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Impact of Noise and Light Pollution on Organisms

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ABSTRACT: Nocturnal animals sleep during the day and are active at night. Light pollution radically alters their nighttime environment by turning night into day.According to research scientist Christopher Kyba, for nocturnal animals, "the introduction of artificial light probably represents the most drastic change human beings have made to their environment.""Predators use light to hunt, and prey species use darkness as cover," Kyba explains "Near cities, cloudy skies are now hundreds, or even thousands of times brighter than they were 200 years ago. We are only beginning to learn what a drastic effect this has had on nocturnal ecology."Glare from artificial lights can also impact wetland habitats that are home to amphibians such as frogs and toads, whose nighttime croaking is part of the breeding ritual. Artificial lights disrupt this nocturnal activity, interfering with reproduction and reducing populations. Sea turtles live in the ocean but hatch at night on the beach. Hatchlings find the sea by detecting the bright horizon over the ocean. Artificial lights draw them away from the ocean. In Florida alone, millions of hatchlings die this way every year. Birds that migrate or hunt at night navigate by moonlight and starlight. Artificial light can cause them to wander off course and toward the dangerous nighttime landscapes of cities. Every year millions of birds die colliding with needlessly illuminated buildings and towers. Migratory birds depend on cues from properly timed seasonal schedules. Artificial lights can cause them to migrate too early or too late and miss ideal climate conditions for nesting, foraging and other behaviors. Many insects are drawn to light, but artificial lights can create a fatal attraction. Declining insect populations negatively impact all species that rely on insects for food or pollination. Some predators exploit this attraction to their advantage, affecting food webs in unanticipated ways.

KEYWORDS: nocturnal, light, noise, pollution, organisms, food, exploit, food webs, populations

I.INTRODUCTION

The impacts of anthropogenic noises on species and ecosystems have been researched for many years. In particular, some taxonomic groups (mammals, birds, fishes), types of noise (transportation, industrial, abstract) and outcomes (behavioural, biophysiological, communication) have been studied more than others. Conversely, less knowledge is available on certain species (amphibians, reptiles, invertebrates),[1,2] noises (recreational, military, urban) and impacts (space use, reproduction, ecosystems). The map does not assess the impacts of anthropogenic noise, but it can be the starting point for more thorough synthesis of evidence. After a critical appraisal, the included reviews and meta-analyses could be exploited, if reliable, to transfer the already synthesized knowledge into operational decisions to reduce noise pollution and protect biodiversity. Sounds are often used to communicate between partners or conspecifics, or to detect prey or predators[3,4]. The problem arises when sounds turn into "noise", which depends on each species (sensitivity threshold) and on the type of impact generated (e.g. disturbances, avoidance, damage). In this case, we may speak of "noise pollution". For instance, man-made sounds can mask and inhibit animal sounds and/or animal audition and it has been shown to affect communication [14], use of space [15] and reproduction [16]. This problem affects many biological groups such as birds [17], amphibians [18], reptiles [19], fishes [20], mammals [21] and invertebrates [22]. It spans several types of ecosystems including terrestrial [23], aquatic [24] and coastal ecosystems [25]. Many types of sounds produced by human activities can represent a form of noise pollution for biodiversity, including traffic [26], ships [27], aircraft [28] and industrial activities [29]. Noise pollution can also act in synergy with other disturbances, for example light pollution [30]. Global expansion of lighting and noise pollution alters how animals receive and interpret environmental cues. Yet we lack a cross-taxon understanding of how animal traits influence species vulnerability to this growing phenomenon. This knowledge is needed to improve the design and implementation of policies that mitigate or reduce sensory pollutants. We present results from an expert knowledge survey that quantified the relative influence of several ecological, anatomical, and physiological traits on the vulnerability of terrestrial vertebrates to elevated levels of anthropogenic lighting and noise. Our findings, based on 280 responses,[5,6] highlight the increasing recognition among experts that sensory pollutants are important to consider in management and conservation decisions. Participant responses show mounting threats to species with narrow niches; especially habitat specialists, nocturnal species, and those with the greatest ability to differentiate environmental visual and auditory cues. Our results call attention to the threat specialist species face and provide a generalizable understanding of which species require additional considerations when developing conservation policies and mitigation strategies in a world altered by expanding sensory pollutant footprints. [7,8]

This analysis, however, expands upon this finding by focusing on the intersection of niche specialization with highly developed sensory function. The logic is simple: sensory degradation may critically depress productivity among habitat specialists. Although noise and lighting have not been featured in recovery plans for several habitat specialists, such as the spotted owl (Strix occidentalis;), black-footed ferret (Mustela nigripes;), our analysis considering the input of hundreds of experts suggests they should be.[9,10]

Here, we apply the framework of assessing sensory pollutant vulnerability to two endangered species to illustrate why noise and lighting management seems apt for their conservation plans. Gray bats (Myotis grisescens) have a nocturnal activity pattern, are habitat specialists (95% of the population roosts in 11 caves), and have eyes adapted to very low light levels. These traits, combined with the responsiveness of their prey to lighting, suggest they will be especially vulnerable to light pollution .Indeed, this species avoids areas affected by lighting . Reduced light pollution can be realized by decreasing lumen output (or eliminating lights), better control over the spatial extent of lighting, limiting lighting to portions of the spectrum to which the bats and their prey are less sensitive, and limiting the seasonal and diel scheduling of lighting. For example, mitigating light pollution radiating from billboards or facades, and setting curfew hours for when they are turned on , especially near the areas in which these animals roost, may be particularly effective.[11,12]

II.DISCUSSION

One scientist might look at this and say, oh, well, these changes mean these animals are essentially coping or dealing with this noise through these strategies that make them successful at living in these environments. Another scientist might look at the same kind of responses, and say, oh, wait a minute, but those might[13,14] have some downstream consequences that we just might not have measured. For example, if a bird is changing how it sounds in terms of its song, well, maybe that has implications for how well it's able to attract a female for mating and securing a territory for reproduction.So, this week in Nature, Clint and his collaborators have been looking at a measure that may give a more direct impression of the effect of noise and light on birds – reproductive success[15,16]. If a bird is successful in producing a lot of offspring, it could indicate that things like noise and light are not having much of an effect, whilst if they produce few or no offspring, it's indicative of something going kind of awry. The challenge there, though, is going from a bird living in a noisy or bright environment to ultimately laying fewer eggs involves, well, a fair few steps. So, you need a lot of data. One such interesting pattern was how human-produced noise affected birds that had calls of different pitches. Take the white-breasted nuthatch, the small songbird found across much of North America. That’s it’s call. Now, it has what's known as low-frequency vocalization[17,18]. It's got a deep voice. Now, noise produced by humans is also typically of a low frequency. Think of a truck rolling down the road or similar. And what this means is that this human noise can mask the birds call, which could mean that they're less able to reproduce well. Perhaps the females can't hear the males calling to them. And indeed, Clint’s analysis showed that when the white-breasted nuthatch lived in a noisier environment, it delayed when it reproduced and tended to produce fewer offspring. Compare that to the house wren. It's called is higher-pitched, at a frequency quite unlike the sounds being produced by humans. Unlike the nuthatch, Clint’s analysis showed that the house wren was unaffected by noise. And this sort of trend, with noise affecting birds with lower-frequency vocalisations, was seen across the dataset. But that's only one part of the sensory equation. Global expansion of lighting and noise pollution alters how animals receive and interpret environmental cues.[19,20] Yet we lack a cross-taxon understanding of how animal traits influence species vulnerability to this growing phenomenon. This knowledge is needed to improve the design and implementation of policies that mitigate or reduce sensory pollutants. We present results from an expert knowledge survey that quantified the relative influence of several ecological, anatomical, and physiological traits on the vulnerability of terrestrial vertebrates to elevated levels of anthropogenic lighting and noise. Our findings, based on 280 responses, highlight the increasing recognition among experts that sensory pollutants are important to consider in management and conservation decisions. Participant responses show mounting threats to species with narrow niches;[21,22] especially habitat specialists, nocturnal species, and those with the greatest ability to differentiate environmental visual and auditory cues. Our results call attention to the threat specialist species face and provide a generalizable understanding of which species require additional considerations when developing conservation policies and mitigation strategies in a world altered by expanding sensory pollutant footprints. We provide a step-by-step example for translating these results to on-the-ground conservation planning using two species as case studies.[23,24]

III.RESULTS

Global expansion of lighting and noise pollution alters how animals receive and interpret environmental cues. Yet we lack a cross-taxon understanding of how animal traits influence species vulnerability to this growing phenomenon. This knowledge is needed to improve the design and implementation of policies that mitigate or reduce sensory pollutants. We present results from an expert knowledge survey that quantified the relative influence of several ecological, anatomical, and physiological traits on the vulnerability of terrestrial vertebrates to elevated levels of anthropogenic lighting and noise. Our findings, based on 280 responses, highlight the increasing recognition among experts that sensory pollutants are important to consider in management and conservation decisions. Participant responses show mounting threats to species with narrow niches; especially habitat specialists, nocturnal species, and those with the greatest ability to differentiate environmental visual and auditory cues. Our results call attention to the threat specialist species face and provide a generalizable understanding of which species require additional considerations when developing conservation policies and mitigation strategies in a world altered by expanding sensory pollutant footprints[25,26]. We provide a step-by-step example for translating these results to on-the-ground conservation planning using two species as case studies. Globally, anthropogenic sound and artificial light pollution have increased to alarming levels. Evidence suggests that these can disrupt critical processes that impact ecosystems and human health. However, limited focus has been given to the potential effects of sound and artificial light pollution on microbiomes. Microbial communities are the foundations of our ecosystems. They are essential for human health and provide myriad ecosystem services. Therefore, disruption to microbiomes by anthropogenic sound and artificial light could have important ecological and human health implications. In this mini-review, we provide a critical appraisal of available scientific literature on the effects of anthropogenic sound and light exposure on microorganisms and discuss the potential ecological and human health implications. [27,28]A limited number of studies have been carried out to investigate the effects of anthropogenic sound and light pollution on microbiomes. However, based on these studies, it is evident that anthropogenic sound and light pollution have the potential to significantly influence ecosystems and human health via microbial interactions. Many of the studies suffered from modest sample sizes, suboptimal experiments designs, and some of the bioinformatics approaches used are now outdated. These factors should be improved in future studies. This is an emerging and severely underexplored area of research that could have important implications for global ecosystems and public health. Finally, we also propose the photo-sonic restoration hypothesis: does restoring natural levels of light and sound help to restore microbiomes and ecosystem stability.[29]

IV.CONCLUSIONS

Noise impacts on birds are well established raising the possibility that the 900 species of bird that are known to contribute to pollination may suffer adverse effects. Despite the overlap between insect hearing and noise pollution frequencies, we remain almost entirely unsure of noise effects on invertebrates, the largest group of pollinators, as studies on noise pollution rarely focus on invertebrates which encompass the largest group of pollinators. Noise is also known to affect plants and can alter physiology, behavior, and gene expression but whether impacts extend to plant reproduction is unknown.[30]

The need for a better understanding of how air, light, and noise pollution affects pollination is well established .However, how pollution interferes with pollination is so understudied that, although identified as a major threat we still lack any quantitative review synthesizing the existing research across all three types of pollution and the whole pollination system. Here, we ask whether air, light, and noise pollution has an impact on the pollination system, as defined by its three sections, namely (1) plant reproductive success, (2) pollinators, and (3) interactions between plants and pollinators. We also ask whether such impacts differ according to (a) the pollutants themselves, (b) the section of the pollination system investigated, (c) the proxies used for pollination, (d) the organisms involved, (e) the habitats investigated, or (f) the study designs.[31]

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