Using NASA resources to better inform wildlife conservation in the Anthropocene: Spatially predicting impacts of anthropogenic nightlight and noise on wildlife habitat integrity across the contiguous United States

NASA Ecological Forecasting Project 2017-2021

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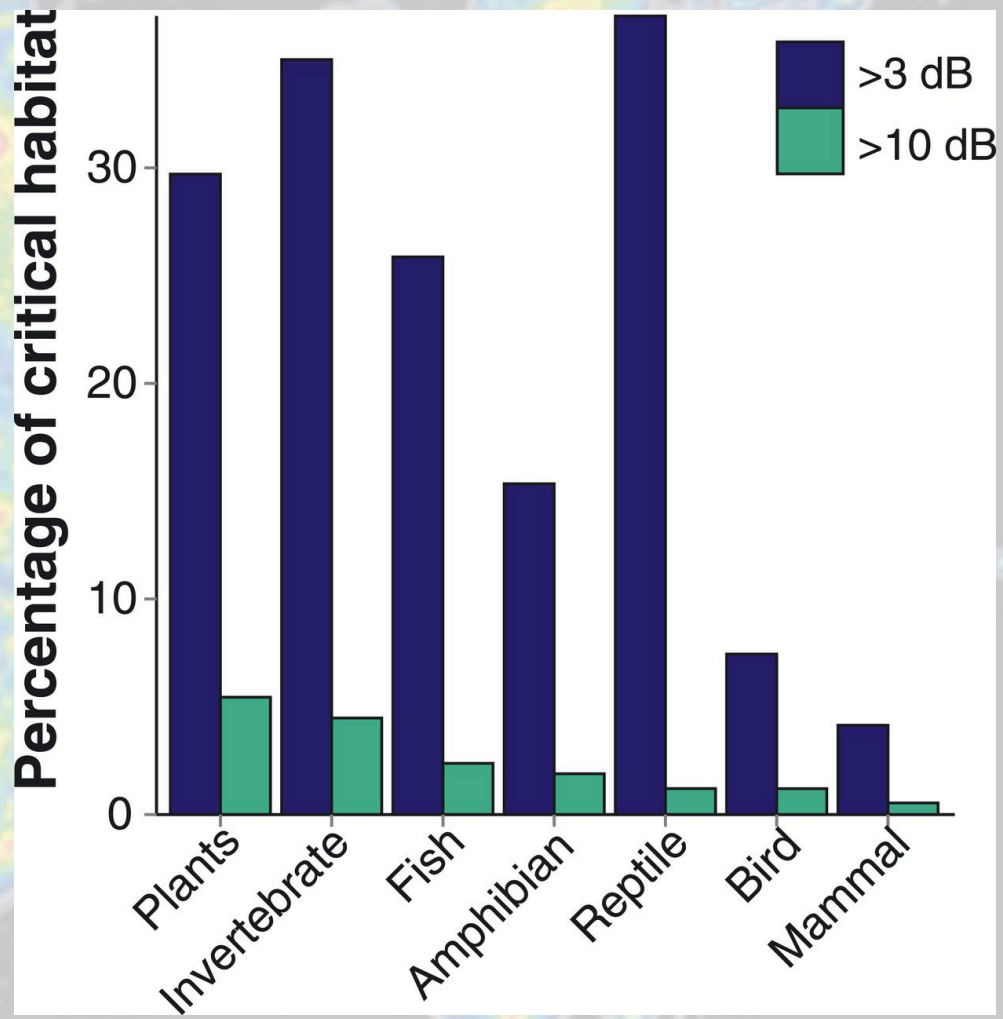
Partners: National Park Service Natural Sounds and Night Skies Division

Outline

- Animal sensitivity
- Macro-scale sensory stimuli data
- Spatial planning tools

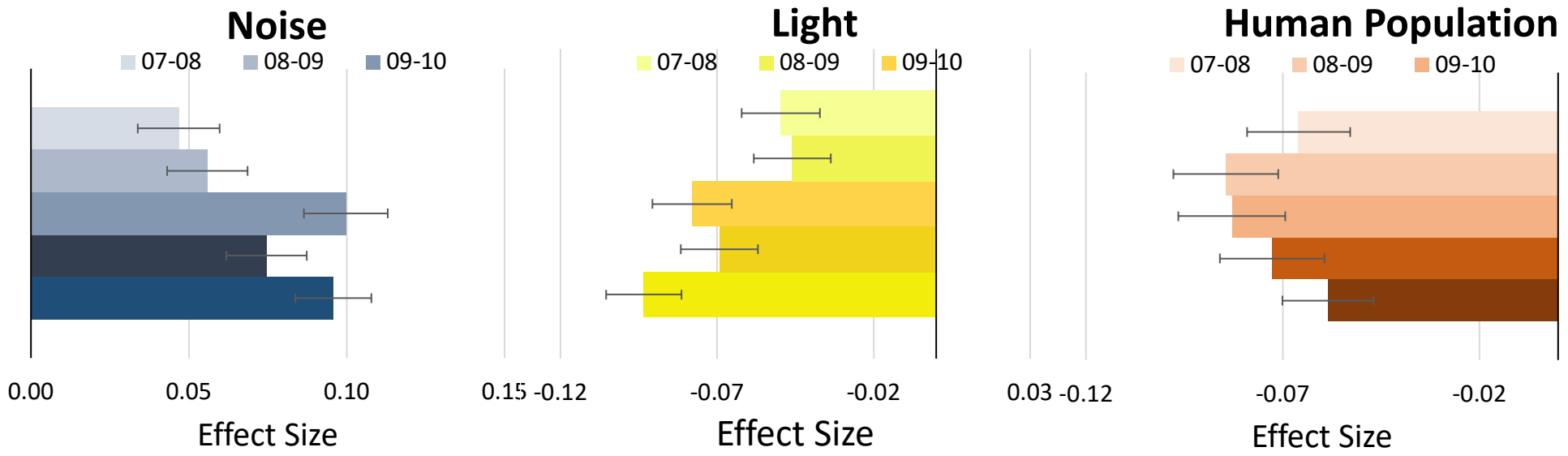
Bright lights, loud people

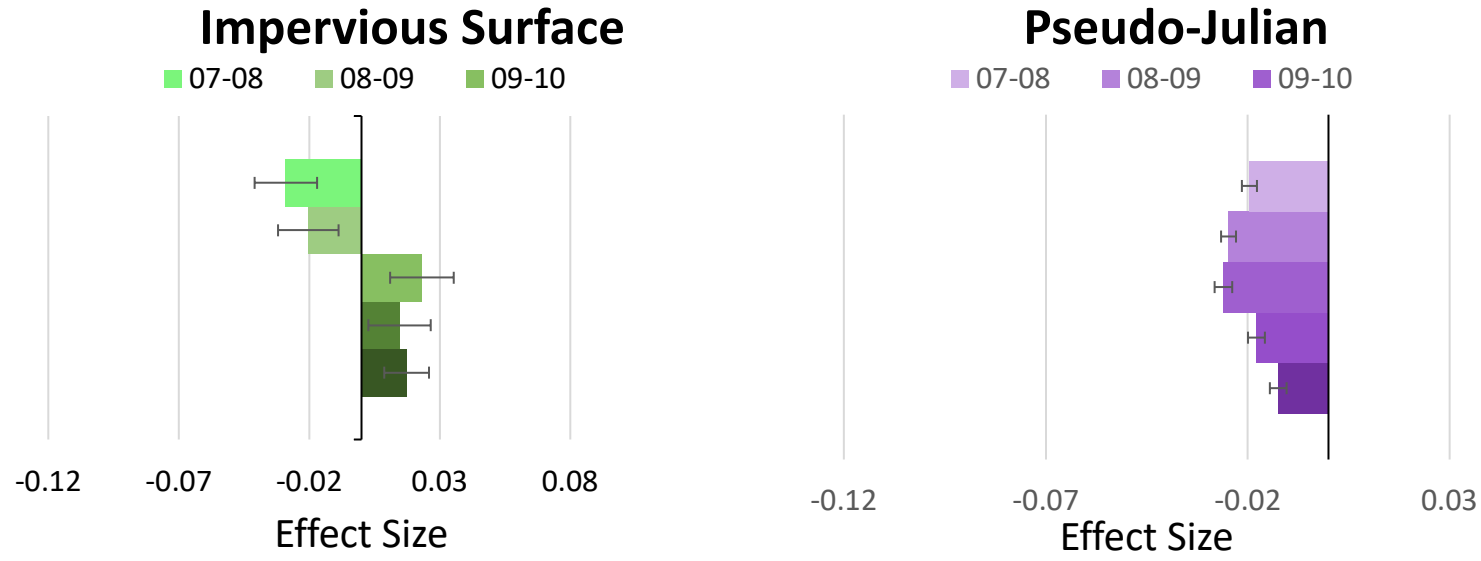
- Light and noise pollution
  - Pervasive and spreading
  - Encroaching protected areas and critical habitats
  - *Understudied*
  - Insufficient information for conservation planning



Buxton et al. 2017, Falchi et al. 2016, Gaston et al. 2014, Mennitt et al. 2013

Macroecological Variable Effects on Bird Abundance Across 5 Years



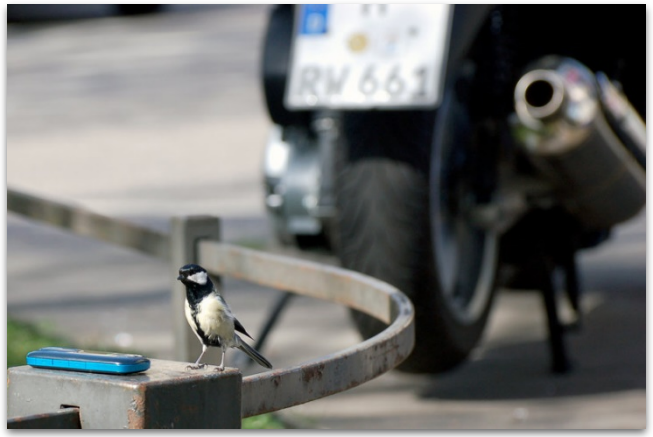


Fill knowledge gaps – link micro to macro

Traits

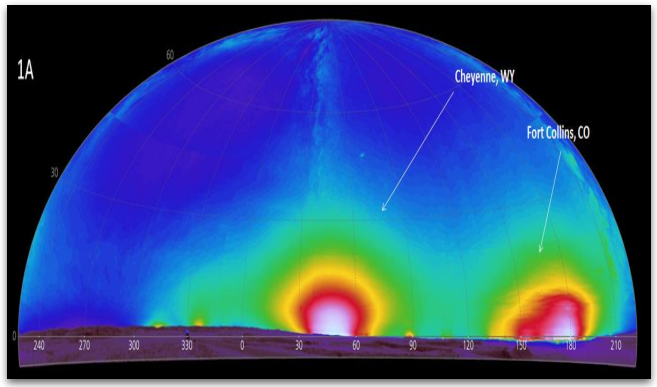
Sensitivity to light

Sensitivity to sound

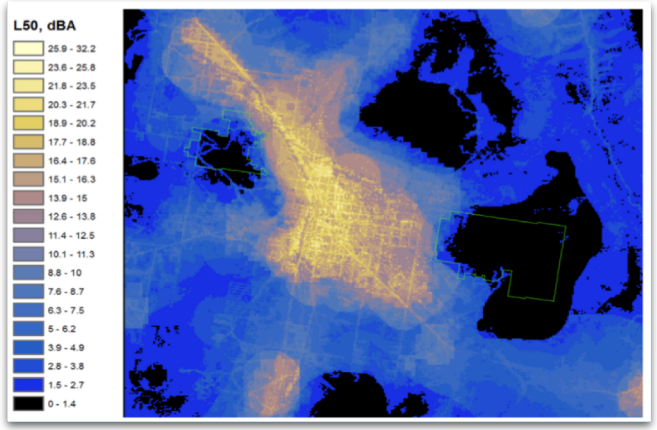


Remotely-sensed data

Light pollution - VIIRS

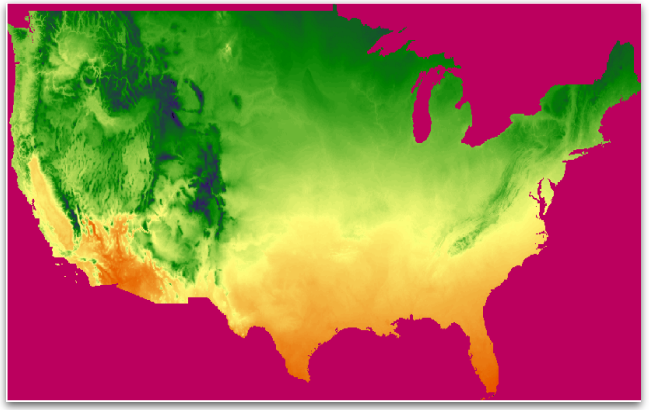


Noise pollution - NPS



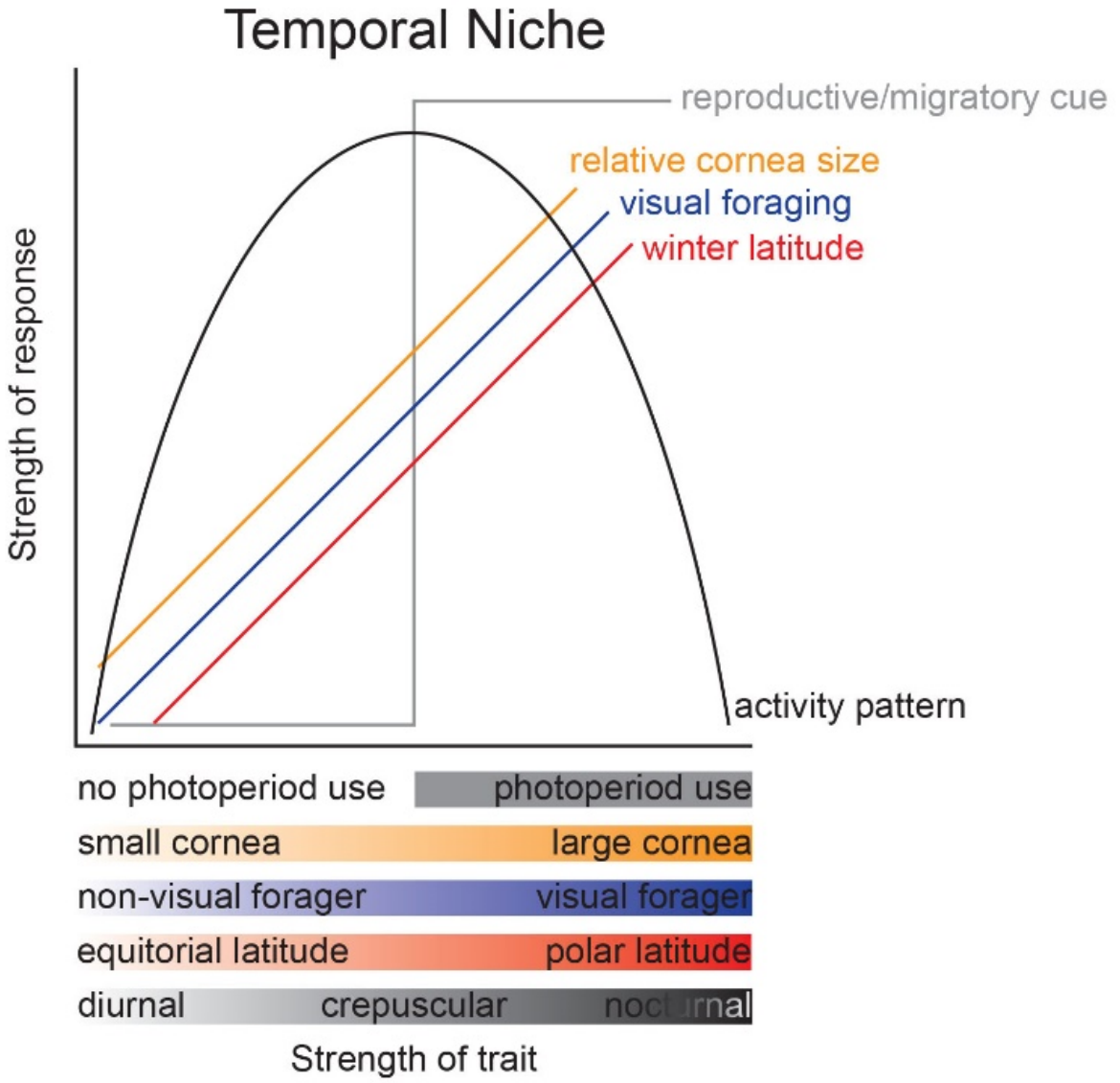
Spatial planning tools

CONUS



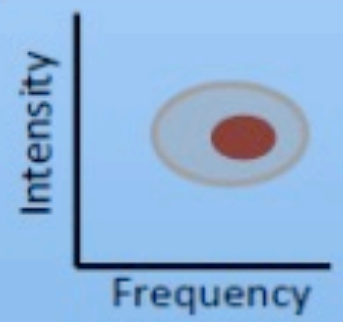
Protected areas

Workshop 2017– Traits predicting sensitivity



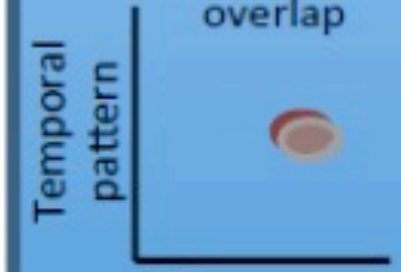
Mechanisms

Effect strength covaries with stimulus level received



Masking[1]
uni-modal & on-band

Distraction[2]
uni- or cross-modal
on or off-band



Misleading[3]
uni-modal cue (mis-)matching

Consequences

Lower Fitness	Equal Fitness	Higher Fitness
Cost	Cope	Benefit

Masking

Lost Information[4]	e.g. signal shifts[5]	Hidden Information / Distractors[6]

Distraction

Divided Attention Limits Information Processing[7]	e.g. reduce task difficulty via habituation[8]	unknown

Misleading

Maladaptive[9]	e.g. modality flexibility[10]	Adaptive[11] (e.g., extension of temporal niche)

Expert elicitation survey – quantify sensitivities

	Under elevated **LIGHT** levels, what is the impact of this trait on vulnerability?	Level of Certainty in Your Response	Notes	Under elevated **NOISE** levels, what is the impact of this trait on vulnerability?	Level of Certainty in Your Response	Notes
Nocturnal activity pattern						
High winter latitude						
High trophic level						
Habitat specialist						
Narrow niche breadth						
Non-migratory						

Macro-scale data on sensory pollution

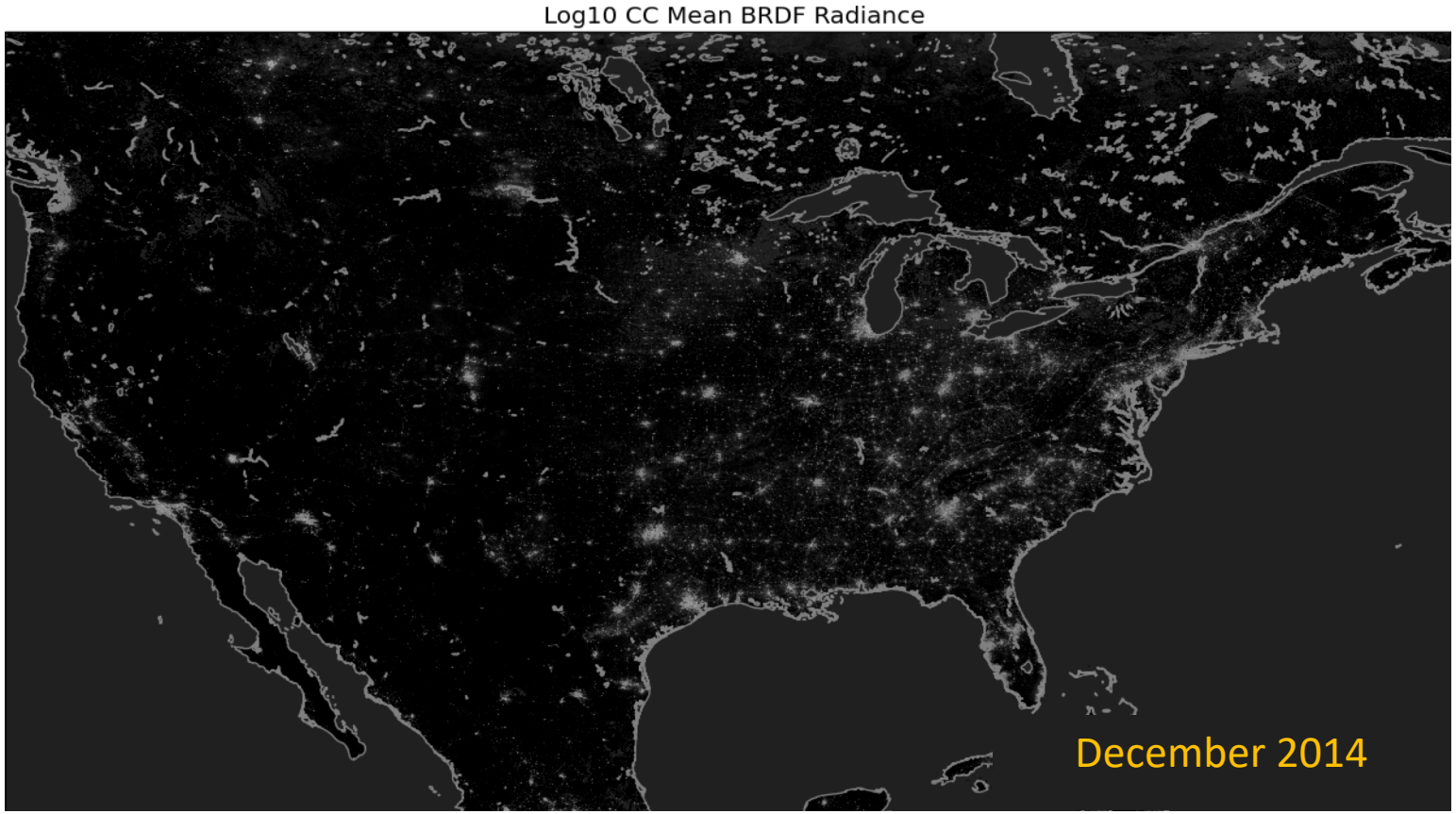
Light pollution – VIIRS day-night band

Current test and Evaluation Product:

- 1 km resolution
- Post processing retrieval algorithm uses all high quality, cloud-free, atmospheric-, terrain-, vegetation-, snow-, lunar-, and stray light-corrected radiances to estimate daily nighttime lights and other intrinsic surface optical properties (Román et. al, 2018)

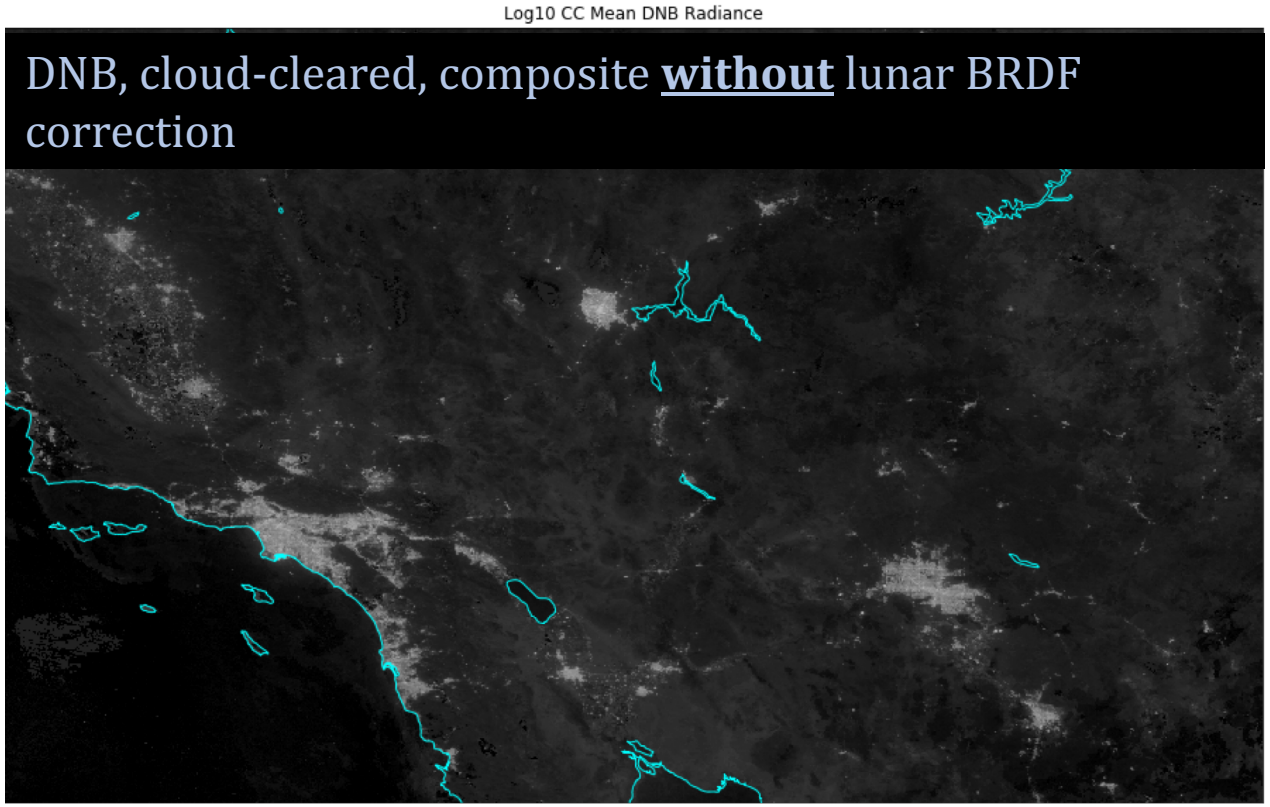
Planned Near Real Time Product:

- 500 m resolution data from VIIRS Day/Night Band (DNB) sensor

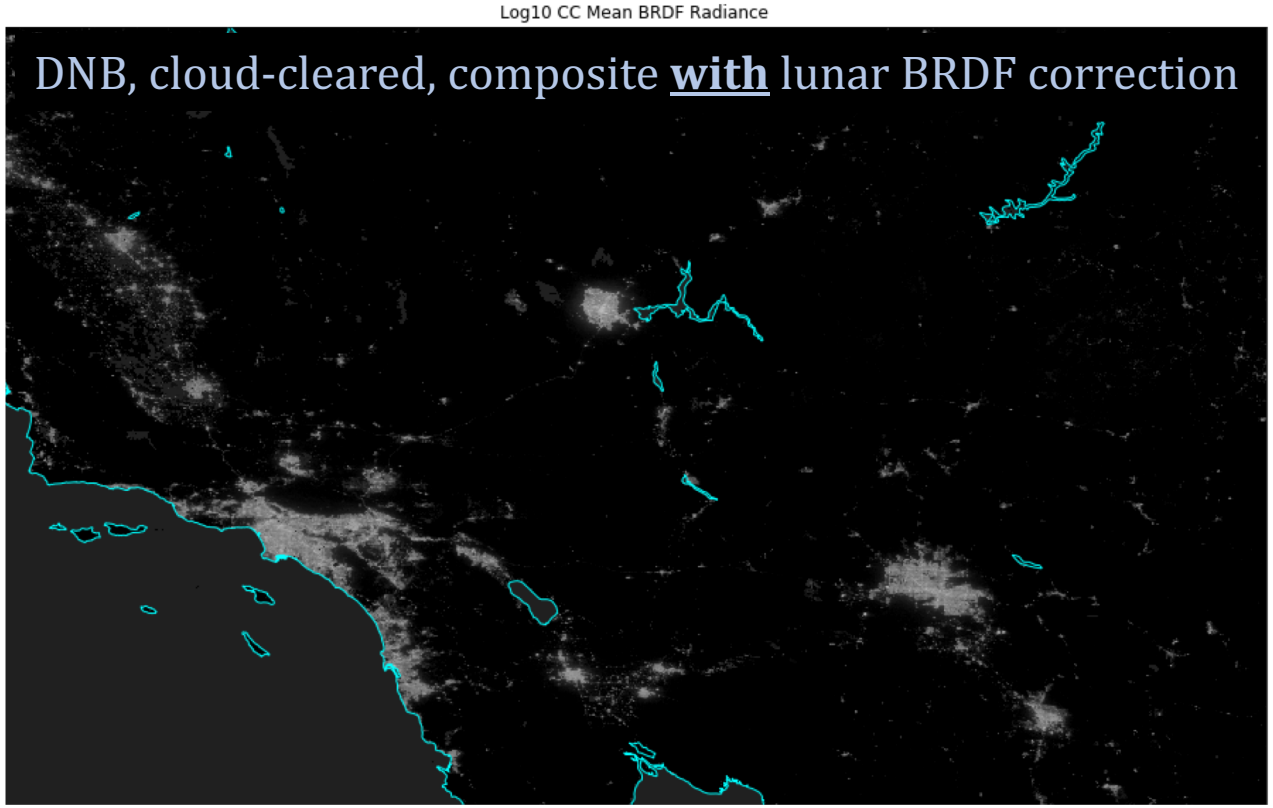


Monthly cloud-free composite images of the corrected radiance values over the CONUS for 2014.

August 2014 monthly composite comparison

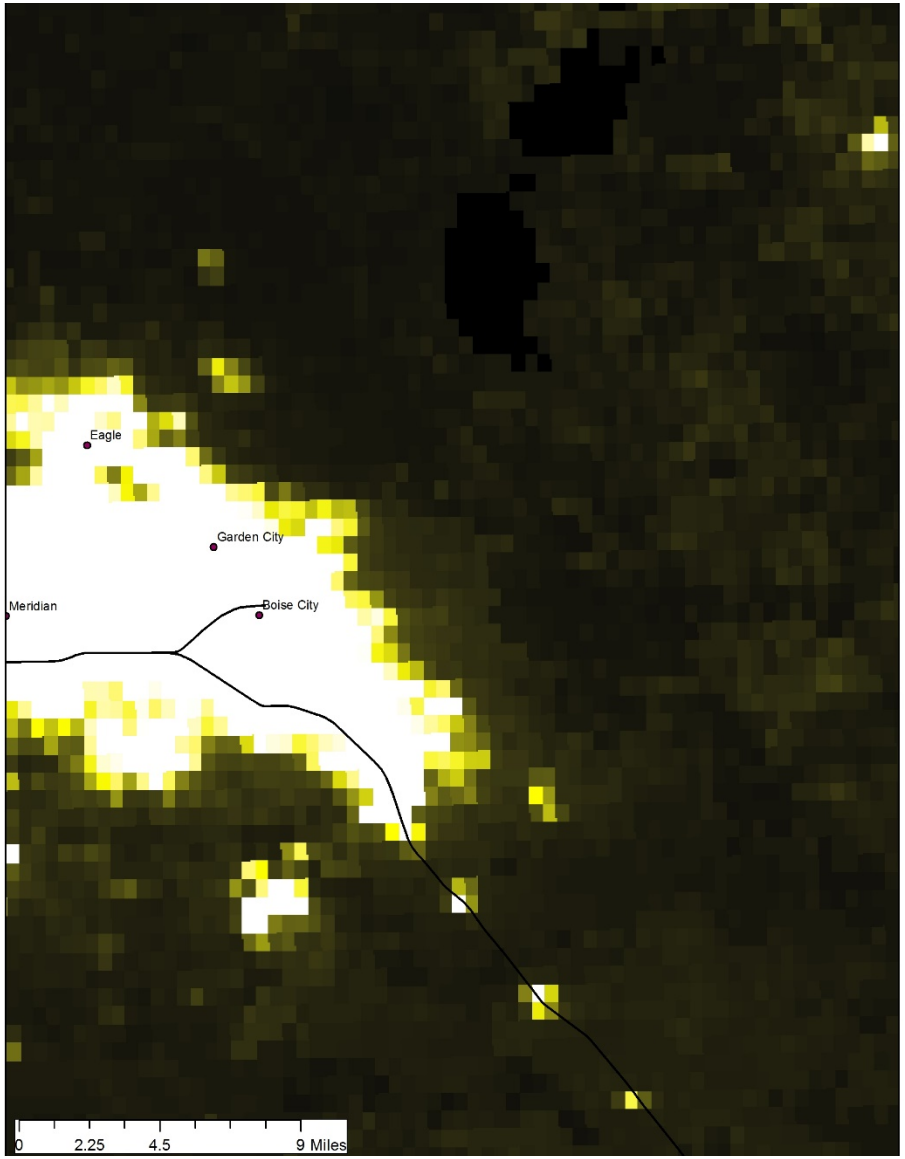


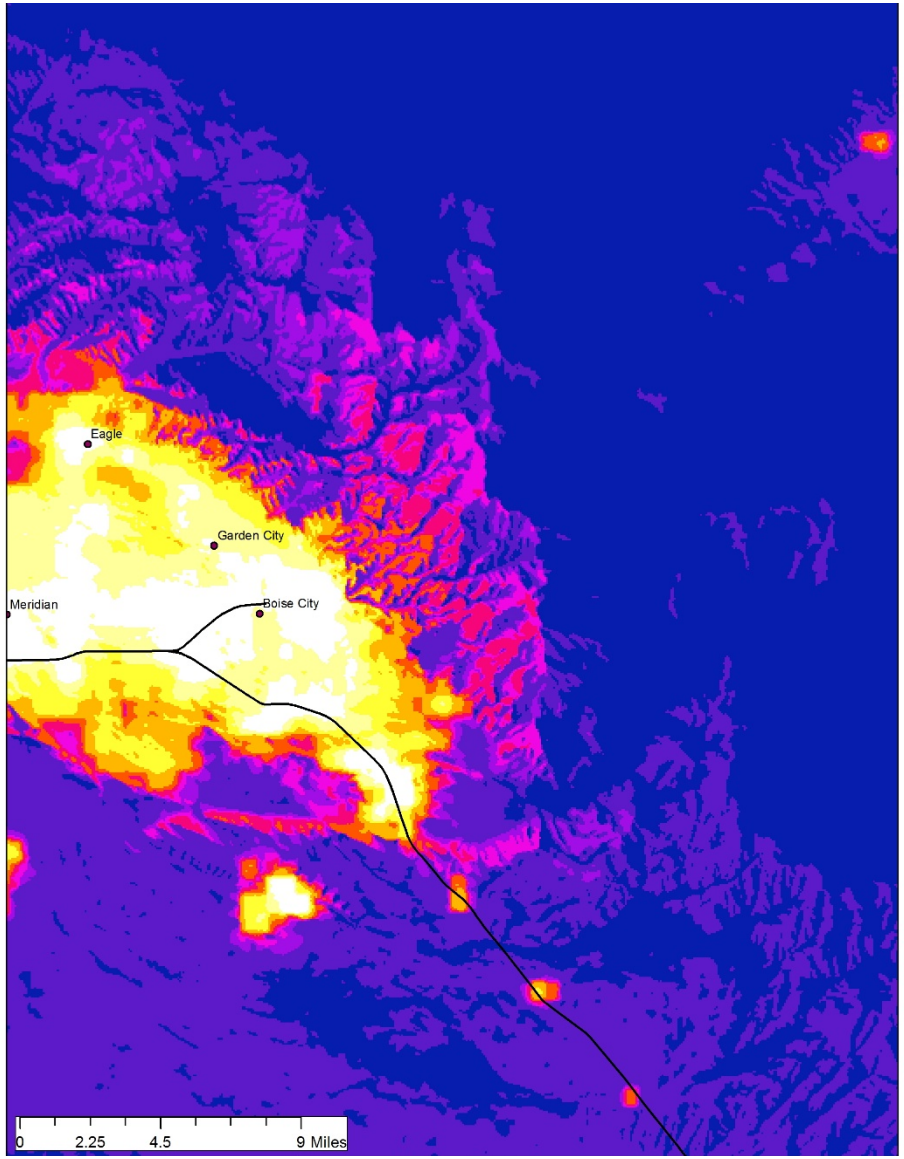
Lunar illuminance showing ground features



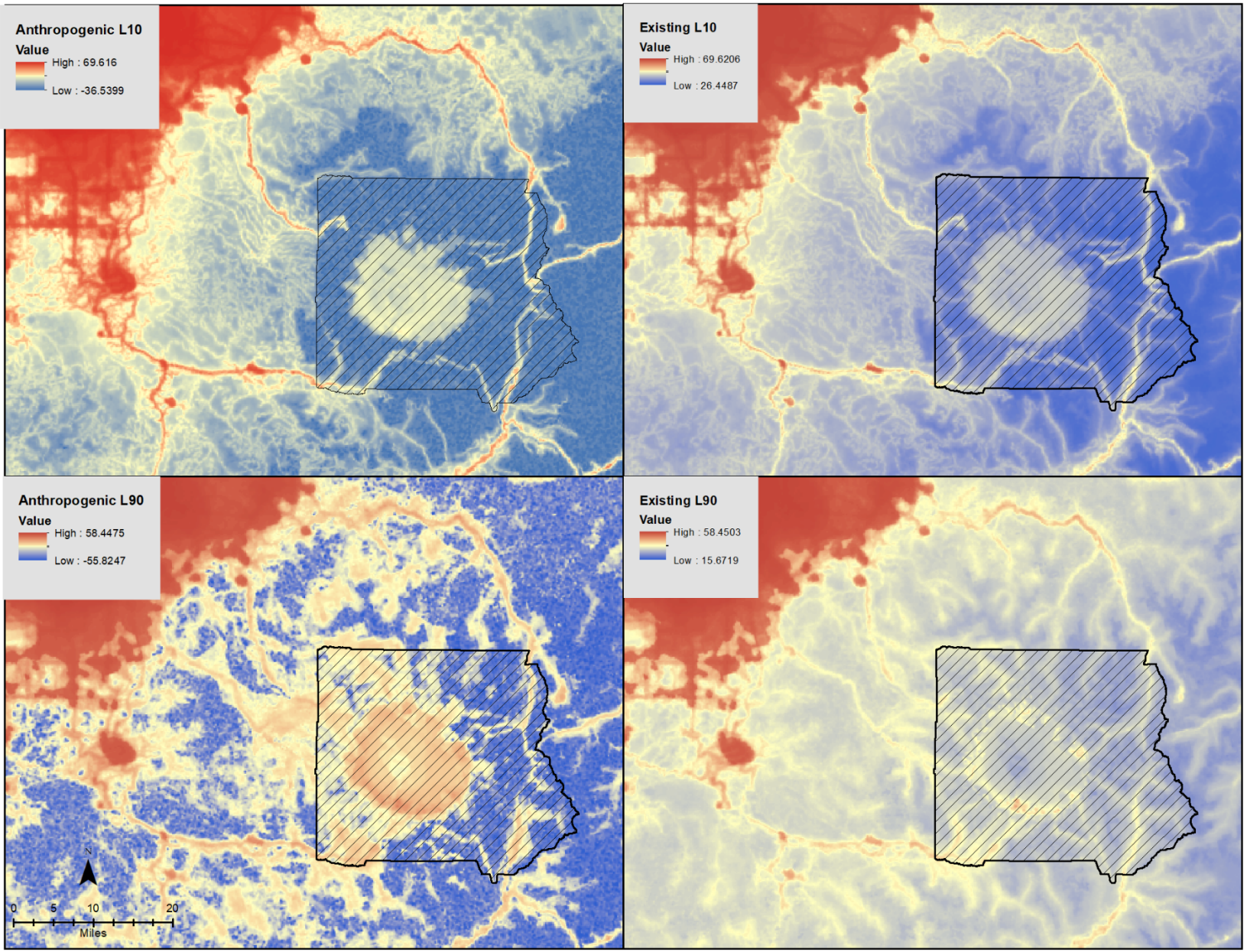
Radiance due to human-made light sources only

Wildlife exposure to nightlight - topography





Noise pollution



Mt. Ranier, WA

Sound maps (NPS)

- >1.5 million hours of sound measurements from 492 sites
- Predictor variables: vegetation, topography, climate, hydrology, and anthropogenic activity
- L_{50} is the sound pressure level exceeded half of the time
- Anthropogenic & natural components

New metrics this year

- L_{10}: Especially loud noises such as cars
- L_{90}: Chronic background noise such as wind & moving water

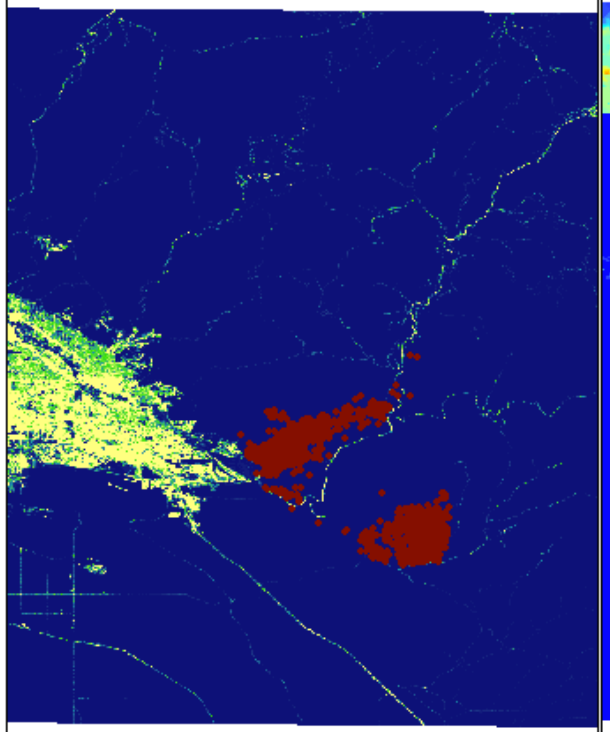
Upcoming

- Leq: “average energy”
- Maps of different sound spectra
- Merger with DOT sound map

Spatial planning tools – prototypes

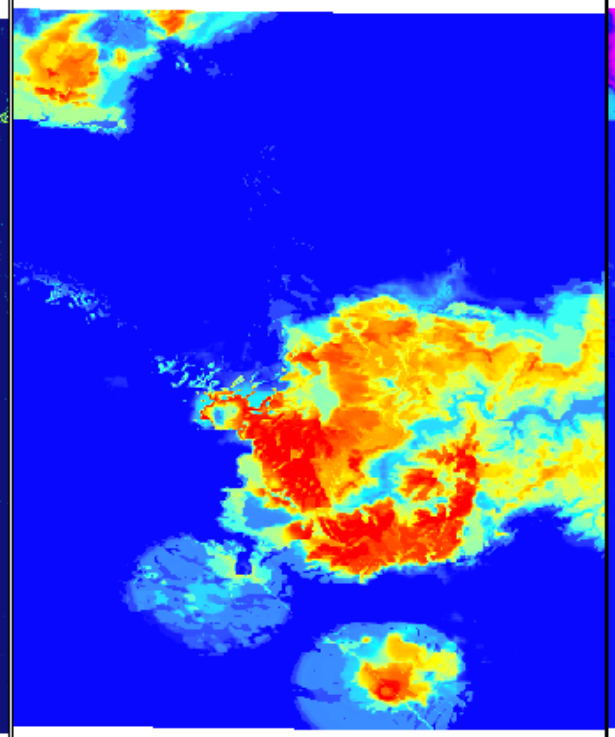
Species distribution modeling workflow

Mule deer in Boise foothills

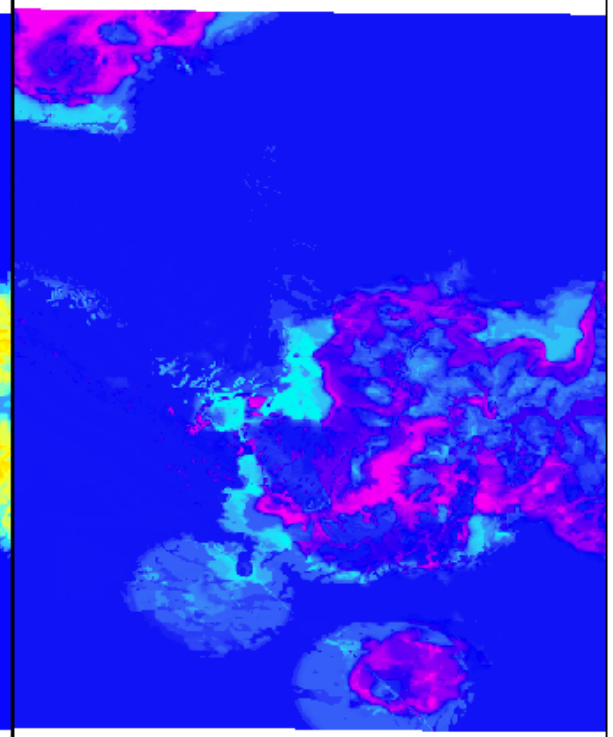


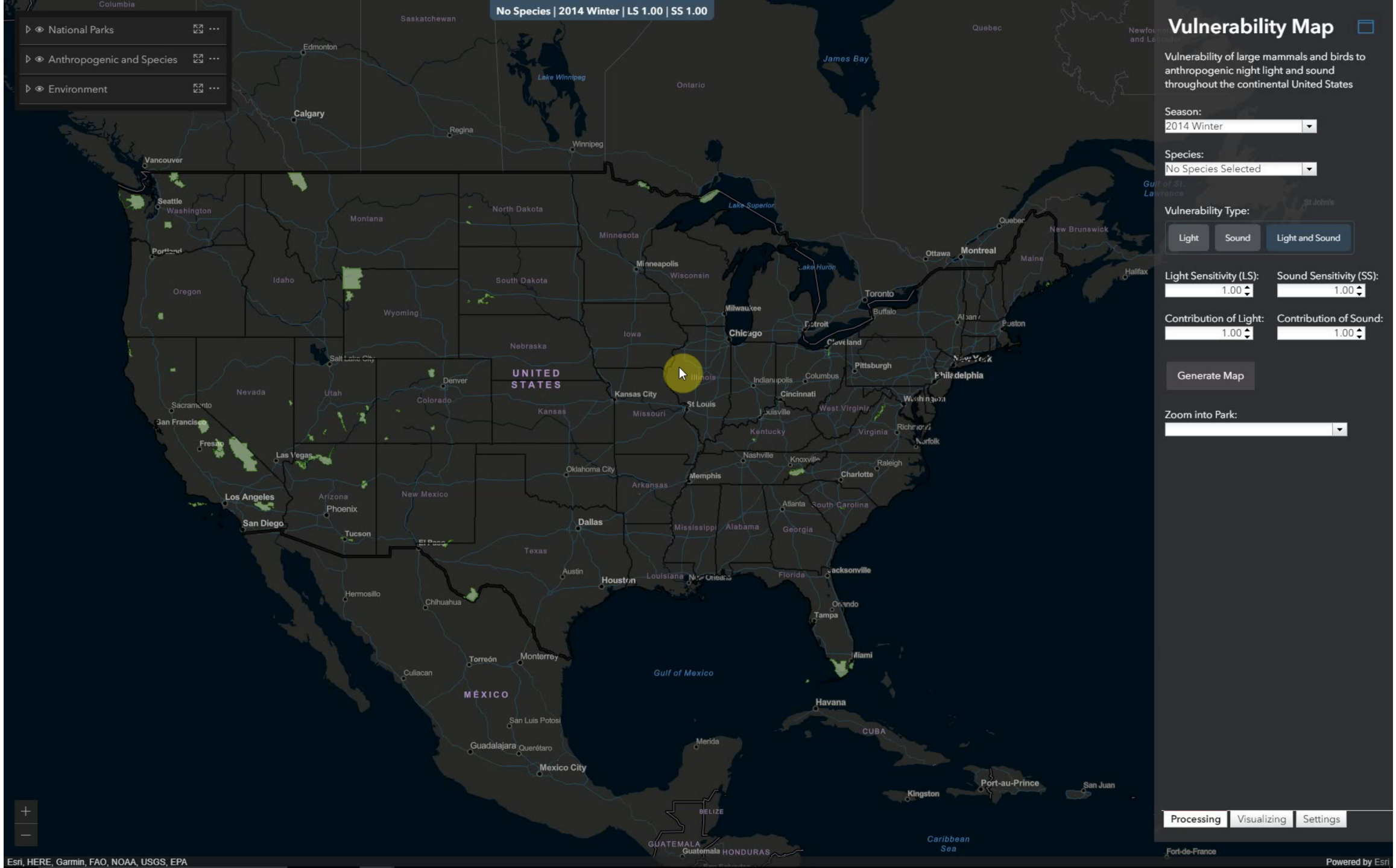
Percent impervious surface area from the 2011 National Land Cover Database.
Presence points for mule deer supplied by Idaho Fish and Wildlife.
Projection: WGS84.

Ensemble habitat suitability model



Net effects of light and sound




No Species | 2014 Winter | LS 1.00 | SS 1.00
National Parks
Anthropogenic and Species
Environment
Vulnerability Map
Vulnerability of large mammals and birds to anthropogenic night light and sound throughout the continental United States
Season:
2014 Winter
Species:
No Species Selected
Vulnerability Type:
Light
Sound
Light and Sound
Light Sensitivity (LS):
1.00
Sound Sensitivity (SS):
1.00
Contribution of Light:
1.00
Contribution of Sound:
1.00
Generate Map
Zoom into Park:
Processing
Visualizing
Settings
UNITED STATES
MÉXICO
Gulf of Mexico
Caribbean Sea
CUBA
Esri, HERE, Garmin, FAO, NOAA, USGS, EPA
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Thanks!

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