Wildlife disturbance

A Guessing Game?

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Human disturbance to wildlife

Usually defined as "anthropogenic activities that cause short- or longer-term fitness responses in wildlife"

Longstanding focal area for science and policy

Lack of consensus on the range, magnitude and impacts of human disturbance

Expanding human activity increases the scope of and potential for disturbance
General framework

Example

Measurement

Moderators

Disturbance

Wildlife

- Disturbance type
  - Pedestrian
  - Vehicle
  - Research
  - Spatially aggregated

- Response type
  - Behavioural
  - Physiological
  - Population

Duration of disturbances
- Frequency of disturbances
- Intensity of disturbances
- Approach speeds
- Approach angles
- Approach distances

Habituation

Study locations
- Species
- Individuals

Moderator variables
- Treatment
- Methodological
- Ecological

62 studies, 75 unsuitable
21 species
543 responses
Methods: meta-analysis

Combine data statistically to calculate effect size (Koricheva et al. 2013)

Require mean, variance and sample size

Hedges g*; Random effects model

Analyze disturbance and response subgroups
Table 2. Effect sizes (ES), lower (ci.lb) and upper bound (ci.ub) confidence intervals and sample size (N) Tau square ($I^2$), $Q$ statistic ($Q$) with its p-value ($Qp$) for all disturbance and response sub-groups, as well as specific responses (SR).

<table>
<thead>
<tr>
<th>Sub-group</th>
<th>ES</th>
<th>ci.lb</th>
<th>ci.ub</th>
<th>N</th>
<th>$I^2$</th>
<th>Q</th>
<th>Qp</th>
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</thead>
<tbody>
<tr>
<td>Overall</td>
<td>-0.39</td>
<td>-0.60</td>
<td>-0.18</td>
<td>78</td>
<td>97.01</td>
<td>767.88</td>
<td>&lt;0.001</td>
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<tr>
<td>Response</td>
<td></td>
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<tr>
<td>Behavioural</td>
<td>-0.26</td>
<td>-0.74</td>
<td>0.21</td>
<td>32</td>
<td>97.37</td>
<td>367.67</td>
<td>&lt;0.001</td>
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<tr>
<td>Physiological</td>
<td>-0.61</td>
<td>-1.11</td>
<td>-0.11</td>
<td>18</td>
<td>97.15</td>
<td>151.75</td>
<td>&lt;0.001</td>
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<tr>
<td>Population</td>
<td>-0.37</td>
<td>-0.56</td>
<td>-0.19</td>
<td>28</td>
<td>92.05</td>
<td>213.28</td>
<td>&lt;0.001</td>
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<tr>
<td>Disturbance</td>
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<tr>
<td>Pedestrian</td>
<td>-1.28</td>
<td>-2.23</td>
<td>-0.33</td>
<td>9</td>
<td>93.03</td>
<td>103.44</td>
<td>&lt;0.001</td>
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<tr>
<td>Vehicle</td>
<td>-1.72</td>
<td>-3.32</td>
<td>-0.12</td>
<td>5</td>
<td>98.74</td>
<td>103.35</td>
<td>&lt;0.001</td>
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<td>Research</td>
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<td>-0.47</td>
<td>-0.11</td>
<td>40</td>
<td>92.99</td>
<td>284.46</td>
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<tr>
<td>Spatially aggregated</td>
<td>-0.02</td>
<td>-0.36</td>
<td>0.32</td>
<td>24</td>
<td>95.66</td>
<td>219.02</td>
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<td>Taxon</td>
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<td>Mammal</td>
<td>-0.43</td>
<td>-1.11</td>
<td>0.25</td>
<td>11</td>
<td>99.27</td>
<td>75.14</td>
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<tr>
<td>Bird</td>
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<td>-0.61</td>
<td>-0.16</td>
<td>67</td>
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<td>SR</td>
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<td>Foraging</td>
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<td>-0.61</td>
<td>0.19</td>
<td>13</td>
<td>85.55</td>
<td>85.76</td>
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<tr>
<td>Perceptions of threat</td>
<td>-0.27</td>
<td>-1.11</td>
<td>0.57</td>
<td>19</td>
<td>98.78</td>
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<td>Heart rate</td>
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<td>-2.52</td>
<td>-0.31</td>
<td>8</td>
<td>96.22</td>
<td>117.48</td>
<td>&lt;0.001</td>
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<tr>
<td>Blood chemistry</td>
<td>-0.02</td>
<td>-0.12</td>
<td>0.08</td>
<td>1</td>
<td>0.00</td>
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<td>1</td>
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<tr>
<td>Hormones</td>
<td>-0.05</td>
<td>-0.21</td>
<td>0.10</td>
<td>8</td>
<td>18.53</td>
<td>8.75</td>
<td>0.27</td>
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<tr>
<td>Temperature</td>
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<td>-1.05</td>
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<td>1</td>
<td>0.00</td>
<td>0.00</td>
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<td>Morphometrics</td>
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<td>-0.98</td>
<td>-0.15</td>
<td>8</td>
<td>93.30</td>
<td>65.43</td>
<td>&lt;0.001</td>
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<td>Abundance</td>
<td>-0.29</td>
<td>-0.49</td>
<td>-0.09</td>
<td>20</td>
<td>89.48</td>
<td>144.95</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Discussion

Significant overall effect, but high variability

Explanatory variables in a meta-regression fail to explain variation

Behavioural responses not significant, may be less important than physiological and population impacts

Guidelines place emphasis on behavioural cues
Recommendations

- Evidence based universal guidelines unlikely
- Precautionary approach required
- What are the population impacts?
- Review pedestrian guidelines
- Develop guidelines to reduce impacts of research itself
- Species and location specific studies to inform guidelines