Upper Mississippi /
Great Lakes Joint Venture

Landbird Habitat Conservation Strategy – 2020 Revision

Upper Mississippi / Great Lakes Joint Venture
Landbird Habitat Conservation Strategy – 2020 Revision

Joint Venture Landbird Committee Members:

Kelly VanBeek, U.S. Fish and Wildlife Service (Migratory Birds), Co-chair
Chris Tonra, The Ohio State University, Co-chair

Mohammed Al-Saffar, U.S. Fish and Wildlife Service (Joint Venture)
Dave Ewert, American Bird Conservancy
Erin Gnass Giese, University of Wisconsin – Green Bay
Allisyn-Marie Gillet, Indiana Dept. of Natural Resources
Shawn Graff, American Bird Conservancy
Jim Herkert, Illinois Audubon
Sarah Kendrick, Missouri Dept. of Conservation
Mark Nelson, U.S.D.A. Forest Service
Katie O'Brien, U.S. Fish and Wildlife Service (Migratory Birds)
Greg Soulliere, U.S. Fish and Wildlife Service (Joint Venture)
Wayne Thogmartin, U.S. Geological Survey
Mike Ward, University of Illinois at Urbana-Champaign
Tom Will, U.S. Fish and Wildlife Service (Migratory Birds)

Recommended citation: Soulliere, G. J., M. A. Al-Saffar, K. R. VanBeek, C. M. Tonra, M. D. Nelson, D. N. Ewert, T. Will, W. E. Thogmartin, K. E. O'Brien, S. W. Kendrick, A. M. Gillet, J. R. Herkert, E. E. Gnass Giese, M. P. Ward, and S. Graff. 2020. Upper Mississippi / Great Lakes Joint Venture Landbird Habitat Conservation Strategy – 2020 Revision. U.S. Fish and Wildlife Service, Bloomington, Minnesota, USA.

Cover photo: Whip-poor-will, by Ian Sousa-Cole.

UPPER MISSISSIPPI / GREAT LAKES
JOINT VENTURE

TABLE OF CONTENTS

STRATEGY SUMMARY

The goal of this revised Joint Venture (JV) Landbird Habitat Conservation Strategy (Strategy) is to *guide regional conservation that results in habitat to support populations of priority landbird species and related social values, consistent with continental bird conservation goals.* Priority birds include JV *focal species* used for regional planning, as well as other species considered a high conservation concern by JV partners. The target audience includes those involved with planning, developing, and implementing landbird conservation at state and Bird Conservation Region (BCR) scales. However, information presented in this Strategy should also help clarify potential roles for local-scale managers, leading to best practices for work areas within a regional context. New to this iteration of the Strategy is organization by grassland- and forest-bird habitats. Also new is emphasis on people and the role of human dimensions research to guide bird conservation. For example, the document includes a novel chapter regarding conservation of *urban birds and developed lands*.

Unlike the 2007 JV Landbird Strategy, with its continental *top-down* approach, this revision provides far more regional-scale information regarding land cover (and bird habitat) change, landscape ecology, and important threats to birds. The Strategic Habitat Conservation (SHC) section conveys a regional overview for each SHC planning component, whereas sections devoted to grasslands, forests, and urban birds offer guild-specific information and objectives, along with a *conservation design* to target bird habitat delivery. Due to the vast diversity of landbird species and habitats, ecological systems, land-use patterns, and conservation opportunities across this large JV region, recommendations provided for bird habitat actions are general. However, links to online resources provided throughout the document offer supplementary conservation information and management examples. Joint Venture scientists also plan to assist conservation partners developing smaller-scale tactical bird-habitat delivery plans with more explicit management actions upon request.

In This Strategy

- A *Call to Action* reviews global, continental, and regional conditions resulting in loss of biological diversity and declining bird abundance, as well as prospective JV responses.
- Estimates of landbird focal species population sizes and distributions, estimates of land-cover distribution and area important to primary landbird guilds, and assessment of abundance and distribution of people throughout the JV region.
- Regional landbird population and habitat trends, review of full annual cycle management considerations, and assessment of bird habitat threats likely to limit population growth for species of high conservation concern.
- Biological models and maps displaying landscape designs to more effectively target grassland and forest conservation actions intended to reverse landbird population declines.
- Detailed technical information, including focal species habitat needs, along with breeding focal species 10- and 30-year population goals linked to the continental Partners in Flight Landbird Conservation Plan.

- *Summary of Regional Management Actions* at the end of the grassland, forest, and urban chapters, providing a useful shortcut for those seeking only bird-habitat delivery guidance.
- Sections regarding high priority monitoring and research needs, communications, and JV program coordination.

This Strategy establishes regional objectives for landbird population and habitat conservation while using current data and new tools for integrating social considerations into bird habitat decisions. The JV planning effort will continue to adapt as our knowledge of human dimensions improves along with our understanding of factors limiting population growth of landbirds through the full annual cycle.

Acknowledgements: Numerous bird research scientists and habitat specialists reviewed drafts of the strategy and provided comments and editorial suggestions resulting in a much-improved final product. These individuals included: Nicole Michel (National Audubon Society), Andy Forbes (U.S. FWS, Migratory Bird Program), Mike Eichholz (Southern Illinois University), Brendan Shirkey (Winous Point Marsh Conservancy), Anna Buckardt Thomas (Iowa Department of Natural Resources), Josh Vest (U.S. FWS, Prairie Pothole Joint Venture), Bob Ford (U.S. FWS, Partners in Flight), Bill Vermillion (U.S. FWS, Gulf Coast Joint Venture), Laura Kearns and Joe Lautenbach (Ohio Division of Wildlife), John Coluccy (Ducks Unlimited),Vic Lane (Grand Traverse Regional Land Conservancy), Angela Larsen-Gray (NCASI Impact Science Solutions), Ted Gostomski and Dave Peitz (U.S. National Park Service), Peg Robertson (USDA Forest Service), Kent Van Horn (Wisconsin Department of Natural Resources), and Doug Gorby (U.S. FWS, Upper Mississippi / Great Lakes Joint Venture). Two social scientists, Jessica Barnes (Virginia Tech University) and Ashley Gramza (Arkansas Game and Fish Commission), provided unique and very helpful perspectives regarding human dimensions and better integrating people into bird conservation planning and habitat delivery. Mike Schroer (Missouri Department of Conservation), Auriel Fournier (Illinois Natural History Survey), Dave Fehringer (The Forestland Group), Anne Mini (ABC, Lower Mississippi Valley Joint Venture), and Ryan Brady, Alaina Gerrits, Sumner Matteson, Dave Sample, and Richard Staffen (all Wisconsin Department of Natural Resources) provided feedback on sections of the draft strategy.

The Upper Mississippi / Great Lakes Joint Venture region occupies ancestral and contemporary homelands of First Nations people, including but not limited to the Dakota Sioux, Delaware, Fox, Ho-Chunk, Illini, Ioway, Kickapoo, Mascouten, Menominee, Miami, Ojibwe, Odawa, Otoe-Missouria, Potawatomi, Sauk, Shawnee, and Wyandotte. The JV acknowledges enormous contributions indigenous peoples have made, and continue to make, in the conservation of migratory birds and their habitats in the region.

CALL TO ACTION

Preamble: Not many years ago, in a typical Midwestern woodlot, the calls from roosting blackbirds could be almost deafening on a fall evening. An early winter walk through a snow-covered grassland might reveal countless meadowlarks, bursting from tufts of shelter after a migration stopover. Remember, too, the nighthawks and whip-poor-wills breaking the silence of summer darkness with their unique vocalizations – and the predictable coating of "bugs" on the windshield after a country drive, reflecting abundant forage for insect-eating birds. The numerous assemblies of birds, abundant insects, and related natural components of a healthy environment have been gradually fading from our lives during the Anthropocene – the current period in which human activity has become a dominant influence on the Earth and its inhabitants. Since 1970, bird abundance in North America has declined 30% – we have 3 billion fewer birds than 50 years ago (Rosenberg et al. 2019).

Although well meaning, past conservation approaches and their collective impact will not be enough to forestall continued bird population declines. Fortunately, some very influential forces are expressing the need for a paradigm shift that could positively affect our environment, bird habitats, and people. For example, there is a growing focus by the U.S. military (The Center for Climate and Security 2019), technology companies and industry (Bowers 2020, Worland 2020a), and even the International Monetary Fund (Worland 2020b) to address climate change. Continental conservation plans for waterfowl (NAWMP 2012, 2018) and landbirds (Rosenberg et al. 2016) are expanding their reach to work with novel partners and integrate social objectives (e.g., clean drinking water, carbon sequestration, outdoor recreation) with bird habitat planning and management. Traditional conservation funding (https://nabci-us.org/funding) is stable, but new sources are under consideration (https://wildlife.org/policy/recovering-americas-wildlife-act/) that can significantly increase financial support for bird habitat restoration and retention. The safeguarding role of Land Conservancies and Land Trusts is expanding, with increased engagement in policy development, government conservation programs, and with interested communities and individuals. Finally, technological advances and social science research are improving our ability to target conservation to meet both biological (bird habitat) and social objectives (Gurdak and Roe 2010, Snep et al. 2016, Soulliere and Al-Saffar 2017, Steven et al. 2017), increasing the relevance of birds and their habitats to society.

Wildlife scientists and business leaders alike are increasingly aware of public concerns regarding climate change, human well-being, and the need to remain relevant to people who provide needed financial and political support. However, conservation awareness must translate into effective conservation actions to reverse declining bird abundance. This document provides scientific information to help understand the status of landbirds and their habitats, reasons for declining population abundance, and a path forward to slow and eventually reverse downward population trends. Challenges across the upper Midwest are diverse and uncertain, but conservation opportunities abound. Recommendations presented here can increase effectiveness of bird-habitat conservation, which will take different forms depending on each situation. By weaving environmental, social, and business priorities into a collective vision for diverse ecological systems, there is hope for healthier landscapes that meet the needs of birds and people.

Birds are excellent indicators of environmental health and ecosystem integrity (Morrison 1986, Burger and Gochfeld 2004), and our ability to monitor birds over large spatial scales far exceeds that of other wildlife. Decline in bird abundance resulting from anthropogenic stressors (Sekercioglu et al. 2004, IUCN 2019) has been documented since about 1970, when large-scale bird population monitoring began. Globally, nearly one in five bird species has an imperiled status (Butchart et al. 2004). In the United States, 99 bird species and subspecies are listed as federally threatened or endangered (USFWS 2020), and without effective intervention over 200 additional species are expected to become candidates for listing in coming decades (Butcher et al. 2007). Despite these declines, the demand for bird-related tourism and the economic importance of birds is increasing.

Avian biodiversity concerns are not limited to rare birds, as once-common species are also rapidly declining in abundance. Across North America, nearly three quarters of grassland bird species have declined since 1970, amounting to a >50% loss in abundance for this group (Figure 1). As a result, there are an estimated 700 million fewer grassland birds in North America today than just 50 years ago. Loss in abundance of forest birds has not been as severe, but over the last five decades, nearly two-thirds of bird species breeding in eastern forests have declined (Rosenberg et al. 2019). This change amounts to a 17% loss in population abundance, equivalent to nearly 170 million fewer birds breeding in eastern forests compared to 1970, despite a 5% net increase in forest area over the same 50-year period (Oswalt et al. 2019).

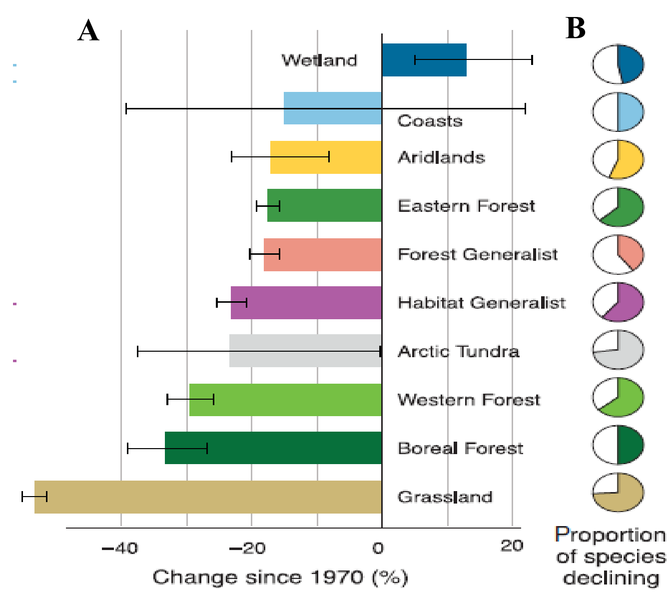


Figure 1. Population change by primary biome in North American birds (from Rosenberg et al. 2019): (A) proportional population abundance change from 1970 to 2017 (± 95% credible interval) and (B) proportion of species declining in each biome.

Within the Midwestern U.S., the number of birds moving through the airspace during migration declined by nearly 40% from 2007 to 2017 (Rosenberg et al. 2019). Across the Upper Mississippi / Great Lakes JV region, 22–45% of breeding landbirds monitored annually have declined since 1970, and 16–22% of monitored species are expected to decline another 50% within the next 30 years. If these trajectories continue unabated, by 2080 an estimated 3–9% of once-common species breeding in the JV region will become *quasi-extinct* – insufficiently abundant to determine population status using current monitoring methods (Stanton et al. 2016; Figure 2; see Appendix A for species scientific names).

Habitat loss and degradation appear to be primary factors driving bird populations downward. However, free-ranging domestic cats (*Felis catus*) kill an estimated 2.4 billion birds annually within the contiguous U.S. (Loss et al. 2013b), whereas collisions with human-constructed objects (buildings, automobiles, communication towers, wind turbines) in the U.S. account for more than 800 million bird deaths per year (Loss et al. 2015). Another direct but less obvious source of mortality is agricultural pesticides. These losses have not been enumerated for the U.S., but in Canada pesticides are estimated to kill more than 2.5 million birds per year (Calvert et al. 2013). In the Midwestern U.S., bird losses from agricultural pesticides would likely be no less than this number (Mineau 2004; Mineau and Whiteside 2006, 2013), given the toxicity of agricultural insecticides has increased as much as 120-fold since the year 2000 (Douglas et al. 2020).

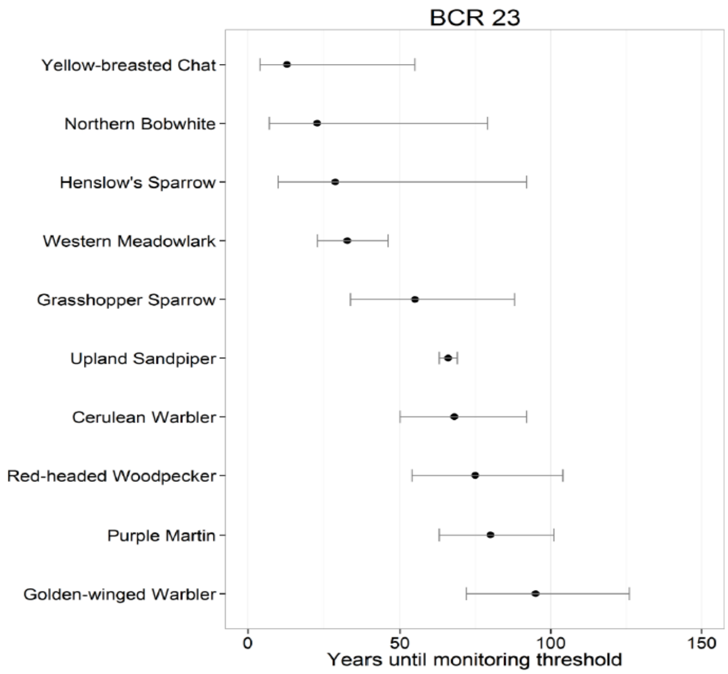


Figure 2. Sample of bird species breeding in the Prairie Hardwood Transition (BCR 23) and predicted number of years (± 95% C.I.) until species will fall below a detection threshold for population assessment, resulting in potential imperilment status (Stanton et al. 2016).

Indirect losses in bird populations come through reduced survival, often related to low food availability. For example, aerial insectivorous birds such as swallows, swifts, nightjars, and flycatchers have experienced significant declines across North America, in part because of declining abundance of high-quality insect prey (Spiller and Dettmers 2019). Burrowing mayflies (*Hexagenia* spp.) have declined by >50% over primary waterways including the Upper Mississippi River and Western Lake Erie Basin since 2012 (Stepanian et al. 2020). Likely causes of declines in both insect abundance and species richness include agricultural intensification, loss of native plant communities, and pesticides (Ewald et al. 2015, Sánchez-Bayo and Wyckhuys 2019). Finally, sub-lethal effects of agricultural chemicals cause physiological and behavioral abnormalities in birds that can prevent successful completion of key life history stages, such as migration (Eng et al. 2019).

Loss and degradation of bird habitats operate in concert with these direct and indirect sources of annual mortality that apparently exceed annual productivity for many species. Numerous studies associate recent grassland and farmland bird declines in the JV region to some aspect of land-use intensification. Most prominent are loss of native grassland, declining area of pasture and other semi-natural plant communities, increasing size of agricultural fields, row-crop monocultures with denser and more uniform structure, increased inputs of fertilizers and pesticides, and reduced fallowing of fields (Herkert 1994, McLaughlin and Mineau 1995, Best et al. 1997, Murphy 2003, Stanton et al. 2018). The quality of forest bird habitat within portions of the region also declined, especially related to simplification (lost diversity) and fragmentation – caused by past timber harvest regimes, pathogens, invasive species, and over-abundant deer populations – largely impacting forest understory-nesting and area-sensitive birds (Alverson et al. 1988, Robinson and Wilcove 1994, Donovan et al. 1995). In contrast, numbers of forest bird species were stable or increased within and across the relatively healthy National Forests of northern Minnesota and Wisconsin in recent years (Niemi et al. 2016).

> *"This loss of bird abundance signals an urgent need to address threats to avert future avifaunal collapse and associated loss of ecosystem integrity, function and services" (Rosenberg et al. 2019).*

It is clear past efforts to conserve birds are not sufficient to forestall losses in our global, national, and regional avifauna, let alone restore population abundance to some historic level. Why is this? In large part, because the footprint of the conservation community is small relative to the magnitude of threats facing birds. We have simply lacked sufficient political and financial advantage to counter these forces, plus our understanding of people and methods to shape human behaviors to benefit birds (via social science research) are limited. The habitat contributions of public lands are essential to wildlife populations, but they alone have not been (nor will they be) enough to stem the losses in regional bird abundance. In fact, the vast majority of landbird habitat loss and population declines in the Midwest U.S. during recent decades occurred on private lands. As such, if the conservation community is to effectively address declines in bird populations, we must gain the trust of private landowners (Ciuzio et al. 2013) and emphasize private lands in bird habitat conservation (Cunningham 2005, Thogmartin and Rohweder 2009, Brasher et al. 2019).

Therefore, to sustain healthy landbird populations in the JV region, we must increase meaningful connections with stakeholders having greatest influence on Midwestern landscapes. We need to integrate bird habitat concerns with land-use policies, fully account for human and political dimensions, and consider the broader range of ecosystem services when advocating conservation practices. We need to increase engagement with state and local governments, seek public support for remedies to bird threats, and collaborate on human needs that can be resolved with conservation actions. We will also need to collaborate with corporations, agri-business, developers and civic planners, the timber industry, and other commodity groups, to seek common ground. Finally, we must take bird habitat planning and delivery beyond the JV region to understand how migratory bird populations are limited and where conservation will be most effective during the full annual cycle. This Strategy provides a foundation to overcome some, perhaps many, of these challenges facing landbirds, but measurable success will depend on our valuable partnerships and the people of this region.

BACKGROUND AND CONTEXT

A primary role of bird habitat joint ventures is to implement continental bird conservation plans at the regional scale, with partners sharing resources and knowledge to complete local projects that address regional and continental conservation concerns. The Upper Mississippi / Great Lakes Joint Venture (JV) is one of 22 bird habitat joint ventures in North America (NABCI 2000). These self-directed partnerships of government conservation agencies, non-government organizations, corporations, tribes, and individuals formally accepted responsibility to implement international bird conservation plans within a specific geographic area (see https://www.fws.gov/birds/management/bird-conservation-partnership-and-initiatives/migratory-bird-joint-ventures.php). Widely accepted as the model for collaborative conservation in North America, joint ventures provide the best means to translate science into effective regional and smaller-scale bird habitat implementation. The goal of this Strategy is to *guide regional conservation that results in habitat to support populations of priority landbird species and related human desires, consistent with continental bird conservation goals.*

Primary audience: Wildlife biologists, conservation social scientists, and other conservation professionals involved in bird habitat planning, implementation (habitat delivery), and/or evaluation of grassland, forest, and other upland communities used by landbirds. This JV Strategy is especially for those seeking:

1) Regional and state-level landbird conservation planning linked to continental initiatives,
2) Species-habitat associations and current habitat threats to landbird populations,
3) Large-scale scientific landbird population and habitat information, plus local scale connection to conservation partners and information sources (via internet links),
4) Regional decision support tools (e.g., maps, models, projections) to assess conservation opportunities and more effectively target landbird habitat actions, and
5) Information regarding monitoring and research needed to track populations, measure management success, fill information gaps, test planning assumptions, and improve landbird habitat delivery over time.

Partners developing conservation grant applications and project proposals that include landbirds may find information in this Strategy essential.

Partners in Flight (PIF) produced the first North American Landbird Conservation Plan in 2004 (Rich et al. 2004), largely focused on results of a comprehensive species vulnerability assessment for the U.S. and Canada. It also provided a "Watch List" that identified species of highest conservation concern, along with a summary of their status, monitoring needs, and estimates of population size, leading to continental population objectives. A 2007 Upper Mississippi / Great Lakes JV Landbird Habitat Conservation Strategy (Potter et al. 2007) *stepped-down* priorities of the 2004 PIF Plan, concentrating on species of high continental concern with relatively high dependence on the JV region. In 2016, PIF revised the North American Landbird Conservation Plan (Rosenberg et al. 2016) with science-based biological objectives, including emphasis on conservation throughout the full annual cycle. The 2016 PIF Plan also encourages decision makers to guide policy and allocate resources to promote the importance of birds as indicators for environmental health and human quality of life.

Finally, the PIF Plan clearly links continental landbird conservation priorities to each bird habitat joint venture with individual regional profiles (Rosenberg et al. 2016).

In this JV document, we provide regional objectives for landbird populations and their habitats and find complementary relationships with other conservation plans and human dimension considerations. We assembled the best available population and bird habitat data and technological tools to guide conservation planning. We relied on the most recent science in our planning process and identified information gaps and assumptions that require investigation to improve subsequent iterations of the Strategy. Compared to the 2007 JV Landbird Strategy (Potter et al. 2007), which was based primarily on focal species assessments, this document emphasizes trends in landscape cover types important to different bird groups, particularly forests and grasslands, but also urban lands and airspace. The approach resulted in better integration of *top-down* (continental PIF priorities) and *bottom-up* (BCR-scale bird habitat trends) understanding and planning. Bird populations and associated community types were organized into separate grassland and forest chapters. These sections encompass focal species and their habitat threats, key planning considerations such as distribution of their current and potential habitats, and identification of broad management approaches providing a foundation for local-scale bird habitat decisions. In addition to working closely with the JV Management Board regarding Strategy content, our JV Landbird Committee collected stakeholder opinions and feedback via email questionnaire (Ewert et al. 2014) and personal interviews (Soulliere et al. 2019).

The Strategy is written with goals expressed over the 30-year PIF Plan time horizon, but JV objectives may be refined as knowledge of social science and regional landbird conservation improves. Moreover, because of the complexity in planning for this diverse bird group and the dynamic nature of conservation in this region (e.g., landscape change, technological tools, financial and human resources for conservation), the Strategy includes numerous internet links to supplemental information. Updated spatial data analyses and future local-scale tactical plans guiding bird habitat delivery will also be available on the JV website www.umgljv.org.

Regional Overview

The JV region encompasses all or portions of Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio, and Wisconsin (Figure 3). Immense natural resources of this area have influenced human settlement patterns and development intensity. There were over 60 million people

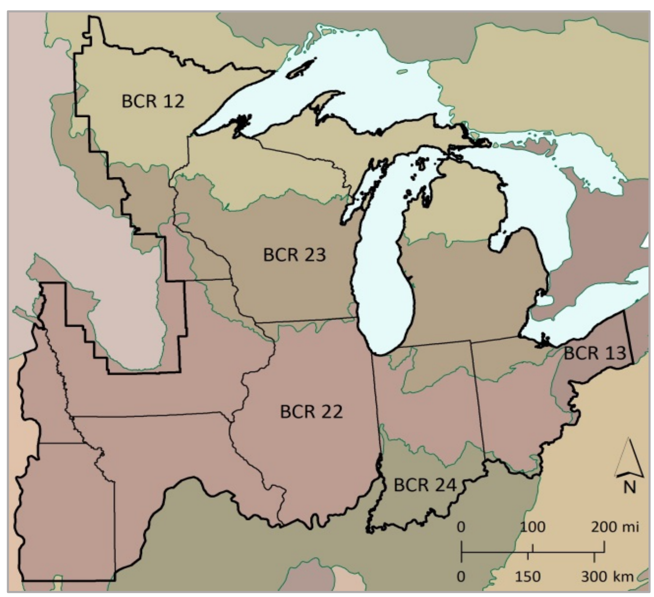


Figure 3. Boundaries of the Upper Mississippi / Great Lakes Joint Venture region (bolded black line), states (thin black line), and associated Bird Conservation Regions (BCRs, color discerned).

living within the JV region as of 2010 (USCB 2010), but human population density varies substantially.

The North American Bird Conservation Initiative (NABCI) has subdivided and classified the continent into Bird Conservation Regions (BCRs) for planning purposes (Bird Studies Canada and NABCI 2014; https:/nabci-us.org/resources/bird-conservation-regions-map/). Similar bird communities, habitats, and resource management issues characterize these planning units. The JV region is largely covered by BCRs 22 (Eastern Tallgrass Prairie), 23 (Prairie Hardwood Transition), and the U.S. portion of 12 (Boreal Hardwood Transition). Portions of BCR 24 (Central Hardwoods) and 13 (Lower Great Lakes / St. Lawrence Plain) also occur within the JV boundary (Figure 3). BCRs are further subdivided into State × BCR polygons in portions of this Strategy to assist JV partners with smaller-scale landscape assessment and bird-habitat objective setting.

Landscape composition and associated bird habitats largely determine the role each JV partnership will play in conservation of priority species identified in the 2016 PIF Plan. Likewise, depending on location, some regions are critical to priority species during the breeding period whereas other locations provide important migration and wintering habitats. Large and diverse JV regions like ours provide bird habitats during multiple life-cycle periods. Land-cover composition and interspersion, combined with soil characteristics, hydrology, and other physiographic features, result in differences among BCRs that influence distribution and abundance of landbirds across the JV region. Understanding these functional differences and trends in key cover types is essential to informed conservation decisions.

Pre-European Settlement and Current Land Cover

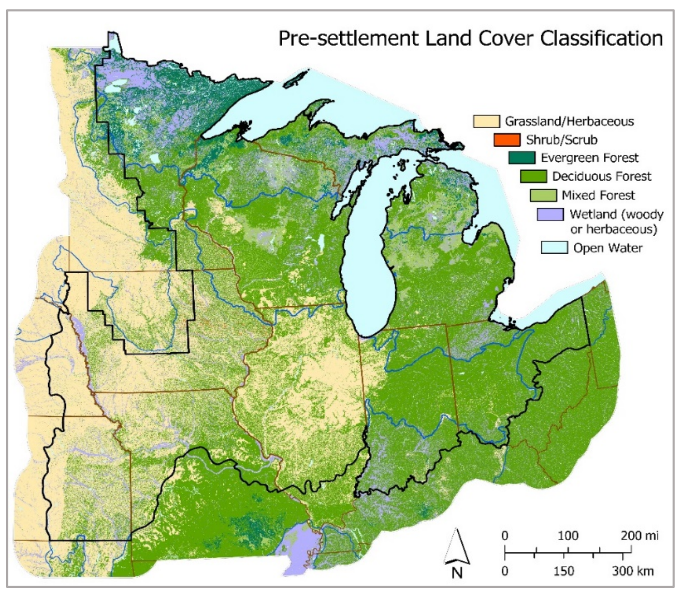


Figure 4. Predicted distribution of dominant land covers prior to Euro-American settlement of the Upper Mississippi / Great Lakes Joint Venture (JV) region (LANDFIRE 2018). JV region (black line) and Bird Conservation Region (blue lines) boundaries indicated. See Appendix B for detailed land cover descriptions.

Awareness of a landscape's natural cover conditions is necessary for effective conservation planning, as soils, hydrology, and climate govern plant communities and succession tendencies. Local managers must use principles of landscape ecology to develop appropriate conservation actions, respecting historical conditions in concert with assessing current ecological circumstances and future threats and opportunities (see Thogmartin et al. 2014). Various data sources were combined to generate a model-based image of landscape composition in the JV region before colonization by Europeans (Figure 4). Forests were the most dominant cover type based on this analysis, but grasslands and wetlands (both woody and herbaceous) were also vast. European settlement resulted in extensive wetland drainage and conversion of prairie, savanna, and forest to agriculture and developed land. Historical estimates suggest that forest area in the 10 states encompassing the JV region is only half as abundant as during the 1600s but still a dominant land cover today. Following initial losses, forest area gradually increased, with timing of losses and gains varying among states (Figure 5).

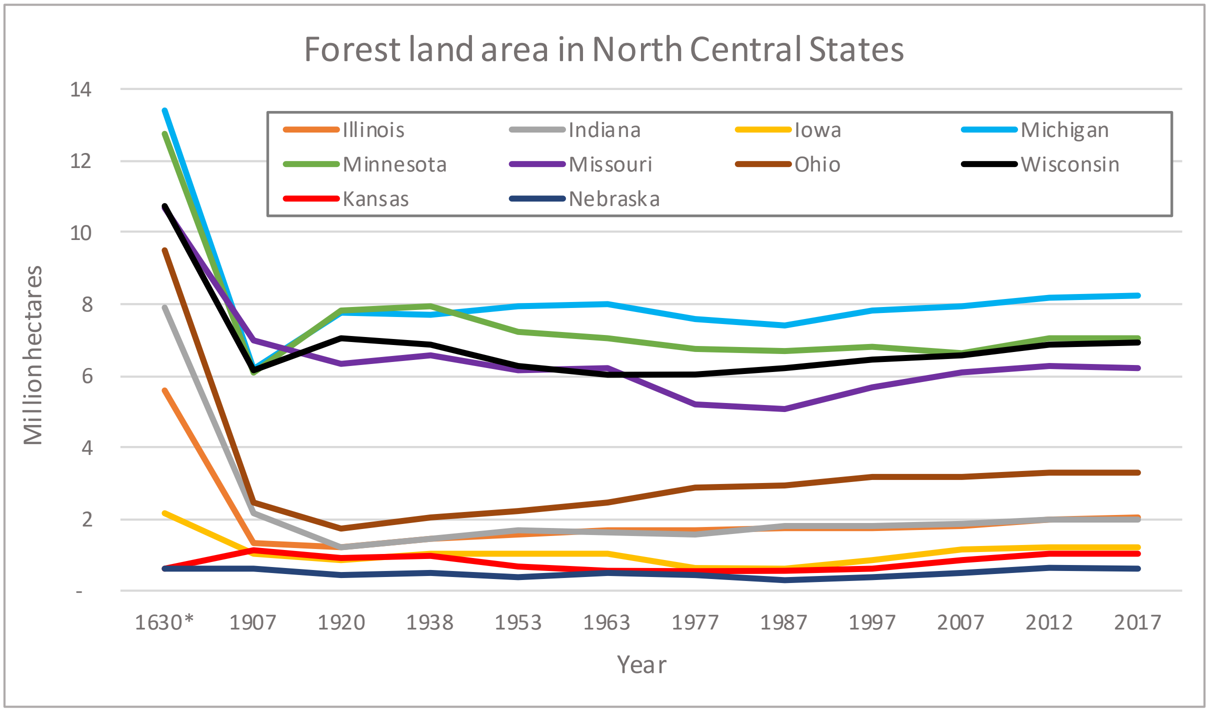


Figure 5. Forest area (1 ha = 2.5 acres) in ten states associated with the Upper Mississippi / Great Lakes Joint Venture region (Oswalt et al. 2019). Estimates of 1630 original forest area were from Kellogg (1909), based on 1907 forest area data and historic land clearing information. These data are for general reference only to convey the relative extent of forest at the time of European settlement.

Current landscape cover types within the JV region vary from heavily forested in the north and east to agriculture-dominated in the south and west (Figure 6). Largely nutrient-poor soils in the north (BCR 12) support evergreen, deciduous, and mixed forests with extensive areas of forested wetland and thousands of glacial lakes. Vegetation communities more closely resemble historical conditions in BCR 12. In much of the central and south (BCRs 23 and 22), however, human-induced landscape changes have altered physical (i.e., hydrology) and ecological (i.e., plant succession) processes and introduced numerous nonnative invasive plants. See Appendix C for detailed descriptions of each BCR.

Density and species composition of landbirds vary considerably across the JV region depending on land cover types and life-cycle period. Whereas extensive northern forests are essential breeding locations for large numbers of landbirds, migration corridors around the Great Lakes and habitat patches further inland are critical for northern breeding species during migration. New monitoring approaches and technological advances (https://midwestmigrationnetwork.org) have helped recognize the importance of the JV region in providing stopover habitat to migrating landbirds.

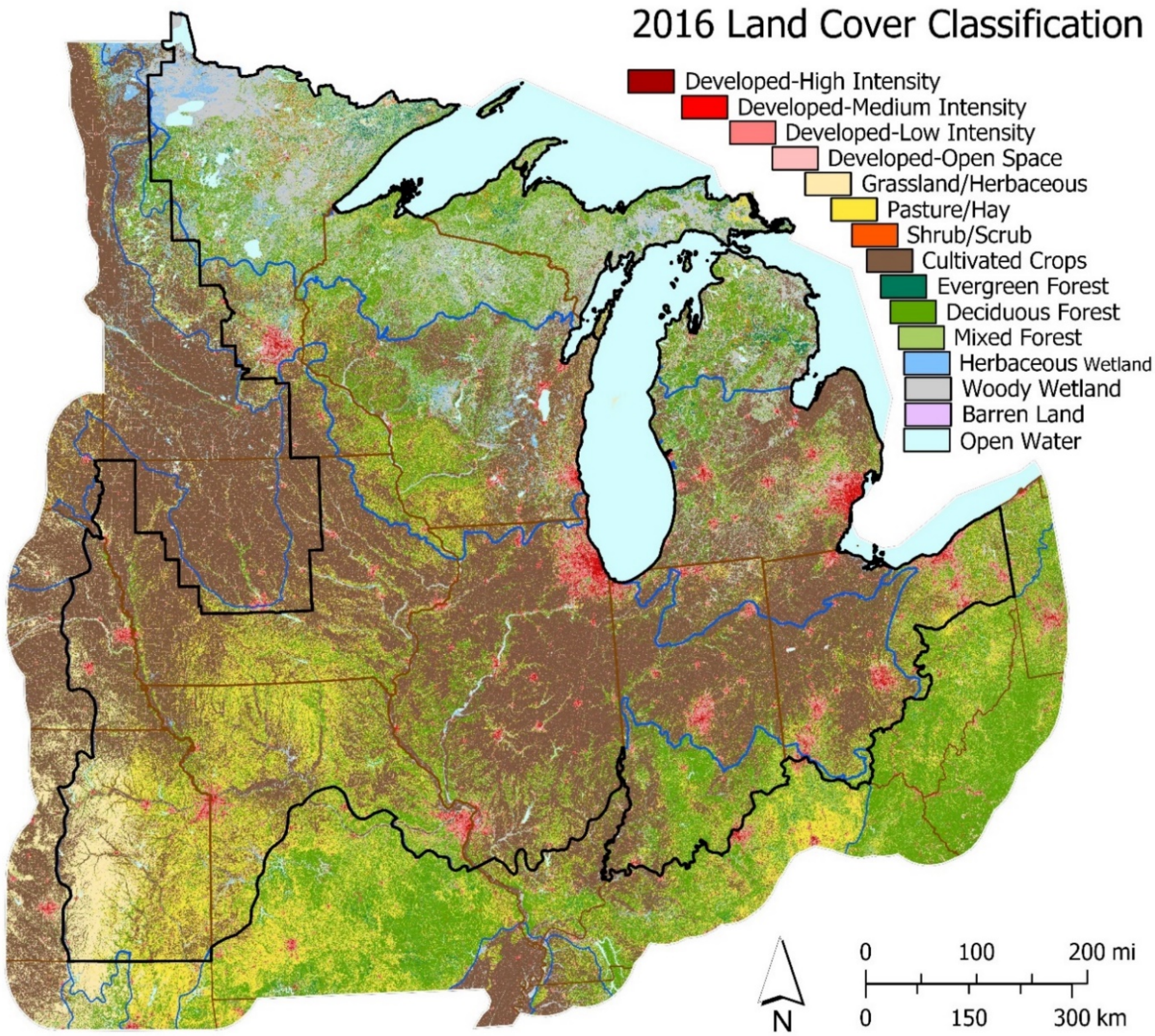


Figure 6. Landscape composition of the Upper Mississippi / Great Lakes Joint Venture region (2016 National Land Cover Database, Yang et al. 2018). JV region (black line) and Bird Conservation Region (blue lines) boundaries indicated; see Appendices B (land-cover class descriptions) and C (BCR descriptions) for more detail.

The consequences of an expanding human population and intense land use in the southern two-thirds of the region have been long-term loss and degradation of most bird habitats. A PIF vulnerability assessment of threats to landbirds found urbanization and changing forest conditions of greatest importance in their *Continental Threat Index* (Rosenberg et al. 2016), and these factors are prominent in the JV region. In much of the region, prairie and savanna, wet meadows, and shrubby / young forest transition zones have been replaced by monocultures and *hard edges* of row crops, invasive plants, mid-successional to mature forest, or development. Native grasslands have been subject to the greatest level of conversion and degradation because of intense row-crop agriculture, development, and fire suppression. Understanding the economic, legislative, and social foundations for intensified land use will be necessary for the JV to increase landbird populations.

Relationship to Other Conservation Plans

The North American Bird Conservation Initiative (NABCI 2000) facilitates conservation of all North American bird species through promoting coordinated delivery of habitat conservation for landbirds, waterbirds, shorebirds, and waterfowl. Continental population assessments, species prioritization, and general planning guidelines were completed for each of these four bird groups in separate North American plans. The most recent PIF Plan (Rosenberg et al. 2016) provided updated landbird species vulnerability assessments, population estimates, population trends, and area importance scores which were used when developing this regional landbird strategy revision. Smaller scale "blueprints for conserving our nation's fish and wildlife and preventing endangered species" are in State Wildlife Action Plans (SWAPs), whose bird-related conservation priorities typically align closely with JV regional priorities.

Other planning documents, such as those resulting from the Landscape Conservation Cooperatives (another system of regional natural-resource partnerships), are helping to identify large-scale environmental stressors and mitigation prospects with potential to benefit landbirds (e.g., Conservation Fund 2016 report addressing Gulf Hypoxia). Moreover, opportunities exist to integrate social objectives into landbird planning as well as conservation for pollinators (e.g., https://www.fws.gov/savethemonarch/ccaa.html; Cardno Inc. 2020) and other wildlife that share the need for healthy upland plant communities. Recently completed JV waterfowl and waterbird strategies (Soulliere at al. 2017, 2018) provide sound examples of integrating regional biological and social objectives with a theme for growing the relevancy of wetland-bird habitats to people.

Landbird Stakeholder Surveys

Considering the diversity of demands on JV partners, and concern about declining societal connection with the outdoors and natural resources, the JV Science Team sought an improved understanding of stakeholder views regarding landbird habitat conservation. In 2014, the JV Landbird Committee developed a short questionnaire survey for conservation stakeholders concerning implementation of the 2007 JV Landbird Habitat Conservation Strategy (Ewert et al. 2014). In 2019, the JV Landbird Committee conducted a more in-depth information gathering exercise, this time using structured interviews of JV Management Board members and other stakeholders likely to use JV landbird planning products (Soulliere et al. 2019). Questions were thorough and standardized, and the interview process allowed for greater inter-personal communication and clarification. Responses by interviewees had direct application to this Strategy revision, especially questions regarding planning tools that JV partners would find most useful for landbird conservation decisions (Figure 7).

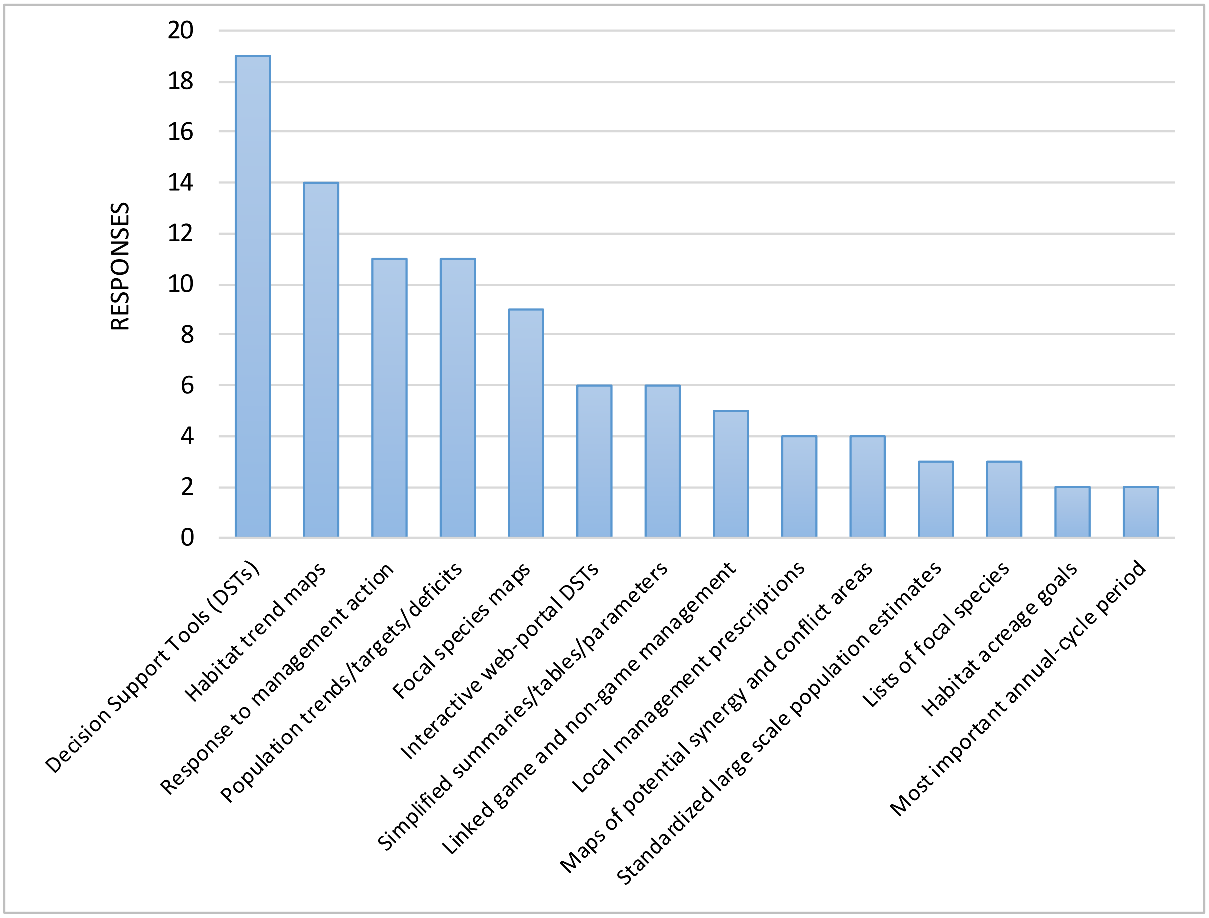


Figure 7. Planning tools that landbird stakeholders (n = 28) in the Upper Mississippi / Great Lakes Joint Venture region indicated would be most useful, based on interviews of conservation agency and organization representatives (Soulliere et al. 2019).

STRATEGIC HABITAT CONSERVATION

Implicit in the Strategy goal is that JV partners will 1) lose no native landbird species currently occurring in the region, 2) return species of concern to agreed-upon levels of former abundance, and 3) be *strategic* and *adaptive* in conservation planning and bird habitat delivery. The JV community views conservation as a multifaceted science, with planning, implementation, and evaluation acting as integrated components of management that strive for greater long-term benefit from conservation investments (NEAT 2006). This approach is partner-based, science-driven, and comprises an iterative planning cycle. Conservation plans change over time as progress in meeting objectives, costs and benefits of techniques, and key planning assumptions are tested and evaluated. Strategic conservation for JVs starts by planning at larger spatial and temporal scales, with JV regional plans providing intermediate or *stepped-down* priorities from continental plans to smaller-scale plans (e.g., SWAPs) and conservation actions. It is the cumulative impact of these local-scale projects that ultimately achieve JV regional goals.

Considering the complexity of current bird habitat threats, strategic habitat conservation (SHC) may be the best system to restore and maintain landbird populations at goal levels. Moreover, understanding people's desires for bird-related recreation or ecosystem services can influence support and placement of bird habitats.

Thus, addressing regional landbird conservation requires the JV to:

1) Determine population and habitat objectives for priority species at ecologically meaningful scales (State × BCR) and in concert with the PIF continental plan.
2) Identify the most significant factors limiting population growth for priority species throughout the full annual cycle.
3) Integrate human dimensions (HD) and social science into the biological aspects of SHC (https://nabci-us.org/wp-content/uploads/2019/05/Incorporating-Human-Dimensions-into-Joint-Venture-Implementation-Plans.pdf) to improve understanding and support.
4) Pool resources and target conservation to ensure efficient and effective bird habitat delivery that also meets human demands.
5) Measure and evaluate results, documenting both successes and failures, and continually improve conservation planning and management actions over time.

Components of SHC – Biological Planning, Conservation Design, Habitat Delivery (implementation), and Monitoring and Research – provide the foundation for this Strategy. Below is a summary of each SHC component as they relate to the grassland, forest, and urban bird habitat sections of the document.

Biological Planning

Biological planning establishes a foundation for effective bird habitat conservation by describing current conditions and trends, establishing species-habitat relationships, recognizing population-limiting factors within and outside the JV region, and identifying conservation goals. *Focal species* (Appendix D) are selected as representatives for various guild-habitat associations. Their population responses (e.g., abundance, distribution, reproductive success) then provide measures of progress toward objectives achievement.

> ***The JV will:***
> - *Lose no native landbird species*
> - *Return species to acceptable abundances*
> - *Practice Strategic Habitat Conservation*

Focal Species and Habitat Associations

Conservation planners use terms such as *focal* and *surrogate* when developing lists of representative *management umbrella* and *management indicator* species. The umbrella concept assumes that activities undertaken for a *focal species* will benefit a suite of ecologically similar species (Zacharias and Roff 2001). Likewise, management indicators are species selected to focus conservation delivery, typically for population recovery and/or ecosystem diversity (Caro 2010). Changes in populations of management indicators should reflect the effects of conservation activities and common environmental influences on other species within the community represented by the focal species (see USFWS 2014). Use of JV focal species in this Strategy provides a means to elevate awareness and concentrate partner efforts on species of high conservation concern, whose continental populations are monitored, and whose population abundance may be influenced by conservation actions in the JV region. However, we also emphasize the need to understand life-cycle connectivity and the potential for a species breeding in one region to be limited by habitat or other factors during nonbreeding periods.

Criteria for selecting focal species included the following:

1) Relatively high continental and/or regional conservation concern,
2) JV region is important to continental population during at least one life-cycle period,
3) Strongly associated with a plant community or complex of cover types important to a community of landbird species that can be classified by regional spatial data,
4) Potential factors limiting population abundance have been identified, even if not completely understood, some of which may occur outside the JV region, and
5) A system of population monitoring has been established or data-informed population abundance estimates have been developed.

Using the 2016 PIF Plan information specific to the Upper Mississippi / Great Lakes JV in concert with the updated PIF Avian Conservation Assessment Database (ACAD; Partners in Flight 2020a), 15 species of conservation concern were selected to represent bird-habitat guilds during breeding and nonbreeding periods across BCRs in the JV region (Table 1 and Appendix D). The ACAD contains biological information generated by the PIF Species Assessment Process, a peer-reviewed, scientific methodology for evaluating information related to the conservation of birds (Panjabi et al. 2020).

Population trends of JV focal species are assumed to generally reflect a suite of co-occurring species characterized by a given plant community or complex of cover types. However, given the range of landscape-level influences and the multifaceted nature of habitats used by a single species during the full annual cycle, this assumption may be invalid. Likewise, assuming that multiple landbird species will respond similarly to focal species habitat restoration and retention is largely untested. Finally, much of the spatial data used to develop this regional Strategy (i.e., NLCD) is not of adequate resolution to interpret species-specific habitat area or quality. For these reasons, we do not quantify focal species habitat objectives using literature- or expert-based population density estimates. Rather, we establish bird habitat objectives at the NLCD cover-class level using general habitat characteristics of grassland and forest bird guilds and landscape change analysis. In addition, we provide a variety of information resources regarding focal-species habitat requirements, threats, and environmental trends to inform the often-complex situational decisions of local managers.

Table 1. Focal species (by habitat category) used for landbird conservation planning in the Upper Mississippi / Great Lakes Joint Venture (JV) region, including color-coded population status and vulnerability, primary period of occurrence in JV region, Bird Conservation Regions (BCRs) of greatest importance, and breeding population (BPOP) goals from the 2016 Partners In Flight (PIF) Plan. [a]

Habitat category, species, and ACAD status[a]	Primary period		BCRs	BPOP goal (compared to 2016)	
	Breeding	Non-breeding		By 2026	By 2046
Forests and barrens					
Eastern Whip-poor-will	X		12, 23, 22, 24	Slow decline >60%	Increase >5%
Red-headed Woodpecker	X		12, 23, 22, 13, 24	Slow decline >60%	Increase >5%
Wood Thrush	X		12, 23, 22, 13, 24	Slow decline >60%	Increase >5%
Golden-winged Warbler	X		12, 23	Follow Recovery Plan (increase >50%)	
Kirtland's Warbler	X		12	Follow Recovery Plan (maintain/expand)	
Cerulean Warbler	X		23, 13, 24	Slow decline >60%	Increase >5%
Canada Warbler	X		12, 23	Slow decline >60%	Increase >5%
Rusty Blackbird		X	12		
Blackpoll Warbler		X	12		
Grasslands					
Henslow's Sparrow	X		12, 23, 22, 24	Slow decline >60%	Increase >5%
Bobolink	X		12, 23, 22, 13, 24	Slow decline >60%	Increase >5%
Eastern Meadowlark	X		12, 23, 22	Slow decline >45%	Stabilize, <25% loss
Short-eared Owl		X	22, 24		
American Tree Sparrow		X	23, 13, 24		
Urban					
Chimney Swift	X		12, 23, 22, 13, 24	Slow decline >60%	Increase >5%

[a] The Avian Conservation Assessment Database (ACAD; Partners in Flight 2020) provides science-based species status relative to extinction risk at the continental scale using color-coded Watch Lists: high/urgent conservation need = red, moderate conservation need = yellow, and common birds in steep decline = brown. Current (2020) ACAD status is different from 2016 PIF Plan for Kirtland's Warbler and Chimney Swift (we used 2020 ACAD status). BPOP goals are from 2016 PIF Plan and relate to Watch List status: Recover = red, Prevent / Reverse Decline = yellow, and Stabilize = brown. Species occurring in the JV region primarily during the non-breeding period do not have BPOP goals for the region.

The primary cover types they depend on (Table 1) often categorize landbirds, but each species requires specific features within these broad plant communities and some species require multiple community types in close proximity. Thus, landscape cover types, habitat components within cover types, and juxtaposition of these cover types often determine habitat quality for birds. For initial spatial data analysis and bird habitat modeling, we identified simple cover-type and areal combinations comprising typical habitats for JV focal species. In addition, species with higher levels of PIF conservation concern were sorted into guilds associated with focal species and grouped by habitat descriptions (Table 2). The most recent spatial data available from the 2016 National Land Cover Database (NLCD; Yang et al. 2018), supplemented with 2014 LANDFIRE biophysical settings (LANDFIRE 2018), were used to designate habitat associations and assess areas that potentially meet focal species requirements.

Table 2. Habitat associations and Partners in Flight continental population status (PIF 2020) for landbirds of conservation concern occurring in the Upper Mississippi / Great Lakes Joint Venture (JV) region. Groupings are for general planning purposes only (JV focal species in bold), as habitat descriptions are simplified and individual species may use multiple habitat categories. Regional Stewardship includes species with >25% of global population occurring in a BCR (BCR number listed; includes BCR area outside JV region).

Habitat group description	Watch List (Red and Yellow)	Regional Concern	Common Birds in Steep Decline	Regional Stewardship (by BCR)
Eastern deciduous forest (mature): Primarily oak-hickory or maple-basswood mixed-mesophytic communities; also mixed oak-pine	**Eastern Whip-poor-will** **Red-headed Woodpecker** **Wood Thrush** **Cerulean Warbler** Black-billed Cuckoo Kentucky Warbler	American Woodcock Yellow-billed Cuckoo Chuck-will's-widow Northern Flicker Least Flycatcher Eastern Wood-Pewee Great Crested Flycatcher Blue Jay Scarlet Tanager Black-and-white Warbler Rose-breasted Grosbeak		**Eastern Whip-poor-will** (24) Black-billed Cuckoo (12) Worm-eating Warbler (24) Kentucky Warbler (24)
Bottomland hardwood forest (mature): *Lowlands* dominated by cottonwood, ash, sycamore, red and silver maple, box-elder, elms, or sweetgum	**Red-headed Woodpecker** Prothonotary Warbler	Yellow-billed Cuckoo	**Rusty Blackbird**	
Early successional eastern forest/shrubland: Includes a variety of communities including beaver-wetlands, abandoned pastureland, early regeneration following disturbance (both hardwood and coniferous forests), power-line right-of-ways, and reclaimed strip mines	**Eastern Whip-poor-will** **Golden-winged Warbler** Black-billed Cuckoo Prairie Warbler	American Woodcock Eastern Kingbird Brown Thrasher Loggerhead Shrike Eastern Towhee Field Sparrow Blue-winged Warbler Yellow-breasted Chat Orchard Oriole	**American Tree Sparrow**	**Golden-winged Warbler** (12)
Eastern northern hardwood and mixed forests (early to mature): *Areas* typically dominated by maple, beech, aspen, and birch, but including a significant component of red and white pine and or hemlock	**Eastern Whip-poor-will** **Golden-winged Warbler** **Canada Warbler** Black-billed Cuckoo Olive-sided Flycatcher Connecticut Warbler	American Woodcock Northern Saw-whet Owl Least Flycatcher Eastern Wood-Pewee Great Crested Flycatcher Veery Black-and-white Warbler Scarlet Tanager Rose-breasted Grosbeak	**Rusty Blackbird**	**Golden-winged Warbler** (12) Broad-winged Hawk (12) Yellow-bellied Sapsucker (12) Veery (12) Ovenbird (12) Nashville Warbler (12) Mourning Warbler (12) Blackburnian Warbler (12) Chestnut-sided Warbler (12) Black-throated Blue Warbler (12) Black-throated Green Warbler (12)
Jack pine and oak-pine barrens: Relatively open and typically dominated by jack pine (early to mixed age) on sandy soils	**Kirtland's Warbler** Prairie Warbler	Eastern Kingbird Eastern Towhee	Common Nighthawk Brewer's Blackbird	
Spruce-fir conifer forest (early to mature): **Areas** dominated by balsam fir and or white spruce; black spruce bogs or flats; lowland white cedar	**Canada Warbler** Olive-sided Flycatcher Evening Grosbeak Connecticut Warbler	Northern Saw-whet Owl Black-backed Woodpecker	**Rusty Blackbird** **Blackpoll Warbler** Pine Siskin	
Eastern grassland: Historically-occurring native herbaceous communities with bluestem, grama, and or wheatgrass; remnant Eastern Tallgrass Prairie; human-created agricultural grasslands (including pasture, hay, and mixed plantings); and grass-dominated reclaimed strip-mines	**Henslow's Sparrow** **Bobolink** Greater Prairie-Chicken Le Conte's Sparrow	**Eastern Meadowlark** Northern Bobwhite Sharp-tailed Grouse Upland Sandpiper Northern Harrier American Kestrel Eastern Kingbird Barn Swallow Loggerhead Shike Sedge Wren Brown Thrasher Vesper Sparrow Grasshopper Sparrow	**Short-eared Owl** Horned Lark Brewer's Blackbird	**Henslow's Sparrow** (22) Dickcissel (22)
Oak savanna: Native prairie grasses and forbs with a sparse tree canopy, usually dominated by bur oak	**Red-headed Woodpecker**	Northern Flicker American Kestrel Eastern Wood-Pewee Eastern Kingbird Tree Swallow Brown Thrasher Eastern Towhee	Common Nighthawk	
Freshwater wetlands: Emergent marshes dominated by plants such as cattails, rushes, sedges, pickerelweed, wild rice, and arrow arum; other freshwater wetlands associated with streams, rivers, and lakes, often with shrub-scrub	Olive-sided Flycatcher Le Conte's Sparrow	American Woodcock Northern Harrier Belted Kingfisher Willow Flycatcher Tree Swallow Bank Swallow Barn Swallow Sedge Wren Marsh Wren		
Generalist/urban/aerial insectivore: Urban and exurban habitats dominated by human structures, both residential and commercial; farm homesteads; excavations and landfills; bridges	**Chimney Swift**	Tree Swallow Bank Swallow Barn Swallow Common Grackle	Common Nighthawk	

Game bird focus.—Hunters, through a variety of funding streams, provide financial support for much of the wildlife habitat conservation conducted by government agencies and several non-government organizations in the JV region. Based on the recent JV landbird stakeholder survey (Soulliere et al. 2019), these conservation agencies and organizations seek synergistic management opportunities for game (hunted) and non-game species. Habitat actions focused on grassland songbirds and Ring-necked Pheasants, and forest songbirds and Eastern Wild Turkey, were two examples provided by survey respondents. Similarly, management for early successional eastern forests can benefit American Woodcock, Ruffed Grouse, and Golden-winged Warbler. Landbird stakeholders generally indicated management should focus on community health and biodiversity, with less emphasis on individual game species. However, some JV partners require significant management focus on hunter interests. Several traditional game species are included on the PIF lists of conservation concern for the JV region including the migratory American Woodcock and non-migratory Greater Prairie-Chicken, Northern Bobwhite, Sharp-tailed Grouse, and Ring-necked Pheasant (Table 2). Some of these species remain abundant within their core ranges, but populations have declined in areas where grassland and young-forests are disappearing. Addressing the needs of game species, in addition to JV focal species, may be especially important when integrating social and biological objectives.

Land Cover and Habitat Assessment

Breeding population objectives in the 2007 JV Landbird Strategy were linked to the first PIF Plan (Rich et al. 2004). Associated JV habitat objectives were generated using biological models to calculate the estimated amount of breeding habitat needed to accommodate regional populations at JV objective levels. This objective setting approach was referred to as top-down planning. However, because implementation occurs at local scales, planning should also include an assessment of existing species abundances and trends in associated habitats at smaller scales to complete a complementary bottom-up planning procedure. The JV completed State × BCR assessments providing general extent and distribution of NLCD land covers associated with JV focal species (https://umgljv.org/planning/state-by-bcr-plans/). However, NLCD has lower accuracy classifying some cover types over others (Wickham et al. 2017), and NLCD-based estimates of primary plant communities do not translate into estimates of high-quality bird habitats. Trend measures of some bird habitats may be improved using the U.S.D.A. Forest Inventory and Analysis (FIA) and U.S.D.A. National Resources Inventory (NRI). Although not spatially explicit, these sources include detailed information regarding plant community composition, structure, and change, with corresponding statistical uncertainty across larger geographic extents like States, BCRs, and the entire JV region.

New spatial data were used to assess regional land cover status for this Strategy, providing an updated indicator of general bird habitat trends. Using biophysical information (LANDFIRE 2018), land-use/land-cover back-casting models (Sohl et al. 2016), and recent satellite-based land cover data (NLCD, Yang et al. 2018), we calculated the area of primary cover types most likely to influence landbird populations during four periods: pre-European settlement, 1938, 2001, and 2016 (current). Our analysis found the greatest degree of landscape change in the JV region occurred between pre-European settlement and 1938 (Table 3). Immense areas of grassland/herbaceous (native prairie) and forest were converted to cultivated cropland and pasture/hay, accounting for 37 million and 21 million ha, respectively, by 1938. The most dominant land cover categories in the JV region by 1938 were cultivated cropland (38%), forest (23%), pasture/hay (22%), and wetland (10%; woody and herbaceous combined). Development (i.e., urbanization with ≥20% impervious surface) accounted for an estimated 2% of land cover in 1938.

Table 3. Estimated area (ha; 1 ha = 2.5 acres) in primary cover types most likely influencing landbird populations in the Upper Mississippi / Great Lakes Joint Venture region from pre-European settlement, 1938, 2001, and 2016.[a]

Land Cover	Pre-settlement (LANDFIRE)	1938 (NLCD backcasted)	2001 (NLCD)	2016 (NLCD)	Current[b] area versus Pre-settle	1938	2001	Change (ha) 2001 to 2016
Grassland/herbaceous	26,105,535	3,151,431	3,510,351	3,368,639	0.13	1.07	0.96	-141,713
Hay/pasture	0	21,035,769	11,838,650	10,582,286		0.50	0.89	-1,256,364
Shrub/scrub	109,195	190,088	407,625	626,235	5.73	3.29	1.54	218,610
Forest (upland, all types)	55,030,747	22,184,769	22,536,822	22,269,302	0.40	1.00	0.99	-267,521
Deciduous	44,436,478	17,763,994	16,354,765	16,150,927	0.36	0.91	0.99	-203,838
Evergreen/conifer	5,178,643	2,161,113	1,682,018	1,600,737	0.31	0.74	0.95	-81,282
Mixed forest	5,415,626	2,259,663	4,500,039	4,517,638	0.83	2.00	1.00	17,598
Wetland (total)	13,538,408	9,702,869	11,427,800	11,419,637	0.84	1.18	1.00	-8,163
Forested/woody	No data	7,839,081	9,458,293	9,542,210		1.22	1.01	83,916
Emergent herbaceous	No data	1,863,788	1,969,507	1,877,428		1.01	0.95	-92,079
Cultivated cropland	0	37,358,594	37,005,655	37,992,779		1.02	1.03	987,124
Developed	0	1,810,431	4,102,483	4,440,056		2.45	1.08	337,573
High intensity	0		376,939	449,215			1.19	72,276
Medium intensity	0		964,533	1,118,525			1.16	153,992
Low intensity	0		2,761,011	2,872,315			1.04	111,304
Developed open space	0		4,024,528	4,124,006			1.02	99,478
Open water (inland only)	2,726,570	2,080,125	2,579,670	2,605,172	0.96	1.25	1.01	25,501
Barren land	103,577	23,100	180,447	185,922	1.80	8.05	1.03	5,475
Total area	97,614,035	97,537,175	97,614,033	97,614,033	1.00	1.00	1.00	0

[a]Area estimates were generated from model-based spatial data in LANDFIRE (2018), National Land Cover Data (NLCD; Yang et al. 2018), and back-casting models (Sohl et al. 2018). Cover type class inaccuracies vary widely, with varying amounts of bias resulting from map-based estimates. There are ongoing efforts to produce model-based and model-assisted estimates of cover-type area that have statistical validity and corresponding estimates of uncertainty.

[b]Current is the calculated area for each cover type in 2016, and values in columns compare to current (e.g., current grassland/herbaceous is 13% of the pre-settlement area, 107% of the 1938 area, and 96% of the 2001 area).

Between 2001 and 2016, apparent loss of forest and grassland continued, but the greatest loss by area was pasture/hay, with nearly 1.3 million ha of net loss (Table 3). Cover classes with greatest estimated area increases during this period were cultivated cropland (+1 million ha) and development (+338,000 ha). Most new developed lands were classified low- to medium-intensity (20–80% impervious surface). Shrub/scrub also appears to have expanded in recent years, with an estimated 218,000 ha gain (Table 3), but forest and shrub/scrub communities can be quite dynamic. For example, succession stages following a severe fire or commercial *clear-cut* (i.e., complete harvest of stand) typically move from forest, to bare ground and grassland/ herbaceous (for a few years), to shrub/scrub (for some years), and finally back to forest. Much of the estimated recent expansion in shrub/scrub occurred in BCR 12, where the practice of clear-cutting has most influenced forest structure. However, disturbance and resulting regeneration of early successional forest varies considerably, both spatially and temporally (Figure 8; also see Nelson and Reams 2017).

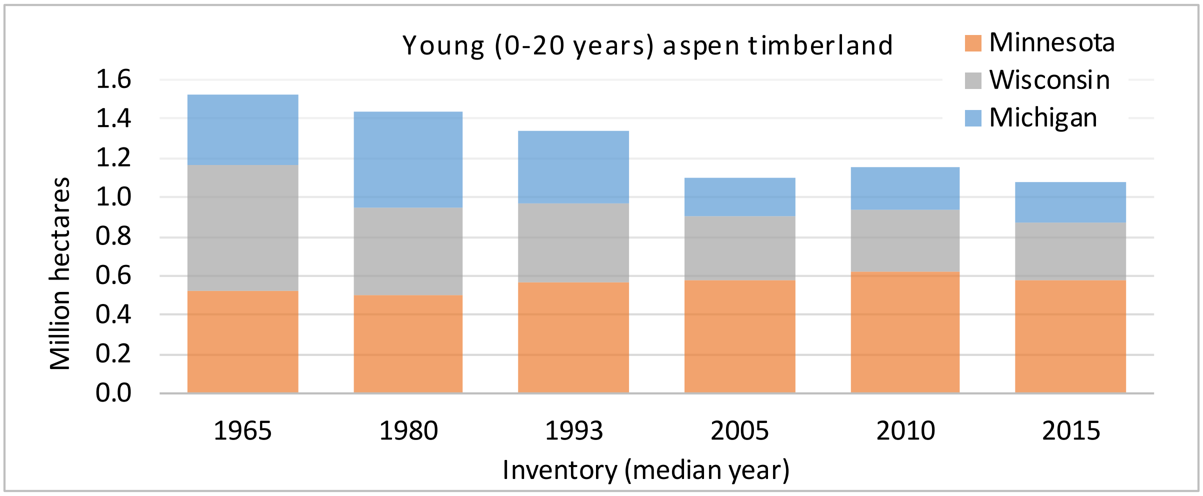


Figure 8. Forest area (1 ha = 2.5 acres) classed as young aspen (*Populus* spp.) based on Forest Inventory and Analysis data (M. Nelson, unpublished data, USDA Forest Service) for northern states in the upper Great Lakes region; area estimates include seedling and sapling stages (shrub/scrub in NLCD) and recently cut aspen stands.

Recent State × BCR assessments (https://umgljv.org/planning/state-by-bcr-plans/) found expansion of developed land (i.e., areas with constructed materials and 20–100% impervious surfaces) occurred at a surprisingly high rate in central and southern portions of the JV region. Bird Conservation Regions 13, 23, 24, and 22 had the greatest proportional change to developed land between 2001 and 2011. Increases in developed land coverage resulted mostly from conversion of cultivated cropland, grassland/herbaceous and pasture/hay, and upland forest. Much of this land-cover conversion represented urban sprawl, occurring primarily adjacent to and between existing human population centers. Some of the greatest losses in bird-friendly land cover since 2001 occurred in BCR 22, where significant areas of grassland/herbaceous and pasture/hay were converted to cropland and developed land. However, substantial gains in herbaceous wetland also occurred in BCR 22, especially around large river floodplains in Missouri, Iowa, Nebraska, and Kansas.

Conservation Estate

Conservation lands include areas in public ownership, land trust and conservancy ownership, or private-land under conservation easement. The lands and associated bird habitats are generally considered protected from development. Primary sources of spatial data available to help measure distribution and abundance of conservation lands in the JV region included the Protected Areas Database of the United States (PAD-US; USGS 2018) and the National Conservation Easement Database (NCED 2020). Staff at the JV Science Office pooled and cleaned these data for compilation errors, then developed a regional map of current conservation lands (Figure 9; see PAD and NCED websites for periodic updates). Although some of the spatial data reflect areas of acquisition interest (not yet acquired) rather than actual ownership, the resulting image provides a general configuration of protected lands across the region. Most public land is in the north (BCR 12), but there are concentrations of protected land in central and southern areas. Local concentrations of private land under perpetual and 30-year conservation easement through the Wetlands Reserve Program (recently renamed Wetland Reserve Easement [WRE] Program) are also prominent in portions of the region. Not displayed are Conservation Reserve Program (CRP) lands, especially valuable to grassland-nesting birds (Herkert 2007). These easement contracts are more temporary (typically 10–15 years), and CRP lands have frequently been converted back to agriculture when contracts expire (Morefield et al. 2016).

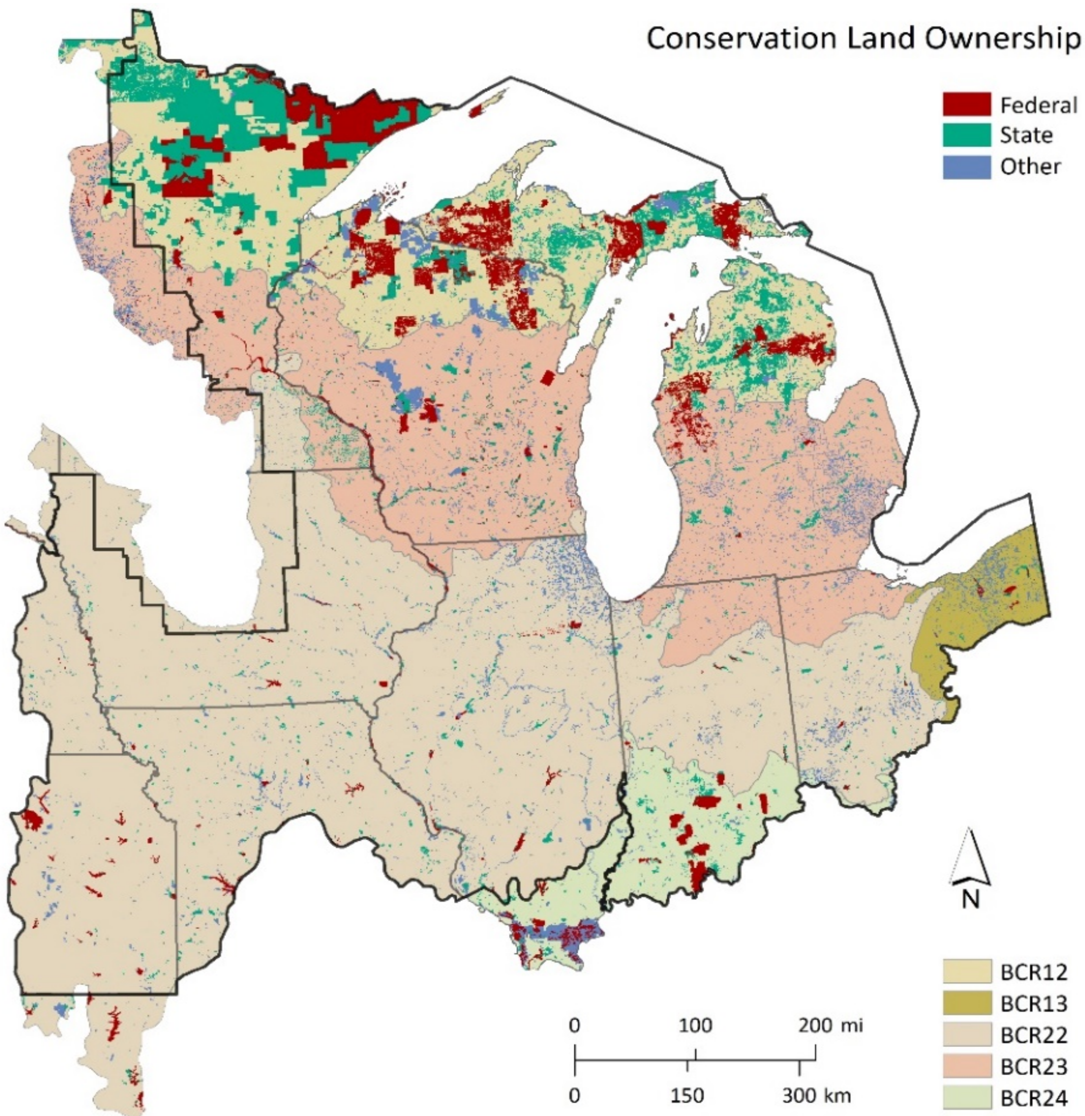


Figure 9. Location of Federal, State, or Other conservation lands in the Upper Mississippi / Great Lakes Joint Venture region. The *Other* ownership category includes private land with perpetual/long-term conservation easement, conservancy/trust land, and county, township, and city-owned land. Some apparent public-land blocks encompass areas of acquisition interest or tribal-lands rather than complete ownership by a conservation agency. Map based on Protected Areas Database of the United States (PAD-US; USGS 2018) and the National Conservation Easement Database (NCED 2020).

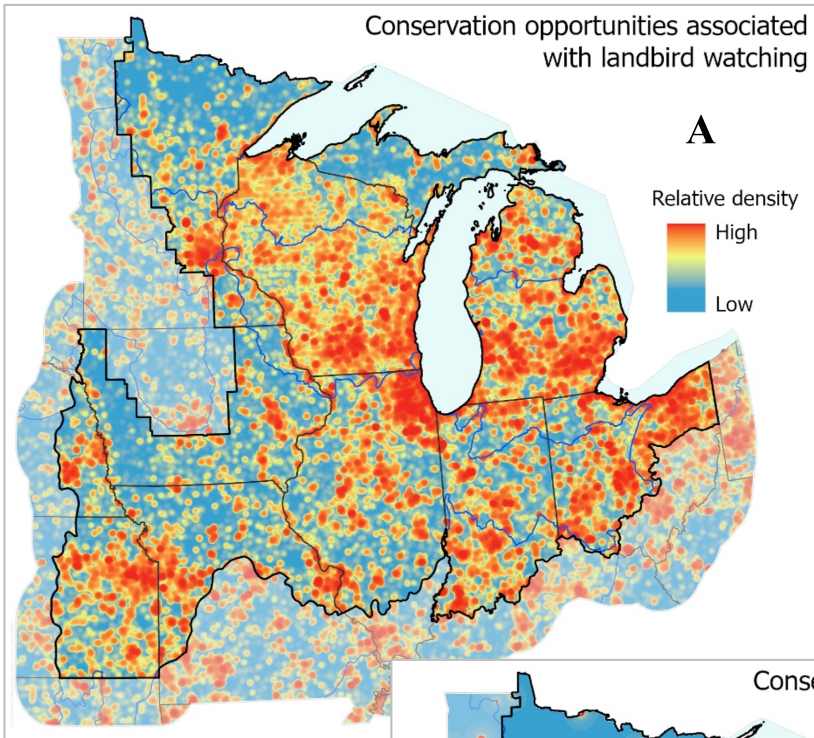
Conservation Design

Conservation design has been described as a process (to design) and a product (a design) that helps achieve partner missions, mandates, and goals while ensuring sustainability of ecosystem services for current and future generations (Bartuszevige et al. 2016, Campellone et al. 2014). Conservation design for JVs offers a landscape assessment and means to quantify and broadly target partner objectives (Soulliere and Al-Saffar 2017). The process involves combining biological and social geospatial data to create tools such as decision-support maps that prioritize landscapes to support JV objectives. Using spatial analysis, we assessed landscape conditions and characteristics needed to achieve particular biological outcomes. A primary step to complete this effort includes partner consensus around regional population objectives and commitment to conservation implementation. Detailed conservation design information (*decision support maps*) related to bird guilds are found in the forest, grassland, and urban chapters of the Strategy and in Appendix F. Using locally pertinent information, decision support maps can be refined to inform smaller-scale management actions.

Landscape conservation design by JVs involves using the best available information to efficiently target conservation and achieve objectives developed during biological and social planning. Ideally, spatially explicit habitat objectives result from a thorough understanding of species-habitat associations, factors limiting population growth, and characteristics of high quality habitat (e.g., features resulting in enhanced breeding success and survival). The continually evolving biophysical conditions of our JV region due to social, economic, and natural influences add a dynamic and very challenging level of complexity to planning. Improved understanding of ecological and social systems over time will help JV partners to more effectively identify and retain the most important bird habitats in the future.

Integrating Social Objectives

To increase the social relevance of conservation, bird habitat restoration and retention may be targeted to locations already important to bird watchers or to locations potentially important to outdoor recreationists due to their proximity to human population centers (Devers et al. 2017). We used eBird (Sullivan et al. 2009) data collected from 2010–2020 for JV focal species to develop a spatial layer depicting areas of greatest importance to bird watchers. High- and low-density *neighborhoods* (Figure 10A) were generated with a kernel density analysis from GPS locations and frequency of bird observations. We assumed conservation activity in these high activity neighborhoods should be a primary focus to increase birdwatcher retention and recruitment. To identify areas of potential importance to general outdoor recreation, we based a kernel density analysis on U.S. census data – distribution and abundance of people across the JV region, and open space within urban landscapes. The resulting map depicts neighborhoods of conservation opportunity within and around human population centers, including buffer areas of 50 km on average surrounding cites (Figure 10B). Developed Open Space (NLCD 2016, Appendix B) within urban areas and undeveloped lands extending out from urban lands represent the predicted geographic distribution of greatest bird-related recreational opportunity based on distance recreationists readily travel from home (Devers et al. 2017). Thus, we expect potential conservation landscapes of average distance ≤50 km from where people reside (i.e., population centers) to receive greatest use by current and new outdoor recreationists if available and accessible to the public.



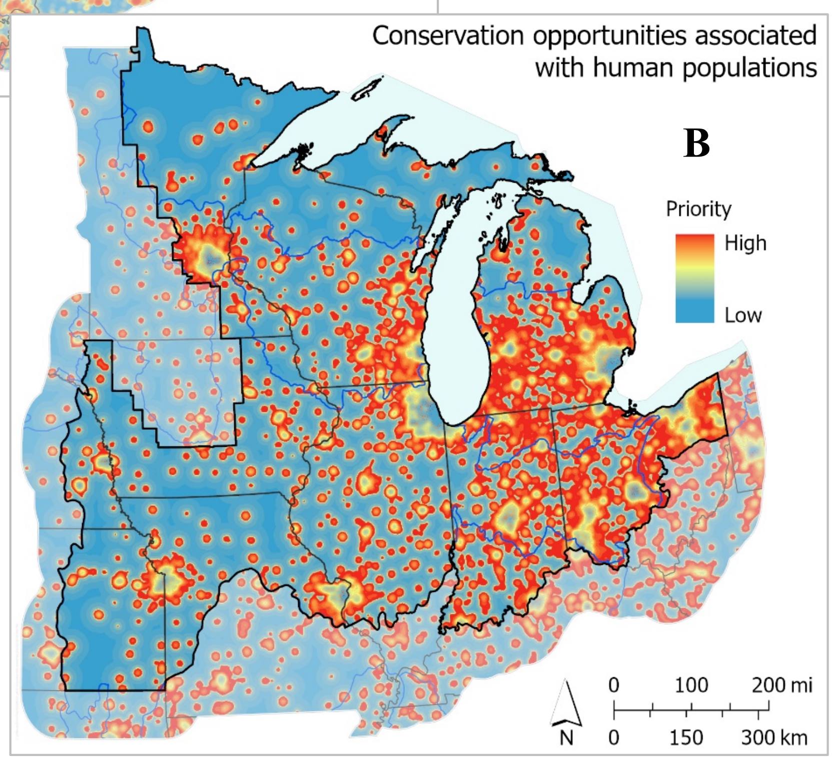


Figure 10. Distribution of bird-viewing activity (A; 2010–2020 eBird records for all JV focal species) and potential recreation areas associated with human-population centers (B; potential high-use areas averaging <50 km from human concentrations determined using 2010 U.S Census data) in the Upper Mississippi / Great Lakes Joint Venture region.

Adapting to System Change

This Strategy seeks to provide the best possible guidance regarding landbird populations and targeting habitat conservation at the JV regional and BCR scales as well as factors most likely to influence bird population trends. Understanding land-cover change, including the *wildland-urban interface* (https://www.nrs.fs.fed.us/pubs/48642), is essential to long-term planning for landscapes that benefit birds and people. Beyond the many traditional and obvious threats to bird habitats, there are other potential sweeping influences to consider when developing long-term conservation strategies. Examples of challenges with high levels of uncertainty in the JV region include impacts from exotic and invasive species, flood intensity and duration, human land use (agriculture and development), and especially climate change – warmer winters, higher amounts of precipitation, and amplified storm intensity (SWCS 2003, USGCRP 2017).

If land cover changes continue at current rates, traditional decision-support models that guide planning and conservation efforts will become less relevant. The composition of migratory birds occurring at any one location is difficult to predict, but forecasting future species response to habitat management may be impossible due to accelerated environmental change. In addition, the focus on customary wildlife products (e.g., abundance and distribution) familiar to previous generations of wildlife managers may need to become more pliable as we plan and work in significantly altered and changing systems. Drawing on information developed by diverse regional science partners outside bird conservation may be key to addressing uncertainty in conserving bird habitats more resilient to environmental changes. JV partners must be aware of these principles, as they will become increasingly important in future conservation planning and implementation at local scales.

Habitat Delivery

The science of bird habitat conservation has advanced rapidly over the last couple of decades, but our ability to implement bird conservation plans is challenged by other demands on natural resources agencies and organizations. The divide between knowing what to do and our ability to get it done is largely due to limited human and financial resources. This difference between a planning document and its prescribed bird habitat delivery has been termed the "implementation gap" (Rosenberg et al. 2016). Finding new mechanisms and resources to bridge this gap is essential if we are to move beyond planning to meaningful conservation success for landbirds. The implementation gap stems from four main issues (our JV emphasis in parentheses):

1) ***Scope and scale*** of the challenge (prioritize species of greatest conservation need at continental scale that can be influenced with habitat delivery in JV region).
2) ***Lack of conservation capacity*** (share resources and use best science to target conservation but also expand influence to private lands and public policy).
3) Need for ***greater societal awareness and engagement*** (be relevant to society by engaging people who already appreciate birds as well as those who are motivated by human health or other ecosystem services provided by bird habitat).

4) ***Address uncertainty*** and adapt conservation methods (improve estimates of bird habitat abundance and change, understand bird population response to management, and predict future conditions likely to influence birds).

Habitat Quantity vs. Quality

Bird habitat objectives are typically expressed as quantity values, yet quality is an equally important consideration. Bird-habitat quality measures have included plant community diversity, stand-area size and degree of fragmentation, forest understory health, and food density. Local-scale management prescriptions must also consider the dynamic nature of vegetation composition and structure with changing environmental conditions (e.g., precipitation patterns, disturbance regimes), finer-scale interspersion, unique bird-habitat features (e.g., snags, cavities), and other aspects influencing site quality for target species of birds. Related factors (brood parasitism, disease, pollutants, etc.) may further limit bird presence or abundance. Ignoring these bird habitat factors disregards landscape features critical to biological diversity and the long-term carrying capacity of an area for birds.

Conservation Categories and Reporting

There was a concern among JV Science Team members that the 2007 landbird-habitat delivery categories were confusing to partners and that activities supporting maintenance vs. those addressing population deficits required more detail. As we plan, deliver, and evaluate management actions in the future, JV partners must be diligent in their focus on activities that produce positive responses by focal species and benefits accrued to society while at the same time not diminishing habitat value for other species of high conservation concern. We recognize there may be management conflicts among species of concern at the project scale, but guidance to help weigh tradeoff decisions is available (Thogmartin et al. 2014). Partners also must be consistent in habitat accomplishment tracking to better relate accomplishments to bird population outcomes (JV goals).

Clearly defined habitat prescriptions coupled with bird population and habitat monitoring before and after a conservation action are essential to adaptive management. However, establishing measures of conservation success can be more complicated for some cover types, such as forest management. For example, cutting a mature forest stand reduces habitat features for species dependent on old-growth characteristics while increasing site value to species dependent on young-growth characteristics or stands with open patches. Thus, monitoring focal species response, overall system biodiversity, and other non-traditional measures may be needed to evaluate success at multiple scales. The following revised bird-habitat delivery categories for accomplishment reporting better distinguish efforts protecting habitats currently valuable to landbirds (*retention*), from those habitat actions that address species population deficits by restoring (*restoration*) or substantially improving degraded sites (*enhancement or reconstruction*). Other commonly used bird-habitat management activities not included in JV accomplishment reporting are also defined below. For additional assistance interpreting restoration and enhancement terminology, and considerations related to wildlife habitat conservation in highly altered landscapes, the Society of Ecological Restoration is a valuable information source.

Retention = retaining habitat of relatively high value to target species (i.e., JV focal species or guilds) often through fee acquisition (permanent protection), perpetual conservation easement, other incentives, or regulation. Retention often involves purchase of existing bird habitats on private lands that are vulnerable to future degradation or development and transfer of ownership to a conservation agency or organization, assuring permanent protection. (*Note:* Acquisition of degraded sites with anticipated / planned restoration to quality bird habitat soon after purchase [<5 years] may be included in both retention and restoration categories. While retention often provides legal protection to ownership parcels, operational management [defined below] may also be required to maintain habitat quality, especially where natural disturbance regimes are interrupted.

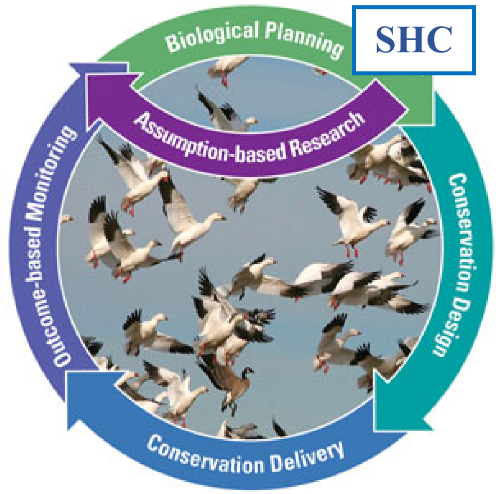
Restoration = returning or replacing a lost natural ecosystem, thus reverting altered sites where ecological function and bird habitat have been compromised to a system with restored ecological functions and high value for focal species or guilds. A common example of bird habitat restoration is reverting an agricultural field to a native-plant grassland.

Enhancement = improving ecological function and quality of degraded bird habitat with practices lasting for extended periods (>10 years), such as eradicating monoculture stands of invasive plants and replacement with desirable species, removing exotic plant species from within native-plant stands, or similar actions to increase community diversity and health. Enhancement elevates long-term carrying capacity for focal species or guilds (i.e., increasing occurrence, recruitment, or survival) but does not reduce biodiversity, ecological functions, or habitat values for other species of conservation concern.

Operational management = periodic or annual manipulation of areas under a persistent management regime to achieve desired outcomes for focal species or guilds. Management includes actions considered routine for the location to retain quality bird habitat (e.g., burning established grassland to reduce brush and retain herbaceous plant diversity).

Operational maintenance = repair or replacement of infrastructure or equipment with limited life expectancy but necessary to conduct bird habitat management at this location. Closely related to operational management, this type of work typically occurs at areas intensively managed due to altered hydrology and surrounding human-influenced landscapes, or maintaining traps to remove cowbirds for improving Kirtland's Warbler productivity. Reporting may simply include costs to complete maintenance rather than acres affected.

Only JV-related migratory bird habitat retention, restoration, and enhancement activities and costs are reported annually to the U.S. Congress. However, partners should consider tracking additional activities associated with operational management and maintenance to assess annual costs related to these categories, as well as return on investment. Results of outcome-based monitoring at project sites are essential to measure effectiveness and practice adaptive management.



Monitoring and Research

Monitoring and research programs are often synonymous in bird conservation. For purposes of this Strategy, most monitoring includes efforts designed and implemented to establish population status and measure progress toward meeting bird population and habitat objectives, and social objectives. In addition to large-scale abundance surveys, monitoring is essential to assess site conditions (and human desires/attitudes) before proposing management actions as well as measuring results of past conservation activity. Research projects, in contrast, are designed to answer specific questions that arise from uncertainties (knowledge gaps) or assumptions inherent in conservation planning. For example, habitat quality may be evaluated by assessing density of focal species, physical or environmental characteristics (e.g., vegetation related to quality habitat), or vital rates (e.g., survival and production). Bird-habitat use surveys that also measure changes in vital rates in response to environmental conditions offer an opportunity to test hypotheses about factors that limit population growth. Even more beneficial are surveys closely integrated with explicit management decisions, where biological and social predictions and testing are used to learn about the effects of conservation practices. In this Strategy, we provide foundational research and monitoring objectives, with lists of complementary and more specific evaluation needs available and periodically updated on the JV website.

FULL ANNUAL CYCLE

The majority of avian ecology research has focused on the breeding period, resulting in limited knowledge regarding other portions of the annual cycle for most species. Fewer than 10% of species-specific studies have included more than one season or interactions between seasons (e.g., carry-over effects), leaving critical aspects of population dynamics unexplored (Marra et al. 2015). Seasonal interactions at the population level may obscure drivers of breeding abundance trends (Wilson et al. 2011). Thus, it is critical to identify limiting factors and their role in population dynamics across all phases of the annual cycle. Below we describe important aspects of each stage of the migratory bird annual cycle and identify areas of research need for landbirds occurring in the JV region. We also discuss *airspace* as habitat because this component of bird life influences all annual-cycle periods.

Breeding

Reproductive success (fledglings/adult) is a key parameter to measure breeding season habitat quality considering adult landbird survival is generally high during this period (e.g., Sillett and Holmes 2002, Rockwell et al. 2017). Habitat features most important to breeding landbirds include nesting cover and surrounding structure, plus adequate food resources. Breeding success can be limited by food supply (e.g., Nagy and Holmes 2005), nest predation (e.g., Sherry et al 2015), and their combined effects (Zanette et al. 2006). Species-specific information regarding breeding habitat characteristics, requirements, and potential limitations is located in the habitat chapters and Appendix D.

Molt

The least understood period of the annual cycle is during seasonal feather molt, with survival, species-specific habitat requirements, and spatial aspects being particularly important information needs (Tonra and Reudink 2018). Many species of landbirds overlap prebasic and/or prealternate molts with migration (i.e., molt-migrations; Leu and Thompson 2002; Pyle et al. 2018; Tonra and Reudink 2018). These molt-migration events range from small-scale movements to extended stopovers in particular molting areas to continuous molt during active migration. The consequences of molt-migration strategies are additional habitat considerations and resource needs within stopover sites. Thus, locations used as stopover sites during molt must meet the energetic and nutrient needs for feather production, in addition to migratory refueling.

In one example from the JV region, Wright et al. (2018a) documented prealternate molt-migration during spring staging of Rusty Blackbird in Ohio and found that intensity of molt interacts with body condition to influence stopover duration. Many species likely remain on breeding territories throughout the molt period, but the extent to which they use the same or different resources during migration needs additional research. Lastly, information regarding the impact that molt has on subsequent stages of the annual cycle through carry-over effects (Harrison et al. 2011), such as migration survival and speed, is required to better understand its role in productivity and population dynamics.

Migration

Research examining landbird survival across the annual cycle estimated highest mortality occurred during migration (Sillett and Holmes 2002, Klaassen et al. 2014, Rockwell et al. 2017, Rushing et al. 2016). Two JV focal species of high conservation concern – Rusty Blackbird and Blackpoll Warbler – occur in the region almost exclusively during their respective migration periods. Because a relatively high proportion of these two species' populations depend on the region during fall and spring migration, addressing their habitat needs during these life-cycle periods is a JV focus.

There are two classes of bird migration habitat, each with their own mortality risks: stopover and airspace. The relative importance of each to a species within the JV region may depend upon migration strategy (Alerstam and Lindstrom 1990; Alerstam 1991). Landbirds that use an energy-minimizing (*hopping*) strategy make many short stopovers interspersed with relatively short bouts of flight. These species will require multiple patches of adequate stopover habitat distributed across the region, as well as minimal impediments to airspace. Species that employ a time-minimizing (*jumping*) strategy make few stopovers between longer bouts of flight. They tend to *stage* when they do stop, with large numbers of individuals congregating for long periods to rest and refuel (Warnock 2010). Protection and enhancement of such areas in the JV region can be of great importance to some species, such as Rusty Blackbird (Wright et al. 2018b). Understanding the overall migration ecology of birds is critical to prioritizing habitat management. A conceptual framework describing landbird stopover habitat in anthropogenic terms (Mehlman et al. 2005) has been useful for planning:

> ***Fire Escapes.***—Sites that are infrequently used, but are at times utterly vital, such as during severe weather events. Habitat quality may be too low to allow birds to gain significant mass, but they can survive, take shelter, and typically acquire fresh water. Fire escape sites are normally adjacent to significant barriers such as deserts or large bodies of water.
>
> ***Convenience Stores.***—Habitat patches along bird migratory routes, such as small parks or woodlots in a non-forested matrix. These sites offer a place where birds can rest and gain mass, perhaps between flights to higher quality sites. A given Convenience Store may be better able to serve the needs of some species than others.
>
> ***Full-service Hotels.***—Larger and often more diverse stopover sites, Full-service Hotels are places where all needed resources (food, water, and shelter) are relatively abundant and available. These places can serve many individuals of many species.

It is unclear to what extent in-route habitats limit migrant bird populations, but the success of an individual migrant is dependent on several factors, primarily the energetic state of the migrant and the abundance and spatial configuration of stopover habitat (Moore and Simons 1992). Networks of stopover sites in the JV region should be linked, and conservation of stopover areas must be in the context of the full annual cycle. To minimize threats affecting migrants, conservation activities should pay particular attention to potential bird habitats (grasslands, wetlands, and forests of all successional stages) imbedded in urban and agricultural landscapes and near Great Lakes shorelines and riparian corridors. Critical stopover networks have been identified along western Lake Erie (Ewert et al. 2006), lake shorelines of Wisconsin (Grveles et al. 2011), the Chicago region (Byrne 2008), and southern Ontario (Bryan et al. 2011). Forests ≤25 km from Lakes Michigan, Huron, Erie, and Ontario provide important stopovers (Ewert et al. 2012; also see Great Lakes Migratory Bird Stopover portal).

Migratory Bird Stopover Facts

- Many species are more flexible in their selection of stopover habitat than breeding or wintering habitat, and some select different habitat types on migration routes (Petit 2000).
- Migrants may select different stopover habitat depending on a bird's age and sex (Woodrey 2000, Marra and Holmes 2001) or molt status (Wright et al. 2018a).
- Birds often use different habitats during spring and fall migration (Petit 2000, Buler et al. 2007, Buler and Moore 2011).
- Forests ≤25 km from Great Lakes shorelines are used as stopovers at a higher rate than associated forest areas further inland (Ewert et al. 2012).
- Migrants do not always use the same routes each season; there is much variability due to weather, barriers, and timing (Mehlman et al. 2005, Cooper et al. 2017).
- While birds make macro-habitat decisions just prior to landfall (Buler et al. 2007), micro-habitat decisions after arriving at a site depend on food availability, competition, and presence of predators (Moore and Simons 1992, Barrow et al. 2000, Wright et al. 2018b).
- Plant communities with greater complexity support greater bird species richness during the migration period (Moore et al. 1990).
- Habitat fragmentation may have less effect on fitness of migrants compared to breeding birds, and corridors of less suitable cover can facilitate movement to resource-rich sites (Petit 2000).
- High densities of migrants have been found in isolated habitat patches surrounded by large areas of unsuitable agricultural and urban cover (Bonter 2009, Buler and Dawson 2014).
- Importance of mortality during migration to the overall annual survival is uncertain, though it may be relatively high for some species (e.g., Sillett and Holmes 2002, Newton 2004, Rockwell et al. 2017).

Overwintering

The primary need of wintering birds is habitat that ensures high seasonal survival (Rockwell et al. 2017). Some species, such as American Tree Sparrow and Short-eared Owl (Appendix D), occur in the JV region primarily during winter. However, most landbird species breeding in and migrating through the region over-winter from the southern U.S. to central South America. Focal species associated with forest habitats overwinter largely in the Neotropics, where threats typically relate to deforestation depending on forest type and overwintering location (Rosenberg et al. 2016). Many landbirds winter in disturbed habitats (Johnson et al. 2004). For example, agroecosystems hold great promise in providing suitable habitat for some forest-dwelling species, in particular shade grown coffee farms that provide sufficient tree canopy (Rosenberg et al. 2016). Grassland focal species overwinter from the southeastern U.S. (Henslow's Sparrow, Eastern Meadowlark) to South America (Bobolink). Like northern breeding areas, loss of fire to maintain grasslands is also a concern across wintering areas. Direct mortality occurs from trapping and other persecution for species using agricultural habitats outside the U.S. (e.g., Bobolink).

There is a growing body of literature documenting the prevalence of within-season relocations for overwintering landbirds (Stutchbury et al. 2016). A recent study using a network of long-term monitoring stations (Monitoreo de Sobrevivencia Invernal, MoSI) across the southern U.S., Central America, and northern South America found multiple wintering species have low residency rates, suggesting birds may shift among habitats during this period (Ruiz-Gutierrez et al. 2016). Residency rates between sites indicates birds are responding to relative habitat quality (e.g., Bulluck et al. 2019). Tracking data has documented within-season movements of hundreds to thousands of kilometers for some focal species, including Eastern Whip-poor-will (Tonra et al. 2019) and Bobolink (Renfrew et al. 2013). The prevalence of such movements by landbirds is largely unknown, yet implications for conservation are substantial, potentially requiring focus on wintering habitats across multiple countries for the same species.

Winter abundance trends (% annual change) by Bird Conservation Region (BCR) for some PIF priority species that overwinter in the JV region, based on Audubon Christmas Bird Counts, 1966-2017 (Meehan et al. 2018).

Species	*BCR*				
	12	***13***	***22***	***23***	***24***
American Tree Sparrow	0.32	-0.34	-1.87	0.18	-2.37
Short-eared Owl	N/A	-1.96	-2.59	N/A	0.92
Horned Lark	-0.32	2.7	-1.02	1.33	-2.77
Long-eared Owl	N/A	-3.35	-4.48	N/A	N/A
Pine Siskin	2.73	-5.54	-2.87	-6.52	-4.58

Of the JV focal species (Table 1), published estimates of overwinter survival are only available for Kirtland's Warbler (Rockwell et al. 2017), Wood Thrush (Conway et al. 1995), and Henslow's Sparrow (Thatcher et al. 2006), representing a limited understanding of how this period may limit population growth. Moreover, because landbird species often use multiple wintering habitats, variation in survival probability (e.g. Johnson et al. 2006) may result from disparate habitat quality. Finally, body condition related to winter habitat quality can result in seasonal carry-over effects, such as sub-lethal but negative impacts during spring migration (Bearhop et al. 2004) and breeding (e.g. Reudink et al. 2009).

Airspace – All Seasons

Healthy airspace is a habitat component required throughout the annual cycle, essential to birds and other flying organisms (Diehl 2013, Diehl et al. 2018). Aerial insectivores depend on food-rich airspace to forage, and survival of migrating birds is higher when anthropogenic obstructions are limited. Aspects of airspace such as light, wind, and geomagnetic field can affect the ability of birds to complete migratory flights. As a result, managing features of airspace that impede migration or cause mortality during flight can an important part of migratory bird conservation. The greatest issue facing bird use of airspace is mortality caused by collisions with anthropogenic structures, including buildings, power lines, communication towers, and wind turbines.

Buildings and Lights.—Collisions with buildings result in an estimated 600 million birds killed in the U.S. annually (Loss et al. 2014a). Factors affecting the rate of fatal collisions include amount of light (Evans Ogden 2002, Zink and Eckles 2010), amount of surface glass (e.g., Klem 2009, Borden et al. 2010), and the amount and proximity of vegetation (Klem et al. 2009, Borden et al. 2010). Two effective approaches to minimizing collisions are treatment of glass to disrupt the reflective surface (Klem 2009) and minimizing light emitted at night. Detailed information with products and recommendations to reduce collisions with buildings is available: (https://abcbirds.org/program/glass-collisions/ and https://pa.audubon.org/sites/default/files/static_pages/attachments/deterrent_methods-double-sided-31_july_2018.pdf).

Cities Active in Lights-out Program

- ✓ Ohio – Akron/Canton, Cincinnati, Cleveland, Columbus, Dayton, Toledo
- ✓ Michigan – Detroit
- ✓ Illinois – Chicago
- ✓ Indiana – Indianapolis
- ✓ Wisconsin – Milwaukee
- ✓ Minnesota – Minneapolis-St. Paul
- ✓ Missouri – St. Louis

Light emissions appear to be an especially important consideration in the JV region, as several cities rank as the highest weighted risk of bird mortality (accounting for spatial variation in volume of migration traffic) during migration, including: Indianapolis, St. Louis, Minneapolis, and Chicago, which ranks the highest nationally (Horton et al. 2019). Furthermore, several JV focal species (Table 1) appear to be disproportionately prone to building collisions (Loss et al. 2014a). Light pollution from cities can also affect migration behavior, including flight altitude (Cabrera-Cruz et al. 2019). Beginning with the Fatal Light Awareness Program (FLAP) in Toronto, many cities have instituted “Lights Out” programs, which have effectively limited migrant bird mortalities in urban areas (e.g. Evans Ogden 2002). These programs engage building owners who commit to minimizing light emissions during migration periods (https://www.audubon.org/conservation/existing-lights-out-programs).

Power Lines.—Collisions with and electrocution from power transmission lines are the second greatest anthropogenic mortality risk in airspace, causing an estimated 25 million bird deaths in the U.S. annually (Loss et al. 2014b). Species that are large and less maneuverable in flight appear to be at greatest risk to these collisions (Bevanger1995). The Avian Power Line Interaction Committee (APLIC; 2006, 2012) developed best practices for minimizing collisions and mortalities from power lines, including use of low conductivity materials when feasible and optimizing distances between parts. Research has demonstrated the effectiveness of retrofitting lines under these recommendations (e.g., Harness and Wilson 2001, Dwyer et al. 2014). Targeted approaches in high-risk areas are probably most advisable, given the undertaking necessary to retrofit large arrays (Loss et al. 2015).

Communication towers.—Collisions with communication towers cause an estimated 6.6 million bird deaths annually in North America (Longcore et al. 2012). The factors influencing collisions most are tower height and the presence of guy-wires, both positively associated with collision rate (Gehring et al. 2011). Three JV focal species are estimated to have annual mortality from communication tower collisions ranging from 1–3% of their total population size (Golden-winged Warbler, Canada Warbler, Henslow's Sparrow; Longcore et al. 2013). The best approach to minimizing collisions, outside of limiting height and guywires, is replacing steady-light with pulsed-lighting fixtures (Gehring et al. 2009).

Wind turbines.—Fatality estimates from collisions with wind turbines are relatively low, causing an estimated 234,000 mortalities in the U.S. annually (Loss et al. 2013a). However, small-bird fatalities at wind turbines are likely underestimated in many monitoring reports (Smallwood et al. 2020). Furthermore, this type of mortality is expected to grow, as the number of wind facilities is projected to increase by 20% in the next decade, and wind turbine height is increasing at these facilities (Loss et al. 2013a). In order to ensure the environmental benefits of wind energy come at a minimal ecological cost, research supporting well-informed siting decisions is critical. The primary causes of high collision rates with wind turbines are height and placement within high-traffic migration corridors (Smallwood and Thelander 2008).

Siting decisions of new wind energy-generation projects is especially critical in locations like western Lake Erie, where shallow water and consistent high winds create great potential for offshore power generation facilities in this area annually hosting high concentrations of migrants. One project is already in the planning and early implementation stages offshore from the city of Cleveland ("Icebreaker"; Nations and Gordon 2017), with a goal of eventually expanding offshore wind facilities across the Great Lakes (http://www.leedco.org/index.php/about-icebreaker). While this wind energy project is an enormous opportunity for economic development that reduces carbon emissions, widespread offshore wind facilities in the Great Lakes could present significant threats to migrating birds. Two critical information needs to inform planning in this regard are the rate at which birds cross the open water of the Great Lakes, and the spatial distribution of any disproportionately high-traffic crossing areas. The limited information available suggests some species primarily cross Lake Erie during spring migration (Rusty Blackbird, Yellow-rumped Warbler, and American Redstart), as opposed to navigating around the lakeshore (Dossman et al. 2016, Wright et al. 2018b).

HABITAT CHAPTERS

The 2007 JV Landbird Habitat Conservation Strategy (Potter et al. 2007) was linked to the first PIF North American Landbird Conservation Plan (Rich et al. 2004) in multiple ways. Priority species at the continental scale occurring in manageable numbers in the JV region served as planning focal species. Regional JV goals were stepped-down from the continental PIF Plan, and goals in both documents aspired to double population size for most species of conservation concern (Rich et al. 2004, Potter et al. 2007). Population estimates were provided by PIF (Rich et al. 2004; Rosenberg and Blancher 2005) and *population deficits* for JV focal species were calculated (population goal - current population = deficit) for BCRs in the JV region. Estimates of breeding densities in high-quality habitat were gathered (or generated) from the literature for focal species, and habitat objectives were developed via models for the JV region, States, BCRs, and each State × BCR polygon (Potter et al. 2007).

Whereas this substantial 2007 JV planning effort resulted in a valuable and informed starting point for regional landbird conservation, populations that were declining in the region have continued their downward trend. Moreover, landbird habitat objectives established in the 2007 JV Strategy eventually were considered unrealistic or of limited relevance to landbird conservation stakeholders (Soulliere et al. 2019) in the context of ongoing landscape and environmental change. A similar realization at the continental scale resulted in a revised approach to population objective setting in the latest PIF Plan (Rosenberg et al. 2016). Because objectives are fundamentally value-based, the PIF community streamlined the process, beginning with basic questions framed around species extinction and acceptable levels of commonness. Continental PIF abundance goals are now statements of desired future condition phrased as *Recover, Prevent Decline, Reverse Decline, and Stabilize* (Rosenberg et al. 2016).

Watch List Prioritization and Goals

We used the 2016 PIF goal categories for this Strategy: 1) recover species of greatest conservation concern (Watch List – Red), prevent decline of species considered highly vulnerable due to restricted range and small population (Watch List – Yellow R), reverse trends for declining species of concern (Watch List – Yellow D), and stabilize downward population trends of common birds in steep decline. Conservation plans developed for two *Recovery* species of greatest conservation concern, Kirtland's Warbler (KWCT 2015) and Golden-winged Warbler (Roth et al. 2019), offer abundance objectives separate from the 2016 PIF Plan. These documents also provide detailed habitat conservation practices benefiting suites of birds occurring in common areas. *Note:* Kirtland's Warbler populations have steadily increased since 1990 and the species was moved from Watch List – Red to Watch List – Yellow R since completion of the 2016 PIF Plan.

For other JV focal species, recent breeding abundance estimates (PIF 2020; Table 4) were used as a baseline condition to establish 10- and 30-year goals for both future abundance and annual trends. These projected abundance estimates will serve as JV population goals for declining species, aligning with PIF's general approach (Rosenberg et al. 2016): *"The objectives reflect a short-term desire to slow and then halt declines, at a minimum, for all these bird groups. The long-term objectives provide targets for longer range conservation planning, and reflect the desire to return declining Watch List species to at least a portion of their former abundance. ... Given population trends and the results of these assessments and partner dialogue, species objectives may be adjusted in the future as part of an adaptive conservation framework."*

Table 4. Focal species used for landbird conservation planning in the Upper Mississippi / Great Lakes Joint Venture (JV) region, and breeding population abundance estimates (BPOP) within USA/Canada, JV region, and Bird Conservation Region (BCR: area within JV region only).[a]

Habitat category and species	USA/Canada BPOP	BCRs (BPOP in JV region only) 12	13	22	23	24	Total (JV region)	Portion of USA/CAN BPOP (%)
Forests and Barrens								
Eastern Whip-poor-will	1,829,900	113,100	0	74,700	13,500	15,600	216,900	12
Red-headed Woodpecker	1,802,600	3,900	6,700	358,000	52,200	21,600	442,400	25
Wood Thrush	12,191,400	261,100	75,300	367,200	302,400	253,800	1,259,800	10
Golden-winged Warbler	393,300	283,100	0	0	29,800	0	312,900	80
Kirtland's Warbler[b]	4,800	4,800	0	0	0	0	4,800	100
Cerulean Warbler	528,900	2,000	4,700	2,100	19,500	33,400	61,700	12
Canada Warbler	2,597,400	291,200	0	0	2,600	0	293,800	11
Grasslands								
Henslow's Sparrow	408,200	1,800		208,700	38,400	47,700	296,600	73
Bobolink	10,195,300	637,100	17,400	561,400	576,800	1,200	1,793,900	18
Eastern Meadowlark	24,431,700	199,300	84,000	5,769,200	677,400	250,400	6,980,300	29
Urban								
Chimney Swift	8,808,600	79,900	120,500	1,164,200	355,800	156,600	1,877,000	21

[a] Model-based, mean breeding abundance estimates (rounded to nearest 100) derived from BBS data (2006-2015) by Partners in Flight (2020b). Model methodology is documented in Will et al. (2020). Estimates are not provided for focal species occuring in the JV region primarily during non-breeding periods (American Tree Sparrow, Blackpoll Warbler, Rusty Blackbird, and Short-eared Owl).

[b] Kirtland's Warbler estimates from Kirtland's Warbler Conservation Team (KWCT 2015).

The PIF approach links trend and future abundance goals, prescribing 10- and 30-year annual trend goals for each species in a designated watch list category. Manipulating projected trends over time and at various geographic scales provided insight into the magnitude of change needed in different geographies to achieve larger-scale goals. We applied a trend-based tool developed for Bobolink (J. Herkert, Illinois Audubon) to other JV focal species to determine interrelated BCR population objectives that when rolled up would meet JV regional population abundance goals. Initial BCR-scale abundance trends for BCRs 12, 22, and 23 were generated from BBS data collected during 2006–2015 (Sauer et al. 2017). Species abundance trends for the relatively small portions of BCR 13 and 24 within the JV region were also determined using BCR-wide trend estimates for the purpose of population objectives setting. Our method of adjusting annual trends to meet 30-year population abundance goals required that very negative trends in some BCRs be significantly dampened and ultimately reversed to positive trends. The approach also assumed recent positive trends for some species could not be sustained indefinitely, and these upward trajectories were generally dampened down over time. Trend forecasts to meet abundance goals are described below by PIF watch list category, with species-specific details included in Appendix E.

Watch List – Red, recover (Golden-winged Warbler). Population objectives are provided in a species-specific conservation plan (Roth et al. 2019).

***Watch List – Yellow R, prevent decline** (Henslow's Sparrow; Yellow R due to restricted range and small population).* We dampened all initial trends 50% by year-10 and furthermore brought all trends to 0 by year-30. This manipulation resulted in achieving PIF trend and abundance goals in the JV region while accounting for the relatively large and currently increasing population in BCR 22, with a conservative prediction that the current increasing condition is unsustainable. Note: *Kirtland's Warbler* was recently moved from Watch List Red to Watch List Yellow-R, and its population objectives are detailed in a separate species-specific plan (KWCT 2015).

***Watch List – Yellow D, reverse decline** (Red-headed Woodpecker, Eastern Whip-poor-will, Wood Thrush, Cerulean Warbler, Canada Warbler, Bobolink, Chimney Swift; Yellow D due to declining populations).* In general, we tried to achieve the PIF goal of slowing declines by 60–75% across the entire JV region, which meant manipulating BCR trends variably for each species. We then adjusted annual trends in each BCR by a similar magnitude in order to derive a 5% total population increase in 30 years (per the PIF 2016 guidance).

***Common birds in steep decline** (Eastern Meadowlark).* We slowed initial trends by 60% and brought all annual trends to zero by year-30, therefore stabilizing populations at a level lower than current population abundance (≤25% loss per PIF 2016 guidance).

We provide additional information regarding developing population objectives, including projected abundance trends by BCR with more concerted and effective conservation vs. the status quo (Appendix E). The numerical difference in projected abundance over time between a scenario with concerted conservation effort (our 30-year objective) and the status quo (business as usual) is presented in summary tables and population abundance graphs, which highlight the significant challenge ahead to reverse declines for many JV focal species.

Our ability to quantify bird habitat objectives based on biological models and species-habitat relationships was limited due to the incredible diversity of regional landscapes, the varied and dynamic nature of threats to bird populations, lack of bird habitat-quality measures (e.g., production and survival rates) from existing spatial data, and uncertainty around breeding density estimates for JV focal species. Moreover, we lacked complete understanding of factors most limiting focal species population growth during the full annual cycle. Using the best information available, we describe primary threats to grassland and forest birds in the JV region and provide general habitat objectives based on recent land cover change. We assumed that retaining current areas of key plant communities and restoring potential bird habitats to recent and measurable extents would provide logical aspirational goals for the JV. We also assumed local managers and associated conservation networks, when provided focal species habitat descriptions and guidance to target key geographies would generate the most appropriate habitat retention, restoration, and enhancement decisions based on their area knowledge.

Meeting range-wide population goals will require focal species conservation addressed at the BCR scale (Appendix E) and ultimately targeted to State × BCR units, where local bird habitat actions are planned and delivered. The following grassland and forest sections establish large-scale objectives while also providing resources (via internet links) to help inform local bird conservation decisions. Trends in relevant landscape cover types (see Land Cover and Habitat Assessment, page 18) and species-habitat relationships (Appendix D) provided the foundation for these habitat recommendations. Finally, this Strategy has integrated human dimensions into conservation planning, recognizing the importance of bird habitats to human quality of life (e.g., outdoor recreation, water filtration, and carbon sequestration). We provide a unique section titled *Urban Birds and Developed Lands*, highlighting the growing habitat overlap between birds and people in this JV region.

Grassland Birds

Grassland Bird Focal Species
Breeding (B) / Nonbreeding (NB)

Henslow's Sparrow - B
Bobolink - B
Eastern Meadowlark - B

Short-eared Owl - NB
American Tree Sparrow - NB

Intensification of row crop agriculture and expanding development (Table 3) are primary and obvious challenges to grassland birds in the JV region, whereas less quantifiable negative influences include pesticide use, invasive species, and effects of climate change. In addition to direct habitat loss, the quality of grasslands as bird habitat is also a concern, particularly at remnant and reconstructed (i.e., replanted native species) grasslands and *working lands*, such as pasture and hay land. Lack of disturbance has resulted in declining habitat quality at native and restored grasslands by allowing woody and invasive herbaceous plants to colonize sites (Fuhlendorf and Engle 2001). Too much disturbance can also be a problem, with complex relationships existing between annual grazing (ranching) intensity, the timing of that grazing, and the timing of burns (Davis et al. 2016). In the Kansas Flint Hills of the western JV region, extensive and uniform annual burning (vs. patch burning) has resulted in loss of prairie structural diversity (Fuhlendorf and Engle 2004, NRCS and WHMI 2005). In Missouri, Iowa, and further east, managing dense monoculture-grass stands for grazing lands has resulted in low quality habitat for grassland birds where diverse pastures once existed (George et al. 2009, 2013). Nevertheless, policies and practices that keep ranches intact and grass-based agriculture on the landscape is favorable to other land use alternatives (i.e., row crops, rural development/fragmentation).

Publicly owned grasslands may not be susceptible to agricultural conversion or development, but they often occur within working landscapes where they face threats of habitat fragmentation via land-cover changes on surrounding ownerships. They also frequently lack adequate disturbance, resulting in subsequent loss of diversity. Bird occupancy on both private and public lands is influenced by patch size and habitat fragmentation. These characteristics impact nest survival and brood parasitism, but the extent of their effect is variable, depending on other aspects of landscape composition (Benson et al. 2013). Grassland bird occupancy generally increases in larger grassland patches (Herkert et al. 1996, Ribic et al. 2009), whereas smaller patches and more edge typically leads to increased brood parasitism (Benson et al. 2013).

To compare relative importance of the numerous threats to grassland bird habitats, we used the Open Standards approach (Conservation Measures Partnership 2013) with focus on BCR

22, where grasslands historically and currently were most extensive in the JV region (Figures 4 and 6). Threats on privately owned vs. public lands were evaluated and ranked by an expert team of JV scientists based on each threat's extent, severity, and irreversibility to grasslands during the next 10 years (Table 5). Threat categories of greatest concern, and most likely associated with downward trends in grassland bird populations (i.e., those ranking Very High and High [red and orange in Table 5]), are summarized below.

Table 5. Threat categories used by Open Standards (OS; Conservation Measures Partnership 2013) and average threat scores (0-4) for privately-owned and public grasslands in Bird Conservation Region 22 within the Upper Mississippi / Great Lakes Joint Venture (JV) region, generated by a team of JV grassland-bird experts. Threats assessed for the next 10 years ranked Very High (>3.0), High (≥2.5 to <3.0), and Moderate (≥1.5 to <2.5). Threats considered lower priority were not listed.

OS category	OS threat	Private	Public
1.1	Housing & Urban Areas	3.3	2.6
1.2	Commercial & Industrial Areas	3.2	2.6
2.1	Annual & Perennial Non-Timber Crops	3.3	2.7
3.1	Oil & Gas Drilling	2.3	1.9
3.2	Mining & Quarrying	2.3	2.2
3.3	Renewable Energy	2.5	2.0
4.1	Roads & Railroads	2.6	2.3
4.2	Utility & Service Lines	2.1	2.1
7.1	Fire & Fire Suppression	2.9	3.0
7.2	Dams & Water Management / Use	2.3	2.0
7.3	Other Ecosystem Modifications	2.0	1.5
7.4	Removing / Reducing Human Maintenance	2.3	2.6
8.1	Invasive Non-Native / Alien Plants & Animals	3.2	2.9
8.2	Problematic Native Plants & Animals	2.5	2.5
8.3	Introduced Genetic Material	2.4	2.1
9.5	Airborne Pollutants	3.0	2.9
11.3	Changes in Temperature Regimes	2.9	2.9
11.4	Changes in Precipitation & Hydrological Regimes	2.7	2.7
11.5	Severe / Extreme Weather Events	2.8	2.8

Residential and Commercial Development (OS 1.1, 1.2).—Human development ranked highest among threats to grasslands (Table 5) because of current expansion trends, proportionately high conversion of private grasslands/croplands to development, and its high irreversibility score. Residential sprawl reduces survival and reproduction of many native plant and wildlife species, decreases native species richness (including insect prey), and increases nonnative species richness (Hansen et al. 2006). Moreover, with expanded exurban development comes growth in commercial development and its associated infrastructure (roads, power lines, and rights-of-way). Remaining bird habitats typically become fragmented, which leads to greater disturbance from human activities and exposure to predators like free-ranging domestic cats and raccoons. Developed areas also create barriers to movement between grassland patches and cause direct mortality through collisions with vehicles or buildings (McLaughlin et al. 2014, Renfrew et al. 2019).

Agriculture (OS 2.1).—Native tallgrass and mixed-grass prairies in the JV region are vulnerable to agricultural conversion because of their nutrient rich soils and high suitability for crop production (Comer et al. 2018, Wilsey et al. 2019b). Cropland was considered highest among the suite of threats on private land (Table 5) due to recent trends in expansion of corn and soybean production, especially for biofuels (Lark et al. 2015). Remnant grassland patches in row-crop settings are often fragmented and low quality for grassland birds because of edge effects like increased rates of predation, brood parasitism, and invasions by nonnative plant species (Winter et al. 2000). Furthermore, agricultural practices may cause direct losses or sub-lethal effects on grassland birds. Haying early and more frequently, for example, is one of the greatest threats to Bobolinks in the Midwest, causing high nest mortality rates and overall reduction in productivity (Renfrew et al. 2019). Grassland birds are also vulnerable to pesticides because they are more likely to forage and nest in open agricultural settings. Pesticide use may cause toxicity via ingestion of treated seeds, which can lead to mortality or sub-lethal effects (e.g. reduced nesting success) on birds that are frequently exposed (Hallmann et al. 2014, Stanton et al. 2018). Increased use of neonicotinoid insecticides in recent years has been linked to significant declines in grassland birds (Li et al. 2020); pesticide acute toxicity is a better correlate of U.S. grassland bird declines than agricultural intensification (Mineau and Whiteside 2013).

Renewable Energy (OS 3.3).—An increasing demand for renewable energy to meet carbon reduction standards and secure energy independence has led to proliferation of wind farms, especially in open landscapes, with their relatively high winds and open space (Shaffer and Buhl 2016, Renfrew et al. 2019). However, we have much to learn regarding the effects of expanding renewable energy infrastructure on grassland birds. The footprints and sweeps of large wind-towers result in direct loss of grassland bird nesting habitats and airspace, in addition to habitat fragmentation due to associated roads, power lines, and rights-of-way (Kuvlesky et al. 2007). Breeding birds also display avoidance behaviors to turbines, which has further reduced area of available habitat in native prairie (Shaffer and Buhl 2016, Winder et al. 2015). Collisions with wind turbines lead to direct mortality of grassland birds although these appear to be rare and often not thought to cause population level effects (Kuvlesky et al. 2007). Large-scale solar energy facilities and associated infrastructure also cause direct habitat loss for many of the same reasons as wind energy. Because renewable energy technology is relatively new, there has been only limited evaluation of direct effects on birds (Lovich and Ennen 2011). Its growing popularity in the Midwest warrants further investigation.

Natural System Modifications (OS 7.1, 7.4).—Fire suppression has resulted in the need for prescribed burns, mowing, or other types of maintenance in many grassland systems to reduce the litter layer and woody encroachment, while adding structural diversity and maintaining the unique array of disturbance-adapted plant species (Wilsey et al. 2019b). Too much disturbance (e.g., over grazing or overuse of fire), however, can lessen structural plant diversity and eliminate suitable bird nesting cover, while too little leads to woody encroachment that lowers breeding success or excludes species that avoid woody growth and edges (Winter et al. 2000, Vodehnal and Haufler 2007, Graves et al. 2010). Deliberate actions to manage and maintain healthy grasslands are required in much of the JV region, and loss of this management ability is a serious threat especially on publicly owned lands.

Invasive Non-Native / Alien Plants & Animals (OS 8.1).—Generally, grassland birds use native or non-native plant communities where structural diversity results in suitable habitat. However, some non-native invasive plants, like tall fescue (*Festuca arundinacea*) and Sericea lespedeza *(Lespedeza cuneate)* often planted for pasture, outcompete native grassland species and can homogenize plant and insect communities (Vodehnal and Haufler 2007, Shaffer and DeLong 2019). These effects have reduced grassland bird abundance and species diversity, especially on private lands, while also making conditions suitable to less-desirable species like Brown-headed Cowbird, a brood parasite (Shaffer and DeLong 2019). Invasive grasses can result in higher nest predation and parasitism rates, but effects vary by bird species (Jaster et al. 2013, Ruth 2015, Maresh-Nelson et al. 2018).

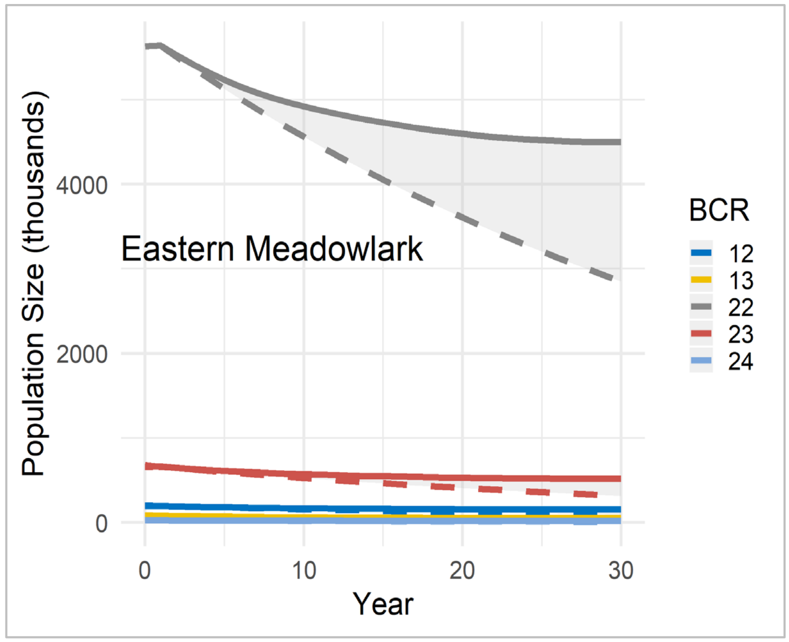
Airborne Pollutants (OS 9.5).—Drift from herbicide use on croplands (e.g., toxic sprays) was considered a threat because it can lead to simplification of vegetation structure and plant diversity in nearby grasslands. Air-borne insecticides can reduce insect abundance, requiring birds to travel greater distances for food, and cause direct mortality or sub-lethal effects, resulting in reduced nest success, increased predation, and starvation risk (Martin et al. 2000, Stanton et al. 2018, Renfrew et al. 2019).

Climate Change (OS 11.3, 11.4, 11.5).—Rising temperatures, changes in hydrological regimes, and extreme weather events associated with climate change threatens grassland birds. Climate change can interfere with grassland management, such as chemical control of invasive plants and prescribed fire (e.g., shortened affective burn periods). Grasslands are particularly vulnerable because they have little buffering capacity due to their openness and often fragmented nature (Jarzyna et al. 2016). Grassland birds also have some of the highest *climate velocities*, with accelerated shifts in home range that will further strain populations already facing dramatic habitat declines (Wilsey et al. 2019c). Phenological mismatches with food resources, and intense and uncontrolled fire may lead to increased mortality and reductions in grassland bird breeding success, causing overall population-level changes (Crick 2004, Skagen and Adams 2012, Wilsey et al. 2019c).

Population and Habitat Objectives

Population objectives for breeding grassland focal species (Henslow's Sparrow, Bobolink, and Eastern Meadowlark) were developed in accordance with 2016 PIF Plan guidance (Appendix E). Assessing population trends and relative abundance across the JV region helps state- and local-scale habitat implementers define their potential role in individual focal species conservation. Depending on a species range and habitat requirements, certain sub-regions (e.g., BCRs) are more important to reverse downward trends (Figure 11). Although grassland-bird habitat objectives were not quantified using biological models, we used the NLCD to estimate current area of potential habitat and the area lost since 2001 within each State × BCR polygon. We then developed a conservation design for restoring and targeting the area of recently lost habitats for grassland focal species within the JV region.

Figure 11. Conceptual depiction of Eastern Meadowlark population abundance goal and current trend in Bird Conservation Regions (BCRs) of the Upper Mississippi / Great Lakes Joint Venture. Solid lines characterize long-term goal achievement (population stability via new habitat conservation), whereas current trend (status quo) is indicated by dashed lines. *Note:* About 15% of the Eastern Meadowlark's global population breeds in BCR 22 (Panjabi et al. 2020), the most important area for this species in the JV region. Habitat actions in BCR 22 will likely result in greatest impact dampening or reversing the downward trend across the JV region.



Conservation Design

Targeting conservation begins with knowing where grasslands once naturally occurred (Figure 4) and where open lands (combining NLCD 2016 herbaceous, pasture/hay, cultivated cropland, and emergent herbaceous wetland) important to grassland birds remain today. Geospatial analysis was used to identify grasslands in open landscapes where restoration and expansion of grass is likely to have the greatest bird response. Building on identified patches (Figure 12A), grassland restoration is the primary means to expand habitat area to address focal species population deficits. Grassland retention (and enhancement) should be emphasized on small and large patches, especially within areas (Figure 12B) currently supporting relatively high grassland bird abundance and diversity (see Appendix D for focal species distribution and abundance).

Extensive blocks of herbaceous grassland and pasture/hay remain in Kansas, Nebraska, Missouri, and Iowa (Figure 12), but much of the pasture in Missouri and Iowa is dominated by tall fescue (*Festuca arundinacea*) and smooth bromegrass (*Bromus inermis*) with limited value to birds. Reconstruction of these large monoculture stands to native prairie could result in significant gains for breeding grassland birds in BCR 22. Smaller-scale grassland restoration opportunities exist throughout the JV region where relatively open lands persist. The PIF *Grassland Bird Conservation Area* (BCA) model helps visualize opportunities for piecing together local habitat complexes with greater value to birds (Figure 13) based on principles of grassland bird ecology (Sample and Mossman 1997). The model integrates needs of species requiring small vs. large habitat areas (e.g., Henslow's Sparrow vs. Meadowlark and Greater Prairie-Chicken, respectively) at the patch and landscape scale (Fitzgerald et al. 2000) and where working agricultural lands represent a prominent land use.

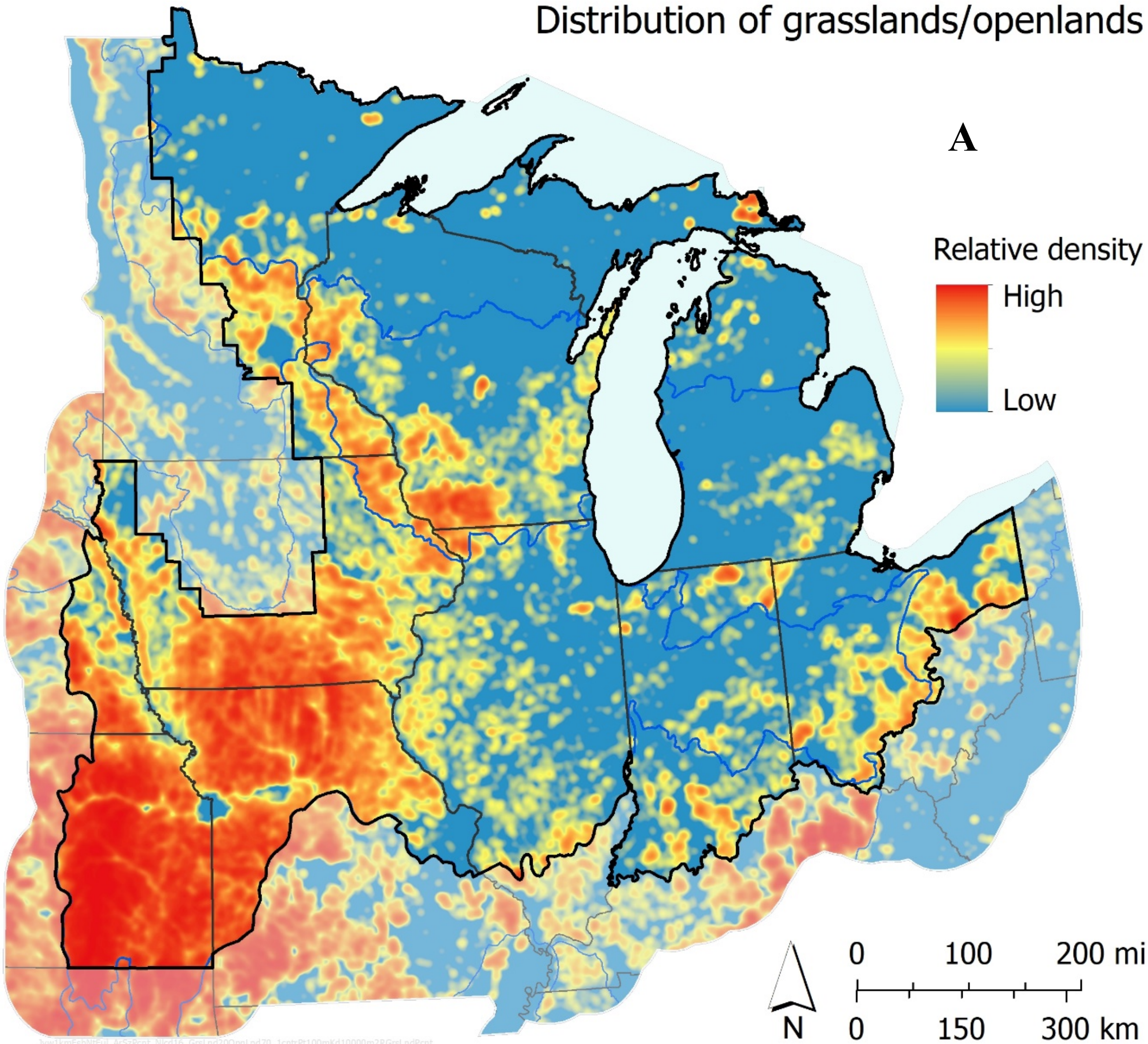
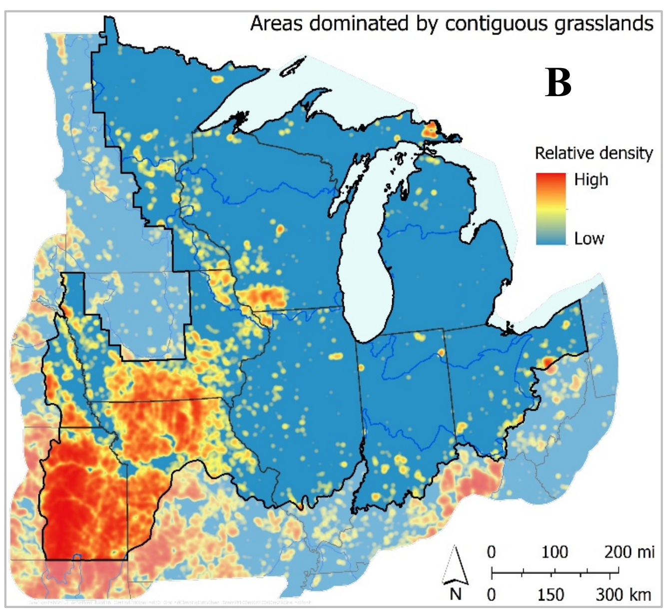


Figure 12. Areas where grassland bird habitats occur (A) and where grasslands are the most prominent land cover (B) in the Upper Mississippi / Great Lakes Joint Venture region. Image A reflects areas where grassland (combining NLCD 2016 herbaceous and pasture/hay) is ≥20% of land cover in landscapes with ≥70% total open-land (combining NLCD herbaceous, pasture/hay, cultivated cropland, and emergent herbaceous wetland). Image B reflects areas with ≥20% grassland in landscapes with ≥70% total open-land, but where grasslands occur in contiguous patches ≥50 ha (125 acres) in size. *Note:* Spatial analyses were completed using 100 ha pixels, thus areas with grassland patches ≥50 ha (B) reflect areas where landscapes are ≥50% contiguous grassland.



Grassland BCA.—Encompassing ≥4,000 ha (10,000 acres) with minimal forest cover, a Grassland BCA is anchored by a contiguous *core* area of permanently protected high-quality grassland bird habitat at least 800 ha (2,000 acres) in size (Figure 13). Around this core is a matrix of primarily private agricultural lands, preferably managed for suitable bird habitats or at least maintained to be neutral in how the land use affects bird life (e.g., small grains). Parcels should include permanent grass cover, totaling about 10% of the BCA, and long-term / long-rotation grass cover (e.g., CRP grasslands, light- to moderately-grazed pasture, and/or idle field), totaling 10–20% of the BCA. The remaining area (50–60%) may consist of active farmland (Figure 13). Ideally, all privately owned lands would be secure from development and forestation that could threaten area openness and viability for grassland birds. Designed to support grassland bird species with large and small area requirements, the BCA model can be downscaled where target species do not require such large open areas (Walk et al. 2010).

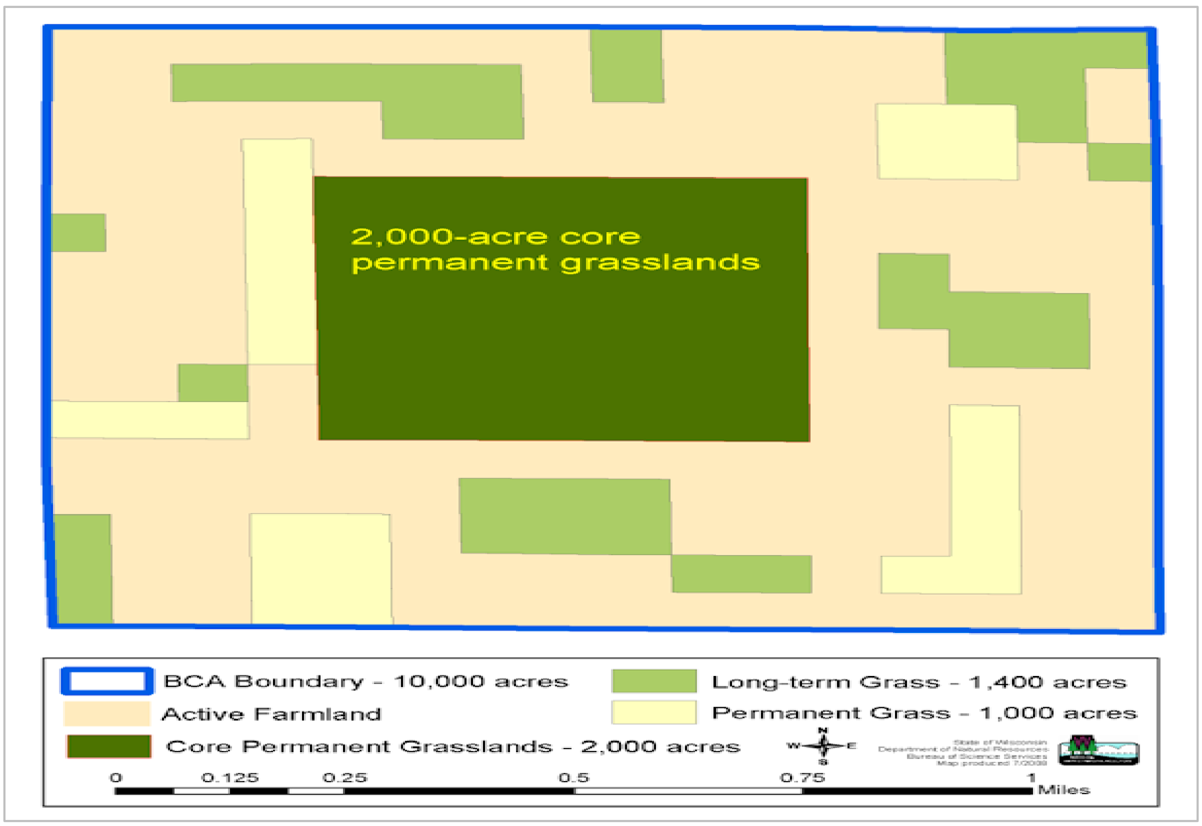


Figure 13. Conceptual diagram of a *Grassland Bird Conservation Area* in a Midwest working landscape (from Wisconsin Department of Natural Resources, unpublished report) encompassing a complex of open-land cover types (2.5 acres = 1 ha).

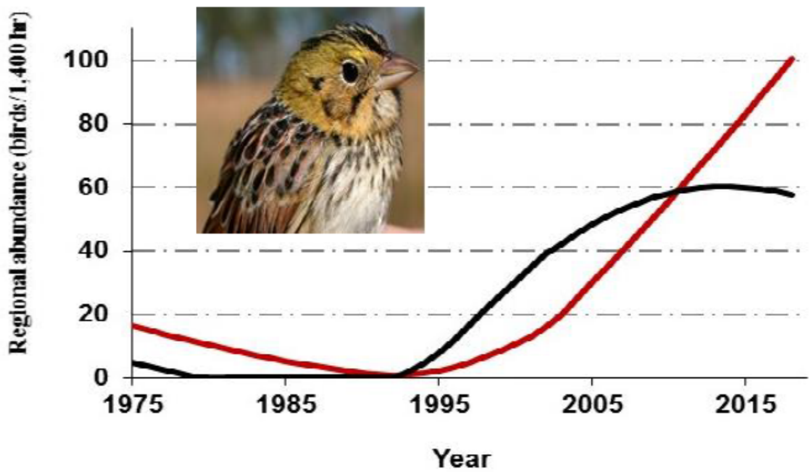
Recent evaluations of scale-specific habitat associations and occupancy in Wisconsin (Guttery et al. 2017) provided further insight to the complexity of designing landscapes for obligate grassland bird species. However, the Grassland BCA model continues to provide a feasible framework to focus conservation efforts in mixed working landscapes with a realistic expectation of benefiting grassland-nesting birds. Moreover, open-land complexes comprised of grassland/herbaceous, pasture/hay, cultivated cropland, and emergent herbaceous wetland can provide grassland birds critical migration and wintering habitat. Data from the annual Christmas Bird Count (Meehan et al. 2018) suggest significant portions of the global wintering populations of American Tree Sparrow (45%), Short-eared Owl (24%), and Horned Lark (16%) occur in the JV region.

The **Henslow's Sparrow** was designated a priority species by the Chicago Wilderness alliance due to the region's global importance providing breeding habitat. State and local land managers partner on grassland restoration and management, benefiting Henslow's Sparrows and other wildlife. The 11-county work area, encompassing one of the country's largest human population centers, includes 200,000 ha (500,000 acres) of land with some form of protection and with extensive natural plant communities. Henslow's Sparrows are found at over 100 locations in the Chicago Wilderness area – including what is likely the most persistent population anywhere in its breeding range (Goose Lake Prairie State Natural Area). Few if any locations have so many Henslow's Sparrow in a secure – publicly owned – site, where area of grassland has actually been expanding in recent years.

Red Line = Chicago Wilderness Region (Lake, McHenry, Boone, DeKalb, Kane, DuPage, Cook, Kendall, Will, Grundy, and Kankakee counties)

Black Line = rest of Illinois

Source: Herkert, unpublished data from Illinois Spring Bird Count (Fitted LOESS line)



Habitat Delivery

Grassland birds occupy a wide spectrum of habitats ranging from short/sparse vegetation to tall/dense vegetation, across a wide range of soil moistures and with varying levels of disturbance and structure (Figure 14). Thus, large-scale and diverse grassland systems best meet the varied habitat associations required by assemblages of grassland birds (Herkert et al. 1996). In much of the JV region, greatest benefits will result from conservation actions that build on remnant prairie, existing grassland core areas, and native-grass restorations or reconstructions adjacent to existing core areas (Figures 12 and 13). Focusing grassland conservation efforts on and near existing grassland complexes in relatively open landscapes is our most effective course of action for grassland bird conservation across the JV Region. At the local scale, simply connecting small grassland parcels (e.g., establishing grassland/open-land corridors, removing mature trees within and between grassland patches) can increase site suitability for area-sensitive species.

Prescribed fire, mechanical disturbance (e.g., brush clearing, mowing), and grazing are effective management tools to maintain openness and diversity in vegetative structure, and their rotation and duration of use will result in varied species response (Figure 14). Managing grasslands for birds requires a balance of long-term need for disturbance to maintain preferred plant composition and structure against the more immediate needs of safe nesting and brood-rearing habitat. Because disturbance is essential to grassland health, availability of alternate habitats in the surrounding landscape beyond the disturbed area is an important management consideration.

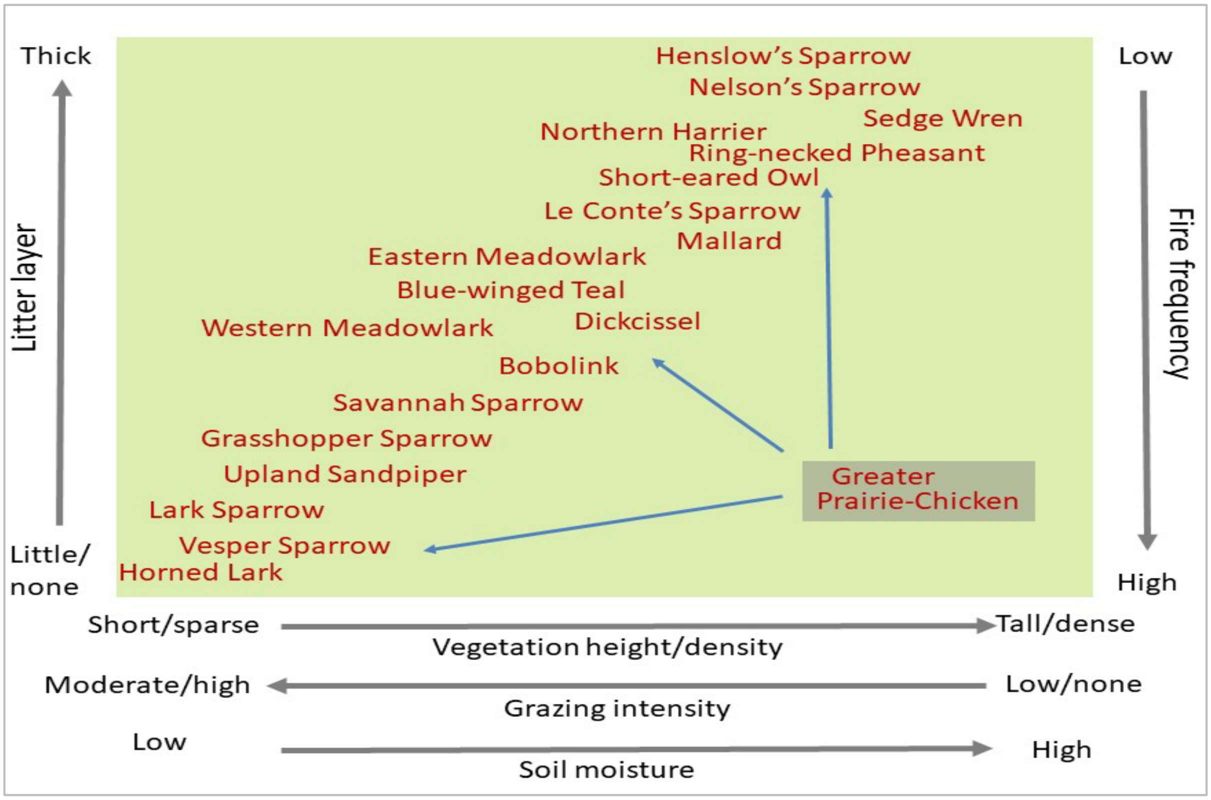


Figure 14. Grassland birds occurring in the Prairie Hardwood Transition (BCR 23) respond to a continuum of vegetation structure; a diversity of management actions, regimes, and timing; and varying edaphic conditions. Species-specific requirements may depend on life stage: placement of Greater Prairie-Chicken at multiple locations in the schematic illustrates its changing habitat needs during the breeding period (e.g., lekking, nesting, brood rearing). This representation of bird occurrence along gradients of vegetation, management, and soil moisture in Wisconsin grasslands based on historical data and expert opinion (David Sample, Wisconsin Dept. of Natural Resources, used with permission). Specific species requirements can vary across the JV geography.

Grassland bird conservation may involve acquisition and public land management to retain or connect key prairie areas, but successful large-scale safeguarding of grasslands will need to focus on private lands where agriculture covers most of the region's historic prairie and savanna. There are useful examples of public-private collaborative grassland conservation efforts benefitting birds at local scales (see https://www.iowadnr.gov/conservation/bird-conservation-areas), and small grassland patches have been integrated into traditional row-crop agriculture while providing multiple ecosystem services (pollinator use, nutrient retention, flood control, carbon sequestration). Prairie Strips, a program piloted at Iowa State University to restore permanent linear grasslands in row-crop matrices, has also improved soil and water retention and provided habitat patches useful as stopovers for migrating grassland birds. Precision farming and associated removal of poor-producing portions of fields from production incentivizes farmers to maintain or increase yield while decreasing cost and increasing patches of grassland bird-friendly habitat. Working with social scientists, JV partners can learn more about agricultural landowners in the region in order to better target programs that appeal to their desires and needs.

Large-scale government incentive programs likely hold the greatest promise to restore and retain significant areas of grassland in the JV region. Established by the 1985 U.S. Farm Bill, the Conservation Reserve Program (CRP) has been responsible for restoration of more grassland bird habitat than any other government-sponsored effort in recent decades. Under this cost-share and rental payment program, the government pays land-owners to take certain lands out of production, converting cropland to natural cover such as cool-season grasslands or native prairie, wildlife and pollinator plantings, buffer strips, and grassed waterways (https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/?cid=stelprdb1041269). The primary purpose of the program is to reduce land erosion, improve water quality, and deliver wildlife benefits by removing highly erodible or environmentally sensitive land from agricultural production through long-term rental agreements.

Between 1985 and 1993, implementation of the CRP resulted in establishment of about 14 million ha (35 million acres) of grassland across the U.S. Acreage enrolled in CRP fluctuated over time but stayed relatively stable between 1994 and 2007. Since 2007, however, nationwide CRP area has been declining, and as of 2018 there were 9 million ha (22.6 million acres) enrolled. Highest CRP enrollment in the JV region occurred in the mid-1990s at 2.8 million ha (7 million acres), with >80% of conservation practices considered beneficial to grassland wildlife. Total CRP enrollment in the JV region declined 30–40% from its peak, but trends have varied by state (Figure 15). Currently the states of Iowa, Missouri, and Illinois account for most of the CRP area in the JV region.

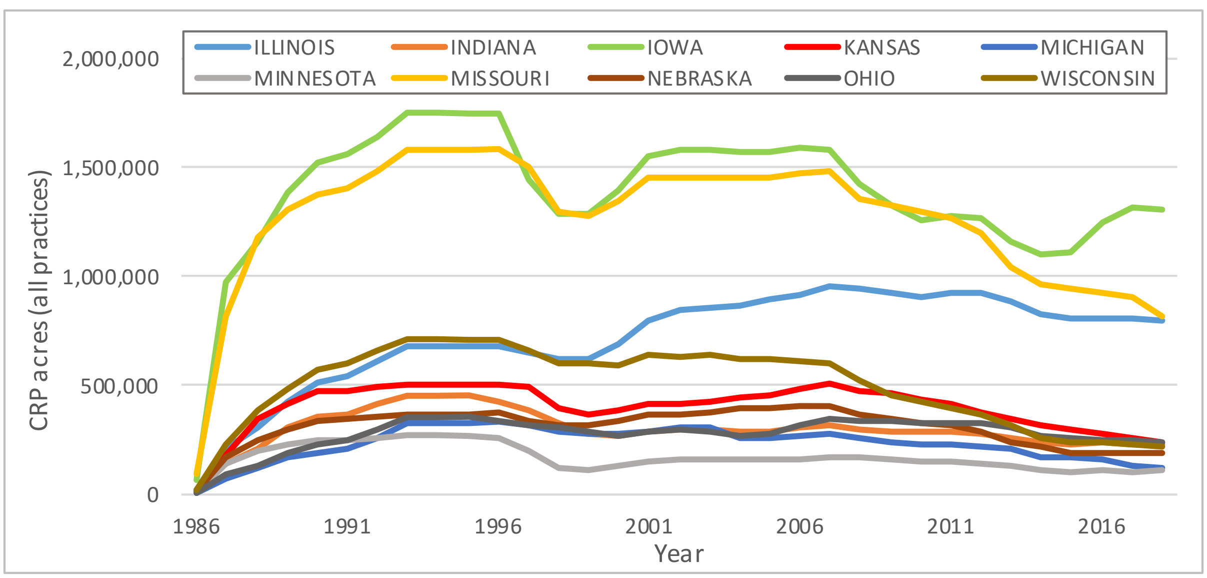


Figure 15. Total area (acres; 1 acre = 0.4 ha) by state within the Upper Mississippi / Great Lakes Joint Venture region enrolled in the Conservation Reserve Program (CRP) since its 1985 inception (includes all conservation practices).

Federal policies such as the Ethanol Fuel Standards (Renewable Fuel Standard mandating crop-based fuel), agricultural crop insurance, and waning support for various aspects of the Conservation Title of the Farm Bill (principally CRP) have increasingly inhibited integrated agro-ecological landscapes capable of sustaining both food production and healthy grassland bird populations. In the absence of consistent federal and state policy protecting grasslands, economic tools such as habitat exchanges, market-based compensatory mitigation programs, and direct payments for ecosystem services may offer promising means for restoring grass to the landscape and the bird populations reliant on them. Understanding landowner motivations for participating in conservation programs and the intersection between prices and decision-making will be essential. For example, participating in CRP has major financial implications, but decisions also are driven by family dynamics, personal conservation ethic, and complexity of enrollment (Reimer and Prokopy 2013, Ranjan et al. 2019).

Establishing meaningful habitat objectives for grassland bird focal species is difficult, considering uncertainty about policies and programs influencing land use, and our limited knowledge regarding which stage of the annual cycle most affects species abundance. However, using NLCD we estimated the area of current potential grassland bird habitat in the JV region (i.e., 2016 NLCD classes *Grassland/herbaceous* and *Pasture/hay*) and the area of this cover type recently lost (comparing 2016 NLCD to 2011, 2006, and 2001). Although NLCD land cover classes vary in map accuracy (Wickham et al. 2017), these spatial data provide a practical habitat baseline for long-term restoration and retention targets to help reverse declining populations of grassland birds.

Current grassland bird habitat in the JV region is most abundant in BCR 22, especially in Kansas, Missouri, Iowa, Nebraska, and Illinois, where grassland restoration and retention opportunity is greatest (Table 6). Grassland restoration and retention opportunity is also considerable in BCR 23, particularly in Minnesota, Wisconsin, and Iowa. Bird habitat objectives (Table 6), combined with grassland distribution and abundance data (Figures 12A and B), should be used to direct conservation, especially through large private-land initiatives such as the CRP. In addition, descriptions of high quality habitats for focal species (Appendix D), an understanding of the varied disturbance/management needs of grassland birds (e.g., Figure 14), and local priorities (e.g., sediment retention, pollinator conservation) can be integrated when developing smaller-scale (e.g., State × BCR) habitat delivery strategies. Local land cover spatial arrangements may be further informed using the annual Cropland Data Layer.

Grassland conservation delivery may be quite variable across the JV region and over time. For example, market-based solutions appealing to landowners may include using warm-season grass to diversify forage for cattle, biofuel production (Meehan et al. 2010), carbon sequestration on agricultural lands, new cultivars and cropping systems, or market-based solutions like the National Audubon Society's Conservation Ranching Program that provides a product premium for beef certified *bird-friendly*. An evaluation of Audubon Conservation Ranches during the first four years of the program (2016-2019) found that grassland bird communities were significantly more abundant and diverse compared to conventionally managed ranch lands (N. Michel, National Audubon, unpublished report).

Table 6. Current potential grassland bird habitat, plus long-term (30 year) habitat restoration and retention objectives, in the Upper Mississippi / Great Lakes Joint Venture (JV) region by state and Bird Conservation Region (BCR). Area (ha; 1 ha = 2.5 acres) estimates are based on National Land Cover Data (NLCD; Yang et al. 2018) classes Grassland/herbaceous and Hay/pasture, and referred to as potential bird habitat due to lack of habitat-quality measures. Current area reflects 2016 NLCD estimates, whereas restoration objectives reflect the area of each habitat type lost between 2001 and 2016 (a "0" value in cell = gain during 2001-2016). Unless indicated otherwise, long-term habitat retention objectives are equivalent to 2001 NLCD estimates for these cover types (current area + restoration objective = retention objective). Shaded cells indicate 2016 (not 2001) area estimate was highest based on NLCD estimates (i.e., there was a gain betweenn 2001 and 2016), thus retention objective reflects the more recent (higher) area amount. See Appendix D for detailed descriptions of habitats used by grassland bird focal species.

				Area objectives (ha)[a]					
		Current area (ha)		Restoration			Retention (current + restoration)		
State	BCR	Herbaceous	Hay/pasture	Herbaceous	Hay/pasture	Combined	Herbaceous	Hay/pasture	Combined
Iowa	22	190,516	1,330,840	28,896	278,464	307,360	219,413	1,609,304	1,828,717
	23	18,551	161,673	712	34,369	35,081	19,264	196,041	215,305
Illinois	22	45,736	725,806	4,227	56,468	60,696	49,963	782,275	832,238
	23	2,915	61,009	146	4,085	4,231	3,061	65,094	68,155
Indiana	22	27,544	179,046	2,614	16,529	19,143	30,158	195,574	225,732
	23	8,581	107,295	257	10,365	10,623	8,838	117,660	126,499
	24	32,065	427,381	0	32,999	32,999	32,065	460,380	492,445
Kansas	22	1,955,570	1,638,531	55,065	125,725	180,790	2,010,635	1,764,257	3,774,892
Michigan	12	313,791	143,695	22,147	7,883	30,031	335,938	151,578	487,516
	23	77,998	305,146	3,997	16,693	20,690	81,994	321,839	403,833
Minnesota	12	114,502	272,610	0	18,042	18,042	114,502	290,652	405,155
	22	23,287	60,411	1,976	9,217	11,194	25,263	69,629	94,892
	23	33,782	421,770	0	50,420	50,420	33,782	472,190	505,972
Missouri	22	38,430	2,648,993	0	416,899	416,899	38,430	3,065,892	3,104,322
Nebraska	22	296,069	68,307	56,791	10,118	66,910	352,860	78,425	431,285
Ohio	13	15,557	419,953	0	27,080	27,080	15,557	447,034	462,591
	22	15,265	347,681	0	40,950	40,950	15,265	388,630	403,895
	23	5,088	30,734	412	2,848	3,260	5,500	33,582	39,082
	24	1,171	32,877	0	2,611	2,611	1,171	35,488	36,658
Wisconsin	12	53,818	133,404	10,686	10,483	21,169	64,505	143,887	208,392
	22	1,950	23,745	1,100	2,304	3,404	3,050	26,049	29,099
	23	69,934	1,019,873	5,630	80,792	86,422	75,564	1,100,665	1,176,229
Total by BCR									
	12	482,111	549,709	32,834	36,409	69,242	514,945	586,118	1,101,063
	13	15,557	419,953	0	27,080	27,080	15,557	447,034	462,591
	22	2,594,367	7,023,360	150,670	956,675	1,107,345	2,745,037	7,980,035	10,725,072
	23	216,849	2,107,498	11,154	199,573	210,728	228,003	2,307,072	2,535,075
	24	33,236	460,258	0	35,610	35,610	33,236	495,868	529,103
Total JV region		3,342,120	10,560,779	194,658	1,255,348	1,450,005	3,536,778	11,816,126	15,352,904

[a] Grassland bird habitat objectives include a *Combined* category as inaccuracy in spatial data interpretation between Grassland/herbaceous and Pasture/hay can be high. Grassland/herbaceous is generally considered more bird friendly than Pasture/hay due to less agricultural manipuation. Retention objectives may be achieved by a number of approaches, but especially programs and policies focused on private lands.

Several large and local scale habitat strategies with potential to affect grassland birds were detailed in the Full Life-Cycle Conservation Plan for Bobolink (Renfrew et al. 2019). Scientists within the agricultural community are also promoting biological or *Regenerative Farming* to address soil and water conservation, climate change, and reducing the use of chemicals known to negatively impact soils, insects, and birds https://www.midwesternbioag.com/research-results/case-studies/; https://rodaleinstitute.org/why-organic/organic-basics/regenerative-organic-agriculture/). Improving working grasslands will require outreach and training in sustainable production techniques and innovation to address underlying economic realities faced by agri-business.

Resources: Managing for Grasslands Birds

- https://pubs.er.usgs.gov/publication/pp1842
- https://www.ontariosoilcrop.org/wp-content/uploads/2015/08/GrasslandBirdsWorkbook.pdf
- https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_009930.pdf

Grassland Game Birds.—Conservation agencies and organizations often have dedicated funds they are required to use for management of traditional game species, such as Greater Prairie-Chicken, Ring-necked Pheasant, Sharp-tailed Grouse, Northern Bobwhite, and waterfowl. The habitat needs of grassland, grass-shrub, and grassland-wetland game species typically overlap with the needs of non-game landbirds occurring in grasslands. The National Wild Pheasant Plan recognizes many of the same habitat challenges discussed in this grassland bird chapter. In addition, the Pheasant Plan includes detailed information regarding human dimensions, such as hunter recreation and related financial expenditures by state. The Pheasant Plan goals comprise state-level targets for pheasant abundance, habitat area, and annual harvest. Similarly, Bring Back Bobwhites is a national conservation initiative, but detailed population and habitat objectives are in separate documents developed by state wildlife agencies. State-level conservation plans also exist for Greater Prairie-Chicken and Sharp-tailed Grouse, where these species occur in manageable numbers, as well as locally breeding waterfowl that benefit from grassland nesting cover.

Pollinators.—Wildlife agencies, NGOs, and some industries are increasingly responding to the needs of pollinators (https://www.fws.gov/savethemonarch/ccaa.html). North America's native pollinators are a highly diverse group comprised of bees, butterflies, moths, and other insects, as well as hummingbirds and bats. Native pollinators are common in grasslands and even developed areas when these locations include patches of cover with a significant native-forb component. Pollinators are extremely important to the North American economy and our quality of life, yet populations of many native pollinator species are in steep decline due to habitat loss and pesticide use (https://www.nwf.org/pollinators). Integrating habitat actions (Table 6) for game and non-game grassland birds, plus pollinators, can provide means to expand the social relevance of grassland conservation. The methodology exists to help JV partners combine biological and social objectives and target conservation to benefit grassland birds and people (e.g., Appendix F).

Summary – Regional Management Actions for Grassland Birds

- Implement grassland bird habitat restoration and retention objectives (Table 6) at locations currently dominated by grasslands (Figure 12B), and where grasslands occur at moderate densities and can be expanded into surrounding open landscapes (Figure 12A).

- Restore, reconstruct, and manage grasslands to meet descriptions of quality habitat for grassland bird focal species (Appendix D, Figure 14), addressing primary grassland threats (Table 5), replacing invasive mono-cultures such as smooth brome and tall fescue, and following the general model for Grassland Bird Conservation Areas within open working landscapes ≥ 2,500 ha (Figure 13).

- Translate State × BCR bird habitat objectives (Table 6) to restoration and retention actions via conservation networks using a suite of programs (e.g., CRP, EQIP, WRP, State conservation initiatives, etc.).

- Engage and integrate with partners outside the traditional landbird conservation community, working toward grassland restoration and protection initiatives focused on game (hunted) species, pollinators, grassland-nesting wetland birds, industry, and biological / regenerative farming.

- Continue to integrate social science into grassland bird planning and habitat delivery, better communicate why grassland conservation is advantageous to society, and seek expanded social science expertise on the JV Management Board and Science Team.

- Develop and refine models that integrate social and biological objectives to target conservation with greater benefits to grassland birds and people (e.g., Appendix F), and with the goal of increasing relevance and support for bird conservation.

Forest Birds

> **Forest Bird Focal Species**
> Breeding (B) / Nonbreeding (NB)
>
> **Eastern Whip-poor-will – B**
> **Red-headed Woodpecker – B**
> **Wood Thrush – B**
> **Golden-winged Warbler – B**
> **Kirtland's Warbler – B**
> **Cerulean Warbler – B**
> **Canada Warbler – B**
>
> **Rusty Blackbird – NB**
> **Blackpoll Warbler – NB**

Compared to grasslands, forest area in the JV region has been relatively stable and remains the dominant land cover in BCR 12 and large portions of BCR 23 and 24 (Figure 6, Appendix C). Encompassing about 30% of total land cover, the area of upland forest today is similar to that of the 1930s, and the estimated area of forested wetland has increased (Table 3). Prior to European settlement, these landscapes were less fragmented and disturbance regimes were natural (i.e., wind throw and fire). Mature-stand conditions and conifers dominated northern mesic forests (Albert 1995), and eastern deciduous forests were predominantly mature. Oak savanna, jack pine barrens, and spruce-fir forest were subject to relatively frequent fires and wind events, resulting in mosaics of mixed-age stands.

Natural disturbances and transformations in forest composition still occur, but anthropogenic activities have become the dominant and more predictable means to set back succession or achieve other desired forest conditions. Based on landscape-change assessment, areas of shrub/scrub and woody wetland are increasing in northern portions of the JV region, replacing areas previously classed as upland forest (Figure 16). Increasing area of shrub/scrub in recent years occurred largely in BCR 12, where timber-harvest activity and natural disturbances are most prominent (see Land Cover and Habitat Assessment, page 18). Much of this gain in shrub/scrub and corresponding loss in upland forest area will revert to forest cover following regeneration at harvested and disturbed sites (Nelson et al 2020).

In the southern half of the JV region, many floodplain forests associated with large rivers are declining in area (Figure 16), becoming more open and replaced by the NLCD classification open water. Floodplain forests along major rivers are normally very dynamic systems whose plant species are adapted to disturbance. However, higher amounts of precipitation and longer flooding duration in recent years have resulted in tree mortality, limited tree regeneration, and increased openness of woody wetlands (USACE 2012). This condition is common where system hydrology has been most altered (i.e., BCR 22 areas with agricultural field tiling and ditching) and where riparian tree species such as ash and elm (*Fraxinus* and *Ulmus* spp.) have been stressed or killed by disease.

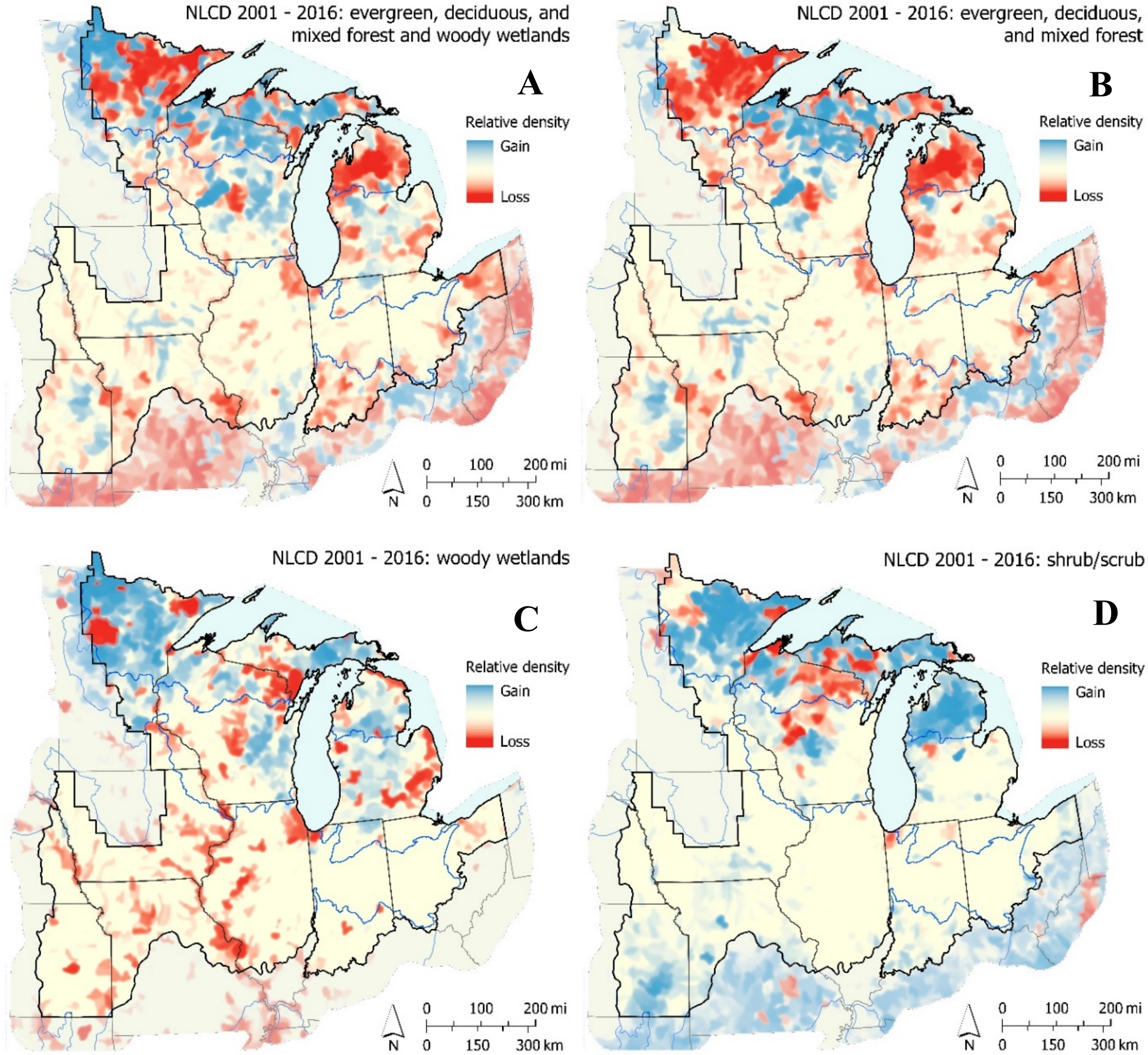


Figure 16. Areas of forest/woody land cover change between 2001 and 2016 in the Upper Mississippi / Great Lakes Joint Venture region, generated from National Land Cover Data (NLCD; Yang et al. 2018) at the HU10 watershed scale (x unit size = 640 km^2). Assessment includes change in (A) total forest area (all forest types), (B) upland forest, (C) woody wetlands, and (D) shrub/scrub. *Note:* NLCD cover-type classification accuracies vary depending on bias resulting from map-based estimates (see Appendix B for NLCD cover type descriptions).

Whereas the northern, largely forested, half of the JV region has experienced far less urbanization than other portions, several metropolitan areas do exist (Figure 6), and rural and recreational home building is substantial in some counties (Hawbaker and Radeloff 2004, Radeloff et al. 2005). Conversion of forest to farmland and forest simplification has also occurred (Matteson et al. 2009). Although gross changes from forest diversion (loss of forest to non-forest land uses) and reversion (gain in forest from non-forest to forest) have recently been similar in area, resulting in minimal net change to total forest cover, forest composition and structure can differ substantially between areas lost and gained. Based on current land cover trends, extensive net gain in forest area is unlikely in the JV region; thus, addressing threats to forest birds and their habitats (including habitat quality) may be the best means to stabilize declining populations. To inform forest-bird conservation planning, we identified and prioritized primary threats across BCR 12 and 23 forests, which encompass most forest-bird breeding areas within the JV region (Figures 3 and 6). Using the Open Standards approach (Conservation Measures Partnership 2013), a team of JV scientists assessed the extent, severity, and irreversibility of each threat to regional forests during the next 10 years (Table 7). Threats most important to forests and forest birds in the JV region (i.e., those ranking Very High and High [red and orange in Table 7]) were summarized below.

Table 7. Threat categories used by Open Standards (OS; Conservation Measures Partnership 2013) and average threat scores (0-4) for forests in Bird Conservation Regions (BCRs) 12 and 23 within the Upper Mississippi / Great Lakes Joint Venture (JV) region, generated by a team of JV forest-bird experts. Threats assessed for the next 10 years ranked Very High (>3), High (≥2.5 to <3.5), and Moderate (≥1.5 to <2.5). Threats considered low priority were not listed.

OS category	OS threat	BCR 12	BCR 23
1.1	Housing & Urban Areas	2.5	2.9
2.1	Annual & Perennial Non-Timber Crops	2.5	2.9
3.2	Mining & Quarrying	2	2
3.3	Renewable Energy	2	2
4.1	Roads & Railroads	2	2.9
4.2	Utility & Service Lines	2	2.4
7.1	Fire & Fire Suppression	3	3
7.4	Removing / Reducing Human Maintenance	2.5	2.9
8.1	Invasive Non-Native / Alien Plants & Animals	2.5	2.5
8.2	Problematic Native Plants & Animals	3	3
8.4	Pathogens & Microbes	3	3
11.3	Changes in Temperature Regimes	2	2
11.4	Changes in Precipitation & Hydrological Regimes	3.5	3.5
11.5	Severe / Extreme Weather Events	2.5	2.5

Development (OS 1.1).—Expansion of human developments has led to a loss of forest-bird habitat, forest fragmentation, and degradation of forest quality, which has in turn negatively impacted forest bird populations (Frelich 1995, Robinson 1996, Radeloff et al. 2005, Schulte et al. 2005, Pidgeon et al. 2007, Rosenberg et al. 2019). Birds near developed areas face more human-associated predators (e.g., free-ranging cats), window collisions, invasive species (e.g., plants, birds), nest parasites (e.g., Brown-headed Cowbirds), light pollution, and loss of large blocks of forest cover (Brittingham and Temple 1983, Dominoni 2015, Hager and Craig 2014, Gnass Giese et al. 2015, Loss et al. 2015, Niemi et al. 2016).

Agriculture (OS 2.1).—The JV forest landscape has been fragmented by agriculture related to livestock (especially cattle) and row crops (e.g., corn, soybeans, potatoes), which lowers the amount of forest cover and increases forest edges, detrimental to many forest-breeding birds (Knutson et al. 2004). Forest birds using areas within agricultural landscapes are negatively affected by human-associated predators (e.g., raccoons), nest parasites (e.g., Brown-headed Cowbirds), and pesticides (Knutson et al. 2004, Loss et al. 2015, Li et al. 2020).

Transportation and Service Corridors (OS 4.1).—The JV region is traversed by a substantial system of roads, railroad tracks, and power lines, all of which fragment forests and provide pathways for invasive plant species (Hawbaker and Radeloff 2004, Radeloff et al. 2005, Fan et al. 2013, Gnass-Giese et al. 2015). Anthropogenic linear corridors, in general, affect birds primarily through the fragmentation of critical interior-forest habitats. However, collisions with vehicles, power lines, and wind turbines, plus electrocutions from power lines, also cause high levels of mortality in some areas (Loss et al. 2015). Conversely, creation and maintenance of young forest stand conditions within and along transportation and utility corridors may benefit bird species associated with this cover type.

Natural System Modifications (OS 7.1, 7.4).—Catastrophic disturbances during European colonization (e.g., clearing extensive pine forests) were often followed by slash fires resulting in forest regeneration favoring hardwood species like maple, oak, paper birch, and aspen. The result of these historic events and subsequent ecological responses has been a loss of diversity both in structure and species (Hupperts et al. 2019), and an associated loss of forest resilience to threats, such as disease and invasive plants. Moreover, fire suppression has resulted in loss and quality of fire-dependent systems, including pine barrens and oak savannas.

Invasive and Problematic Species (OS 8.1, 8.2, 8.4).—Invasive and problematic species are particularly difficult to address in this JV region due to the high level of commerce-related transit (e.g., trucking, rail, and international shipping), human development, and associated plant community disturbance. Because most invasive species are difficult and expensive to control, their establishment can result in widespread loss of native species and structural diversity in forests and lower habitat quality for forest birds (Koenig and Liebhold 2017). For example, invasions by the emerald ash borer *(Agrilus planipennis)* and hemlock woolly adelgid *(Adelges tsugae)* represent insect threats with the potential for permanent loss of associated tree species. Introduced earthworms consume leaf litter and reduce cover and native-plant richness, and they have been linked to declines in some ground-nesting songbirds (Loss et al. 2012). Lower native insect diversity associated with invasive shrubs can also reduce the suitability of habitats for nesting birds (Fickenscher et al. 2014). Forest pathogens can destroy tree roots and reduce water and nutrient uptake, as well as cause cankers or wilt diseases that reduce the flow of water to leaves (e.g., oak wilt in savannas). Over-abundant native species, notably white-tailed deer (*Odocoileus virginianus)*, can also significantly alter breeding forest bird populations by eliminating the forest undergrowth, shrub layers, and even regenerating tree saplings (Vitek et al. 2017).

Climate Change (OS 11.4, 11.5).—Climate change is predicted to have far-reaching, potentially catastrophic impacts to birds due to rising temperatures and related weather events, particularly extreme storms, intense forest fire, and lake/river-level changes (Wilsey et al. 2019a). In addition, climate change can disrupt and intensify natural cycles of insect populations including forest pests such as spruce budworm. Whereas some forest birds may benefit from temporary forage abundance during budworm outbreaks, other bird species respond negatively to the long-term change in forest structure and composition (Drever et al. 2018). Over half of eastern North American forest birds are moderately or highly vulnerable to climate change, while 98% of boreal forest species are moderately or highly vulnerable (Wilsey et al. 2019a). Migration phenology and patterns will change (Jones et al. 2012; Wilsey et al. 2019a), potentially resulting in a mismatch of food resources critical during migration and breeding periods. Ranges of some forest bird species will shift (or continue to shift), while others may disappear entirely due to a lack of required habitat components (Hitch and Leberg 2007, Zuckerberg et al. 2009, Wilsey et al. 2019a). Finally, changes in hydrologic regimes and severe weather events will influence forest birds, particularly related to riverine forest lost due to longer flood duration and lack of tree regeneration.

Population and Habitat Objectives

From a global breeding-bird perspective, forested lands in the JV region are most important to Kirtland's and Golden-winged Warblers, supporting about 100% and 80% of their worldwide breeding populations, respectively. Conservation plans developed for Kirtland's Warbler (KWCT 2015; >1,000 pairs with population expansion) and Golden-winged Warbler (Roth et al. 2019; 50% increase) used traditional approaches to establish objectives for abundance and distribution, and priorities of these detailed species-specific plans are supported in this Strategy. For the remaining five forest-breeding focal species (Eastern Whip-poor-will, Red-headed Woodpecker, Wood Thrush, Cerulean Warbler, and Canada Warbler), population trend and abundance goals that support the 2016 PIF Plan (Appendix E) will serve as long-term JV objectives. Although habitat objectives were not generated using biological models linked to population objectives, we quantified current area of potential forest-bird habitat (by forest type) within each State × BCR polygon and assumed these quantities were required to retain current bird population abundances. We also provide information to help managers restore and enhance forest-bird habitat quality and to spatially target conservation actions to achieve greatest forest-bird population response.

Management of Kirtland's Warbler habitat results in a shifting mosaic of mixed cover types, from patches of low-stature grassland to seedling, sapling, and pole-sized evergreen forest, typically jack pine. Kirtland's Warbler habitat can support Upland Sandpipers, Clay-colored Sparrows, and Brewer's Blackbirds in addition to other birds that use a mix of young forest and openings for nesting.

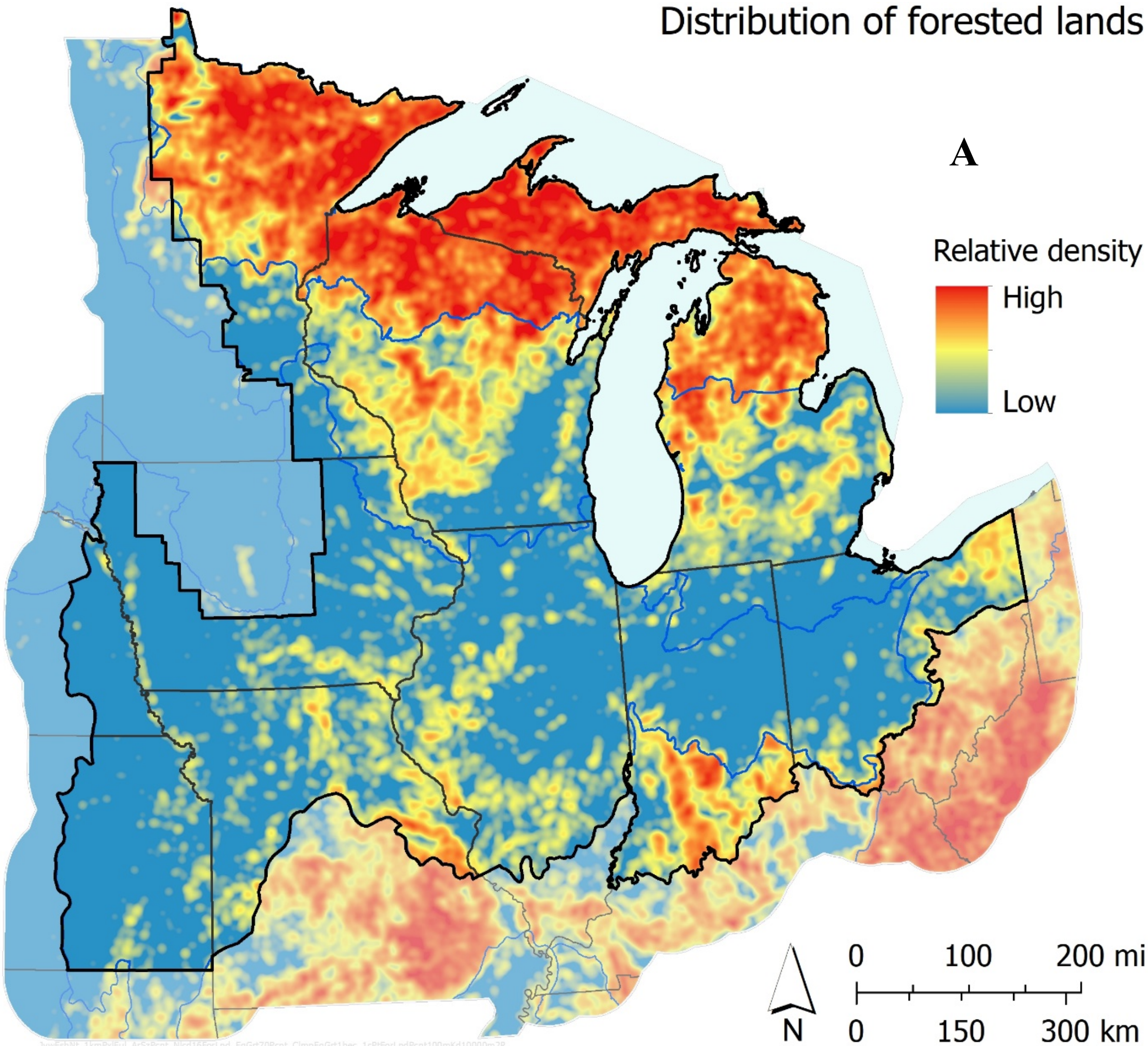
Kirtland's and Golden-winged Warblers were categorized into forest habitat associations (Table 2), but they both occur in mosaics comprising a variety of cover types and successional stages, largely on managed lands (i.e., public and commercial forests). Several breeding focal species benefit from complexes of diverse forest, often with maximum habitat quality achieved through management. Healthy forest systems typically reflect an assortment of forest stand sizes, ages, species compositions, and landscape patterns that support the varied biological needs of birds. One of the great challenges of forest planning and management for wildlife is employing a landscape approach, recognizing that diverse bird habitat needs are provided within a complex of associated forest stands. Each stand provides different attributes at different seral stages, but these characteristics may take decades to develop and lost quickly by a timber sale, wildfire, or severe wind event. Natural disturbances (fire, wind) are unpredictable, but can comprise nearly half of all canopy disturbances in some years (Nelson and Reams 2017). In many unmanaged private lands and some public lands (i.e., wilderness designation), fire and wind-throw represent the vast majority of forest-canopy disturbances. Thus, forest planning and management must take into account actions that support diverse bird habitats, economic interests, and other landowner objectives.

Population objectives were not generated for the nonbreeding period, although threats to and characteristics of high-quality stopover and wintering sites have been articulated (see Full Annual Cycle, page 27, and Appendix D). From a regional scale, the JV must maintain a viable network of stopover sites that connect to stopovers in adjoining regions, requiring future cross-regional collaboration. The quality of a stopover network is influenced by forest patch sizes and distribution, as the distance between these sites impacts fitness of migrants (Matthews and Rodewald 2010, MacDade et al. 2011, Wright et al. 2018). Although virtually all forests in the JV region have potential for use by migrants, their habitat quality (i.e., food and cover provisions) depends largely on tree-species composition and age structure, related insect/mast abundance and leaf structure, and patch size (habitat quantity). Forests with oaks, hickories, American elm, willows, and birches are generally favored during migratory stopover (Graber and Graber 1983, Piaskowski and Albanese 2001, Pollock et al. 2004, Wood et al. 2012). Additionally, migrant birds undertake local movements up to at least 30 km among stopover sites; the function of these flights remains uncertain but may relate to birds finding better habitat or evaluating weather conditions in preparation for the next leg of migration (Mills et al. 2011, Taylor et al. 2011, Wright et al. 2018b).

Conservation Design

We identified primary forest areas in the JV region and completed analyses to determine the distribution of areas most important to forest birds. Areas with ≥70% total forest cover (all forest types combined) were identified (Figure 17A) and location of the largest contiguous forest blocks were determined (Figure 17B). The importance of the northern JV region (BCR 12) in providing extensive breeding habitats critical to forest birds was not a surprise (Niemi et al. 2016), but large forest patches were also common in southern portions of Michigan, Wisconsin, and Indiana. Areas within Missouri, Ohio, Illinois, and Iowa included substantial expanses with moderate densities of forest cover, reflecting locations of potentially high breeding and migratory stopover importance.

Large- and moderate-sized forest patches with limited fragmentation are especially important to the success of breeding forest birds. Areas between moderate-sized patches of forest (Figure 17B), including low-intensity development and poorly producing agricultural lands, may be restored to forest (or expanded forest canopy) over time to increase forest connectivity. Forest-dominated areas and even small forest patches are important during the nonbreeding period, particularly to birds migrating along the Great Lakes shoreline (Ewert at al. 2011). The current need for stopover locations may be greatest where forest cover is most limited (BCR 22; Figure 17A), especially along river corridors, other water features, and developed areas within the JV region. Forest restoration, however, should not conflict with grassland bird conservation, where restoration of herbaceous cover is a better ecological fit (Figure 4).



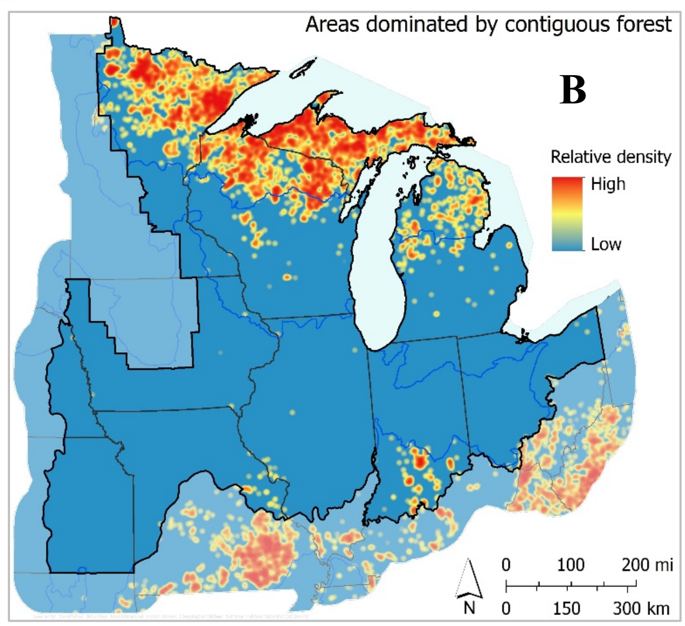


Figure 17. Areas where forest-bird habitats are the dominant land cover in the Upper Mississippi / Great Lakes Joint Venture region: A) Locations where forested lands (combining NLCD 2016 Evergreen, Deciduous, Mixed Forest, Scrub-Shrub, and Woody Wetland) account for ≥70% of total land cover within 1 km^2 pixels, and B) locations of contiguous forest, where 1km^2 pixels are nearly 100% forested (i.e., continuous forest patches are ≥100 ha in size).

Habitat Delivery

The distribution and abundance of total forest cover has been relatively stable in the JV region in recent decades when upland forest types, woody wetlands, and shrub-scrub areas are combined (Table 3). We provide general forest-bird habitat objectives, with a focus on retaining the current distribution of diverse deciduous, evergreen, and mixed forest (Table 8). Understanding the distribution and abundance of forest types along with JV focal species habitat requirements (Appendix D) is essential when developing local-scale conservation activities. For example, healthy and diverse forest-bird communities normally require a mosaic of forest types and conditions (Figure 18) that can also withstand timber product yields, adapt and remain resilient to climate change, and support human communities.

Conservation to sustain viable populations of northern-forest breeding species should chiefly focus on maintaining large, relatively unfragmented forest blocks (Figure 17B) >10,000 ha in size and with limited infrastructure (e.g., permanent roads, development, mining). In central portions of the JV region (and BCR 24), retention of areas with ≥70% forest cover (Figure 17A), especially contiguous patches ≥50 ha in size, is a high priority for forest breeding birds. Finally, semi-forested landscapes (<70% forest cover) can be valuable to forest birds, especially in BCR 22, where breeding habitat is limited and where management focus should be forest restoration and canopy expansion.

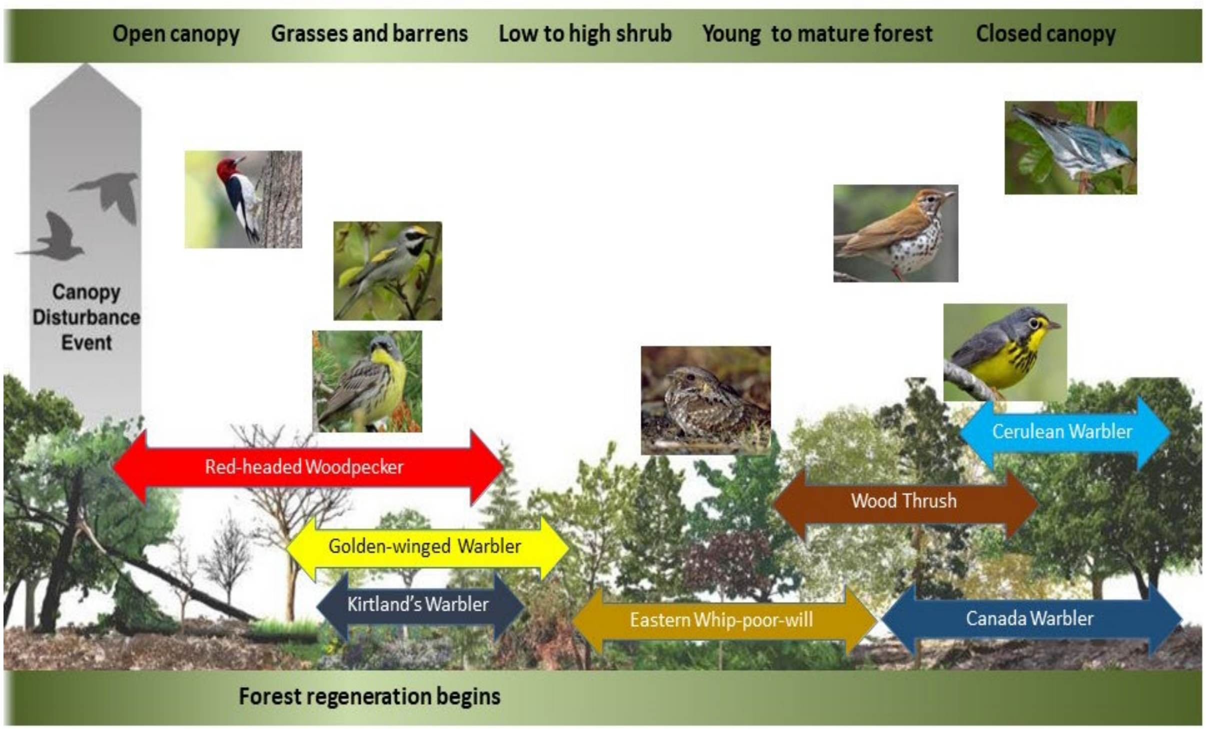


Figure 18. Conceptual forest mosaic depicting bird use of various seral stages following canopy disturbance such as a timber harvest, fire, or severe wind event in the Upper Mississippi / Great Lakes Joint Venture region. The original image was from the [Passenger Pigeon Project](), portraying catastrophic canopy disturbance resulting from intense pigeon-colony use. Photos and associated arrows added to demonstrate the range of forest structure used by breeding JV focal species.

Table 8. Area (ha) of current forest and woodland cover types and potential forest bird habitats in the Upper Mississippi / Great Lakes Joint Venture (JV) region by state and Bird Conservation Region (BCR). Estimates (1 ha = 2.5 acres) are based on National Land Cover Data (NLCD; Yang et al. 2018) classes and referred to as potential bird habitat due to lack of habitat-quality measures. See Appendix B for details on high quality habitats for forest bird focal species.

		Forest (upland)					Woody	Total forest
State	BCR	Deciduous	Evergreen	Mixed	Subtotal	Shrub/Scrub	wetland	and woodland
Iowa	22	666,977	11,662	112,356	790,995	5,875	129,878	926,748
	23	165,880	1,706	20,392	187,978	499	10,259	198,736
Illinois	22	1,105,144	5,662	447,763	1,558,569	5,014	196,414	1,759,996
	23	43,151	1,441	15,676	60,268	1,243	8,535	70,046
Indiana	22	413,468	3,546	36,613	453,627	3,715	46,284	503,625
	23	126,218	3,558	4,673	134,449	3,118	102,685	240,252
	24	1,367,171	18,475	167,632	1,553,278	6,568	49,030	1,608,877
Kansas	22	701,919	4,208	49,098	755,225	13,849	38,797	807,871
Michigan	12	2,048,865	657,465	983,978	3,690,308	189,439	2,220,206	6,099,953
	23	1,183,831	97,775	156,156	1,437,762	21,529	1,042,966	2,502,257
Minnesota	12	1,408,118	452,458	949,963	2,810,539	231,308	2,933,952	5,975,799
	22	53,796	1,121	8,932	63,849	209	9,293	73,351
	23	468,714	19,149	44,470	532,332	4,735	108,248	645,316
Missouri	22	1,543,918	14,070	211,571	1,769,560	10,087	219,551	1,999,198
Nebraska	22	116,508	604	1,346	118,457	692	22,063	141,212
Ohio	13	595,326	7,160	82,244	684,730	7,616	75,842	768,188
	22	483,748	5,971	72,768	562,488	2,604	14,009	579,101
	23	70,035	1,142	1,398	72,575	148	24,925	97,648
	24	76,472	4,253	18,767	99,493	306	394	100,193
Wisconsin	12	1,542,870	137,890	685,411	2,366,171	74,764	1,306,716	3,747,651
	22	17,069	1,267	4,607	22,944	157	3,448	26,549
	23	1,911,583	142,052	427,310	2,480,944	42,459	958,388	3,481,791
Total by BCR	12	4,999,853	1,247,813	2,619,352	8,867,018	495,511	6,460,874	15,823,403
	13	595,326	7,160	82,244	684,730	7,616	75,842	768,188
	22	5,102,549	48,111	945,054	6,095,714	42,201	679,736	6,817,652
	23	3,969,411	266,823	670,074	4,906,308	73,732	2,256,006	7,236,046
	24	1,443,644	22,728	186,399	1,652,771	6,874	49,424	1,709,069
Total JV region		16,110,784	1,592,635	4,503,122	22,206,541	625,935	9,521,882	32,354,358

The need for food-rich, high-quality migration habitat is especially relevant to the large populations of forest birds stopping to rest and refuel in the JV region. Vast forests critical for breeding birds in the northern JV region also provide stopover habitats, especially where management results in structural diversity and where forest composition includes oaks, hickories, American elm, willows, and birches. However, forest restoration and retention for nonbreeding forest birds is a higher priority in the southern two-thirds of the region (Figure 17A). Forest cover adjacent (≤25 km) Great Lakes shorelines, where forest birds stop to refuel before overwater flights (Lakes Erie and Superior), or follow north-south forested corridors during migration (Lakes Huron and Michigan), must remain a conservation focus. Stopover-management actions in the southern half of the JV region should pay particular attention to riparian corridors, forest-savanna transitions, and forest patches within developed areas. Habitat delivery will vary by site condition, but managers can begin local-scale prescriptions following principles of sustainable forest management.

Resources: Managing for Forests Birds

- http://vt.audubon.org/sites/default/files/bird-guide.pdf
- https://obcinet.org/healthy-forest-management/
- https://dnr.wisconsin.gov/topic/forestmanagement/guides
- https://mdc.mo.gov/trees-plants/forest-care/missouri-forest-management-guidelines
- https://www.treefarmsystem.org/stuff/contentmgr/files/2/4e2de1420a5fb11d340fd116076e8695/files/manage_your_woodlands_for_songbird_habitat_07262013.pdf

Sustainable Forest Management.—By adopting the principles of forest certification programs (e.g., Forest Stewardship Council and Sustainable Forestry Initiative) and tenets of ecological forestry, bird habitat partners can mitigate and eventually reverse the effects of forest simplification and natural system modifications. Sustainable forest management generally emphasizes forest attributes important to birds (Audubon Vermont and Vermont Department of Forests, Parks, and Recreation 2011) such as:

- Variety of forest age classes and developmental stages across the landscape.
- Complex vertical stand structure (canopy, mid-story, understory, and ground layer).
- Closed canopy (75–80%) in older stands with small gap openings.
- Large diameter (>24 inches diameter at breast height) tree retention.
- Downed woody material, and thick, well-developed litter layer.
- Retention/creation of snags and cavity trees.
- Diversity of native tree species.
- Retention of softwoods within hardwood forests.

Numerous sources of information are available to guide local-scale forest management for JV focal species (e.g., see Resources: Managing for Forests Birds text box, page 60), with especially detailed guidelines documented in conservation plans for Kirtland's and Golden-winged Warblers. In addition, efforts are underway to provide land managers and forestry professionals with specific enhancements to forest management practices that benefit priority bird species through initiatives such as *Forestry with Birds in Mind Toolkits* (Michigan), *Managing Forests for Birds Video Series* (Ohio), and *Foresters for the Birds Workshops* (Minnesota). New social science research is also informing approaches to bird habitat delivery when working with private foresters (Lutter et al. 2018, 2019).

Role of Land Conservancies and Trusts in Bird Habitat Delivery

Most forests (and grasslands) in the JV region are privately owned, and conserving private lands for birds is essential. Land conservancies and trusts are diverse and increasingly important vehicles for protecting private, often unique, landscapes significant to birds. Numerous conservancies with a bird focus in the JV region range from The Nature Conservancy (https://www.nature.org/.../great-lakes-birds), with its worldwide reach and market-based approaches, to smaller organizations, such as the Grand Traverse Land Conservancy in northern Lower Michigan (https://www.gtrlc.org).

In 2013, the Cornell Lab of Ornithology used social science-based methodology to conduct a national online survey of land trusts and their attitudes toward bird conservation. Results indicated that land trusts, if supported with science and technology, could achieve landscape-scale conservation for birds. Subsequently, Cornell Lab established the Land Trust Bird Conservation Initiative (https://www.birds.cornell.edu/landtrust) with a focus on Engaging People, Planning, Management Guides, and Presentations and Publications. New social science research is also informing approaches to bird habitat delivery on private lands and working with private foresters (Lutter et al. 2018, 2019).

Whereas bird-habitat delivery is local, this Strategy promotes understanding and continually adapting management to large-scale influences on birds. The greatest overarching threat to forest birds may be climate change, but there remains uncertainty regarding which species will be most influenced and where in the annual cycle habitat conservation can best mitigate climate change impacts. General adaptation and mitigation strategies regarding bird habitats have been described (Wilsey et al. 2019a), and several approaches have been identified to guide land managers in retaining healthy forests better able to cope with climate change impacts (Swanston et al. 2016).

Climate Adaptation.—Rules to maintain healthy forests (and bird habitats) in an era of accelerated climate change:

- Maintain fundamental ecological functions (i.e., reduce negative impacts to soils, maintain/restore hydrology and riparian areas, and restore fire-adapted ecosystems).
- Reduce the impact of biological stressors (e.g., pests and pathogens, invasive species).
- Reduce the risk and long-term impacts of severe disturbances (i.e., address risk and severity of catastrophic wildfires, revegetate sites quickly following disturbance).
- Maintain or create refugia (especially for at-risk or sensitive native species and communities).
- Maintain and enhance species and structural diversity.
- Increase ecosystem redundancy across the landscape (i.e., manage for apparent bird habitat surpluses over a range of sites and conditions).

- Promote landscape connectivity (i.e., reduce fragmentation and create corridors).
- Maintain and enhance native-species genetic diversity.
- Facilitate community adjustments through species transitions (i.e., favor species well-adapted to predicted conditions, manage for species with wide temperature and moisture tolerances, move at-risk species to resilient sites, introduce well-adapted species).
- Realign ecosystems after disturbance (i.e., revegetate with best-fitting native species after disturbance, and allow natural regeneration to test for future-adapted species).

Full Annual Cycle Initiatives
Golden-winged Warbler Working Group
Kirtland's Warbler Conservation Team
Canada Warbler International Conservation
International Wood Thrush Conservation Alliance
Cerulean Warbler Working Group
Rusty Blackbird Working Group
Neotropical Migratory Bird Conservation Act
Midwest Migration Network
Southern Wings

Because most JV focal species winter outside of the region, collaboration through strategic partnerships and potential investment in conservation actions outside the Midwest and U.S. will help secure return on investments to bird habitats made in the JV region. Considering climate-related range shifts, we must also expand collaboration and integration of planning across interconnected geographies though working groups and initiatives to advance multi-JV landbird conservation.

Forest Game Birds.—Wildlife management agencies and organizations often have *dedicated funds* they are required to use for management of game species. However, these groups are increasingly exploring management opportunities benefiting suites of game and non-game birds as components of healthy forest communities. For example, the Michigan Young Forests Wildlife Action Plan is framed to address the needs of species like Golden-winged Warbler and Eastern Whip-poor-will as well as American Woodcock and Ruffed Grouse, while also considering vulnerability of Michigan forest wildlife to climate change and other threats. Likewise, the Wisconsin Young Forest Partnership provides guidance for early-successional forest game birds, but songbirds dominate the list of benefiting species recognized by these conservation partners. The Ruffed Grouse Society and American Woodcock Society collaborated to build a model for expanding game bird habitat but with attention to other wildlife and the numerous social benefits of sustainable forest management (https://ruffedgrousesociety.org/the-ruffed-grouse-society-model-of-working-forests/). There also are crossover management opportunities for bird species dependent on old-growth forest characteristics, from Cerulean and Canada Warblers to cavity-nesting Wood Ducks and Eastern Wild Turkeys.

Management for birds can benefit other taxa: cavity-nesting bird habitat benefits cavity-denning mammals; providing large trees for birds benefits tree-roosting bats; retaining standing dead and downed woody materials for woodpeckers benefits amphibian, reptiles, small mammals, and insects; management for early-successional forest and semi-open woodlands benefits white-tailed deer as well as Northern Bobwhite and Eastern Wild Turkey. As we consider how best to broaden landbird conservation support, understanding and integrating the needs of game and non-game species of birds and other wildlife with the desires of people who enjoy birding and hunting will be increasingly important to the success of bird habitat delivery. The technology and methodology exists to help JV partners combine multiple biological and social objectives and target conservation to benefit forest birds and people (e.g., Appendix F).

Summary – Regional Management Actions for Forest Birds

- Implement forest-bird habitat retention objectives (Table 8) at locations currently dominated by forest and having a breeding bird focus (Figure 17B), as well as areas where forest cover should be expanded to benefit both breeding and migrating forest birds (Figures 17A).
- Manage forests to provide characteristics of high quality habitat for forest-bird focal species (Appendix D, Figure 18), addressing primary forest threats (Table 7) and following the principles of Sustainable Forest Management.
- Retain and expand large relatively un-fragmented forest blocks (Figure 17B) >10,000 ha in size in the north JV region, and connect forest stands in areas with ≥70% forest cover (Figure 17A) in other portions of the region, especially where contiguous patches can exceed 50 ha in size (via restoration).
- Retain and expand forest patches (≥50 ha) and corridors of upland and floodplain forest along waterways and within 25 km of Great Lakes shoreline, especially in semi-open (e.g., agricultural) landscapes with potentially high-use as migration stopover sites (see habitat characteristics described in Migratory Bird Stopover Facts in Full Annual Cycle section).
- Support and encourage full life-cycle conservation efforts for JV focal species at stopover and wintering locations outside the JV region.
- Promote forest conservation that integrates game- and non-game bird management objectives, as well as other ecological goods and services provided by forests.
- Continue integrating social science into forest bird planning and habitat delivery, including seeking expanded social science expertise on the JV Management Board and Science Team.
- Develop and refine models that integrate social and biological objectives to target conservation with greater benefits to forest birds and people (e.g., Appendix F) and with the goal of increasing relevance and support for bird conservation.

Urban Birds and Developed Lands

In our spatially explicit planning, the JV has identified bird habitats using remotely sensed land cover data, typically modified using models with species-habitat (e.g., vegetation) covariates. Human aggregations – urban areas classed as *developed lands* – have been generally recognized as *hostile* locations to birds due to subsequent loss of diversity and ecological functions (Alberti 2005). However, developed lands are quite variable, with corresponding NLCD classes subdivided into levels of intensity (High, Medium, and Low Intensity and Developed Open Space) related to building density and amount of impervious surface (Figure 6. Appendix B). Vegetative cover increases along this developed-class continuum, from virtually none in High Intensity to mostly vegetation (lawn grasses primarily) in Open Space. Conversion to developed land is a prominent landscape change occurring in the JV region (Appendix C) and developed land classes with greatest area expansion in recent years include Medium Intensity, Low Intensity, and Developed Open Space (Table 3).

Geologists and ecologists may not agree when the Anthropocene began, but there is consensus we are living in a new age, a time in which human activity has become the dominant influence on Earth's climate and environment. As a result, the longstanding dichotomy of bird habitats (nature) vs. people habitats (development) is being questioned. Perhaps conservation resulting in improved living space for birds and people will be necessary to assure a healthy, albeit steadily changing, environment. The foundation for urban bird conservation resides in a relatively simple idea: humans and the effects of their activities on landscapes are now part of nature and therefore bird habitat. This philosophy stands in marked contrast to traditional conventions where people and development stand apart from the natural world. It also has profound conservation implications, underscoring the importance for addressing bird and human habitats in urban settings.

The remotely sensed description of developed lands fails to capture how human cities and communities affect landscapes outside defined urban areas. For example, water runoff laden with municipal impurities flows through urban waterways, only to permeate aquatic systems far from city hubs. Our transportation and industrial activities transform the aerial bird habitats above cities and far beyond. Urban centers infiltrate existing natural landscapes in space and in time, as raw materials, commodities, and people flow across the ground and in the air. Thus, movement of resources to and from human communities links all other landscapes. The urban supermarket, and its impervious parking lot, is intimately connected in a complex web to the petrochemical-fed monoculture row-crops and vegetable fields in rural settings across the Midwest and elsewhere. Yet, urban areas are often centers for ideas as well as financial, political, and volunteer support needed for effective conservation programs. In this JV region, urban influences are pervasive, and the forecast is for continued expansion of developed cover types (Figure 19). Finding conservation opportunity in these rapidly expanding landscapes is only prudent.

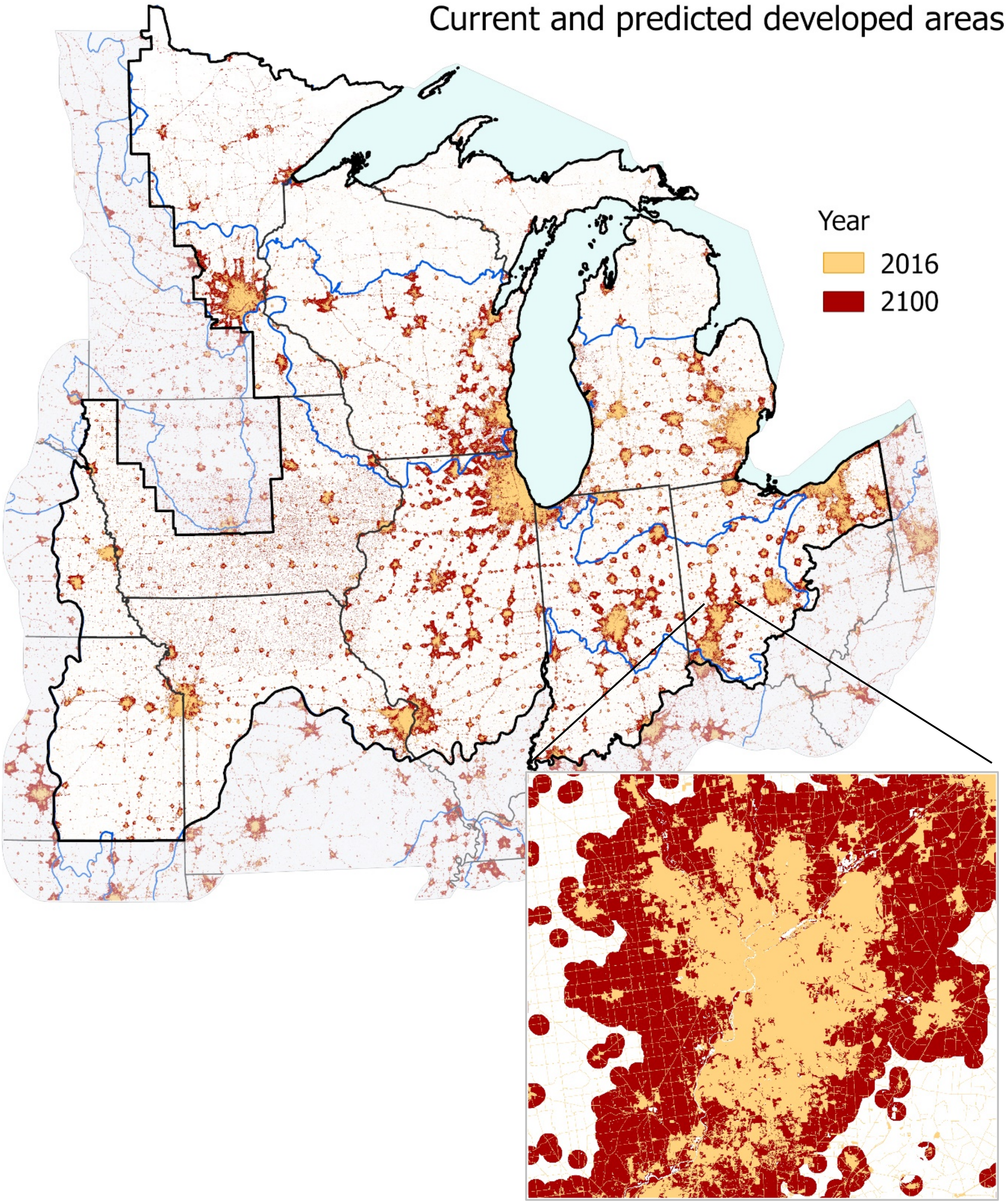


Figure 19. Current and projected developed lands (National Land Cover Database; all development classifications combined) to year 2100 in the Upper Mississippi / Great Lakes Joint Venture region, including an example of expanded area around Dayton OH. Projection was developed using information consistent with the U.S. Geological Survey's spatially explicit forecasting of land-use change (FORE-SCE) model under scenario A1B (Sohl et al 2018).

Biological Foundation

The most important habitat aspects to urban bird conservation include 1) addressing the needs for species breeding in developed settings, particularly provision of sites for successful nesting and food acquisition, 2) maintaining adequate stopover locations for birds whose migration corridors include developed landscapes, and 3) reducing collisions with structures and mortality due to other human threats. Landbird habitat needs (Appendix D) and threats (Tables 5 and 7) vary by species, and species composition differs across the urban-intensity continuum. If we apply the current NLCD developed land-cover classes to species distribution, there are relatively few bird species characteristically breeding in the High Intensity developed areas. Abundance can be high for Rock Pigeon, House Sparrow, and European Starling (all non-native); House Finch; sometimes Chimney Swift (depending on chimney status) and Common Nighthawk (depending on roofing practices and predator presence); American Crow; and more recently, Peregrine Falcon and even Bald Eagle. Of these species, only the Chimney Swift is a JV focal species (Table 1). Medium-to-Low Intensity developed-land classes harbor many species, including Downy, Hairy, and Red-bellied Woodpeckers; Black-capped Chickadee; White-breasted Nuthatch; American Robin; Chipping Sparrow; Northern Cardinal, Blue Jay, and Common Grackle. In developed areas with more vegetative cover (e.g., Developed Open Space), especially metropolitan parks, some 30+ additional species may be added to the list of resident and breeding urban birds, including such newcomers as Wild Turkey, Cooper's Hawk, Merlin, and Pileated Woodpecker.

In this Strategy, we treat forest and grassland bird habitats as distinct planning categories with their respective bird communities and recommended management actions. At the same time, we acknowledge many of these management actions can apply to urban-bird habitat patches and especially at the urban-wildland interface. Designing bird habitat retention and restoration opportunities in urban areas should begin with local-scale inventory of natural cover and potential bird habitats within current and projected developed landscapes (Figures 19 and 20). Areas currently or potentially important (restorable) to landbirds within the forecasted development zone are obviously threatened by development. Thus, bird habitat patches can be targeted for conservation action (or avoided) based on long-term stakeholder desires. The complexes of grassland preserves and restorations developed by the Chicago Wilderness Program illustrate how a collaborative effort can have significant outcomes for landbirds in urban locales. Following the theme of this Strategy, JV technical staff and science partners can provide additional products to assist local partnerships in urban settings of the JV region.

Airspace as Habitat.—Virtually all JV breeding focal species, as well as migrants breeding farther north, pass through the airspace of urban centers. City attributes modify this critical bird habitat (Alberti 2005, Cabrera-Cruz 2019) with buildings, towers, airplanes, transmission wires, industrial exhaust and vehicle-exhaust fumes, light beacons, and electromagnetic currents. The interaction of the urban environment with airspace is particularly important to landbirds, from the aerial residents gleaning flying insects to the millions that occupy that space as migrants. Nocturnally migrating birds are attracted by urban lights, apparently drawn to locations where they seek diurnal shelter and food to refuel.

In fact, Nexrad radar images of migrant evening departures (or dawn migrant *fallout*) reveal nearly complete overlap in patterns of traditional landbird stopover concentrations and urban land cover (Buler and Dawson 2014). Landbirds concentrate in and around developed areas, and bird stopover habitats associated with these areas require conservation (see Full Annual Cycle – Migration, page 28).

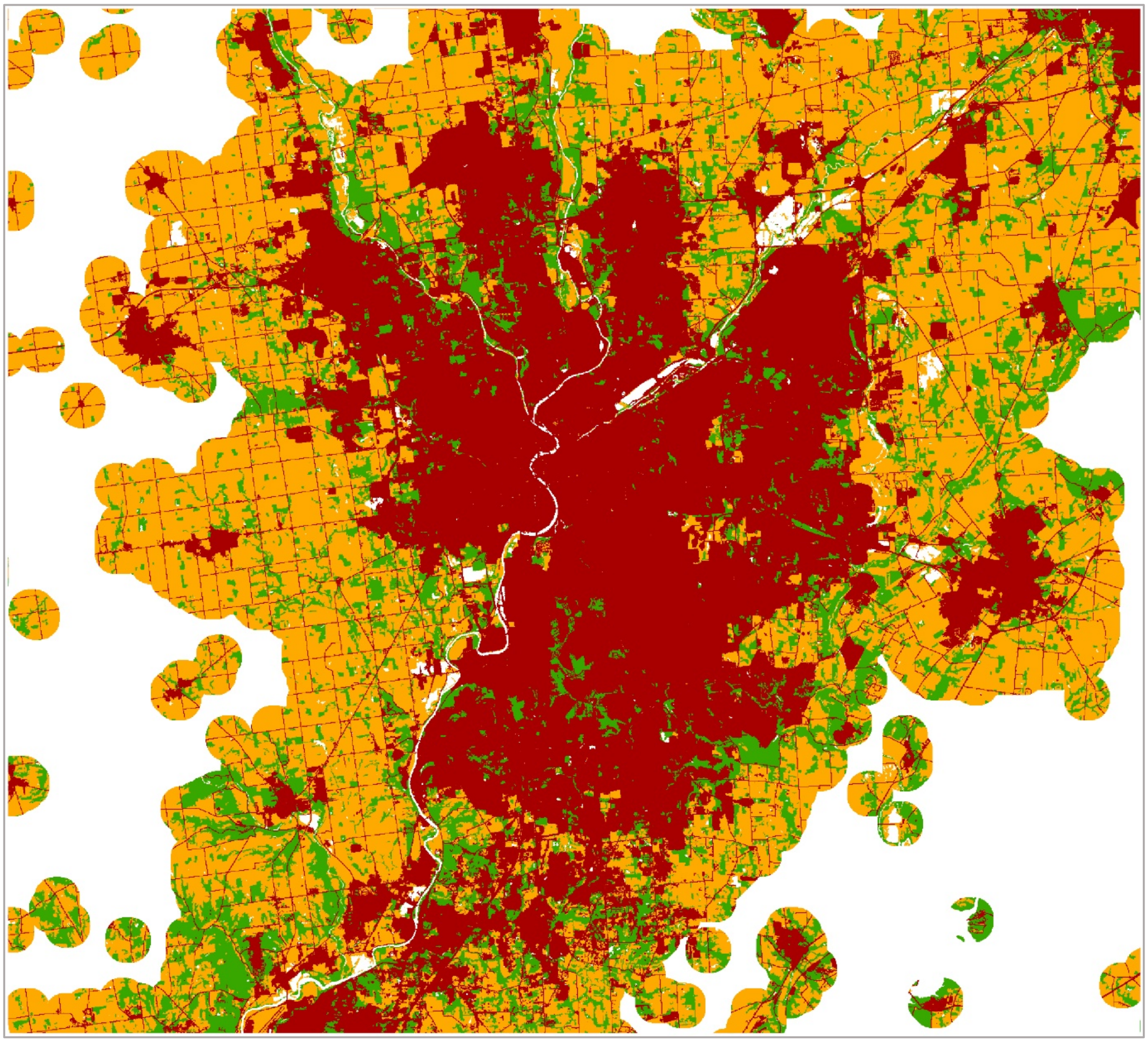


Figure 20. Zone of projected development around Dayton Ohio by 2100, with current forestland (green), grassland/open-land (orange), and current development (red) color indicated (land cover based on 2016 National Land Cover Database; forest = all NLCD forest classes combined and grassland/open-land = herbaceous, pasture/hay, cultivated cropland, and emergent herbaceous wetland classes combined; also see Figure 19 for more detail).

Urban Conservation and Bird Cities

Analyses of threats to grassland and forest birds found expansion of housing and commercial/industrial areas (including towers/wind turbines) and the impacts of climate change high-ranking direct threats to landbird habitats (Tables 5 and 7). Invasive plants and animals, particularly free-ranging domestic cats, also were considered primary threats to birds. These anthropogenic influences (including the three threat classes attributed to climate change) are elevated in and around developed lands. Because the urban landscape will continue to expand across the JV region (Figure 19), increased attention to these threats is needed. Some examples of management actions used in and around the urban environment include reducing light pollution via Lights Out programs, building- and glass-strategies and tower-lighting modifications to reduce collisions with structures, electrocution-abatement strategies, and bird-friendly wind farm siting (see Full Annual Cycle, Airspace – All Seasons, page 31). Practices to enhance bird habitats around housing have included native tree and shrub plantings designed to increase forage and cover diversity, and reduction in the numbers of free-roaming domestic cats.

Bird habitat conservation in urban settings is largely about people. Working with social scientists, civic planners have realized the importance of urban green space for improving public health and decreasing violence (https://smartgrowth.org/6-urban-green-space-projects-that-are-revitalizing-u-s-cities/). Only recently has the bird conservation community identified an interest to better integrate the needs of birds and people (e.g., Appendix F). Yet efforts resulting in outreach, participation, and advocacy for healthy habitats that benefit birds and people has potential to influence conservation outcomes well beyond urban areas and the scope of this Strategy. A platform inspiring community decision-making, empowerment, and collaboration to achieve collective impact for conservation is an achievable goal. For this transformation to occur, however, communities of people must generate those changes, with JV partners serving as the source for science and support in conservation implementation. Ultimately, urban communities can build critical mass that leads to policy change and political support for conservation; hence, for birds, urban environments generate both threats and opportunities.

There are a number of science- and community-based tools available to guide urban-bird conservation, such as strategies for upgrading communications tower lighting, ideas for reducing cat threats, employing bird-friendly building and glass options, and even bird-friendly commodity shopping. Equally important, there is a structure in place for empowering community involvement in bird conservation – the Bird City Program, now active in (Bird City) Wisconsin, Minnesota, Iowa, Indiana, and several states outside the JV region. With initial dedicated funding from the U.S. Fish and Wildlife Service for a national coordinator and development of a web-based tools platform, the Bird City Program will expand by 2021 to Bird City Americas. The enlarged international effort resulted from a partnership between American Bird Conservancy, Environment for the Americas, and Nature Canada.

Bird City is a community certification program, where interested communities apply for Bird City status by meeting a palette of conservation-action criteria (Appendix G) that benefit breeding and migrant birds. Once designated as a Bird City, the urban community becomes nationally recognized for its conservation achievements. Related actions result from community engagement, with some structure to the requirements, but also with the flexibility allowing a community to submit conservation activities commensurate with its particular geography and social context. Most programs offer a menu of required criteria or categories with nested options for bird-friendly actions most suited to a community's level of capacity and resolve (Appendix G). From the perspective of habitat delivery, this suite of potential actions includes guidance for grassland and forest conservation in the urban environment.

Since the Bird City program provides an established platform for directly engaging people with birds at the community/urban scale, the JV network can actively endorse and promote the program. Of particular interest would be support for conservation of JV focal species when a city has significant populations occuring during breeding or migration periods. This support can include helping to initiate the program in states where it does not already exist, serving as technical experts with bird habitat recommendations, or providing dedicated capacity for working to secure continued financial support. The Bird City effort may have the best potential for urban bird conservation, because of its grounding in community engagement that connects people with nature though birds. Municipalities enrolled as Bird Cities also hold an annual celebration recognizing World Migratory Bird Day to educate communities and raise awareness.

Summary – Management Actions for Birds in Urban Landscapes

- Assist stakeholders in planning, retaining, and expanding forest and grassland bird habitats, with focus on high quality (limited bird threats) migration stopovers and outdoor recreation, at logical locations based on forecasted development trends (Figure 19).
- Restore and retain forest, grassland, and open space patches (e.g., see Figure 20) with native plant communities benefiting birds, pollinators, and people, with concerted focus on lakeshore and riverine corridors where bird habitats may provide greatest social benefits (e.g., green space, water filtration).
- Continue integrating social science into bird planning and habitat delivery in and around urban settings, including seeking expanded social science expertise on the JV Management Board and JV Science Team.
- Promote community-based (Bird City) conservation actions especially relevant to urban and developed landscapes and drawn from best practices of the Bird City Program (Appendix F).
- Target and assist ≥2 urban areas (≥20,000 people) annually for enrollment in the Bird City program, with focus on how individual locations can benefit JV focal species.

MONITORING AND RESEARCH

Monitoring and research in bird conservation are often closely associated, both being essential to adaptive planning and management. For purposes of this Strategy, high priority monitoring efforts include those useful to measure population status and progress toward meeting bird population and habitat objectives (i.e., abundance, trends, and or other performance measurements). Priority research, in contrast, is designed to answer specific questions that arise from uncertainties or assumptions inherent in conservation planning. Habitat quality can be assessed by monitoring density of focal species, physical or environmental characteristics (e.g., vegetation related to quality habitat), and/or vital rates (e.g., survival and recruitment). Habitat use surveys that measure responses of bird species vital rates to environmental conditions offer an opportunity to test hypotheses about factors that limit population growth during the full annual cycle. Population surveys closely integrated with explicit management decisions, where biological predictions and testing can result in measures of conservation effectiveness at local scales. Increasingly, social science research has been integrated into bird conservation planning, as results can influence methods, communication approaches, and bird-habitat placement.

The professional bird conservation community can take credit for great progress regarding monitoring concerns identified in the 2007 JV Landbird Strategy. Priorities identified and addressed include: 1) need for centralized data storage and easy retrieval / access by researchers, 2) standard methodologies and integrated techniques across organizations and large geographic scales, 3) monitoring precision goals to better detect population abundance change, and 4) filling information gaps with statistically valid and relevant information. Data from coordinated surveys of bird population abundance and habitats, plus results from numerous JV-supported research projects (https://umgljv.org/science/jv-publications/), were used when revising this Strategy. The planning effort was also informed by survey data regarding landbird stakeholder priorities, human population distribution, and common human values related to ecological goods and services provided by natural landscapes. Monitoring essential to continued improvements in JV landbird habitat planning and delivery are described below.

North American Breeding Bird Survey (BBS).—The BBS has been conducted annually since 1966, primarily in June after spring migration. This roadside survey, conducted by wildlife professionals and qualified volunteer birders, is largely coordinated by the U.S. Geological Survey. There are 600 BBS routes within the JV region; routes are typically 40 km in length with 50 stops that are 0.8 km apart. The BBS may not adequately represent some landbird species due to the survey's proximity to roads and daytime survey methodology. However, species population trends and abundance estimates based on the BBS are vital to JV conservation planning.

eBird.—Launched in 2002 by the Cornell Lab of Ornithology and National Audubon Society, eBird provides rich data sources for basic information regarding bird abundance and distribution at a variety of spatial and temporal scales worldwide. These data are used to understand migration timing and distribution during the full annual cycle, plus relative abundance across states and BCRs. A goal of eBird is to maximize the utility and accessibility of the vast numbers of bird observations made each year by professional and recreational bird watchers (>100 million annually). Observations from each participant are collated in an international network of eBird users. Data are then shared with a global community of stakeholders in real time, including educators, land managers, ornithologists, and conservation planners. Information available through eBird has become the foundation for better understanding bird distribution in time and space across the western hemisphere, and its potential uses and value to conservation are increasing.

Christmas Bird Count (CBC).—The nation's longest-running community science project, data collected by CBC participants since the year 1900 have provided a wealth of information to researchers and managers interested in the long-term study of early winter bird populations across North America. Peer-reviewed articles using CBC data have encompassed categories such as community ecology and biogeography, distribution, count methods, participation, and population dynamics.

State and Smaller-scale Population Surveys.—Several state agencies and organizations within the JV region have conducted presence/absence surveys when developing and revising state *Breeding Bird Atlases*, or when considering a site for *Important Bird Area* (IBA) status. Atlas data are useful to document the presence and general distribution of a species within a state, and related robust point count efforts can result in population density estimates. In addition, local data collection associated with landbird research projects can provide valuable demographic information. Several national forests, wildlife refuges, and parks within the JV region have been part of long-term point-count surveys and local-scale landbird habitat monitoring.

Regional Habitat Surveys.—Joint Venture Management Board representatives have provided annual reports of major bird habitat accomplishments in each state since completing the 1998 JV Implementation Plan. This accomplishment reporting has been segmented into upland and wetland categories and grouped by protection, restoration, and enhancement. Although partners have reported accomplishments that contribute toward their stated focus-area objectives, bird habitat measures remain coarse, with very general category definitions (upland and wetland) and no rating of habitat quality for landbird focal species. In addition, JV partners have long recognized the need to estimate concurrent bird habitat loss in order to monitor *net change* in habitat area over time. Net-change assessments of key land covers for this Strategy signify substantial progress in measuring landscape change using the frequently (5-year intervals) updated and continually improving NLCD. Local-scale assessment of bird habitats also occur through efforts such as the *Young Forest Initiative*.

Banding and MAPS.—Capture, leg banding, and recovery data are used to help determine migration routes and chronology of migratory birds, basic demographic parameters such age- and sex-specific annual survival, and population abundance trends. The Monitoring Avian Productivity and Survivorship (MAPS) program is a collaborative effort that compares banding data collected across multiple stations to identify proximate factors responsible for abundance trends. For example, the MAPS effort is used to assess differences in species population trends among regions or habitats, and the relationship between population change and weather, climate, and habitat loss. Examining vital rates and associated factors can enhance the effectiveness of conservation by directing resources to the period and places in the annual cycle where they are most needed.

Ecological Goods and Services (EGS).—Regional scale partnerships with an EGS focus are relatively new and have had an intermittent emphasis by conservation agencies (e.g., Landscape Conservation Cooperatives, Midwest Landscape Initiative). Local-scale efforts to assess the EGS provided by natural communities are more common and this information can benefit bird habitat JVs now integrating social considerations into bird conservation planning. Moreover, university researchers and staff at several state and federal agencies monitor how human communities prioritize and assess the relative importance of ecological goods and services provided by grasslands, forests, rivers, and wetlands.

U.S. Census and Stakeholder Surveys.—Monitoring trends in human population growth and distribution along with participation rates in outdoor activities (e.g., birdwatching, hunting, and other recreation) are an increasing focus for bird conservation planning. The U.S. FWS, U.S. Census Bureau, and other partners assess trends in human distribution and outdoor recreation at approximately 5-year intervals (https://www.census.gov/programs-surveys/fhwar). In addition, periodic stakeholder surveys have helped determine desired products, satisfaction, and level of knowledge for current conservation programs and funding support (e.g., America's Wildlife Values Project). Similarly, conservation partners in the U.S. and Canada conducted a comprehensive bi-national opinion survey of hunters, birders, and the public at large to compare attitudes toward wetlands and waterfowl (available at nawmp.org), which informed the 2018 North American Waterfowl Management Plan update. Finally, several state agencies within the JV region conduct regular constituent surveys for hunting, wildlife viewing, and other outdoor recreation (e.g., Illinois Hunter Harvest Survey). Smaller scale human dimensions surveys can provide more targeted information than national efforts, and state agencies often have flexibility to tailor stakeholder surveys, including questions to evaluate local management initiatives.

Monitoring Needs

Joint Venture partners, especially state and federal agencies have led many of the population abundance and habitat survey efforts listed above. We anticipate that partners will continue this work and expand effort in strategic areas, including human dimensions research and integration of social and biological objectives, as resources become available. Continuation of standardized species occurrence and population abundance surveys (e.g., BBS), expanded implementation and uses of community-science (eBird), coupled with updated and refined spatial data (e.g., NLCD), will provide opportunities to improve geo-referenced bird databases for conservation planning through the full annual cycle. Access to population data for multi-scale analysis is essential; the Avian Knowledge Network (AKN), BBS, and increasingly eBird, offer centralized data management and sharing across North America. JV partners will benefit by entering relevant monitoring data and using the resources available through the AKN. Local-scale bird survival and reproduction studies (cause and effect monitoring) also remain essential to assess performance of conservation actions.

The primary source of spatial data measuring extent of cover types potentially providing habitat to various landbird guilds across the JV region is the National Land Cover Database (NLCD). Measuring change in NLCD land-cover classes was a means to assess gains and losses in areas potentially influencing landbirds. However, these data are not useful in detecting subtle changes in bird habitat quantity and quality that are likely to result from local scale management actions. The U.S.D.A. Forest Inventory and Analysis (FIA) provides tree species composition and forest structural data useful at intermediate scales (e.g., township or county) to more thoroughly assess forest bird habitats. The U.S.D.A. National Agricultural Statistics Service (NASS) maintains increasingly accessible data regarding the distribution of grassland / cropland structure and other agricultural land use potentially valuable for local-scale grassland bird habitat assessment. These and other landscape data sources (e.g., plant community elevation and vegetative-structure via LiDAR) promise more sophisticated approaches for landbird habitat evaluation, particularly for grassland cover, which undergoes changes frequently at the site scale.

Science partners must continue to identify and improve regional monitoring strategies and survey efforts that complement and support regional and continental landbird habitat conservation. Joint Venture staff and Science Team participation on technical committees (e.g., Unified Science Team) and related initiatives will help maintain connection between biological and social science monitoring efforts important to future bird conservation planning. Monitoring should continue to be addressed in a collaborative manner by the JV Science Team, state and federal agencies, university researchers, non-government organizations, and associated conservation groups that comprise the landbird conservation community. Monitoring objectives to help measure JV performance, inform future Strategy revisions, and increase conservation effectiveness are provided below. Lists of more specific JV monitoring priorities were developed for landbirds and other bird groups (see https://umgljv.org/science/), and these lists will be periodically updated.

1) By 2025–30, expand monitoring to establish population abundance, distribution, and vital rate estimates for priority landbird species (JV focal species) in the JV region during breeding, migration, and wintering periods, and improve understanding of patch (core habitat area) or subpopulation persistence, extinction, and colonization.

A. *Breeding: Ensure all established BBS routes are completed annually. Support State Breeding Bird Atlas updates and other large-scale point count efforts. Continue developing spatially explicit population estimation models, taking advantage of multiple monitoring datasets (BBS, eBird, other point counts).*
B. *Migration: Establish / refine protocols to measure abundance, distribution, and migration chronology at strategic stopover locations. Encourage all active bird banding stations to adhere to banding protocols developed by the Midwest Migration Network* (https://midwestmigrationnetwork.org/resources/documents/migration-banding-protocol/download) *and support migration monitoring via Motus Wildlife Tracking Network stations and targeted eBird survey efforts. Assess distribution of MAPS banding stations and seek establishment of new sites as needed to fill gaps.*
C. *Wintering: Fill information gaps regarding focal species overwintering in JV region, including seasonal survival rates, abundance, and distribution.*

2) By 2025–30, establish monitoring of landscape change important to bird habitat quantity and quality in the JV region, especially related to targeted conservation areas, and evaluation of bird response to change.

A. *Determine long-term and short-term land cover (and bird habitat) change to inform conservation planning, and identify rapidly developing landscapes to better assess need for conservation action or avoidance.*
B. *Develop robust means to assess land cover changes at fine spatial scales, with the ability to detect rapid temporal changes in easily altered cover types (e.g., grasslands) and spatially explicit information related to habitat quality.*
C. *Improve capacity to track bird habitat accomplishments and inventory (build database) large-scale landbird-habitat restoration projects. Use JV focal species to monitor bird response to these restorations (e.g., >100 ha, pre- and post-conservation action), plus assess effectiveness of current focal species to measure management success.*
D. *Improve understanding of local scale enrollment in government-sponsored conservation programs providing persistent cover for birds (e.g., CRP, CREP, and WRP), including social (landowner) drivers to participate and site-specific influence to focal species abundance.*
E. *Inventory and assess quality of potential bird habitats in urban settings to establish guidelines for maintaining/creating high quality habitat for all portions of the full annual cycle, but with a particular focus on migratory stopover habitat.*

3) By 2025–30, develop and expand taxa-specific monitoring initiatives to meet management needs for species inadequately inventoried by the BBS (e.g., raptors, nightjars / nocturnally active birds, and rare species).

A. *Implement / promote reliable monitoring protocols for nocturnal species and others species difficult to detect suing current methods.*
B. *Expand raptor and rare species monitoring in areas where population estimates are needed.*

Research Needs

Research on species demographics and habitat use during the breeding period has been a long-term priority in bird conservation, whereas detailed knowledge regarding migration, molt, wintering, and the dynamic geographic distributions across the annual cycle has more recently gained attention as knowledge gaps hindering effective conservation for migratory species. Without an understanding of high-quality habitat characteristics of focal species, and links between breeding, stopover, and wintering locations, wildlife managers cannot effectively address challenges birds are exposed to throughout the year. In addition to a lack of knowledge on migratory connectivity, information on basic ecology of many species outside of the breeding period is deficient. Likewise, social science research is an emerging priority as people-related assumptions made in bird-habitat planning are often untested.

Research objectives important to fill knowledge gaps and to test planning assumptions were identified below; more detailed research priorities are available for landbirds and other bird groups in periodically updated lists (see https://umgljv.org/science/). Although research is often conducted at local scales, studies may be replicated across larger geographies (e.g., BCRs) and results used to create robust models that inform conservation decisions in multiple places (Ahlering et al. 2020). Although science that informs management may be in conflict with the reward system for some academics (Merkle et al. 2019), increased synergy between scientists and bird habitat managers can result in robust studies that achieve goals of academics and other key stakeholders.

1) By 2025–30, identify breeding habitat characteristics associated with high population density and productivity for priority landbird species (JV focal species).

A. *Where information gaps still exist for focal-species, identify how landscape and site-scale habitat characteristics (e.g., area, plant composition, structure, and configuration) are associated with reproductive success, and relate breeding population densities to relevant habitat characteristics across the JV geography.*
B. *Identify spatially explicit key threats (e.g., urbanization/land development, energy production, pesticides, invasive species, over-browsing by deer, climate change, fire suppression) and their relative influence on reproductive success and/or breeding period survivorship of adults and fledglings.*
C. *Determine the role of the post-fledging period in reproductive output and limiting factors (e.g., habitat quality, predation) on post-fledging survival.*

2) By 2025–30, identify landscapes and site attributes key to high survival during migration.

A. *Identify important stopover locations; understand how juxtaposition of stopover sites influences occupancy and population density; estimate stopover habitat quantity and distribution needed for sustaining Midwest migrant populations.*
B. *Document landscape, site-level habitat features, and site linkages related to landbird stopover site quality (i.e., weight gain, duration of stay, survival), especially near the Great Lakes and in agricultural and urban settings. Also, determine how these factors vary with guilds/species.*
C. *Examine effects of land-use and environmental change (including climate) on food supply, vegetation phenology, and physiological condition of migrants in different landscapes, with particular attention to potential phonologic mismatches.*
D. *Evaluate altitude and angle of ascent/decent of migration relative to land features (e.g., shoreline) and lake crossing behavior, especially related to towers, wind turbines, and other structures acting as potential sources of mortality during migration.*
E. *Identify explicit connectivity between breeding and wintering areas via migration routes.*

3) By 2025–30, initiate a range-wide assessment of priority species (JV focal species) to understand the importance of nonbreeding locations for species breeding in the JV region, as well as those focal species primarily using the region during nonbreeding periods (i.e. molt, migration, and overwintering).

A. *Evaluate wintering habitats for populations breeding in the JV region to assess nonbreeding-season influence (potential carryover effects) on population growth.*

B. *For species whose wintering population may be dependent on habitats within the JV region (e.g., Short-eared Owl and Rusty Blackbird), identify landscapes key to high survival and determine whether wintering habitat is limiting population growth.*

4) By 2025–30, build and refine models used to develop regional habitat objectives during the full annual cycle for priority bird species (JV focal species).

A. *Generate refined breeding density estimates, identify demographic data to model current and future species distributions, and determine amount and location of habitat needed to meet breeding population objectives.*
B. *Generate bird density estimates during migration stopover, identify demographic data to model current and future species distributions, and determine amount, location, and distribution of habitat needed to meet migration population objectives.*
C. *Generate density estimates during winter, identify demographic data to model current and future species distributions, and determine amount and location of habitat needed to meet population objectives during winter.*
D. *Determine focal species habitat needs during post-nesting period (i.e. post-fledging, prebasic molt) and extent to which they match or deviate from nesting habitat. Determine amount and location of focal species habitat within the JV region.*
E. *Examine carry-over effects of bird habitat quantity/quality between seasons in the full annual cycle.*
F. *Using projected future land use and environmental conditions, predict distribution, productivity, and survivorship.*
G. *Develop tools to refine and validate JV species-habitat models, with emphasis on focal species demonstrating steep long-term population decline.*
H. *Acquire data necessary to produce integrated population models, or other full annual cycle demographic models, of JV focal species in order to identify the portions of the full annual cycle that most limit population growth.*

5) By 2025, build our understanding about people, such as their needs and desires related to birds and bird habitat, and communication methods to help achieve JV objectives.

A. *Support social science research and communications, which is often quite distinct from biological science.*
B. *Improve effectiveness of communication with private landowners by increasing understanding of their values and constraints related to conservation activity on their lands, such as economics, culture, and policy.*
C. *Continue to expand information gathering, and use of data gathered on stakeholders or the public to shape JV conservation planning and delivery.*

COMMUNICATIONS AND OUTREACH

The JV is a diverse partnership serving an even more diverse network of stakeholders interested in bird conservation. Dedicating resources towards internal and external communications is essential to tracking our partnership's progress, keeping JV partners informed, engaged, and coordinated, and cultivating support from key constituents. The process requires identification of target audiences, key messages, communication methods, and evaluating effectiveness of communications. Measuring public (and partner) attitudes, opinions, and behaviors requires social science and human dimensions expertise, and, while they have received increasing attention at broad scales, the JV has just started to address these factors.

Recent surveys of bird watchers, hunters, and the general public regarding bird habitat conservation (see https://nawmp.org/nawmp-udpate/national-survey-birdwatchers) have improved our understanding of preferences in information channels and trust in information sources. For example, survey respondents indicated a preference for receiving nature-related information through personal experience, by reading or accessing online content, and through watching visual media online (Wilkins and Miller 2018). People were least interested in receiving information through listening to recorded audio media, attending educational opportunities, and listening to live audio media. Survey results emphasized the importance of having content available online in an easily accessible and appealing format. People generally preferred visual media. In addition, people had the highest trust in scientific organizations, universities/educational institutions, and friends/family and colleagues (Wilkins and Miller 2018). The least trusted information sources were national media/news, faith-based organizations, and local media/news. Urban respondents had higher trust levels overall, particularly for the government. Hunters and those in rural areas had lower levels of trust in the government but higher trust in family/friends.

A primary goal for JV outreach is to promote human behaviors that benefit bird conservation. We must remain relevant to stakeholders, including local communities and elected officials by understanding their needs and modifying our communication strategies accordingly. Some JVs have employed full-time communication specialists or contracted experts to develop communication plans to help bridge the gap between conservation plans and bird habitat delivery. We currently lack a dedicated communications plan, but JV information exchange occurs through internal and external networks formed by the JV Management Board, JV Staff, JV Science Team, and members of the FWS Region 3 Migratory Bird Program Staff. The aim of internal communication is to share information among existing partners, particularly members of the JV Management Board and Science Team, and to facilitate completion of JV bird habitat conservation, monitoring, and research initiatives. The goals of external communications are to provide recommendations to management bodies, recruit new JV partners, raise awareness and support for bird conservation among stakeholders and policy-makers, and learn about the conservation activities and needs of stakeholders. Coordination of information sharing and product marketing through various communication approaches is critical to reach public and private entities that may have greater resources to affect bird habitats than our existing partnership. To fulfill these goals, the JV has established the following priorities:

Internal communications

1) Provide conservation planning and evaluation information and periodically collect feedback from internal (and external) landbird stakeholders. Information transfer may be in the form of publications and research reports, interviews (e.g., stakeholder surveys), partnership bird habitat-accomplishment reports, and various communications via the Upper Mississippi / Great Lakes Joint Venture webpage (www.umgljv.org).
2) Maintain and share meeting minutes from JV Management Board and Science Team / Technical Committee gatherings in a timely manner.
3) Develop annual JV progress reports with bird habitat accomplishments by cover type and periodic reports describing JV science advances.
4) Develop short summary documents with visual appeal to market key messages related to this Strategy and the JV All-bird Implementation Plan.
5) Maintain and distribute a current list (with contact information) of JV partners, including Management Board, Science Team, and Technical Committee members.
6) Maintain and distribute a current list of bird habitat, monitoring, and research priorities associated with achieving JV conservation goals.
7) Develop and maintain a current list of completed and on-going research projects, including an easily accessible (JV website) library of scientific reports, publications, and “step-down plans” (e.g., documents downscaling regional priorities to smaller conservation/management units).
8) Provide up-to-date accounts for JV focal species or key bird habitats used for planning, including social science and ecological information, species population and habitat objectives, and conservation decision tools.

External communications

1) Engage expertise and planning tools (e.g., conservation social science, Open Standards) to help identify target audiences, key messages, and methods for communication that are expected to increase conservation success for focal species and associated habitats.
2) Exchange coordination (human resources, budget, etc.) information and collaborate on priority bird planning, monitoring, and research with other JVs (especially those with shared focal species).
3) Collaborate with university, non-government organization (NGO) scientists, state wildlife agency scientists (game and nongame), and the continental Unified Science Team (which includes PIF scientists) on priority bird planning, monitoring, and research at the regional and continental scales.
4) Promote JV bird conservation priorities and planning tools to private and public land stakeholders, including information to support the Bird Cities Program promoting community engagement and healthy habitats for birds and people.
5) Collaborate on workshops, symposia, and similar gatherings, providing current scientific information and management tools to wildlife managers (public and private lands), agency species experts, policy-makers, and other stakeholders regarding bird habitat conservation in the JV region.

6) Participate in evolving communication and outreach initiatives related to NABCI and other interests experienced in effectively marketing bird conservation. This effort could lead to developing a strategic JV communications plan to help bridge the gap between conservation planning and delivery.
7) Provide above listed materials and other potentially valuable communications to external groups via use of contemporary social media platforms (e.g. Twitter, Instagram, Facebook, etc.) and the JV webpage (www.umgljv.org).

Target audiences and communication responsibilities

Internal target audiences for communications include:

1) JV Management Board.
2) JV Science Team (Technical Committee and Ad hoc Bird-group Sub-committee members).
3) Migratory Bird Program staff of the U.S. FWS.

External target audiences include:

1) Other bird habitat JVs: Prairie Pothole, Atlantic Coast, Rainwater Basin, Playa Lakes, Central Hardwoods, Lower Mississippi Valley, Gulf Coast, East Gulf Coastal Plain, Appalachian Mountains, and Eastern Habitat and Prairie Habitat (both in Canada).
2) State wildlife agencies, non-government conservation organizations (NGOs), and regional science-application partnerships located in the JV region (key contacts not on Management Board).
3) Unified Science Team (including the North American Waterfowl Management Plan Science Support Team and PIF Science Team).
4) Private landowners and land managers who influence large land holdings potentially important to birds, such as land conservancies, professional forestry groups, state agriculture/forestry extension programs, county/district outreach foresters and other forest management plan writers, and wildlife habitat conservation/restoration contractors.
5) Species management groups including the U.S. FWS Ecological Services Program (e.g., endangered species), the Mississippi Flyway Council Non-game Technical Section and associated committees, and state-agency species biologists.
6) Primary public-land management groups including the U.S. FWS National Wildlife Refuge System, U.S. Forest Service, U.S. National Park Service, U.S. Army Corps of Engineers, and state agency and other conservation land managers.
7) National coordinators and/or human dimensions (HD) specialists with Partners in Flight, American bird Conservancy, Bird City Americas, Waterbirds for the Americas, North American Waterfowl Management Plan, U.S. Shorebird Conservation Plan, and North American Bird Conservation Initiative (NABCI).
8) State and federal conservation policy-makers, particularly those jurisdictions not yet enrolled in the Bird Cities Program to promote bird conservation by urban communities.
9) Bird watchers, hunters, other conservation supporters, and members of the public.
10) University researchers to help ensure investigations by academics meet the applied needs of the JV.

Communications and outreach related to partner coordination, bird habitat delivery, and timely stories (internet blogs) will be maintained through ongoing professional channels. The JV webpage (www.umgljv.org) undergoes regular updates related to meetings, conservation initiatives, plans and strategies, and scientific reports. Facebook and other social media avenues may be used to promote JV work, and the value of bird habitat to birders, hunters, and the public. Management Board members and JV staff also will collaborate in hosting gatherings to share information, particularly related to JV conservation plans and related efforts. Science partners completing evaluation projects financially supported by the JV will be required to provide in-depth completion reports, and they will be encouraged to publish study results in peer-reviewed scientific journals and present information at professional meetings. Science and planning documents will be available on the JV webpage. The JV will also periodically evaluate the need for full-time or part-time assistance from a communications professional and weigh this need against other financial obligations.

TIMETABLE AND COORDINATION

This revised Landbird Habitat Conservation Strategy reflects one part of the Joint Venture conservation effort. Since development of the 2007 Implementation Plan, JV partners have expanded and better integrated conservation priorities across bird groups and with increasing consideration of social science. JV bird-group strategies in the past have had 15-year time horizons for goal achievement, with the expectation that objectives and approaches would be updated as needed. The PIF conservation community recently highlighted the importance of integrating conservation across JV regions as well as integration of objectives for birds and people (Rosenberg et al. 2016).
The revised 2016 PIF Plan, accompanied by new research findings and regional landscape-change assessment, prompted this Strategy revision.

- ***JV is dedicated to All-bird Conservation***
- ***Landbird Strategy linked to continental PIF Plan***
- ***Short-term (10-year) and long-term (30-year) focus***
- ***Science Team – planning and evaluation***
- ***Management Board – habitat delivery and reporting, communications, and prioritization***

Regional population and habitat delivery objectives within the bird habitat sections of this Strategy are linked to the continental PIF Plan. Thus, focal species abundance objectives and habitat initiatives for key grassland, forest, and urban settings include a short-term (10-year) and long-term (30-year) focus. This Strategy, however, will likely be updated periodically (i.e., before 30 years) to reflect incremental progress (positive or negative) by JV partners, and to reflect changing priorities of national conservation efforts and the JV Management Board. Moreover, high priority evaluation objectives identified in the *Monitoring and Research* section of the Strategy have earlier completion targets. Substantial knowledge gained through monitoring and research will help define the next interval for updating this document. Future content also may be influenced by adjustments in overall guidelines followed by JVs: *Desired Characteristics For Habitat Joint Venture Partnerships* (NSST 2009, unpublished document).

Development of JV regional conservation plans and strategies has been the responsibility of the JV Science Team, whereas local-scale bird habitat delivery has been completed by agencies and organizations represented by the JV Management Board and their extended partner networks. The JV Coordination staff will generally lead partner coordination, communication and outreach, and tracking of bird habitat accomplishments. Managing geospatial data, conservation model development, and collaboration with the research community has been the responsibility of the JV Science staff. The Joint Venture has an established record of achievement following the JV Implementation Plan and Bird-group Habitat Conservation Strategies. Using the landbird habitat objectives, decision-support tools, and research and monitoring recommendations provided in this Strategy, partners should continue to increase conservation efficiency and effectiveness for landbirds and the diverse ecological communities they occupy.

LITERATURE CITED

Ahlering, M., D. Carlson, S. Vacek, S. Jacobi, S., V. Hunt, J. C. Stanton, M. G. Knutson, and E. Lonsdorf. 2020. Cooperatively improving tallgrass prairie with adaptive management. Ecosphere 11: E03095.

Albert, D. A. 1995. Regional landscape ecosystems of Michigan, Minnesota, and Wisconsin: a working map and classification. U.S. Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota, USA.

Alberti, M. 2005. The effects of urban patterns on ecosystem function. International Regional Science Review 28(2):168-192. https://doi.org/10.1177/0160017605275160

Alerstam, T., and A. Lindström. 1990. Optimal bird migration: the relative importance of time, energy, and safety. In: Gwinner E, editor. Bird migration. Berlin (Germany): Springer.

Alerstam, T. 1991. Bird flight and optimal migration. Trends in Ecology & Evolution, 6:210–215.

Alverson, W. S., D. M. Waller, and S. L. Solheim. 1988. Forests too deer: edge effects in northern Wisconsin. Conservation Biology 2:348–358.

APLIC [Avian Power Line Interact. Comm.]. 2006. Suggested practices for avian protection on power lines: the state of the art in 2006. Pier Final Proj. Rep. CEC-500-2006-022, APLIC/Calif. Energy Comm., Washington, DC.

APLIC [Avian Power Line Interact. Comm.]. 2012. Reducing avian collisions with power lines: the state of the art in 2012. Edison Electr. Inst./APLIC, Washington, DC.

Barrow, Jr, W. C., C. Chao-Chieh, R. B. Hamilton, K. Ouchley, and T. J. Spengler. 2000. Disruption and restoration of en route habitat, a case study: the Chenier Plain. Studies in Avian Biology 20:71–87.

Bartuszevige, A. M., K. Taylor, A. Daniels, and M. F. Carter. 2016. Landscape design: Integrating ecological, social, and economic considerations into conservation planning. Wildlife Society Bulletin 40:411–422.

Bearhop, S., G. M. Hilton, S. C. Votier, and S. Waldron. 2004. Stable isotope ratios indicate that body condition in migrating passerines is influenced by non-breeding habitat. Proceedings of the Royal Society B: Biological Sciences 271: S215–S218.

Benson, T. J., S. J. Chiavacci, and M. P. Ward. 2013. Patch size and edge proximity are useful predictors of brood parasitism but not nest survival of grassland birds. Ecological Applications 23:879–887.

Best, L. B., H. Campa, III, K. E. Kemp, R. J. Robel, M. R. Ryan, J. A. Savidge, H. P. Weeks, Jr., and S. R. Winterstein. 1997. Bird Abundance and nesting in CRP fields and cropland in the Midwest: A regional approach. Wildlife Society Bulletin 25:864–877.

Bevanger, K. 1995. Estimates and population consequences of tetraonid mortality caused by collisions with high tension power lines in Norway. J. Appl. Ecol. 32:745–53.

Bird Studies Canada and NABCI. 2014. Bird Conservation Regions. Published by Bird Studies Canada on behalf of the North American Bird Conservation Initiative. http://www.birdscanada.org/research/gislab/index.jsp?targetpg=bcr Accessed: June 2015.

Bonter, D. N., S. A. Gauthreaux, Jr, and T. M. Donovan. 2009. Characteristics of important stopover locations for migrating birds: remote sensing with radar in the Great Lakes Basin. Conservation Biology 23:440–448.

Borden, W. C., O. M. Lockhart, A. W. Jones, and M. S. Lyons. 2010. Seasonal, taxonomic, and local habitat components of bird–window collisions on an urban university campus in Cleveland, OH. The Ohio Journal of Science 110:44–52.

Bowers, J. 2020. Sustainability and disruption go hand and hand. *In* Fidelity Monitor & Insight (monthly financial newsletter), Reno, Nevada USA.

Brasher, M. G., J. J. Giocomo, D. A. Azure, A. M. Bartuszevige, M. E. Flaspohler, D. E. Harrigal, B. W. Olson, J. M. Pitre, R. W. Renner, S. E. Stephens, and J. L. Vest. 2019. The history and importance of private lands for North American waterfowl conservation. Wildlife Society Bulletin 43:338–354.

Brittingham, M. C., and S. A. Temple. 1983. Have cowbirds caused forest songbirds to decline? Bioscience 33:31–35.

Byrne, M. A. 2008. Defining conservation issues for bird migration stopover sites in the Chicago Wilderness region. Final report, Chicago Wilderness Trust Grant Agreement TR0606.

Bryan, G., A. Hebb, K. Holmes, and D. Kraus. 2011. Federal priorities for biodiversity conservation in the Hardwood Plains and Boreal Hardwood Transition Zone Ecozones of Ontario. Final draft, October 2011, Canadian Wildlife Service and Nature Conservancy of Canada.

Buler, J. J., F. R. Moore, and S. Woltmann. 2007. A multi-scale examination of stopover habitat use by birds. Ecology 88:1789–1802.

Buler, J. J., and F. R. Moore. 2011. Migrant-habitat relationships during stopover along an ecological barrier: Extrinsic constraints and conservation implications. Journal of Ornithology 152:S101–S112.

Buler, J. J., and D. K. Dawson. 2014. Radar analysis of fall bird migration stopover sites in the northeastern U.S. The Condor: Ornithological Applications 116:357–370.

Bulluck, L., E. Ames, N. Bayly, J. Reese, C. Viverette, J. Wright, A. Caguazango, and C. Tonra. 2019. Habitat-dependent occupancy and movement in a migrant songbird highlights the importance of mangroves and forested lagoons in Panama and Colombia. Ecology and evolution 9:11064–11077.

Burger, J., and M. Gochfeld. 2004. Marine Birds as Sentinels of Environmental Pollution. EcoHealth 1, doi:10.1007/s10393-004-0096-4.

Butchart, S. H. M., A. J. Stattersfield, L. A. Bennun, S. M. Shutes, H. Resit Akçakaya, J. E. M. Baillie, S. N. Stuart, C. Hilton-Taylor, and G. M. Mace. 2004. Measuring global trends in the status of biodiversity: Red List indices for birds. PLoS Biology 2:e383. https://doi.org/10.1371/journal.pbio.0020383

Butcher, G. S., D. K. Niven, A. O. Panjabi, D. N. Pashley, and K. V. Rosenberg. 2007. WatchList: the 2007 WatchList for United States birds. American Birds 61:18–25.

Cabrera-Cruz, S. A., J. A. Smolinsky, K. P. McCarthy, and J. J. Buler. 2019. Urban areas affect flight altitudes of nocturnally migrating birds. Journal of Animal Ecology 88(12):1873-1887.

Calvert, A., C. Bishop, R. Elliot, E. Krebs, T. Kydd, C. Machtans, and G. Robertson. 2013. A synthesis of human-related avian mortality in Canada. Avian Conservation and Ecology 8(2):11. http://dx.doi.org/10.5751/ACE-00581-080211

Cardno Inc. 2020. (prepared for the Monarch CCAA/CCA Development Advisory Team) Nationwide CCAA/CCA for Monarch Butterfly on Energy and Transportation Lands. Cardno Inc. Fitchburg, Wisconsin USA.
Campellone, R., A. Bartuszevige, T. Chouinard, J. Lujan, T. Miewald, B. Murry, R. Nelson, K. O'Hara, A. Poe, and A. Robertson. 2014. Minimum Standards for Conservation Design at Landscape-Scales (Landscape Conservation Design): Recommendations from the Landscape Conservation Design Minimum Standards Working Group to the U.S. Fish and Wildlife Service – Office of Science Applications.
Caro, T. 2010. Conservation by Proxy: Indicator, Umbrella, Keystone, Flagship and Other Surrogate Species. Island Press, Washington, D.C., USA.
Ciuzio, E., W. L. Hohman, B. Martin, M. D. Smith, S. Stephens, A. M. Strong, and T. Vercauteren. 2013. Opportunities and challenges to implementing bird conservation on private lands. Wildlife Society Bulletin, 37(2): 267-277.
Comer, P. J., J. C. Hak, K. Kindscher, E. Muldavin, and J. Singhurst. 2018. Continent-Scale Landscape Conservation Design for Temperate Grasslands of the Great Plains and Chihuahuan Desert. Natural Areas Journal Vol. 38(2):196-211.
Conservation Fund. 2016. Mississippi River Basin/Gulf Hypoxia Initiative Conservation Blueprint v 1.02. Report to U.S. Fish and Wildlife Service.
Conservation Measures Partnership. 2013. Open Standards for the Practice of Conservation Version 3. Creative Commons. https://cmp-openstandards.org/wp-content/uploads/2017/06/CMP-OS-V3.0-Final-minor-update-May-2107.pdf. Accessed November 15 2019.
Conway, C. J., G. V. Powell, and J. D. Nichols 1995. Overwinter survival of Neotropical migratory birds in early-successional and mature tropical forests. Conservation Biology 9(4).855–864.
Cooper, N. W., M. T. Hallworth, and P. P. Marra. 2017. Light-level geolocation reveals wintering distribution, migration routes, and primary stopover locations of an endangered long-distance migratory songbird. Journal of Avian Biology 48:209–219.
Crick, H. Q. P. 2004. The impact of climate change on birds. Ibis 146:48–56.
Cunningham, M. A. 2005. A comparison of public lands and farmlands for grassland bird conservation. The Professional Geographer 57:51–65.
Davis, C. A., R. T. Churchwell, S. D. Fuhlendorf, D. M. Engle, and T. J. Hovick. 2016. Effect of pyric herbivory on source-sink dynamics in grassland birds. Journal of Applied Ecology 53: 1004–1112.
Devers, P. K., A. J. Roberts, S. Knoche, P. I. Padding, and R. Raftovich. 2017. Incorporating human dimension objectives into waterfowl habitat planning and delivery. Wildlife Society Bulletin 41:405–415.
Diehl, R. H. 2013. The airspace as habitat. Trends in Ecology & Evolution 28(7):377–379.
Diehl, R. H., A. C. Peterson, R. T. Bolus, and D. H. Johnson. 2018. Extending the habitat concept to the airspace. Chapter 3, pp. 47–69 *in* Chilson, P. B., W. F. Frick, J. F. Kelly, and F. Liechti (Eds.). 2017. Aeroecology. Springer Nature, Switzerland.
Dominoni, D. M. 2015. The effects of light pollution on biological rhythms of birds: an integrated, mechanistic perspective. Journal of Ornithology 156:409–418.
Donovan, T. M., F. R. Thompson III, J. Faaborg, and J. R. Probst. 1995. Reproductive success of migratory birds in habitat sources and sinks. Conservation Biology 9:1380–1395.
Dossman, B. C., G. W. Mitchell, D. R. Norris, P. D. Taylor, C. G. Guglielmo, S. N. Matthews, and P. G. Rodewald. 2016. The effects of wind and fuel stores on stopover departure behavior across a migratory barrier. Behavioral Ecology 27:567–574.
Douglas, M. R., D. B. Sponsler, E. V. Lonsdorf, and C. M. Grozinger. 2020. County-level analysis reveals a rapidly shifting landscape of insecticide hazard to honey bees (*Apis mellifera*) on US farmland. Scientific Reports 10:797. https://doi.org/10.1038/s41598-019-57225-w

Drever, M. C., A. C. Smith, L. A. Venier, D. J. H. Sleep, and D. A. MacLean. 2018. Cross-scale effects of spruce budworm outbreaks on boreal warblers in eastern Canada. Ecology and Evolution 8:7334–7345.
Dwyer, J. F., R. E. Harness, and K. Donohue. 2014. Predictive model of avian electrocution risk on overhead power lines. Conservation Biology 28:159–68.
Eng, M. L., B. J. Stutchbury, and C. A. Morrissey. 2019. A neonicotinoid insecticide reduces fueling and delays migration in songbirds. Science 365(6458):1177–1180.
Evans Ogden, L. J. 2002. Summary Report on the Bird Friendly Building Program: Effect of Light Reduction on Collision of Migratory Birds. Fatal Light Awareness Program (FLAP). 5. https://digitalcommons.unl.edu/flap/5
Ewald, J. A., C. J. Wheatley, N. J. Aebischer, S. J. Moreby, S. J. Duffield, H. Q. Crick, and M. B. Morecroft. 2015. Influences of extreme weather, climate and pesticide use on invertebrates in cereal fields over 42 years. Global Change Biology 21:3931–3950.
Ewert, D. N., G. J. Soulliere, R. D. Macleod, M. C. Shieldcastle, P. G. Rodewald, E. Fujimura, J. Shieldcastle, and R. J. Gates. 2006. Migratory bird stopover site attributes in the western Lake Erie basin. Final report to the George Gund Foundation.
Ewert, D. N., M. J. Hamas, R. J. Smith, M. E. Dallman, and S. W. Jorgensen, 2011. Distribution of migratory landbirds along the northern Lake Huron shoreline. Wilson Journal of Ornithology 123:536–547.
Ewert, D. N., P. J. Doran, K. R. Hall, A. Froehlich, J. Cannon, J. B. Cole, and K. E. France. 2012. On a wing and a (GIS) layer: prioritizing migratory bird stopover habitat along Great Lakes shorelines. Final report to the Upper Midwest/Great Lakes Landscape Conservation Cooperative.
Ewert, D. N., C. L. Roy, G. J. Soulliere, and R. L. Pierce. 2014. Stakeholder input for revision of the Upper Mississippi River and Great Lakes Region Joint Venture Landbird Habitat Conservation Strategy. Upper Mississippi River and Great Lakes Region Joint Venture Technical Report No. 2014-2, Bloomington, MN, USA.
Fan, Z., W. K. Moser, M. H. Hansen, and M. D. Nelson. 2013. Regional patterns of major nonnative invasive plants and associated factors in upper Midwest forests. Forest Science 59(1):38-49.
Fickenscher, J. L., J. A. Litvaitis, T. D. Lee, and P. C. Johnson. 2014. Insect responses to invasive shrubs: Implications to managing thicket habitats in the northeastern United States. Forest Ecology and Management 322:127-135. doi:https://doi.org/10.1016/j.foreco.2014.03.003.
Fitzgerald, J. A., J. R. Herkert, and J. D. Brawn. 2000. Partners in Flight Bird Conservation Plan for The Prairie Peninsula (Physiographic Area 31). Version 1.0.
Frelich, L. E. 1995. Old forest in the Lake States today and before European settlement. Natural Areas Journal 15:157–167.
Fuhlendorf, S. D., and D. M. Engle. 2001. Restoring heterogeneity on rangelands: ecosystem management based on evolutionary grazing patterns: we propose a paradigm that enhances heterogeneity instead of homogeneity to promote biological diversity and wildlife habitat on rangelands grazed by livestock. BioScience 51(8):625–632.
Fuhlendorf, S. D., and D. M. Engle. 2004. Application of the fire-grazing interaction to restore a shifting mosaic on tallgrass prairie. Journal of Applied Ecology 41:604–614.
Gehring, J., P. Kerlinger, and A. M. Manville. 2009. Communication towers, lights, and birds: successful methods of reducing the frequency of avian collisions. Ecological Applications 19:505–514.
Gehring, J., P. Kerlinger, and A. M. Manville. 2011. The role of tower height and guy wires on avian collisions with communication towers. The Journal of Wildlife Management 75(4):848–855.
George, A. D., T. J. O'Connell, K. R. Hickman, and D. M. Leslie, Jr. 2009. Influence of Old World bluestem (*Bothriochloa ischaemum*) monocultures on breeding density of three grassland songbirds in Oklahoma. In Tundra to tropics: connecting birds, habitats and people.

Proceedings of the Fourth International Partners in Flight Conference. (T. D. Rich, C. Arizmendi, D. Demarest, and C. Thompson, Editors). McAllen, Texas, USA, pp. 291–297.

George, A. D., T. J. O'Connell, K. R. Hickman, and D. M. Leslie, Jr. 2013. Use of Seeded Exotic Grasslands by Wintering Birds. Prairie Naturalist 45:77-83.

Gnass Giese, E. E., R. W. Howe, A. T. Wolf, N. A. Miller, and N. G. Walton. 2015. Sensitivity of breeding birds to the "human footprint" in western Great Lakes forest landscapes. Ecosphere 6(6):90. http://dx.doi.org/10.1890/ ES14-00414.1

Graber, J. W., and R. R. Graber. 1983. Feeding rates of warblers in spring. Condor 85:139–150.

Graves, B. M., A. D. Rodewald, and S. D. Hull. 2010. Influence of Woody Vegetation on Grassland Birds Within Reclaimed Surface Mines. The Wilson Journal of Ornithology 122(4):646–654.

Grveles, K. M., S. W. Matteson, S. Eichhorst, and K. Kreitinger. 2011. Protecting bird migration stopover habitat in the western Great Lakes: Final report. Wisconsin Department of Natural Resources, Endangered Resources Program.

Gurdak, J. J., and C. D. Roe. 2010. Review: Recharge rates and chemistry beneath playas of the High Plains aquifer, USA. Hydrogeology Journal 18(8):1747–1772.

Guttery, M. R., C. A. Ribic, D. W. Sample, A. Paulios, C. Trosen, J. Dadisman, and J. A. Horton. 2017. Scale-specific habitat relationships influence patch occupancy: Defining neighborhoods to optimize the effectiveness of landscape-scale grassland bird conservation. Landscape Ecology 32:515–529.

Hager, S. B., and M. E. Craig. 2014. Bird-window collisions in the summer breeding season. PeerJ 2:e460 https://doi.org/10.7717/peerj.460

Hallmann, C., R. Foppen, C. van Turnhout, H. de Kroon, and E. Jongejans. 2014. Declines in insectivorous birds are associated with high neonicotinoid concentrations. Nature 511:341–343.

Hansen, A., R. Knight, J. Marzluff, S. Powell, K. Ireland, P. Gude, and A. Jones. 2006. Effects of Exurban Development on Biodiversity: Patterns, Mechanisms, and Research Needs. Ecological Applications 15:1893–1905.

Harness, R. E., and K. R. Wilson. 2001. Electric-utility structures associated with raptor electrocutions in rural areas. Wildlife Society Bulletin 29:612–23.

Harrison, X. A., J. D. Blount, R. Inger, D. R. Norris, and S. Bearhop. 2011. Carry-over effects as drivers of fitness differences in animals. Journal of Animal Ecology 80:4–18.

Hawbaker, T. J., and V. C. Radeloff. 2004. Roads and landscape pattern in northern Wisconsin based on a comparison of four road data sources. Conservation Biology 18:1233–1244.

Herkert, J. R. 1994. The effects of habitat fragmentation on Midwestern grassland bird communities. Ecological Applications 4:461–471.

Herkert, J. R. 2007. Conservation Reserve Program benefits on Henslow's sparrows within the United States. Journal of Wildlife Management 71:2749–2751.

Herkert, J. R., D. W. Sample, and R. E. Warner. 1996. Management of Midwestern grassland landscapes for the conservation of migratory birds. USDA Forest Service General Technical Report PNW NC-187:89–116.

Hitch, A. T., and P. L. Leberg. 2007. Breeding distributions of North American bird species moving north as a result of climate change. Conservation Biology 21(2):534–539.

Horton, K. G., C. Nilsson, B. M. Van Doren, F. A. LaSorte, A. M. Dokter, and A. Farnsworth. 2019. Bright lights in the big cities: migratory birds' exposure to artificial light. Frontiers in Ecology and the Environment 17:209–214.

Hupperts, S. G., Y. L. Dickinson, C. R. Webster, and C. C. Kern. 2019. Promoting structural and species diversity in Great Lakes northern hardwoods: a conceptual model and its application. Forestry: An International Journal of Forest Research 92:16–25.

IUCN [International Union for the Conservation of Nature]. 2019. The IUCN red list of threatened species. http://www.iucnredlist.org/

Jarzyna, M. A., B. Zuckerberg, A. O. B. Finley, and W. F. Porter. 2016. Synergistic effects of climate and land cover: grassland birds are more vulnerable to climate change. Landscape Ecology 31:2275–2290.

Jaster, L., W. E. Jensen, and A. R. Forbes. 2013. Abundance, territory sizes, and pairing success of male Henslow's Sparrows in restored warm- and cool-season grasslands. Journal of Field Ornithology 84:234–241.

Johnson, M. D., T. W. Sherry, A. M. Strong, and A. Medori. 2004. Migrants in Neotropical bird communities: an assessment of the breeding currency hypothesis. Journal of Animal Ecology 74(2):333–341.

Johnson, M. D., T. W. Sherry, R. T. Holmes, and P. P Marra. 2006. Assessing habitat quality for a migratory songbird wintering in natural and agricultural habitats. Conservation Biology 20:1433–1444.

Jones, G. M., B. Zuckerberg, and A. T. Paulios. 2012. The early bird gets earlier: a phenological shift in migration timing of the American Robin (*Turdus migratorius*) in the state of Wisconsin. Passenger Pigeon 74:131–142.

Kellogg, R. S. 1909. The timber supply of the United States. U.S. Department of Agriculture Forest Service. Government Printing Office, Washington, D.C. p. 24.

KWCT [Kirtland's Warbler Conservation Team]. 2015. Michigan Dept. of Natural Resources, U.S. Fish and Wildlife Service, and U.S.D.A. Forest Service. 2015 Kirtland's Warbler Breeding Range Conservation Plan. *https://www.michigan.gov/documents/dnr/Kirtlands_Warbler_CP_457727_7.pdf*.

Klaassen, R. H., M. Hake, R. Strandberg, B. J. Koks, C. Trierweiler, K. M. Exo, F. Bairlein, and T. Alerstam. 2014. When and where does mortality occur in migratory birds? Direct evidence from long-term satellite tracking of raptors. Journal of Animal Ecology 83:176–184.

Klem, D., Jr. 2009. Avian mortality at windows: The second largest human source of bird mortality on earth. In Tundra to Tropics: Proceedings of the Fourth International Partners in Flight Conference (T. D. Rich, C. Arizmendi, D. Demarest, and C. Thompson, Editors). Partners in Flight, pp. 244–251.

Klem, D. Jr, C. J. Farmer, N. Delacretaz, Y. Gelb, and P.G. Saenger. 2009. Architectural and landscape risk factors associated with bird-glass collisions in an urban environment. Wilson Journal of Ornithology 121:126–34.

Knutson, M. G., G. J. Niemi, W. E. Newton, and M. A. Friberg. 2004. Avian nest success in Midwestern forests fragmented by agriculture. The Condor 106:116–130.

Koenig, W. D., and A. M. Liebhold. 2017. A decade of emerald ash borer effects on regional woodpecker and nuthatch populations. Biological Invasions 19(7):2029–2037.

Kuvlesky, W. P., Jr., L. A. Brennan, M. L. Morrison, K. K. Boydston, B. M. Ballard, and F. C. Bryant. 2007. Wind Energy Development and Wildlife Conservation: Challenges and Opportunities. The Journal of Wildlife Management 71:2487–2498.

LANDFIRE 2018. Biophysical Settings for Conterminous United States. LANDFIRE 1.4.0, U.S. Department of the Interior, Geological Survey. https://www.landfire.gov/version_comparison.php. Accessed 8 July 2019

Lark, T., J. Salmon, and H. Gibbs. 2015. Cropland expansion outpaces agricultural and biofuel policies in the United States. Environmental Research Letters. 10. 10.1088/1748-9326/10/4/044003.

Leu, M., and C. W. Thompson. 2002. The potential importance of migratory stopover sites as flight-feather molt staging areas: a review for Neotropical migrants. Biological Conservation 106:45–56.

Li, Y., R. Miao, and M. Khanna. 2020. Neonicotinoids and decline in bird biodiversity in the United States. Nature Sustainability. https://doi.org/10.1038/s41893-020-0582-x

Longcore, T., C. Rich , P. Mineau, B. MacDonald, D. G. Bert, L. M. Sullivan, E. Mutrie, S. A. Gauthreaux, Jr., M. L. Avery, R. L. Crawford, A. M. Manville II, E. R. Travis, and D. Drake..

2012. An estimate of mortality at communication towers in the United States and Canada. PLOS ONE 7:e34025.
Longcore, T., C. Rich, P. Mineau, B. MacDonald, D. G. Bert, L. M. Sullivan, E. Mutrie, S. A. Gauthreaux, Jr., M. L. Avery, R. L. Crawford, A. M. Manville II, E. R. Travis, and D. Drake. 2013. Avian mortality at communication towers in North America: which species, how many, and where? Biological Conservation 158:410–19.
Loss, S. R., G. J. Niemi, and R. B. Blair. 2012. Invasions of non-native earthworms related to population declines of ground-nesting songbirds across a regional extent in northern hardwood forests of North America. Landscape Ecology 27:683–696. https://doi.org/10.1007/s10980-012-9717-4
Loss, S. R., T. Will, and P. P. Marra. 2013a. Estimates of bird collision mortality at wind facilities in the contiguous United States. Biological Conservation 168:201–209.
Loss S. R., T. Will, and P. P. Marra. 2013b. The impact of free-ranging domestic cats on wildlife of the United States. Nature Communications 4:1396. https://doi.org/10.1038/ncomms2380
Loss, S. R., T. Will, S. S. Loss, and P. P. Marra. 2014a. Bird–building collisions in the United States: Estimates of annual mortality and species vulnerability. Condor, 116(1):8–23.
Loss, S. R., T. Will, and P. P. Marra. 2014b. Refining estimates of bird collision and electrocution mortality at power lines in the United States. PLoS One 9(7).
Loss, S. R., T. Will, and P. P. Marra. 2015. Direct mortality of birds from anthropogenic causes. Annual Review of Ecology, Evolution, and Systematics 46:99–120.
Lovich, J. E., and J.R. Ennen. 2011. Wildlife Conservation and Solar Energy Development in the Desert Southwest, United States. BioScience 61 (12):982–992.
MacDade, L. S., P. G. Rodewald, and K. A. Hatch. 2011. Contribution of emergent aquatic insects to refueling in spring migrant landbirds. Auk 128:127–137.
Maresh-Nelson, S. B., J. J. Coon, C. J. Duchardt, J. R. Miller, D. M. Debinski, and W. H. Schacht. 2018. Contrasting impacts of invasive plants and human-altered landscape context on nest survival and brood parasitism of a grassland bird. Landscape Ecology 33:1799–1813.
Marra, P. P., and R. T. Holmes. 2001. Consequences of dominance-mediated habitat segregation in a migrant passerine bird during the non-breeding period. Auk 118:92–104.
Marra, P. P., E. B. Cohen, S. R. Loss, J. E. Rutter, and C. M. Tonra. 2015. A call for full annual cycle research in animal ecology. Biology Letters 11:20150552.
Martin, P. A., D. L. Johnson, D. J. Forsyth, and B. D. Hill. 2000. Effects of two grasshopper control insecticides on food resources and reproductive success of two species of grassland songbirds. Environmental Toxicology and Chemistry 19:2987–2996.
Matteson, S., K. Kreitinger, G. Bartelt, G. Butcher, D. Sample, and T. Will. 2009. Partners in Flight Bird Conservation Plan for The Boreal Hardwood Transition (Bird Conservation Region 12 — U.S. Portion). Version 1.0. Partners in Flight Science Committee, Falls Church, Virginia, USA.
Matthews, S. N., and P. G. Rodewald. 2010. Urban forest patches and stopover duration of migratory Swainson's Thrushes. Condor 112:96–104.
McLaughlin, A., and P. Mineau. 1995. The impact of agricultural practices on biodiversity. Agric Ecosyst Environ 55:201–212.
Mclaughlin, M. E., W. M. Janousek, J. P. Mccarty, and L. L. Wolfenbarger. 2014. Effects of urbanization on site occupancy and density of grassland birds in tallgrass prairie fragments. Journal of Field Ornithology 85(3):258–273.
Meehan, T. D., A. H. Hurlbert, and C. Gratton. 2010. Bird communities in future bioenergy landscapes of the Upper Midwest. Proceedings of the National Academy of Sciences, 107(43):18533-18538.
Meehan, T. D., G. S. LeBaron, K. Dale, N. L. Michel, G. M Verutes, and G.M. Langham. 2018. Abundance trends of birds wintering in the USA and Canada, from Audubon Christmas Bird Counts, 1966-2017, version 2.1. National Audubon Society, New York, New York, USA.

Mehlman, D. W., S. E. Mabey, D. N. Ewert, C. Duncan, B. Abel, D. Cimprich, R. Sutter, and M. Woodrey. 2005. Conserving stopover sites for forest-dwelling migratory landbirds. Auk 122:1281–1290.

Merkle, J. A., N. J. Anderson, D. L. Baxley, M. Chopp, L. C. Gigliotti, J. A. Gude, T. M. Harms, H. E. Johnson, E. H. Merrill, M. S. Mitchell, T. W. Mong, J. Nelson, A. S. Norton, M. J. Sheriff, E. Tomasik, and K. R. VanBeek. 2019, A collaborative approach to bridging the gap between wildlife managers and researchers. Journal of Wildlife Management 83:1644–1651.

Mills, A. M., B. G. Thurber, S. A. Mackenzie, and P. D. Taylor. 2011. Passerines use nocturnal flights for landscape-scale movements during migration stopover. Condor 113:597–607.

Mineau P. 2004. Birds and pesticides: Are pesticide regulatory decisions consistent with the protection afforded migratory bird species under the Migratory Bird Treaty Act? The William and Mary Environ Law Policy Review 28(2):313–338.

Mineau, P., and M. Whiteside. 2006. The lethal risk to birds from insecticide use in the U.S. – A spatial and temporal analysis. Environmental Toxicology and Chemistry 25(5):1214–1222.

Mineau, P., and M. Whiteside. 2013. Pesticide acute toxicity is a better correlate of U.S. grassland bird declines than agricultural intensification. PLoS ONE 8(2): e57457. https://doi.org/10.1371/journal.pone.0057457

Moore, F. R., P. Kerlinger, and T. R. Simons. 1990. Stopover on a Gulf Coast barrier island by spring trans-gulf migrants. Wilson Bulletin 102:487–500.

Moore, F. R., and T. R. Simons. 1992. Habitat suitability and stopover ecology of Neotropical landbird migrants. *in* Ecology and Conservation of Neotropical Migrant Landbirds (eds. J. M. Hagan III and D. W. Johnston), Smithsonian Institution Press, Washington, D.C., pp. 345-355.

Morefield, P. E., S. D. LeDuc, C. M. Clark, and R. Iovanna. 2016. Grasslands, wetlands, and agriculture: the fate of land expiring from the Conservation Reserve Program in the Midwestern United States. Environmental Research Letters 11 (2016) 094005.

Morrison, M. L. 1986. Bird Populations as Indicators of Environmental Change *in* Current Ornithology, R. F. Johnston, Ed. (Springer US, Boston, MA, 1986; http://link.springer.com/10.1007/978-1-4615-6784-4_10), pp. 429–451.

Murphy, M. T. 2003. Avian population trends within the evolving agricultural landscape of eastern and central United States. Auk 120:20–34.

NRCS and WHMI [Natural Resources Conservation Service and Wildlife Habitat Management Institute]. 2005. Greater prairie-chicken (*Tympanuchus cupido*), Fish and Wildlife Habitat Management Leaflet Number 27.

NABCI [North American Bird Conservation Initiative]. 2000. The North American Bird Conservation Initiative in the United States: A vision of American bird conservation. North American Bird Conservation Initiative Website. http://www.nabci-us.org/aboutnabci/NABCIfndtn.pdf.

Nagy, L. R., and R. T. Holmes. 2005. Food limits annual fecundity of a migratory songbird: An experimental study. Ecology 86(3):675–681.

NCED [National Conservation Easement Database]. 2020. Conservation easements. https://www.conservationeasement.us/

Nations, C., and C. Gordon. 2017. Assessment of Nocturnal Bird Migration Activity from Weather Radar Data for the Proposed Icebreaker Wind Energy Facility, Lake Erie, Ohio. Lake Erie Energy Development Corporation, Cleveland, OH, USA.

NAWMP [North American Waterfowl Management Plan]. 2012. People conserving waterfowl and wetlands. Canadian Wildlife Service, U.S. Fish and Wildlife Service, Secretaria de Medio Amiente y Recursos Naturales.

NAWMP [North American Waterfowl Management Plan]. 2018. Connecting people, waterfowl, and wetlands. Canadian Wildlife Service, U.S. Fish and Wildlife Service, Secretaria de Medio Amiente y Recursos Naturales.

NEAT [National Ecological Assessment Team]. 2006. Strategic habitat conservation. Final report of the NEAT. U.S. Geological Survey and U.S. Department of Interior, Fish and Wildlife Service.
Newton, I. 2004. Population limitation in migrants. Ibis 146:197-226.
Nelson, M. D., and G. A. Reams. 2017. Is the Area of US Forests Increasing or Decreasing? Forestry Source 22(5):16–17, 21.
Nelson, M. D., K. H. Riitters, J. W. Coulston, G. M. Domke, E. J. Greenfield, L. L. Langner, D. J. Nowak, C. B. O'Dea, S. N. Oswalt, M. C. Reeves, and D. N. Wear. 2020. Defining the United States land base: a technical document supporting the USDA Forest Service 2020 RPA assessment. Gen. Tech. Rep. NRS-191. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 70 p. https://doi.org/10.2737/NRS-GTR-191.
Niemi, G. J., R. W. Howe, B. R. Sturtevant, L. R. Parker, A. R. Grinde, N. P. Danz, M. D. Nelson, E. J. Zlonis, N. G. Walton, E. E. Gnass Geise, and S. M. Lietz. 2016. Analysis of long-term forest bird monitoring data from national forests of the western Great Lakes Region. U.S. Department of Agriculture, Forest Service, Northern Research Station NRS-159, Newtown Square, PA. 322pp.
Oswalt, S. N., B. W. Smith, P. D. Miles, and S. A. Pugh. 2019. Forest Resources of the United States, 2017: a technical document supporting the Forest Service 2020 RPA Assessment. Gen. Tech. Rep. WO-97. Washington, DC: U.S. Department of Agriculture, Forest Service, Washington Office. 223pp. https://doi.org/10.2737/WO-GTR-97.
Panjabi, A. O., W. E. Easton, P. J. Blancher, A. E. Shaw, B. A. Andres, C. J. Beardmore, A. F. Camfield, D. W. Demarest, R. Dettmers, R. H. Keller, K. V. Rosenberg, T. Will, and M. A. Gahbauer. 2020. Avian Conservation Assessment Database Handbook, Version 2020. Partners in Flight Technical Series No. 8.1. pif.birdconservancy.org/acad.handbook.pdf.
Partners in Flight. 2020a. Avian Conservation Assessment Database, version 2020. http://pif.birdconservancy.org/ACAD.
Partners in Flight. 2020b. Population Estimates Database, version 3.1. http://pif.birdconservancy.org/PopEstimates.
Petit, D. R. 2000. Habitat use by landbirds along Nearctic-Neotropical migration routes: implications for conservation of stopover habitats. Studies in Avian Biology 20:15-33.
Piaskowski, V., and G. Albanese. 2001. Resource sampling of arthropods in all vegetation strata and correlation with arthropods identified in fecal samples of insectivorous warblers at a spring migration stopover site. Abstract. American Ornithologists' Union meeting, Seattle, WA.
Pidgeon, A. M., V. C. Radeloff, C. H. Flather, C. A. Lepczyk, M. K. Clayton, T. J. Hawbaker, and R. B. Hammer. 2007. Associations of forest bird species richness with housing and landscape patterns across the USA. Ecological Applications 17:1989–2010.
Pollock, J., K. Glennemeir, and D. Stotz. 2004. Migrant bird habitat study. Final report. Urban Conservation Treaty for Migratory Birds partnership. www.bcnbirds.org/greenpapers_files/migranthabitatstudy.pdf
Potter, B. A., G. J. Soulliere, D. N. Ewert, M. G. Knutson, W. E. Thogmartin, J. S. Castrale, and M. J. Roell. 2007. Upper Mississippi River and Great Lakes Region Joint Venture Landbird Habitat Conservation Strategy. U.S. Fish and Wildlife Service, Fort Snelling, MN. 124pp.
Pyle, P., J. F. Saracco, and D. F. DeSante. 2018. Evidence of widespread movements from breeding to molting grounds by North American landbirds. The Auk: Ornithological Advances 135:506–520.
Radeloff, V. C., R. B. Hammer, and S. I. Stewart. 2005. Rural and suburban sprawl in the U.S. Midwest from 1940 to 2000 and its relation to forest fragmentation. Conservation Biology 19:793–805.
Ranjan, P., S. P. Church, K. Floress and L. S. Prokopy. 2019. Synthesizing conservation motivations and barriers: What have we learned from qualitative studies of farmers' behaviors in the

United States? Society & Natural Resources 32(11):1171-1199, DOI: 10.1080/08941920.2019.1648710
Reimer, A. P., and L. S. Prokopy. 2013. Farmer participation in U.S. Farm Bill conservation programs. Environmental Management 53:318–332.
Renfrew, R. B., D. Kim, N. Perlut, J. Smith, J. W. Fox, and P. P. Marra. 2013. Phenological matching across hemispheres in a long-distance migratory bird. Diversity and Distributions 19:1008–1019.
Renfrew, R. B., K. A. Peters, J. R. Herkert, K. R. VanBeek, and T. Will. 2019. A full life cycle conservation plan for Bobolink (*Dolichonyx oryzivorus*). U.S. Fish & Wildlife Service.
Reudink, M. W., P. P. Marra, T. K. Kyser, P. T. Boag, K. M. Langin, and L. Ratcliffe. 2009. Non-breeding season events influence sexual selection in a long-distance migratory bird. Proceedings of the Royal Society B: Biological Sciences 276:1619–1626.
Ribic, C. A., R. R. Koford, J. R. Herkert, D. H. Johnson, J. D. Niemuth, D. E. Naugle, K. K. Bakker, D. W. Sample, and R. B. Renfrew. 2009. Area sensitivity in North American grassland birds: patterns and processes. Auk 126:233–244.
Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. Bradstreet, G. S. Butcher, D. Demarest, E. H. Dunn, W. C. Hunter, D. Inigo-Elias, J. A. Kennedy, A. Martell, A. Panjabi, D. N. Pashley, K. V. Rosenberg, C. Rustay, S. Wendt, and T. Will. 2004. Partners in Flight North American landbird conservation plan. Cornell Lab of Ornithology. Ithaca, NY. 84pp.
Robinson, S. K., and D. S. Wilcove. 1994. Forest fragmentation in the temperate zone and its effects on migratory songbirds. Bird Conservation International 4:233–249.
Robinson, S. K. 1996. Threats to breeding neotropical migratory birds in the Midwest. Pages 1-21 in F. R. Thompson, III, *editor*. Management of Midwestern landscapes for the conservation of neotropical migratory birds. U.S. Forest Service General Technical Report NC-187. North Central Forest Experimental Station, St. Paul, Minnesota, USA.
Rockwell, S. M., J. M. Wunderle, T. S. Sillett, C. I. Bocetti, D. N. Ewert, D. Currie, J. D. White, and P. P. Marra. 2017. Seasonal survival estimation for a long-distance migratory bird and the influence of winter precipitation. Oecologia 183:715–726.
Rosenberg, K. V., and P. J. Blancher. 2005. Setting numerical population objectives for priority landbird species. Pages 57-67 in Bird Conservation Implementation and Integration in the Americas: proceedings of the Third International Partners in Flight Conference (C. J. Ralph and T. D. Rich, Eds.). U.S. Department of Agriculture Forest Service, General Technical Report PSW-GTR-191.
Rosenberg, K. V., J. A. Kennedy, R. Dettmers, R. P. Ford, D. Reynolds, J. D. Alexander, C. J. Beardmore, P. J. Blancher, R. E. Bogart, G. S. Butcher, A. F. Camfield, A. Couturier, D. W. Demarest, W. E. Easton, J. J. Giocomo, R. H. Keller, A. E. Mini, A. O. Panjabi, D. N. Pashley, T. D. Rich, J. M. Ruth, H. Stabins, J. Stanton, and T. Will. 2016. Partners in Flight Landbird Conservation Plan: 2016 Revision for Canada and Continental United States. Partners in Flight Science Committee. https://www.partnersinflight.org/resources/the-plan/
Rosenberg, K. V., A. M. Dokter, P. J. Blancher, J. R. Sauer, A. C. Smith, P. A. Smith, J. C. Stanton, A. Panjabi, L. Helft, M. Parr, and P. P. Marra. 2019. Decline of the North American avifauna. Science 366(6461):120–124.
Roth, A. M., R. W. Rohrbaugh, T. Will, S. Barker Swarthout, and D. A. Buehler, *editors*. 2019. Golden-winged Warbler Status Review and Conservation Plan. 2nd Edition. www.gwwa.org.
Ruiz-Gutierrez, V., W. L. Kendall, J. F. Saracco, and G. C. White. 2016. Wintering strategies of migratory birds: A novel approach for estimating seasonal movement patterns of residents and transients. Journal of Applied Ecology 53:1035–1045.
Rushing, C. S., T. B. Ryder, and P. P. Marra. 2016. Quantifying drivers of population dynamics for a migratory bird throughout the annual cycle. Proceedings of the Royal Society B: Biological Sciences 283:20152846.

Ruth, J. M. 2015. Status Assessment and Conservation Plan for the Grasshopper Sparrow (*Ammodramus savannarum*). Version 1.0 U.S. Fish and Wildlife Service, Lakewood, Colorado. 109pp.

Sample, D. W., and M. J. Mossman. 1997. Managing habitat for grassland birds: a guide for Wisconsin. Wisconsin Dept. of Natural Resources. Madison WI. 154pp.

Sánchez-Bayoa, F., and K. A. G. Wyckhuys. 2019. Worldwide decline of the entomofauna: A review of its drivers. Biological Conservation 232:8–27.

Schulte, L. A., A. M. Pidgeon, and D. J. Mladenoff. 2005. One hundred fifty years of change in forest bird breeding habitat: estimates of species distributions. Conservation Biology 19:1944-1956.

Sekercioglu, C. H., G. C. Daily, and P. R. Ehrlich. 2004. Ecosystem consequences of bird declines. Proceedings of the National Academy of Sciences USA 101:18042–18047.

Shaffer, J. A., and D. A. Buhl. 2016, Effects of wind-energy facilities on breeding grassland bird distributions. Conservation Biology 30:59–71.

Shaffer, J. A., and J. P. DeLong. 2019. The effects of management practices on grassland birds—An introduction to North American grasslands and the practices used to manage grasslands and grassland birds, Chap. A of D. H. Johnson, L. D. Igl, J. A. Shaffer, and J. P. DeLong, eds., The effects of management practices on grassland birds: U.S. Geological Survey Professional Paper 1842, 63 p.

Sherry, T. W., S. Wilson, S. Hunter, and R. T. Holmes. 2015. Impacts of nest predators and weather on reproductive success and population limitation in a long-distance migratory songbird. Journal of Avian Biology 46:559–569.

Sillett, T. S., and R. T. Holmes. 2002. Variation in survivorship of a migratory songbird throughout its annual cycle. Journal of Animal Ecology 71:296–308.

Skagen, S. K., and A. A. Y. Adams. 2012. Weather effects on avian breeding performance and implications of climate change. Ecological Applications, 22:1131–1145.

Smallwood, K. S., and C. Thelander. 2008. Bird mortality in the Altamont Pass wind resource area, California. Journal of Wildlife Management 72:215–223.

Smallwood, K. S., D. A. Bell, and S. Standish. 2020. Dogs Detect Larger Wind Energy Effects on Bats and Birds. Journal of Wildlife Management 84(5):852–864. doi:10.1002/jwmg.21863.

Snep, R. P., J. L. Kooijmans, R. G. Kwak, R. P. Foppen, H. Parsons, M. Awasthy, H. L. K. Sierdsema, J. M. Marzluff, E. Fernandez-Juricic, J. de Laet, and Y. M. van Heezik. 2016. Urban bird conservation: presenting stakeholder-specific arguments for the development of bird-friendly cities. Urban Ecosystems 19(4):1535–1550.

Sohl, T. L., K. L., Sayler, M. A. Bouchard, R. R. Reker, A. M. Freisz, S. L. Bennett, B. M. Sleeter, R. R. Sleeter, T. Wilson, C. Soulard, M. Knuppe, and T. Van Hofwegen. 2018. Conterminous United States Land Cover Projections - 1992 to 2100: U.S. Geological Survey data release, https://doi.org/10.5066/P95AK9HP.

Sohl, T., R. Reker, M. Bouchard, K. Sayler, J. Dornbierer, S. Wika, R. Quenzer and A. Friesz. 2016. Modeled historical land use and land cover for the conterminous United States, Journal of Land Use Science 11(4):476-499, DOI: 10.1080/1747423X.2016.1147619

Soulliere, G. J., and M. A. Al-Saffar. 2017. Targeting conservation for waterfowl and people in the Upper Mississippi River and Great Lakes Joint Venture Region. Upper Mississippi River and Great Lakes Region Joint Venture Technical Report No. 2017-1, Bloomington, Minnesota, USA.

Soulliere, G. J., M. A. Al-Saffar, J. M. Coluccy, R. J. Gates, H. M. Hagy, J. W. Simpson, J. N. Straub, R. L. Pierce, M. W. Eichholz, and D. R. Luukkonen. 2017. Upper Mississippi River and Great Lakes Region Joint Venture Waterfowl Habitat Conservation Strategy – 2017 Revision. U.S. Fish and Wildlife Service, Bloomington, Minnesota, USA.

Soulliere, G. J., M. A. Al-Saffar, R. L. Pierce, M. J. Monfils, L. R. Wires, B. W. Loges, B. T. Shirkey, N. S. Miller, R. D. Schultheis, F. A. Nelson, A. M. Sidie-Slettedahl, C. M. Tonra, and D. J. Holm. 2018. Upper Mississippi River and Great Lakes Region Joint Venture

Waterbird Habitat Conservation Strategy – 2018 Revision. U.S. Fish and Wildlife Service, Bloomington, Minnesota, USA.
Soulliere, G. J., M. A. Al-Saffar, K. R. VanBeek, K. E. Koch, and C. M. Tonra. 2019. Stakeholder interviews to inform revision of the Upper Mississippi / Great Lakes Joint Venture Landbird Habitat Conservation Strategy. Upper Mississippi / Great Lakes Joint Venture Technical Report No. 2019-1, Bloomington, Minnesota, USA.
Spiller, K. J., and R. Dettmers. 2019. Evidence for multiple drivers of aerial insectivore declines in North America. Condor 121(2):1–13.
Stanton, J. C., B. X. Semmens, P. C. McKann, T. Will, and W. E. Thogmartin. 2016. Customizable risk metrics for identifying and monitoring conservation-priority species. Ecological Indicators 61:683–692.
Stanton, R. L., C. A. Morrissey, and R. G. Clark. 2018. Analysis of trends and agricultural drivers of farmland bird declines in North America: A review. Agriculture, Ecosystems & Environment 254:244–254.
Stepanian, P. M., S. E. Entrekin, C. E. Wainright, D. Mirkovic,, J. L. Tank, and J. F. Kelly. 2020. Declines in an abundant aquatic insect, the burrowing mayfly, across major North American waterways. Proceedings of the National Academy of Sciences USA 117:2987–2992.
Steven, R., C. Morrison, and J. G. Castley. 2017. Exploring attitudes and understanding of global conservation practice among birders and avitourists for enhanced conservation of birds. Bird Conservation International 27(2):224–236.
Stutchbury, B. J., R. Siddiqui, K. Applegate, G. T. Hvenegaard, P. Mammenga, N. Mickle, M. Pearman, J. D. Ray, A. Savage, T. Shaheen, and K. C. Fraser. 2016. Ecological causes and consequences of intratropical migration in temperate-breeding migratory birds. The American Naturalist 188:S28–S40.
Sullivan, B. L., C. L. Wood, M. J. Iliff, R. E. Bonney, D. Fink, and S. Kelling. 2009. eBird: A citizen-based bird observation network in the biological sciences. Biological Conservation 142(10):2282–2292.
Swanston, C. W., M. K. Janowiak, L. A. Brandt, P. R. Butler, S. D. Handler, P. D. Shannon, A. D. Lewis, K. Hall, R. T. Fahey, L. Scott, A. Kerber, J. W. Miesbauer, and L. Darling. 2016. Forest adaptation resources: Climate change tools and approaches for land managers, 2nd edition. Ge. Tech. Rep. NRS-GTR-87-2. Newtown Square, PA. U.S. Department of Agriculture, Forest Service, Northern Research Station. 161 p. www.nrs.fs.fed.us/pubs/52760
SWCS [Soil and Water Conservation Society]. 2003. Conservation implications of climate change: soil erosion and runoff from cropland. Soil and Water Conservation Society, Ankeny, Iowa, USA.
Taylor, P. D., S. A. Mackenzie, B. G. Thurber, A. M. Calvert, A. M. Mills, L. P. McGuire, and C. G. Guglielmo. 2011. Landscape movements of migratory birds and bats reveal an expanded scale of stopover. PLoS ONE 6(11): e27054. Doi:10.1371/journal.pone.0027054.
Thatcher, B. S., D. G. Krementz, and M. S. Woodrey. 2006. Henslow's sparrow winter-survival estimates and response to prescribed burning. Journal of Wildlife Management 70:198–206.
The Center for Climate and Security. 2019. A Climate Security Plan for America, Washington, DC: The Climate and Security Advisory Group, Chaired by the Center for Climate and Security in partnership with George Washington University's Elliott School of International Affairs.
Thogmartin, W. E., and J. J. Rohweder. 2009. Conservation opportunity assessment for rare birds in the Midwestern United States: a private lands imperative. Pages 419–425 in Rich, T. D., C. Arizmendi, D. Demarest and C. Thompson [eds.]. Tundra to Tropics: Connecting Birds, Habitats and People. Proceedings of the 4th International Partners in Flight Conference, 13-16 February 2008. McAllen, TX.
Thogmartin, W. E., S. M. Crimmins, and J. Pearce. 2014. Prioritizing bird conservation actions in the Prairie Hardwood Transition of the Midwestern United States. Biological Conservation 76: 212–223.

Tonra, C. M., and M. W. Reudink. 2018. Expanding the traditional definition of molt-migration. Auk: Ornithological Advances 135:1123–1132.
Tonra, C. M., J. R. Wright, and S. N. Matthews. 2019. Remote estimation of overwintering home ranges in an elusive, nocturnal migratory bird. Ecology and Evolution 9:12586–12599.
USACE [U.S. Army Corps of Engineers]. 2012. Upper Mississippi River Systemic Forest Stewardship Plan, Executive Summary. 8pp.
USCB [U.S. Census Bureau]. 2010. Population Change for Counties in the United States and for Municipios in Puerto Rico: 2000 to 2010. www.census.gov/2010census
USFWS [U.S. Fish and Wildlife Service]. 2014. Selecting surrogate species for Strategic Habitat Conservation in the Upper Midwest Great Lakes geography. Bloomington, MN. Writing Team: N. Powers, M. Brouder, S. Blomquist, B. Potter, J. Dingledine, C. Deloria, G. Soulliere, T. Kerr, and K. Steiger-Meister.
USFWS [U.S. Fish and Wildlife Service]. 2020. Summary of listed species listed populations and recovery plans. Environmental Conservation Online System. https://ecos.fws.gov/ecp0/reports/box-score-report (accessed 27 February 2020).
USGCRP [U.S. Global Change Research Program]. 2017. Climate Science Special Report: Fourth National Climate Assessment, Volume I, *editors* Wuebbles, D. J., D. W. Fahey, K. A. Hibbard, D. J. Dokken, B. C. Stewart, and T. K. Maycock. U.S. Global Change Research Program, Washington, DC, USA, 470 pp, doi: 10.7930/J0J964J6.
USGS [U.S. Geological Survey]. 2018. Gap Analysis Project (GAP), 2018, Protected Areas Database of the United States (PAD-US): U.S. Geological Survey data release, https://doi.org/10.5066/P955KPLE.
Vitek J., D. A. Cristol, and M. Leu. 2017. Songbird community varies with deer use in a fragmented landscape. Landscape and Urban Planning 161:1-9. DOI: 10.1016/j.landurbplan.2017.01.003. Accessed 19 April 2020.
Vodehnal, W. L., and J. B. Haufler, *Compilers*. 2007. A grassland conservation plan for prairie grouse. North American Grouse Partnership. Fruita, CO.
Walk, J. W., E. L. Kershner, T. J. Benson, and R. E. Warner. 2010. Nesting success of grassland birds in small patches in an agricultural landscape. Auk 127:328–334.
Warnock, N. 2010. Stopping vs. staging: The difference between a hop and a jump. Journal of Avian Biology 41:621–626.
Wickham, J., S. V. Stehman, L. Gass, J. A. Dewitz, D. G. Sorenson, B. J. Granneman, R. V. Poss, and L. A. Baer, 2017. Thematic accuracy assessment of the 2011 National Land Cover Database (NLCD). Remote Sensing of Environment 191(Supplement C): 328–341. doi:https://doi.org/10.1016/j.rse.2016.12.026.
Will, T., J. C. Stanton, K. V. Rosenberg, A. O. Panjabi, A. F. Camfield, A. E. Shaw, W. E. Thogmartin, and P. J. Blancher. 2020. Handbook to the Partners in Flight Population Estimates Database, Version 3.1. PIF Technical Series No 7.1. pif.birdconservancy.org/popest.handbook.pdf.

Wilsey, C., B. Bateman, L. Taylor, J. X. Wu, G. LeBaron, R. Shepherd, C. Koseff, S. Friedman, and R. Stone. 2019a. Survival by Degrees: 389 Bird Species on the Brink. National Audubon Society: New York.
Wilsey, C. B., J. Grand, J. Wu, N. Michel, J. Grogan-Brown, and B. Trusty. 2019b. North American Grasslands. National Audubon Society, New York, New York, USA.
Wilsey, C, L. Taylor, B. Bateman, C. Jensen, N. Michel, R. Panjabi, G. Langham. 2019c. Climate policy action needed to reduce vulnerability of conservation-reliant grassland birds in North America. Conservation Science and Practice 21.
Wilson, S., S. L. LaDeau, A. P. Tøttrup, and P. P. Marra. 2011. Range-wide effects of breeding-and nonbreeding-season climate on the abundance of a Neotropical migrant songbird. Ecology 92:789–1798.

Woodrey, M. S. 2000. Age-dependent aspects of stopover biology of passerine migrants. Studies in Avian Biology 20:43–52.

Worland, J. 2020a. Shell's crude awakening: Can the oil-and-gas industry survive the climate-change fallout? *In* TIME magazine (27 January 2020), Bryant Park, New York, NY USA.

Worland, J. 2020b. The world of finance groggily awakens to climate change. *In* TIME magazine (10 February 2020), New York, NY USA.

Winder, V. L., A. J. Gregory, L. B. McNew, and B. K. Sandercock. 2015. Responses of male Greater Prairie-Chickens to wind energy development. Condor 117(2):284–296.

Winter, M., D. H. Johnson, and J. Faaborg. 2000. Evidence for edge effects on multiple levels in tallgrass prairie. Condor 102(2):256–266.

Wood, E. M., A. M. Pidgeon, F. Liu, and D. J. Mladenoff. 2012. Birds see the trees inside the forest: the potential impacts of changes in forest composition on songbirds during spring migration. Forest Ecology and Management 280:176–186.

Wright, J. R., C. M. Tonra, and L. L. Powell. 2018a. Prealternate molt-migration in Rusty Blackbirds and its implications for stopover biology. Condor: Ornithological Applications 120:507–516.

Wright, J. R., L. L. Powell, and C. M. Tonra. 2018b. Automated telemetry reveals staging behavior in a declining migratory passerine. The Auk: Ornithological Advances 135:461–476.

Yang, L., J. Suming, P. Danielson, C. Homer, L. Gass, S. M. Bender, A. Case, C. Costello, J. Dewitz, J. Fry, M. Funk, B. Granneman, G. C. Liknes, M. Rigge, and G. Xian. 2018. A new generation of United States National Land Cover Database; requirements, research priorities, design, and implementation strategies. ISPRS Journal of Photogrammetry and Remote Sensing 146:108–123.

Zacharias, M. A., and J. C. Roff. 2001. Use of focal species in marine conservation and management: a review and critique. Aquatic Conservation: Marine and Freshwater Ecosystems 11:59–76.

Zanette, L., M. Clinchy, and J. N. Smith. 2006. Combined food and predator effects on songbird nest survival and annual reproductive success: results from a bi-factorial experiment. Oecologia 147:632–640.

Zink, R. M., and J. Eckles. 2010. Twin Cities bird–building collisions: A status update on ''Project Birdsafe.'' The Loon 82(1):34–37.

Zuckerberg, B., A. M. Woods, and W. F. Porter. 2009. Poleward shifts in breeding bird distributions in New York state. Global Change Biology 15:1866–1883.

APPENDICES

Appendix A. Common and scientific names of birds included in the Upper Mississippi / Great Lakes Joint Venture Landbird Habitat Conservation Strategy – 2020 Revision. List arranged in taxonomic order.

Appendix B. Class descriptions from 2016 National Land Cover Database (NLCD; Yang et al. 2018) used for conservation planning in the Upper Mississippi / Great Lakes Joint Venture region.

Appendix C. Descriptions of Bird Conservation Regions (BCRs) in the Upper Mississippi / Great Lakes Joint Venture region, including primary land-cover and social characteristics.

Appendix D. Focal species habitat accounts with population distribution and abundance, factors limiting population growth, and habitat recommendations in the Upper Mississippi / Great Lakes Joint Venture (JV) region.

Appendix E. Breeding focal species abundance estimates, trends, and goals for Bird Conservation Regions (BCRs) within the Upper Mississippi / Great Lakes Joint Venture (JV) boundary. Abundance goals were established using PIF frameworks for Watch List species in categories *Yellow D – reverse decline, Yellow R – prevent decline,* and *Common Birds in Steep Decline – stabilize population* for each BCR area within the JV region.

Appendix F. Integration of biological and social objectives provides a means to increase the relevance of bird habitat conservation to people. Spatial data layers representing each objective are be weighted for importance (objective prioritization) and combined to produce a decision support tool (DST). The DST identifies highest priority areas of the JV region to target conservation actions that best achieve the integrated objectives.

Appendix G. Check list of community-based (Bird City) conservation actions especially relevant to urban and developed landscapes and drawn from several Bird City Programs. Typical actions to enhance conservation are grouped into categories and best practices. Depending on state-program requirements, a specified number of best practices (usually 2-3) must be completed within each category before a community can be certified as a Bird City. Bird Cities are also required to adopt an official municipal resolution and hold a celebration recognizing World Migratory Bird Day.

Appendix A. Common and scientific names of birds included in the Upper Mississippi / Great Lakes Joint Venture Landbird Habitat Conservation Strategy – 2020 Revision. List arranged in taxonomic order.

Common name	Scientific name	Common name	Scientific name
Wood duck	*Aix sponsa*	Veery	*Catharus fuscescens*
Blue-winged Teal	*Spatula discors*	Wood Thrush	*Hylocichla mustelina*
Mallard	*Anas platyrhynchos*	American Robin	*Turdus migratorius*
Northern Bobwhite	*Colinus virginianus*	Brown Thrasher	*Toxostoma rufum*
Wild Turkey	*Meleagris gallopavo*	European Starling	*Sturnus vulgaris*
Ruffed Grouse	*Bonasa umbellus*	House Sparrow	*Passer domesticus*
Sharp-tailed Grouse	*Tympanuchus phasianellus*	Evening Grosbeak	*Coccothraustes vespertinus*
Greater Prairie-Chicken	*Tympanuchus cupido*	House Finch	*Haemorhous mexicanus*
Ring-necked Pheasant	*Phasianus colchicus*	Pine Siskin	*Spinus pinus*
Rock Pigeon	*Columba livia*	Grasshopper Sparrow	*Ammodramus savannarum*
Yellow-billed Cuckoo	*Coccyzus americanus*	Lark Sparrow	*Chondestes grammacus*
Black-billed Cuckoo	*Coccyzus erythropthalmus*	Chipping Sparrow	*Spizella passerina*
Common Nighthawk	*Chordeiles minor*	Field Sparrow	*Spizella pusilla*
Chuck-will's-widow	*Antrostomus carolinensis*	American Tree Sparrow	*Spizelloides arborea*
Eastern Whip-poor-will	*Antrostomus vociferus*	Vesper Sparrow	*Pooecetes gramineus*
Chimney Swift	*Chaetura pelagica*	LeConte's Sparrow	*Ammospiza leconteii*
American Woodcock	*Scolopax minor*	Nelson's Sparrow	*Ammospiza nelsoni*
Upland Sandpiper	*Bartramia longicauda*	Henslow’s Sparrow	*Centronyx henslowii*
Northern Harrier	*Circus hudsonius*	Savannah Sparrow	*Passerculus sandwichensis*
Cooper's Hawk	*Accipiter cooperii*	Eastern Towhee	*Pipilo erythrophthalmus*
Bald Eagle	*Haliaeetus leucocephalus*	Bobolink	*Dolichonyx oryzivorus*
Broad-winged Hawk	*Buteo platypterus*	Eastern Meadowlark	*Sturnella magna*
Snowy Owl	*Bubo scandiacus*	Western Meadowlark	*Sturnella neglecta*
Long-eared Owl	*Asio otus*	Red-winged Blackbird	*Agelaius phoeniceus*
Short-eared Owl	*Asio flammeus*	Brown-headed Cowbird	*Molothrus ater*
Northern Saw-whet Owl	*Aegolius acadicus*	Rusty Blackbird	*Euphagus carolinus*
Red-headed Woodpecker	*Melanerpes erythrocephalus*	Brewer's Blackbird	*Euphagus cyanocephalus*
Red-bellied Woodpecker	*Melanerpes carolinus*	Common Grackle	*Quiscalus quiscula*
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Ovenbird	*Seiurus aurocapilla*
Black-backed Woodpecker	*Picoides arcticus*	Worm-eating Warbler	*Helmitheros vermivora*
Downy Woodpecker	*Dryobates pubescens*	Louisiana Waterthrush	*Parkesia motacilla*
Hairy Woodpecker	*Dryobates villosus*	Golden-winged Warbler	*Vermivora chrysoptera*
Northern Flicker	*Colaptes auratus*	Blue-winged Warbler	*Vermivora cyanoptera*
American Kestrel	*Falco sparverius*	Black-and-white Warbler	*Mniotilta varia*
Merlin	*Falco columbarius*	Prothonotary Warbler	*Protonotaria citrea*
Peregrine Falcon	*Falco peregrinus*	Nashville Warbler	*Leiothlypis ruficapilla*
Great Crested Flycatcher	*Myiarchus crinitus*	Connecticut Warbler	*Oporornis agilis*
Eastern Kingbird	*Tyrannus tyrannus*	Mourning Warbler	*Geothlypis philadelphia*
Olive-sided Flycatcher	*Contopus cooperi*	Kentucky Warbler	*Geothlypis formosus*
Willow Flycatcher	*Empidonax traillii*	Kirtland’s Warbler	*Setophaga kirtlandii*
Least Flycatcher	*Empidonax minimus*	Cape May Warbler	*Setophaga tigrina*
Loggerhead Shrike	*Lanius ludovicianus*	Cerulean Warbler	*Setophaga cerulea*
Bell’s Vireo	*Vireo bellii*	Bay-breasted Warbler	*Setophaga castanea*
Blue Jay	*Cyanocitta cristata*	Blackburnian Warbler	*Setophaga fusca*
American Crow	*Corvus brachyrhynchos*	Chestnut-sided Warbler	*Setophaga pensylvanica*
Horned Lark	*Eremophila alpestris*	Blackpoll Warbler	*Setophaga striata*
Bank Swallow	*Riparia riparia*	Black-throated Blue Warbler	*Setophaga caerulescens*
Tree Swallow	*Tachycineta bicolor*	Prairie Warbler	*Setophaga discolor*
Black-capped Chickadee	*Poecile atricapillus*	Canada Warbler	*Cardellina canadensis*
White-breasted Nuthatch	*Sitta carolinensis*	Scarlet Tanager	*Piranga olivacea*
Sedge Wren	*Cistothorus platensis*	Dickcissel	*Spiza americana*
Marsh Wren	*Cistothorus palustris*		

Appendix B. Class descriptions from 2016 National Land Cover Database (NLCD; **Yang et al. 2018) used for conservation planning in the Upper Mississippi / Great Lakes Joint Venture region.**

Water
11 – Open Water - areas of open water, generally with less than 25% cover of vegetation or soil.

Developed
21 – Developed, Open Space - areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
22 – Developed, Low Intensity - areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.
23 – Developed, Medium Intensity - areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.
24 – Developed, High Intensity - highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.

Barren
31 – Barren Land (Rock/Sand/Clay) - areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.

Forest
41 – Deciduous Forest - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.
42 – Evergreen Forest - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.
43 – Mixed Forest - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.

Shrubland
52 – Shrub/Scrub - areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.

Herbaceous
71 – Grassland/Herbaceous - areas dominated by graminoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.

Planted/Cultivated
81 – Pasture/Hay - areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.
82 – Cultivated Crops - areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.

Wetlands
90 – Woody Wetlands - areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
95 – Emergent Herbaceous Wetlands - Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

Appendix C. Descriptions of Bird Conservation Regions (BCRs) in the Upper Mississippi / Great Lakes Joint Venture region, including primary land-cover and social characteristics.

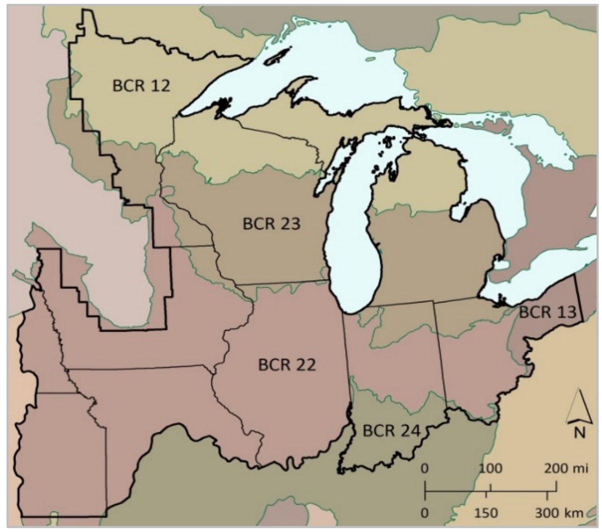
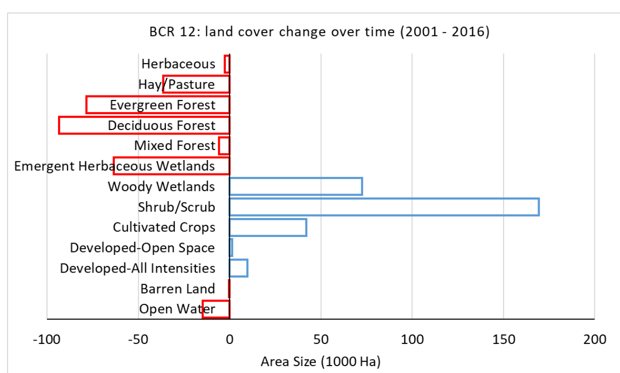


Figure C-1. Boundaries of the Upper Mississippi River and Great Lakes Joint Venture region (bolded black line) and associated Bird Conservation Regions (BCRs, color discerned).

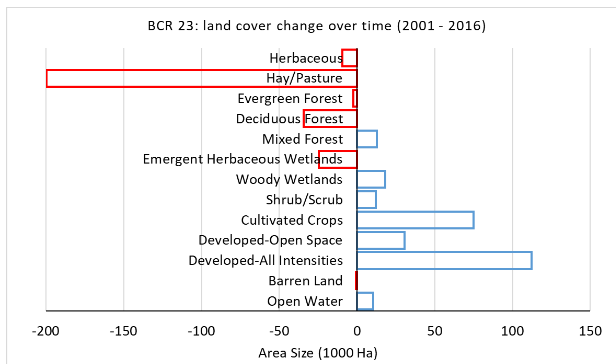
Bird Conservation Regions (Figure C-1) are geographic designations that have similar land-cover types, bird communities, and resource conservation issues (NABCI 2000). They are the fundamental biological units through which the North American Bird Conservation Initiative (NABCI) promotes planning and delivery of large-scale bird conservation. BCRs provide a consistent spatial framework for evaluation, planning, and in some instances implementation. By employing expanses of land ecologically meaningful to bird populations, conservation efforts can be tailored to better support groups of species throughout their range. We use BCRs as primary planning units in this Strategy, and provide characteristics and functional differences among these areas to improve conservation decisions. We also review recent landscape change (2001 to 2016) based on the National Land Cover Database (see Appendix B for detailed NLCD class descriptions). Landbird habitat objectives were subdivided into State × BCR polygons to quantify habitat delivery targets within smaller domains (see Habitat Delivery section).

Boreal Hardwood Transition (BCR 12).—The northern-most area of the JV region is characterized by immense forests, nutrient-poor soils and limited agriculture, an extensive Great lakes coastline, plus an abundance of inland lakes, forested and herbaceous wetlands, and river systems. Bird habitats in this portion of the JV region are least influenced by human activity, although past and ongoing forest harvest operations have largely replaced natural disturbance as a means to setback plant-community succession. Woody cover dominates (69%) the landscape, with upland forests representing 43% of BCR 12 land cover, forested wetlands 17%, and upland and wetland scrub-shrub coverage another 9% (Table C-1). Area of shrub/scrub and woody wetland have recently expanded, whereas upland forest and emergent wetland declined. This BCR is important during the breeding period for several forest birds of high conservation concern; nearly all Kirtland's Warblers breed in this sub-region as do the majority of Golden-winged Warblers. The BCR is also well

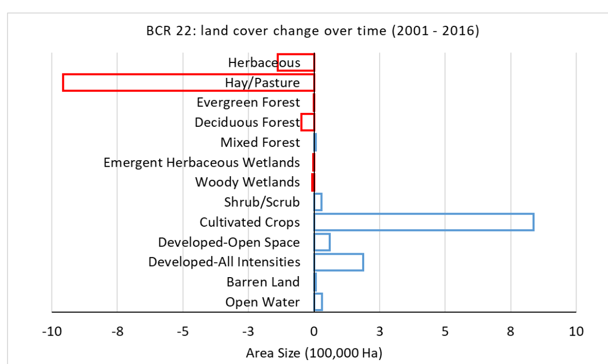


recognized at the continental scale for its coastal migration corridors and stopover sites. Human density is low compared to other BCRs in the JV region (Table C-1), however recreational activity increases substantially during summer, especially in areas with waterfront cottages.

Prairie Hardwood Transition (BCR 23).—Deciduous forest, savanna, and prairie once dominated this sub-region, but cropland (43%) and developed land (9%) now account of much of the land cover (Table C-1). Grassland, wet meadow, and other herbaceous plant communities occurring pre-European settlement were especially vulnerable to conversion, and now account for about 5% of land cover (1% grassland, 4% herbaceous wetland). Hay and pasture now cover about 10% of the landscape, but this cover type has declined in recent years while development and cropland has increased. Upland and wetland forest still cover about 26% of the BCR, and most of the forested area is deciduous upland (16%). Prairies were most common in the west and southcentral portions of the BCR, with beech-maple forests widespread in the north and east. Oak savannas were scattered across the sub-region and especially common in the transition zone leading to the western prairie. There are still remnant populations of Greater Prairie-Chicken in grasslands of west and central BCR 23. Cerulean and Golden-winged Warblers are species of high conservation concern occurring in the more forested north and east portions of the sub-region, whereas Golden-winged Warblers and Henslow's Sparrows use areas in the BCR of shrub-scrub and grassland. Tens of thousands of *pothole* wetlands and shallow lakes occur across the BCR, resulting from glaciation. Current human density and population growth are high relative to other BCRs in the JV region (Table C-1).

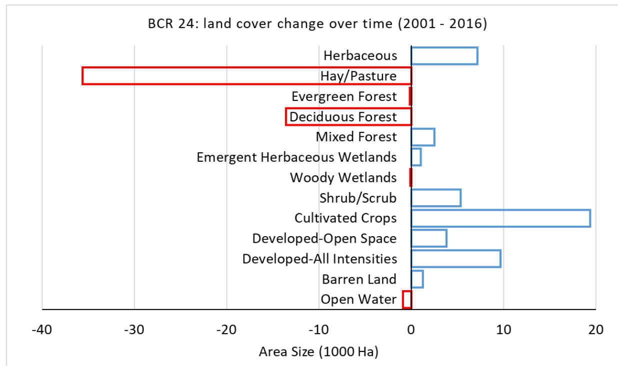


Eastern Tallgrass Prairie (BCR 22).—Covering the southern half of the JV region, this BCR once contained the most extensive tall-grass prairie of the Great Plains, growing on the most nutrient-rich soils in North America. Deciduous forest dominated eastern sections, which transitioned into a broad and dynamic oak-dominated savannas and then vast prairie in central and west portions of the region. The modern landscape (Table C-1) is largely cultivated cropland (54%) and developed areas (7%), with cropland continuing to expand in recent years. However, the BCR also contains interspersed forests (12%), hay and pasture (15%), and herbaceous grassland (6%). Most of the herbaceous grassland in the JV region occurs in Kansas and Nebraska, accounting for 56% and 10% of BCR 22 grasslands, respectively. Portions of the BCR remain especially important to grassland birds, including



Eastern Meadowlark, Bobolink, Greater Prairie-Chicken, and Henslow's Sparrow, as well the Red-headed Woodpecker in savannas and other semi-open woodlands. Human densities are high in urban areas but low elsewhere; population growth is highest here compared to other BCRs of the JV region (Table C-1).

Central Hardwoods (BCR 24).—Only a small area of BCR 24 (southern Indiana) overlaps the JV region (Figure C-1). Once dominated by upland and wetland deciduous forests, BCR 24 within the JV region still includes substantial forest coverage (50%) mixed with cultivated cropland (33%) and hay/pasture lands (13%) (Table C-1). The area of hay/pasture and deciduous forest declined in recent years, whereas the area of cropland, development, and herbaceous grassland increased. However, herbaceous grassland accounts for only 1% of the land cover in BCR 24 within the JV region, and the sub-region is more important to forest-breeding birds such as Cerulean Warbler and Wood Thrush. The human density is relatively low outside of urban centers, but population growth in this portion of the JV region has been relatively high (Table C-1).



Lower Great Lakes/St. Lawrence Plain (BCR 13).—The area of BCR 13 within the JV region (northeast Ohio) is relatively small. Deciduous forest and areas of mixed-coniferous forests originally dominated the sub-region. Now, only 31% of the area is upland forest and 3% is forested wetland (Table C-1). About 21% of the BCR area within the JV boundary is cultivated cropland and 20% is hay/pasture, however, cropland has been increasing while hay/pasture and herbaceous grassland have been declining. Herbaceous grassland represents <1% of land cover, and the sub-region is more important to forest birds including Wood Thrush. This portion of the JV region has the highest human population density (average 2.1 / ha), but population growth has slowed in recent years (Table C-1).

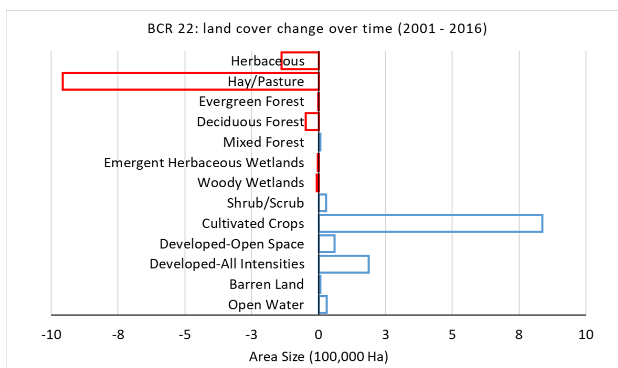


Table C-1. Area estimates of land cover (ha; 1 ha = 2.5 acreas) and social characteristics important to landbird conservation planning in Bird Conservation Regions (BCRs) located in the Upper Mississippi / Great Lakes Joint Venture region. Estimates for BCRs 22 and 23 encompass the entire BCR, including portions outside the JV boundary (i.e., 8% of BCR 22, 9% of 23 outside JV reigon); estimates for BCRs 12, 13, and 24 apply only to those areas within the JV boundary.

	BCR		BCR (JV region only)			Total
	22[a]	23	12	13	24	
Total area (ha)	51,762,267	25,827,603	20,583,051	2,174,150	3,547,207	103,894,278
Primary cover types[a]						
Cultivated cropland	27,997,135	11,015,071	695,871	451,012	1,162,318	41,321,407
Herbaceous/grassland, Hay/pasture	10,852,211	2,615,250	1,032,126	435,569	504,781	15,439,938
Herbaceous/grassland	2,952,016	243,102	482,266	15,570	33,597	3,726,551
Upland forest (all types)	6,480,077	5,233,795	8,874,425	684,831	1,674,169	22,947,296
Deciduous upland forest	5,459,420	4,265,585	5,001,585	595,414	1,460,899	16,782,903
Conifer upland forest	50,931	273,241	1,249,820	7,162	23,229	1,604,383
Mixed upland forest	969,725	694,969	2,623,019	82,255	190,041	4,560,010
Upland scrub/shrub (all types)	59,693	78,558	495,675	7,617	6,933	648,476
Forested wetland (all types)	650,296	1,395,804	3,458,722	62,625	91,844	5,659,290
Deciduous and Broad-leaved	650,192	1,265,022	1,160,136	62,611	91,695	3,229,656
Conifer and Needle-leaved	40	58,783	1,524,366	13	4	1,583,206
Other forested wetland	64	71,998	774,220	0	145	846,428
Scrub/shrub wetland	46,982	470,278	1,308,471	21,087	6,057	1,852,875
Deciduous and Broad-leaved	46,978	467,926	1,121,547	21,087	6,057	1,663,595
Conifer and Needle-leaved	4	2,352	186,924	0	0	189,279
Herbaceous wetland (total)	330,186	1,068,909	696,059	12,046	13,829	2,121,029
Open water (inland and coastal)[b]	978,367	1,258,300	2,272,244	94,602	98,747	4,702,260
Inland waters (AB and UB)	931,936	923,343	1,370,106	48,547	98,747	3,372,679
Coastal zone waters (Great Lakes)	46,431	334,957	902,138	46,055	0	1,329,581
Hydric soils[c]	2,908,099	3,544,223	3,688,886	181,386	77,068	10,399,662
Prospective wetland (wet cropland)	2,216,066	1,879,639	72,631	33,526	51,676	4,253,538
Other related measures						
Great Lakes coastline (km)	171	1,884	5,826	191	0	8,072
Number of inland lakes (≥ 0.5 ha)[d]	22,689	20,657	23,552	1,703	2,728	71,329
Inland lake coverage (ha)[d]	170,200	441,109	497,900	25,476	16,313	1,150,998
Perennial river length (km)[d]	141,639	72,201	63,191	9,042	13,052	299,125
Developed land (ha; ≤49% impervious)	3,786,207	2,201,171	706,370	394,355	255,287	7,343,389
Developed land (ha; >49% impervious)	863,399	582,743	56,645	87,374	36,111	1,626,272
Number of people (residents), 2010[e]	31,743,779	20,560,074	1,875,258	4,584,002	1,482,640	60,245,753
Human density (people/ha)[e]	0.613	0.796	0.091	2.108	0.418	0.580
Number of people (residents), 2000[e]	28,937,401	19,262,360	1,851,778	4,655,292	1,404,258	56,111,089
Population growth (%, 2000 to 2010)[e]	9.7	6.7	1.3	-1.5	5.6	7.4

[a] Area cover-type measures are from the 2016 National Land Cover Database (NLCD), and wetland and open-water cover types based on most recent National Wetland Inventory (NWI) or calculated.

[b] *Open water* includes all inland lakes and rivers with unconsolidated bottom (UB), plus open aquatic bed wetlands (AB), plus Great Lakes *coastal waters* (coastal zone ≤ 1 km from shore).

[c] Area with soils categorized *poorly drained* and *very poorly drained* by Natural Resource Conservation Service - Soil Survey Geographic Database. "Prospective wetland" (drained sites considered most restorable to wetland) was the intersection of hydric soils and cultivated

[d] Number and area (ha) of inland lakes (includes ponds, reservoirs) and river (km) length calculated using National Hydrologic Data Plus v2.

[e] Number of residents, human population density, and population growth based on data from U.S. Census Bureau, 2000 and 2010.

Appendix D. Planning focal species habitat accounts with population distribution and abundance, factors limiting population growth, and habitat recommendations in the Upper Mississippi / Great Lakes Joint Venture (JV) region.

Forest / Savanna / Barrens

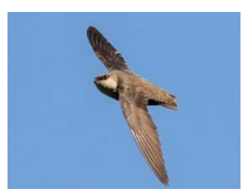
Breeding	Eastern Whip-poor-will
	Red-headed Woodpecker
	Wood Thrush
	Golden-winged Warbler
	Kirtland’s Warbler
	Cerulean Warbler
	Canada Warbler
Migration	Rusty Blackbird
	Blackpoll Warbler

Grasslands

Breeding	Henslow's Sparrow
	Bobolink
	Eastern Meadowlark
Overwinter	Short-eared Owl
	American Tree Sparrow

Urban

Breeding	Chimney Swift



Primary information sources:

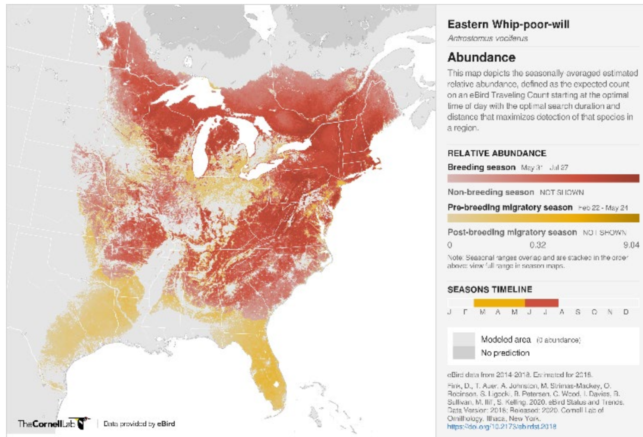
Cornell Lab of Ornithology, Birds of the World *at* https://birdsoftheworld.org/bow/home.
(See Literature Cited for full species-specific Birds of the World citations, plus citations for new research used in species accounts)

Partners in Flight. 2020a. Avian Conservation Assessment Database, version 2020 *at* http://pif.birdconservancy.org/ACAD

Partners in Flight. 2020b. Population Estimates Database, version 3.1 *at* http://pif.birdconservancy.org/PopEstimates

North American Breeding Bird Survey, Patuxent Wildlife Research Center *at* https://www.mbr-pwrc.usgs.gov/

Eastern Whip-poor-will
(Antrostomus vociferus)



Breeding habitat

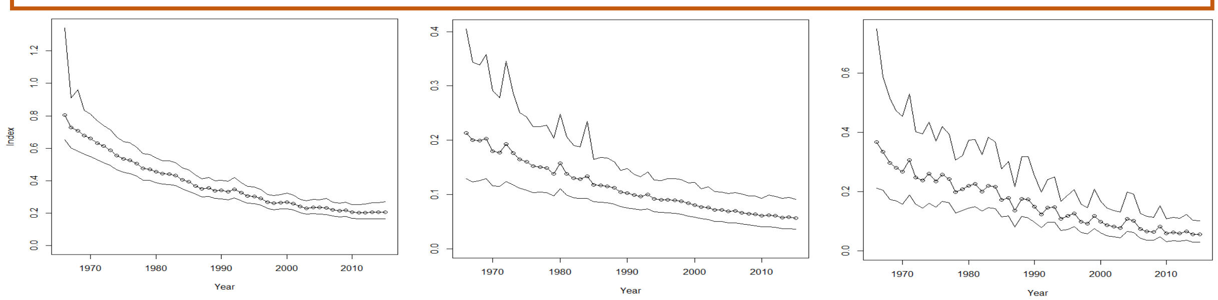
- Upland deciduous or mixed forests with open understories, limited ground cover, and proximate to open areas for foraging.
- Barrens, pine plantations, and savannas.
- Lays eggs directly on layer of leaf litter.
- Minimum forest patch size is unknown; evidence suggests species does not occupy small, isolated woodlots. Long distances between large forest patches may limit occupancy of agricultural landscapes.
- Limited by conversion of forest to agriculture, loss of forest openings to closed canopies with dense underbrush/forest succession, and loss of insect food source from pesticide application and industrial pollution, and collisions with vehicles while foraging along roadways.

Migration and wintering habitat (from Korpach et al. 2019, Tonra et al. 2019)
Tracking data reveal birds from JV region overwinter from Texas to Costa Rica, with most in southern Mexico. Some individuals use multiple winter home ranges, relocating in early February, and forest cover is often more contiguous than characteristic breeding habitat. Species migrates overland and does not cross open water of the Gulf of Mexico.

Population status

- U.S./Canada = 1.8 million, and steady decline in abundance. About 15% of BPOP occurs in JV region, with highest abundance in Boreal Hardwood Transition (BCR 12; 6%), followed by the Eastern Tallgrass Prairie (BCR 22; 4%).
- More at: https://www.mbr-pwrc.usgs.gov/cgi-bin/atlasa15.pl?04171&1&15&csrfmiddlewaretoken=3YKakk7LxT2ki6NSpl4mstudYCqdW02C

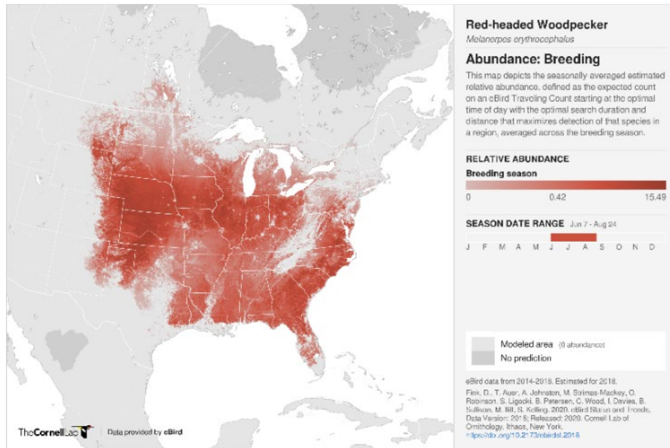
Population trend U.S.	BCR 12	BCR 22



Habitat recommendations
In dry deciduous or mixed forests, maintain openings of adequate size for foraging, but near continuous forest cover with little understory for breeding; habitat conservation should avoid roads with night traffic. Promote clear-cuts interspersed with mature forests, variable density thinning, early thinning, and other partial-cutting practices.

Additional species and habitat management information
https://birdsoftheworld.org/bow/species/whip-p1/cur/conservation

Red-headed Woodpecker
(Melanerpes erythrocephalus)



Breeding habitat

- Most common in savannas and prairie-forest transition areas; also found in semi open bottomland hardwood forests.
- Nest cavities in dead trees and dead limbs of living trees.
- Occur in open forest stands typically >1.5 ha (4 acres).
- Considered limited by loss of savanna-like areas, fire suppression, removal of dead trees and dead tree branches in suburban areas, clear-cutting, agricultural intensification and "cleaner farming" practices (e.g., removal of hedgerows and odd woody corners of fields).

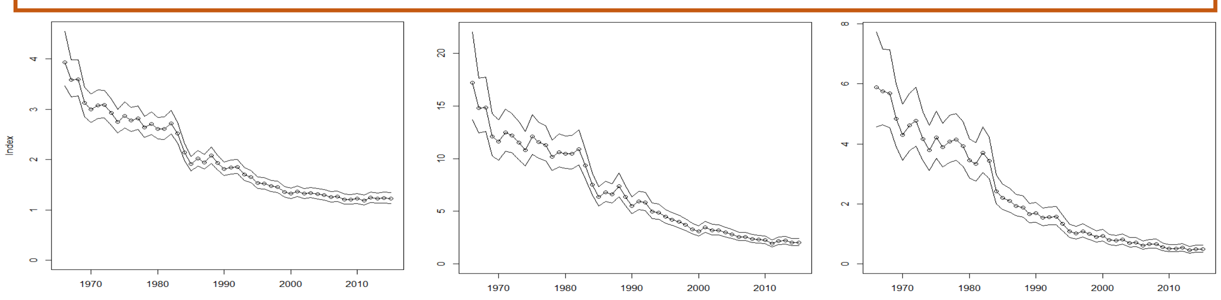
Migration and wintering habitat

- Often non-migratory, but will shift distribution to locations with abundant food.
- Mature forested bottomlands and forest patches with mast-producing trees.
- May be limited in winter by loss of bottomland forest; will abandon areas with mast failure.
- Annual cycle distribution: https://birdsoftheworld.org/bow/species/rehwoo/cur/distribution

Population status

- U.S./Canada = 1.8 million, downward trend slowing. About 25% of BPOP occurs in JV region, with highest abundance in the Eastern Tallgrass Prairie (BCR 22; 20%), Prairie Hardwood Transition (BCR 23; 3%), and the JV portion of the Central Hardwoods (BCR 24; 1%).
- More at: https://www.mbr-pwrc.usgs.gov/cgi-bin/atlasa15.pl?04060&1&15&csrfmiddlewaretoken=3YKakk7LxT2ki6NSpl4mstudYCqdW02C

Population trend U.S.	BCR 22	BCR 23



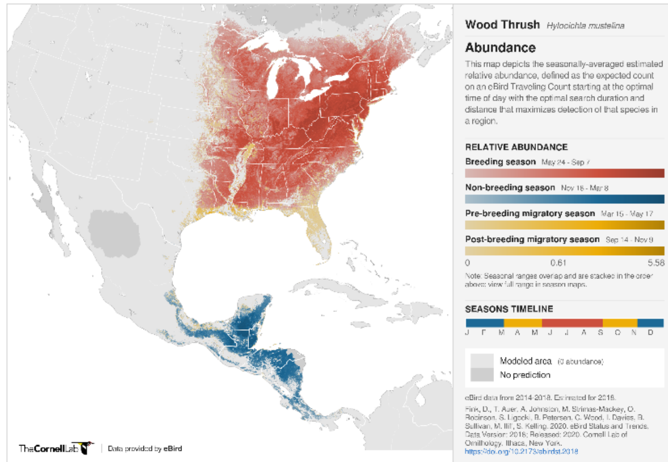
Habitat recommendations

Maintain and restore savanna and mixed grassland/open-forest communities in uplands, especially with oak (*Quercus* spp.) and American beech (*Fagus grandifolia*); support periodic prescribed fire (but avoid snags); retain mast-producing trees, grouped snags, and live trees with dead limbs. Conserve floodplain forests and promote a diversity of mast-producing trees for nonbreeding period. Seek complementary game species management, especially for Wild Turkey and Northern Bobwhite.

Additional species and habitat management information

https://birdsoftheworld.org/bow/species/rehwoo/cur/conservation

Wood Thrush
(Hylocichla mustelina)



Breeding habitat

- Mature upland, mesic deciduous and mixed forests, typically >100 ha (250 acres) in size with canopy height >15 m (50 feet); found in 1-ha sized woodlots though considered far less suitable.
- Nests are about 2 m (7 feet) from the ground in the crotch of trees or on a horizontal branch under leaf cover.
- Likely limited by nest predation, window collisions, reduced contiguous forest cover and edge effects that can increase Brown-headed Cowbird parasitism in some areas.

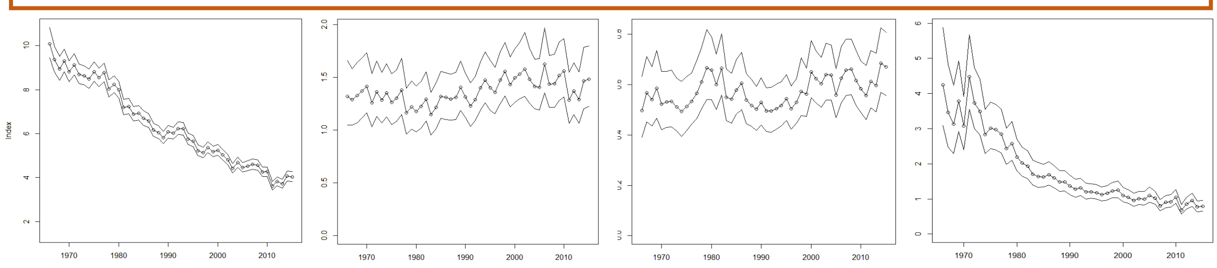
Migration and wintering habitat

Occurs in mature forests and forest edges with fruiting plants and trees during migration; less fragmented woodland areas appear to be most important during winter. Birds breeding in the JV region (Indiana) cross the Gulf of Mexico and overwinter primarily in southern Mexico (Stanley et al. 2015). Loses recorded due to severe storms over the Gulf and tower collisions during migration.

Population status

- U.S./Canada = 12 million, overall declining. About 9% of BPOP occurs in JV region with highest abundance in the Prairie Hardwood Transition (BCR 23; 3%) and Eastern Tallgrass Prairie (BCR 22; 3%), followed by the Boreal Hardwood Transition (BCR 12; 2%).
- More at: https://www.mbr-pwrc.usgs.gov/cgi-bin/atlasa15.pl?07550&1&15&csrfmiddlewaretoken=3YKakk7LxT2ki6NSpl4mstudYCqdW02C

Population trend U.S.	BCR 23	BCR 22	BCR 12



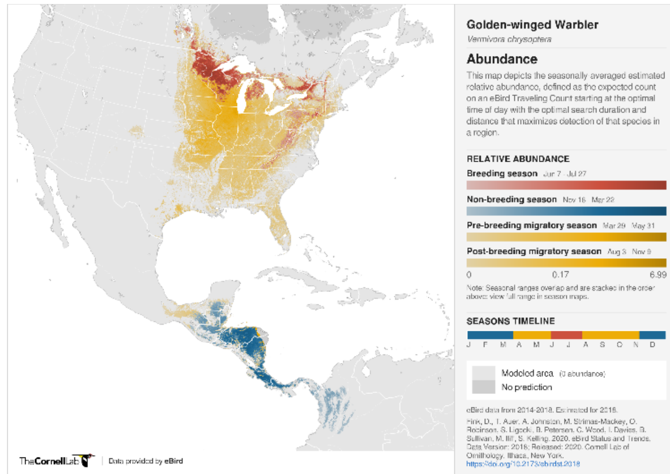
Habitat recommendations

Protection and management focused on large upland forest blocks, with well-developed canopy and limited edge (i.e., few roads, artificial corridors). Optimal stand conditions include: canopy cover ≥80%, sub-canopy height 3-6 m (10-20 feet), basal area 20-30 m^2/ha (90-130 $feet^2$/acre), and semi-open or open forest floor with thick leaf layer. Retain fruit-bearing trees and shrubs.

Additional species and habitat management information

https://birdsoftheworld.org/bow/species/woothr/cur/conservation

Golden-winged Warbler
(Vermivora chrysoptera)



Breeding habitat

- Most common in shrubby, young forest growth, especially aspen (*Populus* spp.) and alder (*Alnus* spp.) wetlands, with herbaceous openings. Sites often wet, and with widely spaced over-story trees as individuals or groups resulting in 10-30% canopy cover. Properly managed (brushy/patchy) utility corridors used.
- Nests built on the ground along the shaded edge of a forest opening.
- Minimum patch size 2-6 ha (5-15 acres), with 30-70% shrubs and saplings.
- Probably limited by reduced area of disturbance resulting in loss of young forest and mixed open conditions, collisions with towers, and competition and hybridization with Blue-winged Warbler.

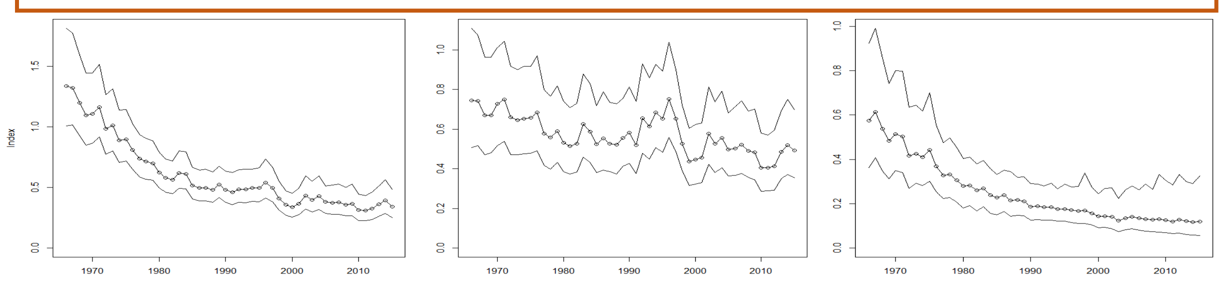
Migration and wintering habitat

Found along mature forest edges during migration. Winters in semi-open forest areas, found in both upland and lowland sites. Birds from the JV region primarily overwinter in Honduras, Nicaragua, and Costa Rica (Kramer et al. 2018).

Population status

- U.S./Canada = 390,000, with downward trend slowing in recent years. About 80% of BPOP occurs in JV region, with highest abundance in the Boreal Hardwood Transition (BCR 12; 73%) followed by the Prairie Hardwood Transition (BCR 23; 8%).
- More at: https://www.mbr-pwrc.usgs.gov/cgi-bin/atlasa15.pl?06420&1&15&csrfmiddlewaretoken=3YKakk7LxT2ki6NSpl4mstudYCqdW02C

Population trend U.S.	BCR 12	BCR 23



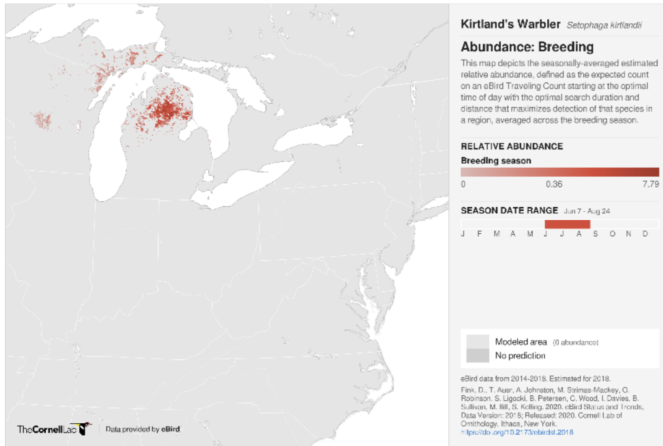
Habitat recommendations

- Encourage disturbance via timber sales and prescribed fire, but retain herbaceous patches and widely spaced over-story trees throughout patch. Complementary game species management would include habitat provision for Woodcock and Ruffed Grouse.
- More at: http://gwwa.org/wp-content/uploads/2020/06/GWWA-GLRegionalGuide_190711.pdf

Additional species and habitat management information

https://birdsoftheworld.org/bow/species/gowwar/cur/conservation

Kirtland's Warbler
(Setophaga kirtlandii)



Breeding habitat

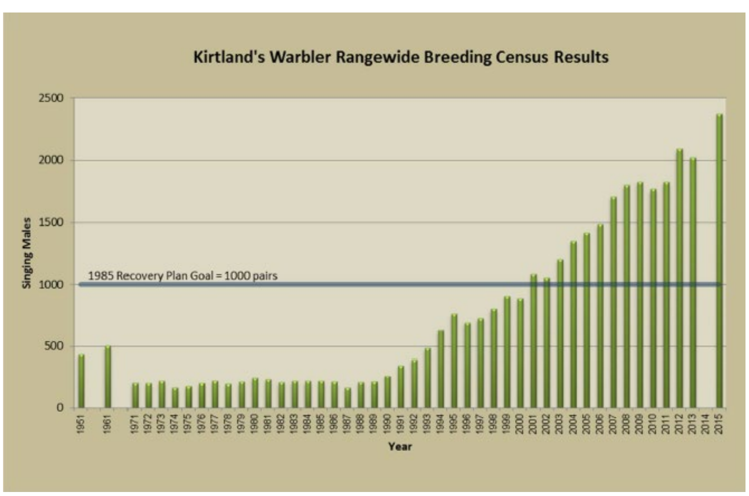
- Large stands of seedling and sapling jack pine (*Pinus banksiana*) forests on sandy soils, often mixed with young oaks (*Quercus* spp.), aspen (*Populus* spp.), and cherries (*Prunus* sp.).
- Nests built on the ground under grass and other low vegetation.
- Prefers larger patches, typically >80 ha (200 acres), with highest quality habitats located in jack pine complexes dominated by early succession trees 2-6 m (6-20 feet) tall abundant scattered openings.
- Conservation-reliant due to fire suppression, but species has responded positively to management of suitable breeding habitat, as well as continued disturbance of nonbreeding habitat. Brown-headed Cowbird nest parasitism may have been a factor limiting population growth, but this species has become less abundant recently, reducing the need for cowbird management within its core range.

Migration and wintering habitat

Typically found in low shrub/scrub areas dominated by woody plants <6 m (20 feet) tall; winters primarily in the central Bahamas. Spring migration primarily from Florida and southern Georgia north through western Lake Erie basin; fall migration further southeast to Appalachians and Carolinas. During migration found most often in early-to-mid successional woody cover.

Population status

US/Canada = 4,800, with increasing abundance trend in recent decades. Nearly 100% of BPOP occurs in JV region, with highest abundance in the Boreal Hardwood Transition (BCR 12; 99%), followed by the Prairie Hardwood Transition (BCR 23; 1%).

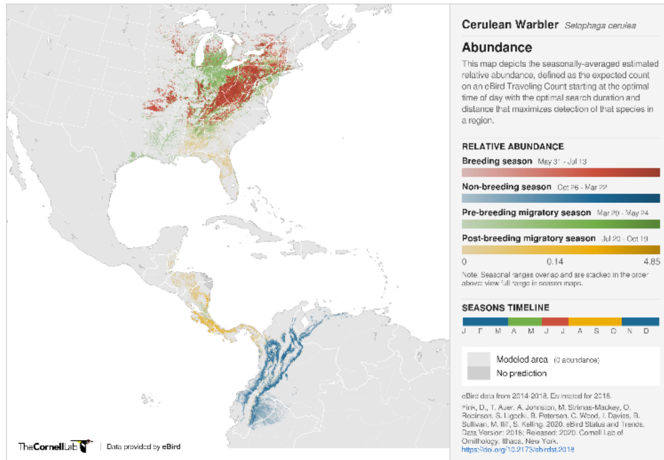


Habitat recommendations

Harvest and regenerate large stands of jack pine; reforestation usually requires prescribed burns or mechanical scarification. When tree planting is required, stocking density should be >3,600 seedlings / ha (>1,400/acre) and roughly 2 m spacing. Small openings in regeneration, totaling about 25% of stand area, improves site quality for species.

Additional species and habitat management information

https://birdsoftheworld.org/bow/species/kirwar/cur/conservation



Cerulean Warbler
(Setophaga cerulea)

Breeding habitat

- Most common in large tracts of upland or lowland/bottomland forest with large deciduous trees in mature to older-growth forest with multiple understory layers and openings in the canopy.
- Nests often placed on horizontal tree limb in upper canopy, concealed by leaves or tree limbs.
- Thought to be area-sensitive, but minimum patch size can be as low as 20-30 ha (50-70 acres; Ohio).
- Considered limited by loss and fragmentation of mature deciduous forests; shorter-rotation periods between harvests and increased even-aged management may also contribute to breeding habitat loss. Brown-headed Cowbird parasitism may also limit populations.

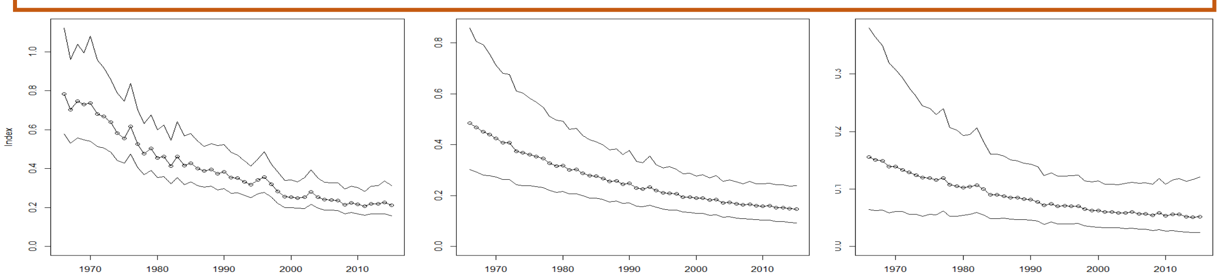
Migration and wintering habitat

In migration, often found in forest canopies, near canopy gaps, edges, and semi-open areas. Winters mostly at mid-elevations on east slope of Andes, South America.

Population status

- U.S./Canada = 530,000, with downward trend steady but slowing in recent years. About 12% of BPOP occurs in the JV region, with highest abundance in the JV portion of the Central Hardwoods (BCR24; 6%) and the Prairie Hardwood Transition (BCR 23; 4%).
- More at: https://www.mbr-pwrc.usgs.gov/cgi-bin/atlasa15.pl?04060&1&15&csrfmiddlewaretoken=3YKakk7LxT2ki6NSpl4mstudYCqdW02C

Population trend U.S.	BCR 24	BCR 23



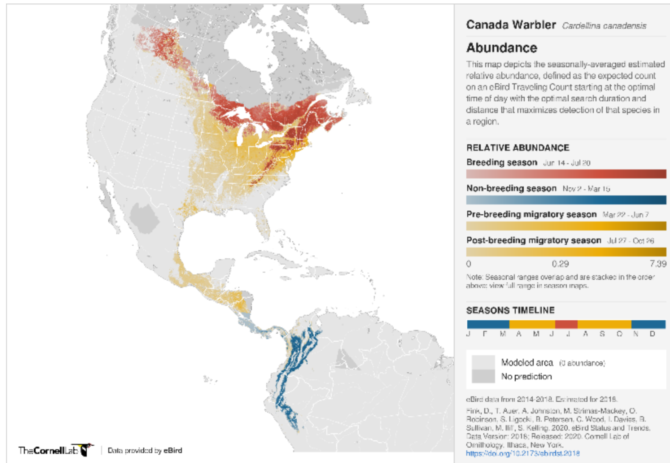
Habitat recommendations

Forest management can emphasize saw-timber products through the use of long rotations with intermediate treatments, uneven-aged management that produces large diameters and relatively closed canopies from dominant trees, or even-aged management (e.g., shelter-wood) with relatively high residual basal area (>10 m^2/ha; >45 $feet^2$/acre) and long rotations. Protect large tracts of forest whenever possible.

Additional species and habitat management information

https://birdsoftheworld.org/bow/species/cerwar/cur/conservation

Canada Warbler
(Cardellina canadensis)



Breeding habitat

- Wet mixed coniferous-deciduous forests often with white cedar (*Thuja occidentalis*), red maple (*Acer rubrum*), and eastern hemlock *(Tsuga canadensis)*, plus spruce (*Picea* spp.) and tamarack (*Larix laricina*) bogs, with a well-developed understory, often near open water. These habitats typically include a moss layer.
- Species also occurs in young mixed forest or gaps resulting from disturbance, such as downed trees from wind-throw.
- Typically nests on the ground, well-concealed under vegetative cover, or in tree stumps, upturned root masses, or sphagnum hummocks.
- Considered limited by collisions with towers, other tall structures, and houses, plus reduction of forest understory (especially from deer browse), and practices that severely reduce canopy cover.

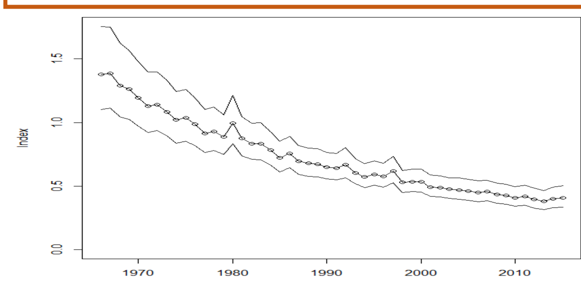
Migration and wintering habitat

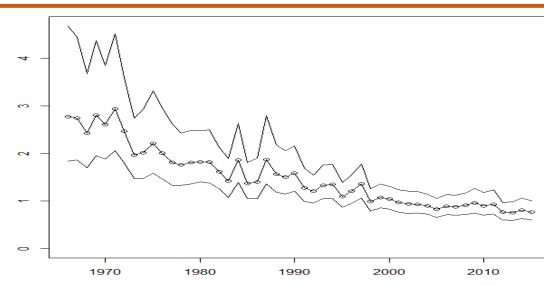
Uses brush and young forest, edges of lowlands or parks, wet woody thickets, swamps, and willow stands. Winters in forests at mid-elevations in northern Andes of South America.

Population status

- U.S./Canada = 2.6 million, with downward trend slowing in recent years. About 11% of BPOP occurs in JV region, with nearly all breeding in the Boreal Hardwood Transition (BCR 12; 11%).
- More at: https://www.mbr-pwrc.usgs.gov/cgi-bin/atlasa15.pl?06860&1&15&csrfmiddlewaretoken=3YKakk7LxT2ki6NSpl4mstudYCqdW02C

Population trend U.S.	BCR 12





Habitat recommendations

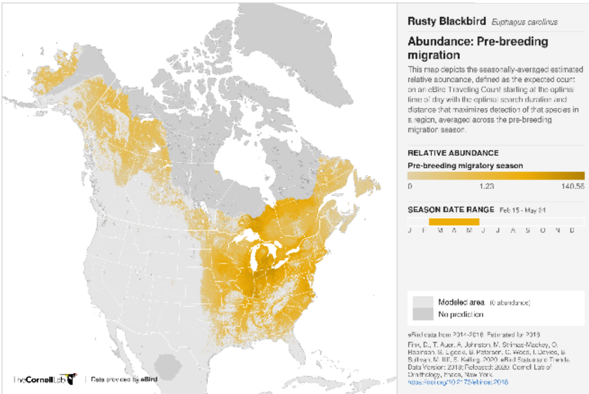
Forest management practices that increase understory vegetation density, especially near open water, and retain canopy trees. Maintain or create mixed-wooded stands with 50-70% canopy cover, a dense understory (height of 0-1.5 m; 0-5 feet) and mid-story (2-10 m; 6-30 ft.), and an uneven forest floor. Often occurs in understory during migration.

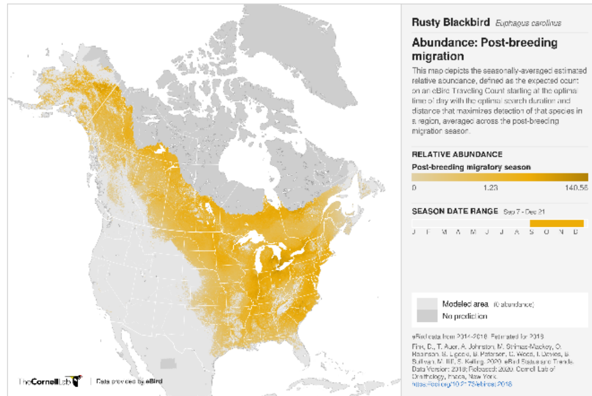
Additional species and habitat management information

https://birdsoftheworld.org/bow/species/canwar/cur/conservation

Rusty Blackbird (nonbreeding) *(Euphagus carolinus)*

Some breeding in JV region, but area most important during migration; small number of individuals remain in southern portions of region throughout winter.





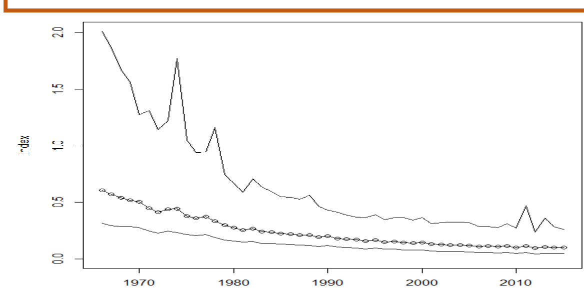
Migration and wintering habitat (Largely from Wright 2017, Wright et al. 2018, 2020)

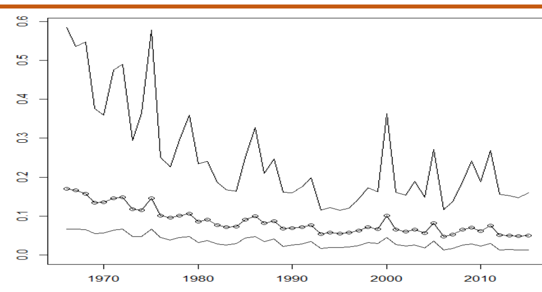
- Foraging flocks during migration use areas with less grass cover and more wet leaf litter, shallow water, shrubs, row-crop stubble fields, mixed habitat complexes, and near edges.
- Roosting habitat at Ohio stopover locations was primarily *Phragmites* and *Typha* marshes, where this species was found mixing in large congregations with other blackbirds.
- At the patch scale, birds prefer dogwood-willow (*Cornus-Salix* spp.) swamp, low-lying forest areas, and locations with greater habitat complexity for foraging.
- Migrates nocturnally, and majority of birds cross open water, including the Great Lakes.
- Nonbreeding habitat limitations include degradation of wet wooded areas (e.g., large-scale clear-cutting that opens areas to invasive species), tower collisions, and potentially mercury toxicity.

Population status

U.S./Canada = 6.8 million, with downward trend slowing.
More at: https://www.mbr-pwrc.usgs.gov/cgi-bin/atlasa15.pl?05090&1&15&csrfmiddlewaretoken=3YKakk7LxT2ki6NSpl4mstudYCqdW02C

Breeding population trend Canada	U.S.





Habitat recommendations

Conservation of complex plant communities in wet woodlands and brush, and herbaceous marsh.

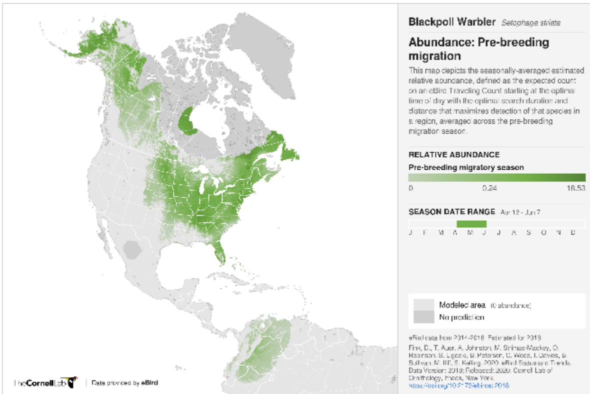
Additional species and habitat management information

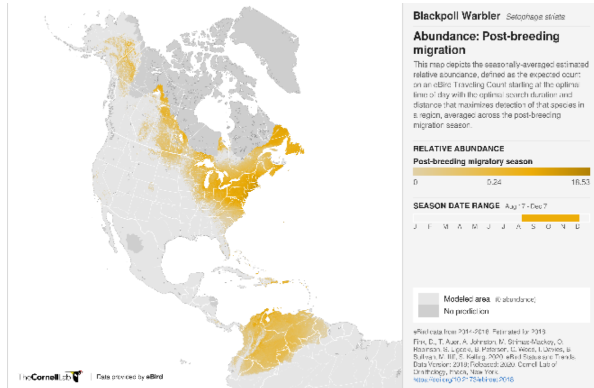
https://birdsoftheworld.org/bow/species/rusbla/cur/conservation

Blackpoll Warbler (nonbreeding)

(Setophaga striata)

JV region most important during the migration period.





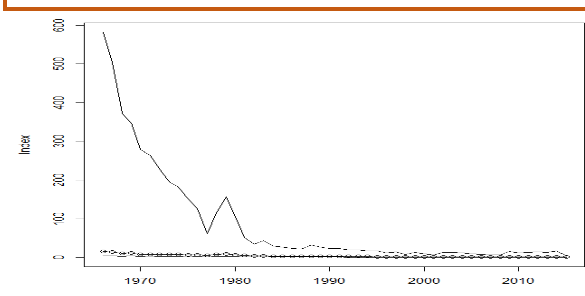
Migration and wintering habitat

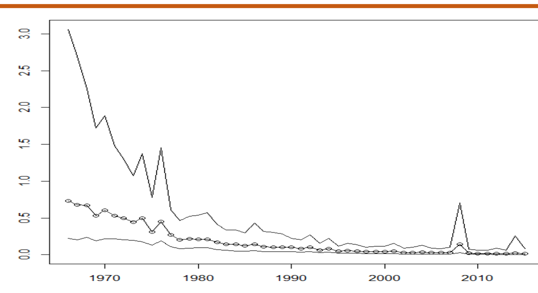
- Species uses a variety of stopover habitats, including mature deciduous and evergreen forests and scrubby areas; appears to favor spruces (*Picea* spp.) and tamarack (*Larix laricina*).
- Migrates through much of eastern North America, with routes as long as 20,000 km (12,000 miles), beginning in Alaska and ending at wintering locations in northern South America.
- Mortality during migration has been high at some artificial structures, including towers and wind-energy facilities.
- More at: https://birdsoftheworld.org/bow/species/bkpwar/cur/habitat

Population status

- U.S./Canada = 60 million, with downward trend continuing in recent years.
- More at: https://www.mbr-pwrc.usgs.gov/cgi-bin/atlasa15.pl?06610&1&15&csrfmiddlewaretoken=3YKakk7LxT2ki6NSpl4mstudYCqdW02C

Breeding population trend Canada U.S.





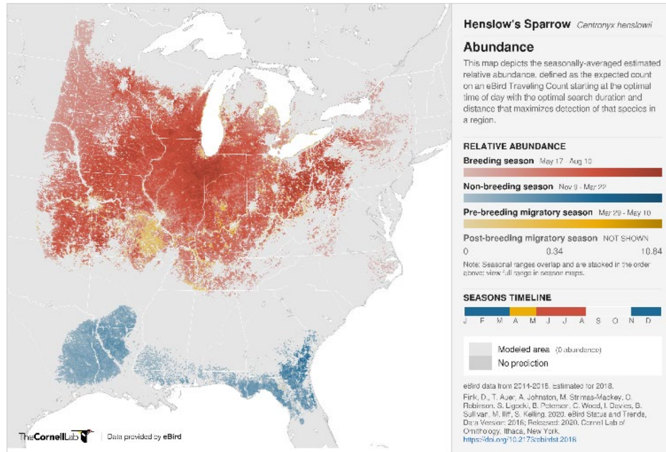
Habitat recommendations

Species appears to be a habitat generalist when occupying the JV region during the migration period, using a wide range of forested or shrub/scrub habitats. It may not require much plant community (habitat) manipulation, but opportunities exist for urban-bird conservation, such as reducing collisions. Little known about specific habitat features that may be limiting population growth.

Additional species and habitat management information

https://birdsoftheworld.org/bow/species/bkpwar/cur/conservation

Henslow's Sparrow
(Ammodramus henslowii)



Breeding habitat requirements

- Dense stands of herbaceous grasslands >30 cm (1.5 feet) tall, >30 ha (75 acres) in size, with well-developed litter layer and standing dead vegetation and minimal woody cover.
- Recently burned grasslands seldom used but species often occupies grasslands 1 year post-fire with densities increasing second year.
- Densities may reach >30 pairs/km^2 (>80/mile^2) in high quality habitat. Densities measured in strip mines (Indiana) were 16 individuals/km^2 and in large prairie fragments densities of 22-28 males/km^2 have been recorded.
- Populations most limited by lack of large native herbaceous grasslands with little woody cover; intense use of agricultural pesticides around grasslands may also influence recruitment.

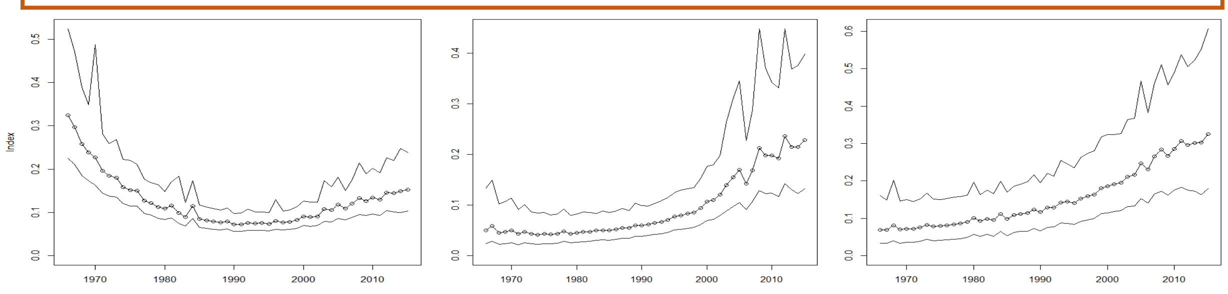
Migration and wintering habitat

Grassy areas similar to breeding habitat but also will use open pines with grassy understories.

Population status

- U.S./Canada = 410,000, recently increasing in BCRs 22 and 24. About 73% of BPOP occurs in JV region, with highest abundance in the Eastern Tallgrass Prairie (BCR 22; 51%), Central Hardwoods (BCR 24; 12%), and Prairie Hardwood Transition (BCR 23; 9%).
- More at: https://www.mbr-pwrc.usgs.gov/cgi-bin/atlasa15.pl?05470&1&15&csrfmiddlewaretoken=3YKakk7LxT2ki6NSpl4mstudYCqdW02C

Population trend U.S.	BCR 22	BCR 24



Habitat recommendations

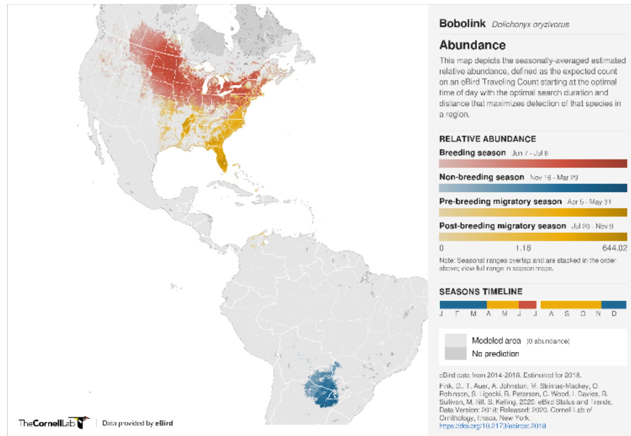
Promote large blocks of native-species grassland >1 km^2 and prescribed burning, with fires 3-4 years apart, as the preferred management approach.

Additional species and habitat management information

https://birdsoftheworld.org/bow/species/henspa/cur/conservation#mngt
https://partnersinflight.org/wp-content/uploads/2017/03/Henslows-Sparrow-Focal-Species-Plan.pdf

Bobolink

(Dolichonyx oryzivorus)



Breeding habitat

- Prairie and hay fields comprised of mixed grasses and forbs, grass-sedge meadows, and other open habitats in low-lying areas. Occupied sites nearly always in landscapes with limited nearby forest cover.
- Population densities typically greater in patchy fields with high litter cover and hay fields having high grass-to-legume ratios. These characteristics often occur in older (>8 years since last plowing and reseeding) hayfields and sites with more warm-season grasses.
- Species limited by grassland loss; in hay fields, vulnerable to mowing due to direct mortality of young or due to weather following removal of protective cover.

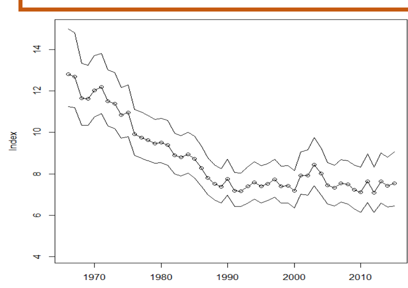
Migration and wintering habitat

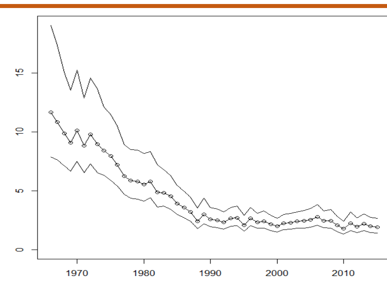
- Grassland and open-lands with herbaceous cover; species often moves along major waterways, taking advantage of wild rice and other seed sources.
- Birds use multiple wintering sites, first in Venezuela, then moving to either Bolivia and remaining, or continuing on to Paraguay (Renfrew et al. 2013).

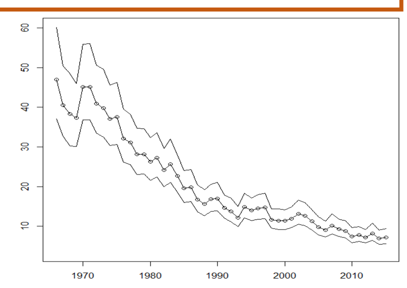
Population status

- U.S./Canada = 10 million, downward trend stabilizing. About 18% of BPOP occurs in JV region, with similar abundances (6% each) in the Eastern Tallgrass Prairie (BCR 22), Prairie Hardwood Transition (BCR 23), and the JV portion of the Boreal Hardwood Transition (BCR 12).
- More at: https://www.mbr-pwrc.usgs.gov/cgi-bin/atlasa15.pl?04940&1&15&csrfmiddlewaretoken=3YKakk7LxT2ki6NSpl4mstudYCqdW02C

Population trend U.S.	BCR 22	BCR 23







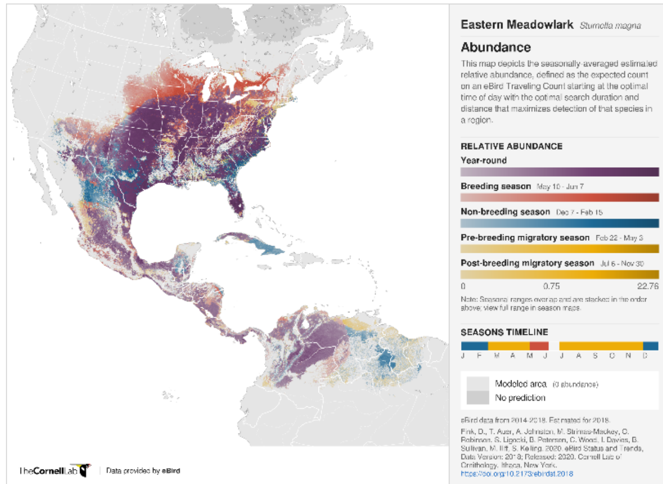
Habitat recommendations

Retain and restore grasslands free from mowing in open (un-forested) landscapes; for working lands, promote delayed mowing (after 1 August) and sustainable ranching / pastures (see links below).

Additional species and habitat management information

https://birdsoftheworld.org/bow/species/boboli/cur/conservation#mngt
https://partnersinflight.org/wp-content/uploads/2019/07/A-Full-Life-Cycle-Conservation-Plan-for-Bobolink.pdf

Eastern Meadowlark
(Sturnella magna)



Breeding habitat requirements

- Most common in open (un-forested) landscapes of native grasslands, pastures, savannas, and tall-grass prairie.
- Also uses hay and alfalfa fields, weedy borders of croplands, roadsides, orchards, golf courses, reclaimed strip mines, airports, shrubby overgrown fields, or other large open areas.
- Species shows preference for grass with a well-developed litter layer and nests in dense vegetation on the ground in a shallow depression.
- Territories are relatively large, ranging from 1-6 ha (3-15 acres) in high quality habitat.
- Loss and degradation of suitable habitat due to intensive agriculture (elimination of grassy corners, use of stronger pesticides) appears to limit species. Early mowing and haying of fields can kill young and adults on nests.

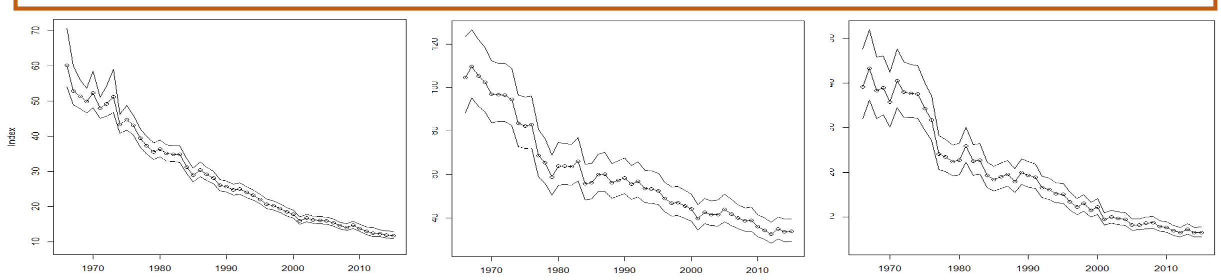
Migration and wintering habitat requirements

Similar to open-country breeding habitat, but including more cropland, feedlots, and also marshes.

Population status

- U.S./Canada = 24 million, still relatively abundant but persistent downward trend. About 29% of BPOP occurs in JV region, with highest abundances in the Eastern Tallgrass Prairie (BCR 22; 24%) and the Prairie Hardwood Transition (BCR 23; 3%).
- More at: https://www.mbr-pwrc.usgs.gov/cgi-bin/atlasa15.pl?04940&1&15&csrfmiddlewaretoken=3YKakk7LxT2ki6NSpl4mstudYCqdW02C

Population trend U.S.	BCR 22	BCR 23



Habitat recommendations

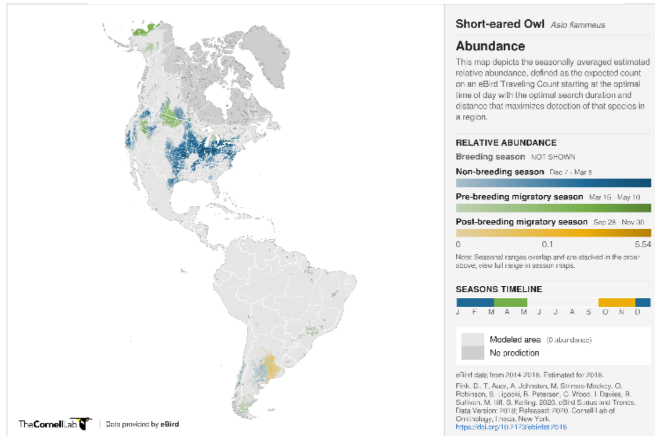
Retain and restore large open complexes of land dominated by grass; delay mowing of hay fields, road right-of-ways, and other open spaces until after first broods are fledged (after 1 July; 1 August if possible). Species may be expanding north with changing climate, potentially creating habitat development opportunities in open but non-traditional landscapes. Complementary management in southwest JV region include practices that benefit Greater Prairie-Chicken and Northern Bobwhite.

Additional species and habitat management information

https://birdsoftheworld.org/bow/species/easmea/cur/conservation#mngt

Short-eared Owl (nonbreeding)
(Asio flammeus)

JV region important to species primarily during wintering period.



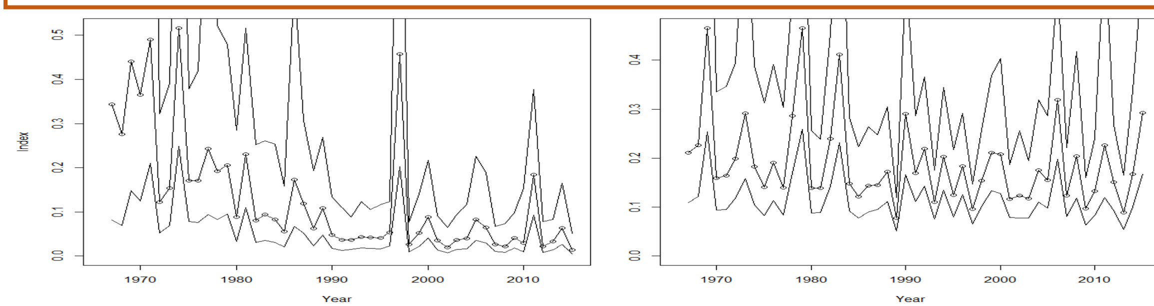
Wintering habitat

- Species uses JV region primarily during winter, requiring large blocks of habitat (>100 ha; 250 acres), typically with relatively short grasses (i.e., shorter than found in idle fields).
- Species hunts low to the ground during the day and night. Studies have documented an apparent preference for grasslands with vegetation less than 30 cm (1 foot) in height (Missouri).
- Most commonly found in native grassland, pasture, and savanna, but also use complexes with fields of hay and alfalfa, weedy borders of croplands, tall-grass prairie, roadsides, orchards, golf courses, reclaimed strip mines, airports, shrubby overgrown fields, or other open areas.
- Wintering range may also include woodlots (they occasionally roost in trees), stubble feeds, fresh marshes, weedy fields, dumps, gravel pits, rock quarries, and shrub thickets. Species may shift wintering sites due to changes in local prey abundance, provided suitable habitat is available (they may even remain in region during breeding period in a given wintering area if food is plentiful).
- Loss and degradation of suitable habitat often related to intensive agriculture practices.

Population status

U.S./Canada = 660,000, breeding primarily in the Arctic Tundra, and wintering primarily in the U.S. Scientists have documented a 65% population decline between 1970 and 2014.

Breeding population trend Canada U.S.



Habitat recommendations

Promote creating and retaining open landscapes with core areas of grassland/herbaceous and pasture/hay >100 ha (>250 acres) in size. Enrollment of private lands into CRP (and/or WRP) can help provide long-term openness and adequate plant structure to provide food and cover. Late summer or early fall burning resulting patches of short grasses in open complexes can enhance wintering habitat. Complementary species management in region include practices that benefit Greater Prairie-Chicken.

Additional species and habitat management information

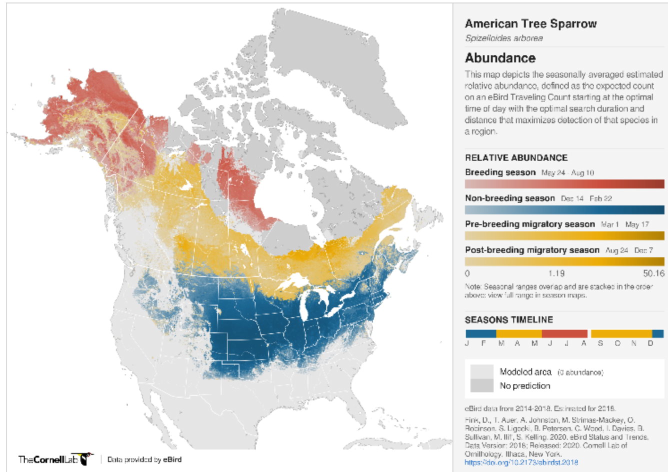
https://birdsoftheworld.org/bow/species/sheowl/cur/conservation

American Tree Sparrow (nonbreeding) *(Spizella arborea)*

Species readily uses herbaceous and woody plant communities. JV region important primarily during wintering period.

Migration and wintering habitat

- Common winter visitor throughout the JV region, settling into weedy fields, marshes, open groves of trees, open forests, gardens, and even backyards with feeding stations, which are similar habitats used during migration.
- Land use practices such as agricultural intensification and succession of old fields into brush and forest, have resulted in loss of open habitats favored by this species in winter.
- Species abundance may be limited by a loss of suitable wintering areas.



Population status

U.S./Canada = 22 million, breeding primarily in the Arctic tundra, and wintering in the northern U.S. and Canada. Species breeding abundance and trends not generated from the BBS, but scientists have documented a 53% population decline between 1970 and 2014.

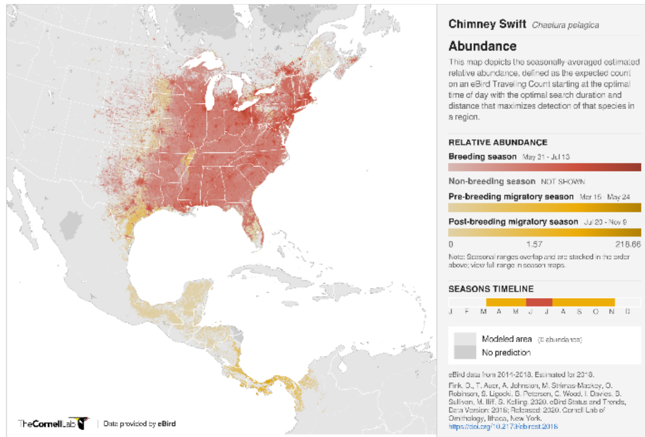
Habitat recommendations

Promote grasslands, including weedy fields, grassy hedgerows, and other herbaceous stands with scattered shrubs and saplings, and reduce agricultural intensification. Establishment of native plantings around homes may provide forage such as seeds, berries, catkins, and insect eggs and larvae. Seek complementary game species management, especially for Ring-necked Pheasant and Northern Bobwhite.

Additional species and habitat management information

https://birdsoftheworld.org/bow/species/amtspa/cur/conservation

Chimney Swift
(Chaetura pelagica)



Breeding habitat requirements

- Largest concentrations occur in urban and suburban areas, where older homes and buildings have open (accessible) chimneys constructed of brick or stone.
- In remote areas, species typically uses hollow trees, tree cavities, or cave walls for nest and roost sites.
- Fewer chimneys, unsuitable chimney construction materials and more caps, and a transition away from wood for home heating has likely negatively influenced species distribution and abundance. Loss of old-growth forest and associated nest and roost sites can also result in local population declines.
- May be limited during breeding period by mortality associated with chimney fires and cleaning. Prolonged periods of cool wet weather can depress insect abundance and survival of adults and their young; increasingly toxic pesticides and lower overall insect abundance also assumed.

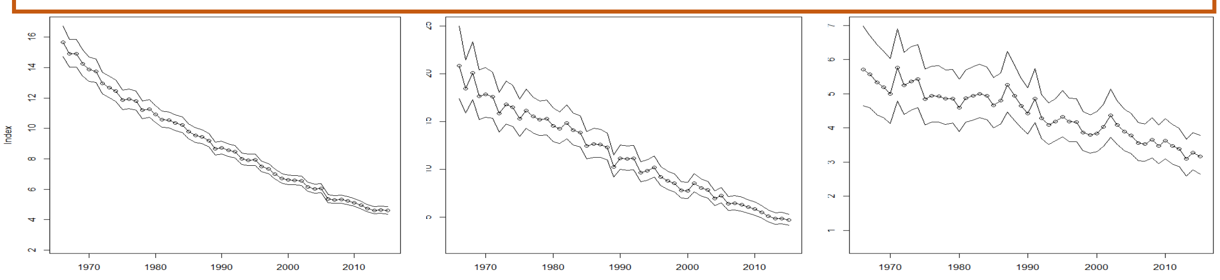
Migration and wintering habitat requirements

- Chimneys in urban areas, old-growth forest, and sometimes caves are used during migration and winter; large flocks often roost in accessible chimneys.
- Mortality due to collisions with towers has been recorded, but declines in insect populations is likely more detrimental to this aerial insectivore.

Population status

- U.S./Canada = 9 million, with continuous downward trend. About 21% of BPOP occurs in JV region, with highest abundances in the Eastern Tallgrass Prairie (BCR 22; 13%) and the Prairie Hardwood Transition (BCR 23; 4%).
- More at: https://www.mbr-pwrc.usgs.gov/cgi-bin/atlasa15.pl?04230&1&15&csrfmiddlewaretoken=3YKakk7LxT2ki6NSpl4mstudYCqdW02C

Population trend U.S. | BCR 22 | BCR 23



Habitat recommendations

Retain suitable nesting and roosting sites, particularly old-growth forest with hollow trees. Avoid chimney cleaning during breeding period, and seek alternatives to extensive insecticide use.

Additional species and habitat management information

https://birdsoftheworld.org/bow/species/boboli/cur/conservation#mngt

Cornell Lab of Ornithology Birds of the World citations and other references for JV focal species accounts – Appendix D (only)

Avery, M. L. 2020. Rusty Blackbird (*Euphagus carolinus*), version 1.0. In Birds of the World (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.rusbla.01

Bocetti, C. I., D. M. Donner, and H. F. Mayfield. 2020. Kirtland's Warbler (*Setophaga kirtlandii*), version 1.0. In Birds of the World (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.kirwar.01

Buehler, D. A., P. B. Hamel, and T. Boves. 2020. Cerulean Warbler (*Setophaga cerulea*), version 1.0. In Birds of the World (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.cerwar.01

Cink, C. L., P. Pyle, and M. A. Patten. 2020. Eastern Whip-poor-will (*Antrostomus vociferus*), version 1.0. In Birds of the World (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.whip-p1.01

Confer, J. L., P. Hartman, and A. Roth. 2020. Golden-winged Warbler (*Vermivora chrysoptera*), version 1.0. In Birds of the World (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.gowwar.01

DeLuca, W., R. Holberton, P. D. Hunt, and B. C. Eliason. 2020. Blackpoll Warbler (*Setophaga striata*), version 1.0. In Birds of the World (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.bkpwar.01

Evans, M., E. Gow, R. R. Roth, M. S. Johnson, and T. J. Underwood. 2020. Wood Thrush (*Hylocichla mustelina*), version 1.0. In Birds of the World (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.woothr.01

Frei, B., K. G. Smith, J. H. Withgott, P. G. Rodewald, P. Pyle, and M. A. Patten. 2020. Red-headed Woodpecker (*Melanerpes erythrocephalus*), version 1.0. In Birds of the World (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.rehwoo.01

Herkert, J. R., P. D. Vickery, and D. E. Kroodsma. 2020. Henslow's Sparrow (*Centronyx henslowii*), version 1.0. In Birds of the World (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.henspa.01

Jaster, L. A., W. E. Jensen, and W. E. Lanyon. 2020. Eastern Meadowlark (*Sturnella magna*), version 1.0. In Birds of the World (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.easmea.01

Korpach, A. M., A. Mills, C. Heidenreich, C. M. Davy, and K. C. Fraser. 2019. Blinded by the light? Circadian partitioning of migratory flights in a nightjar species. Journal of Ornithology 160:835–840.

Kramer, G. R., D. E. Andersen, D. A Buehler, P. B. Wood, S. M. Peterson, J. A. Lehman, K. R. Aldinger, L. P. Bulluck, S. Harding, J. A. Jones, and J. P. Loegering. 2018. Population trends in Vermivora warblers are linked to strong migratory connectivity. Proceedings of the National Academy of Sciences 115(14): E3192–E3200.

Naugler, C. T., P. Pyle, and M. A. Patten. 2020. American Tree Sparrow (*Spizelloides arborea*), version 1.0. In Birds of the World (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.amtspa.01

Reitsma, L. R., M. T. Hallworth, M. McMahon, and C. J. Conway. 2020. Canada Warbler (*Cardellina canadensis*), version 2.0. In Birds of the World (P. G. Rodewald and B. K. Keeney, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.canwar.02

Renfrew, R., A. M. Strong, N. G. Perlut, S. G. Martin, and T. A. Gavin. 2020. Bobolink (*Dolichonyx oryzivorus*), version 1.0. In Birds of the World (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.boboli.01

Stanley, C. Q., E. A. McKinnon, K. C. Fraser, M. P. Macpherson, G. Casbourn, L. Friesen, P. P. Marra, C. Studds, T. B. Ryder, N. E. Diggs, and B. J. Stutchbury. 2015. Connectivity of wood thrush breeding, wintering, and migration sites based on range-wide tracking. Conservation Biology 29:164–174.

Steeves, T. K., S. B. Kearney-McGee, M. A. Rubega, C. L. Cink, and C. T. Collins. 2020. Chimney Swift (*Chaetura pelagica*), version 1.0. In Birds of the World (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.chiswi.01

Tonra, C. M., J. R. Wright, and S. N. Matthews. 2019. Remote estimation of overwintering home ranges in an elusive, migratory nocturnal bird. Ecological Evolution 9:12586–12599. https://doi.org/10.1002/ece3.5723

Wiggins, D. A., D. W. Holt, and S. M. Leasure. 2020. Short-eared Owl (*Asio flammeus*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.sheowl.01

Wright, J. R. 2017. Migration Ecology of a Declining Songbird, the Rusty Blackbird *(Euphagus carolinus).* M.S. Thesis, The Ohio State University, Columbus OH.

Wright, J. R., L. L. Powell, and C. M. Tonra. 2018. Automated telemetry reveals staging behavior in a declining migratory passerine. Auk: Ornithological Advances 135:461–476.

Wright, J. R., L. L. Powell, S. N. Matthews, C. M. Tonra. 2020. Rusty Blackbirds select areas of greater habitat complexity during stopover. Condor: Ornithological Applications: duaa040.

Appendix E. Breeding focal species BCR abundance estimates, trends, and goals within the Upper Mississippi / Great Lakes Joint Venture (JV) boundary. Abundance goals established using PIF frameworks for Watch List species in categories *Yellow R – prevent decline, Yellow D – reverse decline,* and *Common Birds in Steep Decline – stabilize population.*

Breeding Focal Species
Eastern Whip-poor-will
Red-headed Woodpecker
Wood Thrush
Cerulean Warbler
Canada Warbler
Bobolink
Eastern Meadowlark
Henslow's Sparrow
Chimney Swift

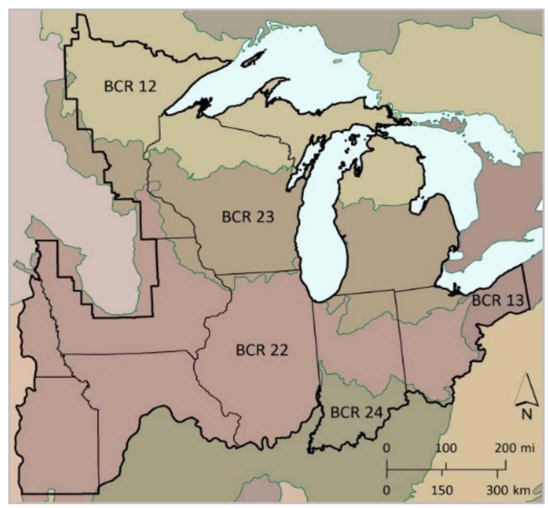
Note: Kirtland's Warbler *(Watch List – Yellow R)* and Golden-winged Warbler *(Watch List – Red)* conservation plans offer abundance objectives separate from the 2016 PIF Plan, and these JV focal species were not included in the analysis below.

Kirtland's Warbler: Breeding Range Conservation Plan (2015) goal is to sustain a population throughout its known breeding range >1,000 breeding pairs. Current estimate in JV region = 4,800 individuals.

Golden-Winged Warbler: Status Review and Conservation Plan (Roth et al. 2019) population goal for the Great Lakes Region = 441,000 individuals by 2020 and 588,000 by 2050. Current estimate in JV region = 313,000.

Tables and Figures

Bird Conservation Regions (BCRs) include 12 (Boreal Hardwood Transition, JV portion only), 13 (Lower Great Lakes/St. Lawrence Plain, JV portion only), 22 (Eastern Tallgrass Prairie), 23 (Prairie Hardwood Transition), and 24 (Central Hardwoods, JV portion only).



Boundaries of Joint Venture region (bolded black line) and associated Bird Conservation Regions (color discerned).

Tables

- Initial population size based on mean abundance estimate for 2006 – 2015, and BBS population trend is from the same period.
- Goals for annual trend estimates provided for Year 10 (interim) and Year 30.
- Projected population Year 30 – serves as population abundance objective over time with effective conservation actions.
- Business as usual Year 30 – projects population abundance using current trend, without new effective conservation actions.
- Difference = Estimated population loss over 30 years with and without effective conservation (Population Objective Year 30 – Projected Population with Business as Usual scenario).

Figures

- Solid trend lines are based on projected annual populations out to 30 years with conservation goal achievement (i.e., serving as moving population objectives)
- Dashed lines are projected population estimates out to 30 years based on current (2006–2015) trends without effective conservation actions.

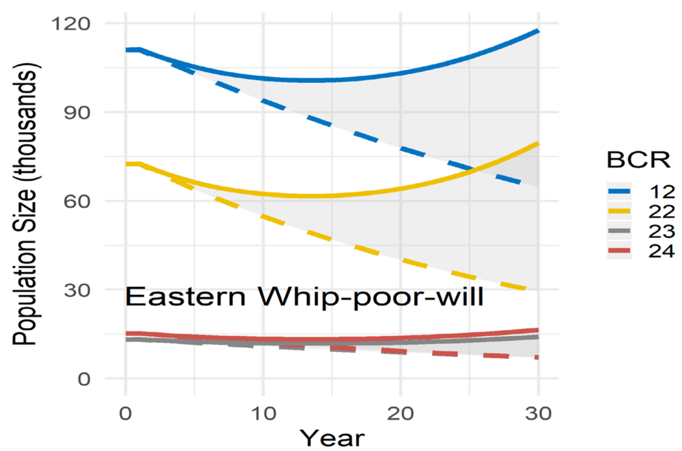
Continental Concern Group	PIF Population Goals	
	10 years	30 years
"R" Yellow Watch List (prevent decline)	Maintain at least a stable population (+ 3% change)	Maintain at least a stable long-term population (+3% change)
"D" Yellow Watch List (reverse decline)	Slow rate of decline by 60 - 75%	Increase current population by 5 – 15%
Common Bird in Steep Decline	Slow rate of decline by 45 - 60%	Achieve stable population at 10 – 25% below current level

Forest / Savanna Breeding Focal Species

Eastern Whip-poor-will
PIF Watch List Yellow D (reverse decline)

Year 10: Reduce downward trends in all BCRs by 75%

Year 30: Achieve positive annual trends in all BCRs and achieve the goal of +5% total change in population after 30 years

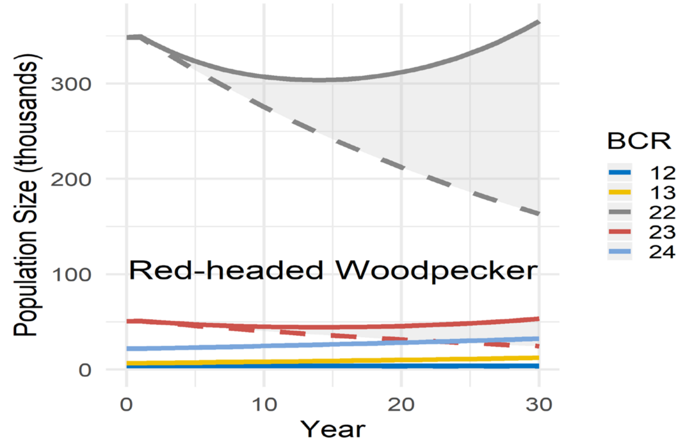


BCR	Initial population size	BBS trend (2006-2015)	Annual trend goal Year 10	Annual trend goal Year 30	Projected population Year 30 (objective)	Business as usual Year 30	Difference
12	113,100	-1.85	-0.46	1.85	117,710	64,928	52,782
22	74,700	-3.05	-0.76	3.05	79,643	29,919	49,724
23	13,500	-2.07	-0.52	2.07	14,114	7,255	6,859
24	15,600	-2.56	-0.64	2.56	16,472	7,237	9,235

Red-headed Woodpecker
PIF Watch List Yellow D
(reverse decline)

Year 10: Maintain positive trends in BCRs 13 and 24 and reduce downward trend in BCRs 12, 22, and 23 by 75%

Year 30: Achieve positive annual trends in all BCRs and achieve the goal of +5% total change in population after 30 years

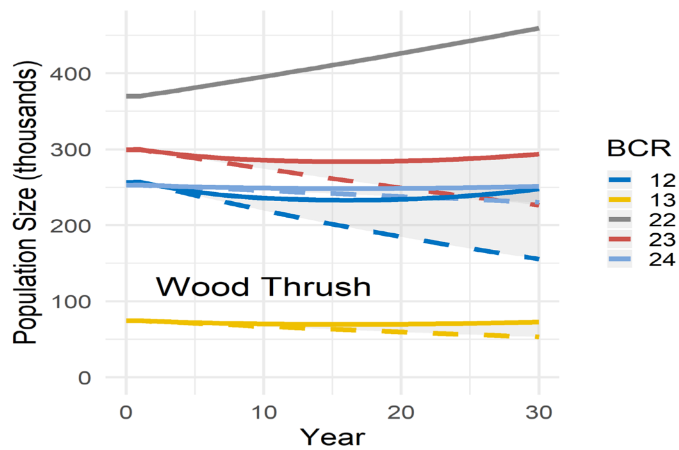


BCR	Initial population size	BBS trend (2006-2015)	Annual trend goal Year 10	Annual trend goal Year 30	Projected population Year 30 (objective)	Business as usual Year 30	Difference
12	3,900	-0.29	-0.07	0.25	3,910	3,575	335
13	6,700	2.06	2.06	2.06	12,352	12,430	N/A
22	358,000	-2.58	-0.64	2.26	365,748	165,097	200,651
23	52,200	-2.50	-0.62	2.19	53,299	24,658	28,641
24	21,600	1.36	1.36	1.36	32,393	32,482	N/A

Wood Thrush
PIF Watch List Yellow D
(reverse decline)

Year 10: Maintain positive trend in BCR 22 and reduce downward trends in BCRs 12, 13, 23, and 24 by 75%

Year 30: Achieve positive annual trends in all BCRs and achieve the goal of +5% total change in population after 30 years

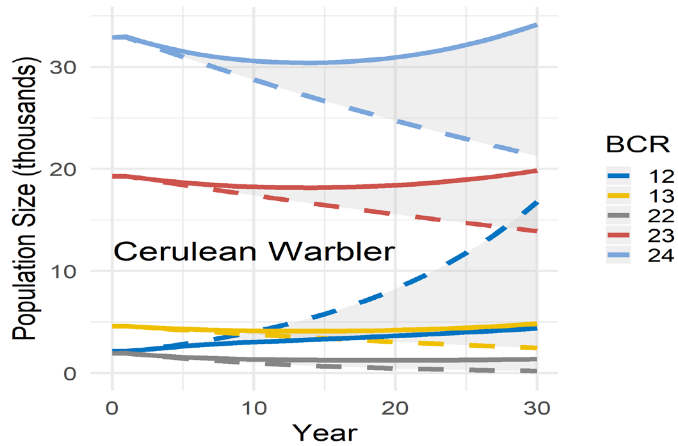


BCR	Initial population size	BBS trend (2006-2015)	Annual trend goal Year 10	Annual trend goal Year 30	Projected population Year 30 (objective)	Business as usual Year 30	Difference
12	261,100	-1.71	-0.43	0.85	247,852	156,320	91,532
13	75,300	-1.15	-0.29	0.57	72,721	53,329	19,392
22	367,200	0.75	0.75	0.75	459,467	459,853	N/A
23	302,400	-0.96	-0.24	0.48	293,744	226,728	67.016
24	253,800	-0.32	-0.08	0.16	251,368	230,568	20,800

Cerulean Warbler
PIF Watch List Yellow D
(reverse decline)

Year 10: Reduce downward trends in BCRs 13, 22, 23, and 24 by 75%; assume current positive trend in BCR 12 is not sustainable

Year 30: Achieve positive annual trends in all BCRs and achieve the goal of +5% total change in population after 30 years

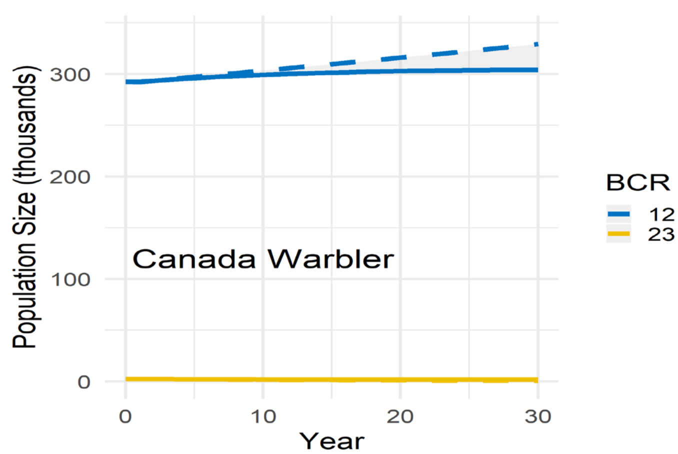


BCR	Initial population size	BBS trend (2006-2015)	Annual trend goal Year 10	Annual trend goal Year 30	Projected population Year 30 (objective)	Business as usual Year 30	Difference
12	2,000	7.35	1.84	1.84	4,389	18,141	N/A
13	4,700	-2.10	-0.52	1.97	4,850	2,503	2,347
22	2,100	-7.14	-1.78	1.79	1,390	247	1,143
23	19,500	-1.12	-0.28	1.05	19,840	13,935	5,905
24	33,400	-1.49	-0.37	1.40	34,168	21,361	12,807

Canada Warbler
PIF Watch List Yellow D
(reverse decline)

Year 10: Reduce downward trend in BCR 23 by 60%; assume positive trend in BCR 12 is not sustainable

Year 30: Achieve annual trend population stability (0% annual trend) and +4% total population change

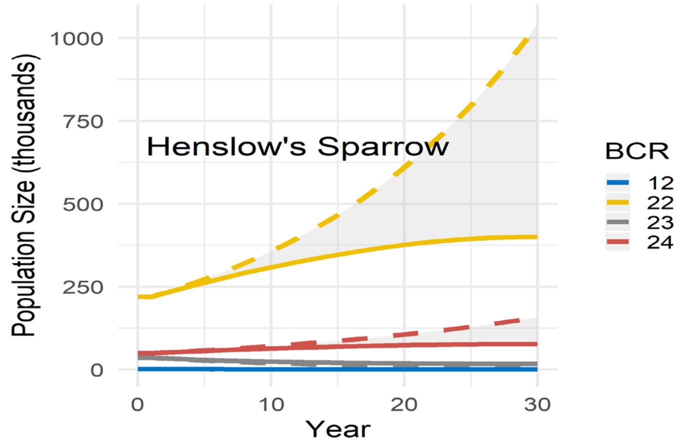


BCR	Initial population size	BBS trend (2006-2015)	Annual trend goal Year 10	Annual trend goal Year 30	Projected population Year 30 (objective)	Business as usual Year 30	Difference
12	291,200	0.41	0.16	0.00	303,995	329,314	N/A
23	2,600	-3.25	-1.30	0.00	1,843	981	862

Henslow's Sparrow
PIF Watch List Yellow R
(prevent decline)

Year 10: Reduce trends in all BCRs by 50% assuming the steep positive trend in BCR 22 is not sustainable

Year 30: Achieve annual trend population stability (0% annual trend) and long term population stability



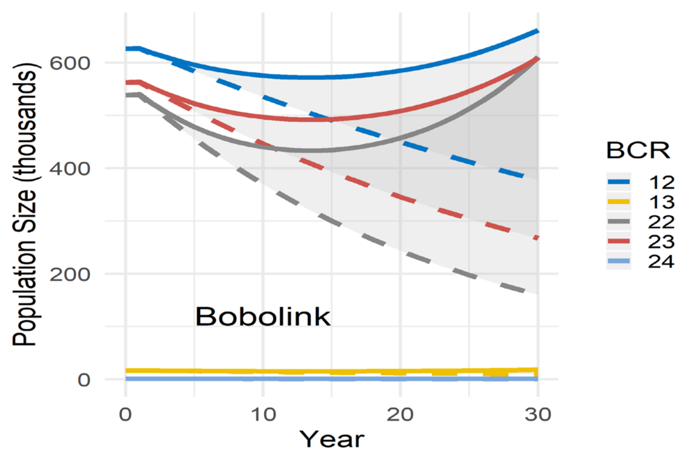
BCR	Initial population size	BBS trend (2006-2015)	Annual trend goal Year 10	Annual trend goal Year 30	Projected population Year 30 (objective)	Business as usual Year 30	Difference
12	1,800	-3.20	-1.60	0.00	1,222	689	533
22	208,700	5.51	2.75	0.00	400,103	1,089,962	N/A
23	38,400	-6.35	-3.17	0.00	17,664	5,715	11,949
24	47,700	4.06	2.03	0.00	77,205	161,246	N/A

Note: Projected large populations in BCRs 22 and 24 with Business as usual Year 30 scenario reflect a continuation of current (unrealistic) upward trends in these BCRs for a 30 period.

Bobolink
PIF Watch List Yellow D
(reverse decline)

Year 10: Reduce downward trends in all BCRs by 75%

Year 30: Achieve positive annual trends in all BCRs and achieve the goal of +5% total change in population after 30 years

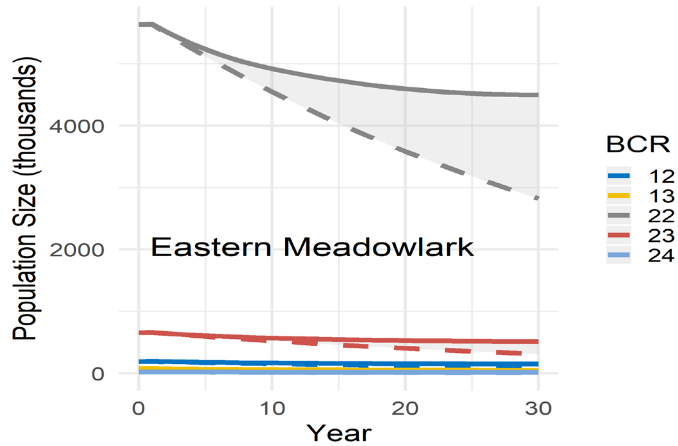


BCR	Initial population size	BBS trend (2006-2015)	Annual trend goal Year 10	Annual trend goal Year 30	Projected population Year 30 (objective)	Business as usual Year 30	Difference
12	637,100	-1.73	-0.43	1.73	661,418	379,148	282,270
13	17,400	-1.95	-0.49	1.95	18,147	9,694	8,453
22	561,400	-4.09	-1.02	4.09	610,503	164,586	445,917
23	576,800	-2.53	-0.63	2.53	608,677	270,020	338,657
24	1,200	-2.78	-0.69	2.78	1,273	521	752

Eastern Meadowlark
PIF Watch List - Common bird in steep decline

Year 10: Reduce downward trends in all BCRs by 60%

Year 30: Achieve annual trend population stability (0% annual trend) and lose no more than 25% of the original population size



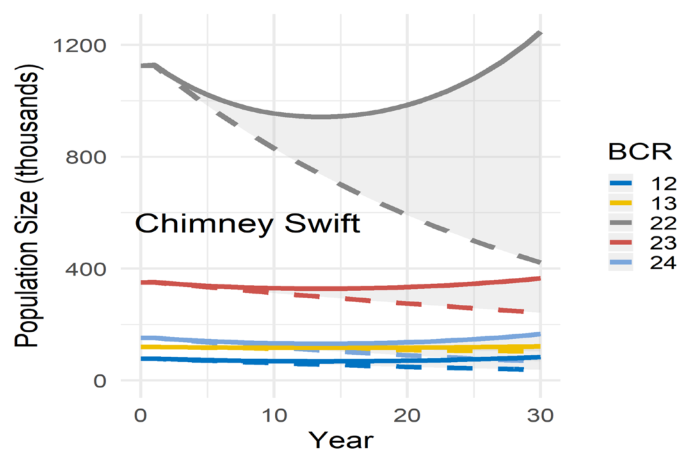
BCR	Initial population size	BBS trend (2006-2015)	Annual trend goal Year 10	Annual trend goal Year 30	Projected population Year 30 (objective)	Business as usual Year 30	Difference
12	199,300	-2.46	-0.98	0.00	153,660	95,279	58,321
13	84,000	-4.48	-1.79	0.00	52,170	21,907	30,263
22	5,769,200	-2.35	-0.94	0.00	4,500,426	2,850,611	1,649,815
23	677,400	-2.54	-1.02	0.00	517,846	316,164	201,682
24	25,400	-3.06	-1.22	0.00	18,370	10,143	8,227

Urban Breeding Focal Species

Chimney Swift
PIF Watch List Yellow D (reverse decline)

Year 10: Reduce downward trends in all BCRs by 75%

Year 30: Achieve positive annual trends in all BCRs and achieve the goal of +5% total change in population after 30 years

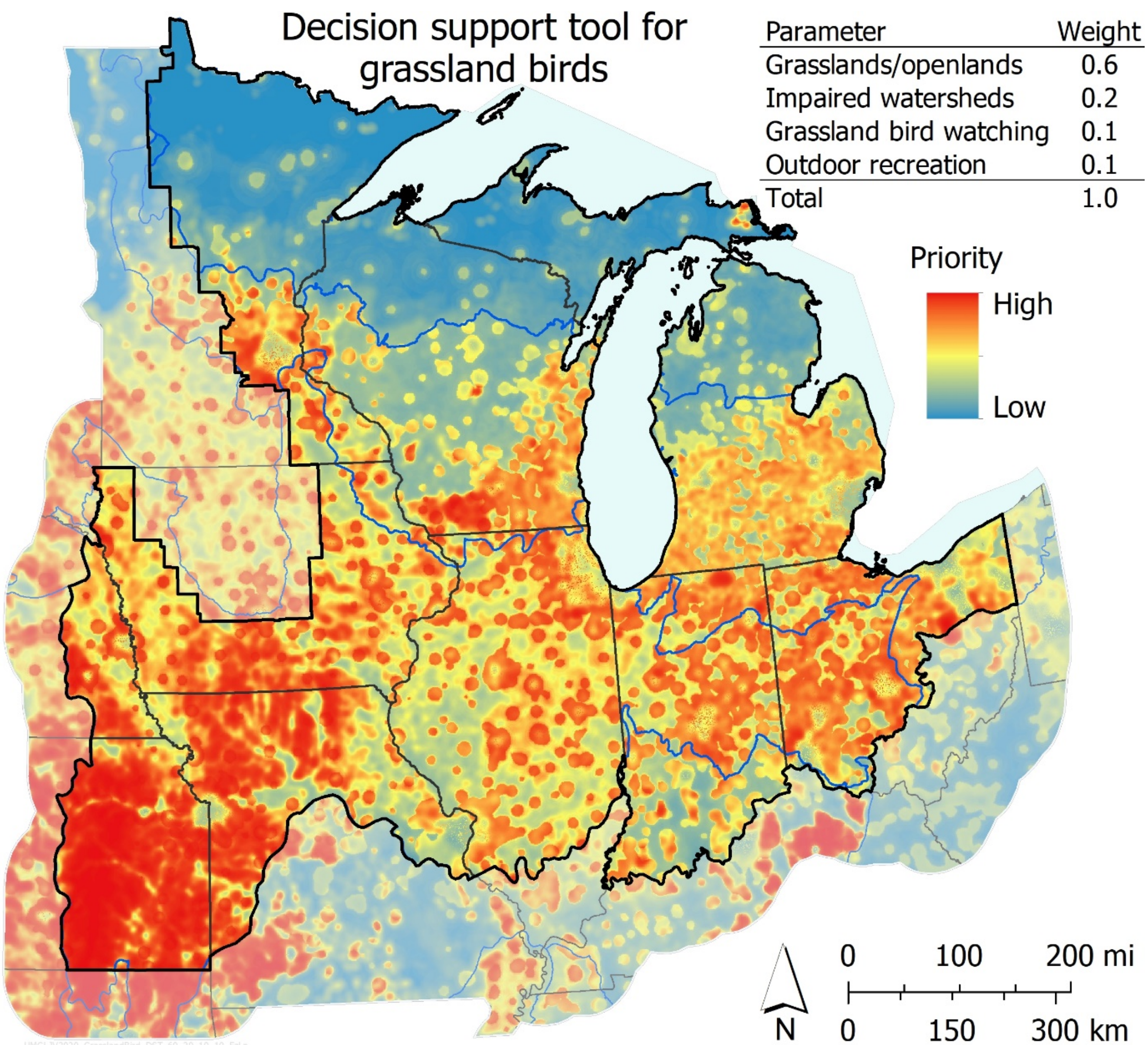


BCR	Initial population size	BBS trend (2006-2015)	Annual trend goal Year 10	Annual trend goal Year 30	Projected population Year 30 (objective)	Business as usual Year 30	Difference
12	79,900	-2.43	-0.61	2.43	84,147	38,198	45,949
13	120,500	-0.50	-0.13	0.50	121,848	103,676	18,172
22	1,164,200	-3.33	-0.83	3.33	1,247,993	421,482	826,511
23	355,800	-1.27	-0.32	1.27	365,824	242,482	123,342
24	156,600	-2.73	-0.68	2.73	165,915	68,259	97,656

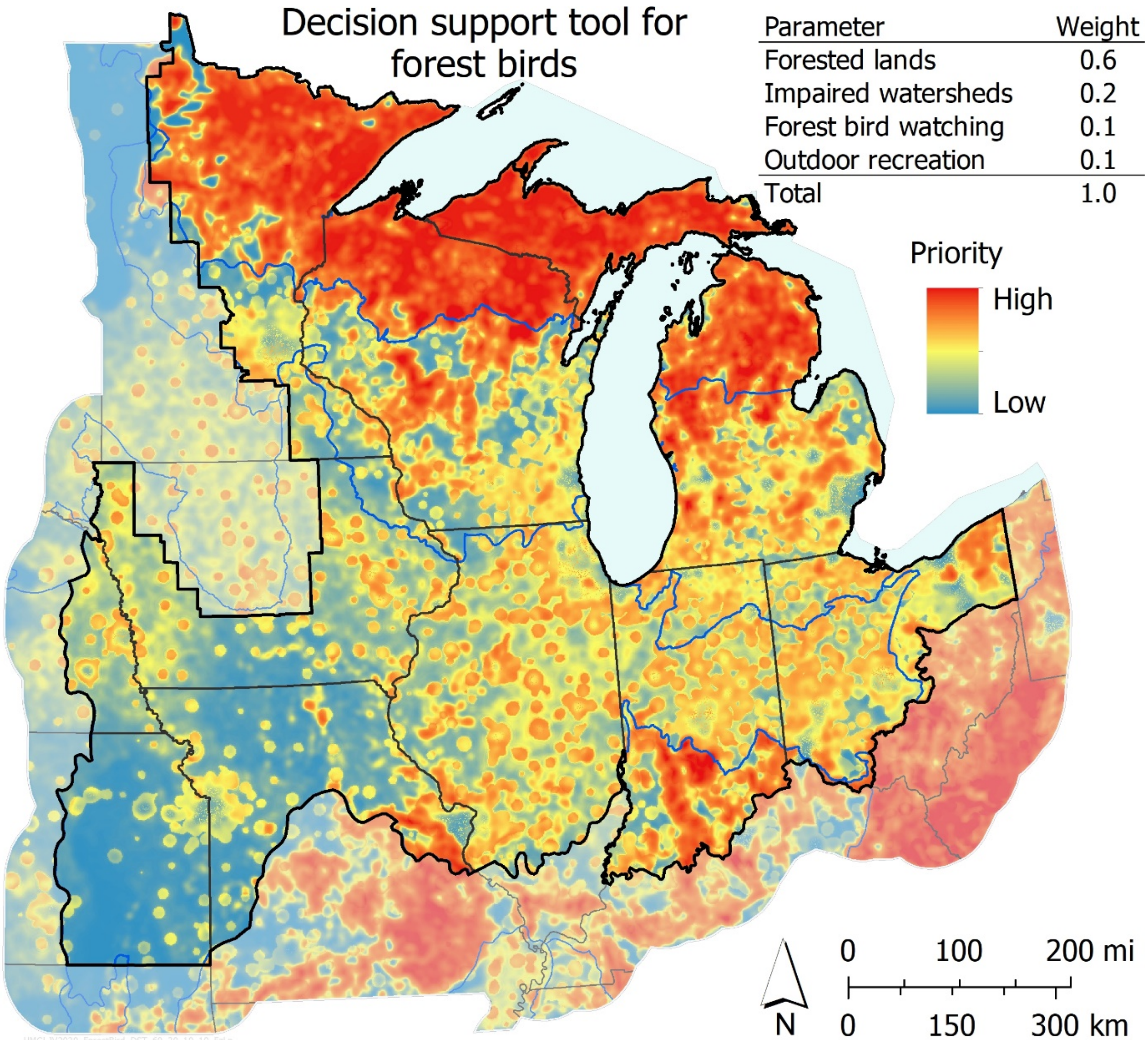
Appendix F. Integration of biological and social objectives provides a means to increase the relevance of bird habitat conservation to people. Spatial data layers representing each objective are weighted for importance (objective prioritization) and combined to produce a decision support tool (DST). The DST identifies highest priority areas of the JV region to target conservation actions that best achieve the integrated objectives.

Below are example DSTs for grassland birds (A) and forest birds (B) with the following sample objectives and weights: Habitat density and distribution (60%; A–grasslands/open-lands and B–forest cover; Figures 12A and 17A in Strategy), Impaired landscapes (20%; combined cropland and developed land density and distribution), Bird watching opportunity (10%; based on eBird data; Figure 10A in Strategy but forest and grassland birds analyzed separately here), and Outdoor recreation opportunity (10%; potential high-use areas based on human population density; Figure 10B in Strategy). This methodology (see Soulliere and Al-Saffar 2017) was used in other JV bird-group strategies; objectives and weights can be adjusted with input from stakeholders, resulting in a reprioritized map to target conservation.

A



B


Decision support tool for forest birds
Parameter Weight
Forested lands 0.6
Impaired watersheds 0.2
Forest bird watching 0.1
Outdoor recreation 0.1
Total 1.0
Priority
High
Low
0 100 200 mi
0 150 300 km
N

Appendix G. Check list of community-based (Bird City) conservation actions especially relevant to urban and developed landscapes and drawn from several Bird City Programs. Typical actions to enhance conservation are grouped into categories and best practices. Depending on state-program requirements, a specified number of best practices (usually 2-3) must be completed within each category before a community can be certified as a Bird City. Bird Cities are also required to adopt an official municipal resolution and hold a celebration recognizing [World Migratory Bird Day](#).

Category I: Educate and Engage Communities in Birding and Conservation

- ☐ *Best Practice #1:* Increase awareness of birds in your community
  - ☐ (1) Create a map and/or information about birding locations in your area and make it available to community members and tourist outlets in print and/or online.
  - ☐ (2) Develop a birding checklist for your area and make it available to community members and tourist outlets in print and/or online.
  - ☐ (3) Install and maintain a birding kiosk and/or signage that identifies birding locations in your area.
  - ☐ (4) Share regular social media posts about birds and birding.
  - ☐ (5) Promote Important Bird Areas (IBAs), birding hotspots, birding trails and phenomena (ex. Raptor, waterfowl or songbird migration, Chimney Swift roosts in your area).
  - ☐ (6) Install or promote local nest cameras (but take care if/when disclosing nest locations to avoid disturbance).
  - ☐ Other - provide details of other actions for consideration to meet this best practice.

- ☐ *Best Practice #2:* Involve residents in conservation and stewardship projects
  - ☐ (1) Create and maintain and/or encourage bird feeding stations at parks, nature centers, schools and tourism / lodging sites.
  - ☐ (2) Illustrate how your community has a program that involves schools, garden clubs, or other organizations in bird conservation activities.
  - ☐ (3) Develop a program to involve community members in hands-on land and stewardship projects. (GS #18.8)
  - ☐ (4) Research Important Bird Areas (IBAs) in your community and encourage stewardship activities within them (ex. Bird and/or habitat monitoring, restoration, advocacy).
  - ☐ (5) Support the creation of a stewardship group for important birding resources in your community - an Important Bird Area (IBA), Bird Sanctuary, Birding Trail or similar.
  - ☐ Other - provide details of other actions for consideration to meet this best practice.

- ☐ *Best Practice #3:* Educate and engage youth audiences
  - ☐ (1) Promote the creation of a youth birding club / support their activities.
  - ☐ (2) Demonstrate that schools in your community participate in *Flying WILD*, helping ensure that the nation's students are knowledgeable about the conservation needs of migratory and other birds.
  - ☐ (3) Sponsor or facilitate training for educators in *Flying WILD* curriculum.

- ☐ (4) Provide bird related programs for children, youth and families.
- ☐ Other - Demonstrate actions that meet this best practice in an attached narrative.

☐ *Best Practice #4:* Promote community science monitoring and research

- ☐ (1) Demonstrate that your community is represented in at least one bird monitoring program such as the Christmas Bird Count, Great Backyard Bird Count, or Chimney Swift Sit.
- ☐ (2) Attach a summary of bird monitoring results and/or other data obtained from researchers or local volunteers at sites within the municipality.
- ☐ (3) Create an eBird account for your community, designate your local birding areas as hotspots and encourage park visitors, volunteers and staff to submit sightings.
- ☐ (4) Encourage bird monitoring (ex. In conjunction with regular park programming or in cooperation with local birding groups) and submit sightings to eBird.
- ☐ (5) Encourage / support nest box and feeder monitoring through Nestwatch, FeederWatch or equivalent.
- ☐ (6) Facilitate citizen participation in water quality monitoring (ex. WHEP - Wetland Health Evaluation Project).
- ☐ Other - provide details of other actions for consideration to meet this best practice.

☐ *Best Practice #5: Ensure access to nature*

- ☐ (1) Work to get traditionally underserved communities visiting / birding in your parks.
- ☐ (2) Offer multilingual programs and/or materials on birds and birding.
- ☐ (3) Develop one or more accessible nature / birding trails.
- ☐ (4) Identify and remedy gaps within your community's system of parks, off-road trails and open spaces. (GS #18.1)
- ☐ (5) Plan and budget for a network of parks, green spaces, water features and trails in all new development areas. (GS #18.2)
- ☐ (6) Measure your community's park score (http://parkscore.tpl.org/methodology.php) and make a plan to increase your score.
- ☐ Other - provide details of other actions for consideration to meet this best practice.

Category II: Protect, Restore and Enhance Bird Habitat

☐ *Best Practice #6:* Practice conservation planning

- ☐ (1) Certify your community as a Green Step City (http://greenstep.pca.state.mn.us/index.cfm).
- ☐ (2) Develop/fund a conservation easement program, such as a purchase of development rights program, in collaboration with a land trust (GS#10.5) or otherwise protect existing bird habitat through ordinances, easements, fee title acquisition and other methods.
- ☐ (3) Include ecological provisions in the community's comprehensive planning process that explicitly aim to minimize open space fragmentation and/or establish a growth area with expansion criteria (GS BP#6.4).

- ☐ (4) Demonstrate that the local Chamber of Commerce (or a similar group) takes an active role in the planning process for protecting and enlarging favorable bird habitat.
- ☐ (5) Conduct a Natural Resource Inventory or Assessment (NRI or NRA); incorporate protection of priority natural systems or resources through the subdivision or development process. (GS BP#10.1)
- ☐ (6) Document that current community planning seeks to provide additional bird habitat.
- ☐ Other - provide details of other actions for consideration to meet this best practice.

☐ *Best Practice #7:* Create and protect habitat

- ☐ (1) Attach ordinance or other evidence that existing bird habitat has legal protection.
- ☐ (2) Increase the amount of bird habitat in the community by enlarging existing habitat, acquiring new and/or restoring parcels - creating connections wherever possible.
- ☐ (3) Ensure that local rules do not restrict brush piles that provide essential cover for birds.
- ☐ (4) Provide information to property owners on how to create and enhance backyard habitat for birds and/or participate in bird-friendly habitat certification programs (ex. National Wildlife Federation, Audubon Native Plants for Native Birds - spring 2016).
- ☐ (5) Assess your acreage of manicured greenspace (mowed grass) and document conversion of some of that area to low maintenance turf or native landscaping. (similar to GS #18.5)
- ☐ (6) Restore habitat in power line and pipeline rights-of-way.
- ☐ (7) Certify at least one golf course in the Audubon Cooperative Sanctuary Program. (GS BP#18.6)
- ☐ Other - provide details of other actions for consideration to meet this best practice.

☐ *Best Practice #8:* Promote use of native and beneficial plant species

- ☐ (1) Develop and disseminate recommendations on preferred plantings for birds.
- ☐ (2) Create demonstration areas with signage to promote bird-friendly plantings.
- ☐ (3) Participate in existing "pollinator friendly" programs and / or develop a program to provide pollinator habitat.
- ☐ (4) Adopt local landscaping/nuisance ordinances that promote, rather than create barriers for, native vegetation including taller grasses and forbs which provide important food and cover for birds. (GS BP#16.5c)
- ☐ (5) Increase the number and proportion of locally sourced native plants used in city projects and encourage similar standards for new development.
- ☐ Other - provide details of other actions for consideration to meet this best practice.

☐ *Best Practice #9:* Control invasive and detrimental species

- ☐ (1) Show how the community offers the public information on control and removal of invasive plant species (ex. buckthorn, garlic mustard and purple loosestrife).
- ☐ (2) Actively manage species that are having a detrimental impact on habitat or wildlife (ex. Cats, White-tailed Deer, etc.).

- ☐ (3) Actively manage invasive plant species (ex. buckthorn, garlic mustard and purple loosestrife).
- ☐ (4) Educate communities about management of invasive plant species on private property (ex. Conduct a workshop and/or involve people in invasive species removal projects).
- ☐ Other - provide details of other actions for consideration to meet this best practice.

☐ *Best Practice #10:* Create and protect nesting opportunities

- ☐ (1) Develop a policy to avoid trimming of trees and shrubs on city lands from early May until mid-July to allow tree and shrub nesting species to complete nesting. Encourage this practice on private lands as well.
- ☐ (2) Develop a policy to delay mowing of road ditches, storm-water retention ponding basins and other grasslands until August 1st to allow ground-nesting species to complete nesting.
- ☐ (3) Develop a risk tree management policy that allows, whenever possible, dead trees to remain standing as a nesting and foraging resource for birds.
- ☐ (4) Encourage the use of nest boxes / structures including not only creation, siting, and installation but also maintenance and monitoring. Keep records of structures and usage.
- ☐ Other - provide details for consideration to meet this best practice.

☐ *Best Practice #11*: Ensure best management of urban forests

- ☐ (1) Certify your community as a Tree City USA. (GS#16.1)
- ☐ (2) Work with city or contract foresters to manage intact plots of land with a diversity of overstory and understory trees and shrubs including native and beneficial species.
- ☐ (3) Develop a list of recommended tree and shrub species, at least 1/3 of which are native and beneficial to birds.
- ☐ (4) Work with local growers / suppliers to increase / ensure local supply of native trees / shrubs / plants.
- ☐ (5) Build community capacity to protect existing trees/to plant resilient species by certifying at least one or more local staff/volunteers as MN Certified Tree Inspectors from the MN Dept. of Natural Resources. (GS BP#16.6)
- ☐ Other - provide details of other actions for consideration to meet this best practice.

☐ *Best Practice #12:* Ensure clean water in natural waterways

- ☐ (1) Maintain set-backs and buffers of at least 50 feet from wetlands, rivers and lakes.
- ☐ (2) Encourage and support the creation of rain-gardens on private and public land.
- ☐ (3) Host / sponsor training on planting for clean water (ex. http://www.bluethumb.org/).
- ☐ (4) Allow high and low water oscillation to best mimic the natural system.
- ☐ (5) Adopt low-impact design standards that infiltrate or retain all 2 inch, 24-hour storm water events on site. (GS #18.4)
- ☐ (6) Use sources of non-potable water, or surface/rain water for irrigation. (GS #18.5c)
- ☐ (7) Support a multi-party community conversation around improving local water quality. (GS BP#19.2)

- ☐ (8) Create/assist a Lake Improvement District. (GS BP#19.7)
- ☐ (9) Adopt goals to revegetate shoreland and create a local program or outreach effort to help property owners with revegetation. (GS BP#19.5)
- ☐ Other - provide details of other actions for consideration to meet this best practice.

Category III: Reduce Threats to Birds

☐ *Best Practice #13: Reduce collisions with windows*

- ☐ (1) Demonstrate that your community provides property owners with information on how to protect birds from window-strikes.
- ☐ (2) Adopt bird-friendly design practices for all new municipal owned and operated buildings.
- ☐ (3) Assess all current municipal owned and operated buildings for bird collision problems.
- ☐ (4) Develop an action plan for fixing existing collision problems at municipal buildings.
- ☐ (5) Implement action plan for fixing existing collision problems at municipal buildings.
- ☐ (6) Develop comprehensive guidelines or requirements for addressing bird-safety in the design of both municipal and private buildings in the community.
- ☐ Other - provide details of other actions for consideration to meet this best practice.

☐ *Best Practice #14: Reduce collisions with other man-made structures*

- ☐ (1) Follow federal guidelines for siting and operations of wind power facilities (will provide links for each guideline) to study and reduce impacts on birds and other wildlife.
- ☐ (2) Follow federal guidelines for siting and operations of powerlines (will provide links for each guideline) to study and reduce impacts on birds and other wildlife.
- ☐ (3) Follow federal guidelines for siting and operations of communication towers (will provide links for each guideline) to study and reduce impacts on birds and other wildlife.
- ☐ (4) Document how new bridge projects were planned to consider their potential impacts on birds.
- ☐ (5) Where vehicle collisions with birds occur, reduce speeds, post signage and/or modify corridor to reduce threat.
- ☐ Other - provide details of other actions for consideration to meet this best practice.

☐ *Best Practice #15: Reduce light pollution*

- ☐ (1) Adhere to Lights Out operations according to Audubon's Lights Out program; sign each municipal building on; encourage participation community-wide.
- ☐ (2) Inventory all municipal lighting (building, facility, street) for Dark Sky compliance.
- ☐ (3) Develop a plan for Dark Sky compliance including a timeline and priority actions.
- ☐ (4) Implement plan to replace inefficient fixtures (exterior building, street, parking lot/ramp and traffic lighting) with Dark-Sky compliant, energy efficient, automatic dimming lighting technologies. (GS#4.6, 4.7 and 4.8)

- ☐ (5) Require energy efficient, Dark-Sky compliant new or replacement outdoor lighting fixtures on city-owned/private buildings and facilities. (GS#4.1)
- ☐ Other - provide details of other actions for consideration to meet this best practice.

☐ *Best Practice #16: Reduce predation by free-roaming cats*

- ☐ (1) Develop an educational program to control free-roaming cats and/or actively publicize the "Cats Indoors!" program about the danger of free-roaming cats and the benefits of keeping cats indoors.
- ☐ (2) Provide "Cats Indoors" educational materials in print with every spay / neuter (at city, veterinary offices, local NGO and private facilities).
- ☐ (3) Require owners of every cat adopted from local facilities (city or NGO) to sign a pledge to keep cats indoors.
- ☐ (4) Prohibit Trap-Neuter-Release programs.
- ☐ (5) Prohibit free-roaming cats in your community (ex. Cat leash law).
- ☐ Other - provide details of other actions for consideration to meet this best practice.

☐ *Best Practice #17: Reduce the threat of pesticides and other toxins*

- ☐ (1) Demonstrate that the city's pesticide management program reduces the use of toxins, takes advantage of the least toxic choice(s) and that you are following manufacturers guidelines in application.
- ☐ (2) Adopt U.S. FWS Pollinator Guidelines (will provide links) or similar pollinator-friendly ordinance / policy.
- ☐ (3) Encourage and promote the use of non-lead tackle and ammunition. Work with local sportsman's clubs to include related education in hunter education / gun safety.
- ☐ (4) Reduce toxins in the environment by coordinating cleanup of lead ammunition on gun ranges and lead tackle at fishing areas. (Pick up fishing line while you're at it to reduce this entanglement and ingestion risk).
- ☐ (5) Prohibit the use of lead ammunition and tackle on municipal land.
- ☐ Other - provide details of other actions for consideration to meet this best practice.

☐ *Best Practice #18: Reduce climate impacts*

- ☐ (1) Develop a climate action plan as part of comprehensive plans or in a separate policy document to reduce energy use and carbon emissions. (GS#6.5)
- ☐ (2) Ensure residents have the option of purchasing green energy.
- ☐ (3) Demonstrate a decrease in energy use and carbon emissions through operational or building design changes.
- ☐ Other - provide details of other actions for consideration to meet this best practice.

UPPER MISSISSIPPI / GREAT LAKES
JOINT VENTURE