

From Grassroots to Governments: Curtailing the Environmental Challenges Threatening Bird Migration

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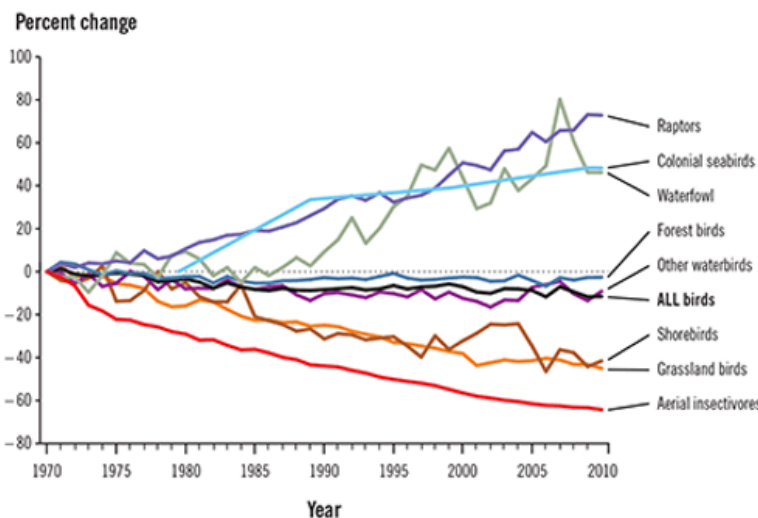
Abstract

Will include later.

Introduction

Nearly one-third of all Nearctic migratory bird species that winter in the Neotropics have undergone significant population declines [1]. Since the 1970s, a cumulative loss of nearly 3 billion birds across North American biomes has been observed, as shown in Fig. 1 [2]. This signals a pervasive and ongoing avifaunal crisis that needs to be addressed. Not only does this pose a threat to biodiversity but it contributes to net gains or losses of migratory behaviour. This affects ecosystem services that humans rely on [3]. Migration is an important process for birds as it allows them to escape physiological stresses that an unfavorable climate may produce; an important aspect being the food scarcity during the cold months [4]. During migration, birds are able to maintain and connect ecosystem services and act as indicators of ecosystem health. This is achieved through influencing intraspecific/interspecific interactions and trophic cascades through food chain patterns [5, 6]. Climate change and human interactions are affecting migration routes and the prevalence of migrant species in avian assemblages [3]. Migratory birds provide numerous ecosystem services including: provisioning, regulating, supporting, and cultural services, with examples being food, pollination, nutrient cycling, and tourism, respectfully [7, 8, 9].

To address the issues of migratory bird population decline, this paper will focus on two main



causes for such observations. The first is light pollution (LP), followed by urban development (UD). I examine these issues further to understand their impact. It is important to acknowledge that multiple other issues also affect migratory bird populations, including

Figure 1. Population Trends for Migratory Birds. This line graph shows the trend in certain migratory bird populations from 1970 to 2010. While some populations have increased, others are experiencing a significant decline (Government of Canada, 2013)

wildfires, invasive species, and rapid climate change. However, this paper will solely focus on the aforementioned two angles. The intended audience of this paper includes persons living in communities proximal to breeding grounds, stakeholders of companies, as well as, government officials and policy makers.

Despite clear evidence of avifaunal migration complications as a result of both man-made and natural challenges, limited progress has been made to enhance migratory safeguarding [10]. To address the deficiency in tangible steps towards migratory conservation, this paper approaches the issue from a unique angle; a holistic response that integrates multiple levels of socioeconomic involvement. In this approach, specific deliverables, including policy changes, community practices, and financial decisions, will be defined as campaigns. While existing campaigns have been able to increase recognition of bird migration issues, there is still a need for practical action items that align communities, businesses, and governments towards the same outcome [11]. Previous approaches which addressed each group separately have typically led to conflicts, inconsistencies, and poor deliverable outcomes [11]. Thus, through integration of communities, businesses, and governments, I aim to overcome this issue by promoting collaboration and aligning agendas. I begin by progressively assessing grassroots campaigns, business strategies, and government decisions aimed at mitigating threats affecting migratory birds. I then illustrate the outcomes of successful bird-protection campaigns by evaluating the efficacy of existing ones. Finally, I present a cumulative campaign strategy to i) promote positive deliverables towards migratory bird protection, and ii) empower sustainable changes at multiple socioeconomic levels.

Light Pollution

Light pollution (LP) is the release of artificial light at night (ALAN) by urbanized areas. LP is a key disrupter of bird migratory patterns due to direct interference with natural circadian rhythms. Such rhythms are essential in maintaining orientation, direction, and consistency during migratory flight [12].

ALAN is most often sourced from urban centers, buildings, streetlamps, traffic lights, and cars [12]. Independent sources of ALAN typically accumulate as skyglow in the form of increased sky brightness and glare which both reduce visibility [13]. This leads to changes in intraspecific/interspecific interactions, mating behavior, and flight patterns which accumulate to reduce bird biodiversity over time. Recent studies have shown that light pollution from buildings has caused nearly 100 million bird deaths due to collisions each year in the United States [14].

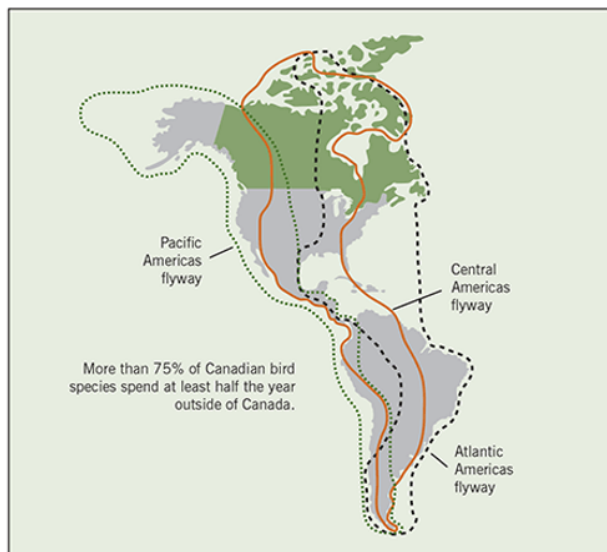


Figure 2. **Flight Patterns.** This map shows three flight paths of migrating birds in North and South America: the Pacific Americas flyway along the west coast, the Central Americas flyway, which covers the center of both continents, and the Atlantic Americas flyway along the east coast (Government of Canada, 2013).



Figure 3. **Light pollution in North and South America.** NASA Blue Marble Navigator shows satellite images of night-light (NOAA Earth Observation Group, 2020)

Research shows that LP can affect birds in multiple ways. Nocturnally migrating birds tend to rest longer in areas with more lighting (even if it's artificial), especially when they fly lower at night [12]. This alters the time-scheme of their migration - shifting the migratory cycle further into the season. Unsurprisingly, LP also causes visibility issues which result in disorientation and collisions described earlier [12]. There is evidence that LP may also influence resting site choice; with some birds nesting closer to well-lit areas, and others opting to stay away [12]. Lastly, LP causes changes in competitive interactions, specifically mating calls and predator/prey visibility - making it harder for birds to pursue their natural needs [12].

Existing strategies to reduce LP largely target the physical science behind lights. A study found that one species of migratory birds, the blue tit, will become active earlier in the morning under red and white lighting. However, changing to green-light caused little disruption in their natural circadian patterns [15]. By opting to use green-light for infrastructure at night, the negative impacts of LP may be mitigated. Other existing strategies include: half-mirror bulbs for interior lighting, shielding existing light fixtures, closing blinds/curtains at night, and replacing lights with reflectors wherever possible [16]. While these strategies are effective, it takes a great deal of motivation to encourage people, businesses, and governments to actively engage in such activities.

Urban Development

Urban development (UD) is the process of refining natural habitat into city infrastructure. In the last century alone, there has been a ten-fold increase of city-dwelling populations [17]. Such figures have



Figure 4. **Urban Extents.** NASA Global Rural-Urban Mapping Project (GRUMP) image of North America. Shows the composition and density of urbanized places (red). Each dot represents a population with 5000 or more inhabitants. (NASA GRUMP, 2009)

caused cities to be known as heterotrophic ecosystems as they are dependent on large inputs of energy for functioning, and have a vast capacity to absorb emissions and waste [17]. In fact, it is postulated that by 2030 more than 60% of the world's population will be living in cities [17]. However this expansion of urban areas is not without consequences, as UD alters the size, shape, composition and interconnectivity of natural habitat patches [17]. Additionally, urbanization alters local

temperature through a 'heat island' effect, whereby the temperature observed within these areas is higher than outlying regions [18]. These unprecedented disturbances result in the isolation and degradation of land, changes in energy flow, and altered nutrient cycling, which pose a multitude of

concerns for biota proximal to these areas [17].

The detrimental effects of UD can be observed in almost all niches. The resulting habitat loss and fragmentation is causing a decline in the abundance and biodiversity of many migratory species [18]. As a result of UD, habitats that constitute the migratory nesting sites are reduced in size and dispersed in sparse patterns - creating many obstacles for migratory birds and reducing realized niches. Moreover, the heat island effect creates warmer temperatures in urbanized areas due to the absorbance and emission of heat by infrastructure [19]. These temperatures allow for earlier vegetation in urban areas which favors the arrival of migrant birds to cities rather than rural habitats [18]. In doing so, the migratory patterns and behaviors of these birds are altered, and in some cases these migrant species become sedentary [18]. When such species do not travel their normal migratory route, they cease to provide ecosystem services and cause drastic changes in interspecific interactions.

Existing strategies to reduce the detrimental effects of UD target critical stakeholders and create arguments to advocate for the conservation of bird species in urbanized areas [20]. These suggestions aim to incorporate the impacts of habitat fragmentation, vegetative composition, interspecific interactions, and infrastructure, on bird species to provide plausible solutions for UD [20]. Current strategies being used include maximizing the green space in UD plans and connecting new green areas with pre-existing habitats both within and outside of cities [20]. Additionally, use of bird-friendly external construction materials, will i) provide migratory bird species with resting areas and ii) reduce the heat island effect [20]. These overarching approaches allow city stakeholders to alleviate bird survival challenges and promote the protection of migratory species.

C. METHODS AND SCOPE

My primary data sources (see Appendix A) will consist of surveys of: (will include later on)

II. DATA SUMMARY

Will include figures after more surveys

II. CONCLUSION

A. SUMMARY OF FINDINGS

B. RECOMMENDATIONS

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FIGURES:

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