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

Macroecological Variable Effects on Bird Abundance Across 5 Years

### Noise

<table>
<thead>
<tr>
<th>Year</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>07-08</td>
<td>-0.12</td>
</tr>
<tr>
<td>08-09</td>
<td>-0.07</td>
</tr>
<tr>
<td>09-10</td>
<td>-0.02</td>
</tr>
</tbody>
</table>

### Light

<table>
<thead>
<tr>
<th>Year</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>07-08</td>
<td>-0.12</td>
</tr>
<tr>
<td>08-09</td>
<td>0.03</td>
</tr>
<tr>
<td>09-10</td>
<td>0.08</td>
</tr>
</tbody>
</table>

### Human Population

<table>
<thead>
<tr>
<th>Year</th>
<th>Effect Size</th>
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</thead>
<tbody>
<tr>
<td>07-08</td>
<td>-0.07</td>
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<tr>
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<td>0.08</td>
</tr>
<tr>
<td>09-10</td>
<td>0.03</td>
</tr>
</tbody>
</table>

### Impervious Surface

<table>
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<td>07-08</td>
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<td>-0.07</td>
</tr>
<tr>
<td>09-10</td>
<td>-0.02</td>
</tr>
</tbody>
</table>

### Pseudo-Julian

<table>
<thead>
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<th>Effect Size</th>
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<tbody>
<tr>
<td>07-08</td>
<td>-0.12</td>
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<td>08-09</td>
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<td>09-10</td>
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</table>
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

Consequences

<table>
<thead>
<tr>
<th>Lower Fitness</th>
<th>Equal Fitness</th>
<th>Higher Fitness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>Cope</td>
<td>Benefit</td>
</tr>
</tbody>
</table>

Masking
- uni-modal & on-band
- Lost Information
- e.g. signal shifts
- Hidden Information / Distractors

Distraction
- uni- or cross-modal on or off-band
- Divided Attention
- Limits Information Processing
- e.g. reduce task difficulty via habituation

Misleading
- uni-modal cue (mis-)matching
- Maladaptive
- e.g. modality flexibility
- Adaptive (e.g., extension of temporal niche)
# Expert elicitation survey – quantify sensitivities

<table>
<thead>
<tr>
<th>Trait</th>
<th>Level of Certainty in Your Response</th>
<th>Notes</th>
<th>Level of Certainty in Your Response</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nocturnal activity pattern</td>
<td>▼</td>
<td></td>
<td>▼</td>
<td></td>
</tr>
<tr>
<td>High winter latitude</td>
<td>▼</td>
<td></td>
<td>▼</td>
<td></td>
</tr>
<tr>
<td>High trophic level</td>
<td>▼</td>
<td></td>
<td>▼</td>
<td></td>
</tr>
<tr>
<td>Habitat specialist</td>
<td>▼</td>
<td></td>
<td>▼</td>
<td></td>
</tr>
<tr>
<td>Narrow niche breadth</td>
<td>▼</td>
<td></td>
<td>▼</td>
<td></td>
</tr>
<tr>
<td>Non-migratory</td>
<td>▼</td>
<td></td>
<td>▼</td>
<td></td>
</tr>
</tbody>
</table>

**Under elevated LIGHT levels, what is the impact of this trait on vulnerability?**

**Under elevated NOISE levels, what is the impact of this trait on vulnerability?**
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

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

Lunar illuminance showing ground features

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

Radiance due to human-made light sources only
Wildlife exposure to nightlight - topography
Noise pollution

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

Mt. Ranier, WA
Spatial planning tools – prototypes
Species distribution modeling workflow

Mule deer in Boise foothills

Ensemble habitat suitability model

Net effects of light and sound