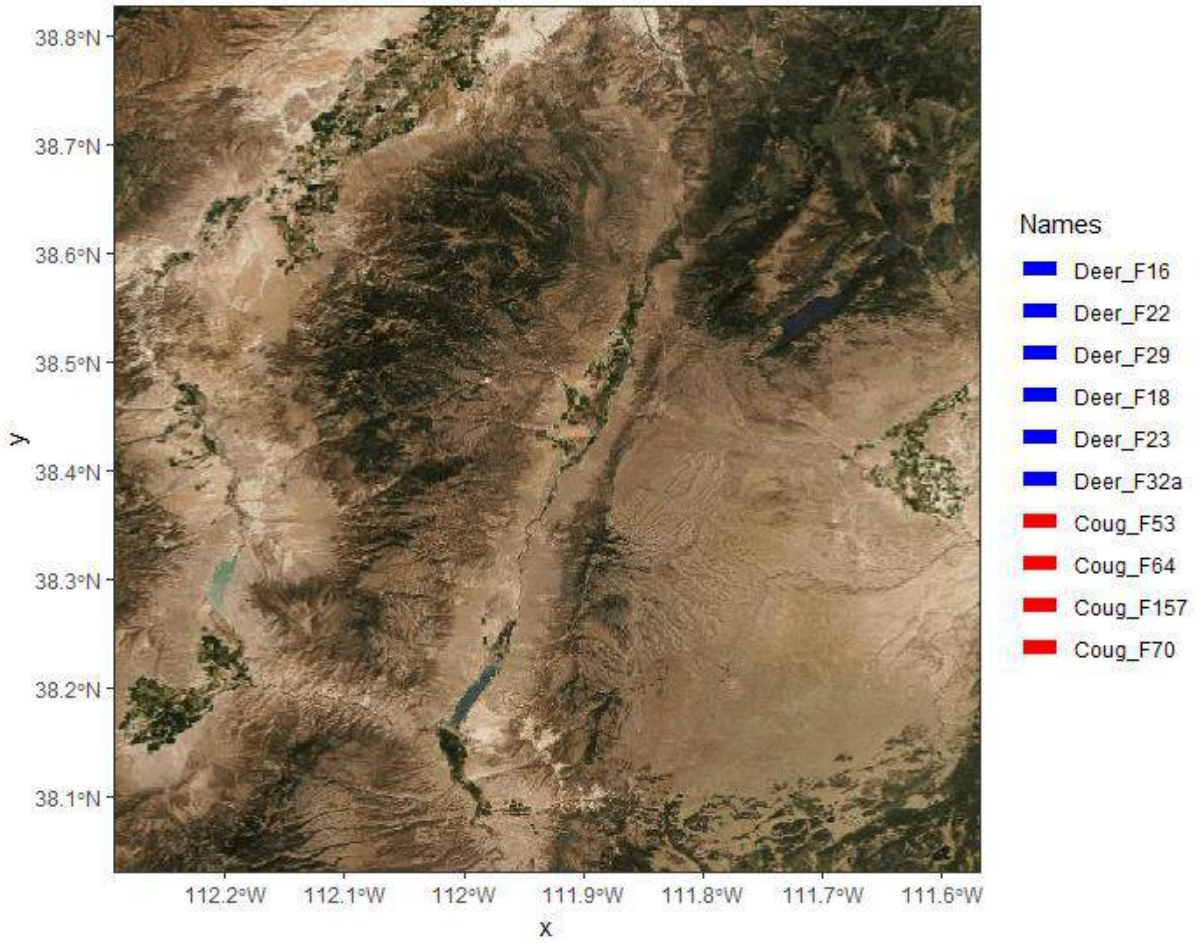
Salt Lake City

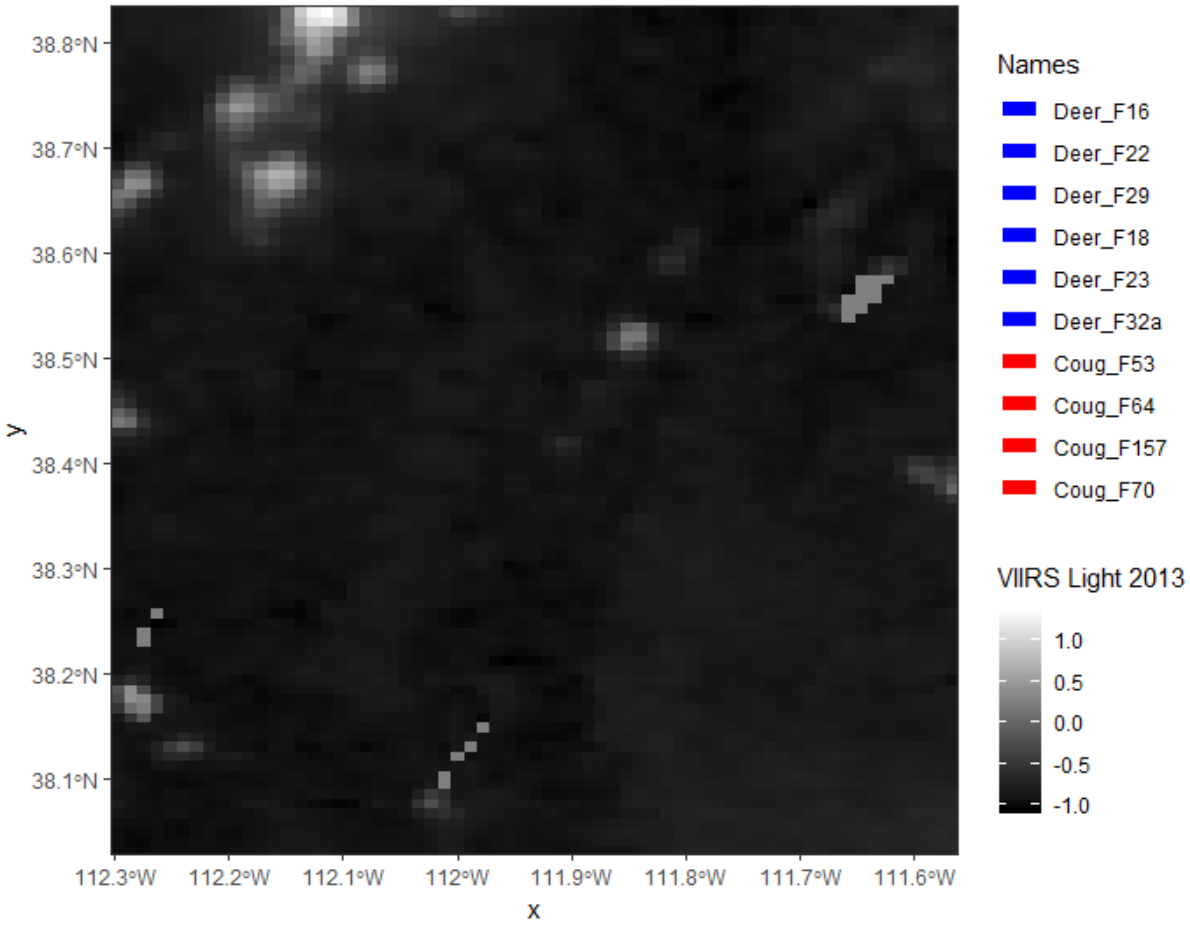


Capital Reef NP



How does ALAN influence habitat selection and movement?





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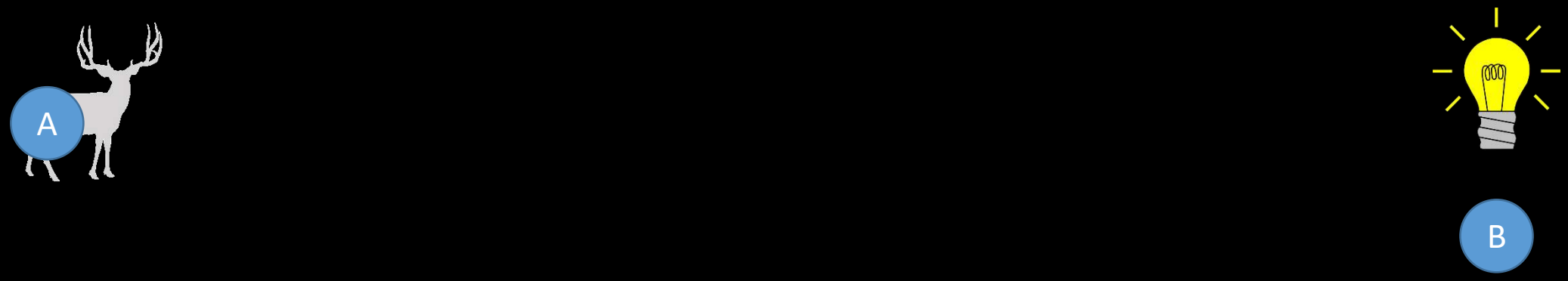

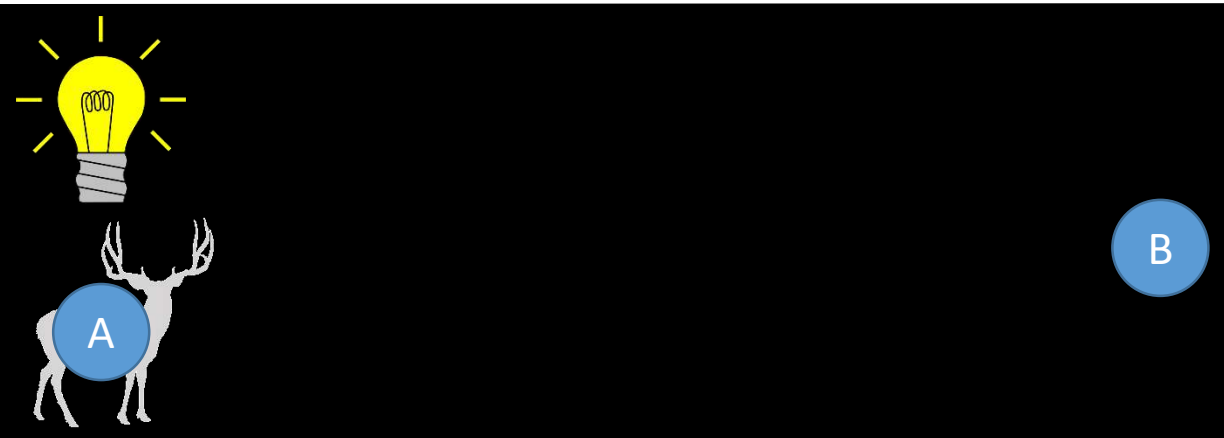

Preliminary Results (iSSF)

- Incorporated: 1) movement, 2) land cover, 3) landscape (dist. to edge), 4) traditional human metrics (e.g., road density), 5) NDVI, 6) nightlight

Deer top models (n = 228):

79% incorporated ALAN

12% traditional human metrics only

Cougar top models (n = 56):

75% incorporated ALAN

14% traditional human metrics only

Hypothesis Support

Limited Predator Buffet

- Large numbers of cache sites in urban-interface --

-- but they occurred in the relatively darkest locations

- Activity and iSSF analysis (preliminary) of both deer and cougars appear to also support the limited buffet idea

Conclusions

- At a macro-scale predators and prey respond differently to nightlight across the gradient
- Nightlight influence on fundamental ecological processes and ecosystem services
- Predict effects of increasing nightlight (area and intensity) on wildlife communities and dynamics

Thanks!

Data Contribution:

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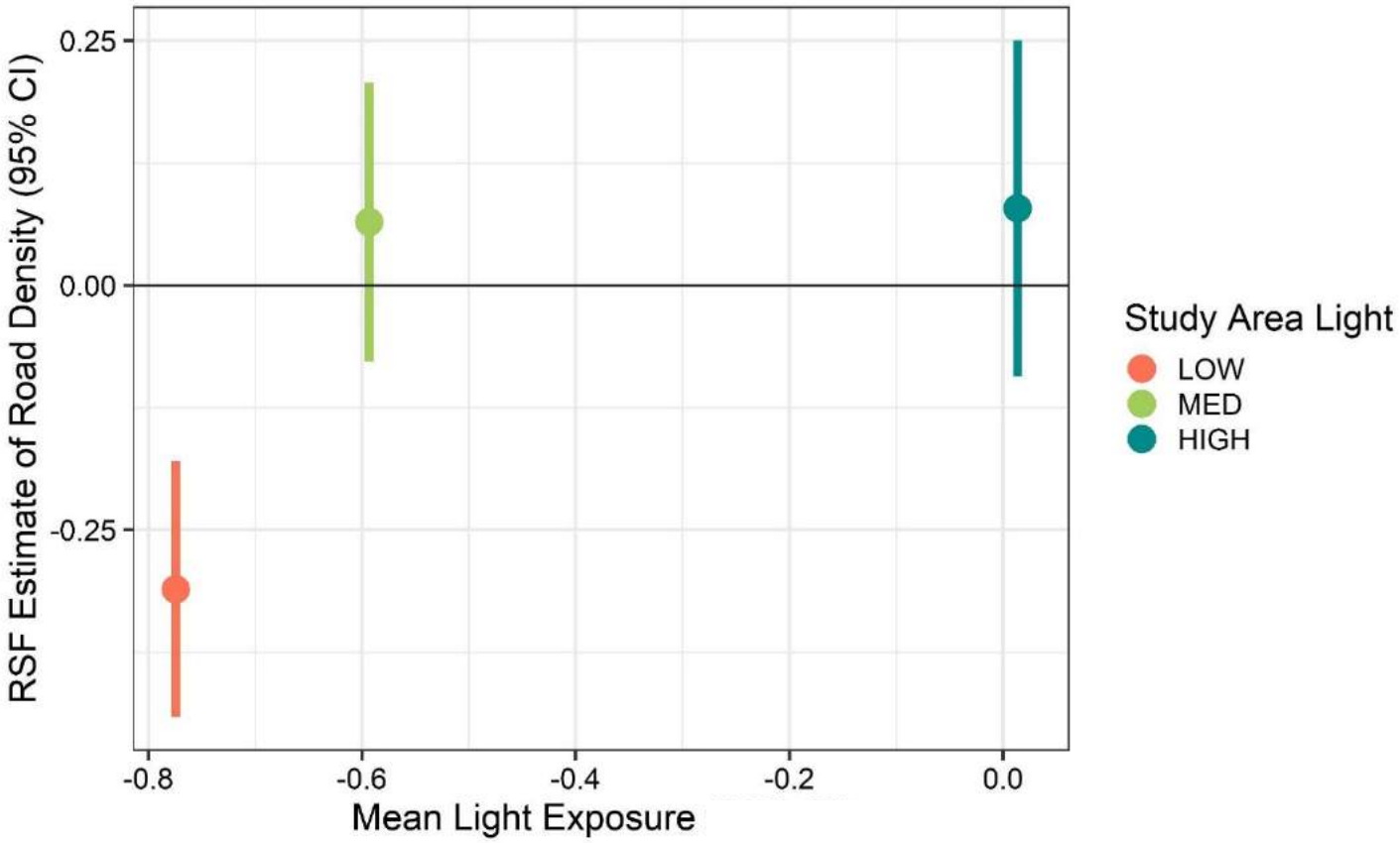
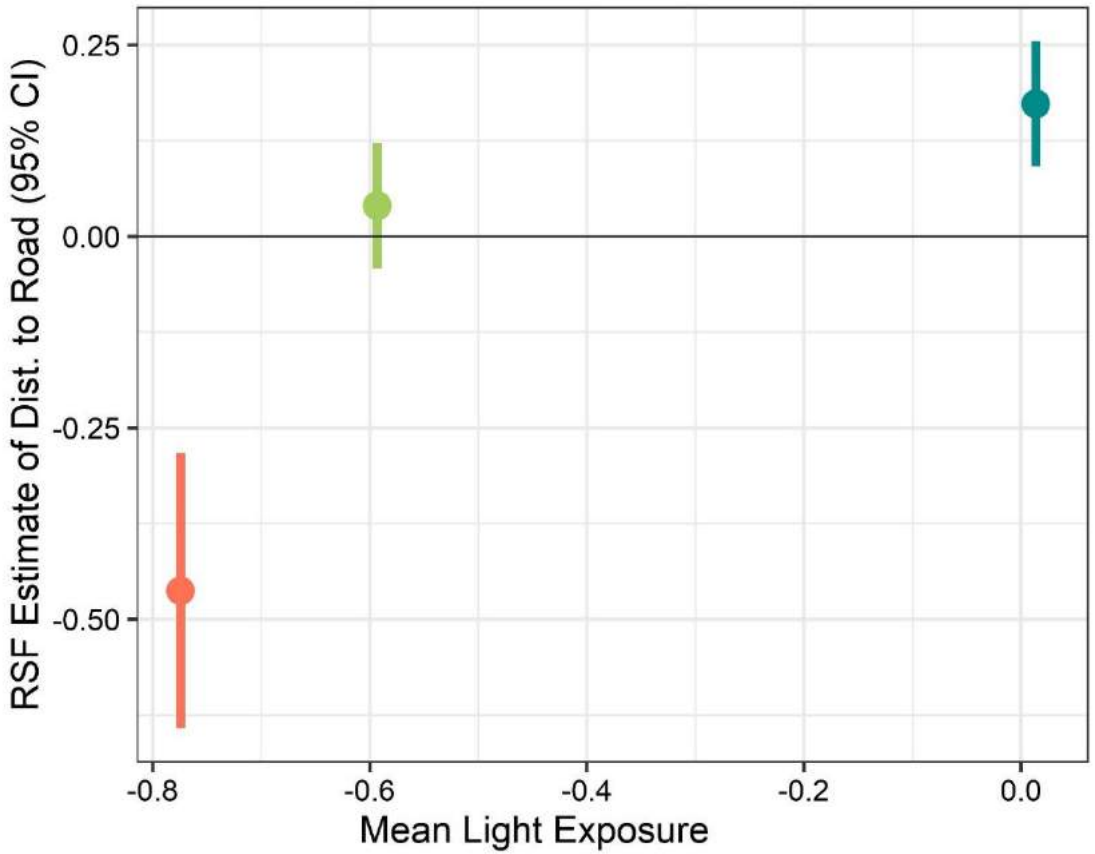
School for Environment and Sustainability

How does ALAN influence predation risk?
- Roads (density & distance)-





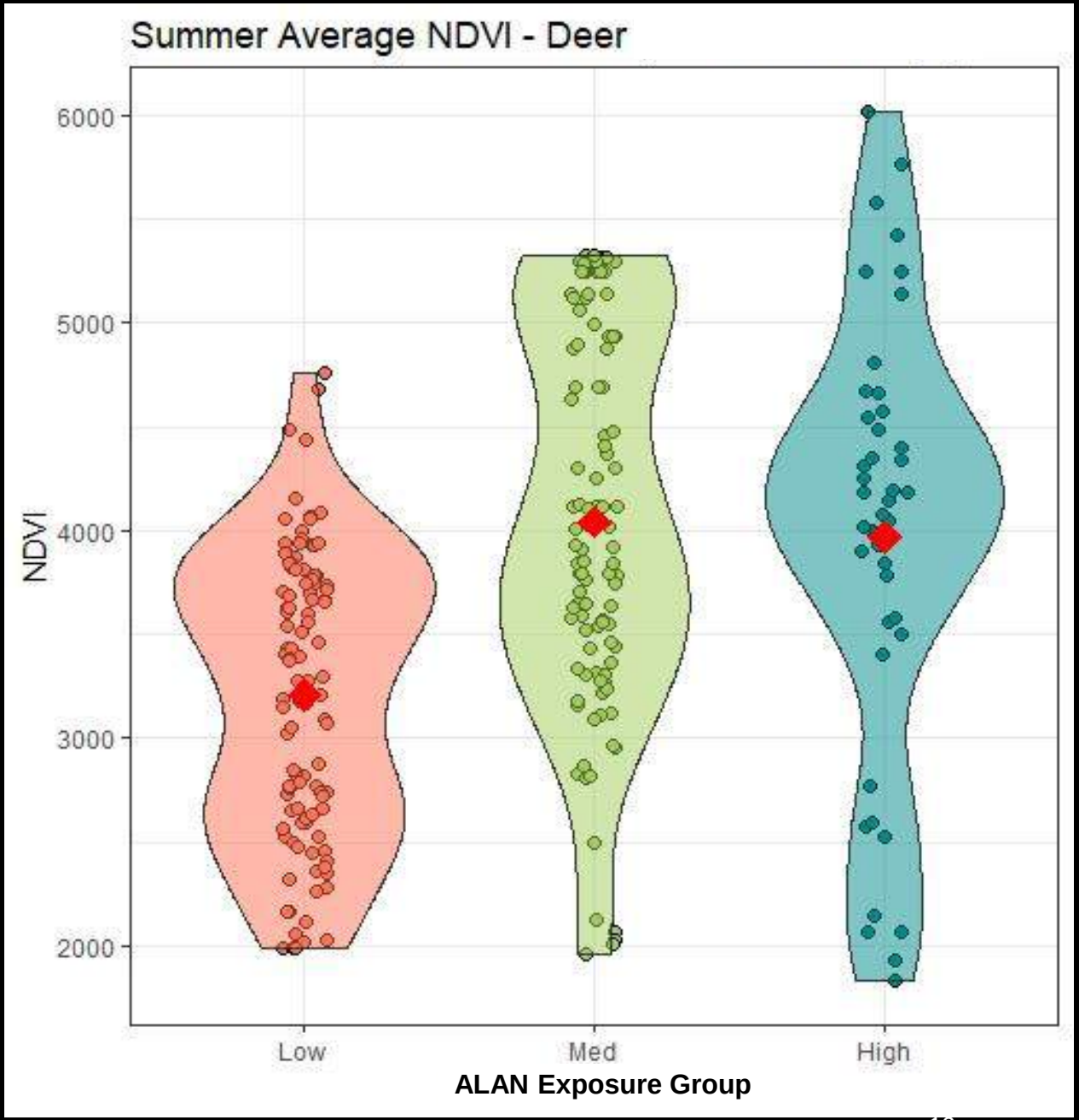
Changing Risk Landscapes Across Nightlight Gradient

LOW Light	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-8.00	0.08	-105.8	< 2e-16
scale(rough)	0.09	0.05	1.95	0.05
scale(Lt2015)	0.03	0.06	0.46	0.64
scale(MaxHous)	0.00	0.11	-0.02	0.98
scale(RDdenc)	-0.31	0.07	-4.65	0.00
scale(RdDistc)	-0.46	0.09	-5.05	0.00
scale(dist2edge)	-0.53	0.10	-5.20	0.00
NLCDHCropPast	-2.21	0.72	-3.07	0.00
NLCDHDevel	-0.98	0.73	-1.35	0.18
NLCDHHerb_Barren	-0.16	0.16	-0.99	0.32
NLCDHOpnWtr	-11.63	171.74	-0.07	0.95
NLCDHShrub	-0.69	0.11	-6.54	0.00
NLCDHWetland	-1.02	0.71	-1.44	0.15

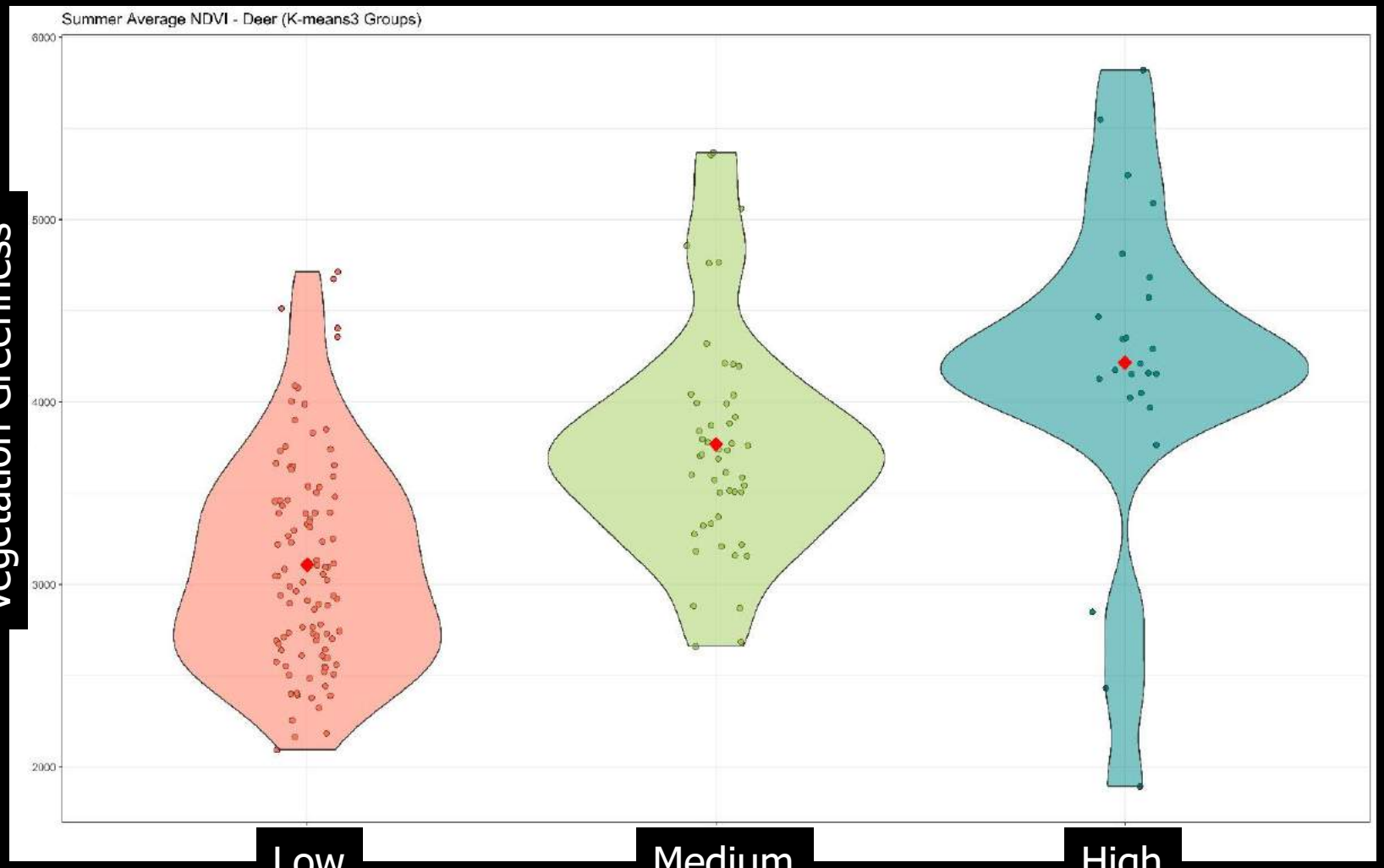
MED. Light	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-6.41	0.10	-66.18	< 2e-16
scale(rough)	0.39	0.04	10.94	< 2e-16
scale(Lt2015)	0.23	0.05	4.27	0.00
scale(RDdenc)	0.06	0.07	0.89	0.37
scale(RdDistc)	0.04	0.04	0.95	0.34
scale(dist2edge)	-0.23	0.07	-3.27	0.00
scale(MaxHous)	-0.88	0.43	-2.03	0.04
NLCDHCropPast	-0.66	0.46	-1.43	0.15
NLCDHDevel	-1.08	0.45	-2.40	0.02
NLCDHHerb_Barren	-0.92	0.27	-3.42	0.00
NLCDHOpnWtr	-0.29	1.01	-0.29	0.77
NLCDHShrub	0.02	0.09	0.27	0.79
NLCDHWetland	1.24	0.33	3.75	0.00

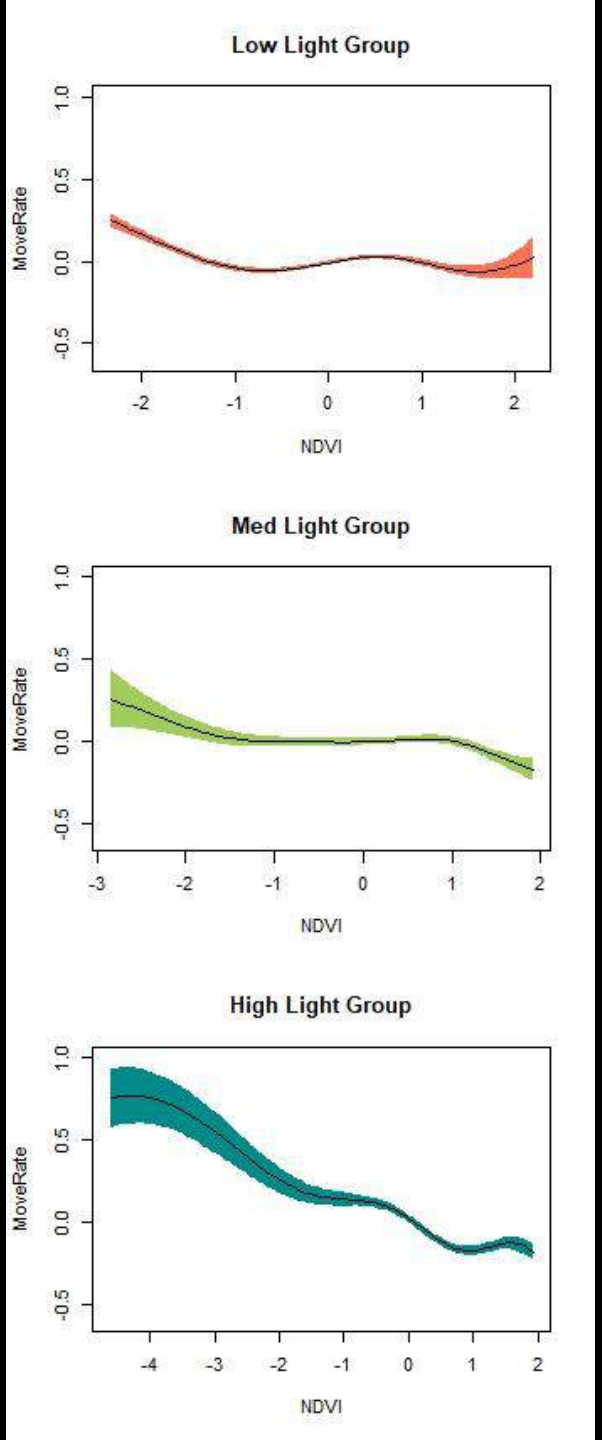
HIGH Light	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-3.68	0.12	-29.93	< 2e-16
scale(RdDistc)	0.17	0.04	4.15	0.00
scale(dist2edge)	0.16	0.07	2.24	0.03
scale(RDdenc)	0.08	0.09	0.90	0.37
scale(MaxHous)	0.00	0.13	0.04	0.97
scale(rough)	-0.16	0.06	-2.61	0.01
scale(Lt2015)	-0.38	0.09	-4.45	0.00
NLCDHCropPast	-1.74	0.39	-4.46	0.00
NLCDHDevel	-2.41	0.67	-3.62	0.00
NLCDHHerb_Barren	-0.58	0.21	-2.77	0.01
NLCDHOpnWtr	-10.55	264.41	-0.04	0.97
NLCDHShrub	0.68	0.13	5.29	0.00
NLCDHWetland	1.38	0.28	5.01	0.00

Resources vs Risk



Activity Analysis – Vegetation Greenness

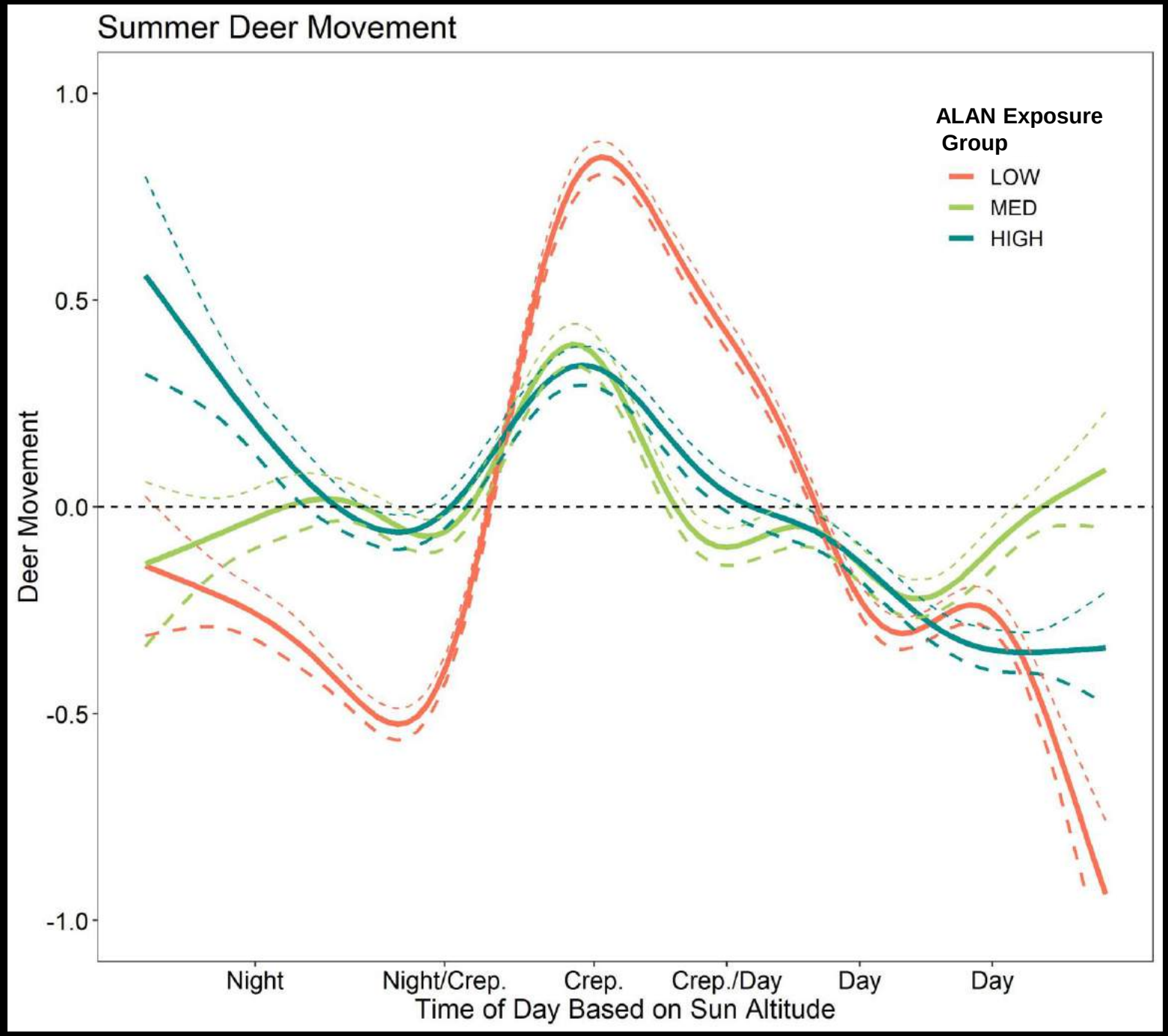




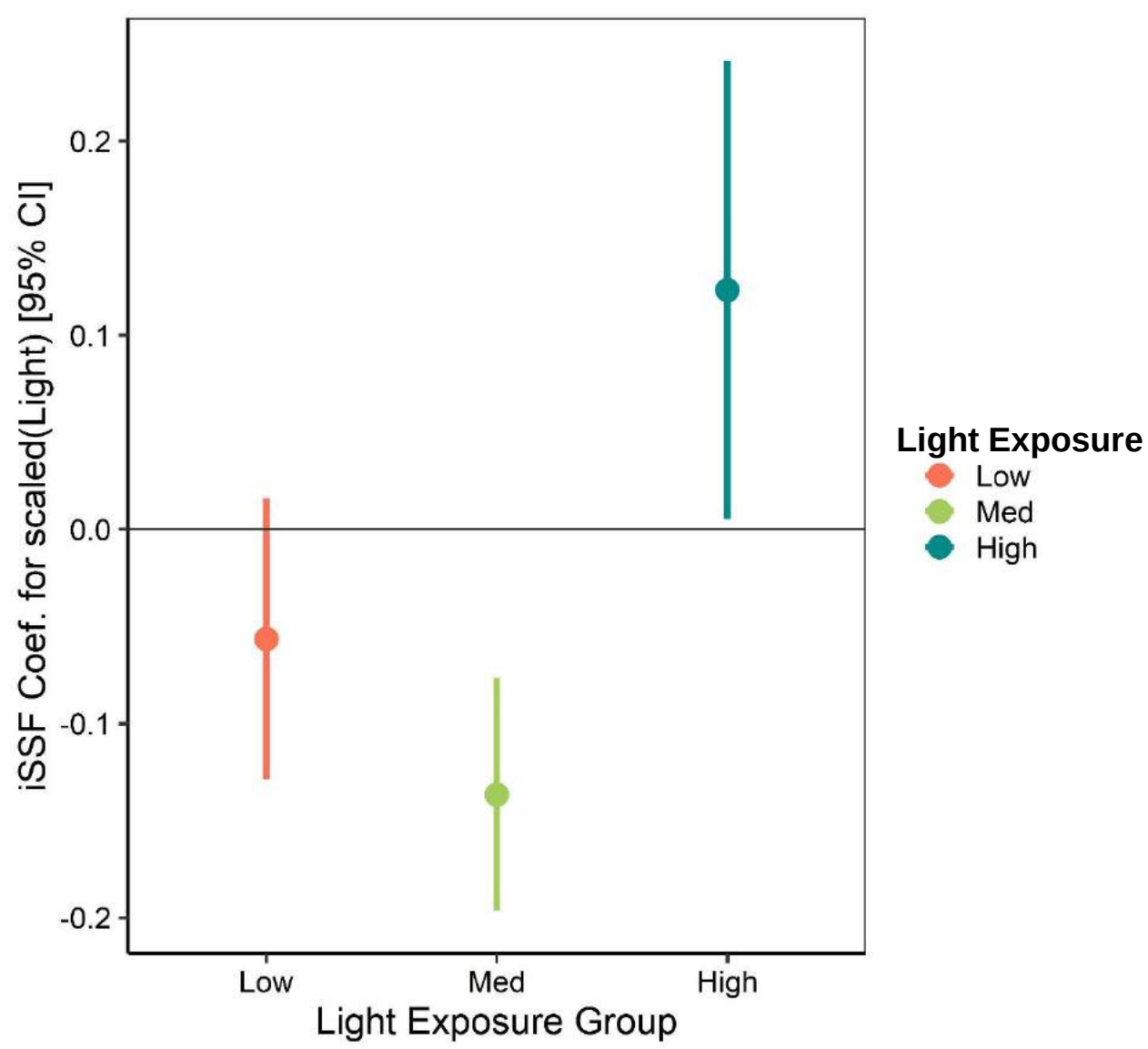
Activity Analysis – Activity Period

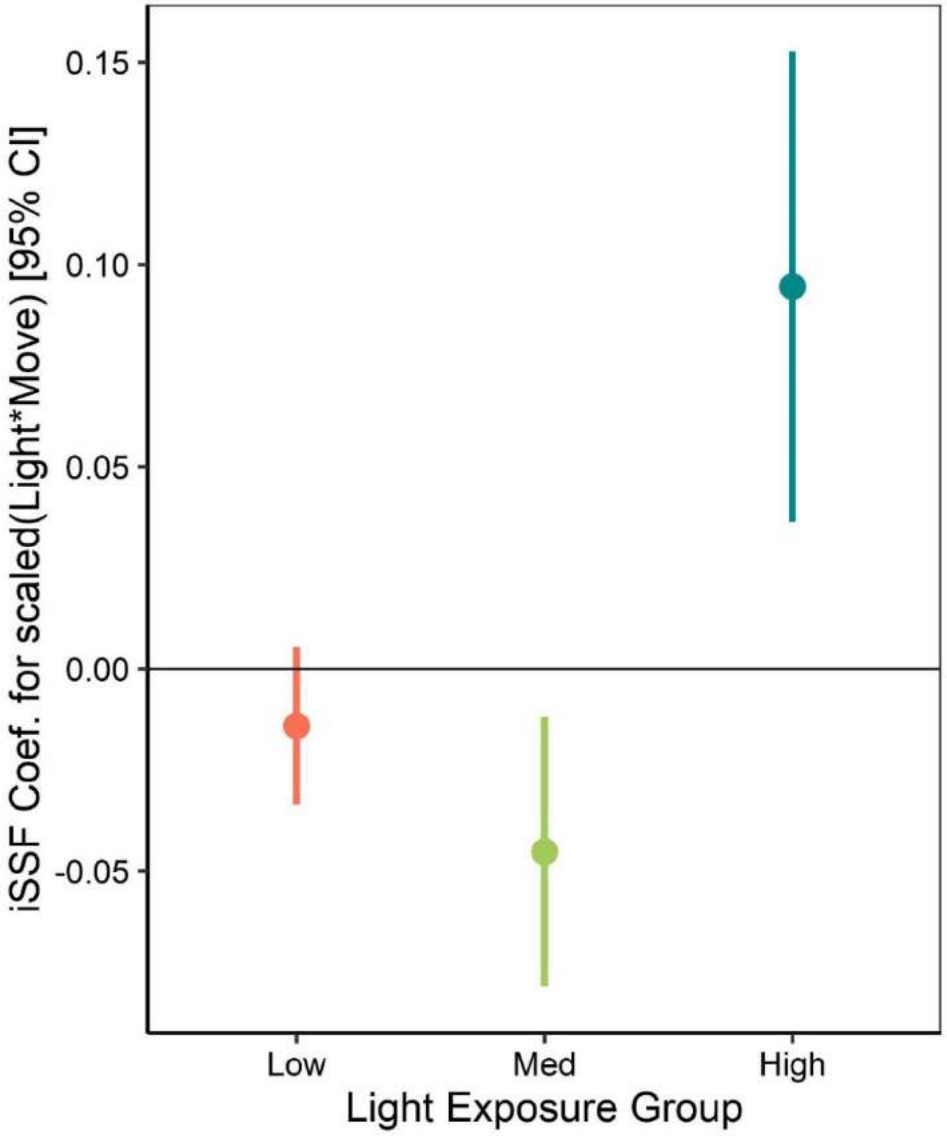
Predator Buffet: Activity periods shorten in high ALAN sites – go here anyways due to higher NDVI

Predator Shield: Activity lengthens and drastic change from darker sites –more activity at night since cougars not a threat (avoid humans)



Mule Deer iSSF Results

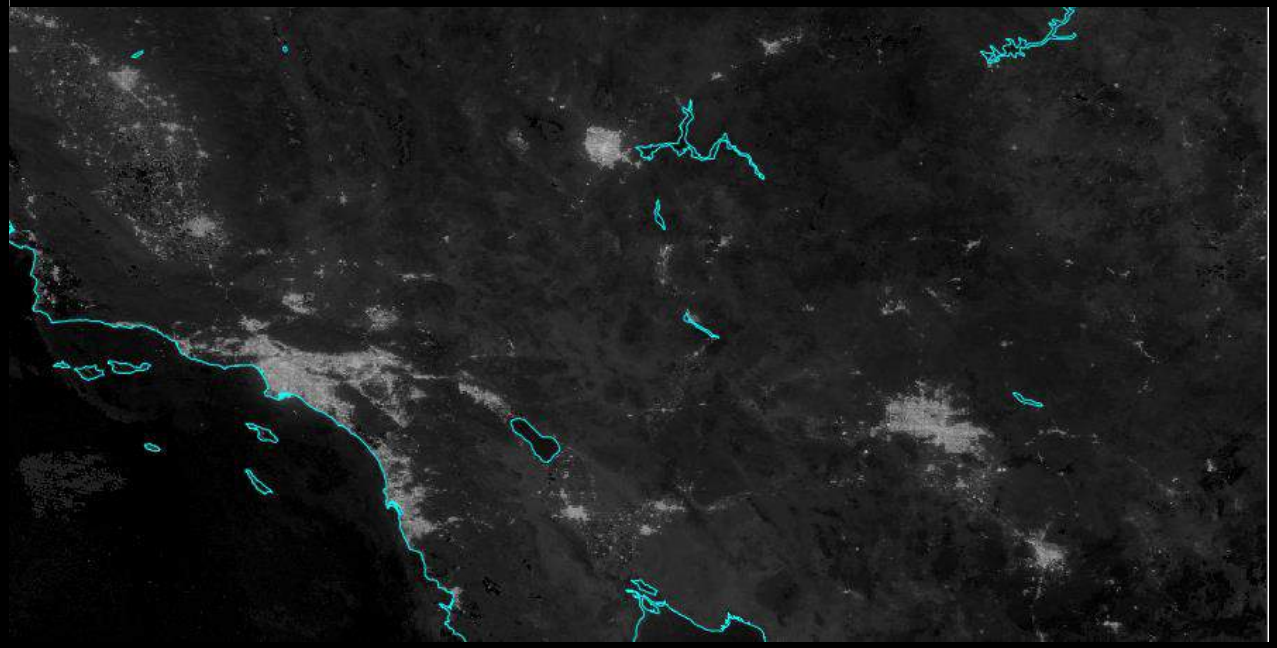
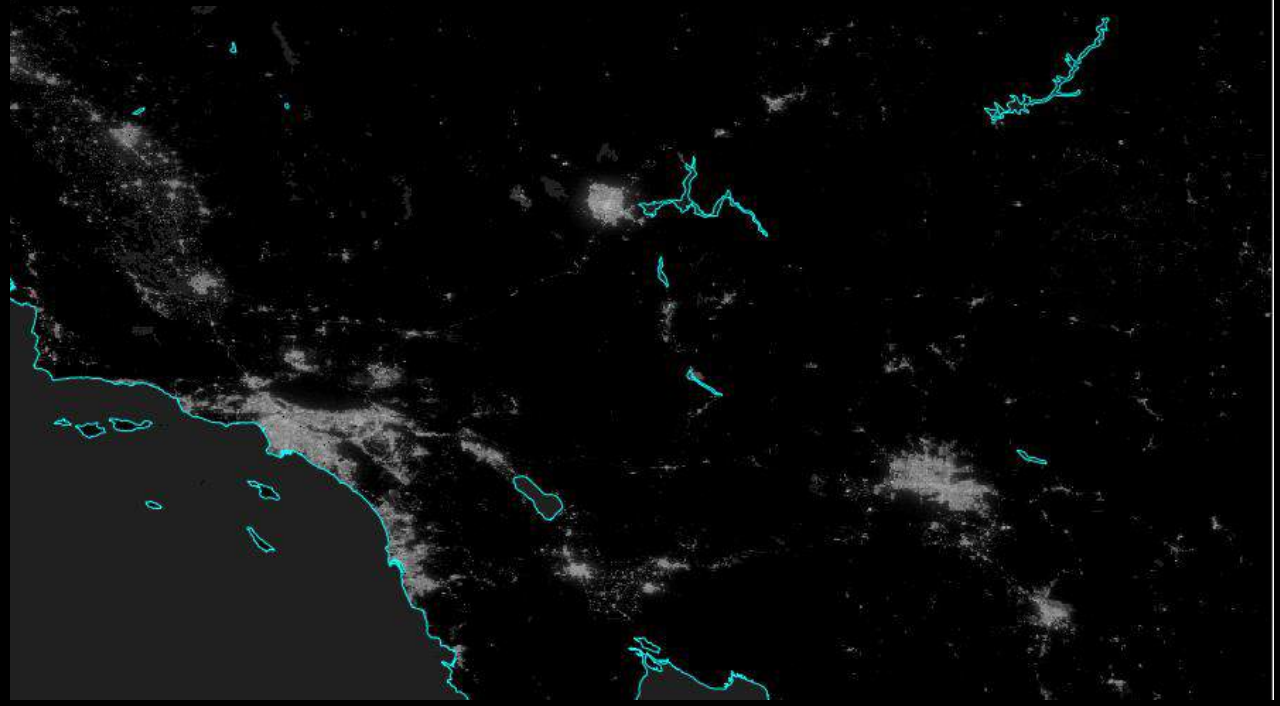




Light Exposure
- Low
- Med
- High

Nightlight monthly composites (blackmarble)

DNB, cloud-cleared, composite **without** lunar BRDF correction



DNB, cloud-cleared, composite **with** lunar BRDF correction