BIRDS IN THE NORTH AMERICAN AGRICULTURAL LANDSCAPE: A COLLAPSE OF BEAUTY

by

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A THESIS

Presented to the Department of Environmental Science
and the Robert D. Clark Honors College
in partial fulfillment of the requirements for the degree of
Bachelor of Science

May 2024

An Abstract of the Thesis of

Libby Mackin for the degree of Bachelor of Arts Science
in the Department of Environmental Science to be taken June 2024

Title: Birds in the North American Agricultural Landscape: A Collapse of Beauty

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Bird populations across North America have plummeted by nearly three billion since 1970; steep, irrecoverable losses across nearly every avian family with grave global environmental implications. In the same time frame, the American agricultural landscape has changed dramatically through the green revolution, a time of great agri-technological innovation that has introduced widespread monocropping, pervasive pesticide use, feed lotting, and a host of pollution from agricultural byproducts. Among the guilds facing the most decline are grassland birds, migratory birds, and avian insectivores, all of which are acutely and uniquely affected by industrial agricultural practices and anthropogenically driven climate change. Birds that fall in the intersection of these groups are at great risk for endangerment and extinction, and the grassland ecosystems in which they live are in jeopardy of experiencing trophic cascades. Climate, topography, vegetation, and anthropogenic influence range greatly across the United States, and faunal interactions vary with it. This paper focuses on the status of three migratory grassland avian insectivores that reside in three geographically and ecologically distinct regions of the US: the Henslow's sparrow (*Ammodramus henslowii*) in Illinois, the grasshopper sparrow (*Ammodramus savannarum)* in Kansas, and the western meadowlark (*Sturnella neglecta*) in Oregon. All three focal species have experienced declines due to industrial agriculture, impacted uniquely based on their life strategies and the management of the states within their ranges.

Acknowledgements

Thank you to the many, many people who have supported me throughout the journey of this thesis! Thank you to my brilliant advisors, Dr. Peg Boulay and Dr. Barbara Mossberg, for all your guidance, encouragement, and inspiration throughout my entire undergraduate career. It has been an honor to know and work with you. Thank you to my family and friends, who inspire me in everything I do and am, for the love you have given this thesis and the author. Finally, thank you to every bird I have encountered in my life for your inspiration and your songs.

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Introduction

Anthropogenically-driven climate change is one of the greatest existential threats facing human and environmental health globally in the twenty-first century. Extreme weather events, droughts, wildfires, floods, tornadoes, hurricanes, freezes, and heatwaves are occurring in increasing frequency and magnitude globally, endangering lives of all types, including human.

Sweeping land conversion, pollution from chemical inputs, and rampant fossil-fuel usage are among the common practices in industrial, or intensive, agriculture that shift natural ecological processes and contribute to the climate crisis.

The United States of America's agriculture was among the first to become industrialized in the world. During WWII, the U.S. was able to demonstrate for the first time that they were a serious economic and military power on the global stage because of its booming war industry (Jaworski, 2017). As a result, the social, economic, and technological landscapes following WWII encouraged further industrialization across sectors, including agriculture, and an agricultural revolution was underway (Dimitri et al., 2005; Thompson, 2001). The second half of the twentieth century is broadly referred to as the green revolution, a time of rapid and drastic change and industrialization across all aspects of agriculture and food production to this day. The environmental costs of this shift are severe, and this thesis seeks to investigate the role of industrial agriculture in the climate crisis through the lens of some of the world's most vital, beloved, and endangered species: birds.

Passerines are valuable for environmental monitoring because they are relatively easy to detect and identify, cheap to monitor, and there are many knowledgeable volunteers who are willing and excited to count birds (Fraixedas et al., 2020). Birds have been monitored globally for decades, and they react quickly to environmental change, so there is ample data to track how

population changes with their environments over time (Rosenberg et al., 2019). As a result, birds are "indicator species;" ecologists use their well-being to gauge the overall health and stability of the ecosystems where they reside (Fraizedas et al., 2020). Avian populations have faced steep decline across families, breeding biomes, and geography, indicating that the many different ecosystems they inhabit may be imperiled.

Grassland, migratory, and insectivorous birds are among the most rapidly declining avifaunal guilds in the last 50 years, all of which are especially impacted by intensive agriculture (Rosenberg et al., 2019). Birds that are all three are particularly at risk of extirpation. The Henslow's sparrow (*Ammodramus henslowii*), the grasshopper sparrow (*Ammodramus savannarum*), and the western meadowlark (*Sturnella neglecta*) are three migratory grassland avian insectivores that inhabit different ranges in the USA. This paper will focus on populations of these species in Illinois, Kansas, and Oregon respectively, states that vary widely in their geography, climate, topography, native vegetation, and agricultural practices. This offers a lens into the far-reaching and wide-ranging impacts of agriculture on these species and the array of ecosystems and biomes they inhabit.

Methods

Literature Review and Data Collection

I did my research through literature review. I used the University of Oregon library database, Jstor, and Proceedings of the National Academy of Sciences of the United States of America (PNAS) for my primary literature search. Key phrases included: "industrial/intensive agriculture," "environmental damage," "biodiversity crisis," and "avian decline in North America." For species-specific information, I used publications from eBird, All About Birds, and the National Audubon Society. For state- and region-specific information, I used publications from state departments dedicated to environmental concerns: Illinois Department of Natural Resources (DNR), Kansas Department of Wildlife and Parks (KDWP), and the Oregon Department of Fish & Wildlife (ODFW).

For data about range, trends, and abundance for the species of interest, I used eBird Status and Trends. I used published data from the USDA Census of Agriculture for the states of Illinois, Kansas, and Oregon in the years 1900, 1974, 2017, and 2022 (Tables 1-3). In Oregon, because the agricultural and avian area of interest is the Willamette Valley (WV), I additionally used 2022 USDA Census of Agriculture county-level data for the twelve counties in the WV: Benton, Clackamas, Columbia, Lane, Linn, Marion, Multnomah, Polk, Washington, and Yamhill (Table 3).

Data Analysis

For synthesis of totals and averages of total farmland, % state land area of farmland, and average farm size, I used Microsoft Excel (2008) (Tables 1-3). 1974 was the only year in this study that the USDA Census of Agriculture published % land cover; for 1900, 2017, and 2022, % land cover was calculated proportionally to the data published for 1974 (Table 1-3).

Results & Discussion

History of Agricultural Industrialization in the United States

At the end of WWII in 1945, the United States of America was an unprecedented global power (Reynolds, 1992). At the heart of the nation's success was the booming military-industrial complex. In this time of newfound peace, war industries needed to pivot to another sector in order to maintain profits. Thus, steel manufacturers turned from guns, tanks, and planes to tractors, combine harvesters, and other agricultural machinery. The Haber-Bosch process (1909) is one of the most impactful technological developments in human history because it allowed for the synthesis of ammonia (NH_3), a usable form of nitrogen (Rouwenhorst et al., 2022). This innovation allowed for the development of chemical weapons, including mustard, chlorine, and phosgene gas, by war industries during WWI and WWII (Friedrich & James, 2017). It also allowed for the production of synthetic, nitrogen-rich fertilizers, which aided in fast-growing, healthy crops, for the developing agricultural industry (Friedrich & James, 2017; Rouwenhorst et al., 2022). Thus, ammonia manufacturers turned from chemical weapons to chemical fertilizers and new powerful insecticides.

At the same time as this wave of technological innovation, American culture and societal needs were becoming increasingly industrialized and capitalistic. The ideals of efficiency and profit spread to all areas of life, including agriculture, and the "agribusiness" was born (Thompson, 2001). Historically, farms were family owned and operated, and needed only to support the immediate community on the land. During the green revolution, farms fell under the control of agribusinesses and banks, and suddenly needed to feed people across the nation, and eventually the globe (USDA ERS, 2024).

All aspects of farm labor were able to be done far more efficiently with the advent of fossil-fuel powered, biotechnological, and chemical tools. The labor required to feed the growing American population could be done by fewer and fewer people. This allowed, or forced, many farmers to leave their land and pursue jobs that would boost the economy in other ways. Bountiful harvests were nearly ensured by chemicals to protect the crops and, later, genetically modified seeds to grow resilient and large crops. Mechanical irrigation infrastructure broadly expanded the amount of area that could be cultivated. At the local scale, mechanized sprinkler systems allowed for this, because larger areas could be watered much more quickly than using historical irrigation methods. Thus, farms could grow. At the state and national scale, infrastructure for the transportation of water across long distances allowed for the irrigation of arid areas, greatly expanding the number of regions that could be made suitable for agriculture (Evett, et al., 2020). Large agricultural vehicles, like tractors and combines, further assisted in the cultivation of increasingly large swaths of land by mechanizing many aspects of farm labor, including transportation, planting, and harvesting. Therefore, the landscape transformed from a mosaic of small, labor-intensive, diverse farms to a smaller number of large, input-intensive, monoculture farms throughout the rest of the twentieth century and into the twenty-first (USDA ERS, 2024).

The green revolution allowed for growing populations to be supported by a food system that requires significantly less labor than traditional, historic practices. However, this convenience has come at many economic, social, and human health costs. This paper will look at the consequences of the industrialization of agriculture during the green revolution using bird species as indicators of environmental harm.

Environmental Impact of Agricultural Intensification

As the climate crisis grows, threatening global health on micro and macroscopic levels, it is critical to assess systems that cause environmental harm. Industrial agriculture does an incredible amount of ecological destruction, directly affecting the world's waters, air, soil[6], organisms, and ecosystems (Aneja et al., 2009; Carvalho, 2017; Garcia et al., 2013; Godfray et al., 2014; Raven et al., 2021; Kremser et al., 2002; Horrigan et al, 2002).

The transition from hand tools to machinery for efficiency has led directly to air and water pollution through the required and continuous use of fossil fuels. The introduction of heavy machinery and tillage practices have additionally led to soil compaction and topsoil erosion, both of which deplete the land's ability to support life, much less successful crops to feed a population (Ågren, 2012). The Corn Belt in the midwestern United States once had some of the world's most fertile soils, but the region currently faces the highest soil erosion rates in the nation (Wang & Ortiz-Bobea, 2019; Thaler et al., 2021). For example, it is estimated that 35% (±11%) of the cultivated land, across a 390,000 km^2 study area in the Corn Belt, has lost A-horizon soil. The large-scale erosion of A-horizon soil has released an estimated 1.4 (±0.5) $*10^{12}$ kg of carbon into the atmosphere, exacerbating climate change (Thaler et al., 2021).

The pervasive use of pesticides, herbicides, and fungicides to protect crop yields have led to pollution of air and waterways, and direct harm to the living organisms that rely on them, including humans (Aneja et al., 2009; Carvalho, 2017). The innovation of ammonium rich fertilizers through Haber-Bosch technology provided crops with ample nitrogen, a limiting nutrient for terrestrial plants, allowing for large, strong plants (Ågren, 2012). Unfortunately, the

excess nitrogen enters waterways, and then alters biogeochemical processes in aquatic ecosystems, causing significant damage or even collapse (Aneja et al., 2009; Carvalho, 2017).

Beyond the mechanical and chemical applications that were broadly encouraged and used to increase yield, the physical landscape itself was dramatically changed. Monocropping, a system of growing a single crop on an area of land long-term, became common practice, a far departure from traditional, historical agriculture. Inter-cropping, growing crops among other plant species, crop rotation, cultivating different crops at different times on the same land, are ancient agricultural processes that benefit the communities and ecosystems where they are used. Expansive mono-cultured farms have replaced diverse native habitats, harming all of the flora and fauna within those habitats; this is one of the greatest contributing factors to the biodiversity crisis.

Birds: At the Heart of the Biodiversity Crisis

Mass extinctions are geologically short periods of time where at least 75% of the Earth's species die off; many scientists say that the Earth is currently experiencing its sixth mass extinction in the last 540 million years due to anthropogenic climate change (Ceballosm et al., 2015; Barnosky et al., 2011). Under normal environmental conditions, the expected number of vertebrate extinctions globally in 115 years would be about 9; under conservative estimations, 477 vertebrate species went extinct from 1900-2015, 53x the background rate of extinction (Ceballosm et al., 2015). Biodiversity loss of this magnitude and pace means the loss of vital ecosystem services, such as pest control, pollination, and seed dispersion, as well as anthropogenic benefits like bird watching, food sources, and climate monitoring (Dalton et al., 2023)and no species to fill their place. The frequent and widespread extirpation of species across families, geographic space, and regardless of how rare or common a species is one of the most

critical consequences of environmentally exploitative human practices, threatening precious natural systems at local and global scales (Ceballosm et al., 2015; Barnosky et al., 2011).

North American avifauna populations plummeted by 29%, a net loss of 3 billion birds, from 1970-2017, a staggering level of decline (Rosenberg et al., 2019). Population loss affected birds across guilds, and was not limited to rare and threatened species, many (historically) widespread and common species have also suffered great losses (Rosenberg et al., 2019). Birds provide many ecosystem services, including seed dispersal, pollination, pest control, nutrient cycling, as well as cultural and economic uses like birdwatching tourism; the environment and humanity stand to lose a lot when bird populations decline and go extinct, especially at this rate (Şekercioğlu et al., 2004).

Grassland birds, migratory birds, and avian insectivores are guilds experiencing particularly steep declines in the twenty-first century (Rosenberg et al., 2019). All are uniquely and acutely affected by intensive agricultural practices, and thus this paper will focus on three migratory grassland insectivores in three different agricultural regions in the United States: the Henslow's sparrow (*Ammodramus henslowii*) in the Central Corn Belt Plains ecoregion of Illinois, the grasshopper sparrow (*Ammodramus savannarum*) in the Arkansas River Sandsage Prairie (ASRP) Ecological Focus Area (EFA) in Kansas, and the western meadowlark (*Sturnella neglecta*) in the Willamette Valley ecoregion in Oregon.

Grassland birds

Grassland birds have experienced the steepest decline across North American breeding biomes with 74% of grassland species declining (Rosenberg et al., 2019). The total population loss of grassland birds from 1970-2017 was 53% of the total population, more than 700 million individuals across 31 species, the largest proportional loss of any breeding biome (Rosenberg et

al., 2019). This loss has been driven by habitat loss and toxic pesticide use in breeding and wintering grounds (Rosenberg et al., 2019, Bengtsson, 2019). Avian grassland specialists often require large areas of undisturbed grassland habitat in order to breed, and species richness is highest in landscapes with a high proportion of grasslands (Drum et al., 2015).

Temperate grasslands are among the most endangered biomes globally, including the majority of grasslands in the United States. Temperate grasslands are specifically endangered by agriculture, because they often provide vast areas of land with the ideal topography, soil, and climate to support industrial agricultural practices. Significant amounts of native grasslands- at least 70% globally and 50-80% in North America (Rosenberg et al., 2019), have been lost to human development, agriculture, and urbanization (Rosenberg et al., 2019; Otto et al., 2022). Less than 0.1% of native tallgrass prairie remains on North American land with soil and topography that is favorable for agriculture (Brennan & Kuvlesky, 2005). The expansive nature of monocultures and row-cropping under industrial agriculture has destroyed the majority of grasslands throughout North America, and still poses a grave threat to the remaining fragments and all of the species, including birds, that rely on this habitat.

Anthropogenic changes to the fire regime in North America have further imperiled remaining grasslands. For millennia before colonization, Indigenous peoples regularly burned grasslands as a tool for land management and hunting, overtime evolving fire-resilient landscapes full of fire-adapted species (Copes-Gerbitz et al, 2022; Trauernicht et al., 2015). With colonization came the practice of fire suppression, the prevailing practice used throughout the USA to this day, greatly hindering the productivity and biodiversity of remaining native grasslands and leaving them vulnerable to succession and disturbance (Copes-Gerbitz et al, 2022; Trauernicht et al., 2015). Many grasslands that have not been lost to agriculture are now

being encroached by woodland and invasive species; without fire to prevent their growth, grasslands are being overgrown with invasives, shrubs, and trees (Botha et al., 2020; Copes-Gerbitz et al., 2022; Trauernicht et al., 2015). This is further reducing grassland specialists' habitats and accelerating their decline.

Grasslands serve vital ecologic, economic, and cultural services to human and environmental communities. Highly diverse grasslands sequester carbon, provide erosion control, regulate climate, aid pollinators, and regulate water supply and flow (Lengyel et al., 2023). Grassland birds provide salient ecosystem services to their habitats, including nutrient deposition, pest control, pollination, waste decomposition, and seed dispersal (Flack et al., 2022). Grassland ecosystems, along with the birds in them, are greatly endangered both in the U.S.A. and internationally.

Migratory Birds

Migratory birds, who move locations seasonally for breeding and wintering, are declining at staggering rates compared to residents, who spend the entire year in their breeding grounds. From 1970 to 2019, the total North American population across 419 native migratory avian species declined by a net 2.5 billion (Rosenberg et al., 2019). In this same period, there was a net increase of 26 million individuals across 100 native resident species (Rosenberg et al., 2019).

Billions of migratory birds journey long distances between their breeding and nonbreeding grounds every fall and spring. This yearly migration is the most dangerous period of their lives, already facing natural obstacles from predation and weather, growing threats as climate continues to change, and storms are increasing in frequency and magnitude (Farnsworth et al., 2024; Hallworth et al., 2021). Migratory birds also are particularly affected by collision with human structures. Most migration happens at night, and artificial lights as well as reflective

glass surfaces disorient birds in flight, causing many to fly into buildings, windows, wind turbines, and power lines. It is estimated that building collisions alone kill 388-965 million birds annually in the US, though this figure is decades old, and likely an underestimation in 2024 (Hallworth et al., 2021).

Migratory birds are acutely affected by habitat loss, degradation, and fragmentation of their breeding and non-breeding grounds, as well as along their migration networks to human development, especially urbanization and agriculture (Xu et al., 2019; Diehl et al., 2014). International treaties, like the Migratory Bird Treaty Act of 1918, attempt to save migratory birds from their population declines, but policy will not be enough to protect them if their habitats continue to be destroyed by human development.

Insectivorous Birds

Globally, insect populations have suffered losses of 20%-75% in biomass, abundance, and diversity across taxonomic groups and habitat over the last several decades (Raven & Wagner, 2021). Avian insectivores, whose diets include insects, experienced a net loss in abundance of 156.8 million birds, or 32%, in North America from 1970 to 2017 (Rosenberg et al., 2019). Insectivores range broadly in habitat, behavior, and anatomy, facing many differing environmental threats across the guild. The global decline of insects acutely and uniquely affects insectivores, resulting in trophic cascades- the collapse of a food web due to an imbalance in predator-prey relations- across ecosystems worldwide (Rosenberg et al., 2019).

Insects are rarely protected; they are often overlooked at best and hated or killed at worst, but they are essential for healthy, functional ecosystems. They aid with critical ecosystem services like pollination, nutrient cycling, (somewhat ironically) pest control, and serve as a base

trophic level, feeding species directly and indirectly throughout the food web (Raven & Wagner, 2021).

Broad-spectrum pesticide application is common practice in industrial agriculture, despite well-documented damage to the health of ecosystems and humans (Dudley et al., 2017; Godfray et al., 2014). Chemical insecticides are extremely effective in reducing crop yield loss from pest damage; however, their toxic properties do not only affect target species. Direct or indirect exposure to synthetic insecticides kills non-target insect species- pollinators among the most worrisome, damages or kills plants and animals in the surrounding environment and alters natural aquatic and soil systems (Godfray et al., 2014; Pathak et al., 2022). Insectivorous animals are especially vulnerable to non-target species of pesticide use, facing the compounding risks of both direct consumption and environmental exposure.

Agricultural intensification is one of the primary causes of the decline of both insect and avian insectivore populations through rampant habitat loss via pollution, land use change, and monoculturing, as well as extensive pesticide application (Raven & Wagner, 2021; Hedlund et al., 2019). Avian insectivores, as well as other consumers in higher trophic levels, suffer from losing this base food source. Thus, without insects, ecosystems face imminent collapse. The pervasive use of synthetic pesticides across intensive agricultural landscapes protects crop yields at the cost of global environmental health, and the immense loss of insect and avian insectivore populations demonstrate this.

The three case studies in this paper seek to magnify industrial agriculture's array of environmental damages by looking at the Henslow's sparrow, grasshopper sparrow, and western meadowlark, who are all affected acutely and uniquely in their ranges.

Henslow's Sparrow (Ammodramus henslowii)

The Henslow's sparrow is a secretive grassland and marsh bird that migrates throughout the eastern United States (Cornell Lab of Ornithology, 2019). They breed throughout wet meadows, pastures, and lowland prairies in midwestern states- spanning throughout eastern Kansas to central Pennsylvania longitudinally and from northern Wisconsin to southern Tennessee latitudinally (Cornell Lab of Ornithology, 2019; ABC, 2024), a region colloquially called the Corn Belt. Henslow's sparrows winter in longleaf pine ecosystems (Cooper, 2012) within a thin belt along the Gulf Coast and southern Atlantic Coast, spanning throughout eastern Texas to central Virginia (ABC, 2024; Cooper, 2012). For this paper, the focus will be on Henslow's sparrow populations in Illinois, and thus their behaviors and habitat requirements during the breeding season- from mid-May to mid-August (Fink et al., 2023).

Henslow's sparrows spend much of their time on the ground, where they nest and forage for food. They nest at the base of thick clumps of grass on or near the ground among thick litter (Cornell Lab of Ornithology, 2019). In the summer, *A. henslowii* eat insects from the ground, primarily grasshoppers, beetles and caterpillars (Cornell Lab of Ornithology, 2019).

There has been difficulty reliably tracking *A. henslowii* populations over time because they are secretive ground-dwellers by nature (1, 3). This is especially true in their winter range, where they are mostly silent and therefore extremely difficult to document (Cooper, 2012). This has resulted in conflicting reports on whether their overall population has increased or declined since 1960 (Cornell Lab of Ornithology, 2019; ABC, 2014; Cooper, 2012). Even without unified data on its decline rate, the Henslow's sparrow is classified by the U.S. Fish and Wildlife Service as a "Bird of Management Concern" in 2008, a state or threatened bird in 13 states, and as a

"Species of Greatest Conservation Need" (SGCN) in 30 states' wildlife action plans (Cooper, 2012).

Illinois

Illinois is a state in the Corn Belt of the midwestern region of the United States. It is one of the nation's leading producers, responsible for 5% of the nation's agriculture sales (Fink et al., 2023). Since colonization, agriculture has been the predominant cover class across the state (Table 1). Notably, since 1900, farmland in the state has decreased by more than 15% because of urbanization, especially Chicago. Crops are the cornerstone of Illinois' agricultural market and landscape, accounting for 84.4% of state sales in 2022 (*2022 Census of Ag.,* 2024). Cropland covers 22,913,841 acres of Illinois, 87% of the state's farmland. In comparison, pastureland and woodland make up 742,228 acres (2.8%) and 1,758,270 acres (6.7%) of the state's farmland respectively (*2022 Census of Ag.,* 2024). Grains, oilseeds, dry beans, and dry peas make up most of the agricultural production and sales in the state (*2022 Census of Ag.,* 2024).

Year	Total Farmland (Acres)	% State Land Area	Avg. Farm Size (Acres)
1900	32,664,707	91.5	135
1974	29,094,794	81.5	262
2017	27,006,288	75.6	372

Table 1: Illinois Agricultural Land Area since 1900

Agricultural land usage across Illinois, USA in 1900, 1974, 2017. Data from the USDA NASS Census of Agriculture Historical Archive.

The topography and climate throughout Illinois are ideal for grain production, with flat expanses, fertile soil, and moderate precipitation and temperature throughout the growing season. Grains have been the foundation of Illinois' agriculture throughout its history. In 1900, Illinois

by-far led the nation in corn and oat production and in 2022 led the nation in corn and soy production (2022 Census of Ag., 2024; Twelfth Census, 1902). Intensive practices like tilling, monocultures, and row-cropping are especially effective for mass grain production, which are maintained using intensive inputs like steel tools, synthetic biochemicals, and fossil-fuel machinery. Illinois is one of the most intensively farmed regions in the nation. Tens of thousands of farms rely on hundreds of thousands of vehicles and millions of dollars of chemicals throughout Illinois (*2022 Census of Agriculture,* 2024). In 2022, 17,407,602 acres of land were treated with commercial fertilizers and tens of millions of acres were treated to control insects, weeds, and nematodes (*2022 Census of Agriculture*, 2024).

Agriculture has degraded or destroyed habitat for many species throughout Illinois, grassland obligates among the most affected. Native grasslands have been degraded or destroyed by human development in Illinois across centuries, and the widespread use of intensive practices has only accelerated this. The Henslow's sparrow is a declining grassland insectivore that breeds throughout the state.

Henslow's Sparrow in Illinois

Although Illinois is central to the Henslow's sparrow's range, in 2022, only 27% of the state was occupied during the breeding season (Fink et al., 2023). Henslow's sparrows are particularly picky about their habitat selection, requiring large areas of land with tall, dense vegetation and thick litter (ABC, 2024). The low occupation of their Illinois range reflects the loss of suitable habitat, largely due to agricultural conversion.

The USDA Farm Service Agency (USDA FSA) provides incentive and support for farmers to cease agricultural production from environmentally sensitive land in the name of environmental health (USDA FSA, 2024). Illinois' CREP is a partnership between the USDA

FSA, Illinois Department of Natural Resources (IDNR), the Soil and Water Conservation Districts (SWCDs), and private landowners established in order to strengthen the CRP within the Illinois and Kaskaskia River Watersheds (*What is CREP*, 2022). CRP and CREP lands foster large areas of native habitats that typically remain undisturbed, including by mowing, grazing, and burning (USDA FSA, 2024; Illinois' CREP, 2022). Henslow's sparrows specifically benefit from the land management practices encouraged by CRP and CREP.

From 1966 to 2013, Henslow's sparrow populations were generally declining throughout their range, except for in Illinois, where their populations increased at a rate of 6.02% each year (IDNR, 2022). During this same time period, the CREP was established, and grew steadily, and thus, Henslow's sparrow habitat grew with it. As of 2022, 1,396 CREP easements protect over 90,000 acres of land in Illinois (*What is CREP*, 2022). Unfortunately, these figures have not increased since 2015, when further enrollment was suspended due to a lack of funding from the IDNR and FSA (*What is CREP*, 2022; *Annual Report 2021,* 2022). From 2012 to 2022, *A. henslowii* population trends dove to a loss of -6.7% per year (Fink et al. 2022). Further research must be done in order to explain the drastic change in population trends. However, it is likely the lack of funding and further enrollment for such an important program for their success in the state has contributed to their decline.

In 2005, the Illinois Wildlife Action Plan (IWAP) established 32 Conservation Opportunity Areas (COAs) in Illinois as regions with the existing or potential wildlife, habitat, financial, and human resources to support successful and substantial conservation efforts for SGCN (IDNR, n.d.; IDNR, 2022). The Vermilion River COA (VR COA) is a 791,665 acre region in eastern Illinois in Champaign, Vermilion, Ford, Edgar, and Iroquois Counties. The native vegetation in the region was primarily tall-grass prairie, with forests and savannas

dominating the moraines and major drainage areas (IDNR, 2022). Today, most of the land in the VR COA is privately owned and has been converted for monoculture agricultural production of corn and soybeans; 76.7% of the VR COA is covered by cropland (IDNR, 2022). Remaining fragments of grasslands have fallen victim to damage from agricultural byproducts and encroachment by invasive species, woody vegetation, and development (IDNR, n.d.; IDNR, 2022).

The Vermilion River COA is home to 270 bird species, many of whom are endangered or threatened in Illinois, including the Henslow's sparrow Vermilion River, 2011). The majority of the VR COA is privately owned, introducing additional socio-economic challenges to conservation efforts in the region. Cooperation of private landowners and stakeholders, especially farmers, is one of the greatest obstacles to conservation efforts in this area; three of the principle objectives outlined by the VR COA Wildlife Action Plan are the reduction of excess nutrient and pesticide loads in rivers, promotion of education about best management practices, and the protection of biodiversity in order to increase populations of SGCN (Vermilion River, 2011). Farmers are encouraged to limit their fertilizer and pesticide application, support more diverse plant communities, and to participate in programs like the Federal CRP, Illinois' CREP, and county-level Wildlife Habitat Incentive Programs (WHIPs) in order to receive both guidance and financial support for environmental restoration efforts on their land (Vermilion River, 2011).

The widespread conversion of Henslow's sparrows' native grassland habitat to agricultural land, especially corn and soy monocultures in Illinois, has contributed to their decline. They are a threatened species, the focus of many conservation efforts throughout the state, including VR COA. Socio-economic factors relating to land-management practices, especially by farmers, have especially hindered the protection of Henslow's sparrows in Illinois.

However, there is historical evidence that with proper funding, restoration efforts have had success in supporting Henslow's sparrows.

Grasshopper Sparrow (Ammodramus savannarum)

The grasshopper sparrow is a common grassland insectivore throughout North America. Their wintering habitats are throughout Mexico, along the Gulf Coast of the United States, and Florida (Fink et al., 2023; Lin et al., 2017). They breed in the summers north of their wintering range, primarily spanning from the Rocky Mountains to the Atlantic Coast, though there are some scattered breeding sites throughout western states (Fink et al., 2023; Lin et al., 2017). The scope of this paper will focus on grasshopper sparrow populations in Kansas, and thus their behaviors and habitat need during the breeding season, from early June to mid-July (Locklear, 2021).

Grasshopper sparrows are ground-nesting birds, who tend to prefer to hop or run rather than fly. Their nests are built hidden at the base of clumps of grass within extensive patches of grasses or sedges (Fink et al., 2023). They forage insects from the ground during the summer, where they are camouflaged by tall grass and dense litter. Their favorite prey is grasshoppers, but they also eat beetles, caterpillars, and spiders (Fink et al., 2023; *KWAP*, (n.d.).

A. savannarum populations have faced steep decline since the green revolution, with a cumulative loss of 72% from 1966-2015 (Fink et al., 2023). Grasshopper sparrows are one of Partners in Flight's Common Birds in Steep Decline, and one of the USFWS' conservation focal species, with a breeding population of about 320 million as of 2022 (Fink et al., 2023). Range wide habitat degradation, fragmentation, and destruction for the development of agricultural and urban areas are the primary drivers of grasshopper sparrows' decline (Lin et al., 2017; Freeman, 2022).

On farmland, heavy agricultural machinery, mowing, and haying serve as direct threats to grasshopper sparrows and their nests due to their ground-dwelling nature. Pesticide use impacts grasshopper sparrow populations through direct consumption due to their insect-based diet and through indirect effects caused by chemical pollution of the air and water (Locklear, 2021). Kansas, in the Great Plains region of the central United States, is a heavily, intensively farmed state where *A. savannarum* is abundant in the breeding season.

Kansas

Kansas is a state in the Great Plains in the central United States responsible for much of the nation's livestock and grain production. Kansas has moderate elevation changes, fertile soils, and semi-humid conditions, though precipitation varies throughout the region. Western Kansas falls in the rain shadow of the Rocky Mountains and tends to be dryer than the rest of the state (*ARSP,* n.d.). Agriculture has been a dominant feature of the Kansas landscape predating the turn of the twentieth century, with at least 80% of the state's land area devoted to farmland consistently since 1900 (Table 2) (*Farms and Farm Property,* 1902*; 1974 Census*, 1976; *Land: 2017 and 2012,* 2019). There are 14,664,767 acres of pastureland, 28,340,827 acres of cropland, and 633,691 acres of woodland farms in Kansas, 33%, 63%, and 1.4% of the state's farmland respectively (*2022 Census,* 2024).The average farm nearly tripled in size from 1900 to 2017, illustrating the expansive nature of agricultural intensification in the state since the green revolution (*Farms and Farm Property,* 1902*; 1974 Census*, 1976; *Land: 2017 and 2012,* 2019).

Year	Total Farmland (Acres)	% State Land Area	Avg. Farm Size (Acres)
1900	43,530,790	83.2	270
1974	47,945,722	91.6	605
2017	45,759,319	87.4	804

Table 2: Kansas Agricultural Land Area since 1900

Agricultural land usage across Kansas, USA in 1900, 1974, 2017. Data from the USDA NASS Census of Agriculture Historical Archive.

Cattle and grain are the two main drivers of Kansas' agricultural sector, responsible for 56.6% and 32.4% respectively of the state's agricultural sales in 2022 (*2022 Census,* 2024). Industrial livestock and cereal grain production often go hand in hand, because soy, corn, wheat, barley, and sorghum are often used for feed in intensive operations, even though this often differs from livestock's natural diets (Makkar, 2018; Sylvester, 2009). A substantial portion of agricultural resources go towards growing crops for animal feed. Globally, one third of total cereal production is used for livestock feed, about 882 million tons annually, and this figure is only projected to increase (Sylvester, 2009). Thus, feedlots are common throughout Kansas because of the ready access to cereal grains and oilseeds for food (Greenwood, 2021). Intensively managed feedlots and monocultures now stand in the place of native grassland habitats, allowing Kansas to produce the amount of grain and livestock that they do, but these practices come at environmental costs (Sylvester, 2009).

Advancements in irrigation infrastructure in the 20th century allowed for the expansion of agriculture into dryer, marginal regions, but the prioritization of water for agriculture has resulted in drought conditions throughout the 20th and 21st centuries, including the Dust Bowl (Seager & Cook, 2013; Alexander et al., 2018). The Dust Bowl was an environmental and socioeconomic catastrophe throughout the Great Plains in the 1930s. For years, drought afflicted the land and dust filled the air, largely a result of years of unsustainable agricultural practices and the disturbance of fragile grassland ecosystems, including irrigation and mono-cropping (Seager & Cook, 2013; Alexander et al., 2018). 3.5 million people were displaced from their homes, and

illness from dust inhalation diseased or killed an unknown number of people in the years following the storm (Seager & Cook, 2013). Kansas has already experienced the ramifications of industrial agriculture, and if intensive practices persist, history is doomed to repeat itself.

Grasshopper Sparrows in Kansas

91% of Kansas is occupied by A. savannarum during the breeding season, where 11% of the global population breeds, making it an imperative region for the species' success (Fink et al., 2023). An intensive agricultural landscape has replaced much of their habitat throughout the state, including within the Shortgrass Prairie Conservation Region (SPCR) which encompasses the western third of Kansas, USA (Locklear, 2021). The SPCR is in the rain shadow of the Rocky Mountains, so it only receives about 10-20" of precipitation each year. Therefore, this region is dominated by drought and fire tolerant plants, especially short grass species. With the aid of irrigation infrastructure, this flat expanse of shortgrass prairie is an ideal site for agriculture. and has become one of the state's most intensively farmed areas.

The Arkansas River Sandsage Prairie (ARSP) is an Ecological Focus Area (EFA) within the SPCR. EFA's are landscapes identified within Kansas' Wildlife Action Plan where conservation actions can be applied to benefit wildlife throughout Kansas, including Species of Greatest Conservation Need (SGCN). The ARSP is the habitat of 20 of the 88 birds on Kansas' list of SGCN, including the grasshopper sparrow. (Rohweder, 2022; ARSP, n.d.). It is bordered by the southwestern portion of the Colorado-Kansas state line and the Arkansas River in Hamilton County and Kearney County (KWAP, n.d.). The ARSP is characterized by sandy soils and the presence of sand sagebrush (Artemisia filifolia) and sand tolerant native grasses, like sand bluestem (Andropogon hallii), sand lovegrass (Eragrostis trichodes), and giant sandreed grass (Calamovilfa gigantea) (Locklear, 2021).

Sandsage prairie habitat was once a widespread host of dynamic and resilient biodiversity throughout the central and southern Great Plains, and common throughout western Kansas (Locklear, 2021; Rohweder, 2022). However, following the introduction of center pivot irrigation technology in the 1960s, much of this habitat has been degraded or destroyed through the conversion to farmland. Now only about 12 million acres of discontinuous sandsage prairie remain throughout this region, now fragmented by feedlots and monocultures of wheat, corn, soybeans, and grain sorghum (Locklear, 2021; Rocha, 2022).

The Kansas Wildlife Action Plan delineates agriculture as one of the principal conservation issues to the ARSP and its residents, specifically unsustainable grazing on native grasslands and conversion of grasslands to farmland. Agricultural intensification in western Kansas has decreased habitat heterogeneity, and changed in vegetative community composition, endangering native flora and altering habitat structure and function for fauna (KWAP, n.d.).

In addition to the typical consequences of industrial agriculture on native grassland habitats, the ARSP is facing new dangers as climate changes in the region. The conversion of grasslands to farmland, especially when it is intensively managed, makes soil less resilient and alters the hydrology of the ecosystem. Kansas' climate is changing rapidly, and ecosystems weakened by agricultural practices are extremely vulnerable. Kansas has seen some of the warmest temperatures on record, save the extreme heat during the Dust Bowl (Seager et al., 2013; Alexander et al., 2018). Precipitation has become more irregular, and falls in higher volumes than historical storms did. As a result, both drought and flood are becoming greater in both frequency and intensity throughout the state, but especially in the semi-arid western portion where the ARSP is located (Alexander et al., 2018). Grasshopper sparrows are extremely vulnerable to the changing flood regime specifically due to their affinity for being on the ground.

Historically, A. savannarum's range was not prone to flooding, and therefore they are not adapted to survive floods.

Grasshopper sparrows face a growing number of threats as their habitat continues to be lost to agriculture and the climate continues to change. The good news is that, in spite of their decades-long decline, they are still numerous, and therefore still rescuable. Most conservation efforts in Kansas have been established relatively recently, so data on their success is inconclusive, but other data indicates that they are responsive to restoration efforts, especially those that integrated controlled burns, moderate grazing and mowing (Londe et al., 2019). Time will tell how A. savannarum fares, but there is ample evidence that industrial agriculture and climate change pose unique and complex threats to their viability throughout their range. It is important to take steps to protect the grasshopper sparrow sooner rather than later to prevent an ecological tipping point, a degree of loss from which recovery is no longer possible. for them and other grassland species.

Western Meadowlark (Sturnella neglecta)

The western meadowlark is a migratory grassland bird native to western North America- from the Pacific Coast to the Mississippi River Valley latitudinally and from central Mexico to central Canada longitudinally. They winter throughout the southern portion of their territory, from December to February, breed throughout the northern portion of their range, especially east of the Rocky Mountains. They can be found year-round throughout the middle of their range. Western meadowlarks inhabit open grasslands, prairies, meadows, and, when needed, some agricultural fields ranging in elevation from sea level to 10,000 feet (Fink et al., 2023). An area of at least 100 continuous acres of open grassland is generally required to support a western meadowlark population, as each family requires about 20 acres of nesting territory (Oregon

Wildlife Institute, n.d.; Altman et al., 2011). They avoid areas with dense woody vegetation, but singing perches, like fence posts and large rocks, are critical habitat elements (Oregon Wildlife Institute, n.d.; Altman et al., 2011).

Western meadowlarks spend the majority of their time on the ground, where they nest and forage. These birds build their nests in small dips and depressions in the ground surrounded by dense grass to hide the nest from view (Fink et al., 2023; Oregon Wildlife Institute, n.d.). *S. neglecta* use a feeding strategy called "gaping," where they use their beaks to probe through soil, soil clods, and manure piles seeking insects, including ants, cutworms, grasshoppers, and crickets, that other species cannot access in the summer, and grains and seeds for the rest of the year (Fink et al., 2023). Western meadowlarks' affinity for the ground is reflected in the short "runaways" that branch from the nest to the surrounding grasslands created by parents traveling back and forth from the nest (Fink et al., 2023).

The global breeding population of western meadowlarks is estimated to be about 100 million (Fink et al., 2023). Though numerous, meadowlark populations have consistently faced decline since 1966 at a rate of -0.9% per year at a continental scale, or a cumulative decline of -47.7% from 1966-2019 (Fink et al., 2023; Oregon Wildlife Institute, n.d.). As a result, *S. neglecta* is a priority conservation species across the country in order to save them from reaching an ecological tipping point.

Oregon

Oregon is a state in the Pacific Northwest region of the United States that has a less intensive agricultural landscape than Illinois or Kansas. The Cascade Mountain Range divides the state into distinct climates from west to east (Smith et al., 2005). West of the Cascades, bordered by the Pacific Ocean on the west, has a rainy, temperate climate, low elevation, and is

heavily forested. The Cascades experience mountain climate, and therefore variable weather conditions and high, variable elevation. East of the Cascades is primarily high-elevation desert, receiving very little rain in the rain shadow (Smith et al., 2005). The vast range of climate, topographic, and vegetative conditions across Oregon make it less suitable for agriculture than those of states throughout the Great Plains and Corn Belt.

Oregon has 4,558,927 acres of cropland, 8,833,816 acres of pastureland, and 1,576,892 acres of woodland farms, 29.8%, 57.8%, and 10.3% of total farmland respectively (*2017 Census,* 2019). Although the majority of farmland is for pasture, crops make up 69% of agriculture sales in Oregon, with livestock, poultry, and products accounting for the other 31% (*2017 Census,* 2019). The agricultural landscape in eastern Oregon is relatively small, in terms of production and sales, producing primarily livestock (*2017 Census,* 2019). The majority of Oregon's agriculture is concentrated in between the Coast Range on the west and Cascade Range on the east: the Willamette Valley (WV).

County	Land in farms (acres)	Avg. farm size (acres)	% Farmland cover
Benton	127,626	132	21
Clackamas	157,426	37	13
Columbia	43,379	55	5
Lane	203,148	77	11
Linn	314,947	142	12
Marion	288,671	105	36
Multnomah	25,435	39	23
Polk	148,905	120	14
Washington	104,715	60	17
Yamhill	169,357	79	17

TOTAL	**1,583,609**	**X**	**X**
AVERAGE	**158,361**	**X**	**16.9**

Table 3: Farms in the Willamette Valley by County (2022)

Agricultural land usage by county in the Willamette Valley, Oregon. Values marked by an X indicate mathematical discrepancies that render these values insignificant. Data taken from the USDA Census of Agriculture (*2022 Census,* 2024).

The valley has rich soils and relatively flat topography, making it suitable for cultivation (Strimbu et al., 2021; City of Eugene, 2016). The region receives an ample 40” of precipitation each year, but experiences drought during the primary growing season each summer, often receiving less than 2” of rainfall in July and August combined (Garrett, 2019). Many of the specialty crops that the WV is known for, including berries, apples, and grass seed, cannot handle drought conditions, and thus irrigation and water availability are a concern for farmers, the environment, and society throughout the region

(Strimbu et al., 2021, Taft & Haig, 2003). When severe drought hit Oregon in the summer of 2015, many vegetable farmers who relied on surface water to irrigate their crops were cut off early in the season, provoking widespread loss of yield and money (Garrett, 2019).

46% of the land in the Willamette Valley, 1,583,609 acres, is dedicated to agriculture (Table 3) (ODA, 2020). The Willamette Valley is one of the most diverse agricultural regions in the country, if not the world, producing more than 170 different crops across 5,308 square miles (3,397,120 acres) (ODA, 2020; Houston et al., 2017). Farms in the Willamette Valley grow grain, grass seed, hay, many specialty crops, including hazelnuts, berries, wine grapes, hops, nursery products, and Christmas trees, as well as beef, dairy, and poultry (ODA, 2020). Urbanization makes up most of the rest of land cover, as nine out of ten of Oregon’s most

populated cities are in the Willamette Valley (OCS, n.d.). The average farm size ranges from 37-142 acres across counties in the Willamette Valley, compared to Illinois, where the average farm is 375 acres (Table 3) (ODA, 2020; EPA, (n.d.). This smaller farm size indicates that there is less of a reliance on the intensive practices that allow for farms to be so vast, like row-cropping. In spite of this, habitat loss and fragmentation from agricultural developments, as well as degradation from pollution from industrial practices are a focal threat to biodiversity and ecosystem health in the Willamette Valley.

Before colonization in the 1840s, the Willamette Valley was a mosaic of native oak savannas, wetlands, and prairies (Taft & Haig, 2003). It is estimated that less than 2% of the native oak savannas that once filled the Willamette Valley remain standing, a result of the profound amount of human development in the region (City of Eugene, 2016). Farms within the Willamette Valley, as well as the region itself, tend to be smaller than other agricultural hubs in the United States. However, the presence of industrial practices like mono-cropping, the use of chemical inputs, and reliance on fossil-fuels still jeopardize ecosystem health, at the cost of some of Oregon's most beloved species. Twelve species native to the WV are listed under the federal Endangered Species Act, including the California brown pelican (*Pelecanus occidentalis californicus*), the northern spotted owl (*Strix occidentalis caurina*), and the California Least Tern (*Sternula antillarum browni*), and many more have experienced years or decades of decline and extinction (USFWS, 2017). One species in distress is Oregon's state bird: the western meadowlark, who lives in grasslands throughout the state.

Western Meadowlarks in the Willamette Valley, Oregon

In Oregon, Western Meadowlark populations have declined at a rate of -1.01 per year from 1966-2008, a cumulative decline of -42%, and an additional decline of -8.1% from 2012-

2022 (OWI, n.d.). Western meadowlarks live throughout Oregon across seasons, excluding the Coast and Cascade Ranges. West of the Cascades, they are found primarily in the Willamette Valley (Fink et al., 2023). They winter in grasslands from Portland to Corvallis and are found year-round from Corvallis to Eugene (Fink et al., 2023). In 1940, the western meadowlark was one of the most common and widely distributed birds in Oregon, but much of their range has been damaged by agriculture and urbanization, and they have suffered steady decline for decades (OWI, n.d.). Now, the once prevalent western meadowlark has been reduced to abundance primarily near Coburg Hills and Fern Ridge Reservoir in Lane County, in the southern end of the Willamette Valley (OWI, n.d.). As a result, western meadowlarks have been identified as a Species of Greatest Conservation Need by the Oregon Department of Fish and Wildlife (ODFW) and a priority species across every natural resource assessment for the Willamette Valley (OWI, n.d.).

Habitat fragmentation due to pervasive human development is the primary driver of the western meadowlark decline in the WV. *S. neglecta* have relatively large territory requirements (OWI, n.d.). For this reason, western meadowlarks are considered an umbrella species for grassland bird conservation in Oregon; conservation efforts for them will support the conservation of grassland species and ecosystems as a whole (Altman et al., 2011).

Habitat restoration efforts have been taken throughout the Willamette Valley for the protection of priority species on private and public land alike, including controlled burns, removal of invasive species and woody vegetation, and planting/seeding grasses and forbs (OWI, n.d.). The Willamette Floodplain Research Natural Area (WFRNA) is a collection of seven wet-prairie restoration sites spanning 615 acres throughout Lane, Linn, and Benton County in the

southern portion of the WV. Two of the sites were previously intentionally farmed and have since been under conservation efforts for decades.

The habitat restoration efforts have led to successful (re)establishment of western meadowlark breeding populations in the WFRNA in recent years. Attributes of the most successful western meadowlark recruitment sites include high percent cover (>65%) of native species, especially low-growing wildflowers, sedges, and rushes, high structural diversity with high percent cover of native forbs (>10%), and bare ground for nesting (>5%) (OWI, n.d.).

Western meadowlarks have faced decades of decline throughout its range, largely as result of habitat loss and degradation due to agriculture and urbanization. Reestablishment of *S. neglecta* populations as a result of restoration efforts throughout the Willamette Valley have proven that the long-term anthropogenic harm done can be mended. Industrial agriculture has done direct and undeniable damage to Oregon's vibrant state bird but treating the landscape kindly through taking actions to support native biodiversity and natural, healthy fire and water regimes can still save them, along with the vital ecosystems where they live.

Conclusion

The condition of avifauna is a microcosm of environmental systems as a whole, and their steep decline in recent decades is an alarming glimpse into the realities of the biodiversity crisis and climate change globally. Agriculture intensification does undeniable environmental damage, and grassland insectivores are profoundly and uniquely affected by it. The Henslow's sparrow (*Ammodramus henslowii*), the grasshopper sparrow (*Ammodramus savannarum*), and the western meadowlark (*Sturnella neglecta*) are migratory grassland avian insectivores, falling in the intersection of three of North America's most endangered guilds. Their steep decline indicates nationwide ecological impacts of industrial agriculture since the green revolution, a concerning reality with dire consequences now and in the future. While this is scary, the success of habitat restoration efforts offers hope for an uncertain future. Damage has been done to the environment for decades, reflected in today's numerous biodiversity and climate crises, but it can be healed for a healthier future for all, including the birds.

Appendix: A Collapse of Beauty

In order for me to write poetry that isn't political
I must listen to the birds
and in order to hear the birds
the warplanes must be silent.

– Marwan Makhoul
Palestinian Poet (1979-)

Birds have long symbolized freedom, peace, and beauty for people across time and space, and they are now dying due to irresponsible human action. Avifaunal collapse is indicative of environmental catastrophe, an unlivable future for all of Earth's beings. Avifaunal collapse is a catastrophic loss of beauty, as well. The relationship between birds and humans is longstanding and rich; it is hypothesized that humans found our voices through listening to birdsong, through wanting to partake (Jarvis, 2008). Without birds as our guides, who will teach us to sing?

The United States of America is a country of war; it was born from it, it has fed it, it has mastered it, and it will likely die by it should the nation continue down this path. Even in times of peace, war industries pivoted to weapons to be used against the environment in order to prop up industrial agriculture- the war has not stopped, and the casualties are innumerable and growing, humans and birds included.

People and birds alike yearn to be free, to sing, to soar, and our futures are intertwined. Our short-sighted wars on each other must stop, for the sake of the birds, humans, the environment, and beauty. May there be a future where there are many birds thriving in good health and may all the people be free to share in their songs.

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