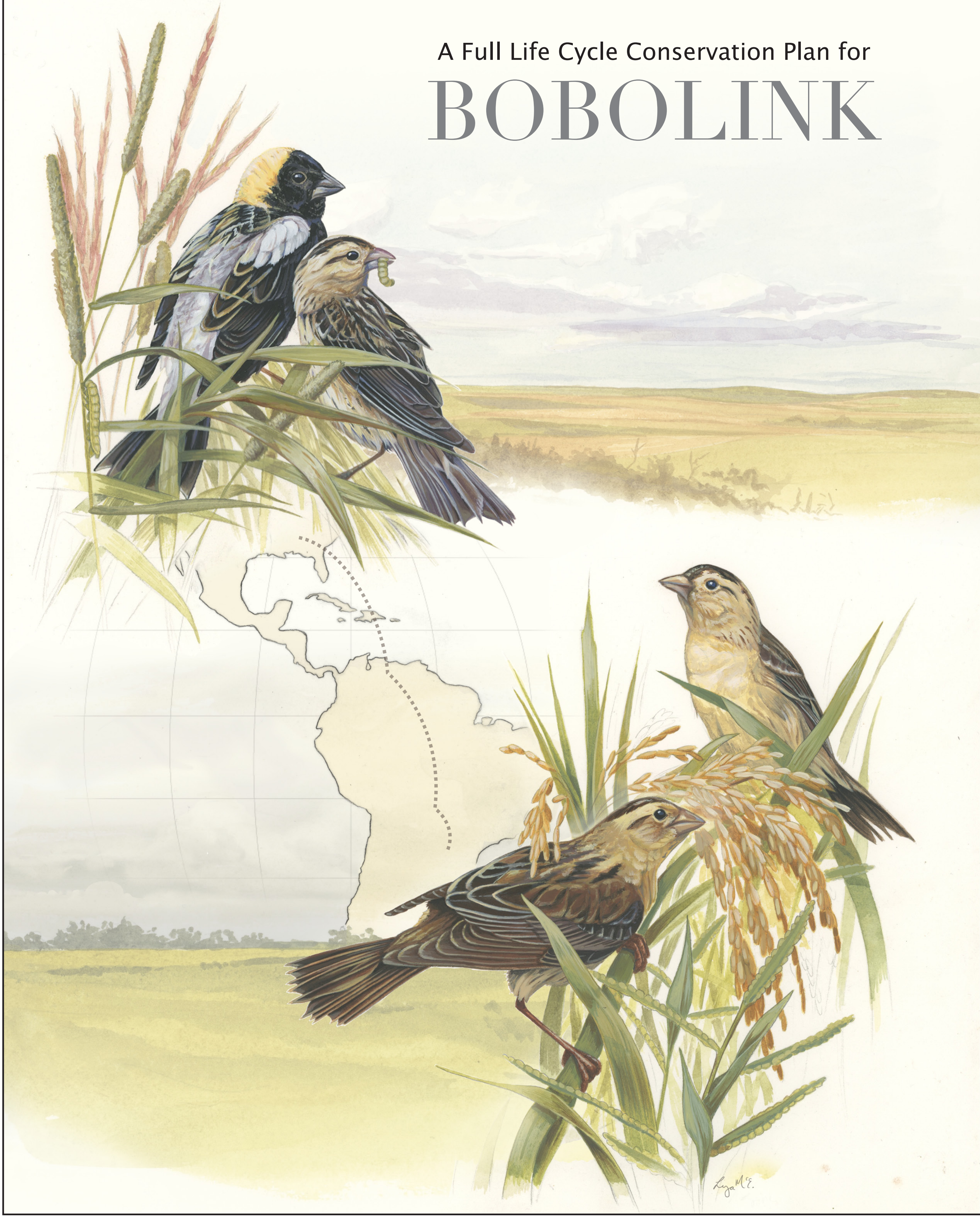
A Full Life Cycle Conservation Plan for

BOBOLINK



A Full Life Cycle Conservation Plan for Bobolink (*Dolichonyx oryzivorus*)

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Dedicated to Peter Vickery.

Thank you for your leadership,

your passion,

and for reminding us of what matters.

A Full Life Cycle Conservation Plan for Bobolink

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Executive Summary

Bobolink (*Dolichonyx oryzivorus*), one of the most iconic and charismatic grassland birds, has declined in numbers on its North American breeding grounds by nearly 60% since 1970. Many other grassland obligate birds share a similar fate, as do the native grasslands on which they depend, now one of the most endangered ecosystems in the Americas. Bobolink is a Partners in Flight Watch List species, a U.S. Fish and Wildlife Service Focal Species and Bird of Conservation Concern, a Species of Greatest Conservation Concern in most U.S. states and Canadian provinces in which it occurs, and is listed as Threatened under the Species at Risk Act in Canada. In nine of the Bird Conservation Regions (BCRs) in which it breeds, populations are predicted to decline by 30% over the next two decades.

Bobolink breeds in temperate grasslands across much of southern Canada and the northern U.S., spanning seven provinces, 34 states, and 15 BCRs. It then migrates great distances, staging for several weeks in the Llanos grasslands of Venezuela and eastern Colombia, continuing to open grassland and associated wetland wintering areas in Bolivia, Paraguay, and Argentina, and returning to its North American breeding grounds following a similar route in the spring. While Bobolink relies on grasslands throughout every portion of its hemispheric annual cycle, those grasslands are affected by different limitations, threats, policies, cultures, and political jurisdictions. Scientific research indicates that the different phases of Bobolink's life cycle are inextricably linked, so conservation practitioners require a geographically and biologically integrated approach to conservation for the species. *A Full Life Cycle Conservation Plan for Bobolink* (Plan) acknowledges that, given the multiple services grasslands provide, effective conservation will require coordination and creative solutions that merge economic, social, ecological, and conservation needs.

The overarching goal of the Plan is to provide the essential biological information, tools, and strategies necessary to sustain global Bobolink populations into the future through strategic, full life cycle conservation measures—and concurrently, populations of other grassland bird species, the habitats they depend on, and associated ecosystem services across continents and sectors. The Plan draws on extensive input from North and South American partners—including the Bobolink Full Life Cycle Conservation Working Group (BWG)—and six partner workshops. Planning objectives include:

- Directing resources to essential research and the most promising conservation strategies.
- Maintaining native and restored grasslands at landscape scales sufficient to sustain bird populations, vital ecosystem services, human health, and long-term economic benefits to associated communities.
- Integration with conservation plans for other grassland-dependent species and with other cooperative grassland conservation initiatives.
- Building and strengthening partnerships for coordinated action at local, regional, national, and hemispheric scales.

Partners contributed to the processes and workshops that identified the top-ranking threats to Bobolinks on the breeding grounds in North America: widespread conversion of grasslands (including hayfields, pasture, and rangeland) to row-crop agriculture (driven in large part by demand for biofuels), intensification of haying/mowing practices, and conversion to development and development-dominated landscapes. Conversion of grasslands to agriculture and development emerged as dominant threats on the South American staging and wintering grounds as well. Targeted direct take of Bobolinks to control depredation on rice in Bolivia and Argentina has been largely mitigated; lethal effects of pesticides used in rice cultivation remain a source of concern and uncertainty. In terms of potential population impacts, predicted changes in precipitation associated with climate change and loss of wet grasslands emerged as the highest ranked threat for nonbreeding habitat.

The impacts of climate change cross all boundaries, connecting ecological, social, and economic interests alike. Climate change will not only affect grassland birds, but also those who supply the vast majority of their habitat—farmers, ranchers, and private landowners. A full life cycle climate change conceptual model for Bobolink suggests that variability in precipitation is likely to be the most important variable affecting Bobolink demography and persistence both in terms of increased grassland productivity and extreme events associated with drought. Bobolinks, like other grassland birds, will be vulnerable to climate impacts—although the magnitude of the vulnerability remains highly uncertain.

The Bobolink Plan follows Partners in Flight in setting conservation objectives based on population trends derived from North American Breeding Bird Survey (BBS) data. Although the BBS is conducted during the breeding season, its resulting trend estimates should be understood as an integration of all demographic parameters affecting Bobolink population size during the entire annual cycle, including events that occur during the non-breeding season in South America. The BWG set a qualitative long-term goal of maintaining a stable Bobolink population—thereby also contributing to the conservation of associated grassland bird species and their habitats—and two quantitative objectives: (1) slowing the annual rate of Bobolink population decline over the next decade to 0%/year, as measured by the BBS, and (2) over the next 20 years, maintaining population stability at ≥ 85% of the 2016 population of an estimated 10,000,000 breeding individuals. (Canadian partners incorporated these Plan objectives in their Recovery Strategy for Bobolink.) A trend-based Bobolink Population Objectives tool (Bobolink Tool) was developed to apportion responsibility for reaching the rangewide objective among BCRs and Bird Habitat Joint Ventures (JVs) comprising the Bobolink's North American range. The Prairie Pothole JV piloted the Bobolink Tool and demonstrated an approach for translating the trend-based objectives into grassland habitat acres. The Bobolink Tool approach significantly advances regional coordination of population and habitat objectives so that participating entities can each contribute meaningfully and realistically toward a measurable rangewide goal.

A working subgroup of the BWG, the Midwest Grasslands Network (MGN), developed a Conservation Planning Atlas for Midwest Grasslands (hosted on Data Basin) which includes the Bobolink Conservation Opportunity Map—an online interactive tool that incorporates ecological, land-use, and economic information summarized at the county scale and that allows the user to explore customizable scenarios. The BWG used this tool to identify four county clusters that consistently surfaced as high opportunity areas for Bobolink conservation: North and South Dakota, the transition zone between the Midwest corn belt and the northern forest, the northern Allegheny Plateau, and a discontinuous band of counties extending from the eastern Great Lakes lowlands to agricultural areas of northern New England. Areas of critical importance in South America were derived largely from geolocator data that indicated regions where Bobolink resided for from three weeks to four months: the Llanos of Colombia and Venezuela (which hosts nearly the entire global population of Bobolink during fall and spring migration), northeastern Bolivia, central Paraguay, and northeastern Argentina.

The BWG conducted a series of online exercises and in-person workshops to begin the work of developing conservation strategies and associated actions for Bobolink and its grassland habitats; these were augmented with products that emerged from a MGN conservation deliberation graduate seminar hosted at the University of Minnesota. Three parallel partner workshops in South America explored non-breeding season conservation strategies. In all cases, the groups recognized that conserving a species that relies heavily on lands used for food and fuel production throughout its annual range required creative solutions that merged biological, social, economic, and conservation needs. Ultimately, in order to accomplish grassland conservation at the scale needed to stabilize grassland-dependent bird populations, bird conservation needs must be embedded within efforts that have other environmental service objectives and priorities.

The strategies that emerged from the workshops are at this point best understood as a palette or menu from which partners can draw depending on the scale at which they are operating and the opportunities and capacity available to them. They span a wide range of actions, encompassing grassland management, public policy, communication and education, scientific study, and market-based programs. Included are proven local solutions that could be scaled up as well as more innovative approaches that address rangewide drivers of population decline. Most are articulated in greater detail in the Plan. Ideas that surfaced repeatedly during planning workshops include:

- Maintaining and appropriately managing existing large tracts of public grasslands.
- Promoting grazing systems that provide vegetative structure and disturbance levels that are compatible with successful grassland bird reproduction and survival.
- Maintaining hay and pasture while developing and promoting economically viable mowing schedules that allow birds to fledge young.
- Strengthening U.S. Farm Bill and other public conservation programs that aim to enhance grassland habitat.
- Maintaining and improving practices on Conservation Reserve Program (CRP) lands in the U.S.
- Reducing incentives (e.g., the Renewable Fuel Standard) for converting grassland to other uses through investments in private conservation and best management practices.
- Communicating messages about the value of grasslands for human health and security and the importance of birds in agroecosystems.

- Eliminating the use of highly toxic pesticides on migration and wintering grounds.
- Supporting research and development of bird-friendly agricultural cultivars and practices.
- Modeling full life cycle Bobolink demographics in order to strengthen the scientific basis for conservation actions.
- Developing and exploring innovative solutions that break through the economic barriers to successful grassland conservation by broadening partnerships to include other disciplines and stakeholders.
- Forging non-traditional and hemispheric partnerships.
- Implementing grassland conservation strategies across multiple themes, pathways, and scales simultaneously.

By building on previous conservation successes and identifying new strategies, the Plan continues a broad-scale, long-term process to sustain grassland bird populations. North American partners can begin by following the lead of the Prairie Pothole Joint Venture: setting population and habitat objectives for BCRs, selecting priority strategies and linking them to desired outcomes, integrating with other grassland initiatives, and using existing mapping tools to create more explicit conservation landscapes to meet rangewide goals and objectives. In South American countries, priority strategies already have been selected and projects related to these are already underway; these projects simply require more support.

Successfully implementing a plan that incorporates so many partners across such a broad range will require dedicated teams guided by a coordinated implementation strategy. For the near-term, progress will depend on the capacity of individual organizations, partnerships, and agricultural associations to develop, execute, and coordinate work plans that meet the multiple needs of diverse stakeholders. Ultimately, however, successful conservation of Bobolink and other grassland birds will require a paradigm shift in the scale, approach, and coordination of conservation activities, similar to successful efforts to conserve waterfowl. Bold leadership will be required to implement, at minimum, an international policy of No Net Loss for grasslands.

"When you fail to achieve a goal…the defining factor that you're missing is never resources, it's resourcefulness." — Tony Robbins

INTRODUCTION

The Bobolink as a Conservation Priority

Arguably one of the most charismatic species of the blackbird family, the Bobolink is also an icon of one of the most endangered ecosystems in the Americas, grasslands (McCracken 2005). With an annual cycle that spans much of the western hemisphere, the Bobolink is a year-round grassland obligate dependent on a diversity of grassland habitats spread out across a vast range. In the spring and summer, to breed and raise chicks, Bobolinks utilize temperate grasslands across much of southern Canada and the northern U.S. During migration, as they travel great distances to wintering areas in South America, they make multi-week stops in the vast Llanos grasslands of Venezuela and eastern Colombia. Eventually, they move on to wintering locations in Bolivia, Paraguay, and Argentina, where they inhabit open grasslands loosely associated with major waterways and wetland systems. Return to the breeding grounds follows a similar route, with birds relying on grasslands throughout every step of their remarkable journey.

As is the case for so many species, changes in habitat quality and quantity related to human land use patterns have significantly impacted Bobolink populations. Before Europeans settled the interior of North America, a mosaic of prairie ecosystems blanketed the heart of the continent from the Rocky Mountain foothills across the Great Plains to beyond the Mississippi River. These extensive grasslands even connected the Gulf Coast to the boreal forest, spanning a distance of nearly 2,000 miles. However, sweeping conversion of native grasslands to crops and intensification of haying practices have greatly diminished this once abundant resource, and estimates of total North American losses since European settlement range from 70-80% to over 99% depending on grassland type (e.g., shortgrass, mixed-grass, tallgrass prairie; McCracken 2005, Johnson 2005). As a result, substantial reductions in many grassland bird species have occurred, with Bobolink numbers declining by 59% between 1970 and 2014 according to the 2016 PIF Landbird Conservation Plan (Rosenberg et al. 2016). Similarly, on the migration and wintering grounds, habitat loss also threatens the species, as does exposure to pesticides, though the impact on the overall population is not quantified.

Long-term population decline and unabated threats have raised concern among conservation scientists about the future of this species. As a result, the Bobolink has been identified or proposed as a conservation priority or as a protected species under various conventions and listings. In addition, the U.S. Fish and Wildlife Service's (USFWS) Migratory Bird Program initiated a Focal Species strategy for migratory birds and selected the Bobolink as a Focal Species. Birds with this designation include species from the USFWS's Birds of Conservation Concern list that need investment because they have high conservation need, are representative of a broader group of species sharing the same or similar conservation needs, act as a potential unifier for partnerships, and/or have a high likelihood that factors affecting their status can be realistically addressed. The Focal Species strategy identified species on which the Migratory Bird Program will focus conservation efforts for the next several years, and was a major impetus for developing the Bobolink Conservation Plan.

Planning Approach: Full Life Cycle Conservation

The Bobolink's vast year-round range includes many different habitats, threats, politics and cultures. As a result, circumstances on the enormous breeding and nonbreeding grounds can be quite different from one another and can give rise to complex and sometimes conflicting issues that affect populations at a broad scale. One such issue is that while Bobolink is recognized as a conservation priority on the breeding grounds, it is often regarded as an agricultural pest on its South American wintering grounds and along its migration routes. Thus, benefits from conservation dollars spent in one part of its annual cycle can be jeopardized elsewhere. As such, the Bobolink exemplifies the need for full life cycle conservation (FLC) that considers the limitations, threats, and needs of a species throughout its entire life, and coordinates actions across its annual range.

FLC has been advocated for years as a necessity to holistically and effectively address declining migratory bird populations (Faaborg et al. 2010), including grassland birds (Vickery and Herkert 2001). The concept is not novel, and has been employed in conservation plans for migratory shorebirds (Winn et al. 2013) and some songbirds like Golden-winged Warbler, Cerulean Warbler, and Henslow's Sparrow (USFWS Division of Migratory Bird Management 2007, Cooper 2012, Roth et al. 2012). Using an approach that explicitly addresses the full life cycle of migratory birds has gained tremendous support, and is being actively promoted as an approach for several suites of migratory bird species.

However, our understanding of how each part of a migratory songbird species' life cycle contributes to its population dynamics is quite limited, and conservation of the places that support species across the span of a year is challenging. For 91% of migratory bird species worldwide, designated protected areas are inadequate in at least one part of the annual cycle (Runge et al. 2015). Further, grassland birds in particular breed mostly on private lands, and their conservation lies largely in finding economically feasible ways to manage working lands to benefit these species. Coordinating such efforts across the span of a long-distance migratory bird's range requires thoughtfully-distributed resources towards prioritized actions, and sustained international coordination. Given the multidisciplinary (geographic, socio-economic, political, ecological) scope of the challenge, a PIF full life cycle conservation symposium was held at the North American Ornithology Conference in 2012 at Vancouver, BC, to address these issues. Symposium participants concluded that "With limited resources, research is best applied to species of conservation concern or to ‘model' species," i.e., focal species for which conservation action would benefit co-occurring species.

The Bobolink, as noted above, has been identified as a focal species for which research and conservation actions are expected to not only benefit Bobolinks, but also other migratory and resident grassland species. Moreover, because of its close association with grassland habitat, a focus on Bobolink will necessarily generate detailed thinking about this habitat type. This aspect is especially critical because grasslands are not only at the heart of grassland bird conservation, but also comprise a highly utilized system humans depend on for multiple ecological and agricultural services. For successful conservation of grassland birds, multiple uses of grasslands have to be considered at a broad scale, which a species like Bobolink facilitates. Additional features that enhance Bobolink for FLC include known migration routes and wintering areas, with some known associated threats; a winter range that overlaps with those of other species in the grassland suite; occupation of habitat and regions on the breeding grounds not entirely encompassed by existing conservation plans for other species (Grasshopper Sparrow (*Ammodramus savannarum*), Henslow's Sparrow (*Ammodramus henslowii*), and mixed/short-grass Great Plains species); widespread distribution, providing a means to link partners in Canada, the U.S., and South America; and identification as a focal species for research and conservation in the Southern Cone grasslands region (Argentina, Paraguay). Thus, a FLC Plan for Bobolink provides a way to link geographical areas across continents and a conservation model that goes beyond just birds.

Goals, Objectives, and Audience

Goals

The overarching goal of this Plan is to provide the means to sustain global Bobolink populations over the long-term through FLC conservation, and concurrently, populations of other grassland bird species, the habitat they depend on, and associated ecosystem services. The proximate goal of this Plan is to develop a comprehensive, regional-based framework for FLC conservation of Bobolinks across their range, based on extensive input and feedback from both North and South American biologists and conservationists.

Objectives

The process of developing the Plan can set the stage for future iterations and implementation, therefore objectives of this Plan relate to both the process and the product:

- Direct efforts to sustain Bobolink populations by focusing limited resources to most needed research and most beneficial conservation strategies, with participation and buy-in from organizations poised to carry out strategies.
- Promote conservation actions that maintain native and restored grasslands at landscape scales sufficient to sustain vital ecosystem services, provide long-term economic benefits to associated communities, and benefit human health.
- Integrate Plan development and implementation with conservation plans for other grassland-dependent species, in particular bird species.
- Integrate Plan with landscape approach for cooperative grassland conservation via the Midwest Landscapes Network and other coordinated conservation initiatives in North America.
- Provide a conceptual FLC model for Bobolink as a structure for priority decision-making and an exercise to determine critical knowledge gaps.
- Establish partnerships for coordinated action and build conservation capacity in terms of funding and outreach at local, regional, national and hemispheric scales. Provide a structure and focus around which to build, formalize, and strengthen relationships

between grassland biologists and conservationists in the U.S., Canada, and South American countries, which will ultimately serve many migratory species and their habitats.
- Ensure follow-through by initiating processes with partners to develop research and conservation proposals using specific, key strategies to address threats and information gaps as outlined in the Plan.

Audience

In its original form, the Plan is intended for firsthand users and interpreters, mostly conservation biologists and planners. Audience-specific, tailored versions of the Plan will need to be developed and disseminated to engage with other stakeholders who have intersecting interests regarding priority conservation strategies. These audiences include private landowners, farmers, policy makers, agronomists, the agricultural industry, and sociologists.

Plan Development and Integration

During the PIF-V International Conference in August 2013 at Snowbird, Utah, working sessions were held to develop a Bobolink Southern Cone (South America) / Eastern North American Grasslands Business Plan to address conservation needs of grassland birds in this area, and Bobolink emerged as the umbrella species for the plan. An initial network of collaborations and research related to Bobolink was created, and provided a foundation and potential framework for FLC conservation. A Bobolink FLC Conservation Plan Steering Committee was formed to provide guidance, input, and review to the Plan authors, especially during initial and final phases of plan development (see Acknowledgements, p. v). Six of the seven Steering Committee members participated in the PIF-V 2013 work sessions that focused on developing the business plan.

Input from North American Partners

Various avenues were used to obtain input on the Plan from North American partners. Between 2013 and 2017, several workshops were held in the U.S., often in conjunction with other meetings, to bring together grassland bird biologists and address various planning elements (Appendix A). Workshops focused on vetting a draft outline of the plan, questions surrounding scale, audience, general approach and participants in Plan development, and developing initial conservation objectives and strategies for the breeding grounds. Workshop participants included individuals from the U.S. and Canada that represented federal and state agencies, NGOs and multiple BCRs. Activities also occurred before and after workshops to help obtain input and focus discussions, and included pre-workshop surveys, post-workshop email discussions, formation of an ad hoc committee to discuss several of these elements, and a subcommittee to determine the overall population/trend goal for the Plan and other goals at various scales. More recently, the Plan was presented as a model for integrating different approaches to landscape-scale grassland conservation at the 77th Midwest Fish and Wildlife Conference (2018) in a symposium entitled *Restoring Heritage and Expanding Horizon:*

Midwestern Agroecology and the Conservation of Grassland Birds.

To obtain input from a broader audience, the need for the Plan, its unique attributes, its development process, and general content were also presented in several forums. Presentations were given to the Mississippi Flyway Council Nongame Technical Section, coordinators of State Wildlife Action Plans, and at the LCC & CSC Symposium at the Midwest Fish & Wildlife Conference.

The Midwest Grassland Bird Conservation Working Group (MGBCWG) was also important in the development of this Plan. Working under the auspices of the Midwest Coordinated Bird Monitoring Partnership, this group aims to inform conservation, management, and policy decisions affecting grasslands. It has spawned important efforts to step up grassland bird conservation and effect population impacts at the regional scale. Its work has resulted in the formation of a Midwest Landscapes Network and the dedication of USFWS staff to carry these efforts forward. It is well-poised to implement conservation plans and tools that have been developed with input from the very entities that direct and carry out conservation actions.

While the Bobolink Full Life Cycle Conservation Plan is an outgrowth of efforts by the MGBCW, the Plan intentionally and necessarily reaches much more broadly to other regions, countries, and hemispheres. In the midst of both literal and figurative uncertainty in the future of our collective landscape, the Bobolink Conservation Plan supports ongoing successful strategies, but perhaps most importantly, strives to find new strategies to sustain grassland bird populations that are resilient over time and amidst change.

Input from South American Partners

Workshops were held in Colombia, with participation from Venezuela, and in Argentina and Bolivia to obtain input from the four countries that host most of the global Bobolink population during the non-breeding season. Although the goal of the workshops was to obtain country-specific input on the Plan, the specific objectives of the workshops varied and were related to how much was known in individual countries. For example, in Argentina years of research and conservation efforts in grasslands and in rice fields has resulted in a greater understanding of Bobolink life history, as well as conservation outreach and actions. In contrast, in Colombia and Venezuela, basic research about the distribution and habitat of Bobolink is still needed to inform conservation.

Workshop participants included biologists from environmental NGOs, agronomists, and academic staff (Appendix A). In each workshop, participants presented what is currently known about Bobolink occurrence and ecology in their country, and listed resident and migratory bird species that occur or are likely to occur with Bobolinks. Participants were then asked to list threats following the IUCN-CMP Threats and Actions Classifications in the Open Standards framework (Salafsky et al. 2008, CMP 2016); see next section for details). They ranked known and potential threats for regions where Bobolinks are known to occur; or, lacking that information, in habitats and regions where they are most likely to occur. Conservation actions to address threats were developed to different degrees depending on the conservation history around grassland birds in the country; these actions were classified based on the IUCN-CMP Actions Classification Scheme (Salafsky et al. 2008, CMP 2016). Research needs were added directly to the Action Classifications, based on the IUCN Research Needed Classification Scheme (IUCN 2012). Participants in the Buenos Aires, Argentina workshop articulated actions to address threats, while participants from Venezuela, Colombia and Bolivia focused more on discussing, listing and ranking potential threats for Bobolinks and other grassland birds; to their knowledge, this exercise had not yet been carried out for those countries. Outside of these workshops, we also obtained input from other sectors in discussions with rice producers, agronomists, and government agricultural extension agencies. Some of these discussions led to additional conservation measures outlined in the Plan.

Open Standards for the Practice of Conservation and the Miradi Program

To develop portions of this plan, workshop participants followed standardized definitions and frameworks contained in Open Standards (OS) for the Practice of Conservation (hereafter Open Standards; CMP 2013). The Open Standards framework brings together common concepts, approaches, and terminology in conservation project design, management, and monitoring in order to help practitioners improve the practice of conservation. Relatedly, we utilized the Miradi Adaptive Management Software for Conservation Projects (Foundations of Success 2009), a software program that provides a step-by-step process for conservation teams to implement the Open Standards framework. Together the Open Standards framework and the Miradi software were used to rank threats, develop conservation strategies, and determining actions within those strategies.

Plan Integration

An important objective of the Bobolink Plan that shaped much of its development is to integrate with the existing plans, decision support tools, programs and initiatives aimed at conservation of grassland-dependent species, from regional to continental scales. As a first step towards integration, we compiled a synopsis of the many planning efforts and programs that support grassland conservation in a way that overlaps with Bobolink needs (Appendix B). Some address the conservation of grassland ecosystems in general, while some are single or multi-species plans that overlap with Bobolink distribution and general habitat requirements. This resource will enable better coordination and help partners examine how they might best participate in and amplify broader-scale geographic and conceptual opportunities. It also provides significant context for the approaches and conservation strategies we examined, and highlights the importance of non-traditional and international partnerships.

Similarly, some tools and ideas developed by other planning efforts relevant for Bobolink conservation are also integrated into this Plan. These include two projects of the Midwest Grasslands Network (a spinoff of the MGBCWG) designed to facilitate the development of conservation landscapes that can help to sustain grassland bird populations. In 2015 the Network convened a seminar hosted by the University of Minnesota to develop strategies for scaling up grassland bird conservation efforts to achieve landscape-level outcomes. The interdisciplinary participants developed a multi-path approach to sustaining grasslands, bird populations, and the aggregated resources and services that prairies and surrogate grasslands provide (Anderson et al. 2015). The proposed strategies are incorporated in the Conservation Strategies section in Chapter 2 of this Plan (see Appendix B for additional information on the seminar). The Network also initiated an interactive, online Conservation Atlas for Midwest Grassland Birds—a flexible coordination and implementation tool for planners in the U.S. Midwest region. A team of scientists and JV coordinators worked in concert with the Conservation Atlas to develop the Plan's Bobolink Conservation Opportunity Map. This interactive online tool identifies areas within the U.S. breeding range of the Bobolink where conservation may be most feasible. Key outputs are summarized in Chapter 2 (see U.S. and Canada / Where to Focus).

CHAPTER ONE: DISTRIBUTION, POPULATION STATUS, BIOLOGY, AND THREATS

Bobolink is one of the longest-distance songbird migrants in the hemisphere, and it has an unusual life history. It is one of a handful of passerines worldwide that carries out a complete molt twice per year. Movement patterns outside of the breeding season are so complex that ornithologists have limited vocabulary with which to describe them. Multi-week stays occur in multiple locations, between sometimes lengthy flights of up to 2000 km in a day. Unlike many other songbirds, it is a blackbird that does not remain on a territory in winter, but follows transitory food resources. Its hemispheric distribution (Figure 1–1) brings both challenge and opportunity for its conservation.

Distribution

Breeding Distribution

The Bobolink breeds east from the Canadian Atlantic Maritime provinces, south to Pennsylvania, with some breeding along the West Virginia/Maryland Appalachian Ridge (Figures 1–2, 1–3). Scattered observations based on June and July eBird records (eBird 2016) extend farther south along the ridge, into the Carolinas (Figure 1–4a). The western boundary of its range runs from southern British Columbia through Washington and Oregon east of the Cascade Range. The southern edge of the breeding range, excluding Appalachian ridge, extends from southern Idaho, through northern Missouri, into Pennsylvania and northern New Jersey. Isolated breeding populations are found in Nevada, Utah and Colorado. In Canada the breeding range extends northward up to 500 km from the U.S. border, with scattered populations in the western provinces of Saskatchewan, Alberta, and British Columbia. Bobolink abundance is greatest primarily in North and South Dakota, Minnesota, southern Manitoba, southern Ontario, parts of southern Quebec, and in western New York (Figure 1–3).

Wintering Distribution

The Bobolink's wintering range is defined here as the region where birds undergo their prealternate molt, generally from mid-January to mid-March (Renfrew et al. 2011). Bobolinks winter primarily in northeastern Argentina south to northern Buenos Aires province, eastern Bolivia in the Santa Cruz and Beni departments, and to a lesser extent, in Paraguay (Figure 1–1; detailed maps in Chapter 2). Bobolinks are loosely associated with the Paraná and Paraguay river systems in Paraguay and especially in Argentina. Records in Paraguay may be biased by observer effort, but there are fairly regular records in the mid-Tebicuary watershed in the Misiones Department in the southeast of the country, where flocks of up to 500 birds have been seen in rice fields. Small flocks are seen on a fairly regular basis in the Asuncion area primarily during Dec-Feb. In Argentina, most records and highest counts are reported from the Chaco, Formosa, Corrientes, Entre Rios, and especially the Santa Fe provinces, south to the northern edge of the Buenos Aires province. They occur in smaller numbers in northwestern Argentina along the eastern edge of the Andes, in the provinces of Salta, Jujuy, and Tucimán

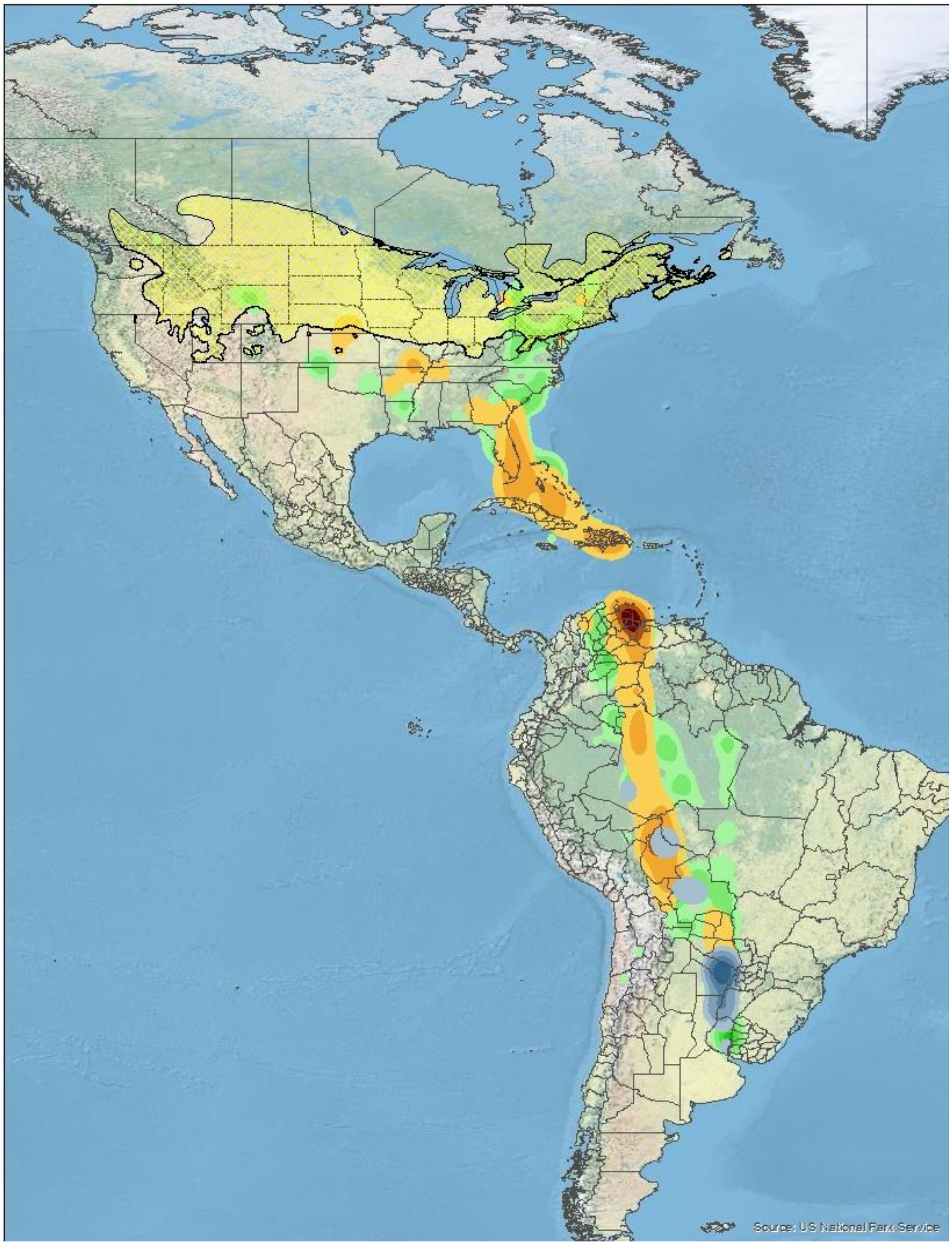


Figure 1– 1. *Distribution of Bobolink across its annual cycle; except for breeding range, based on kernel density estimates from geolocator data (Renfrew et al. 2013). The breeding range (yellow hatch) spans much of northern U.S. and southern Canada. Migration during fall (brown shades) and spring (green shades) follows similar paths at a broad scale, and the wintering range (blue shades) occurs in at least two regions separated by more than a thousand kilometers. Note that fall (brown) routes are covering some of the spring (green) routes, and the seasons are presented separately in other figures.*

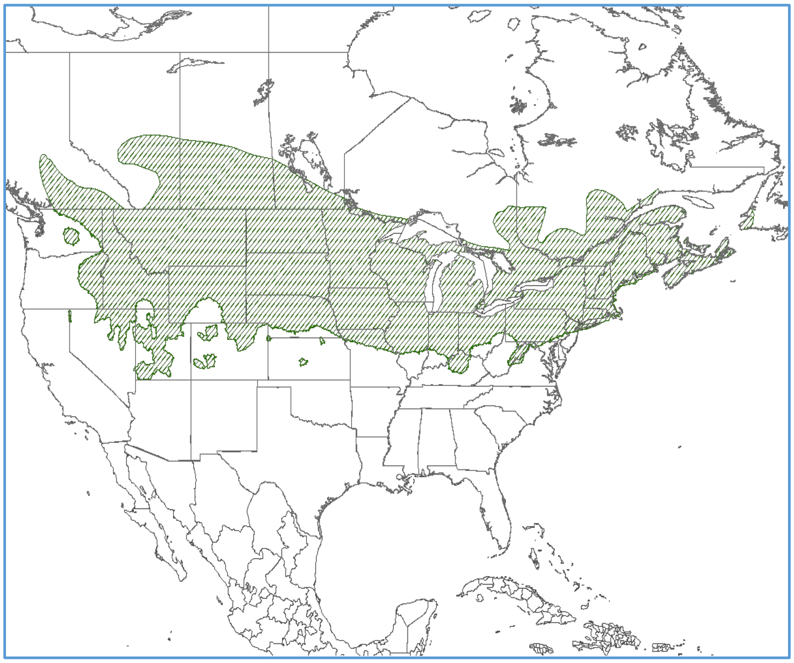


Figure 1– 2. *Bobolink breeding range. U.S. data are based on USGS National GAP Analysis Program (USGS 2011). Canadian data (BirdLife International and NatureServe, 2013) include minor adjustments based on input from J. McCracken (Bird Studies Canada).*

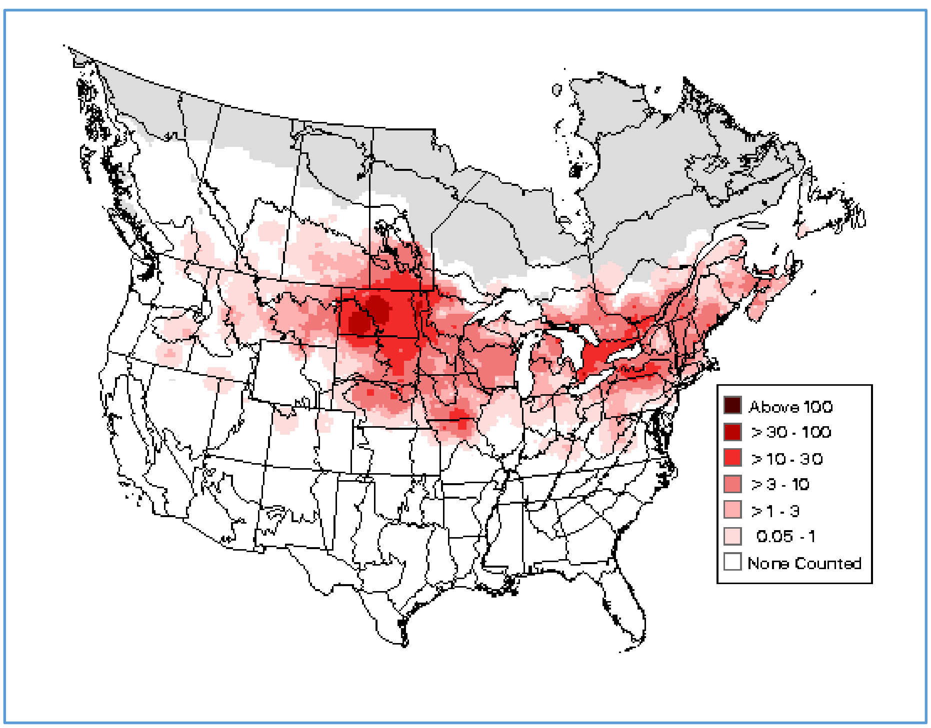
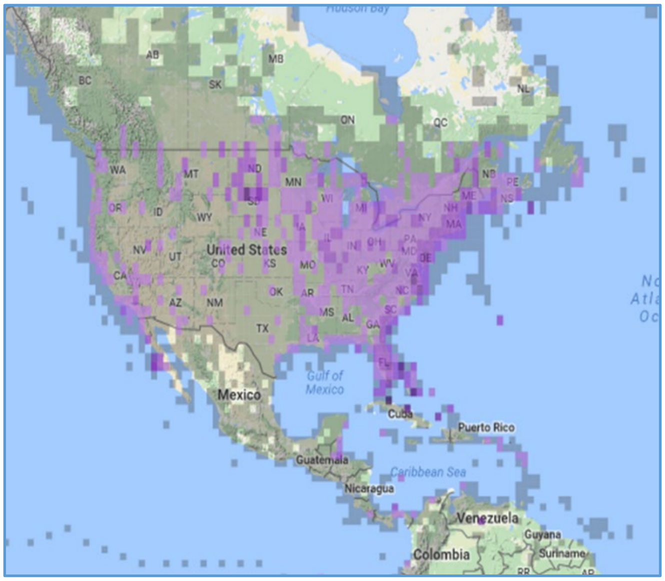


Figure 1– 3*. Relative abundance of Bobolink during 2007 – 2013 based on Breeding Bird Survey data (Sauer et al. 2017).*

a)



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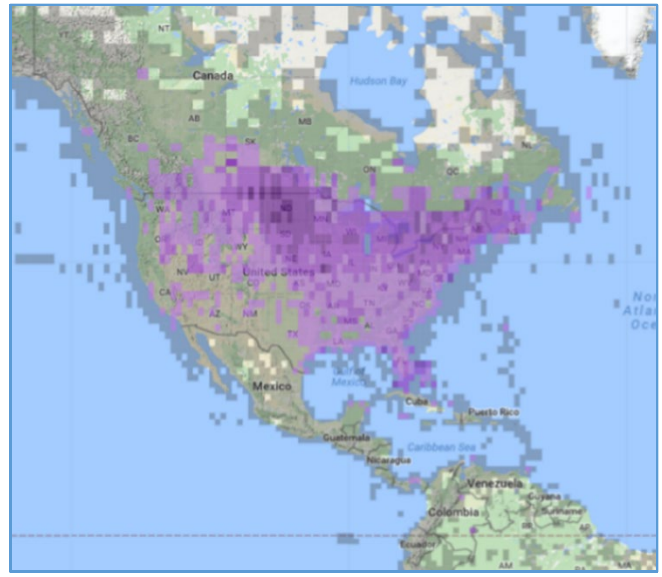

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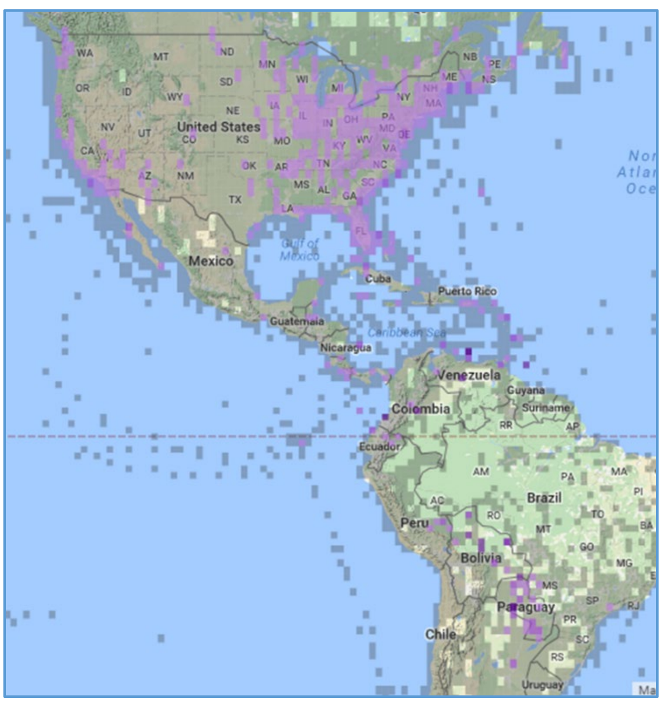


d)

Figure 1– 4. *Bobolink distribution based on eBird data for (a) Summer (Jun–Jul) for 2006–2016, (b) all September records (between 1900–2016), (c) all records for fall (Oct–Dec), and (d) all records for spring (Mar–Apr). Images provided by eBird (www.ebird.org) and created Sept 29, 2016.*

(Pearson 1980, Ridgely and Tudor 1989, Canevari et al. 1991, Di Giacomo et al. 2003, Renfrew et al. 2013). Bobolinks were found to occur less frequently in the northern Buenos Aires province in recent decades compared to the early 1900s (Di Giacomo et al. 2003). Very small numbers have been reported along the coast of Peru (Renfrew et al. 2015), and as far south and west as northern Chile (Howell 1975).

Distribution during Migration

After the breeding season Bobolinks form flocks, and in September as southbound migration begins, they appear to become more concentrated eastward, particularly along the Atlantic coast (Figure 1–4b; eBird 2016). Migration from across the breeding range is primarily along the Atlantic Flyway, although a few birds travel along the coast of California and Baja, Mexico (Figure 1–4c; Sullivan et al. 2009, Renfrew et al. 2013). Lincoln (1939) described how European settlement led to the expansion of Bobolink populations from lowland prairies in the tallgrass region, westward to more arid regions. He noted that these relatively new populations first flew eastward in the fall and then followed the traditional southbound route; this has been corroborated by geolocator data (Renfrew et al. 2013). In fall, Bobolinks pass through the Carolinas, Georgia, and especially Florida, although geolocators from some individuals breeding in the east show birds leaving the coast from points farther north (N. Perlut, pers. comm.; see Literature Cited for a list of pers. comm., pers. obs., and unpubl. data sources). Birds proceed southeast through the Caribbean (Lucayan, Greater and Lesser Antilles archipelagos) and based on observational data, to a lesser extent through Central America. Caribbean stopovers include Cuba, Jamaica, Hispaniola, and Puerto Rico. Based on geolocator data, birds from across the breeding range make a multi-week stop in the Llanos grasslands of Venezuela and eastern Colombia beginning in October (Renfrew et al. 2013). Records compiled in Venezuela and spanning the Lesser Antilles just north of the coastline since 1990 corroborate these findings, with most records from September and October (Figure 1–5; M. Lentino, unpubl. data).

After their lengthy stay in the Llanos region, Bobolinks fly over Amazonia to Bolivia. Some birds (<1/4 of the population) remain in Bolivia for the entire winter, while others stop for up to three weeks before continuing to wintering grounds in Paraguay or Argentina, generally in December or early January (Figure 1–6a, Renfrew et al. 2013). In El Bagual preserve in the eastern Formosa province in northern Argentina, Bobolinks regularly arrive between 25 Oct and 6 Nov each year, coinciding with seed availability of *Paspalum spp*., and with the arrival of other seed-eating bird species (A. Di Giacomo, pers. obs.).

The northbound route is generally similar to the southbound route, and takes five to six weeks to complete based on geolocator data (Renfrew et al. 2013). In late March and early April, Bobolinks begin moving north through Bolivia, western Brazil (including the Pantanal), to eastern Colombia along the eastern edge of the Andes, or western Venezuela (Figure 1–6b), where they may stop for up to two weeks. Northward migration proceeds from northern Venezuela through Hispaniola, Cuba, Jamaica, Bahamas, and/or Bermuda to Florida, Alabama, Georgia, or the Carolinas (Chapman 1890, Renfrew et al. 2013), and then to breeding grounds (Figure 1–4d). Bobolinks can appear in Louisiana and Texas, presumably from a less common

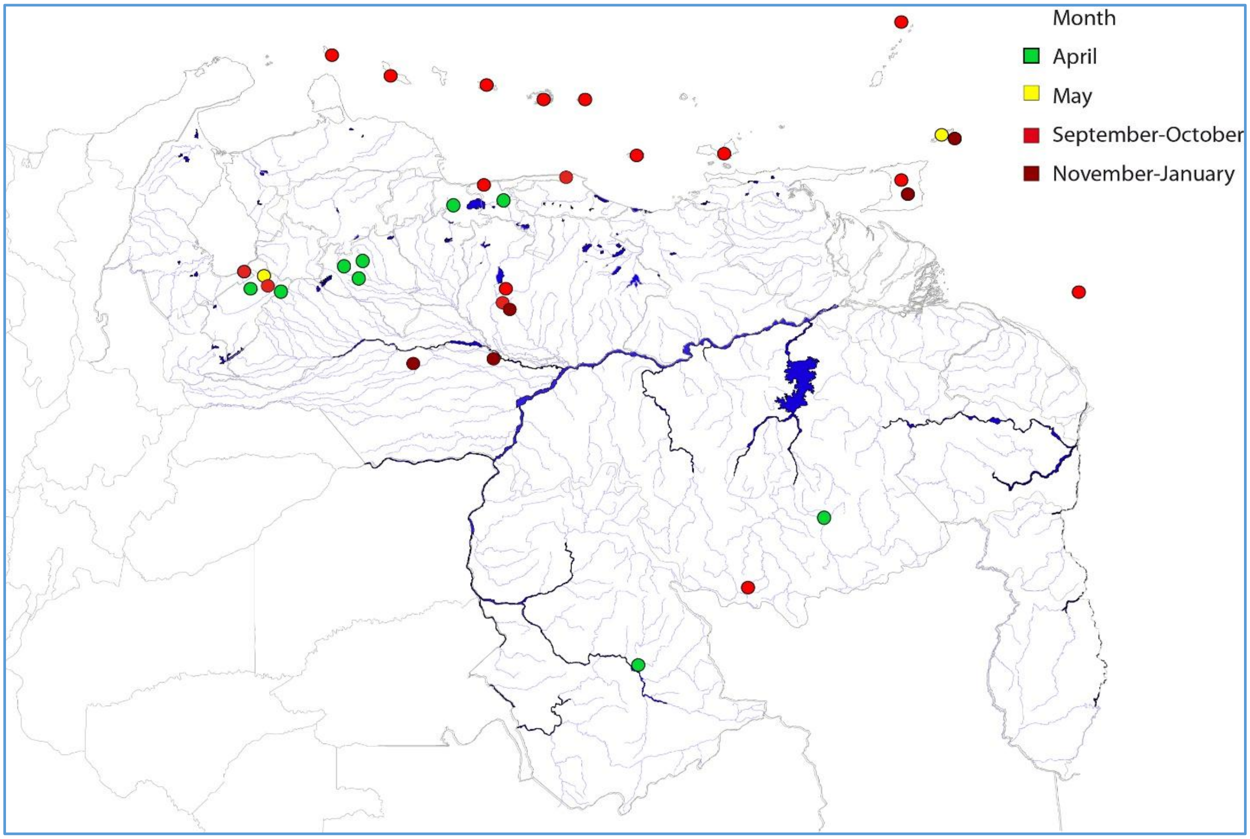


Figure 1– 5. *Locations of Bobolinks recorded in Venezuela 1990-2015 (M. Lentino, Phelps Ornithological Collection, unpubl. data) based on direct observations compiled by the Colección Ornitologica Phelps (COP), Museo de Estación Biológica de Rancho Grande (EBRG), Museo de Historia Natural La Salle (MHNLS), and eBird.*

route from Yucatán Peninsula in April (Bent 1958), although geolocator data suggest these birds can come from the Caribbean through western Florida (Renfrew et al. 2013).

Legal Status, Population Status, and Trends

Global Status

The Convention on the Conservation of Migratory Species of Wild Animals, which currently has 116 countries party to the Convention, works for the conservation of a wide array of endangered migratory animals worldwide through the negotiation and implementation of agreements and action plans. Because Bobolink populations have experienced population declines and the species is not protected by any international instrument, the Bobolink has been listed in the Convention's Appendix II, *Migratory Species Conserved Through Agreements*. Under this listing, the Convention recommends habitat conservation, reduced hunting, improved management practices and raising awareness to address declining Bobolink populations.

a) **b)**

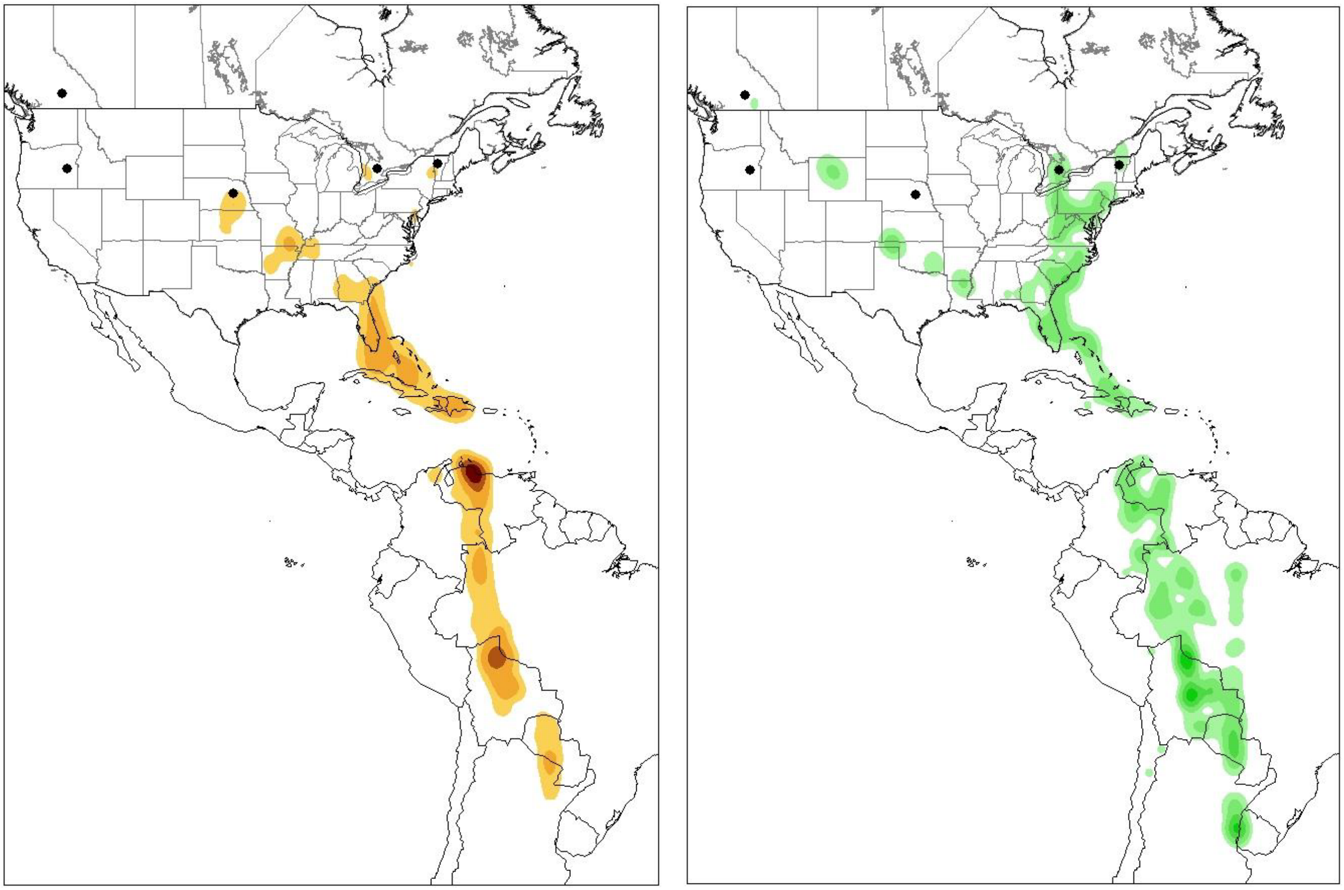


Figure 1– 6. *Migration routes for 19 Bobolinks in (a) fall (n= 19) and (b) spring (n=7) based on light-level geolocator data (Renfrew et al. 2013), using kernel densities encompassing 50%, 75%, and 90% of the maximum density. Black dots indicate breeding locations.*

The IUCN Red List of Threatened Species listed Bobolink as Least Concern despite decreasing trends (Birdlife International 2012). This assessment is based on its large range, large population size, and because declines were not above thresholds for a Vulnerable listing (>30% decline over 10 years or three generations; Birdlife International 2012).

Continental and National Status

Bobolink is included on the PIF Watch List primarily due to population declines and also due to threats during both the breeding and non-breeding seasons. Based on current trends the Plan reports that the Bobolink population is predicted to decline by another 50% in 48 years, although the uncertainty around that estimation is large (Rosenberg et al. 2016).

Bobolink was placed on the Watch List in the 2016 State of North America's Birds report, devoted to "species most at risk of extinction without significant conservation actions to reverse declines and reduce threats." It ranked high (more vulnerable) relative to many other species because of its ongoing, long-term declining population trend, and to a lesser extent, because of threats on the breeding and non-breeding grounds. On the non-breeding grounds, due to its more limited, concentrated distribution and potential threats, it also ranked high. In addition, the International Union for Conservation of Nature (IUCN) has ranked Bobolink as Vulnerable specifically in Argentina.

Across the entire breeding range, the Bobolink's declining population trends have been less negative in a recent 10-year short term period (2004-2013) compared to the longer term (1970-2013). Nationally, declines have been more severe in Canada compared to the U.S. over both the long- and short-term (Table 1–1).

As a result of strong population declines in Canada, the Committee on the Status of Endangered Wildlife in Canada listed the Bobolink as Threatened in 2010 (COSEWIC 2010). In Ontario, Bobolink is afforded special legal protection as a Threatened species under the province's Endangered Species Act, again because of significant population declines (COSSARO 2010).

Regional trends in Bird Conservation Regions (BCRs) vary geographically and temporally (Figure 1–7; Table 1–1). According to the PIF 2016 Landbird Conservation Plan, the most important breeding regions for Bobolink are BCRs 11, 13, 12, 17, 14, 23 (Rosenberg et al. 2016). As a PIF Yellow Watch List species, Bobolink is important in all BCRs in which it regularly occurs (Partners in Flight 2019a; Table 1–1). The PIF goal for Yellow Watch species is to keep populations above the level requiring special protection. Of all BCRs, BCR 11 supports the largest proportion of Bobolinks and appears to have been relatively stable in recent years, possibly due to exceptionally wet years that have resulted in taller vegetation (C. Artuso, pers. comm.).

Most states that support substantial Bobolink populations include this species on their list of Species of Greatest Conservation Need (SGCN) in their State Wildlife Action Plans, and most states rank Bobolink as either imperiled, vulnerable, or apparently secure. In addition, the majority of states and provinces that have conducted two breeding bird atlases have reported declines in Bobolink occupancy of atlas blocks, except Iowa, Pennsylvania, and Massachusetts (Appendix C).

Defining Scale and Boundaries for Trend Estimates

We selected the BCR as the unit for evaluating population trends and determining population objectives in the Plan. Using BCRs facilitates the ease with which regional managers can incorporate and evaluate Plan actions because these units have been used for other conservation plans, and are often used (e.g., by PIF) to evaluate bird population trends.

However, in the future regional entities may want to consider the application of management and conservation actions for *natural populations*, those with boundaries derived from data on the populations, and that comprise geographic units identified by clustering areas of similar demographic attributes such as trend and abundance. For a species like Bobolink that occupies

TABLE 1– 1. *Bobolink population trend estimates and credible intervals (CI) based on Breeding Bird Survey (BBS) data (Sauer et al. 2017) for Bird Conservation Region (BCR), Joint Venture, country, and survey-wide.*

Joint Venture	BCR #	Bird Conservation Region	BBS Trend 1970-2013	1970 - 2013 2.5% CI	1970 - 2013 97.5% CI	BBS Trend 2004-2013	2004 - 2013 2.5% CI	2004 - 2013 97.5% CI
Intermountain West (US), Canadian Intermountain	9	Great Basin	-7.53	-10.03	-4.88	-6.7	-12.21	2.26
Intermountain West (US), Canadian Intermountain	10	Northern Rockies	-1.98	-4.26	-0.17	-1.21	-6.55	3.99
Northern Great Plains	17	Badlands and Prairies	4.33	2.6	6.09	6.79	0.78	13.42
Playa Lakes	18	Shortgrass Prairie	2.48	-6.62	13.6	13.26	-9.62	58.63
Playa Lakes	19	Central Mixed Grass Prairie	0.5	-1.12	2.12	0.84	-1.79	4.47
Prairie Pothole (US), Prairie Habitat (CAN)	11	Prairie Potholes	0.03	-0.48	0.5	-0.94	-2.79	0.58
Upper Mississippi /Great Lakes (US), Southern Shield & Maritimes (CAN)	12	Boreal Hardwood Transition	-2.62	-3.24	-2.04	-2.22	-3.81	-0.82
Upper Mississippi /Great Lakes	22	Eastern Tallgrass Prairie	-3.41	-4.42	-2.49	-1.44	-4.86	2.11
Upper Missisippi /Great Lakes	23	Prairie Hardwood Transition	-3.88	-4.46	-3.21	-3.47	-5.83	-0.75
Central Hardwoods	24	Central Hardwoods	1.67	-2.39	5.31	2.8	-6.13	12.64
Appalachian Mountains	28	Appalachian Mountains	-0.44	-0.96	0.09	-0.13	-1.56	1.49
Lower Great Lakes/St. Lawrence	13	Lower Great Lakes/St. Lawrence	-3.48	-3.88	-3.06	-3.45	-4.6	-2.43
Atlantic Coast	14	Atlantic Northern Forest	-4.32	-5.07	-3.69	-2.45	-4.11	-0.76
Atlantic Coast	29	Piedmont	-4.06	-7.23	-0.9	-2.12	-9.47	8.05
Atlantic Coast	30	New England/ MidAtlantic Coast	-2.26	-3.26	-1.2	-2.02	-4.23	0.33
Eastern Habitat (CAN)	8	Boreal Softwood Shield	-1.16	-4.18	1.76	-0.84	-6.39	4.16
		Canada	-3.45	-4.52	-3.01	-2.37	-3.42	-1.27
		United States	-0.95	-1.31	-0.56	-0.26	-1.69	1.24
		Survey-wide	-1.88	-2.56	-1.56	-0.82	-1.92	0.29

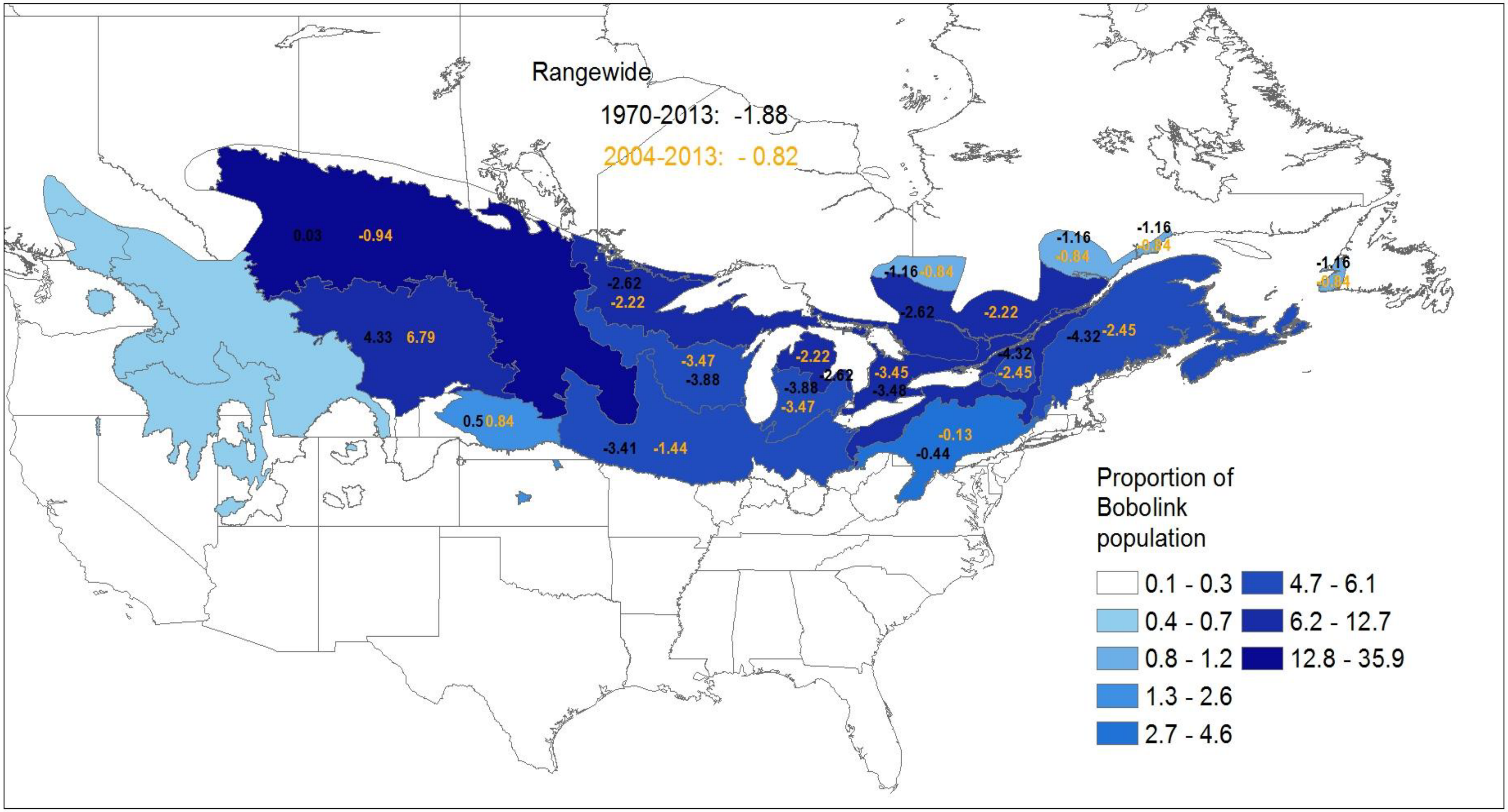


Figure 1– 7. *Proportion of Bobolink population and their trends (Sauer et al. 2017) for 2004-2013 (orange) and 1970-2013 (black) based on Breeding Bird Survey (BBS) data (Sauer et al. 2017). The estimated proportion of the global Bobolink population within each BCR is based on PIF estimates (Blancher et al. 2013 and categorized using natural breaks in ArcMap 10.3.1. Trend data are indicated only for BCRs supporting ≥1% of global population.*

a broad geographic range and has spatially variable demographic trends, this concept is particularly useful in defining population boundaries. Using this approach, Figure 1–8 (Rushing et al. 2016) shows demographic-based delineations for Bobolink that, while different from BCR boundaries, still show similarities with BCR-based data. For example, steep negative trends are apparent in Ontario and the northeastern U.S. Because boundaries for natural populations are based on ecological processes, managing units so delineated allows for management of ecological processes.

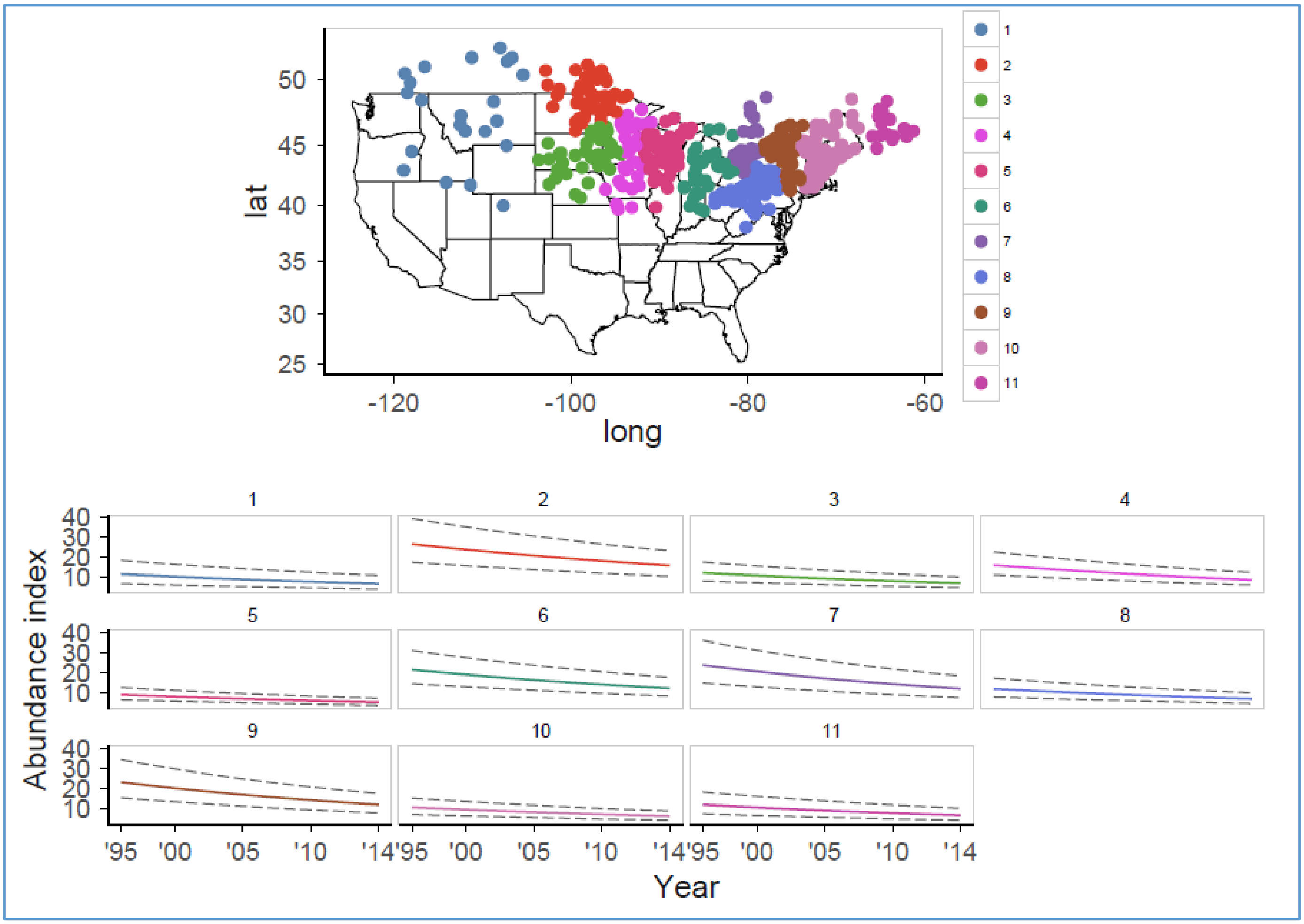


Figure 1– 8. *Bobolink natural populations and their trends (after Rushing et al. 2016).*

With adequate data, the concept of natural populations can also be used to assess trends on a finer, more local scale. Alternatively, smaller units within a BCR or other regional boundary can be delineated. Estimating trends for small spatial units shows the variability within BCRs for Bobolink trends (Ethier and Nudds 2015). This approach can rectify some of the problems associated with non-demographic-based boundaries such as BCRs by showing population structure, albeit in this case defined by non-ecological attributes, at a finer scale. Likewise, trends for smaller land units can inform management at finer scales. Local trends can indicate where declines are most severe, and perhaps equally important, what land units of interest support stable or increasing populations. Areas contributing to Bobolink populations, despite declines elsewhere, may demonstrate functional or recovering grassland landscapes. However, the relatively few BBS routes per unit area does not lend itself to trend estimates at this finer scale. Surveys that are spatially more intensive would provide more useful data for this approach.

Demographic Indicators

The Institute for Bird Populations analyzed 15 years (1992-2006) of data from the Monitoring Avian Productivity and Survivorship (MAPS) program to provide [vital rates for 158 species] (DeSante et al. 2015). Based on year-unique captures of 477 adult Bobolinks at 12 banding stations in the U.S., mean productivity index (young per adult) was 0.11, similar to analogous indices for Dickcissel (0.07) but substantially lower than indices for Savannah Sparrow (0.39) and Grasshopper Sparrow (0.63). Population change (lambda) was negative (<1) in the eastern BCRs (14 and 30) and positive in BCRs 12, 13 and 19. Statistically significant changes were limited, although among the BCRs, BCR 12 (Boreal Hardwood Transition) had the highest lambda (despite negative population trends). This BCR hosted 12.4% of the global Bobolink population, and also had the lowest reproductive index and highest adult apparent survival, a pattern suggesting that survival was driving trends in that BCR during that time period. Alternatively, BCR 19, which hosts only 1.6% of the global population, had a positive lambda value, and the highest reproductive index and the lowest survival among all BCRs, suggesting that productivity was associated more strongly with population growth than survival for that BCR. These analyses are of limited value, however, as they were based on a relatively small data set (there are few MAPS stations operated in grasslands).

Population Projections

To predict the potential implications of Bobolink population trends, if they continue at current rates, on populations in BCRs in the future, we used quasi-extinction (QE) estimates. QE estimates provide probabilities of future outcomes given current or past trends of a population, and can be used to help identify population or trend objectives, or designed to monitor risk on an annual basis in order to monitor progress towards goals (i.e., as conservation strategies are implemented). Recently QE estimates have been used to examine risk in 330+ North American bird species in terms of whether they will be adequately monitored by the BBS (Stanton et al. 2016).

We were interested specifically in 1) estimating quasi-extirpation risk, or the risk of dropping below detectable rates by the BBS, and 2) estimating risk of a percentage decline from current population levels. Risk can be presented in terms of a defined time-scale (minimize risk of extinction in 50 or 100 years), or the half-life of a population (time in which a population decreases by 50%). Assumptions of quasi-extinction analyses are that patterns in the past will continue, and that populations are closed within BCRs.

We derived current population estimates from PIF Science Committee estimates (Blancher et al. 2013). A Monte Carlo approach was used to incorporate the uncertainty in BBS abundance, specifically between-route and within-route variation. This allows a distribution of population size estimates for each species in each geographic region which can be described by standard statistical descriptions (mean, median, quantiles) rather than a single point estimate.

We calculated QE rates for Bobolink using recent (2003 – 2012) and long-term (1970 – 2012) BBS trends. Because our population objectives are established at a BCR scale, we determined QE values for BCRs, as well as throughout the breeding range. Significant declines are predicted in multiple BCRs. Declines of 30% within four to 10 years are expected in four BCRs, and within 11-20 years in five BCRs (Figure 1–9). Declines of 50% are expected within 21 years in BCRs 13 (95% CI: 18-23 years) and 22 (95% CI: 6-89 years). In BCR 11, which hosts the largest percentage of the population (34%), Bobolinks would decline by 30% in 32 years (95% CI = 16 – 68) and by 50% in 64 years (95% CI = 38 – 111). The next largest proportion of the Bobolink population (15%) resides in BCR 13, where it is expected to decrease by 30% in 11 years (95% CI = 9-13), and by 50% in 21 years (95% CI = 18-23).

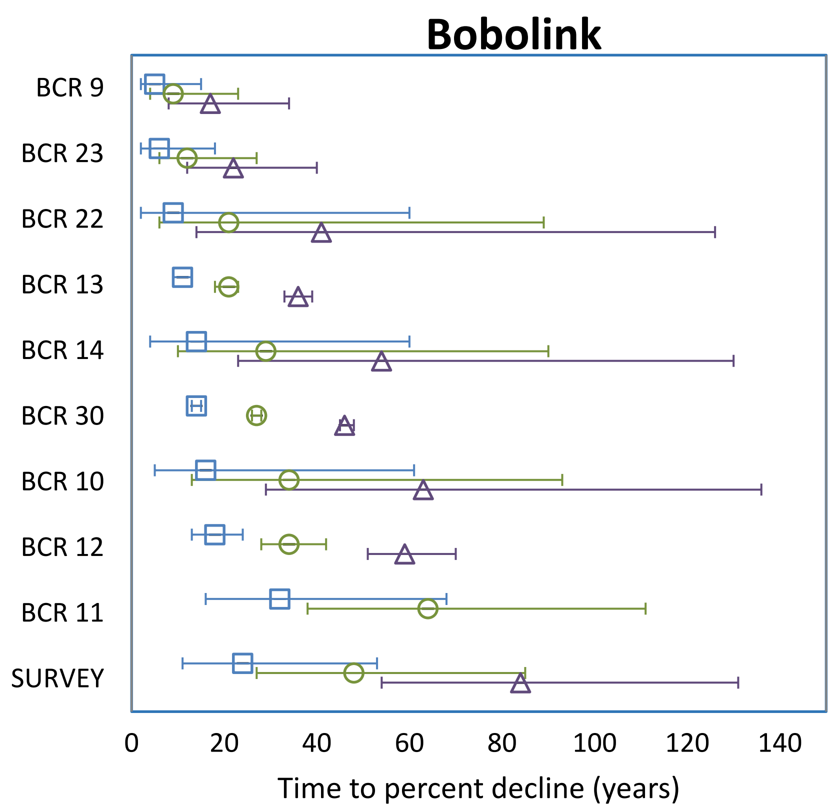


Figure 1– 9. *Estimated years until Bobolinks decline by 30, 50, and 70% based on 2003-2012 BBS trends. Symbols and lines depict estimated trend and 95% CI, respectively, for 30% (blue), 50% (green), and 70% (purple) decline in the Bobolink population.*

Work by Stanton et al. (2016) indicates that in one BCR, BCR 9, Bobolink may reach a population threshold within the next 100 years where it can no longer be adequately surveyed by the BBS (Figure 1–10a). In fact, that threshold could be reached much sooner, with the BBS inadequate for surveying Bobolink in BCR 9 within 16 years (95% CI = 8-30). In addition, several other BCRs (BCRs 10, 17, 22, 23, and possibly 14) may become difficult areas in which to survey Bobolink with BBS toward the latter part of this century. In BCRs 23 and 28, other grassland species such as Upland Sandpiper (*Bartramia longicauda*), Grasshopper Sparrow, Henslow's Sparrow, and/or Eastern Meadowlark (*Sturnella magna*) are also predicted to not be adequately surveyed by BBS by the end of this century (Figure 1–10 b,c).

Habitat, Behavior, and Ecology

General Year-round Habitat

Bobolink is a year-round grassland obligate, but may inhabit different types of grasslands at different times during its annual cycle. During the breeding period, Bobolinks utilize temperate grasslands. During the non-breeding period, as defined by the IUCN habitats classification scheme, Bobolinks may use: Dry Savanna; Moist Savanna; Subtropical/Tropical Dry Lowland Grassland; and Subtropical/Tropical Seasonally Wet/Flooded Lowland Grassland. During this period, they also temporarily flock in fresh or saltwater marshes in the following habitat types: Bogs, Marshes, Swamps, Fens, Peatlands; Permanent Inland Deltas; and Permanent Saline, Brackish or Alkaline Marshes/Pools.

Breeding Habitat

Originally a species of the tallgrass and mixed-grass prairies in the U.S. and Canada, Bobolinks are grassland generalists that now rely primarily on surrogate agricultural habitats, primarily in well-established (> eight years since establishment) hayfields and lightly-grazed pastures, and to a lesser extent, in younger hayfields (Renfrew et al. 2015). They also breed in undisturbed lowland meadows, recently idled fields (typically one to three years since cultivation), old fields (typically four or more years since cultivation, with more perennial grasses and forbs than idle fields), and remaining intact and restored prairie (Schmitz 2013). Alfalfa fields are frequently used, especially older fields with a large grass component (Bollinger and Gavin 1992), and newer fields that are also seeded with grass. Bobolinks are one of the dominant species in cool season Conservation Reserve Program (CRP) fields in Wisconsin and other parts of the Midwest (Ribic et al. 2009*b*). In Ontario, nesting Bobolinks have also been documented infrequently in large fields of oats, winter wheat and rye (Sample and Mossman 1997; McCracken et al. 2013).

The size of fields in which Bobolinks breed often depends on the context of the surrounding landscape, especially in more fragmented open lands. Bobolinks favor landscapes with a high proportion of non-forested habitats (Ribic et al. 2009*a*, Shustack et al. 2010, Davis et al. 2013, Guttery et al. 2017). They are area-sensitive (e.g., Vickery et al. 1994, Ribic et al. 2009*a*), with higher densities found on larger hayfields than smaller ones (e.g., Bollinger and Gavin 1992). However, they will use smaller fields in more open landscapes (Thogmartin et al. 2006, Renfrew and Ribic 2008). In addition, certain landscape mosaics are more desirable for breeding grassland birds than others. Based on the landscape-scale responses observed for Bobolink

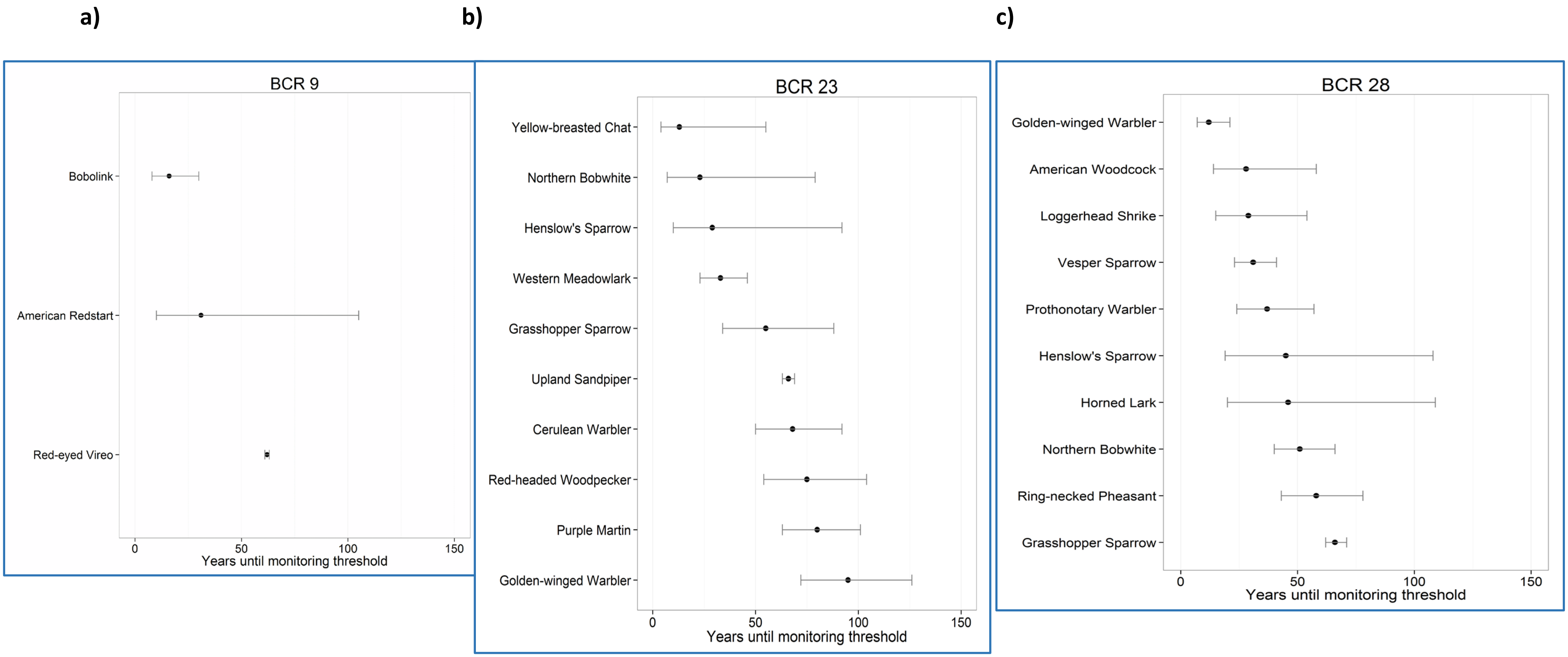


Figure 1– 10. *Estimated time (years) it will take bird species to decline to the minimum monitoring threshold (threshold index = 0.01) in (a) BCR9, (b) BCR 23, and (c) BCR 28 from 2012 BBS index values if population trends observed between 1970-2012 continue (Stanton et al. 2016). Shown for Bobolink, other grassland bird species, and other species for comparison. Bars indicate 95% confidence intervals. Symbols are placed at the year where the cumulative probability first reaches 0.5. Species shown are expected (with at least 0.5 probability) to reach QE threshold within 100 years and with upper confidence intervals less than 150 years. The BBS may no longer adequately survey Bobolink in BCR 9 within 16 (95% CI = 8-30) years.*

(Ribic and Sample 2001, Renfrew and Ribic 2008, Ribic et al. 2009*b*), grassland patches are more likely to be used when they are embedded within large, open landscapes. More specifically, Bobolink may be responding to certain types of grasslands in the landscape more than others. Guttery et al. (2017) found that hay at small (<300m) scales and pastures at a variety of scales (up to 3000m) in the landscape were important to Bobolink patch occupancy in Wisconsin grasslands. Bobolinks also respond strongly to social information, and use cues during post-breeding to identify potential habitat for the following year (Nocera et al. 2006).

Bobolinks generally select structural attributes rather than composition of vegetation (Sample and Mossman 1997). They prefer medium to tall grasslands with a high percentage of grass, some forbs (especially stiff-stemmed species, for perching), and moderate herbaceous litter (Bollinger and Gavin 1992; Herkert and Glass 1999, Quamen 2007, Renfrew et al. 2015). Up to a point, Bobolinks prefer vegetation that is relatively tall and dense compared to other grassland habitats (Sample and Mossman 1997, Winter et al. 2005). In the northern tallgrass prairie region, Bobolink density increased from 0.43 to 1.23 pairs per 100 ha for each cm increase in vegetation height (Winter et al. 2005). Vegetation that was taller and denser in the prebreeding season was linked to increased occupancy rates and abundance of Bobolinks in study regions in Wisconsin and Nova Scotia (Nocera et al. 2007). Bobolinks occur in fields with relatively few shrubs (reviewed in Dechant et al. 2001).

The type of grass also influences Bobolink density, but depends on management such as prescribed fire frequency. Bobolink density was higher in cool-season compared to warm-season grasses in CRP fields in eastern South Dakota (Eggebo 2001) and Iowa (Vogel 2011). In Wisconsin, however, Bobolink density in warm-season grasslands one to two years post burn was higher than in cool-season CRP (Ellison et al. 2013).

Bobolinks avoid placing nests near edges (see Fragmentation in threats section). Nest density is usually greater farther from edges (Bollinger 1995, Johnson and Igl 2001, Renfrew et al. 2005; but see Davis et al. 2006), and Bobolinks have been found to avoid placing nests within at least 50m from edges (e.g., Bollinger and Gavin 2004, Renfrew et al. 2005, Perkins et al. 2013). Response to edge types varies among studies, but in general Bobolinks appear to prefer to place nests where the viewshed is relatively open (Keyel et al. 2012, 2013). Nests are well-concealed and placed on the ground, often at the base of forbs (Renfrew et al. 2015).

Breeding Behavior and Ecology

Male territories are usually non-overlapping and their size varies from approximately 0.4 – 2.0 ha (Renfrew et al. 2015). Territory size likely depends on factors such as vegetation structure, management, field borders, proximity to edges, breeding status, age and geographic location. Older males have smaller, higher-quality territories compared to second-year males (Nocera et al. 2009). In New York hayfields where the average territory size was 0.5 ha (Bollinger 1988), nest density was 0.3-3.9 nests/ha (Bollinger and Gavin 2004).

Nesting phenology is later in western parts of the breeding range than in the east. Initial territories begin to be established 1–5 May in New York, 10–13 May in Wisconsin and 13–22

May in Oregon. Females arrive at nesting sites 4-8 days after males, and pairs form within two days. Polygynous males pair with second females three to eight days later, and may pair with up to four females in a season (Martin 1971). Females construct nests over one to two days, laying one egg/day beginning within one to two days of nest completion. Average clutch sizes are 4.7 – 5.1 eggs, and range from two to seven eggs (Renfrew et al. 2015).

Earliest recorded egg dates are 13-25 May in Vermont and 10-13 May in Wisconsin (C. A. Ribic, unpubl. data). The female incubates for 10-13 days. For first nest attempts, hatching begins in early- to mid-June for eastern and Midwestern fields, and later in June for more western sites. Both males and females feed nestlings, and young leave the nest 10–11 d after hatching (Renfrew et al. 2015). In the East, nests begin fledging around the third week of June, but because of renestings, fledging can extend as late as 24 July (Norment et al. 2010). Based on video evidence from at six sites in the U.S. and Canada, all chicks in 36 of 41 Bobolink nests with >1 chick fledged within one day (Ribic et al. 2018). Bobolinks rarely have more than one brood per season, and some renest after failure early in the season. The percent of females that renest after failing depends on the date of failure (more likely to renest earlier in season) and may also be due to cause of failure and/or habitat type. After initial nesting where hayfields were mowed (causing nest failure), 25% of females renested on other fields (N. Perlut, unpubl. data). Renesting on the same site after failure due to weather is likely to be equal or higher than renesting after mowing, given the same date of failure. Second nesting attempts have one or fewer eggs on average compared to the first attempt (Renfrew et al. 2015, Frei 2009). In eastern Ontario and western Quebec, hatch dates for second nest attempts after predation or weather causing failure ranged from 21-30 June and fledge dates ranged from 1-12 July (Frei 2009).

Non-breeding Habitat, Behavior, and Ecology

Flocks of families with young fledglings and birds that failed or did not nest begin forming in late June. Flocks occur in grasslands, but not necessarily in fields where breeding took place. In July and August during prebasic molt, birds may leave upland fields and gather in freshwater marshes and coastal areas locally or hundreds of km away from breeding areas. Each year in North America reports of flocks begin in the hundreds in July, and observed flocks grow to several thousand individuals in August and early September (eBird 2016).

The current distribution of Bobolinks during much of the non-breeding season is strongly related to the distribution of cultivated rice (Figure 1–11). This is not a new phenomenon; Bobolinks historically fed on cultivated and wild rice during their initial southbound migration through the U.S. During this period, their diet is mostly seeds (Renfrew et al. 2015) although they also feed on insects, usually opportunistically (Renfrew and Saavedra 2007, Lorenzón 2016), but also intentionally when seed is superabundant and concentrated (Renfrew 2007).

Bobolinks feed in agricultural fields, particularly rice, in Venezuela in October (G. Basili, pers. comm.); but more study is needed on habitat use during their stop in the Llanos in both Colombia and Venezuela. They are present in northeastern Bolivia as early as mid-November (Renfrew et al. 2013). Their diet in eastern Bolivia before mid-late January, when rice becomes widely available, is not well known.

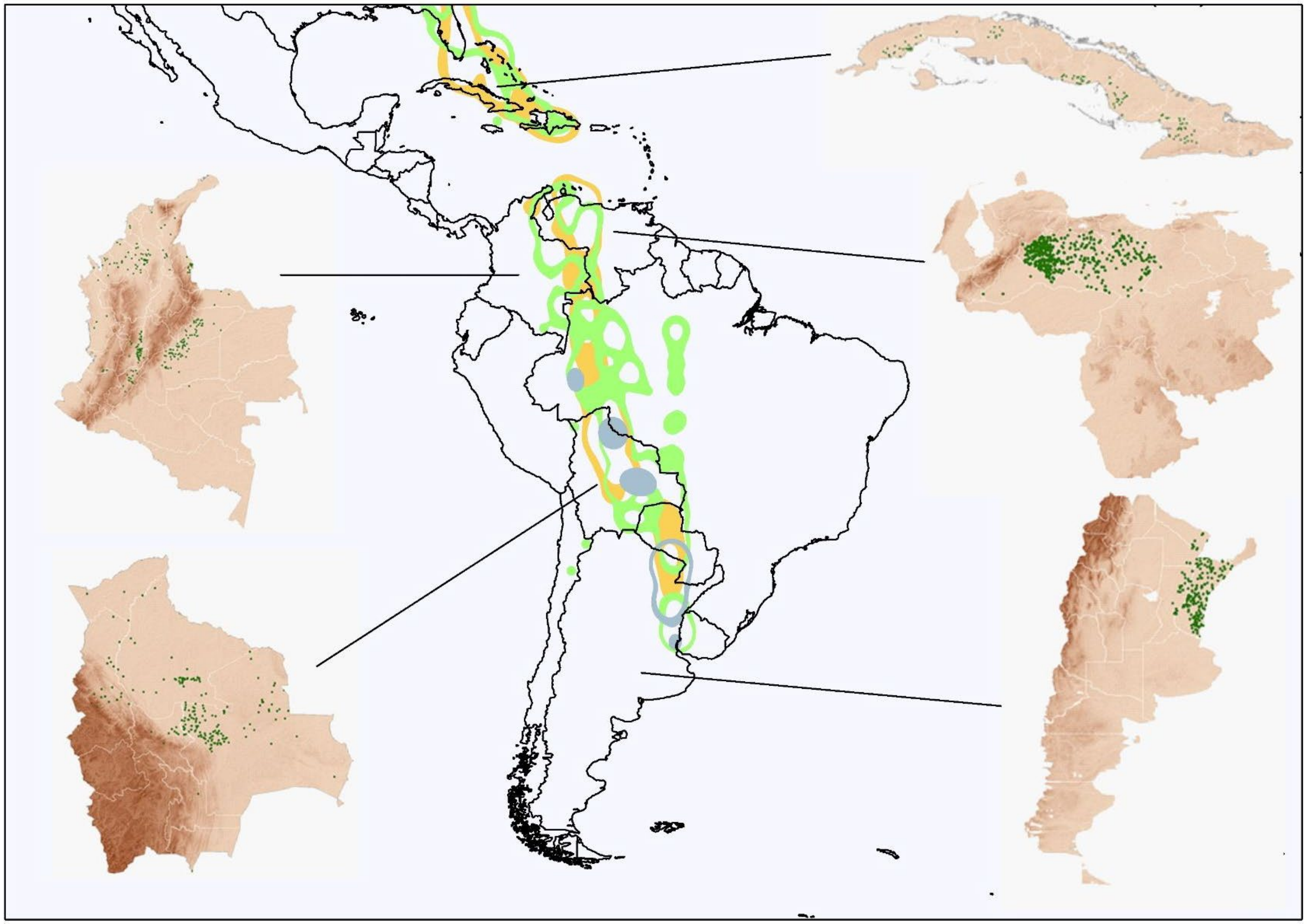


Figure 1– 11. *Bobolink occurrence and rice production. Bobolink occurrence is based on outer limits of 90% kernel density estimates from geolocator data (Renfrew et al. 2013), where green = spring migration, tan = fall migration, and blue = wintering. Rice production (1 green dot = 1,000ha except in Cuba, where 1 green dot = 2,000ha) in Caribbean and South America countries was compiled in 2013 (GRiSP 2016).*

In winter (austral summer) Bobolinks inhabit open grasslands loosely associated with major waterways and wetland systems. They occur in wet lowlands and drier uplands, feeding on grass, forb, and shrub seed in ranchlands, ungrazed grasslands, marshes, and in crops (Di Giacomo et al. 2003, Renfrew and Saavedra 2007, López-Lanús and Marino 2010). Bobolinks occur at relatively low densities in natural grasslands, and forage in small, more dispersed flocks (Di Giacomo et al. 2003). Unlike most Neotropical migrants, the Bobolink flocks in the winter, tracking available food resources, and operates under different limitations from species that establish winter territories and are subject to density dependence (e.g., Marra et al. 2015). In rice production regions they form large flocks and are often considered a pest in inundated rice paddies. They occur less frequently in sorghum, soybean, sunflower, and corn, where they eat insects and/or seeds. They opportunistically feed near rice fields in roadside grasses and shrubs along field margins, on dikes, and in fallow fields (Renfrew and Saavedra 2007, Blanco and López-Lanús 2008). Seed resources may be intermittent, temporarily abundant, and spatially variable, features that likely drive local and regional within-season movements of Bobolink.

During northbound migration, Bobolinks have been documented in the Paraguayan Pantanal along watercourses, feeding on seeds of emergent vegetation in March and April (RBR). They feed in rice fields in Colombia, where they are considered a pest (C. Ruiz, pers. comm.), and in Cuba in April and early May, where they are sometimes captured for the pet trade (E. Iñigo-Elias, pers. comm.).

Demography

Nesting success can vary dramatically, from 5 – 50% (Renfrew et al. 2015) among sites and between years. Success varies with weather, and depends on the local landscape, predator community, grassland patch size and habitat type, structural characteristics of the field and the nest site, and the timing and level of disturbance or management. Extreme weather events affect nests directly; in addition, these events and patterns can influence behavior and demographics of predators. On managed sites such as hayfields, nest success rates vary dramatically (discussed under Threats). Aside from impacts of field management, predation is the major source of nest failure, with variable predation rates depending on the predator community, patch and landscape characteristics, and the location of a nest relative to edges (e.g., Kuehl and Clark 2002, Winter et al. 2004).

Similar to nest success, annual reproductive success varies depending on the same factors. In Vermont Bobolinks raised 2.15 fledged young/clutch (n = 881), and first clutches were more productive, with 3.9 fledged/clutch (n = 457; N. Perlut, unpubl. data). Annual reproductive success in New York was 2.55 young fledged per female (n=379 females); in heavy flooding years in Wisconsin, nests unaffected by flooding fledged 2.69 young per nest (215 young fledged by 80 females), otherwise 2.13 young fledged per nest by 103 females (Martin 1971). In warm-season fields in southwestern Wisconsin, 35 of 48 nests were successful and fledged an average of 3.2 (SD = 1.5) fledglings (C. A. Ribic, unpubl. data). In Vermont, success ranged from 0.04 to 2.8 fledged young per female depending on the intensity of hayfield and pasture management (Renfrew et al. 2015).

Breeding site fidelity varies and appears to have a geographic pattern. In Vermont where available sites are more limited, fidelity is high: 85% of males returned to breeding sites in the subsequent year following banding (Fajardo et al. 2009). In the Midwest, however, site fidelity appears to be lower. Of 143 males banded in Indiana, 30 (21%) were recaptured in three subsequent breeding seasons. Of these, 24 (80%) were site faithful (Scheiman et al. 2007). At seven cool-season CRP sites in southwest Wisconsin, average annual return rate of adult male Bobolinks was 22.8% (N = 57). Of the 13 males that returned the year after banding, only three returned the second year after banding (K. Ellison, pers. comm.). There are fewer data on natal fidelity. In Vermont, of 759 Bobolink nestlings banded in 2002-2011, 83 (12.5%) were recaptured in 2003-2012, and 22% of these individuals returned to their natal fields (Perlut and Strong 2016).

Dispersal distance data from Vermont indicated a mean adult dispersal distance of 370 m in the year first relocated after banding, and distance did not differ between sexes but was negatively associated with reproductive success (Fajardo et al. 2009). Eighty-three returning first-year Bobolinks dispersed a mean (SD) and median distance of 1287.2 m (1146.9) and 1037.1 m, respectively (Perlut and Strong 2016). In Indiana, 10 of 143 males dispersed up to 14.2 km (mean = 7.4 km, median = 7.3 km), either within or between the three years following banding. The maximum, mean and median observed dispersal distances were less than the maximum (17.8 km), mean (9.3 km) and median (9.7 km) inter-patch distances (Scheiman et al. 2007). Mean natal dispersal distance in Vermont was 975 m (max = 8,424 m), with ~30% of second year birds returning to the natal field. Maximum natal dispersal distance was 8.4 km (Fajardo et al. 2009). USGS Banding Lab data show that seven individuals recaptured away from their banding site in a subsequent breeding season traveled an average of 145 km, and up to 739 km (USGS Banding Laboratory, unpubl. data).

Estimates of apparent annual survival are based on data from a few sites using return rates to the breeding grounds, while seasonal survival data during non-breeding periods are lacking. Apparent annual survival in Vermont juveniles across 10 yearly estimates averaged 0.412 (N. Perlut, unpubl. data). For adults, survival averaged 0.51 (range 0.37-0.80) for males and 0.41 for females (range 0.28-0.72). Annual adult survival was higher on unmanaged fields compared to hayed fields, and positively associated with number of nest attempts, nest success, and number of young fledged. Male adult survival (n = 112) in Iowa was estimated to be 0.70 (Fletcher et al. 2006). The month after fledging can be a period of high mortality for birds (e.g., Barn Swallow, Grüebler et al. 2014), but post-fledging survival is not known for Bobolink.

Non-breeding seasonal survival and seasonal dependencies have not been studied in Bobolinks. These parameters are very difficult to obtain because Bobolinks do not hold territories in winter, making it difficult to determine individual survival.

Threats

Bobolink life history includes complex movement patterns across the annual cycle, and during each phase the Bobolink faces myriad potential threats. The relative importance of each to Bobolink populations may vary in terms of whether, when, where, and how much the individual threat limits population growth. Several threats have been long recognized and revolve around common broad-scale practices shared among countries and even between continents, such as grassland conversion to croplands, unsustainable grazing, and energy and mining. Efforts to more specifically identify threats to grasslands and the birds occupying them have been ongoing, and for this Plan included literature review, workshops (see Introduction, Plan Input and Development, Appendix A and Appendix B, Coordination, Planning and Tools) and online surveys.

To begin the threats assessment process, Renfrew assembled an initial list of potential Bobolink breeding season threats derived from the literature, workshops, and personal communications and vetted the list to the Plan Steering Committee and workshop attendees at The Wildlife Society conference in 2013. Based on this list, and in preparation for a Bobolink planning workshop at Port Washington, Wisconsin in August 2014, authors Renfrew and Peters then conducted an online survey of 21 grassland bird ecologists working within the Bobolink's breeding range (hereafter referenced as the Port Washington survey). Survey participants could also add or delete threats, and the results were summarized for the Port Washington workshop for final review.

Conservation of Bobolinks has been carried out mostly on the breeding grounds, addressing habitat loss and degradation. The relative impact of threats during migration and winter on the Bobolink global population, however, are unknown. The Port Washington survey indicated that 60% believed the populations face the greatest threats on the breeding grounds, while 25% and 15% felt the greatest threats are on wintering and migration grounds, respectively. Based on that survey, threats on the wintering grounds were considered more severe than threats during migration. Although the impacts of threats on the wintering and migration grounds to Bobolink populations are unknown, the same threats are often also problematic for resident bird species. Addressing these threats is therefore important to South American conservationists, regardless of unknown implications for migratory bird species like Bobolink.

Threats can be organized based on their general category, their proximate or ultimate impact on bird populations, or by the type of conservation measures needed to address them. In addition, many can be classified into more than one category, and many are related to one another. In Figure 1–12, we present some of the known and potential threats affecting Bobolink, which vary across the annual cycle of the species.

Ranking threats. To develop strategies that can effectively address threats, we needed to identify more detailed threats specific to each region where the species occurs, and to rank them in terms of potential population impact. To do this, we used information captured in the 2014 Port Washington online survey (for North America) and in non-breeding season

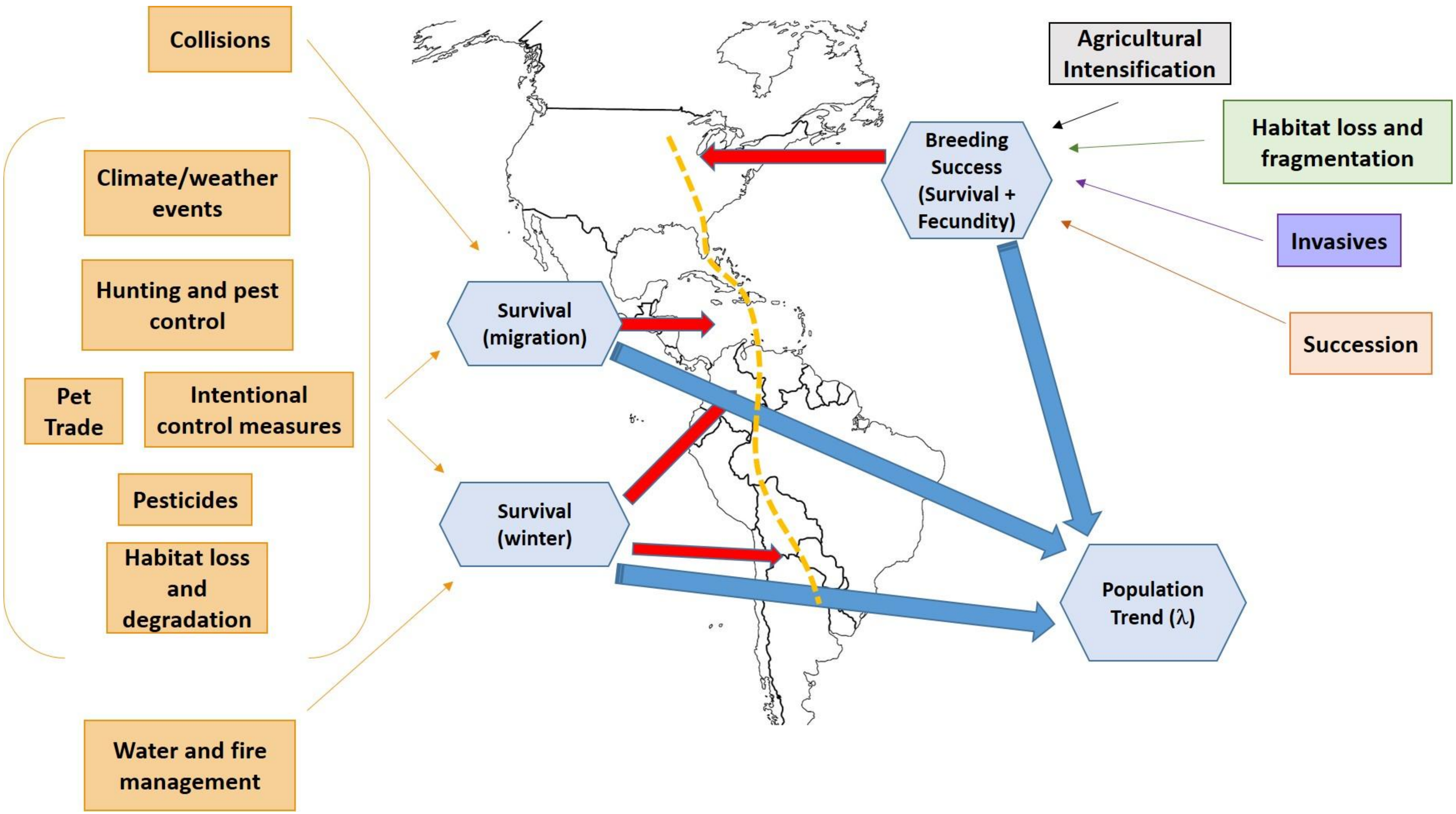


***Figure 1– 12**. Full life cycle influence diagram showing some of the known and potential threats to Bobolink populations throughout the annual cycle. Some of the threats shown are categories that encompass several threats listed in the Plan.*

Threats \ Targets	Bobolink	Non-breeding habitat	Breeding habitat	Summary Threat Rating
Pesticides (esp. for rice)	Medium			Low
Burning pastures		Low		Low
Conversion of pasture to cropland		Medium		Low
Road construction		Medium		Low
Introduction of exotic grasses (potential)		Medium		Low
Killing BOBO as crop pests in rice fields	Low			Low
Changes in precipitation & loss of wet grasslands		Very High		High
Dam construction (potential)		Low		Low
Grassland succession to shrubland, forest			Medium	Low
Grazing pressure too high			High	Medium
Invasive grassland species			Medium	Low
Earlier, more frequent haying & mowing			High	Medium
Farm abandonment			Medium	Low
Conversion from hay, rangeland, pasture to row crops			Very High	High
Wind & Solar infrastructure			Medium	Low
Urban & Suburban sprawl			Medium	Low
Extreme weather & phenology mismatch			High	Medium
Fracking & drilling - western part of range (habitat loss)			Low	Low
Toxic classes of pesticides used on adjacent fields			Medium	Low
Conversion from hay & pasture to corn and soy			Medium	Low
Suboptimal land use & agricultural policy decisions[?]			Not Specified	Not Specified
[Uncertain how to classify need for data here as a threat]				Not Specified
Summary Target Ratings	Low	High	Very High	Very High

Figure 1– 13. *Threats to Bobolink populations ranked across the annual cycle using Miradi software in an Open Standards framework.*

workshops (for North and South America) and classified threats as direct or indirect following the Open Standards framework. A direct threat is a human action (except climate change, invasive species, and pathogens) that directly degrades a conservation or resource management target. It has at least one actor associated with it. Residential development is an example of a direct threat. Alternatively, a reduction in the use of a particular rice variety is not a direct threat; instead, it is an indirect threat or contributing factor that may perhaps lead to less rice cultivation (the direct threat). Further explanation of these distinctions can be found in the manual for the Miradi software (Foundations of Success 2009). Threats were then ranked following the Open Standards framework based on three criteria:

1. Scope of threat: proportion of population affected
2. Severity of threat: proportion of affected population lost due to threat
3. Irreversibility of threat: difficulty of reversing threat

To assign an overall threat magnitude rating, the Miradi program combines scope (1) and severity (2) ratings using a rule-based system, and then combines this rating with the irreversibility (3) rating, again using a rule-based system. Irreversibility has a relatively large influence on the final threat rating.

Figure 1–13 presents the direct threats identified, their rankings, and contributing factors within each major region. Threat rankings within each major region are also shown on Miradi program diagrams in chapter 2. Not all threats were scored in all countries, and those without scores tended to be low-level or speculative and are not presented in the diagrams. For these threats we did not develop strategies, as conservation efforts should be focused on higher priority threats unless there is a broader strategic goal (e.g., political, awareness-raising, funding).

Not included in the Bobolink diagrams are stresses, or attributes of a conservation target's ecology that are impaired directly or indirectly by human activities, such as reduced population size or forest habitat fragmentation. In other words, stress is what makes a threat a negative actor. In the Open Standards Miradi system, a stress is placed between direct threat and the conservation target. In our rice example, a loss of foraging habitat due to the direct threat of less cultivated rice is a stress that impairs the conservation target (Bobolink).

Threats during the Breeding Season

Among the myriad threats to Bobolinks and co-occurring bird species in North America, grassland bird ecologists consistently agree on the two primary threats to populations: the conversion of grassland habitat to unsuitable croplands, followed by the intensification of haying/mowing practices. Biofuels were considered the third major threat; they have driven recent conversion of grasslands to corn, and therefore contribute to the primary threat of grassland conversion. Conversion to development was the fourth most significant threat. These top four ranking threats on the breeding grounds result in habitat loss, although haying can also be a means by which habitat quality but not quantity is reduced.

Habitat Loss

Native and agricultural grassland[1] habitats have decreased dramatically on both a global (Vickery et al. 1999*a*, White et al. 2000) and continental (Johnson 2005, Brennan and Kuvlesky 2005, Askins et al. 2007) scale, representing one of the most decimated and still rapidly-declining land cover types worldwide. In North America, the main causes of losses depend on the time period and the region. In general, both native and non-native (surrogate) grasslands have been converted to cropland, as well as to urban, suburban, and exurban development, particularly in the tallgrass prairie region of the Central U.S. and adjacent southern Canada (Askins et al. 2007, Rosenberg et al. 2016). In the 1980s and 1990s, conversion of rangeland to crops in the Great Plains, virtually all native grassland, was the primary source of habitat loss (Murphy 2003). More recently, 53 (13%) of the 419 million acres of grassland that remained intact in 2009 were converted to crops by the end of 2015; this loss represents an area equivalent to the size of Kansas (WWF 2016).

McCracken (2005) and Johnson (2005) review losses of native grasslands in North America since European settlement and report losses ranging from approximately 70-80% in shortgrass and mixed-grass prairie habitat, and over 99% in tallgrass prairie. It has been suggested that less than 0.1% of tallgrass prairie remains where soils and topography have been favorable for crop production (Samson and Knopf 1994, Brennan and Kuvlesky 2005); much of the eastern tallgrass prairie type was plowed, overgrazed, or succeeded to woods by 1900 (Sample and Mossman 2008). Of the native tallgrass prairie that does remain, an estimated 80% lies within the Flint Hills region of Kansas and Oklahoma (With et al. 2008), south of the core Bobolink breeding range. Loss of mixed-grass prairie continues as the use of center-pivot irrigation and drought-resistant corn varieties expands westward.

The primary land use replacing native and surrogate grasslands is cropped agriculture, with losses varying regionally. In the Great Plains, hay and pasture are lost more often to small grains. In the Midwest, the conversion of pasture and grass hay acreage to corn, soybeans, and alfalfa has been associated with Bobolink declines during the last 50 years (Herkert et al. 1996, Sample and Mossman 2008). Pasture and hay constitute the majority of remaining grassland habitat in the region, along with CRP grasslands, which have recently undergone significant losses since 2008 (discussed below). In the northeastern US, loss of hay and pasture is associated with the loss of dairy farms and increasing human population (Perlut 2014), in addition to substantial reforestation in some states. In North America's remaining untilled prairie habitat agroeconomic pressures have driven the most recent losses. Over the course of the 20th century, pasture and grass hayfield conversion to more intensively farmed forage crops such as early-blooming varieties of alfalfa (*Medicago sativa*) has reduced the amount of available breeding Bobolink habitat in the Northeast and Midwest (Askins et al. 2007).

In Canada, losses of pasture and hay acreage since 1970 have coincided with similar changes in the eastern and Midwestern US, and have been associated with increases in corn, soy, and

[1] Agricultural grasslands such as non-native hayfields, small grains, fallow and old fields, pastures, and idled croplands (e.g., CRP grasslands) that replaced native prairie communities are often called *surrogate* grasslands.

wheat in Ontario (Smith 2015). Similar to the northeastern U.S., since the 1960s hayfields are more frequently planted to pure or mixes of alfalfa. In general, pastured land has declined by about 75% since the 1960s. Declines in hay and pasture are associated with declines in livestock, in part due to a shift in beef production from Ontario to western provinces, and a decrease in demand for beef (McCracken et al. 2013).

In the U.S., corn and soy prices more than doubled between 2006 and 2011 (Wright and Wimberly 2013). Expansion of biodiesel and ethanol markets were important contributors to price increases, along with the value of the U.S. dollar, higher energy prices, higher costs of production in agriculture, weather-related production shortfalls, economic growth following the 2009 recession, greater foreign exchange holdings by countries importing foods, and policies adopted to mitigate food price inflation (Trostle 2008, Trostle et al. 2011). Such vast, large-scale economic policies and other influences are ultimately what drive major changes in habitat for grassland birds, making grassland bird conservation a vexing problem that is very difficult to tackle at its roots.

The price increases in corn and soybeans resulted in what has been identified as one of the most important land conversion events in recent U.S. history (Wright and Wimberly 2013). Nationally, net cropland area on land not previously used for either crops or pasture increased by over 1.2 million ha from 2008 to 2012 (Lark et al. 2015). Between 2010 and 2012, planted acres of soybean have hovered around 77 million, and were predicted to increase to 86.5 million in 2015-16 (Wisner 2015*a*). During the same period, acres planted to corn increased from 88 to 97 million, and were predicted to return to 88 million acres in 2016 (Wisner 2015*b*). In the western Corn Belt region of North Dakota, South Dakota, Nebraska, Minnesota, and Iowa, an estimated 530,000 ha of grass-dominated land cover were lost between 2006 and 2011 (Wright and Wimberly 2013), with new cultivation most extensive in the Dakotas (Lark et al. 2015). A spatial assessment by the University of Michigan Ecosystem Management Initiative recently identified dramatic increases in corn plantings and loss of grassland habitat in the Prairie Pothole Region, with remaining grasslands degraded by erosion, sedimentation, pesticides and fertilizer pollution.

Higher crop prices motivate farmers to plant more land to crops. In addition, with an increase in crop prices comes higher land values and higher land lease rates. In turn, higher land lease prices result in yet more land planted to crops in an attempt to cover the higher rental costs. In the U.S., commensurate with the increase in cropped lands was a 34% loss in CRP acreage from 2007 to 2015, down to 24.2 million acres (USDA 2015). This reduction is permanent with the passage of the Agricultural Act of 2014, which reduced the cap on CRP enrollments from 32 to 24 million acres by 2017.

The extent to which grassland habitat losses on the breeding grounds have driven Bobolink declines is unclear. Uncertainty remains in part because it has been historically difficult to accurately assess the extent of native and anthropogenic grassland using current agricultural statistics, land cover layers and remote sensing techniques (McCracken 2005). Broad-scale land cover data (e.g., from satellites) do not classify grassland habitats accurately, making it difficult to monitoring habitat change in grasslands. With et al. (2008) conducted recent modeling exercises suggesting that even in areas containing large tracts of land with apparently suitable habitat, many grassland bird populations may not be viable at a regional scale. Although unreliable land use data may underlie this finding, the authors conclude "Habitat area is thus no guarantee of population viability in landscapes managed predominantly for agricultural or livestock production."

Alternative Energy—Wind

Concern about potential negative impacts of wind power development on wildlife, particularly migratory birds and bats, has prompted creation of standard guidelines for identifying, assessing, and monitoring those potential impacts (USFWS 2012). Similar guidelines are in place in Canada (Environment Canada 2006). Impacts of wind facilities include direct mortality due to collisions, especially during migration, the loss of available habitat for birds, directly and due to displacement by turbines and their infrastructure, and indirect mortality resulting from wind structures (reviewed in Smith and Dwyer 2016).

A paucity of data on collisions and displacement continues to be addressed with increasingly rigorous methods. In the meantime, risk assessments can provide guidance as to what impacts may be expected over the long term. An assessment of population-level impacts on 428 species of breeding birds in the U.S. from wind energy development found Bobolink and several other grassland species (Northern Harrier (*Circus cyaneus*), Upland Sandpiper, Henslow's Sparrow, Grasshopper Sparrow, and Sedge Wren (*Cistothorus stellaris*) to be among the 40 species at high risk (Beston et al. 2016). This assessment based risk on fatalities at wind facilities, population size, life history, species' distributions relative to turbine locations, number of suitable habitat types, and species' conservation status. The vulnerability of Bobolink was in part driven by the large proportion of the population living in the vicinity of wind turbines (based on grid cells of 21 X 21 km used in the study).

Wind turbines are placed in open areas with high winds, and large grasslands support the needed conditions for adequate energy generation. Turbines placed in grasslands may remove suitable habitat for breeding birds, and can cause displacement of birds away from the wind generation area in addition to some direct habitat loss. Leddy et al. (1999) reported that total bird density was lower in CRP grasslands containing turbines than in CRP grasslands without turbines. Density was lowest within 40 m of turbines, and linearly increased to 180 m from turbines. Shaffer and Buhl (2015) used a before-after-control-impact study design to evaluate the effects of three turbine developments. They found that although Bobolink was initially attracted to the turbines, after year one they avoided them, in some cases beyond 300 m. Preliminary analyses from a 10-year study indicate that Bobolink may avoid wind turbines up to 200 m (Shaffer et al. 2012); however, results thus far have varied temporally and spatially, precluding any general conclusions about large-scale displacement.

Collisions of small songbirds (<31 cm in length) account for approximately 60% of fatalities at U.S. wind facilities (Loss et al. 2013). Bobolink mortality due to collisions with turbines during the breeding season may be low, but there are few data. A total of 22 Bobolinks were found dead from collision with turbines at the Wolfe Island Wind Facility, comprised of 67 turbines, in eastern Ontario between May 2009 and August 2011 (Stantec Consulting Ltd. 2010*a*,*b*; 2011*a*,*b*,*c*; 2012). In 2012, three female Bobolinks were found dead from colliding with turbines, representing an estimated 23 actual fatalities after applying correction factors (Stantec Consulting Ltd. 2014). All reports were from the breeding or post-breeding (mid-Aug - early Sept) periods. It is unknown how much of this mortality is additive, and the probability of strikes as well as the proportion of those that are additive may both be season-dependent, varying with the birds' behavior and vulnerability to other threats. Solar

The impacts of solar developments on grassland birds and other wildlife are not yet well understood, and more rigorous, standardized research is needed to understand local and population-level impacts. The basic types of solar technology are photovoltaic (PV) cells that convert sunlight, and concentrating solar power (CSP) technology, which uses reflective surfaces to concentrate the sun's heat. Potential impacts from solar development to grassland and other birds are habitat loss, and direct and indirect mortality (reviewed in Smith and Dwyer 2016).

Although the majority of solar potential in the U.S. is in the west and southwest (Walston et al. 2015), development within the breeding range of Bobolink also occurs on open lands, and therefore has the potential to impact grassland bird habitat. The potential impacts of habitat loss, fragmentation, and degradation from solar developments need study. Grasslands used for solar development are likely not suitable for grassland bird nesting; and outright loss of habitat and displacement are among the potential impacts. The same impacts apply to associated infrastructure and related activities such as construction, roads, and decommissioning. The extent of potential impact is especially large for utility-scale facilities.

Documentation of bird mortality and its causes from solar facilities has been largely incidental to date, limited to a few facilities and documented in few impact evaluations. The cause of death is often difficult to ascertain. An assessment of six projects found about half of fatalities with known causes were due to collisions (Walston et al. 2015). Impact from collisions has been documented at all types of facilities. Birds flying over solar facilities may mistake PV panels for water and attempt to land. Birds have also been scorched, potentially from feeding on insects that were attracted to glare and polarized light emitted by solar projects. In addition, feathers have been shown to be scorched by solar flux power towers, resulting in fatalities (Walston et al. 2015). As an example of one of the few studies documenting impacts, at three solar facilities in California (PV and CSP), 233 birds (study period/duration not indicated) from a variety of taxonomic families were found dead due to singed feathers, impact trauma, predation trauma, electrocution, and emaciation (Kagan et al. 2014). Substantial direct mortality from solar panels has not been demonstrated for grassland songbirds to date.

Alternative Energy—Biofuels

Policies resulting in government-subsidized biofuel production have had a dramatic impact on grassland bird habitat over the last decade. The U.S. Renewable Fuels Standard (RFS), established under the Energy Policy Act (EPAct) of 2005, was expanded under the Energy

Independence and Security Act (EISA) of 2007. The expansion included an increase in the volume of renewable fuel required to be blended into transportation fuel from 9 billion gallons in 2008 to 36 billion gallons by 2022. Intended to decrease greenhouse gas emissions, the RFS has been sharply criticized for actually increasing emissions (e.g., Cassidy 2014). This is in part because the legislation was originally designed to encourage the development of cellulosic ethanol (produced from grass) production. However, technological complications and other barriers have prevented mass production of cellulosic ethanol. Instead of rolling back the blend mandate, corn was used instead of grass to meet the ethanol blend standards, with detrimental environmental consequences, including increased soil erosion and nutrient overload in waterways that exacerbated problems such as hypoxia in the Mississippi Delta.

RFS created subsidies for producers and refiners to make ethanol mixtures affordable, as well as establish tariffs on imports. Commensurate benchmark production requirements stimulated rapid increases in corn and soybean production (Robertson et al. 2012, McGuire and Rupp 2013). In 2010-2013, over 40% of the acreage planted to corn in the U.S. was used for ethanol production, and only a slightly lower proportion (39%) was predicted for 2015-16 (Wisner 2015*b*). The proportion of soybean oil used for biodiesel nearly doubled, increasing from seven to 13% in 2010-2013, although it was predicted to decrease to 11% by 2016 (Wisner 2015*a*). In addition to the demands for corn created by these domestic ethanol standards under the RFS, an export market for ethanol has grown rapidly. In 2010-2013, export markets (including to Canada) grew by 47%, and these markets have continued to expand. A government subsidy in the form of up to a 20% tax break for ethanol exports is in part responsible for this increase (Funk 2015). The U.S. government invested half a million dollars in 2015 to develop more export markets for biofuels (Schill 2015).

Existing crops make up the bulk of the land source for biofuels production (Robertson et al. 2012), but a massive conversion of native and non-native grasslands took place in response to RFS demands that increased crop prices. In the Corn Belt, new crops were planted by converting non-native CRP. In the Prairie Pothole Region, much of the land converted to crops from 2008 to 2012 had been in CRP, but at least 58% of the converted land came from other sources (Lark et al. 2015). The conversion of wetlands and grasslands to crops has increased carbon emissions (Cassidy 2014), and has been demonstrated to be detrimental to breeding birds (Greer et al. 2016), with Bobolink showing a strong negative response (Fletcher et al. 2011). RFS blends and standards are hotly debated, creating uncertainty about future domestic demand for biofuels.

At the time of this writing, recent, significant drops in corn prices are expected to slow additional losses of native grasslands. The future of corn ethanol depends largely on a fragmented political landscape. The biofuel industry is lobbying to increase exports. Meanwhile, a bill to eliminate the ethanol mandate was introduced in the U.S. as this Plan was being written. Regardless of future demands for biofuels, the ongoing coupling of grasslands conversion/reversion to crop prices will likely continue to leave grasslands vulnerable to market volatility.

Development—Urban, Suburban, and Oil

Agricultural habitats can be especially vulnerable to various forms of development because of the ease with which they can be transformed. In many regions, habitat loss to agriculture is being exacerbated by rapid human industrial and residential development (Hansen et al. 2005). Losses up to 20% have been documented for some areas of the northern Great Plains due to low-density 'exurban' development (Brown et al. 2005). Decades ago, habitat losses in the core breeding range were buffered somewhat by gains in the northeastern U.S. However, the northeast region has experienced habitat decreases, primarily due to reforestation throughout much of the 20th century, and more recently, to residential development. This is particularly apparent in coastal areas where a substantial proportion of this region's native grasslands once occurred (Vickery et al. 1999*a*, Askins et al. 2007).

Hydraulic fracturing and horizontal drilling to extract oil and gas deposits can effectively reduce available grassland bird habitat. The northern Great Plains is an oil-rich region that has seen substantial increases in extraction activity over the last decade. For example, in the Williston Basin (mostly western ND), about half of the 12,990 ha converted for gas and oil well pads in 2000 - 2015 had been prairie, while the other half had been agriculture; in addition, another 12,000 ha had been disturbed and reclaimed during the 15-year period (Preston and Kim 2016).

In grasslands, direct habitat loss, as well as oil pads and associated infrastructure such as roads that birds avoid, reduce the effective available habitat. Habitat quality may be compromised due to associated threats and disturbances such as pollutants (Souther et al. 2014) and noise (Slabbekoorn and Ripmeester 2008), which may in part underlie avoidance. In North Dakota, Bobolink avoided areas within 250 m of well heads, and was one of the six of nine species to avoid these structures (Thompson et al. 2015). The North Dakota study concluded that depending on the configuration of pads, the effective habitat loss per well ranged from 20-56 ha for grassland birds, plus 33 ha/km of new road. The authors recommended the use of multi-bore pads and clustering wells to minimize impacts. There may be opportunities for such practices to be required on public lands. As with other forces that impact grassland bird habitat, the level of impact of this threat on grassland birds will depend on the social, political, and economic landscape that influences oil and gas extractions in the region.

Fragmentation

Often coinciding with the outright loss of grassland habitat is associated fragmentation of the remaining habitat. Bobolinks are considered area sensitive (Ribic et al. 2009*a*), typically occupying patches >10 ha (Johnson and Igl 2001, Renfrew and Ribic 2008). Winter et al. (2006) reported patch size effects on Bobolink density in northern tallgrass prairie, and the strength of the effects varied among years and regions. Patch shape (e.g., edge/area ratio) can also affect Bobolink habitat selection, with patches that are less block-shaped and with greater proportions of edge less likely to be used (e.g., Helzer and Jelinski 1999). In general, patch-size selection is variable and influenced by landscape context (e.g., Guttery et al. 2017), patch structure, and the degree of 'openness' perceived by individuals (i.e., how much of an animal's visual field is not occluded by ground, vegetation structure, or human-made structures, Keyel et al. 2012, 2013).

The effect of landscape context can be substantial enough to overshadow potential benefits of field-level management to grassland birds (Pillsbury et al. 2011). Several studies have demonstrated that Bobolink area sensitivity is related to large-scale landscape characteristics, wherein Bobolinks are more likely to occur -- or occur in greater densities -- in fields that are small when they are surrounded by more open (treeless) habitat (Ribic and Sample 2001, Renfrew and Ribic 2008, Ribic et al. 2009*a*). Renfrew and Ribic (2002) found that Bobolink in Wisconsin selected pasture in open upland settings over more closed-in, lowland areas. Guttery et al. (2017) found Bobolink patch occupancy was positively associated with grass in the surrounding landscape at multiple scales, from 100m to 3000m, although the type of grassland that was important varied across scales.

Edge-avoidance and perceived openness appear to be the primary processes behind area-sensitivity in Bobolink (Fletcher and Koford 2003, Bollinger and Gavin 2004, Keyel et al. 2012, 2013, Perkins et al. 2013). In northern Iowa, Bobolink showed the strongest negative relationship with edge density of any grassland bird species monitored in 10 native tallgrass prairies and 10 restored grasslands (Fletcher and Koford 2002). In Wisconsin, Bobolink nest density near tree row edges increased after the trees were removed (Ellison et al. 2013).

Edge effects can vary depending on edge type, although not consistently (Ribic et al. 2009*a*). In several cases, wooded edges have been identified as strong detractors to territory establishment (Fletcher and Koford 2002, Bollinger and Gavin 2004, Keyel et al. 2013). Bollinger and Gavin (2004) found that Bobolink nest densities in New York were much lower than expected within 25 m of forest edges, an effect that extended to 100 m at one site; some road avoidance was also exhibited. Similarly, Fletcher and Koford (2003) documented forest edge avoidance up to approximately 75 m, a distance that was greater than observed for road and cropland edges (although density increased as a function of distance from all edge types). Conversely, although Perkins et al. (2013) observed that Bobolinks in Vermont were unlikely to nest <50 m from edges, forest edges were avoided less than were other edge types (e.g. road, wetland, agricultural, developed), particularly hedgerows. Finally, urban and suburban edges may also deter Bobolinks from nesting. Bock et al. (1999) reported that Bobolink were less likely to nest in grasslands closer to the suburban interface than in more distal interior sites, but did not account for patch-size effects in their study.

There is evidence that fragmentation of grasslands negatively influences grassland bird fitness, although the pattern is not consistently found. In New York, nests placed within 50 m of forested or wooded hedgerow edges exhibited lower survival than patch-interior nests, an effect that was not observed in relation to old field or pasture edges (Bollinger and Gavin 2004). Bobolink nests in tallgrass prairie also demonstrated lower daily survival rates when located near edges (Johnson and Temple 1990, Ellison et al. 2013). In one of those studies, after tree rows along edges were removed, fledging success in fields increased for Bobolink (Ellison et al. 2013). These findings are in agreement with a large number of artificial nest and productivity studies for other grassland species, which have also revealed negative edge effects on reproduction (e.g., Winter et al. 2000). However, Winter et al. (2006) found that distance to the nearest tree, patch size, shrub cover and tree cover (i.e. on the landscape) did not have a significant effect on Bobolink nesting success in tallgrass prairie habitats. In Vermont, neither openness nor distance-to-edge affected measures of nest success (Keyel et al. 2013, Perkins et al. 2013). In New Hampshire, Bobolink fledging success was high within a small (approximately 10 ha) military training area, although these findings were based on a very small sample size (Weidman and Litvaitis 2011).

Fragmentation of grasslands has been cited as a major cause of grassland bird population declines over the past century (reviewed in Brennan and Kuvlesky 2005). Although associated edge effects and their impacts on productivity vary based in part on the predator and nest parasite community (see next two sections), predation associated with fragmentation is one likely mechanism behind declining population trends.

Parasitism by Brown-headed Cowbirds

Parasitism by Brown-headed Cowbirds (Molothrus ater) evolved in grasslands, and is common in the Great Plains region (Johnson and Igl 2007). In fragmented, edge-dominated landscapes, nest parasitism by Brown-headed Cowbird is often elevated (Robinson et al. 1995). Although much of the literature regarding fragmentation and other anthropogenic effects on parasitism has centered on forested habitats, increased rates of nest parasitism have been observed in fragmented grasslands as well (Johnson and Temple 1990).

Blackbirds are the most frequently parasitized grassland bird species in the Great Plains (Johnson and Igl 2007); and cowbirds may show a preference for Icterid host species (Hanka 1979). Bobolink nests were parasitized at higher rates than were Clay-colored (*Spizella pallida*) or Savannah (*Passerculus sandwichensis*) sparrows (Winter et al. 2004).

Bobolinks do not eject cowbird eggs (Rivers et al. 2010), and Winter et al. (2004) found that parasitized nests fledged fewer young than those that were not parasitized. Further, Bobolink pairs that are parasitized in high-density cowbird areas are likely to experience multiple parasitism events (e.g., 53% of initially parasitized nests were parasitized again in the Great Plains, Johnson and Igl 2007).

The rates of parasitism of Bobolink nests by cowbirds, and how the rates are affected by habitat fragmentation, vary substantially by geographic location (reviewed in Shaffer et al. 2003, McCracken et al. 2013). Parasitism rates on Bobolink appear to be highest in the core and western regions, with reported rates of <5-37% in Minnesota (Johnson and Temple 1990), 25 - 31% in North Dakota (Granfors et al. 2001, Pietz et al. 2009), 44-69% in Nebraska (Skipper 2008, Renfrew et al. 2015), and 50% in Manitoba (Davis and Sealy 2000). Conversely, rates reported for the eastern part of the breeding range from Vermont, New York, Ontario, Wisconsin, and Illinois are near zero (Norment et al. 2010, Peck and James 1987, Frei 2009, Buxton and Benson 2015, R. Renfrew unpubl. data, J. Herkert unpubl. data, N. Perlut unpubl. data).

Regional differences in Bobolink nest parasitism rates are likely driven by differences in female cowbird densities, with higher parasitism rates in high cowbird-density areas (Jensen and Cully 2005*b*, Johnson and Igl 2007). Edge effects (i.e., higher parasitism rates near edges than in grassland interior) are variable but tend to be most pronounced in low-density cowbird areas (Jensen and Cully 2005*a*). For example, in the Prairie Pothole Region, where cowbird densities are the highest (Sauer et al. 2017), cowbird abundance was unrelated to the presence or removal of woody edges (Quamen 2007). Parasitism rates may also be influenced by local management. Parasitism in the Great Plains is purportedly exacerbated by the presence of road cuts, prescribed fire, and grazing (Patten et al. 2006), but in Minnesota tallgrass prairie, time since last burn had no significant impact on parasitism rates for Bobolink or several other grassland obligates (Shaffer et al. 2003).

Predation

Predators can impact Bobolink and other grassland bird species populations through direct take of eggs, nestlings, fledglings, juveniles, and adults. Predation is a proximal cause of mortality that is often related to one or more of the other threats discussed in this section. For example, when hayfields are mowed, nest loss is close to 100%, but any nests that do survive are highly likely to be depredated by predators that scavenge after the mowing event (e.g., Perlut 2007, Buckingham et al. 2015). Predation rates vary substantially among regions (McCracken et al. 2013). From a management perspective, gaining a better understanding of the local predator communities that depredate nests is crucial, as effective strategies will likely differ substantially depending on the suite of predators in the community and their behavior (Thompson and Ribic 2012).

Similar to most bird species, predation is the greatest cause of nest failure for Bobolinks (e.g., Winter et al. 2004) in habitats that are not intensively managed. Eggs and nestlings are commonly eaten by snakes, a variety of mammals (especially striped skunk [*Mephitis mephitis*] and thirteen-lined ground squirrel [*Ictidomys tridecemlineatus*]), and avian predators (crows, raptors, gulls). Incubating females and fledglings are vulnerable to predation by meso- and large-mammals such as raccoon *(Procyon lotor)*, opossum (*Didelphis virginiana*), squirrel, cat (*Felis catus*), skunk, fox, dog (*Canis familiaris*), badger (*Taxidea taxus*), coyote (*Canis latrans*), and even white-tailed deer (*Odocoileus virginianus*) (Pietz and Granfors 2000, Johnson and Temple 1990; Renfrew and Ribic 2003; Renfrew et al. 2005, Pietz et al. 2012, Ellison et al. 2013, McCracken et al. 2013).

Predation risk is affected by how predator communities interact with landscape structure, including edge effects associated with habitat fragmentation (reviewed in Ribic et al. *2009a*). Grassland bird nest predators respond to habitat at multiple scales, and these responses tend to be species-specific (Kuehl and Clark 2002, Kuld et al. 2009). In Wisconsin, Renfrew and Ribic (2003) reported that over one-third of grassland bird nest depredation events were caused by species that prefer wooded edges, with these predators traveling up to 150 m into grassland patches to depredate nests (Renfrew and Ribic 2003). In a related study, Renfrew et al. (2005) found that although mammalian predator activity was high along wooded (e.g., raccoon) and non-wooded (e.g., thirteen-lined ground squirrel) edges, nests near edges did not experience different depredation rates than those farther from edges. They suggested that this was partly due to high grassland predator abundances (e.g., small mammals) in the interior. Ellsion et al. (2013) corroborated this finding, when tree removal along edges resulted in reduced predation by edge-associated predators but increased predation rates by grassland predators. Studies focused on Grasshopper, Clay-colored and Vesper (*Pooecetes gramineus*) sparrows likewise reported more successful nests closer to wooded edges (Ribic et al. 2012) or higher depredation rates away from wooded edges (Grant et al. 2006); in both cases, thirteen-line ground squirrel was the major nest predator and active primarily in the interior of fields.

The complex nature of edge dynamics has made it difficult to clearly discern how landscape-scale processes affect productivity of Bobolink and other grassland birds. Predator-prey dynamics are complex, with small-predator abundance affected by large-predator abundance and vice-versa (Ribic et al. 2009*a*); both respond to landscape structure. Predators may also respond differently to grassland habitat characteristics; for example, smaller mammalian predators may respond positively to the cover afforded by tall grass while meso-mammalian predators may prefer the ease of mobility in shorter grass. Conversely, the relationship between human development and predation pressure on grassland birds is clearer (Askins et al. 2007, Kuld et al. 2009). Grassland bird nest survival has been negatively associated with an increase in the percent of development and human structures within 1600 m (Kuld et al. 2009). Developed areas tend to 'subsidize' some species of nest predators, with several subsidized species increasing in number, including raccoon (Johnson and Temple 1990), red fox (*Vulpes vulpes*; Johnson and Temple 1990), and domestic cat (Loss et al. 2013).

Direct predation on individuals is difficult to document; Pietz et al. (2012) documented only one instance of a thirteen-lined ground squirrel killing an adult Chestnut-collared Longspur (*Calcarius ornatus*) on the nest. Therefore, rates of predation have not been quantified for most species, including Bobolink. Based on estimates in North America, predation of birds in general by cats results in greater mortality than all other sources of anthropogenic mortality combined (Loss et al. 2015). Cats are commonly associated with farm buildings in agricultural areas, and pose a risk for Bobolink and other grassland birds, but few direct observations of predation are available.

Road Development

The construction of roads is associated with several forms of development, including urban expansion and housing subdivisions, petroleum fuel extraction and alternative energy development. Regardless of the development project, associated road construction has direct and indirect impacts in grassland systems.

Roads can pose direct threats to birds through vehicle collisions (Erickson et al. 2005, Kociolek et al. 2011, Calvert et al. 2013). In the U.S., approximately 80 million birds are estimated to be killed annually due to vehicle strikes (Erickson et al. 2005). In Canada, road fatalities number between approximately 9 and 18 million birds annually (Calvert et al. 2013). Between 1970 and 2007, traffic on U.S. roads nearly tripled due to population growth (i.e., to nearly 5 trillion vehicle km/yr; Barber et al. 2010), and with such rapid development and increasing traffic, fatality rates will likely increase. Some grassland bird species may be particularly at risk because evidence suggests that collisions are more likely to occur in open areas rather than in forests (review in Kociolek et al. 2011). Attention to road design may be a strategy to decrease collision risk (Kociolek et al. 2011), as roadside features (e.g., trees, hedgerows) typically cause birds to fly higher across roads and reduce collision rates, although in some cases roadside features may actually increase collisions (cf. citations in Kociolek et al. 2011).

For Bobolink, perhaps because even their short flights tend to be relatively high, roads have not been documented as a direct hazard. However, by increasing noise (Halfwerk et al. 2011) and stress (Strasser and Heath 2013) roads can have indirect but nevertheless significant impacts on many birds, Bobolinks included. Noise, along with artificial light and edge effects, are primary factors leading birds to avoid roads (Kociolek et al. 2011). In some species, traffic noise likely disrupts breeding activity by interfering with communication (e.g., territory defense, mate attraction; Halfwerk et al. 2011), an effect that is especially pronounced for species that vocalize at low frequencies (Goodwin and Shriver 2011). Data on the effects of roadway noise on Bobolink and other grassland birds are sparse, but evidence for other species suggests that noise associated with busy roads can reduce effective habitat and also breeding success. In the northeastern U.S. Bobolink has been shown to avoid roads (Bollinger and Gavin 2004), particularly those with heavy traffic (Forman et al. 2002), and it has been hypothesized that this is primarily due to noise effects (Forman et al. 2002). Approximately 83% of the land area of the continental U.S. currently lies within 1,061 m of a road, a distance at which an average automobile will project a noise level of 20 dB (Barber et al. 2010).

Avoidance of roads by breeding birds (e.g., Thompson et al. 2015) is important because it effectively reduces available suitable habitat and results in increased habitat fragmentation (Fletcher and Koford 2003, Bollinger and Gavin 2004, Perkins et al. 2013) and associated edge effects (Patten et al. 2006). In some regions, road building also promotes the development of woody edges, which can increase nest parasitism by cowbirds (Patten et al., 2006) and predator activity (Renfrew et al. 2003). Other factors associated with roads include pollution and poisoning, although their influences on bird populations relative to other road-effects are probably minimal (Kociolek et al. 2011).

Agricultural Intensification

Since the 1960s, intensified agricultural practices on working grasslands that affect grassland bird populations have included mechanized agricultural operations, advances to increase yields, expansion of monoculture row crops, and clean farming). The indirect effects of the resulting homogenization (habitat and landscape simplification) associated with industrial farming practices have contributed to grassland bird population declines (reviews in McCracken 2005, Askins et al. 2007, McCracken et al. 2013). The conversion of smaller diversified farms to larger operations that rely on monocultures results in a loss of uncropped areas (Rodenhouse et al. 1995). In Europe, agricultural intensification has led to reductions in avian diversity (Wretenberg et al. 2010, Concepción et al. 2012) and productivity (Kentie et al. 2013), but these processes are highly dependent on the greater landscape context (Wretenberg et al. 2010, Concepción et al. 2012).

The central and western portions of the Bobolink breeding range have seen dramatic increases in corn and soy production, at both historical (Ramankutty and Foley 1999) and contemporary (Wright and Wimberly 2013) time scales. The expansion of center pivot irrigation and the development of drought-resistant varieties allowed production where it was previously not viable. In addition, between the 1930s and 1990s, corn productivity per unit area increased in the U.S. (from 1.6 tons/ha to 9.6 tons/ha) primarily due to increases in nitrogen fertilizer use, although with diminishing returns (i.e., slower rate of productivity increase over time; Foley et al. 2005). Agricultural practices such as tillage, disking, cultivation, rotary hoeing and chemical applications harm nests, fledglings and incubating females (review in McCracken 2005), and in general render suitable habitat unsuitable for nesting. As yields reach their maximum potential, intensification will likely increase to try to meet demand, resulting in even greater use of methods to prevent disease, combat climatic events, adjust soil nutrient levels, and irrigate land (particularly in the western U.S.; Foley et al. 2005).

Incompatible Mowing Schedules

Nest failure due to more frequent and earlier mowing of hayfields is considered one of the greatest threats to breeding Bobolink in the eastern and Midwestern part of the breeding range (reviews in Askins et al. 2007, McCracken 2005, McCracken et al. 2013, Sample and Mossman 2008). Although haying of idled lands such as CRP can improve habitat suitability for Bobolink and sometimes other grassland birds species (Igl and Johnson 2016), many managed hayfields are population sinks (Bollinger and Gavin 1992, Perlut 2008*a,b*).

Earlier, more frequent, and more intensive mowing (i.e., greater mechanization, lower mowing heights, faster mower speeds) have gone hand in hand with changes in the plant species and varieties used. Hayfield composition has shifted in North America since the 1950s from perennial grasses such as timothy (*Phleum sp*.) and clover (*Trifolium sp*.) to alfalfa (Rodenhouse et al. 1995; Sample and Mossman 2008). In some areas (e.g., southern Ontario, eastern U.S.), the trend towards alfalfa is likely to continue because of the higher nutritional value it provides to livestock (Bollinger and Gavin 1992, McCracken et al. 2013). Alfalfa has been specifically bred to be harvested on a shorter rotation and earlier in the breeding season compared to species of forage grasses.

The development of alfalfa varieties that provide crude protein earlier in the season and other efficiencies valued by humans have all led to earlier and more frequent mowing (McCracken et al. 2013). Perlut et al. (2006) conducted surveys throughout the Champlain Valley of Vermont and found that 3–8% of hayfield habitat was cut by 1–4 June, 25–40% by 12–16 June, and 32–60% by 28 June–2 July. In Ontario, first haying dates for grass/alfalfa (and other forb) hayfields followed latitudes: in southern, central, and northern Ontario, they spanned 21 June and 7 July, 23 June and 14 July, and 3 July to 16 July, respectively (Brown and Nocera 2017).

Bobolink nest mortality rates as a result of early mowing can be extremely high (Bollinger et al.

1990, Perlut et al. 2006, Perlut 2007), resulting in low productivity (review in Askins 2007). In Vermont and New York, mowing machinery was responsible for 78-100% percent of Bobolink nest failures (Perlut et al. 2006, Perlut 2007), with early-mowed fields cut before 11 June and again in early- to mid-July faring the worst. Bollinger et al. (1990) estimated a 40% mowing-induced mortality rate for Bobolink nests found on hayfields in New York, with mortality at some sites exceeding 90%. Even if grassland bird nests survive a mowing event, they are more susceptible to subsequent predation (Perlut 2007, Davis et al. 2016) and weather events.

The likelihood of renesting after a mowing event depends mostly on how late the mowing occurs and the geographic area. After nest failure due to early mowing in Vermont, Bobolinks abandoned fields for at least two weeks before attempting to renest (Perlut et al. 2006). In Ontario, however, birds did not return to hayed fields at all regardless of mowing date (Diemer and Nocera 2016). In Vermont, Bobolinks were capable of successfully renesting if the mowing occurred early (i.e., at the onset of the nesting season in late May), and if the second cut occurred 65 or more days later (Perlut et al. 2011). This strategy was not effective in southern Ontario, however; Bobolinks did not return to nest in hayfields harvested before 1 June. In addition, precipitation events in late May often prevented farmers from being able to carry out early first cuts (Diemer and Nocera 2016). In alfalfa-timothy mixtures, regrowth following the first cut may be less suitable for nesting because it tends to be alfalfa-dominated (McCracken et al. 2013). Invertebrates may also decline in hayfields after harvest, which can negatively affect grassland bird provisioning rates, although the extent to which these effects occur is unclear (Zalik and Strong 2008).

Mowing activities can also indirectly influence adult survival. Perlut et al. (2008*a*) reported that adult apparent survival in Vermont was higher for birds that nested in late-hayed (hayed after 1 August) vs. earlier-hayed fields. Ingold et al. (2010) found that annual return rates were lower for Bobolinks associated with fields with early mowing on reclaimed surface mines in Ohio. Finally, intensively mowed or hayed areas may be avoided altogether (e.g., Weidman and Litvaitis 2011).

Mowing practices can have substantial effects on overall Bobolink populations. Models estimate the direct mortality of eggs and pre-fledged young from mowing in Canada to be approximately 667,000 individuals, with indirect mortality of another 321,000 individuals (Tews et al. 2013). This loss represents a significant number of birds, as the current national estimate for Canada is 2,200,000 adult individuals. In the Northeastern U.S. regional Bobolink population trends were most sensitive to low productivity and survival on early-hayed fields, despite the fact that this habitat comprised only 18% of the landscape (Perlut et al. 2008b).

Pesticides

Given the reliance of Bobolinks and other grassland birds on agroecosystems during parts if not most of the life cycle, some level of exposure to pesticides is inevitable. On the breeding grounds, impacts may be most likely through indirect effects on insect prey, or more direct impacts for birds nesting adjacent to treated crops. In Maine, territory density of Bobolinks decreased for two to five years following the application of the herbicide hexazinone on lowbush blueberries (*Vaccinium angustifolium*) (4 kg/ha, Vickery 1993, cited in Dechant et al. 2001). In winter, exposure of Bobolinks to the toxic organophosphate monocrotophos has been documented at lethal and sublethal levels (Renfrew and Saavedra 2007, R. Renfrew unpubl. data) and presents an ongoing threat to Bobolink.

Despite these known effects at local scales, the impacts of pesticides on Bobolink at the population level have not been evaluated. Lethal and especially sublethal effects (which can lead to death) at such scales are challenging to estimate. For birds in general, the Avian Incident Monitoring System listed 113 pesticides which have caused bird deaths (Heath 2008), with overall mortality estimates ranging from 67 million in the U.S. (Pimentel 1992) to 91 million in the Midwest alone (Mineau 2005).

Recent evaluations of population-level effects of insecticides versus other threats to grassland birds in the U.S. have produced conflicting results. Mineau and Whiteside (2013) concluded that lethal risk of pesticides may be most highly correlated with 1980 - 2003 grassland bird declines, followed by changes in habitat availability (cropped pasture). Alternatively, a more recent examination of data from the same period suggested that habitat availability (e.g., CRP, pasture) and agricultural intensification had approximately 3.6 and 1.6 times more effect, respectively, on trends than did lethal insecticide risk (Hill et al. 2014). The latter study suggested that acute toxicity from insecticides may be negatively related to grassland bird trends, but that this factor alone was a poor predictor of the trends.

Although many of the highly-toxic insecticides potentially associated with long-term bird population declines are no longer in use (Osteen and Fernandez-Cornejo 2013), there are well-publicized concerns about their replacement, neonicotinoids. Now the most widely used class of insecticides in the world (Goulson 2013), neonicotinoids have been criticized for their environmental impacts. The concern stems from their characteristics of environmental persistence, high water solubility, runoff and leaching, and toxicity to pollinators (e.g., reviewed in Godfray et al. 2014, Alkassab 2017) and birds (Mineau and Palmer 2013). Recent evidence from the Netherlands indicates that high concentrations of imidicloprid in surface water may be linked to declines in local populations of farmland-breeding passerines, although it is unclear if direct or indirect processes may be driving those declines (Hallmann et al. 2014). Indirect, trophic effects of pesticides on nesting and adjacent foraging areas are of particular concern, as insecticides such as neonicotinoids reduce invertebrate abundance and diversity (reviewed by Rodenhouse et al. 1995, Boatman et al. 2004). They also have had negative effects on non-target invertebrates (Easton and Goulson 2013, Van Dijk et al. 2013, Gibbons et al. 2015), including predatory insects that are beneficial to agricultural crops, resulting in lower crop yields (Douglas et al. 2014).

As neonicotinoids continue to replace organophosphates on the wintering grounds, overall risk to Bobolinks could be reduced; Bobolinks are not known to feed on seeds during planting, which is the main application method for neonicotinoids. Bobolinks would likely be more vulnerable to exposure during foliar applications late in the growing season. Studies are lacking on the long-term effects, impacts in the field, synergistic effects with other pesticides, and perhaps most importantly, sublethal effects - which can be more harmful overall than lethal effects from neonicotinoids (van der Sluijs et al. 2015). Indirect exposure via insect prey and decreased prey availability during the breeding season are also a potential concern (Gibbons et al. 2015), particularly for birds nesting in cropland regions.

Grazing

The native prairie grasslands of the Americas evolved as highly disturbance-dependent systems, primarily driven by fire and grazing. Grassland birds are therefore adapted to and dependent upon disturbances caused by bison (*Bison bison*) herds, prairie dogs (*Cynomys* spp.) and fire (Brennan and Kuvlesky 2005, Askins et al. 2007). There is a growing body of literature to suggest that some forms of domestic livestock production are compatible with grassland bird conservation (e.g., Ahlering and Merkord 2016) and perhaps serve as surrogates for natural disturbance dynamics (e.g., Askins et al. 2007, Brennan and Kuvlesky 2005, Derner et al. 2009, Henderson 2014).

Cattle grazing practices can have negative or positive effects on grassland bird communities, depending on many factors including livestock stocking levels, type of grazing system (e.g., dairy or beef operation, management-intensive rotational grazing vs. traditional continuous grazing), soil conditions, patterns of seasonal rainfall and temperatures, fire management and target bird species (Saab et al. 1995, Brennan and Kuvlesky 2005, Fuhlendorf et al. 2006, Askins et al. 2007, Perlut and Strong 2011, Ahlering and Merkord 2016). Changes in vegetation height and density caused by grazing and soil compaction, reductions in water flow, and other processes resulting from cattle activity can be problematic for grassland bird conservation (Saab et al. 1995). The degree to which the timing, extent, and duration of specific grazing practices degrade habitats for grassland birds can be of great concern (Fuhlendorf et al. 2006, With et al. 2008).

An estimated 150 million hectares or more of public rangelands in the western U.S. are considered to be overgrazed (Wuerthner and Matteson 2002 [referenced in Brennan and Kuvlesky 2005]). Relatively high-stocking densities and short-grazing rotations alter grassland composition and structure and potentially reduce the insect prey base (reviews in Saab et al. 1995, McCracken et al. 2013). Habitats degraded by high grazing-intensity may be less able to sustain grassland bird communities, especially during periods of drought (Schultz 2009). High-density grazing also removes the fine vegetation needed to fuel fires that have historically controlled shrub invasion, creating conditions across large swaths of land (i.e., millions of hectares) that are unsuitable for grassland birds (Saab et al. 1995, Brennan and Kuvlesky 2005).

Grassland birds may respond more positively to grazed areas that are also managed by other means. On some public lands, management of native grazers such as bison results in increased habitat heterogeneity (Vinton et al. 1993, Fuhlendorf et al. 2006, Askins et al. 2007), which is typically beneficial to breeding grassland birds. Lueders et al. (2006) observed significantly more Bobolinks on plots in North Dakota that were grazed by bison coupled with prescribed fire than on those grazed by cattle with no fire management.

The effects of grazing on nesting Bobolink is rarely the same for all regions, landscapes, and cattle stocking densities. But in general, Boblinks avoid heavily-grazed pastures (Renfrew and Ribic 2002, Ribic et al. 2012). Responses to moderate-heavy grazing were negative in the Northern Plains and North Dakota, but neutral and positive to moderate grazing in Minnesota and Missouri (Saab et al. 1995). Bock et al. (1993) similarly reported that Bobolinks responded positively to moderate grazing in tallgrass habitats, but negatively to heavy grazing in shortgrass habitats; Bobolinks In the core breeding habitat of North Dakota, Bobolink abundance was generally higher on relatively lightly grazed sites, but was overall positively associated with grazing (Ahlering and Merkord 2016). Renfrew et al. (2005) found no evidence in Wisconsin that grazing influences Bobolink nest-placement patterns or predator movements at the field scale. In essence, the relationship between cattle grazing and birds depends on the management, the natural habitat niche, and the detailed habitat requirements of the species in question.

The impact of direct trampling of nests by grazing cattle depends on stocking densities, and can be a significant threat to ground-nesting grassland birds (Paine et al. 1996, Schultz 2009) including Bobolink (e.g. Renfrew et al. 2005, Perlut and Strong 2011). This is especially true in intensively managed rotational grazing systems, where a high number of cattle are moved from paddock to paddock using temporary fencing (e.g., Paine et al. 1996). In Wisconsin, artificial nest studies revealed an average nest trampling rate of 75%, with maximum rates in small paddocks with high cattle density (Paine et al. 1996). Damage or destruction can occur as a result of crushing by hooves or noses, eggs or young being kicked out of nests or consumed (Nack and Ribic 2005), or smothering by manure piles (Paine et al. 1996). In Vermont, nest failure directly due to cattle can exceed losses from predation (Perlut et al. 2011), although overall reproductive and apparent survival rates in affected fields may be similar to those in ungrazed fields (Perlut et al. 2006, 2011, Ribic et al. 2012).

In much of its range, Bobolinks depend on grazing to maintain vast acreages of grassland habitat. Grazing only becomes a threat to grassland bird habitat when it results in vegetation structure that is not compatible with nesting requirements. The intensity and types of grazing that lead to incompatibility vary based on a variety of local conditions. Where grass growth is more robust, and where ample, untrampled vegetation for nesting remains, higher grazing intensity can be tolerated.

Succession and Woody Encroachment

Succession of grasslands and invasion of woody plants have been increasing across short- (review in Askins et al. 2007), mixed- (Grant et al. 2006) and tallgrass prairie (Briggs et al. 2005, Winter et al. 2006) regions. Farm abandonment, especially in northeastern North America, has led to forest regrowth, particularly on lands that are marginal for farming based on soils, geology, and slopes.

Fire suppression (primarily in the East, Vickery et al. 1999*a*, extirpation of bison, and planting of tree shelterbelts contribute to woody encroachment. The decline of keystone species such as beavers (*Castor canadensis*) and prairie dogs has also been implicated as a major factor in allowing woody encroachment in some regions (Vickery et al. 1999*a*, Askins et al. 2007). In the Great Plains and Midwest, much of the source material for woody invasion has come from deliberate plantings that have served as seed sources (Igl and Johnson 1997). The interaction between grazing and fire is widely acknowledged: heavy grazing removes fuel loads necessary for natural fire disturbance (Bachelet et al. 2000), thus reducing fire frequency, increasing woody seedling survival, and accelerating the growth of woody species.

Woody encroachment has been associated with regional grassland bird population declines (Coppedge et al. 2001), patch avoidance (e.g., Grant et al. 2004, Quamen 2007, Renfrew and Ribic 2008, Graves et al. 2010, Keyel et al. 2012) and reduced nesting success (Johnson and Temple 1990, Patten et al. 2006, Graves et al. 2010). Responses of Bobolinks to woody encroachment have been scale-dependent. Several studies have reported negative associations or declines in Bobolink numbers or density relative to percentage of woody vegetation within various distances (Grant et al. 2004; Graves et al. 2010; Winter et al. 2006; Renfrew and Ribic 2008). Renfrew and Ribic (2008) found that when the percentage of woody cover in the Wisconsin landscape (within 1200 m) was high, Bobolink abundance and grassland patch core area were positively related, but no relationship existed when percentage of woody cover on the landscape was low. On pasture and idle grasslands in Wisconsin, Bobolink presence decreased with increasing woody habitat in the landscape at all scales out to 3 km (Guttery et al. 2017).

Bobolink likely avoid areas with significant encroachment due to a loss of perceived ‘openness' (Keyel et al. 2012, 2013). Woody encroachment may also influence breeding success, but this relationship is less clear and some studies have been unable to identify negative effects of woody invasion on nest survival at the patch level (e.g., Winter et al. 2005; see above, Fragmentation). Other grassland obligates such as Grasshopper Sparrow, Eastern Meadowlark, and Henslow's Sparrow experienced lower breeding success at formerly open sites (i.e., surface mines) undergoing encroachment by invasive woody species (Graves et al. 2010).

Removal of woody species can be an effective means to create larger contiguous grassland patches. Quamen (2007) demonstrated through experimental manipulation that following the removal of tree-lined hedgerows in Minnesota and Iowa prairies, Bobolink and other grassland obligates will breed in formerly unused habitat. Removal of invasive woody species has been suggested as a management strategy (Graves et al. 2010). Although a Wisconsin study found that removal of tree lines did not reduce nest predation rates, nest density and the number of successful nests increased for Bobolink and Henslow's Sparrow, and nest density for Eastern Meadowlark (Ellison et al. 2013). Removal needs to be carefully targeted to avoid negatively affecting declining early-successional bird species that prefer areas with substantial woody invasion (Graves et al. 2010). Both grassland and shrub-dependent species can be accommodated using conservation measures in a broad, landscape-scale context that balances their habitat needs.

Fire Suppression

Bobolink breeding habitat has historically been maintained through frequent disturbance events including natural (particularly in the west) and anthropogenic fire (Brennan and Kuvlesky 2005, Askins et al. 2007). Decreased fire frequency can reduce primary productivity in tallgrass prairie (Zimmerman 1992, Briggs and Knapp 1995), allowing the persistence of standing dead vegetation, leaf litter, C3 grasses, forbs and woody species (Zimmerman 1992) that renders habitat less suitable for grassland bird species like Bobolink. Once established, woody species may actually benefit from infrequent or low-intensity fires (Briggs et al. 2005), further driving the shift towards successional, wooded habitats. In the prairie regions, fire suppression coupled with the removal of fuels through intensified livestock grazing has in part led to the loss of large contiguous grasslands (Herkert et al. 1996, Askins et al. 2007).

Threats during Migration and Winter

Most threats to Bobolink during migration and winter are considered as only potential threats due to a lack of information on their occurrence, frequency, or impacts. Throughout the life cycle of a species, even if a threat is known to be occurring, we may not know whether its impacts are producing population-level effects. Below are threats most likely to have some impact on Bobolink populations. There are at least some data for these threats, but other potential threats about which we know little are not listed. For example, extensive uncontrolled grassland fires occur in Bolivia each year in regions where, based on geolocator data, Bobolinks pass through. However, we lack any additional information about habitat use and timing, and it is unknown whether the fires displace the birds or alter their movements or energetics.

Collisions

During nocturnal migration, Bobolinks are at risk of colliding with structures. Avian mortality rates from collisions are site-specific, and the population-wide impacts are usually unknown. A review of 47 studies on the impacts of communication towers in the U.S. summed 1,201 dead Bobolinks at 30 towers (Shire et al. 2000). Peak rates of mortality due to wind turbines occur during spring and fall migration at most sites (Strickland et al. 2011), but strike or risk data specific to Bobolink are lacking. Building collisions are estimated to kill 365–988 million birds annually, but on average blackbirds are at lower risk to collisions with buildings compared to other families of birds (Loss et al. 2014). In addition, for most threats it is unknown what proportion of the mortality is additive versus compensatory.

Habitat Loss and Degradation

As on the breeding grounds, grasslands on Bobolink migration and wintering grounds have been converted to agriculture and lost to development. Traditionally used for extensive cattle-ranching, the Pampas grasslands are increasingly being replaced by agricultural crops, forestry plantations and urban expansion, while invasive species also pose a threat (Krapovickas and Di Giacomo 1998, Di Giacomo et al. 2003, Renfrew and Saavedra 2007, Azpiroz et al. 2012). Resident grassland birds have been negatively impacted (Codesido et al. 2011) but the implications for Bobolinks are not clear.

It is highly likely that conversion will continue in many regions where Bobolinks occur during the non-breeding season. The northeastern plains region of Colombia, used by Bobolinks during both northbound and southbound migrations based on geolocator data (R. Renfrew, unpubl. data), has been undergoing dramatic changes in recent decades, and pressures are likely to continue. Between 2010 and 2012, more than 52,000 ha were converted in the Department of Vichada, Colombia, for the production of corn and soy (Oxfam 2013). This and neighboring departments of Meta and Vichada, which together comprise the high plains of Colombia, have been targeted for massive corn and soy development in recent years (USDA-FAS 2009). Colombia is home to South America's greatest quantities of palm oil production, and in this region palm plantations increased from 31 km2 in 1987 to 162 km2 in 2007 (Romero-Ruiz et al. 2012). More land, especially areas already under some type of agricultural production such as pasture, is slated for palm oil biofuel production, up to 930,000 ha (Castiblanco et al. 2013). In the above departments plus the department of Arauca, also known as the Llanos Orientales of Colombia, 70% of the 17,000 km2 have been identified for conversion to plantation, or for petroleum and mining extractions (Romero-Ruiz et al. 2012). Establishing protected/conserved areas in advance of actual land use changes will be essential to conserving natural resources.

Because crops are a very dense food resource, redirection of foraging to agricultural fields amidst grassland habitat loss translates to larger concentrations of Bobolinks in smaller areas (Renfrew and Saavedra 2007). The formation of large flocks translates to more individuals being at risk to a local threat compared to smaller, more widely dispersed flocks.

In addition, studies of edge effects on resident grassland birds are needed in South America. In Argentina grasslands, one grassland bird species had lower nest survival in more fragmented grasslands due to increased predation risk, although sample sizes were low. Nests in fragmented areas were associated with altered parental behavior such as incubation and feeding rates (Pretelli et al. 2016). While these studies are not relevant to wintering Bobolink needs, they influence co-occurring, resident grassland bird species.

Seed Availability and Water Management

Studies in Europe suggest that seed is a limiting factor for wintering granivorous birds in agricultural landscapes. There, population declines have been linked to a decrease in over-winter survival due to a reduction in winter food availability (Newton 2004, Gillings et al. 2005). In fact, food availability in winter is predicted to have a larger effect on population size than food availability during the breeding season (Payne and Wilson 1999). Farmland bird abundance was positively associated in experimental plots with higher seed availability, especially in landscapes with low baseline food availability (Hammers et al. 2014). Although seed availability on a plot was associated with bird abundance, it was especially important when the landscape as a whole provided less seed.

It is unknown whether limitations of seeds found for birds wintering on European farmlands may also occur in South America for species like Bobolink. However, the Bobolink's reliance on rice may be greater in landscapes with little other seed types available. Seed resources may be limited by dam installments, changes in water regime management, and climate change. Bobolinks loosely follow major river systems during migration and winter, and dams and other water management projects that alter flow patterns are likely to change plant phenology and the availability of seed resources.

Mortality from Agricultural Operations—Pesticides

Pesticides used in rice, such as organophosphates (OPs) are of concern in some countries occupied by Bobolinks during migration and winter. In Bolivia, where the OP monocrotophos (MCP) has been widely used in rice, approximately 40% of Bobolinks feeding in rice production areas were exposed at lethal and sublethal levels (Parsons et al. 2010). Despite a temporary ban on this insecticide in 2009-2012, a lack of enforcement rendered the legislation ineffective, and the ban was not extended (R. Renfrew, pers. obs.). This issue resulted in the 2016 PIF Landbird Conservation Plan listing Bolivia as an important region for conservation of Bobolink (Rosenberg et al. 2016). MCP is also still used in Venezuela and Colombia. Based on interviews with agronomists, neonicotinoids are gradually replacing OPs such as MCP in Colombia and in Bolivia (R. Renfrew, pers. obs.). Seeds treated with neonicotinoids are highly toxic to birds (Lopez-Antia et al. 2016), but Bobolinks may not be vulnerable to this mode of exposure if they feed only on live seed on the plant. However, neonicotinoids have been demonstrated to remain in plants at high enough concentrations to be toxic to pollinators, and they are persistent in soils and waterways (Goulson 2013). It is untested whether this may result in toxicity to seed-eating species like Bobolinks in agricultural fields.

Pet Trade

Bobolinks have been captured in Argentina, Cuba, and perhaps other countries for local and international sale as pets (Bent 1958, Di Giacomo et al. 2003, E. Inigo-Elias, pers. comm.), and generally do not survive. The total number of individuals captured may be in the tens of thousands per year, but actual or even estimated numbers are not available. These practices may not have substantial population-level impacts on Bobolink, but they are illegal activities that need to be addressed.

Pest Control

Historic taking of Bobolinks as a means to control them in rice fields has been documented on breeding, migration, and wintering grounds, with large numbers taken in the southeastern U.S. (Bent 1958), and until recently, in Argentina (Pettingill 1983, Di Giacomo et al. 2003) and Bolivia (Renfrew and Saavedra 2007). Currently, however, lethal control is not suspected to be a large source of mortality; it appears Bobolinks are typically controlled through scare tactics (Renfrew and Saavedra 2007, Blanco and Lopez-Lanus 2008). It is unknown whether they are taken (other than for the pet trade) in other regions where they consume rice, such as Colombia, Venezuela, and Cuba.

Climate Change

The impacts of climate change cross all boundaries, and in so doing, connect ecological, social, and economic interests alike. Climate change will not only affect grassland birds, but also those who supply the vast majority of their habitat—farmers and private landowners. Over the next five to 25 years, some counties in Missouri, Illinois, and Indiana are predicted to experience average crop losses of 18-24% each year. By the end of the century, corn and wheat losses in the Midwest are predicted to be from 11-69% (Risky Business Project 2015). Climate change, as vexing, complex, and difficult to solve as it is, may also be a means to unite interests that in the past have been disparate or even seen as being in conflict. Negative impacts of climate change may be common to birds and to agricultural markets alike.

Birds may be falsely assumed to be less vulnerable to climate change compared to many other wildlife because of their ability to disperse and move large distances. Latitudinal shifts in distributions in response to climate change have already been documented (e.g., Zuckerberg et al. 2009). Models that predict geographic regions expected to be climatically suitable for a species, or the bioclimatic envelope (e.g., National Audubon Society 2015) provide one key layer of information. Those data need to be considered in the context of land cover (e.g., Jarzyna et al. 2016) to determine whether suitable habitat is or will be available within a future potential breeding range and how species will respond to land cover changes. Myriad other complicating factors would determine whether the new range could be inhabited, but underlying processes are poorly understood. Climate change assessments that incorporate secondary effects on birds, such as impacts on food resources (Marra et al. 2014) and human land-use changes are especially relevant to grassland species like Bobolink that rely mostly on agricultural habitats. Modeling the impacts of climate change on birds is an enormous challenge, and is complicated by uncertainty and by the indirect effects on resources and the time lag in responses (e.g., Strong et al. 2015), making direct cause-effect relationships difficult to establish. The very process of attempting to predict outcomes under various scenarios, however, is helping scientists to identify the potential factors and processes that may impact species and entire systems.

Predicted Climate Change Impacts on Grasslands

In the core of the breeding range of most North American grassland bird species, predicted changes to habitat from climate change vary by region. Historically, unusually wet or dry years have tended to occur more frequently in short and mixed-grass prairies than in tallgrass prairies (Askins et al. 2007). All regions, however, are expected to be subject to more variable conditions. Grasslands in general are likely to experience higher climate change velocity because of the low topographic complexity (Dobrowski et al. 2013). By altering activities of humans (Pearce-Higgins and Gill 2010, Jakoby et al. 2014) and ungulates (Allred et al. 2013) increased drought frequency or intensity could have significant consequences for breeding grassland bird productivity, and changing the frequency of wildfires. Droughts may reduce insect prey abundance (Bolger et al. 2005, With et al. 2008). The Great Plains is predicted to have more days of extreme heat and more high-intensity precipitation events. The southern region is expected to experience increased drought, and the north is expected to be wetter (Shafer et al. 2014). The consequences of climate change to breeding grassland birds in North America will interact with land use and land management. For example, in both burned and unburned Kansas tallgrass prairie, March soil moisture was associated with greater total bird abundance, but grassland bird species responded negatively to low soil moisture only on grasslands that were periodically burned. In dry years, burning may reduce above-ground plant productivity below an acceptable threshold for grassland birds (Zimmerman 1992). Modeling changes over time, Bachelet et al. (2000) demonstrated that future climate conditions will likely favor woody encroachment of shrubs and expansion of woodlands in South Dakota prairies, particularly in areas under high grazing pressure. They concluded that large C4 grasslands can only persist in these areas when subjected to frequent natural fires, and that the high levels of precipitation predicted over the next 100 years will likely result in woodlands outcompeting grasslands in the region (Bachelet et al. 2000).

Predictions from models of the impacts of changing climatic conditions in South America vary depending on underlying assumptions. There is general agreement, however, that while the Amazon basin is expected to experience increases in temperatures, changes in the Bobolink wintering range will be driven mainly by precipitation. Grasslands and croplands in northeastern Argentina are expected to have greater and more variable precipitation, primarily associated with ENSO, while eastern Bolivia is expected to be drier (Grimm 2011, Jones and Carvalho 2013, da Rocha et al. 2014). Predicted changes in total precipitation vary spatially at a finer scale, and within the Bobolink wintering range (see section below).

Climate change will influence agricultural management decisions and land-use patterns (Pearce-Higgins and Gill 2010, Jakoby et al. 2014, Shafer et al. 2014). For example, in North America, lands set aside in Farm Bill conservation programs such as CRP are released for haying or grazing under drought conditions or when there is excessive precipitation, resulting in reduced available grassland bird habitat (Johnson 2005). Modern agricultural practices can exacerbate climate-related changes by adversely affecting water and air quality, carbon sequestration in the soil, and soil fertility (Foley et al. 2005). In general, altered rainfall regimes will determine the set of feasible strategies available to farmers and ranchers, and the alternatives adopted will be in turn influenced by various social and economic factors including whether producers are responding to short- or long-term risk (Jakoby et al. 2014).

Sleeter et al. (2012) projected the impacts on land use in the U.S. for four scenarios from the IPCC Special Report on Emission Scenarios (IPCC 2001). Each scenario is based on socioeconomic factors such as economic growth, technological development, and mobility of people, and in essence span from low to high emissions scenarios. Under two higher-emission (economic-driven) scenarios, increases in agricultural land use were predicted to reduce grasslands and shrublands in the core of the Bobolink breeding range (Figure 1–14), while in a low-emission (environmental) scenario, a net gain of 15,000 km^2 in grasslands and shrublands was predicted. All models are limited by available data, but the exercise drives home the point that the conservation of grasslands and other habitats is inextricably connected to and entirely dependent on economic, political, and social decisions and conditions. These scenarios have since been replaced by more complex *Representative Concentration Pathways* scenarios that predict outcomes, but also provide different socioeconomic response scenarios, and provide explicit trajectories (Moss et al. 2010). How birds will respond to predicted land-use changes is still unclear, underscoring the need for landscape-level, species-specific studies. Results can be

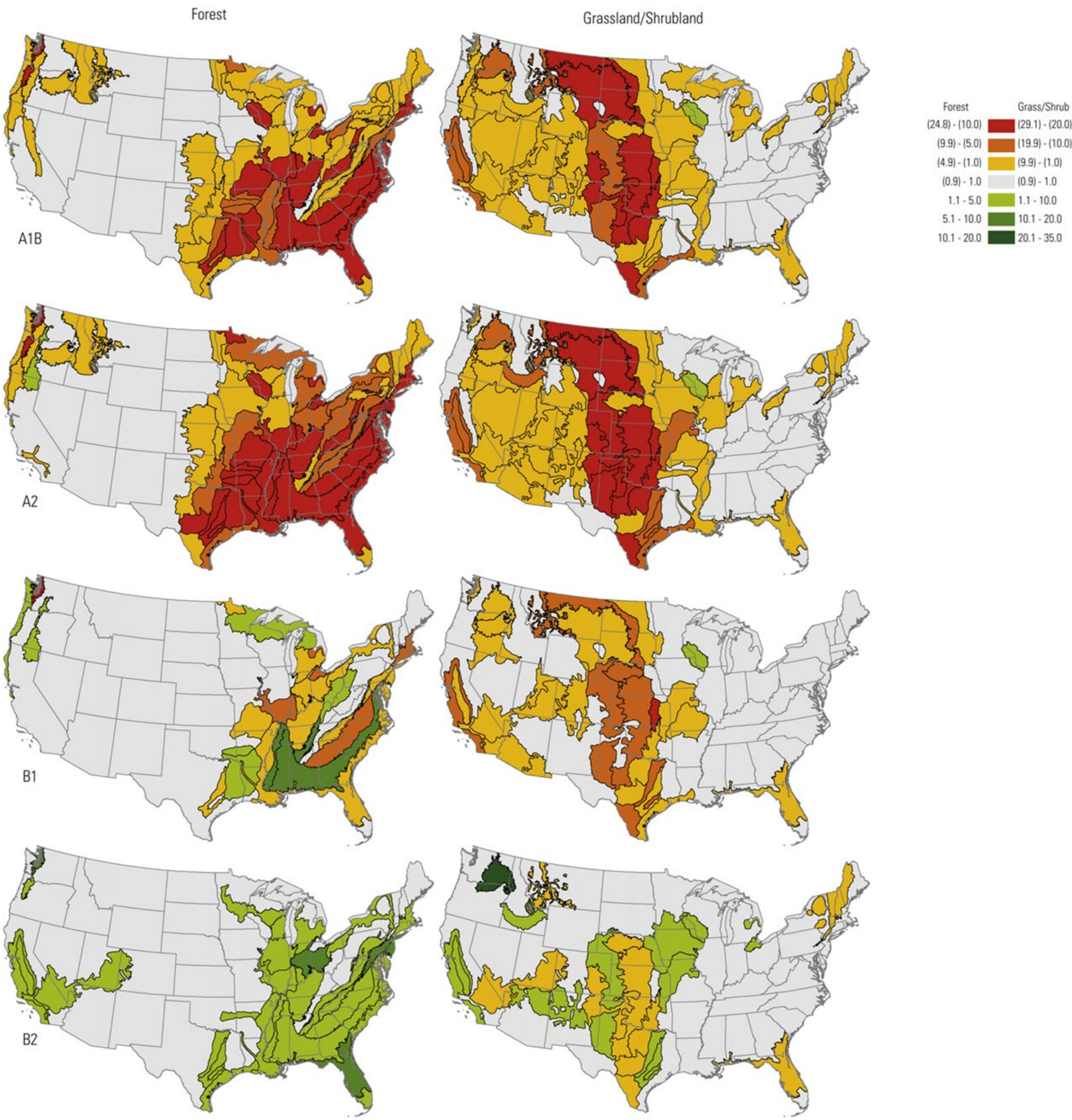


Figure 1– 14. *Distribution of change in forest and grassland/shrubland land covers predicted from 2000–2100. Units are percent of ecoregion area that changed. From Figure 11 in Sleeter et al. (2012).*

used in coupled human-natural systems models for predicting climate impacts (Knowlton and Graham 2010, Pearce-Higgins and Gill 2010), and to design effective agri-environment initiatives (e.g., Corncrake [*Crex crex*] recovery in Scotland; Pearce-Higgins and Gill 2010).

Potential Climate Change Impacts on Bobolink

On the breeding grounds, grassland birds have been found to be vulnerable to climate change in the northeastern U.S. where habitat is limited (Jaryzna et al. 2016). In that study, Bobolink occupancy of New York Breeding Bird Atlas blocks was particularly sensitive to increasing temperatures. Other research suggests that birds of open habitats in general may be more sensitive to climate change because the associated advancement of shrub and forest communities will limit grassland distribution, at least at high altitudes (Chamberlain et al. 2013), while more investigation is needed for grasslands at lower altitudes.

As a long-distance migrant, the Bobolink is susceptible to phenological mismatch. Long-distance migrants are departing wintering grounds from several thousand kilometers away, cued by day length rather than by local conditions. Furthermore, their long migration may also constrain their reproductive time period, and therefore their ability to flex departure from the breeding grounds. Spring arrival has been found to advance less for long-distance migrants and single-brooded species (Moller et al. 2008) – both characteristics of Bobolinks – which can ultimately lead to reduced reproductive output (Both et al. 2006).

Travers et al. (2015) evaluated spring arrival or passage of birds relative to the plant growing season (measured by growing degree units) near the North Dakota – Minnesota border. They found that: most migrants are indeed arriving earlier in the years 2001-2012 compared to years 1910-1949; the growing season has also advanced; and that in general, changes in the arrivals relative to the growing season have changed more for long-distance migrants than for short-distance migrants. In terms of the latter, as a group, long-distance migrants arrived at a later point in the growing season in the more recent time period. For most individual species these changes were not significant. For Bobolink, the stage of growing season encountered by arriving individuals increased slightly between the two time periods. The mismatch in timing with availability of important resources may ultimately reduce fitness. Long-distance migrants are hypothesized to be particularly vulnerable to this phenomenon.

Some research provides evidence that goes beyond speculation, providing hints about the potential links between Bobolink productivity and climate. For example, January climate was one of the most important predictors of Bobolink abundance and occurrence; birds were more likely to be recorded on routes when January temperatures were low between 1972 and 1990 (O'Connor et al. 1999). Similarly, Thogmartin et al. (2006) reported that Bobolink abundance in the upper Midwest was higher when temperatures were lower during the coldest quarter of the year. Predictions of Bobolink density (i.e., models incorporating vegetation structure covariates) in the northern tallgrass prairie region were slightly improved by adding climate variables, but individual climatic factors had no detectable effect on density or nesting success, presumably due to low inter-annual climatic variability during the four-year study (Winter et al. 2005). In northern North Dakota, Niemuth et al. (2008) found that Bobolink abundance from the BBS was positively associated with measures of soil moisture and precipitation (e.g., the number of local water-filled ponds within 200 m). We need to further evaluate such correlations, and understand the underlying mechanisms in order to better predict the effects of future climate scenarios.

Predictive Models of Climate Change Impacts

A variety of approaches have been used to evaluate the potential impacts of climate change on bird species, ranging from assessments of species' vulnerability to predictions of changes in breeding range to modeling outcomes using demographic data. Some methods assess the degree to which species might be affected. A sensitivity analysis assesses risk to a species from climate change based on its innate characteristics that make it adaptive or not. A vulnerability assessment incorporates sensitivity, exposure of the species to climate change, and its adaptive capacity. Models can be used to predict changes in the distribution of a habitat type or a species, and more complex models include spatially explicit data. Each method can produce very different results (Lankford et al. 2014). Approaches are increasingly sophisticated due in large part to the advancement of climate models and the advance of geolocation technologies that reveal movements of birds throughout their annual cycle.

Some exercises have made coarse predictions about the impacts of climate change on birds, including Bobolinks. The U.S. Forest Service developed models to predict changes in habitat under climate change for their Climate Change Bird Atlas. Using BBS data and climate and habitat variables, models under high and low-emission scenarios project a dramatic contraction northward in the Bobolink range, and a decrease in Bobolink abundance in the eastern U.S., primarily driven by winter temperatures (Matthews et al. 2007). However, these models are based on projected changes in tree distributions, rather than changes in grasslands. Hence, while the results may be useful for developing hypotheses to test, they are not likely to provide accurate predictions of future Bobolink habitat.

NatureServe's Climate Change Vulnerability Index (CCVI) used a scoring system to assess vulnerability of species to climate change relative to other species and provided an indication of vulnerability in a specified area (e.g., a state) by 2050. However, for wide-ranging species like Bobolink, the value of CCVI scores is limited because variation in climate predictions, especially for precipitation, are too large to predict the direction and magnitude of population and range change. CCVIs have been done for Bobolink in New York (Schlesinger et al. 2011; not vulnerable, presumed stable), West Virginia (Byers and Norris 2010; moderately vulnerable), Nevada (https://connect.natureserve.org/sites/default/files/documents/Nevada-CCVI-Results-ALL-013012.pdf, 2012, not vulnerable), and the Lake Simcoe Protection Area Watershed, Ontario (Brinker and Jones 2012; not vulnerable).

Other assessments of climate change impacts evaluate potential shifts in the breeding range in response to climate scenarios. For example, in Sohl (2014), a combination of predicted climate and land use changes is expected to result in a net 24.9% decrease of the U.S. Bobolink breeding range by 2075. While populations are predicted to be lost in most of the east and lower Midwest, expansions are predicted in the Dakotas, Montana, eastern Wyoming, and to a lesser extent northern Minnesota, northern Wisconsin, and Maine (Sohl 2014).

Using citizen science and climate data, Audubon assessed potential changes in the climate envelope for birds in North America under various climate change and species response scenarios (National Audubon Society 2015). The model predicts that by 2080 only 20% of the Bobolink's current range will remain; most of the potential range in terms of suitable climate will be entirely in Canada, shifting north as far as the northern boundary of the southern tier provinces and westward as far as northeastern British Columbia. Current land cover and land use would not accommodate this range shift. While results from this model can be assessed in the context of other information, if model predictions are accurate, grasslands conservation in Canada will be absolutely essential to the long-term stability of Bobolinks. The data used in these models are provided as a layer in the Bobolink Opportunity Map presented in Chapter 2.

The first climate change vulnerability assessment for Bobolink in a full life cycle context was part of an analysis for 46 species of conservation concern in the Upper Midwest Great Lakes LCC (Marra et al. 2014). Bobolink was rated moderately vulnerable, with a score of 2.6 out of 5.0. Bobolink life history characteristics that contributed to a higher vulnerability score included its long-distance migration, high site fidelity, and specialized breeding habitat requirements. It was one of four species rated as highly vulnerable to temperature change on both the breeding and non-breeding grounds, and was also predicted to be highly vulnerable to moisture change on the breeding grounds in the region. Vulnerability of breeding habitat to climate change was predicted to be low, but the impacts of predicted dramatic temperature increases on Bobolink winter diet were unknown. Although Bobolinks were predicted to be sensitive to moisture during winter, changes in moisture were not predicted to be significant in the area used as wintering grounds.

Although the Great Lakes assessment advances our understanding of potential impacts of climate change on Bobolinks throughout their annual cycle, more recent data can address some of its limitations. The assessment, based on limited records, considers only a small region known to support wintering Bobolinks. Data from recent research not included in this model reveals other important wintering areas as well as locations of long-term stops during southbound migration (Renfrew et al. 2013). Assessments or models are needed to incorporate these other regions, their predicted climate changes, and associated food availability. Furthermore, the indirect effects of changes in the frequency of major weather events need to be included. For example, flooding on wintering grounds could decrease availability of seed resources. Similarly, predicted increases in the frequency and intensity of hurricanes associated with climate change could decrease the chance of survival during fall migration. On the wintering range, predictions of drying trends in some regions and heavier precipitation in others (see next section) make it challenging to predict the overall impact on Bobolinks.

A Conceptual Full Life Cycle Climate Change Model for Bobolink

One way to tie together all the different ways climate change might impact Bobolinks is to develop a conceptual model that considers the potential impact of climate change on Bobolinks throughout its annual cycle. This conceptual model can serve as a biological framework for developing models to understand how Bobolink distribution might respond to various aspects of climate change.

To illustrate, a team of researchers built a conceptual model that serves as a framework for a demographic model to predict changes in the Bobolink's U.S. breeding distribution in response to climate change (McCauley et al., , unpubl. data). The primary focus of the demographic model is Bobolink productivity. The conceptual model has four components reflecting the full annual life cycle of the Bobolink: breeding season, fall migration, winter, and spring migration. In each component, possible climate impacts on the life history of the Bobolink are outlined. The model also included speculated carryover effects of wintering ground conditions on breeding productivity.

Here we present the rationale for each portion of the Bobolink's annual cycle (McCauley et al., unpubl. data).

Breeding Season

Temperature and precipitation both play a critical role in breeding productivity. Warmer daily temperatures have a positive effect: birds are better able to thermoregulate, adults have increased foraging success due to insects being more active resulting in less time foraging and more time for guarding the nest (Stauffer et al. 2011, Skagen and Yackel Adams 2012). However, extreme temperatures (e.g., heat waves) can cause nests to fail for a variety of reasons.

Precipitation appears to play a more important role than temperature in affecting breeding productivity (McCauley et al. 2017). Precipitation can have a direct effect on productivity, with higher hatching rates associated with increased precipitation (Rotenberry and Wiens 1991, Skagen and Yackel Adams 2012). However, too much rain, either in total or as extreme events, can lead to nest loss (e.g., desertion, flooding, drowning, death from exposure) (Wittenberger 1976, Martin 1971, Skagen and Yackel Adams 2012). Higher precipitation during the nestling stage can reduce adult foraging success (Martin 1971, Siikamaki 1996). While higher total precipitation can lead to nest loss due to increased snake predator activity (Dinsmore et al. 2002), extreme precipitation events can depress snake predator activity (Stauffer 2008).

Precipitation during the year prior to the breeding season also appears to affect breeding season productivity through its effect on grassland habitat quality. Wetter conditions in the preceding year leads to higher primary productivity in the current breeding season (i.e., better habitat quality) and more food resources (Rotenberry and Wiens 1991, Chase et al. 2005).

Fall Migration

Bobolinks migrate south to the Llanos in early fall which coincides with the latter part of the hurricane season (June through November). Migration across the Gulf of Mexico is likely affected by weather (Richardson 1978). Of potential concern is the likely increase in tropical storm frequency and intensity due to climate change (IPCC 2013). Bobolinks may be tracking primary productivity in natural grasslands and agricultural crops during southbound migration (Renfrew et al. 2013). Therefore if storms delay Bobolink arrival to South America, there may be a mismatch with primary production on the wintering grounds and a subsequent potential effect on overwinter survival.

Winter

For this conceptual model, wintering areas were based on geolocator data (Renfrew et al. 2013), plus the Llanos grasslands region in northern South America where Bobolinks make a protracted stop during their southbound migration (Figure 1–15). The winter season was defined to be the three months when Bobolink carry out their prealternate molt (January, February, and the first half of March).

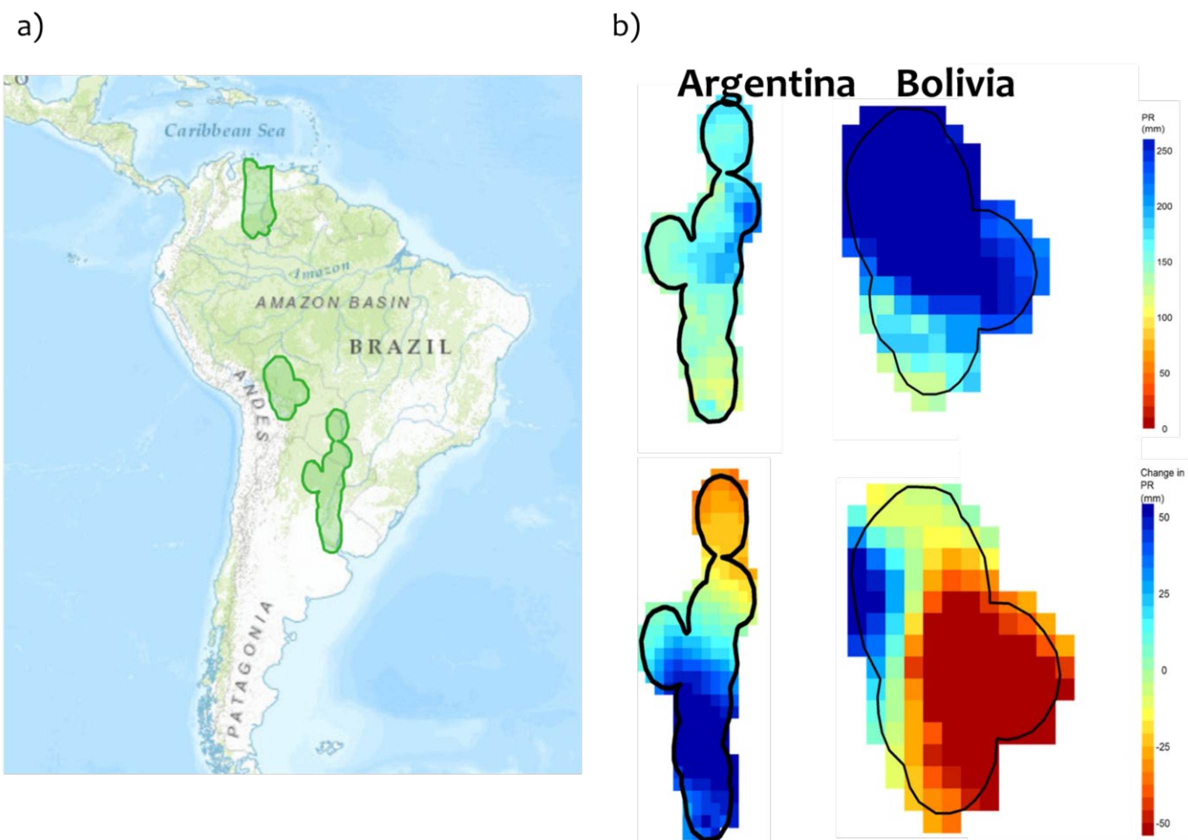


Figure 1– 15. *Predicted changes in precipitation for Bobolink non-breeding regions used in full life cycle conceptual model to assess potential impacts of climate change: (a) regions of occurrence during long-term stops based on compilation of kernel density estimates derived from light-level geolocator data (Renfrew et al. 2013); (b) historical (1961-1990; top) and change in future (2046-2065; bottom) total average precipitation. Positive (blue) and negative (red) indicates an increase and decrease in the mean from the historic to the future time period, respectively.*

Climate data show variability in predicted changes in precipitation across the Bobolink's main wintering range. Specifically, the southern portions of the wintering area in Argentina are predicted to become wetter while the wintering areas in Bolivia are predicted to become drier (using data from Climate Wizard, www.climatewizard.org; Girvetz et al. 2009). Native grass seed production is expected to be related to temperature (Young et al. 2004) and to precipitation in the previous growing season (Cable 1975). Crop production increases with greater precipitation to a point, and then temperature becomes important (Magrin et al. 2005). If these changes result in a reduction in primary productivity and seed production (Magrin et al. 2005), Bobolink overwinter survival may be affected and there may be distributional shifts as Bobolink track the changing primary productivity landscape.

Carryover Effects

While carryover effects are unknown for Bobolink, a suggested mechanism that could lead to a carryover effect is seed production. The effect of food resources may be especially important during late winter as birds become hyperphagic in preparation for spring migration. Possible scenarios include:

- Increased precipitation leads to increased primary production (Magrin et al. 2005) resulting in more and/or higher quality food. This results in better body condition (and increased survival; England 2000, Di Giacomo et al. 2003) and/or earlier arrival to breeding grounds, which in turn generally leads to increased productivity for migratory birds.
- Extreme precipitation events (e.g., storms, flooding) could lead to loss of food resources, resulting in poorer body condition (and potentially decreased survival), and reduced Bobolink productivity.

Spring Migration

Spring migration is likely triggered by photoperiod. Bobolinks carrying geolocators may stage or work their way slowly northward in northern South America for up to 2 weeks. Because spring migration occurs outside of hurricane season, impacts of climate change were not considered to be important for this period of the annual cycle.

Summary

This conceptual model shows that variability in precipitation is likely to be the most important climate variable influencing Bobolink demography and persistence both in terms of positive changes to grassland productivity, and also in terms of extreme events associated with drought. However, future change in precipitation is one of the most difficult components of climate change to project due to the heterogeneous nature of precipitation regimes. As such, Bobolinks, like other grassland birds, are undoubtedly vulnerable to the impacts of climate change, but the magnitude of the vulnerability is highly uncertain due to the difficulties of projecting changes in precipitation and extreme events.

Chapter Two: Bobolink Full Life cycle Conservation Strategy

Shaping the Strategy

Grassland Bird Conservation: The Need To Go Beyond Birds

For decades, organizations, institutions, and agencies have devoted substantial resources to discovering and promoting agricultural and other land use practices aimed at long-term sustainability of ecosystems and agriculture. From federal Farm Bill programs to local erosion control efforts, these practices frequently benefit grassland birds because they often include fewer chemical inputs, greater plant diversity, or using rotations that include fallow periods. Moreover, awareness and consideration of the needs of grassland birds has resulted in the uptake of programs to support beneficial practices, such as delayed haying. However, while important strides towards the conservation of grassland birds have been made through effective research, outreach, and partnerships, populations of grassland birds have continued to decline, and even establishing goals of no net loss of grasslands (e.g., Herkert et al. 1996) have continued to elude conservationists.

Conserving a species that relies heavily on lands used for food and fuel production throughout its annual range will require creative solutions that merge economic, social, and conservation needs. Such solutions will necessarily entail a valuation of conservation benefits that go beyond birds. The value of habitat to the interests of other stakeholders must be considered, and the benefit to other ecosystem services (e.g., water quality, biomass production, carbon sequestration) should be evaluated. There has been important, ongoing debate about valuing ecosystem goods, but given the use of open lands to service human needs, the value of grassland habitats is not likely to be convincingly sold to the general public based on its value to birds alone.

Ultimately, in order to accomplish grassland conservation at the scale needed to stabilize grassland-dependent bird populations, bird conservation needs must be embedded within efforts that have other environmental service objectives and priorities. Some broad-reaching strategies that are developed to tackle issues such as water quality could have the greatest benefit to grassland birds even if bird population objectives are not mentioned as beneficiaries. The conservation needs of grassland birds must be at the table, but the largest audiences may be best reached by spotlighting other environmental, social, and economic services.

This chapter identifies opportunities to partner with and strengthen existing programs that ultimately provide or sustain Bobolink and other grassland bird habitat. By forging more non-traditional partnerships, we may find new or underexploited means to protect grasslands in ways that are economically viable and desirable for farmers and other landowners.

Conservation Design and Geographic Scale

Regardless of how grassland conservation is achieved, grassland bird conservationists use measures of progress that are still assessed in terms of populations or habitat. Elements of effective conservation design include:

1. Assessment of current habitat/population conditions, distribution in relation to land use, potential threats, as well as the habitat potential for each region.
2. Evaluation to determine where on the landscape there is adequate, suitable habitat and/or the potential habitat to achieve bird population objectives. This includes an assessment to determine where the greatest opportunities lie for future conservation at scales sufficient to achieve population objectives.
3. An adaptive framework driven by feedback through monitoring and evaluation.

Establishing a conservation design framework is essential, and the above activities are best carried out at the regional scale. This Plan provides a framework for JV coordinators to follow for setting objectives and relating them to habitat needs. This initial component of conservation planning is within the comfort zone of most biologists, who possess the expertise to establish conservation objectives and identify related habitat needs, and monitor and evaluate the outcomes to adapt strategies as they learn what works.

At the broad scale needed for a species like Bobolink and several other grassland bird species, following a conservation design with implementation using feasible, effective actions can be challenging. Because even when effectively carried out, recommended conservation actions may still not result in advances significant enough to close in on population objectives. Therefore, we need to be explicit about possible combinations of actions that are needed to operate at scales that will enable us to truly reach population objectives. The solution, and simultaneous challenge, is to scale up existing grassland conservation efforts and to address complex, underlying forces that have prevented conservation from halting grassland bird declines in new and creative ways. This Plan seeks to not only outline general strategies that can be used to reach population objectives, but to also propose creative ideas that require new approaches, and in doing so, broaden how we define grasslands conservation.

Recently, strategies proposed for maximizing crop production with the least impact on the environment have been placed into one of two categories: *land sharing*, or extensive agriculture that is wildlife friendly; and *land sparing*, or intensive agriculture that is less wildlife friendly but also less extensive. Although more research is needed to determine where and under what circumstances to prioritize either strategy (Balmford et al. 2012), the underlying tenets of each can be kept in mind as conservation measures are determined. For grassland birds, a mix of both strategies are likely needed, as reflected in the actions found in this Plan.

To reach grassland bird population goals, this chapter introduces and encourages creative, novel strategies. Amidst the conservation actions identified are ideas that range from general to specific, from those tested in other systems to those that appear completely out of the box. Collectively, they are intended to serve as a springboard for new, creative, and broad-reaching conservation thought and action. Taken together, the approaches that emerge from this menu need to be aimed at achieving grassland conservation at the scale required to sustain Bobolink populations.

Strategic Habitat Conservation: A Conceptual Conservation Model

More than a decade ago, Brennan and Kuvelsky (2005) recommended a multi-species and multi-stakeholder approach to restore grassland habitat in North America via cultural and economic incentives to improve management of hayfields, grazing, and fire. They proposed that existing coordinating bodies, such as NABCI and JVs, lead this work. Since then, NABCI and JV cooperators have evaluated a variety of grassland conservation alternatives for the eastern US. Their assessment calls for the development of grassland-based markets that sustain a variety of ecosystem services on agricultural lands (Drum et al. 2015*b*), a strategy that requires closer collaboration between farmers, ranchers, natural resource professionals, and representatives of the food and energy industries.

However, the complexity and scale of such a strategy is challenging, particularly if the coordination is to encompass breeding, migratory, and wintering grounds of a species like Bobolink. One way to address this complexity is through the use of conceptual models. By visually portraying the complex context in which conservation projects often operate, conceptual models capture and distill relationships among conservation targets, threats, opportunities, and primary interests. In so doing, they broaden understanding of the situation in which a particular conservation problem exists, and help identify which strategies might be the most appropriate to apply.

Strategic Habitat Conservation (SHC) is a conceptual model that involves a continuous and adaptive cycle of conservation planning, design, and delivery, with adjustments made periodically based on outcome-based monitoring (Johnson et al. 2009; Figure 2–1). It also provides a useful framework for understanding the roles and relationships of individual

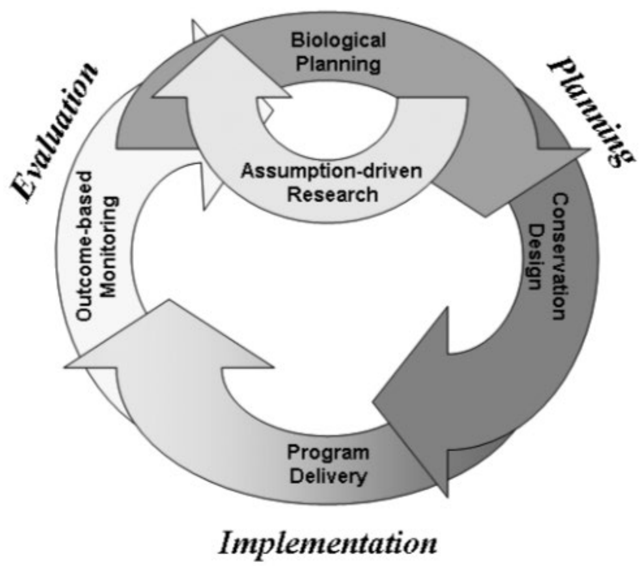


Figure 2– 1. *The Strategic Habitat Conservation conceptual model (Johnson et al. 2009).*

cooperators in the kind of collective conservation enterprise required for Bobolink FLC. SHC is most directly applicable to stewardship of the Bobolink breeding grounds where population changes can be most easily measured. However, it could also help guide conservation activities throughout the annual cycle if impacts can be measured or estimated. In the future, the SHC model may more formally include social sciences to incorporate the evaluation of ecosystem services and how they contribute to human well-being.

In recent decades, practitioners of SHC have made significant advances toward enhancing grassland ecosystems in North America. For example, State Wildlife Action and Joint Venture Implementation Plans have drawn on Breeding Bird Survey (BBS) data (monitoring) to identify threats (biological planning) and opportunities (conservation design) at multiple spatial scales. Additionally, numerous plans, initiatives and programs have developed spatial products to help guide where grassland habitat conservation may be most desirable and feasible (conservation design). Several plans reference an adaptive framework approach for addressing objectives, but none have yet to articulate the actual changes in management that would result from specific monitoring outcomes that would exemplify an adaptive management framework as interpreted in the strictest sense (e.g., cf. Igl et al. 2018).

To initiate an SHC process, Figure 2–2 summarizes how habitat needs derived from demographic information and trend goals could be allocated to different sector-based actions in support of the overall population goal (described in the next section). Some actions will be BCR-specific, while others might address processes operating at higher levels that affect multiple BCRs in the Bobolink range (e.g., crop markets). These discussions should generate answers to critical questions, such as:

- What actions could be both effective and feasible in priority landscapes?
- Over what acreage could each action be applied?
- What population outcomes might be expected based on current understanding of demographic responses?
- If all actions are implemented, will the projected demographic responses add up to the population goal?
- And, how much of the unmet conservation need would be left for other sectors to bear?

To further inform sector acreage targets, conceptual models that incorporate multi-sector benefits can be used to examine policy alternatives. Figure 2–3 provides one such example in relation to the agrofuels sector, showing how the valuation of the economic costs and benefits (e.g., pest control) of grassland birds to agrofuel production, together with strategic conservation planning, can help inform new sustainable agrofuel policy that feeds back within an adaptive-management framework.

In North America, executing the SHC model will require extensive collaboration amongst entities such as NABCI and Joint Ventures, with indicators of success driven by grass-based habitat objectives. In South America, the regions used by Bobolinks provide a potential spatial framework for conservation efforts. Success in South America will likely be driven by habitat or threat reduction objectives rather than Bobolink abundance objectives. On both continents,

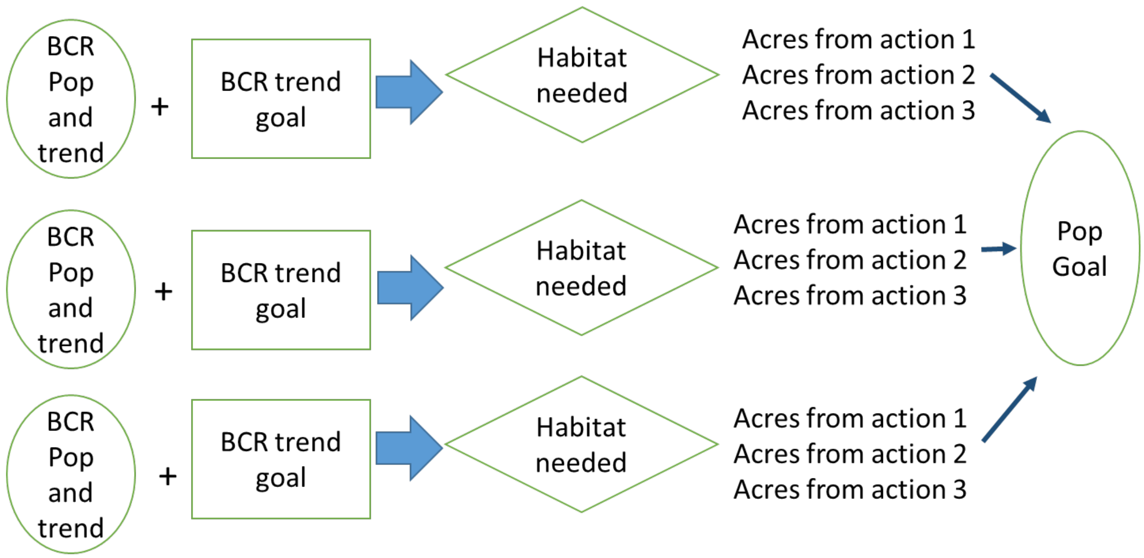


Figure 2– 2. *Conceptual model for how regional bird population trend goals can be translated to habitat needed and subsequent actions needed that will collectively reach the overall population goal.*

Bobolinks may often be a beneficiary of measures aimed at the conservation of other co-occurring, more vulnerable species.

Overall Population Goals and Objectives

The major source of information on population trajectories for Bobolink derives from the North American Breeding Bird Survey (BBS) in the U.S. and Canada—a survey currently designed to produce annual indices of trend estimates (Sauer et al. 2017). Although the BBS is conducted during the breeding season, the resulting trend estimates must be understood as an integration of all demographic parameters that might influence Bobolink population size, including adult and first-year survival during migration and stationary non-breeding periods in South America; in other words, the BBS itself provides little information regarding the ultimate causes of Bobolink population change. Population goals and objectives derived from BBS data should therefore be understood as applicable to the entire Bobolink full life cycle—although North American conservation planners inevitably translate these objectives into acres of suitable habitat on the breeding grounds. Few would argue that new or enhanced quality grassland acres would not benefit grassland birds, Bobolink included; nonetheless, the notion that increased habitat on the breeding grounds will be sufficient to sustainably reverse grassland bird declines should be understood as a reasonable but unverified major assumption.

Regardless of where we think a migratory bird population is most limited at a particular point in time, a full life cycle approach is still both necessary and precautionary for several reasons. The different periods of the annual cycle are intrinsically linked due to carryover effects. Changes in population can lead to changes in the impact of a threat; e.g., rice farmers in Bolivia increased

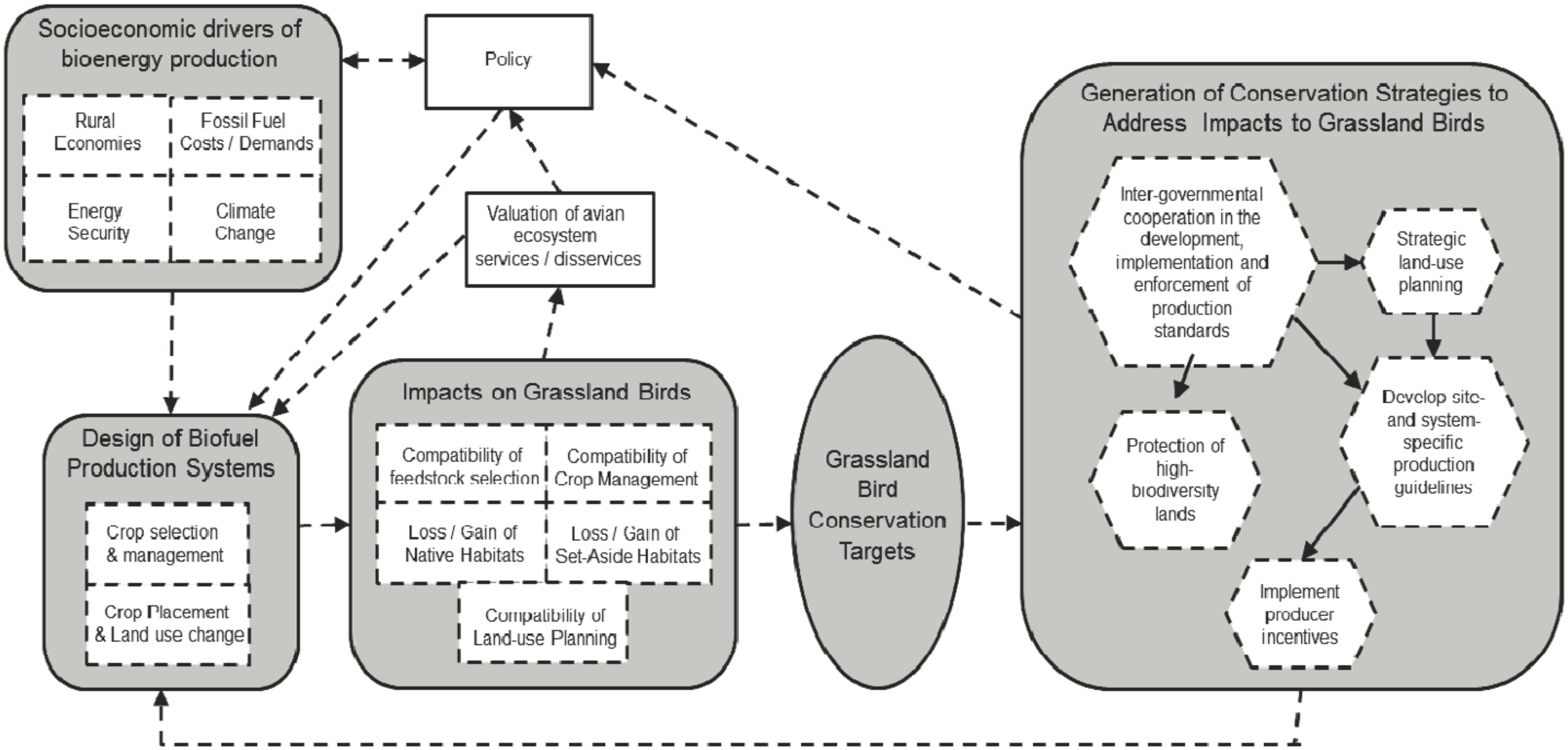


Figure 2– 3. *A conceptual model for understanding how grassland bird conservation can be integrated into the production of agrofuel crops in the United States (Robertson et al. 2012). A complex set of socioeconomic and political drivers (top left) will ultimately determine which crops are selected for production in various agricultural regions and how they will be managed (bottom left). The direct and indirect effects of these production systems on grassland birds at local and landscape scales will need to be studied and monitored, then evaluated for their effectiveness in meeting regional conservation targets for grassland birds (bottom center). Conservation strategies (right) must then be designed to mitigate the effects of agrofuel production on grassland birds, and to influence, when possible, production system design.*

the level of take of Bobolinks when Bobolink populations were perceived to increase. Given the uncertainties associated with climate change, we have little knowledge if and when threats in seasonal geographies will change in severity or impact. A full life cycle plan provides a framework for growing the partnerships needed to deal with uncertainty throughout the annual cycle—in short, providing the response resiliency necessary for successful conservation under uncertainty across multiple geographies and jurisdictions.

Despite advances in planning and design, work on the breeding grounds has yet to produce conservation outcomes on a scale needed to stem and halt grassland bird declines. The Bobolink population goals developed in this plan, strengthened by possible derivation of habitat objectives, are intended to address this problem and provide useful conservation delivery guidance in North American BCRs. Equipped with these targets, ecologists and conservation professionals will be able to initiate focused dialogue with various stakeholders that drive land use, including leaders within each major production system or industry sector within or across BCRs.

To establish an overall Bobolink population goal, this Plan uses an approach that focuses on population trends and differs from that of other species conservation plans for a few reasons. First, the global Bobolink population is relatively large and not in danger of extirpation in the core area of its range. Second, the main goal of this Plan is to halt the long-term, negative trajectory that Bobolink populations continue to exhibit. Third, as a focal species representing grassland habitat that supports a grassland community in decline, continued population losses of Bobolinks is commensurate with a continued loss of the grassland community. We ultimately aim for no net loss of grasslands, as measured by no net loss of Bobolinks.

Population Trend Goals for Bobolink

A population goal subcommittee was established to develop and propose an overall Bobolink population goal to the Conservation Plan steering committee. The subcommittee followed an approach established during the development of the Ontario 2013 Bobolink Recovery Strategy (McCracken et al. 2013) that: 1) includes both a short-term and longer-term goal; 2) is explicit about both the desired trend and the desired population level; 3) recognizes that many regional populations are likely to continue to decline due to unabated threats while the Plan is being implemented; and 4) that it is not possible to completely counteract all of the factors causing declines. Population estimates for a widespread species like Bobolink have very large uncertainty bounds, and therefore a relatively robust trend-based goal was preferred over a population goal.

An assessment of the current conservation community's capacity to implement conservation actions suggests that even major modifications to the landscape often cannot meet population goals. This is in part because conservation demands for other species preclude meeting the goals for any single species when humans increasingly appropriate more of the environment for their own needs (Thogmartin et al. 2014). Although this Plan ultimately aims to stabilize the Bobolink population, it accounts for some continued losses during implementation. This makes the goal reasonably achievable, yet requires a substantial positive impact on Bobolink populations.

The rangewide population goal developed for Bobolinks includes three components:

(1) **A general, long-term qualitative goal:** to achieve and maintain a stable population of Bobolinks, and in doing so contribute to the conservation of associated grassland bird species and their ecosystems.

(2) **Short and long-term quantitative trend goals**:

- The **short-term quantitative goal** (over the 10-year period from 2017-2026) is to slow the annual rate of population decline to 0 percent per year, as measured by the BBS.
- Thereafter, the **long-term quantitative goal** is to maintain population stability at ≥ 85% of the 2016 population size.

(3) **A general conservation goal** that states how trend goals will be reached: to achieve these population goals through strategic conservation measures that address the full life cycle of the Bobolink.

Derivation of the Quantitative Population Trend Goal

The Bobolink Plan steering committee considered three options for the range-wide population trend goal. All were aimed at halting declines (population trend = 0) in 10 years as measured by the BBS and maintaining population stability thereafter. This general approach of setting specific 10- and 30-year population trend objectives has been adopted recently by PIF for all landbird Watch List and Common Birds in Steep Decline species (Rosenberg et al. 2016). PIF's short term objectives differ in terms of the rate at which declines would be halted (or at least slowed) depending on the overall vulnerability, abundance, and threat level of a species. After the initial recovery period, the 30-year trend objective reflects the desire to return declining species to at least a portion of their former abundance (Rosenberg et al. 2016).

The three Bobolink Plan steering committee options varied in terms of how the short-term, 10-year range-wide goal would be reached. The first option considered was to slow the annual rate of population decline to an average of 0 percent per year during the 10 years while maintaining the initial, starting population—requiring that negative trends in early years be offset by positive trends in later years. Given the large, socioeconomic forces that impact populations, the committee recognized that populations may continue to decline while conservation measures are being implemented, and therefore this goal, while desirable, was not achievable. The second option was to allow additional, permanent population loss while the Plan is being implemented, but achieve level trends by the end of a 10-year period. This option would tolerate any amount of loss in the first 10 years as long as the trend fell to 0 at the end of that period. The third option was similar to option 2, except that net losses to the population during the first 10 years would be capped at some predetermined level. The committee selected this third option because it was ambitious yet achievable and would prevent steeper population declines.

Next, the committee identified 1985 as a benchmark period for projecting trends and establishing population goals because it was in this year that that the U.S. Farm Bill first included the Conservation Reserve Program (CRP). The rationale was to avoid losing ground once conservation gains were made as a result of major U.S. Farm Bill programs. Essentially, the goal reflects a Farm Bill conservation era, and does not include trends from before influential grasslands conservation programs were enacted. The committee then determined the minimum population size in the quantitative trend and population goals beginning with the overall rangewide trend since 1985 (-1.67%). Then the committee allowed for a continued -1.67% trend for four years after the Plan is finalized, followed by a reduction in annual losses of 0.28% for the following six years, to reach a 0% trend at the end of 10 years. This would allow for 88.2% of the 2016 population to remain. However, to account for various uncertainties, additional loss was allowed, setting the minimum 2026 population goal as 85% of the 2016 population.

Regional (BCR) Population Objectives

The Bobolink Plan population goals subcommittee developed theoretical population trend goals for each BCR that collectively would meet the goal of obtaining a stable population trend across the breeding range. Like the overall population goal, regional objectives were based on population trends. However, population estimates were needed to derive the number of birds and habitat needed to achieve trend goals.

A trend-based Bobolink Population Objectives Tool was developed by James Herkert (Illinois DNR, now with Illinois Audubon) to determine the interrelated BCR population objectives that when rolled up would meet the overall population goal of this Plan. Initial BCR population estimates were derived from the PIF Population Estimates Database (Partners in Flight 2019b) and BCR-scale trends for the decade 2006–2015 from BBS (Sauer et al. 2017)using the PIF (route-regression) methodology (cf. Rosenberg et al. 2017). The Bobolink trend objective for each BCR was scaled by its trend relative to trends in the other BCRs. The interactive spreadsheet tool calculates whether the range-wide population goal is met given the contributions of the BCR-scale trend-based objectives.

The original goal of the exercise was to create scenarios whereby each BCR attains a stable trend of zero in 10 years and maintains stability through an additional 20 years. However, in some BCRs, achieving this scenario over time required that some populations increase by as much as 200% while others would decrease by as much as 85%. Planners needed to account for the carrying capacity of each BCR in the context of recent population trends, in part because even small annual percentage changes result in substantial population changes over time. This issue was addressed by establishing 10-year BCR trend goals that often differed from zero but that were constrained with a maximum, for both positive (≤ 1.2%/yr) and negative (≥ -2%/yr) trends. The result was a set of more feasible BCR trend objectives that still attained the overall goal. This approach did, however, require that BCRs with very negative trends be significantly dampened. It also assumed that BCRs with large positive trends in recent years would not be able to continue to increase at such a high rate.

Proposed BCR population trend objectives in Table 2–1 were based on the above constraints

TABLE 2– 1. *A scenario for Bobolink Bird Conservation Region (BCR) population trend objectives that achieves the range-wide population trend goal for this species. Accompanying BCR x country population estimates are for number of individual breeding Bobolinks; starting population estimates were derived from the PIF Population Estimates Database (Partners in Flight 2019b). The desired trend after the first 10 years (light green) is negotiated with partners; thereafter the goal is to maintain that trend. BCRs in pink are those for which objectives are based on feedback from Joint Venture coordinators. Objectives for other BCRs were developed by dampening existing trends toward the 10-year trend goal. Raw density is based on the amount of area that overlaps with the Bobolink breeding range, regardless of habitat type. ([1]Not included in calculations)*

BCR Name	BCR	Country	Area of Range (km^2)	Pop. Estimate	% Global Pop.	BBS Trend (1985 - 2013)	Annual Trend Goal Year 10+	Annual Pop. Change Recovery Phase	Projected Population		BCR Projected Pop. Change (%)	Estimated Raw Density (birds/km2)			
									Year 10	Year 30		Year 0	Year 10	Year 30	30-Yr Chg
Shortgrass Prairie	18	US	24,371	8,136	0	5.25	1.20	-0.41	10,951	13,902	68.84	0.33	0.45	0.57	0.24
Badlands and Prairies	17	US	296,251	1,166,322	12	4.68	1.00	-0.37	1,515,066	1,848,669	56.93	3.94	5.11	6.24	2.30
Central Hardwoods	24	US	7,233	15,740	0	2.70	1.00	-0.17	18,747	22,875	43.89	2.18	2.59	3.16	0.99
Central Mixed Grass Prairie	19	US	94,456	259,603	3	0.56	1.00	0.04	281,189	343,104	30.86	2.75	2.98	3.63	0.88
Prairie Potholes	11	US	414,618	2,738,188	28	-0.11	0.00	0.01	2,724,663	2,724,663	-0.49	6.60	6.57	6.57	-0.03
Prairie Potholes	11	CAN	408,853	707,047	7	0.30	0.00	-0.03	716,648	716,648	1.36	1.73	1.75	1.75	0.02
Appalachian Mountains	28	US	169,583	444,973	5	-0.37	0.50	0.09	449,811	496,994	11.14	2.62	2.65	2.93	0.31
Boreal Softwood Shield	8	CAN	154,098	115,885	1	-1.08	0.00	0.11	110,369	110,369	-4.76	0.75	0.72	0.72	-0.04
Northern Rockies	10	US	262,615	47,473	0	-3.40	0.00	0.34	40,670	40,670	-14.33	0.18	0.15	0.15	-0.03
Northern Rockies	10	CAN	23,140	25,082	0	0.87	0.00	-0.09	26,081	26,081	3.98	1.08	1.13	1.13	0.04
Boreal Hardwood Transition	12	US	221,175	624,443	6	-1.14	0.00	0.11	593,106	593,106	-5.02	2.82	2.68	2.68	-0.14
Boreal Hardwood Transition	12	CAN	262,000	617,486	6	-3.78	0.00	0.38	519,820	519,820	-15.82	2.36	1.98	1.98	-0.37
Eastern Tallgrass Prairie	22	US	379,665	549,601	6	-1.97	-1.50	0.05	462,456	341,818	-36.86	1.45	1.22	0.90	-0.55
Boreal Taiga Plains	6	CAN	57,209	114,640	1	-2.34	-0.50	0.18	100,280	90,714	-20.47	2.00	1.75	1.59	-0.42
New England/Mid-Atlantic Coast	30	US	30,178	26,935	0	-2.28	-0.50	0.18	23,626	21,372	-20.25	0.89	0.78	0.71	-0.18
Lower Great Lakes/St. Lawrence	13	US	88,309	256,806	3	-1.56	-1.00	0.06	226,403	185,177	-27.16	2.91	2.56	2.10	-0.81
Lower Great Lakes/St. Lawrence	13	CAN	112,915	775,376	8	-4.02	0.00	0.40	645,548	645,548	-16.74	6.87	5.72	5.72	-1.15
Prairie Hardwood Transition	23	US	229,491	567,520	6	-3.03	0.00	0.30	494,525	494,525	-12.86	2.47	2.15	2.15	-0.32
Piedmont	29	US	11,273	6,520	0	-3.96	-2.00	0.20	4,866	3,249	-49.16	0.58	0.43	0.29	-0.29
Atlantic Northern Forest	14	US	156,377	324,151	3	-2.42	-1.00	0.14	274,751	224,721	-29.97	2.07	1.76	1.44	-0.64
Atlantic Northern Forest	14	CAN	200,697	271,816	3	-6.94	-1.00	0.59	186,670	152,678	-43.26	1.35	0.93	0.76	-0.59
Great Basin	9	US	81,930	45,399	0	-7.07	-2.00	0.51	29,275	19,544	-56.07	0.55	0.36	0.24	-0.32
Great Basin	9	CAN	34,391	2,038	0	-9.99	-2.00	0.80	1,142	763	-61.81	0.06	0.03	0.02	-0.04
Southern Rockies/Colorado Plateau[1]	16	US	93,273	2,575											
TOTAL				9,713,755					9,456,664	9,637,010		2.11	2.02	2.06	-0.05

and the need to fulfill the overall population goal; knowledge about conservation capacity in BCRs was sometimes incorporated as well. Steering Committee members familiar with the tool instructed coordinators from relevant JVs in its use and solicited feedback regarding appropriate population objectives for their BCRs. The objectives are presented as a starting point and as a means of estimating the amount of habitat needed in each BCR to reach the overall goal. Note that meeting the overall population goal is most influenced by changes in BCRs that contain the most Bobolinks, especially the Prairie Potholes BCR (BCR 11). For this reason, we fully explore the feasibility of meeting BCR 11 population objectives in the next section and include suggestions for an alternative means to evaluate capacity in other BCRs.

Using the scenario presented in Table 2–1, BCR responsibilities vary, and populations may continue to decline as conservation actions strive to implement the 10-year trend objective. Thereafter, the trend objective is to be maintained for another 20 years. Realistically, the range-wide population may continue to decline, and the spreadsheet contains a cell (YES or NO calculation) that indicates whether the combined BCR-scale trend objectives will result in more than a 15% overall population decline from the starting population in the first 10 years. After year 10, the population is considered stabilized, and in the case of the tabled scenario, the population even increases from year 10 to year 30. Although the final population (year 30) may still be lower than the initial population (e.g., in the Table2–1 scenario there is a decrease of 5% in the range-wide Bobolink population from year 0 to year 30), it is important to note that the population is on an increasing trajectory.

Similar to conservation actions in an adaptive framework, the Bobolink population tool is intended as a dynamic template, to be updated with input from JVs regarding the numerous parameters and factors that contribute toward developing a feasible trend goal. A limitation of this approach is that it assumes that each BCR represents a closed population. As a result, small populations would continue to decrease, and large populations would continue to increase, and inevitably over time, the overall population increases. This is more of a limitation when the model is played out over several decades; over the short term the impact of this assumption is very small. If this is a major concern, the BCR trends can be used as population status metric, and the conservation goal may be more qualitative: if the trend is negative, the goal is to reach a trend of zero as soon as possible (or in x years); if the trend is positive, it will eventually decline to zero, and the goal would be to ensure that the trend does not become negative.

The Bobolink shared responsibility trend-based tool approach was presented at Tri-Initiative Science Team (TriST) and PIF Science Committee meetings in 2015. It was met with great enthusiasm, and other species working groups (e.g., Wood Thrush) have adopted it. In its generic form, it is now being referred to as the Population Objective Regional Trend (PORT) tool. PORT tool objective setting encourages an iterative approach among regional partners, and Bobolink population objectives will continue to be updated based on input from JVs. An immediate goal is to estimate the habitat acreage needed to reach the trend objective for each BCR and to determine the feasibility of achieving that habitat objective.

Translating Population Objectives to Habitat on the Ground

Demonstrating the Approach:
Assessing Bobolink Objectives in the Prairie Pothole Joint Venture

The Northern Great Plains contains the highest diversity of breeding grassland bird species on the continent, based on BBS data (Peterjohn and Sauer 1999), including populations of several species of conservation concern. Bobolink in Prairie Pothole Joint Venture (PPJV) states comprises approximately 29% of the global breeding population and is a conservation priority. This section describes efforts undertaken by the PPJV to assess the feasibility of Bobolink trend-based population objectives by translating them to habitat conservation targets.

Conservation Objectives. The PPJV is committed to addressing the conservation needs of all priority avian species that use the U.S. Prairie Pothole Region (U.S. PPR; Table 2–2). PPJV partners use a strategic, science-based approach to conservation optimizing diverse partners, strategies and tactics. The draft 2017 PPJV Implementation addresses the conservation needs of four bird groups: waterfowl, shorebirds, waterbirds, and landbirds. For landbirds, planning relies on the 2016 North American Landbird Conservation Plan revision (Rosenberg et al. 2016) for conservation planning guidance.

TABLE 2– 2. *PPJV priority species are selected based on population abundance, population trend, and partner priorities.*

Waterfowl	***Landbirds***	***Shorebirds***
Mallard	Baird's Sparrow	Wilson's Snipe
Northern Pintail	Sprague's Pipit	Long-billed Curlew
Gadwall	Chestnut-collared Longspur	Wilson's Phalarope
Blue-winged Teal	McCown's Longspur	American Avocet
Northern Shoveler	Clay-colored Sparrow	Willet
Redhead	Bobolink	Marbled Godwit
Lesser Scaup	Western Meadowlark	Upland Sandpiper
Canvasback	Grasshopper Sparrow	Piping Plover
	Lark Bunting	
Waterbirds	***Gamebirds***	
Franklin's Gull	Greater Prairie-Chicken	
Pied-billed Grebe	Greater Sage-Grouse	
American Bittern	Ring-necked Pheasant	
Sora	Sharp-tailed Grouse	
American Coot		
Black Tern		
Whooping Crane		

The ultimate goal of PPJV bird conservation efforts is to enhance or maintain populations at desired levels. Given this objective, PPJV partners focus on population vital rates to guide conservation for priority species. Understanding variation in vital rates, identifying which vital rates are most responsible for population change, and quantifying how vital rates vary across landscapes and time, are all critical to informing conservation planning and management.

For many non-game birds, only gross population trends based on surveys that index populations are understood. Until those demographic knowledge gaps are filled, population trends provide the best available information from which to develop many priority species objectives. The BBS is the only landbird survey conducted in all PPJV states (Figure 2–4). The annual, continent-wide survey is the primary source of information regarding populations of many North American bird species and serves as the primary landbird monitoring program in the PPJV. Models developed and/or validated with BBS data (e.g., Niemuth et al. 2007, Niemuth et al. 2008, Lipsey et al. 2015, Drum et al. 2015*a*) are used to predict the results of landscape-level changes in the relationship of breeding landbirds to habitat quality and quantity. The BBS offers the considerable advantage of being collected across most of North America, enabling comparisons of the PPJV with other regions.

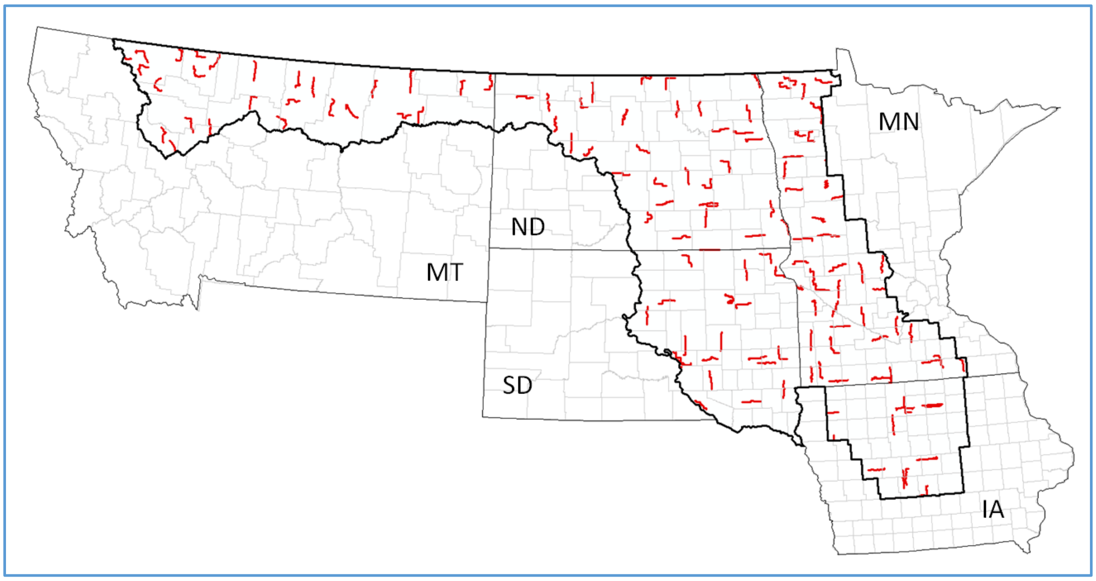


Figure 2– 4. *Distribution of 156 established BBS routes (shown in red) in the five Prairie Pothole Joint Venture (PPJV) states.*

Biological Models. Currently, the PPJV uses one conceptual model and two data-driven empirical models that provide decision support tools to guide strategic habitat conservation actions for the Bobolink through spatial prioritization. These models highlight the value of this landscape to grassland bird conservation. The conceptual model uses Grassland Bird Conservation Area (GBCA)s defined at three levels to address the needs of grassland breeding birds with different area requirements (Johnson et al. 2010; Figure 2–5). Type 3 GBCAs (55-acre core) are then combined with empirical breeding duck models (a.k.a. Thunderstorm Maps; Reynolds et al. 2006) to identify areas across the PPJV landscape that are priority areas for both bird groups. This approach allows PPJV partners to leverage funding and conservations targeted at breeding waterfowl to simultaneously benefit breeding grassland birds.

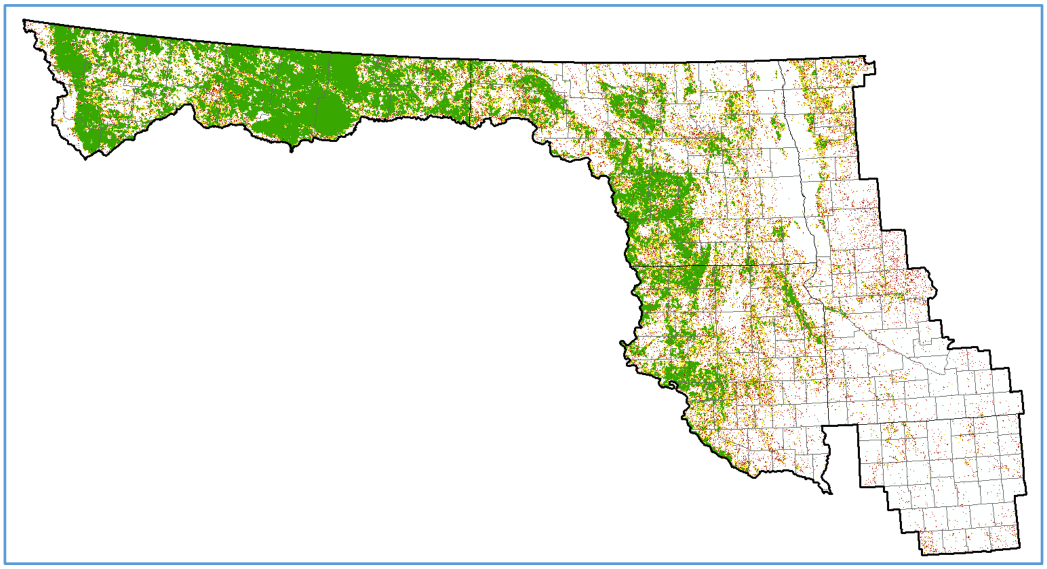


Figure 2– 5. *Prairie Pothole Joint Venture (PPJV) Grassland Bird Conservation Areas (GBCAs). All GBCAs consist of a grassland core with a surrounding 1-mile wide matrix. Type 1 core: ≥ 640 acres, ≥ 1 mile wide, matrix and core ≥ 40% grassland; Type 2 core: ≥ 160 acres ≥ ½ mile wide, matrix and core are ≥ 30% grassland; Type 3: ≥ 55 acres ≥ ¼ mile wide, matrix and core are ≥ 20% grassland.*

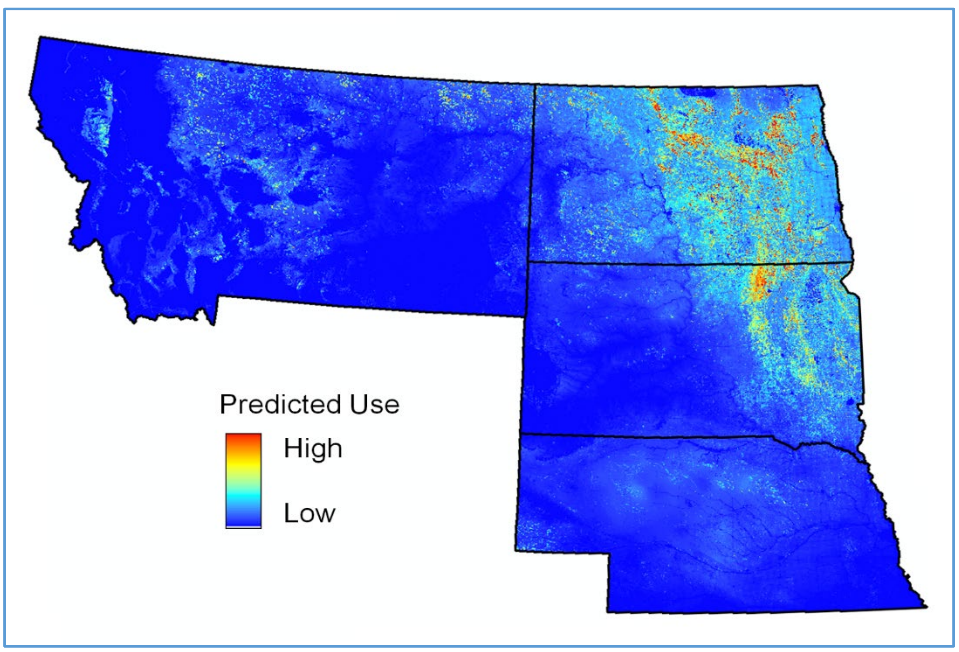


Figure 2– 6. *Logistic regression model of Bobolink abundance developed by Niemuth et al. (2017).*

To estimate probability of occurrence, a logistic regression model that uses BBS data has been developed (Niemuth et al. 2017; Figure 2–6). Stop-level BBS data from 2005-2011 are applied to predictor variables derived from the National Landcover Database 2006 (NLCD), USDA National Agricultural Statistics Service, delineated CRP fields, and climate databases. Future proposals include expanding applications of this model outside of the prairie potholes. The data used to develop the BBS logistic regression model are publicly available (except CRP field locations), and similar analytical methods can be used throughout the breeding range to guide Bobolink conservation.

To estimate breeding pair abundance, the PPJV also uses a zero inflated Poisson (ZIP) regression model (Drum et al. 2015*a*; Figure 2–7a). The model is based on data collected using 100-meter fixed-radius point counts conducted throughout the PPJV during May/June 2003–2005 using a spatially allocated stratified random sampling design (Quamen 2007). The raw survey results were adjusted to account for unequal detection probabilities using program DISTANCE (Buckland et al. 2001, Thomas et al. 2005). Observations were modeled against 2005 landcover data with climate variables to estimate Bobolink abundance across the majority of the PPJV. The model was validated with an independent BBS dataset. Although the ZIP abundance model is useful for estimating breeding Bobolink densities and overall population abundance, it requires intensive field work to collect the data, and is impractical to repeat annually. Therefore, the BBS trends are better suited for providing estimates that can be used for long-term population assessment.

When compared with BBS results, Bobolink population estimates from the ZIP model are considerably larger (2.8M vs 22.1M). This discrepancy may be because BBS routes are located along roads, which are avoided by Bobolinks (see Chapter 1 threats). Further, BBS data are coarse in scale, and use relative abundance as an index to populations instead of absolute abundance. However, the approximately eight-fold difference in population estimates is unlikely to stem solely from these causes, and potentially originates from model processing and landcover data issues. For example, lands that are not suitable breeding habitat may be classified as suitable and would result in inflated bird population estimates. Regardless of these discrepancies, the ZIP model illustrates a means to assess the feasibility of achieving the Bobolink population trend objectives in the PPJV.

Achieving a Stable Bobolink Population in the PPJV. The PPJV used the ZIP abundance model to estimate breeding Bobolink densities and assess the feasibility of the trend-based regional objective for the U.S. portion of BCR 11, an area which approximates the PPJV administrative area. Using the Bobolink Population Objectives Tool developed for the Bobolink Conservation Plan, the long-term population decline of -0.11% in the PPJV would be reduced to 0 (i.e., stable population) over 10 years to achieve the Plan goal. This would equate to a +0.01% annual change in the population decline for each of the first 10 years. Using the population estimate from the ZIP abundance model, in year-one of enacting conservation measures, a -0.10% change in the population results in 2,433 fewer birds lost compared to the current rate of -0.11% (Table 2–3). A total of 21,900 Bobolinks would be removed from the population to achieve a population trend of -0.10% after the first year. At the end of 10 years, 109,267 Bobolinks would have been lost in reaching a stable population trend compared to 242,131 with the BBS long-term population decline estimate of -0.11%.

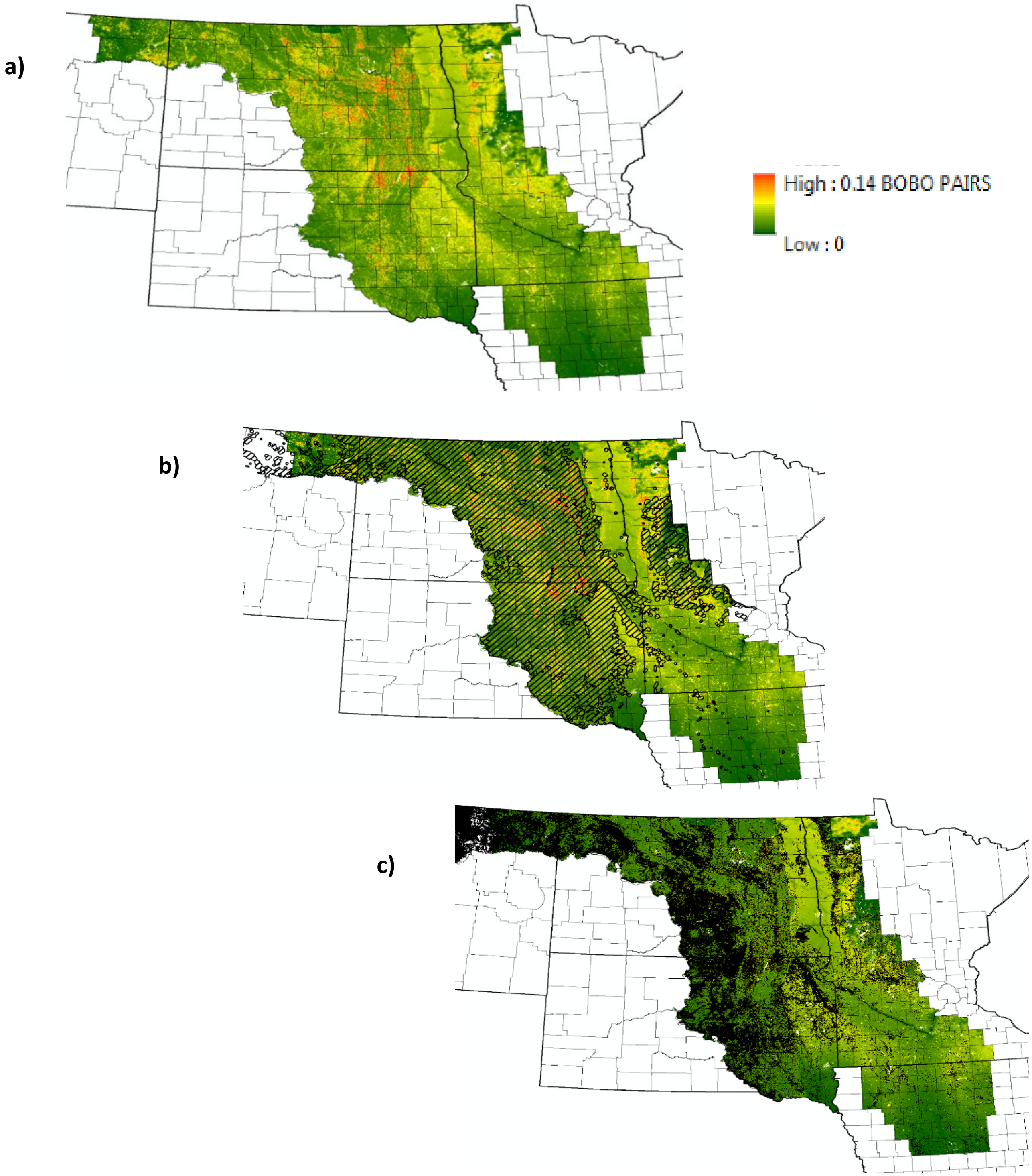


Figure 2– 7. *Modeled Bobolink abundance (a) in the Prairie Pothole Joint Venture (PPJV) region based on a zero-inflated Poisson regression model developed by Drum et al. (2015*a*), overlaid with (b) upland priority areas for breeding waterfowl habitat protection (shown in black cross hatching) and (c) Type 3 Grassland Bird Conservation Areas (≥ 55 acres ≥ ¼ mile wide, matrix and core are ≥ 20% grassland), shown in black.*

TABLE 2– 3. *Grassland habitat conservation needed to achieve the 10-year Bobolink population trend in the PPJV assuming an equal reduction in trend loss over 10 years to achieve a stable population trend. Population estimates and Bobolink densities in grassland were derived from the zero-inflated poisson model developed by Drum et al. (2015a). Current grassland loss rates were estimated by Claassen et al. (2017); value of .20% loss from original 2016 submitted version of manuscript).*

	Continued Loss at Current Rates			Proposed Dampened Loss Rates			Net Losses (Current - Dampened Loss Rates) Under BOBO Plan Objectives		Current Grass Loss Rates		
Year	Population	Constant Trend	Loss (birds)	Population (Dampened Trend)	Dampened Trend	Dampened Loss (birds)	Net Gain (birds)	Acres Required	PPJV Grass (acres)**	PPJV Grass Loss Rate	PPJV Grass Lost (acres)
0	22,121,097			22,121,097					25,541,545		
1	22,096,764	-0.11%	24,333	22,099,197	-0.10%	21,900	2,433	7,157	25,490,462	-0.20%	51,083
2	22,072,457	-0.11%	24,306	22,079,750	-0.09%	19,447	4,859	14,292	25,439,481	-0.20%	50,981
3	22,048,178	-0.11%	24,280	22,062,748	-0.08%	17,001	7,278	21,407	25,388,602	-0.20%	50,879
4	22,023,925	-0.11%	24,253	22,048,187	-0.07%	14,561	9,692	28,505	25,337,825	-0.20%	50,777
5	21,999,698	-0.11%	24,226	22,036,060	-0.06%	12,127	12,100	35,588	25,287,149	-0.20%	50,676
6	21,975,499	-0.11%	24,200	22,026,365	-0.04%	9,696	14,504	42,658	25,236,575	-0.20%	50,574
7	21,951,326	-0.11%	24,173	22,019,096	-0.03%	7,269	16,904	49,719	25,186,102	-0.20%	50,473
8	21,927,179	-0.11%	24,146	22,014,252	-0.02%	4,844	19,302	56,771	25,135,730	-0.20%	50,372
9	21,903,059	-0.11%	24,120	22,011,830	-0.01%	2,422	21,698	63,819	25,085,458	-0.20%	50,271
10	21,878,966	-0.11%	24,093	22,011,830	0.00%	-	24,093	70,863	25,035,287	-0.20%	50,171
TOTALS			**242,131**			**109,267**	**132,864**	**390,777**			**506,258**

** does not include most of Montana not covered by the BOBO abundance model

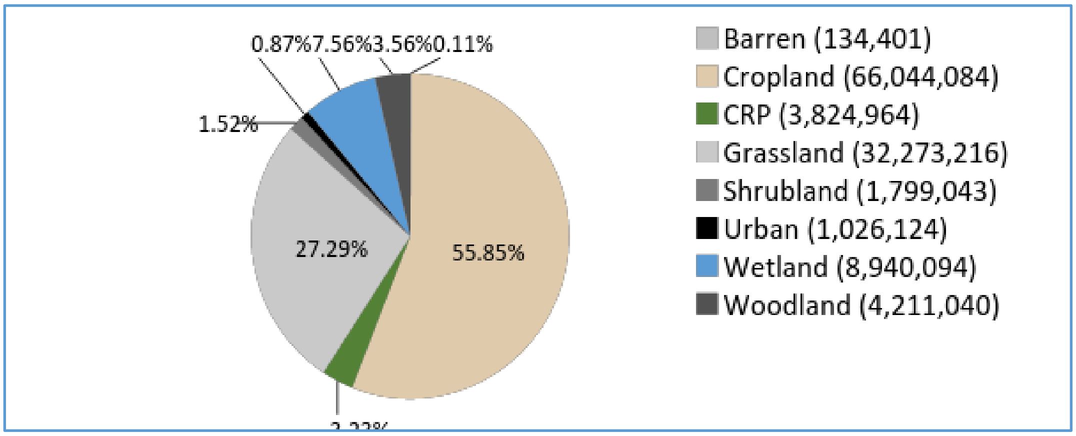


Figure 2– 8. *2015 PPJV Land cover composition.*

To assess the feasibility of achieving this population objective, current U.S. landcover data (circa 2015; Figure 2–8) was analyzed with the ZIP model to estimate breeding Bobolink densities in each landcover class. A breeding Bobolink density of 0.34 per acre of habitat was estimated from the point-count data for the combined landcover classes of grass, CRP, and hay. Using this density estimate, approximately 390,000 acres (160,000 ha) of optimal Bobolink habitat would need to be conserved over the course of 10 years to achieve a stable breeding population in the U.S. PPR.

Comparing these perpetual protection objectives with projected loss rates provides insight to the feasibility of achieving a stable Bobolink population. Stephens et al. (2008) estimated 0.4% of grasslands were lost annually in the Missouri Coteau region of North Dakota and South Dakota during 1989–2003. Claassen et al. (2017) provided an updated loss rate estimate of 0.28% annually for native prairie in the North Dakota and South Dakota PPJV from 1998-2010. In subsequent calculations, we use the value from the first 2016 submitted version of Claassen et al. (2017): 0.2% annual loss. At this rate, an estimated net loss of approximately 500,000 acres (202,000 ha) of native grasslands over the next 10 years would occur in the geographic area covered by the ZIP model (excluding most of the Montana PPJV).

The USFWS has secured a program whereby approximately 75,000 acres (30,000 ha) of grassland can be perpetually protected annually through grassland easements, acquired primarily for breeding waterfowl conservation. Over the next 10 years, these easements are slated to protect approximately 750,000 acres (300,000 ha) of grassland and wetland habitat, and they can be leveraged to protect optimal grassland bird habitat where it coincides with optimal waterfowl habitat. But not all grassland is equally suitable for Bobolink, and currently only 6% of the modeled Bobolink populations are on perpetually protected lands in the PPJV.

Strategic habitat conservation – protecting those lands that provide quality habitat for the species of interest – is critical to successfully meet Bobolink population objectives in the PPJV and elsewhere. Because protected lands generally have not been occupied by Bobolinks, they have so far contributed little to conserving populations. If protected areas continue to occur on the same lands as in the past, the USFWS program would do little to compensate for the

500,000 acres (202,000 ha) estimated to be lost over the next 10 years. However, strategically allocating where losses and protection occur can make Bobolink population objectives feasible.

The grasslands lost to conversion could be allowed to occur where Bobolink abundance is lowest, to minimize the number of birds lost. The ZIP model can be used to model this scenario. First, all perpetually protected lands are removed from the model and abundance is evaluated only for grass/hay/CRP lands. Then we assume that only grassland habitat that supports low Bobolink numbers would be lost over the next 10 years. The result is that the loss of an estimated 4.8 million acres (1.9 million ha) of unprotected grassland with very low Bobolink abundance will result in a loss of 260,000 pairs (520,000 birds). Meanwhile, the 750,000 protected acres (300,000 ha) would be allowed for areas with the highest quality Bobolink habitat. To reach a stable Bobolink population in the PPJV, a loss of 109,267 birds is still allowed over the next 10 years as we work from a negative population trend towards a zero (stable) trend. If those allowed losses occur in some of the poorest Bobolink habitat, the population objective becomes a realistic possibility. However, this requires changing the conservation strategy.

Meeting the Challenge. In the PPJV, considerable resources are invested in waterfowl habitat conservation, and thoughtful targeting of integrated conservation has been shown to greatly benefit other priority species. Overlays of the current conservation targeting tools for waterfowl conservation (Figure 2–7b) and GBCAs (Figure 2–7c) show a high level of overlap with high density areas identified by the Bobolink ZIP model. Waterfowl priority areas, which cover 51.3 million acres (20.7 million ha), include approximately 60% of the breeding Bobolink population; and GBCAs, which cover 20.5 million acres (8.3 million ha), include approximately 40% of the Bobolink population. The potential exists to improve conservation targeting to help bridge the gap between projected conservation gains and losses. By incorporating a rigorous risk assessment in the current prioritization framework to protect habitat that would have been otherwise converted to other uses in the absence of an easement, PPJV partners will greatly increase the efficiency in conserving the best habitat for priority species. These efforts are currently underway in the PPJV.

The trend-based Bobolink Population Objectives tool and general guidance from the Bobolink Conservation Plan may appear oversimplified considering the uncertainty associated with achieving desired biological outcomes from conservation actions. Several gross assumptions are also inherent in this analysis, including the basic assumption that habitat losses on the breeding grounds are the primary driver of population declines. However, translating Bobolink trend-based population objectives to habitat conservation targets is a valuable exercise to assess the feasibility of such an approach considering current and projected conservation gains and losses.

Under current conservation strategy and constraints, such as willing easement sellers and funding limitations, maintaining and or restoring the habitat needed to achieve a stable Bobolink population in 10 years is not logistically feasible in the PPJV. Further, estimated native prairie loss rates do not account for the reduction in CRP land cover in the PPJV. However, if the best Bobolink habitat is prioritized for protection and degraded habitats are strategically targeted for restoration and enhancement, PPJV conservation gains could feasibly conserve enough optimal Bobolink habitat to accomplish the 10-year trend objective. Alternatively, a dedicated funding source for Bobolink conservation, or an increased CRP acreage cap in the next Farm Bill that allows for more set-aside land in years of low commodity prices, would greatly increase the probability of achieving the population trend objectives.

Matching Population Objectives to Habitat Needs Across the Breeding Range

Other JVs differ from the PPJV in that they are often tasked with conserving grasslands, but cannot yet take the next step of attending to the quality of the grasslands for birds and other wildlife. Regardless, it is important to try to establish grassland habitat strategically to maximize the efficacy of any conservation effort in both the short and long term.

Conservation actions are included in this Plan that recommend other JVs receive support in adopting, when possible, an approach similar to the one above, using existing BBS data. In the U.S., USFWS will continue to work with JVs interested in evaluating and finalizing their regional population objectives, and adopting the BBS model to determine habitat needs. A next step to this approach is to link reproduction/fecundity and survival to the population objectives using population models. This will allow JVs to set ecologically-based population objectives.

Focus: The Breeding Grounds in The U.S. and Canada

Grassland habitat can be created within a short timeframe. As long as new habitat units are of sufficient size to meet species; habitat requirements, they are likely to attract one or more grassland bird species that regularly breed in the region. But despite the temporal expediency of establishing grassland habitat, a lack of coordination and successes at large scales, as well as fluctuating social capacity to allow grassland habitat to persist, have led to continued negative trends on the breeding grounds.

Where to Focus: The Bobolink Conservation Opportunity Map

To identify areas within the Bobolink's U.S. breeding range where conservation may be most effective—with both biological and social capacity to support grasslands for Bobolink—we assembled a team of grassland bird ecologists and spatial analysts representing government agencies and NGOs from California to New England. After several discussions of data availability and quality, we developed a set of Bobolink conservation opportunity models that incorporate ecological, land-use, and economic information summarized at the county scale. Each model is based on the proposition that opportunities to maintain and restore Bobolink habitat are greatest in counties that

1. contain relatively high Bobolink numbers;
2. feature large areas of grass, pasture, and hay;
3. contain sizable grassland reserves;
4. are likely to support Bobolinks in future climates;

5. face a relatively low risk of grassland conversion; and
6. contain less productive soils, which reduce the financial incentive to convert wildlife habitat to row crops.

TABLE 2– 4. *Model inputs, data sources, and layer weights for the six scale-dependent models of Bobolink conservation opportunity.*

Model Input	Data Source(s)	Layer weight by spatial and temporal scale					
		State	Regional	Range-wide	Short-term	Mid-term	Long-term
Bobolink relative abundance	North American Breeding Bird Survey (Sauer et al. 2017)	40%	40%	40%	40%	25%	15%
Area of grass (hay, pasture, and other hay/non-alfalfa) relative to other counties in the state	NASS Cropland Data Layer (CDL) 2014	15%	0%	0%	0%	0%	15%
Area of grass relative to other counties in the region	NASS Cropland Data Layer (CDL) 2014	0%	15%	0%	0%	0%	0%
Area of grass relative to others in the US Bobolink breeding range	NASS Cropland Data Layer (CDL) 2014	0%	0%	15%	10%	10%	15%
Area of protected grass	NASS Cropland Data Layer 2014, Protected Areas Database of the US 2014, National Conservation Easement Database 2012, and Conservation and Recreational Lands Database 2007	15%	15%	15%	10%	10%	0%
Future climate suitability	Schuetz et al. 2015	10%	10%	10%	0%	30%	40%
Risk of grassland loss	Radeloff et al. 2012	10%	10%	10%	25%	5%	5%
Soil productivity for commodity crops	National Commodity Crop Productivity Index (2012)	10%	10%	10%	15%	20%	25%

For each of these attributes we compiled county-level estimates (Table 2–4) and adapted a ranking approach developed for Monarch Butterfly conservation planning (Rohweder and

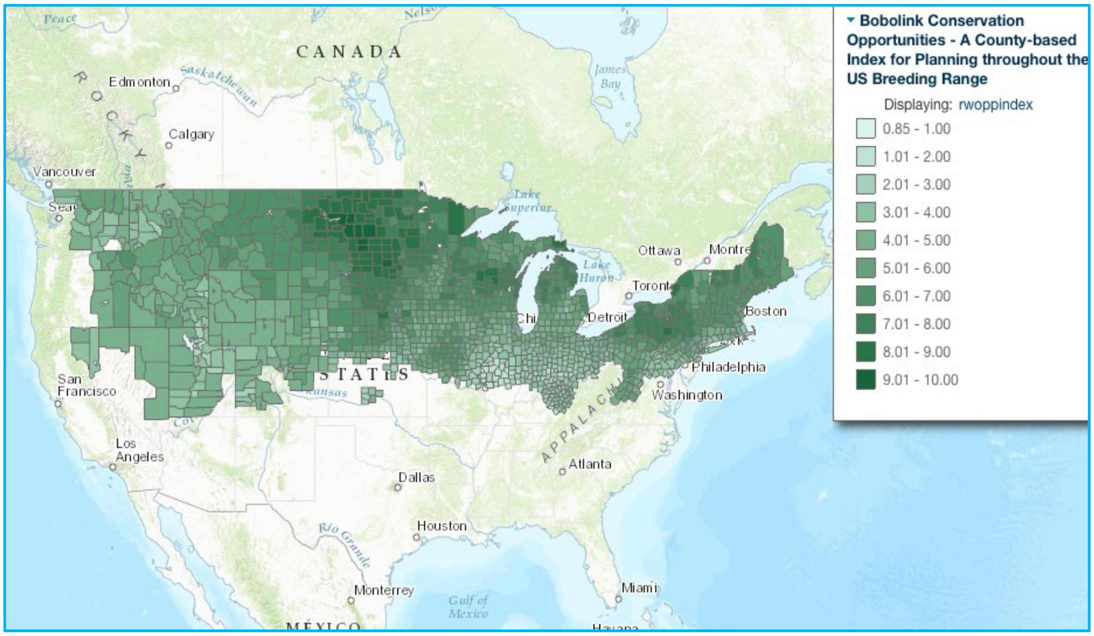
Thogmartin 2016). This involved scoring all counties overlapped by the Bobolink breeding range on a scale of 1 to 10 for each of the attributes (or layers). Scores were based on each county's decile rank relative to other counties, with 1 representing the lowest value/highest risk to Bobolinks and 10 representing the highest value/lowest risk. For example, the 10% of counties with the lowest estimates of Bobolink abundance received a score of 1 for that layer, while the 10% of counties with the highest abundance estimates received a score of 10.

Next, we performed weighted overlays of the county ranks (*i.e.*, six input layers) using different weighting schemes for three spatial scales (state, regional and range-wide) and three planning horizons (10-20 years, 20-100 years, and > 100 years). We also produced an average of the six scale-dependent models. All of the input data, weighting schemes, and model results are available for visualization and download through The Conservation Planning Atlas for Midwest Grasslands, which is hosted at Data Basin by the Midwest Grasslands Network (see also Appendix B). Filters and other exploratory tools at this site enable users to customize maps to meet program-specific needs. A video orientation to The Atlas, including the Bobolink conservation opportunity maps is also available. These interactive maps provide regional and national planners a means to evaluate where Bobolink conservation in the U.S. may be most fruitful at a coarse scale, and county-level planners a means to determine at what level their county contributes to the larger conservation landscape.

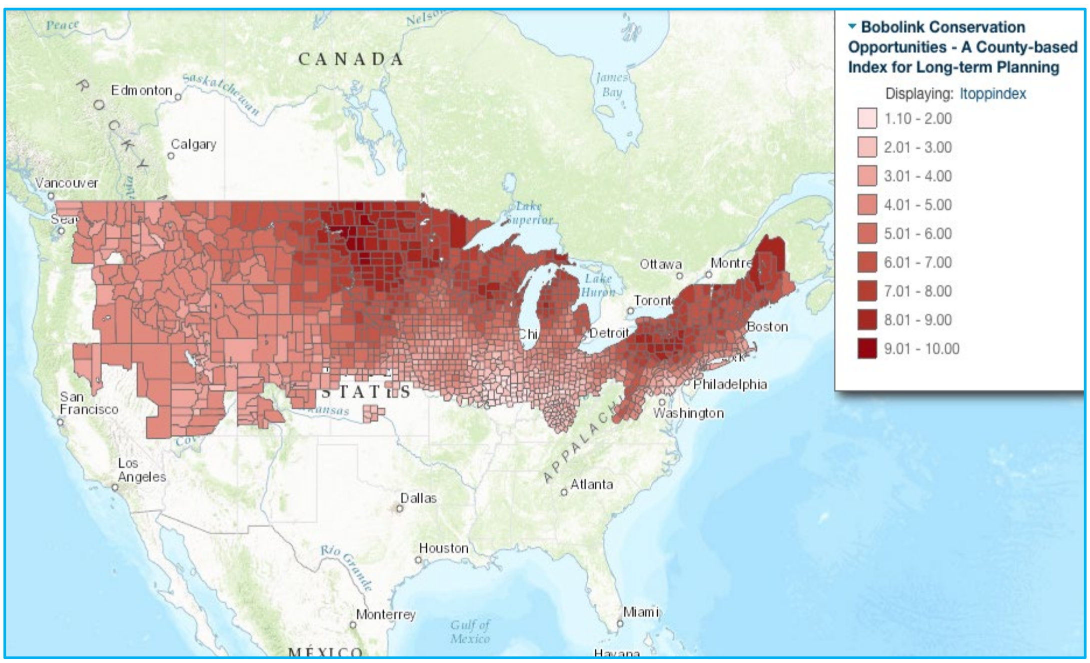
Opportunities for range-wide and long-term conservation planning are shown in Figures 2–9a and 2–9b, respectively. Figure 2–9c displays counties that scored high in both present and long-term Bobolink conservation, and Figure 2–9d shows the average of all six conservation opportunity models (state, regional, U.S. range, short-term, mid-term, and long-term). Although close examination reveals subtle differences among these outputs, four county clusters consistently surface as high priorities for Bobolink conservation:

1. North and South Dakota, encompassing eastern portions of the Northern Great Plains and Prairie Pothole Joint Venture regions;
2. the transition zone between the corn belt and northern forest, stretching from northern Minnesota to west-central Michigan and occurring within the Upper Mississippi Great Lakes Joint Venture region;
3. the broad, northern Allegheny Plateau, which spans the New York–Pennsylvania border and lies primarily in the Appalachian Mountain Joint Venture region; and
4. a discontinuous band of counties scattered along the northern edge of the Atlantic Coast Joint Venture region, extending from the eastern Great Lakes lowlands to agricultural areas of northern New England.

The models provide a consistent foundation of information that can be applied across the entire range of the Bobolink. Recognizing model limitations from underlying assumptions and the quality of available data, these maps provide a starting point for future discussions of appropriate weighting schemes and scenarios. The Opportunity Maps represent a step toward

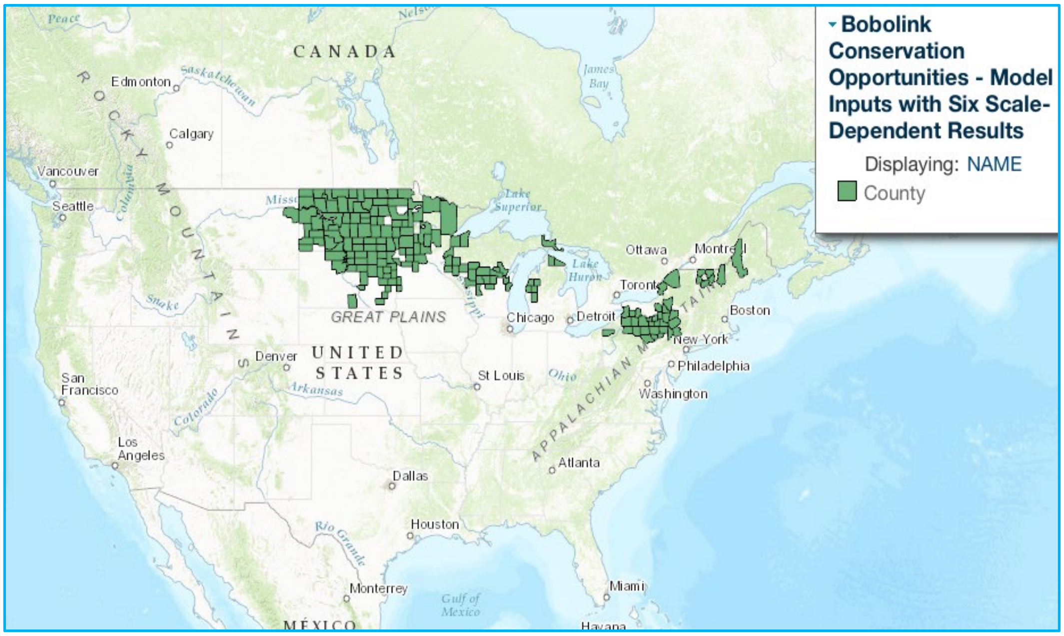


a) *A county-based index of Bobolink conservation opportunities designed to guide grassland maintenance and restoration initiatives throughout the U.S. breeding range.*

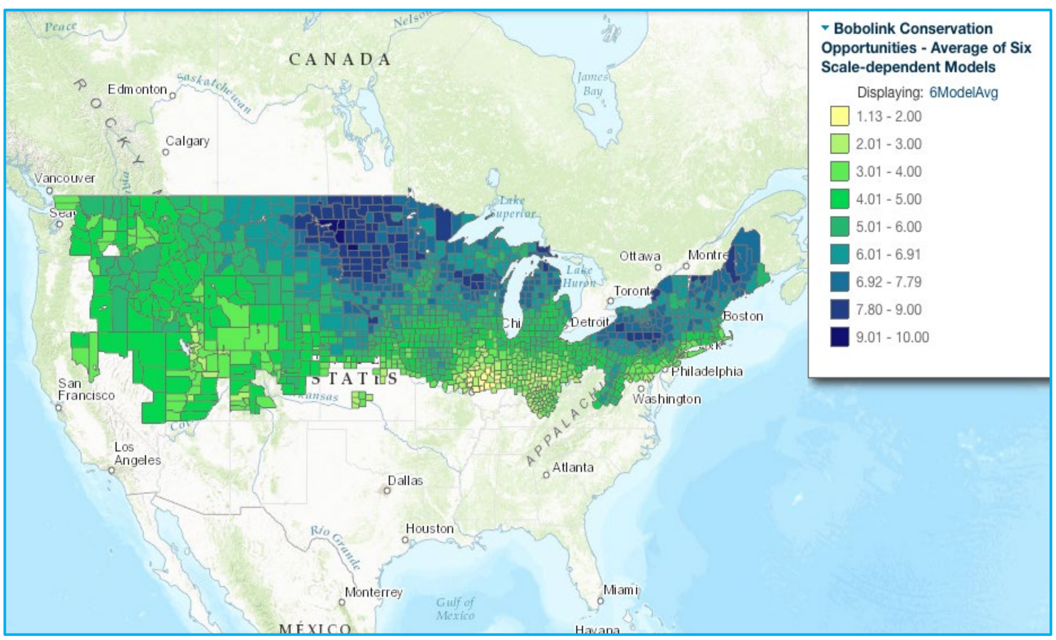


b) *A county-based index of Bobolink conservation opportunities designed to support long-term planning of grassland maintenance and restoration initiatives that are likely to benefit the species as climate conditions change beyond the next 100 years.*

Figure 2– 9. *Maps depicting levels of conservation opportunities for Bobolink in the U.S. across its breeding range based on a compilation of some characteristics that influence conservation feasibility and efficacy.*



c) *Counties exhibiting high potential for both present and long-term Bobolink conservation (range-wide and long-term indices of conservation opportunity > 7*)



d) *Average of the six Bobolink conservation opportunity models, developed to support work at three spatial scales (state, regional and range-wide) and three planning horizons (10-20 years, 20-100 years, and > 100 years).*

Figure 2–9 (cont.). *Maps depicting levels of conservation opportunities for Bobolink in the U.S. across its breeding range based on a compilation of some characteristics that influence conservation feasibility and efficacy.*

comprehensive spatial assessments that include crop practices and expansion, similar to an exercise carried out for Sage Grouse (Smith et al. 2016). For Bobolink, these models might also include demographic-based predictions under climate change currently being developed.

In Canada, the Ontario Recovery Strategy for Bobolink and Eastern Meadowlark (McCracken et al. 2013) suggests a modeling approach in order to determine where to focus conservation efforts. In addition, the CEC North American Grassland Priority Conservation Areas (Pool and Panjabi 2011) establishes grassland bird conservation focal areas for the Great Plains in both countries.

It is highly likely that changes in agricultural practices and their effects on Bobolink habitat use and breeding success will also be spatially context-dependent as well. For example, agricultural extensification measures (i.e., decrease in intensified practices) may be most effective if directed towards regions with intermediate levels of landscape complexity (Concepcíon et al. 2012) and away from forested landscapes (Wretenberg et al. 2010).

Co-occurring Bird Species Likely to Benefit from Bobolink Conservation

As a focal species, Bobolink represents a suite of grassland species and habitats, and inherent in this approach is implementation of multi-species conservation strategies. Consequently, the Plan identifies other bird species that overlap spatially in terms of geographical range and habitat. The focal species approach provides a framework for strengthening coordination at many scales among programs and initiatives. In so doing, it strengthens the case for conserving Bobolinks as a means to conserve an entire ecological system.

Figure 2–10 shows the grassland bird species that co-occur with Bobolink on the breeding grounds and that stand to benefit through efforts undertaken for Bobolink. Grassland birds have evolved to select for finer-scale habitat characteristics within their larger, landscape-scale preferences. The height and density of the grass, the cover and thickness of dead grass (litter layer) versus bare ground beneath the live vegetation, and the proportion of the vegetation composed of other flowering herbaceous plants (forbs) are among the structural and compositional characteristics that are selected for by each species. Within mixed and tallgrass systems, Bobolinks tend towards the generalist end of the grassland bird suite - one reason they serve well as a focal species. Their preferences overlap with those of some grassland bird species more than others, based on the natural variation in the vegetation structure and a management-induced continuum.

The prairie in which Bobolinks and other grassland birds evolved is a dynamic system. Heterogeneity in vegetation structure produced by a complex mix of ecosystem processes such as drought, flood, fire, and grazing provides diverse habitats and species. Conservation strategies therefore must also be aimed at providing a mosaic while recognizing that climatic and environmental conditions constantly, and perhaps increasingly, alter this mosaic. At a finer scale, the possible ways to manage and produce heterogeneous vegetation structure will depend in large part on where the management is occurring (drier western states versus the more mesic Midwest or eastern sites); there is no single prescription. In general, however,

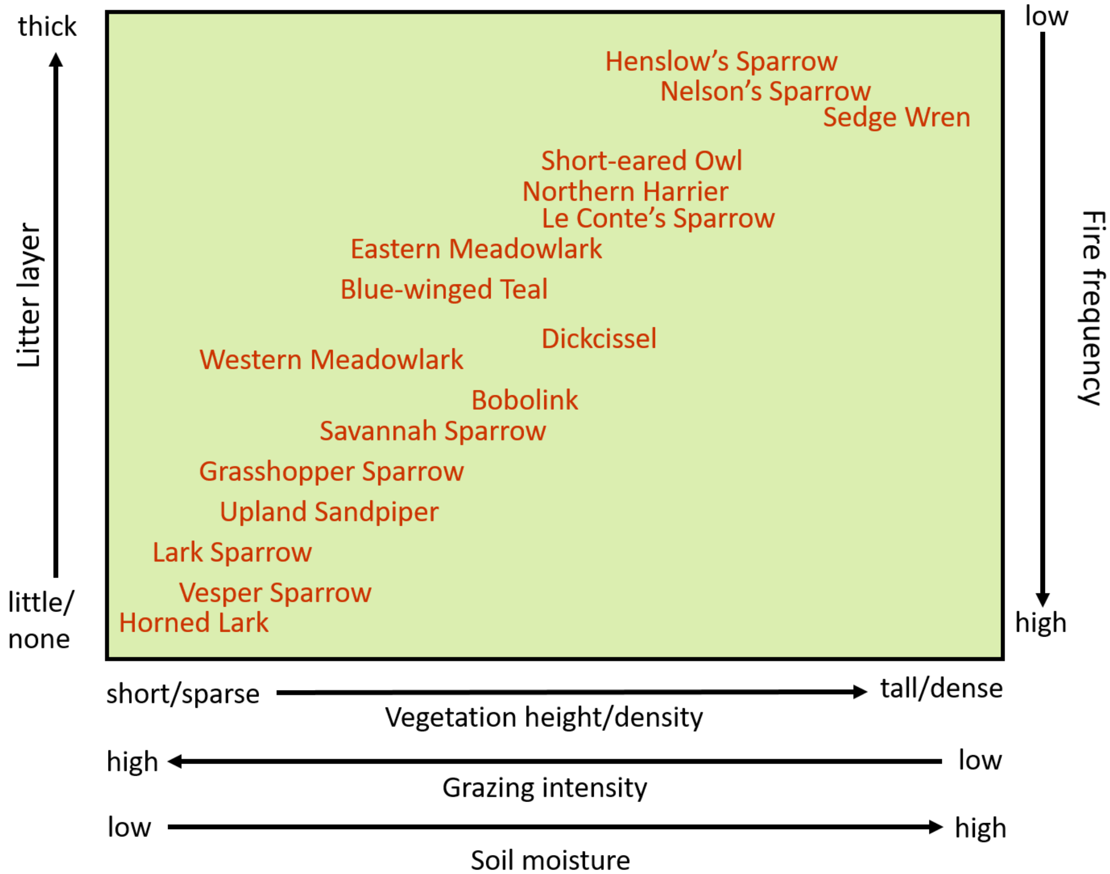


Figure 2– 10. *Species that co-occur with Bobolink during the breeding season, in relation to a continuum of vegetation characteristics found across the breeding range (shared with permission from D. Sample, WI Department of Natural Resources). Greater Prairie Chicken is not included in the diagram because it requires short, medium, and tall vegetation structure. Upland Sandpiper also requires taller structure for nesting and shorter vegetation for foraging with young.*

varying the management temporally and spatially in a way that provides a variety of habitat structures will result in greater bird species diversity.

Major themes that emerge from plans for species overlapping with Bobolinks (Appendix B) include:

1. Support incentives to maintain Conservation Reserve Program (CRP) in the U.S. and to manage CRP in ways that provide suitable habitat for grassland birds.
2. Support grazing to prevent ranchlands and pastures from being converted to other uses.
3. Modify BBS to better monitor grassland birds, especially where populations are small.
4. Manage public grasslands to maximize grassland bird habitat, and manage for a mosaic of various vegetation structures on large, open tracts of lands.
5. Forge non-traditional and international partnerships.

The Socioeconomic Context

Landowner demographics, values and economics are all important drivers of land use changes and thus the prevalence of grassland cover. For example, when landowners convert grasslands to cropland, among the most important drivers are crop prices, available technologies, and farm program payments (USGAO 2007). Given that the majority of grassland bird habitat is located on private lands, successful conservation efforts must address the complex socio-economic conditions that drive land-use decisions. Moreover, conservationists must understand the complex social-ecological context in which agroecosystem practices are implemented. To illustrate this complexity and provide a general framework to guide grassland conservation, Atwell et al. (2010) use a conceptual model (Figure 2–11) that incorporates innovation and local creativity, powerful partnerships and norms of reciprocity, landscape planning, and broad systems to generate ethical and market values.

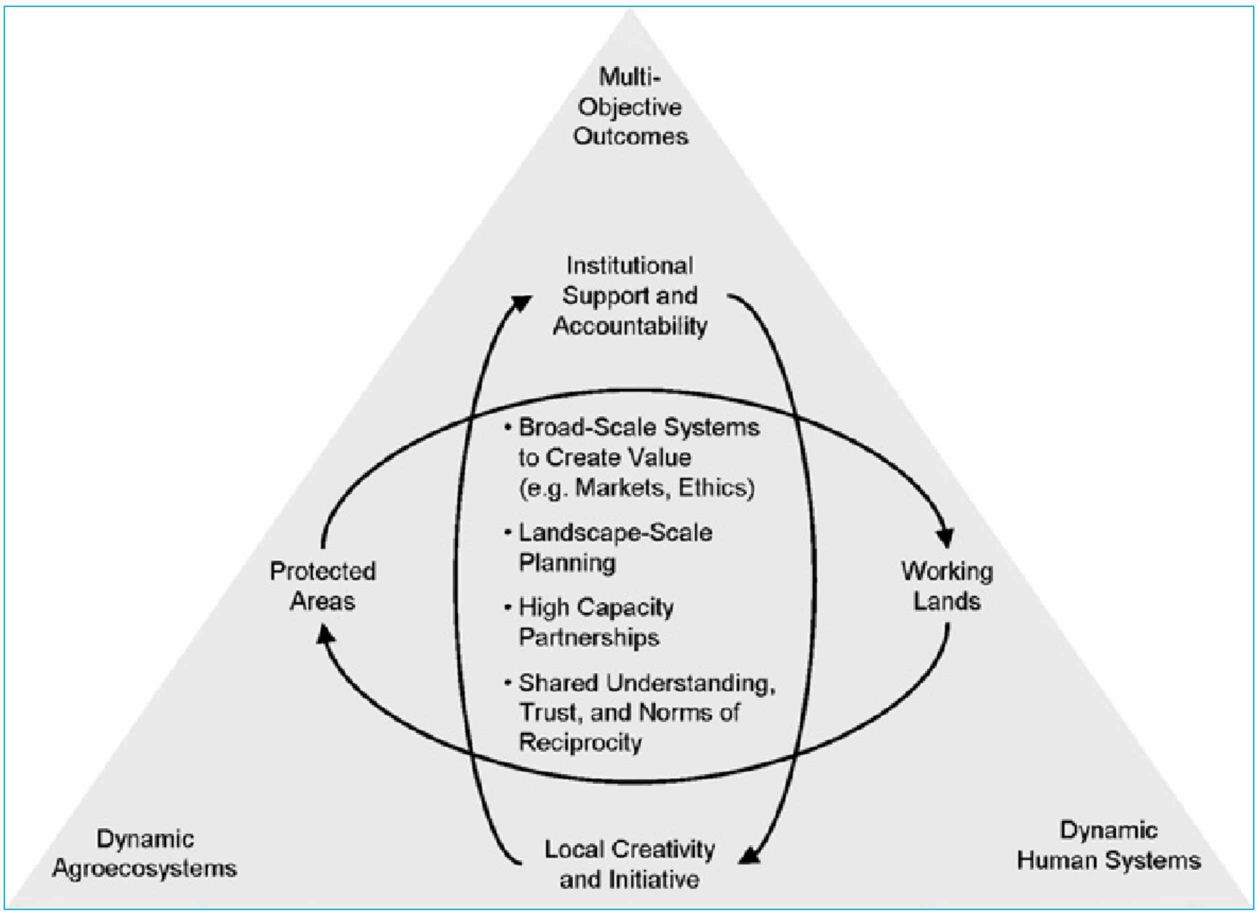


Figure 2– 11. *An example of the complex social-ecological context in which agroecosystem practices are implemented in the U.S.Corn Belt. From Atwell et al. (2010): "At the triangle's corners lie three themes highlighting aspects of this complexity emphasized by regional leaders…the arrows represent two bridges that must be built between or within themes to bolster long-term resilience of desired agroecosystem outcomes and the four center bullet points are focal strategies to build these bridges."*

While landowners may value conservation practices, the volatility of agricultural markets, including both commodity prices and land rental rates, makes farming an unpredictable business that presents barriers to committing to long-term conservation programs such as a 10- or 15-year CRP contract. Instead, farmers must constantly respond to market conditions with short-term adjustments.

Despite these barriers, participation in conservation programs can be fairly high. For example, nearly half of 127 farmers surveyed in a county in Indiana participated in U.S. Farm Bill conservation programs (Reimer and Prokopy 2014). Economically, adoption of conservation measures in crop production can be beneficial because of agricultural input cost savings and risk reduction caused by farming marginal lands. These measures can reduce reliance on fertilizer, pesticides, fuel, equipment, and/or labor and may increase crop resilience to droughts, floods, or pest outbreaks. Tying conservation practices to insurance rates may be sensible, given these reductions in risk associated with conservation measures (Mine et al. 2014).

Economics may not be the sole driver of landowner decision. Farmers may also be concerned with leaving a legacy and something valuable for future generations (R. Atwell, pers. comm.). Furthermore, conservation easements have been shown to benefit landowners indirectly through increased community involvement and networking (Horton et al. 2017).

Studies have evaluated farmers' willingness and behavioral tendencies to adopt new practices. It is important to reach innovative community leaders as they tend to strongly influence decisions of others (Prokopy et al. 2014). There are often adoption thresholds beyond which a new practice becomes widely implemented in the community. Therefore, communities with strong stewardship networks and demonstrated ability to carry out sustained conservation practices may have capacity to most impact conservation targets and serve as focal areas. Some research suggests that an ethical dialogue may be effective in conveying the importance of practicing environmental stewardship and maintaining the viability of rural communities (Atwell et al. 2010). Furthermore, farmers also respond to representatives of various agencies and professions differently, and the response can vary geographically (Prokopy et al. 2014).

Ultimately farmers need technical assistance specific to their operation in order to address their individual concerns (Prokopy et al. 2014). Although varied program offerings provide flexible participation terms, many programs involve complexity that can be time-consuming to navigate. In some cases, individual technical assistance is required that involves clearly identified on-farm financial and environmental benefits of a promoted practice with consideration for current practices.

In addition to many aforementioned social and economic complexities, grassland conservation must address climate change and its impact on not only grassland ecology, but also its effects on crop yields and subsequently food supplies and rural communities (Kennel et al. 2016). Models that include climate change complexities beyond biological conditions must be a part of future prioritization efforts for species such as Bobolink.

Given the myriad barriers facing grassland conservation, partnering with experts in fields such as sociology, economics, and agronomy is essential to grassland bird conservation and has fueled the formation of restructured and new institutions. For example, the Gund Institute is a relatively new multidisciplinary branch at the University of Vermont that is devoted to research spanning ecological, social, and economic systems to generate solutions to challenging conservation problems. Sources of funding related to this work include the USDA Agriculture Economics and Rural Communities (AERC) Program, which supports social science research related to sustainable agriculture and rural communities.

Social networks have been identified through research as important drivers for conservation practice adoption, and existing networks may be used to encourage practices that benefit Bobolinks. For example, the Environmental Defense Fund (EDF) Farmer Network has established relationships with farmers in piloting and implementing practices to reduce nutrient inputs. It may be valuable to explore such networks as means to trial and promote practices that benefit grassland birds. Existing networks devoted to bird conservation will also benefit from integration of social sciences. For example, a committee devoted to human dimensions has been established within the North American Bird Conservation Initiative, and a social science coordinator has been added to its staff.

Focus: Migration and Wintering Grounds

If the focus of grassland bird conservation was solely to benefit Bobolinks, it would be difficult to determine how much effort to invest outside of the breeding season, given the uncertainty about whether non-breeding survival is limiting populations. However, known threats exist even if their scope and severity are not well understood. Addressing threats to Bobolink in South America will benefit other resident and migratory bird species, some of which are critically imperiled and all of which are important to conservation of grasslands. Meanwhile, investigating seasonal survival and the nature and degree of known and potential threats to Bobolink populations during the non-breeding season is necessary if we are to determine where and when bottlenecks that are limiting their populations occur, and therefore where conservation efforts will be effective.

Where to Focus

For the migration and wintering grounds, the kinds of data needed to develop Bobolink conservation opportunity maps were not available. Therefore, in this section we describe what is known about Bobolink distribution during the nonbreeding season, and use geolocator data to identify focal areas based on where Bobolinks make multi-week stops lasting three weeks to four months (R. Renfrew, unpubl. data, and N. Perlut, unpubl. data, unless otherwise noted).

The southbound migration of the Bobolink is complex and geographically broad (Figure 2–12a). Conservation of this species will require a network of coordinated conservation action involving several countries, similar to (or adjoining) what has been used for migratory shorebirds in the Americas (Lanctot 2006, Winn et al. 2013). Areas important during migration are still being

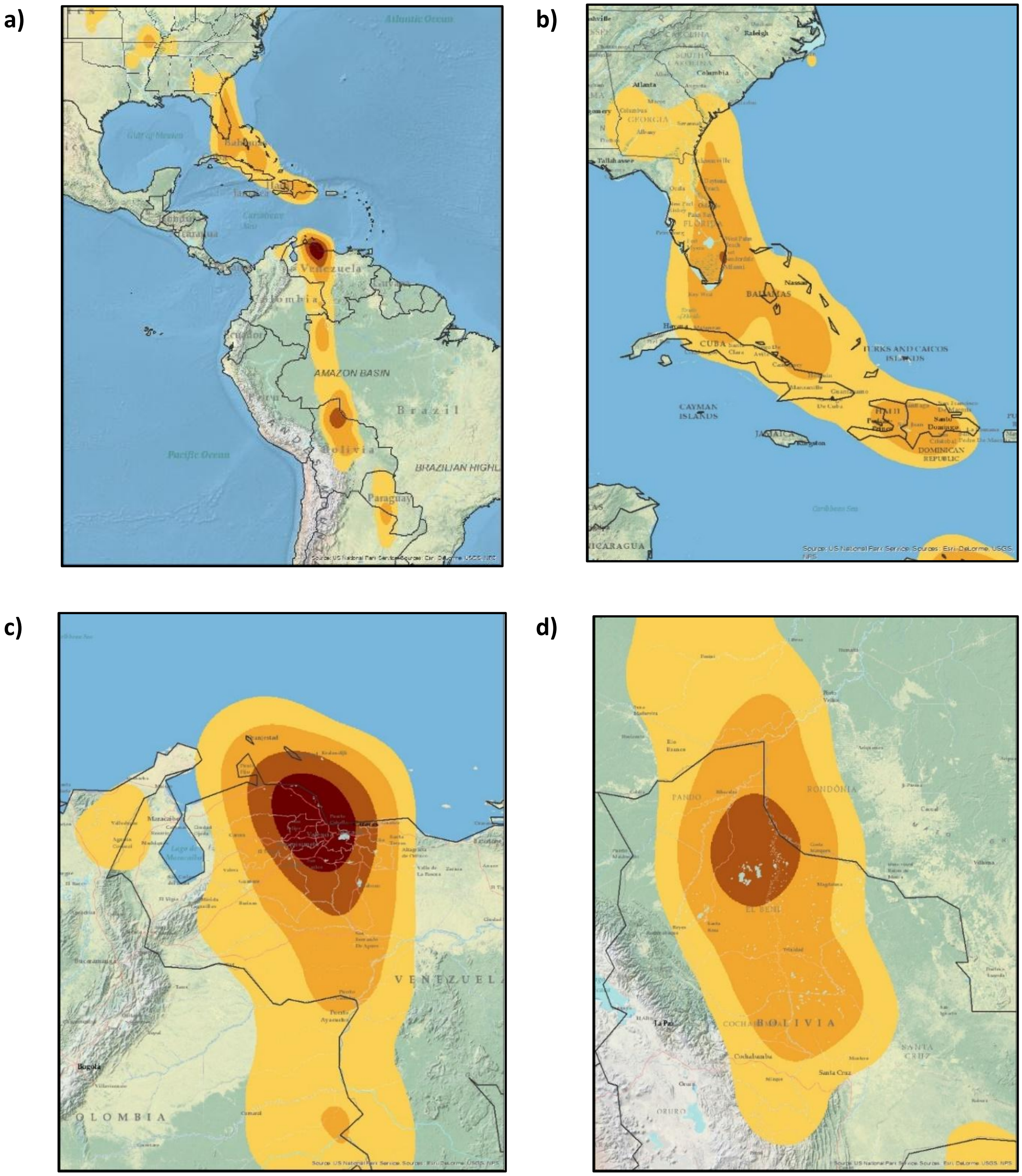


Figure 2– 12. *Areas most used by Bobolinks during (a) southbound migration (Sept – Dec) in (b) Florida and the Caribbean (Bermuda also used, but not shown), (c) the Caribbean coast and the Llanos in Venezuela and Colombia, and (d) Bolivia, based on data from 20 geolocators from across the breeding range (Renfrew et al. 2013). Darker areas represent greater number of bird days; lighter areas represent shorter stops and/or fewer birds.*

discovered, and research is needed to understand basic Bobolink ecology such as habitat use and diet. More is known about its ecology and potential threats to populations on the wintering grounds.

The geolocator data indicate that the southbound migration routes of most Bobolinks converge in Florida and the Caribbean islands (Figure 2–12b). There is little known about the resources they exploit in this region, nor any contemporary, documented threats. Bermuda also appears to be important for some individuals from northeastern breeding populations. Given these birds fly at least 1,000 km to reach Bermuda, and must fly another 1,300 km to reach landfall again, the presence of adequate food resources at this stop are likely important.

One of the most prominent features of the Bobolink's southbound migration is its long stop in the Llanos grasslands (Figure 2–12c). Shared by Colombia and Venezuela, the Llanos is populated by nearly the entire global population of Bobolinks during both fall and spring migrations. In fall, the eastern part of the Llanos in western Venezuela appears to comprise the core of the Bobolink's distribution, where birds remain for three to six weeks before crossing the Amazon Basin to Bolivia and beyond. The western part of Colombia, also part of the Llanos, is also used to a lesser extent. This extended pause in southbound movements falls outside the definition of a *stopover*, a term generally used for shorter duration stops to replenish fat stores. Despite the apparent importance of this area where the global population of Bobolinks descends in October and early November, little is known about habitat use, diet, and potential threats. Conservation actions in this region need to focus on research to determine the basic ecology of the species during this stop, and to assess potential threats.

A third bottleneck in Bobolink southbound movements occurs in northeastern Bolivia (Figure 2–12d). Geolocator data suggest that nearly the entire global population passes through this region. Although a few individuals remain in eastern Bolivia for the winter, those headed further south do not stop for weeks, as they do in the Llanos (Renfrew et al. 2013). This region in Bolivia hosts expansive, remote savannas with cattle widely dispersed across the landscape. Much of this region is burned by uncontrolled fires each year, mostly between August and October (Asociación Armonía 2011). Whether this phenomenon affects seed availability for Bobolinks passing through in November and December is unknown.

The wintering range of the Bobolink extends from southwestern Brazil to the Santa Fe province of Argentina (Figure 2–13). Geolocator data remain limited, and some locations are based on data from only one or two individuals. It appears that the majority of Bobolinks winter in a few provinces in northeastern Argentina (Di Giacomo et al. 2005), although there are substantial numbers that winter in Bolivia (Renfrew and Saavedra 2007) and records of smaller flocks throughout the winter in Paraguay (R. Renfrew, unpubl data). Conservation actions for these regions focus on rice production, where there appears to be the greatest potential for immediate, deleterious effects from pesticide use. Other conservation actions for the wintering region address threats that result in the loss of native grassland habitat that deepen Bobolink dependence on crops for food and reduce habitat for resident grassland birds, many of which are declining or already imperiled.

The geolocator data indicate that the northbound migration of Bobolinks generally follows the same routes as the southbound migration (Figure 2–14), with the exception of the Llanos region. During northbound migration, Bobolinks appear to concentrate further west in the Llanos, along the Colombia/Venezuela border. Conservation strategies are likely to differ in each country due to the very different and changing social, economic, and political contexts. Although geolocators do not show Cuba as an important stopover country during northbound migration, trapping of tens of thousands of Bobolinks is known to occur there during April and May.

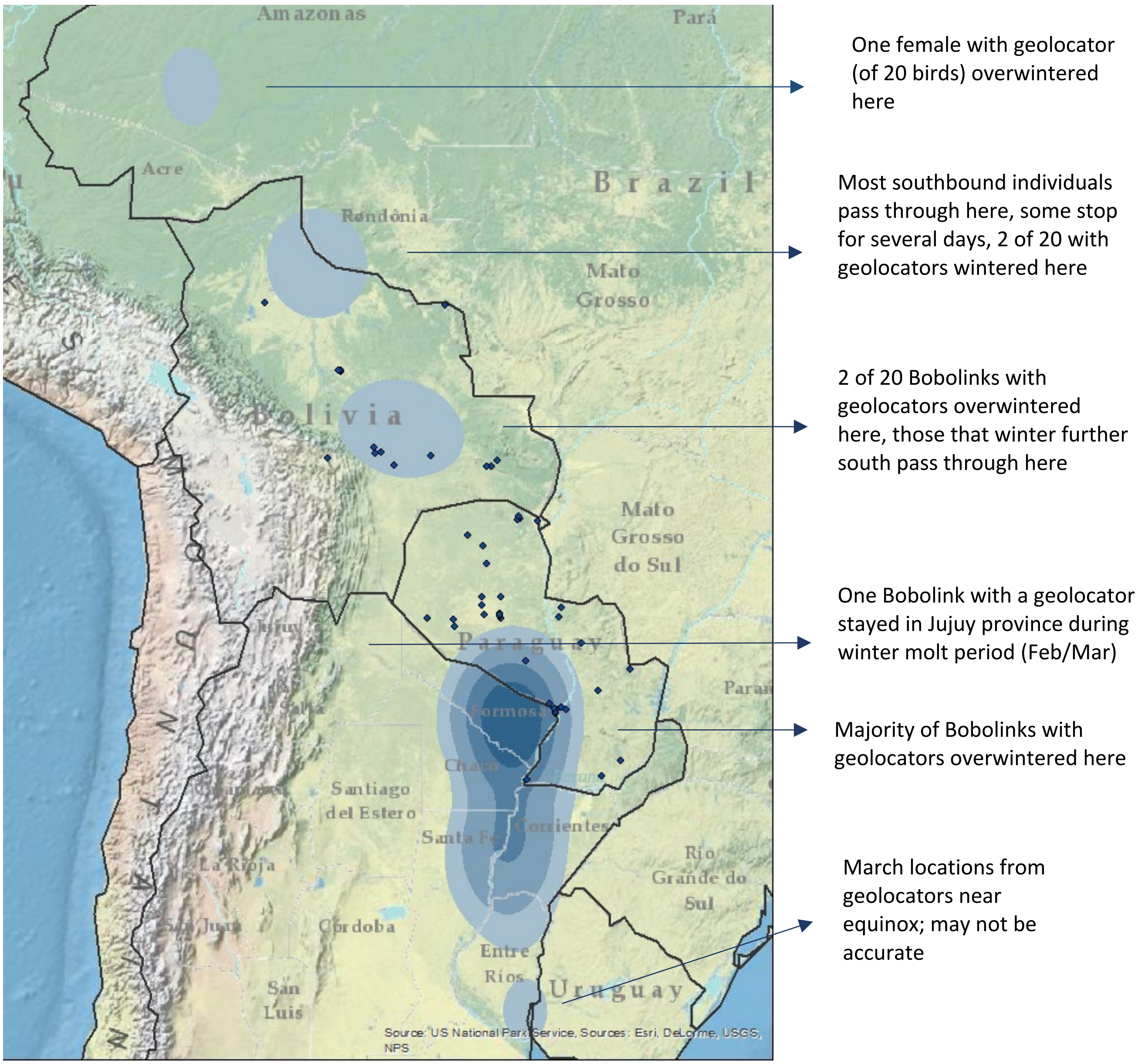


Figure 2– 13. *Bobolink winter distribution in South America based on geolocator results (blue kernel density estimates) and observations in December–March, 1975–2007 (points) for Bolivia and Paraguay (R. Renfrew and Guyra Paraguay, unpubl. data). Argentina observations presented in DiGiacomo et al. (2003) correspond with geolocator data.*

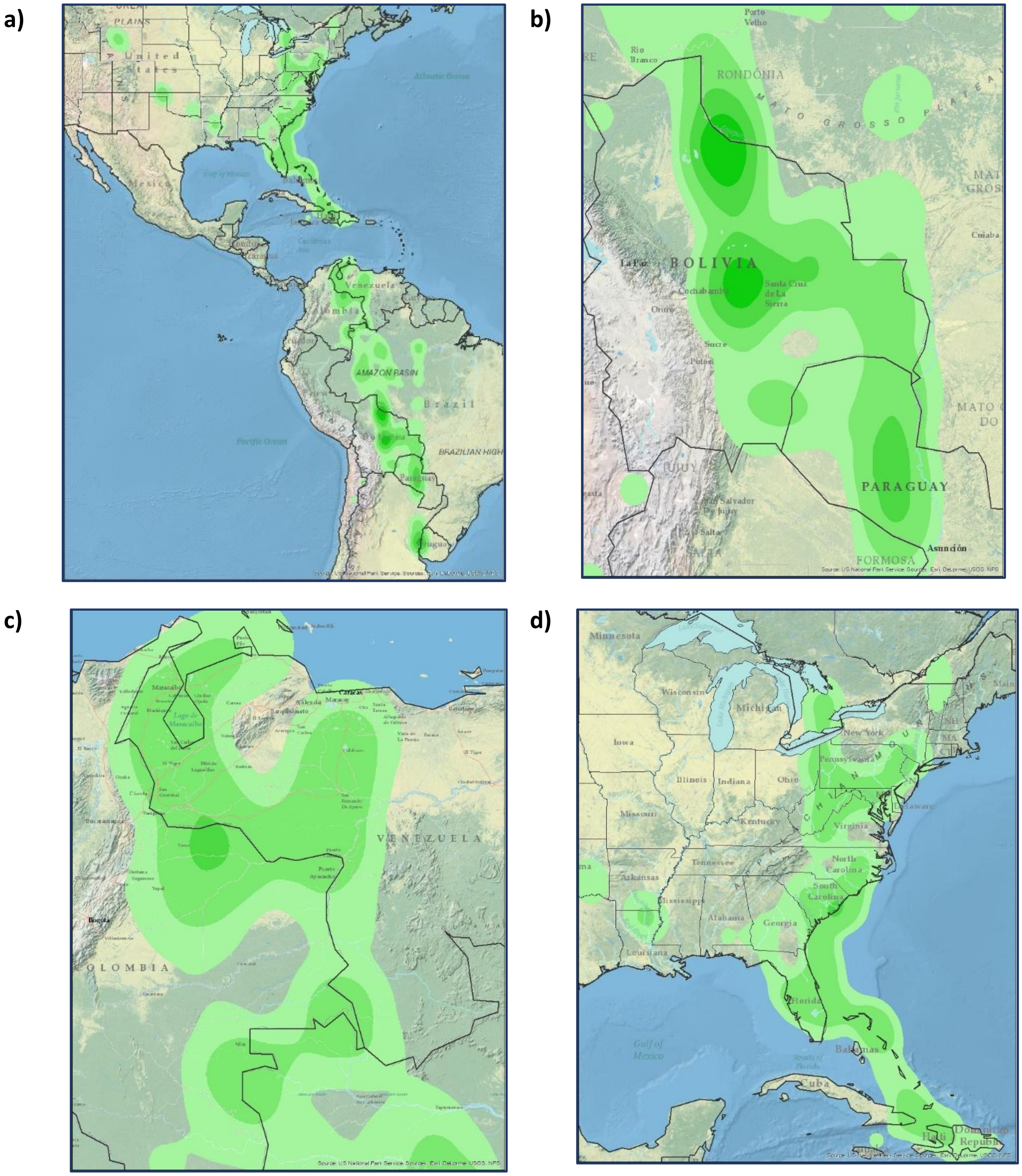


Figure 2– 14. *Areas most used by Bobolinks during (a) northbound migration (April - May) in (b) Bolivia and Paraguay, (c) the Llanos in Venezuela and Colombia, and (d) the Caribbean and eastern Appalachians, based on data from seven geolocators (Renfrew et al. 2013). Darker areas represent greater number of bird days; lighter areas represent shorter stops and/or fewer birds.*

The Orinoco savannas, also known as the Llanos region, is the second largest savanna ecosystem in South America, after the Cerrado of Brazil (Bibby et al. 1992, Mittermeier et al. 1998). They are the northern component of the 2.6 million km^2 of South American savannas. They lie east of the Andes across eastern Colombia and southern Venezuela in the Orinoco watershed, a 450,000 km^2 tract all below 250m altitude (Etter et al. 2010). Wetlands in the Llanos are concentrated in southwest Venezuela and eastern Colombia and cover an estimated 107,000 km^2, making the Llanos the second largest wetland complex in South America, after the Brazilian Pantanal (Hamilton et al. 2002).

Precipitation in the Llanos is highly seasonal (May–Sep), with 23% of the floodplain susceptible to seasonal flooding at maximum inundation. In contrast, only 2,080 km^2 of open water remain during the dry season (Nov–Mar), principally in rivers and lakes (Hamilton et al. 2002). The savannas of the Llanos belong to the Pedobiomes (Armenteras et al. 2005), with azonal vegetation and extreme soil types that play a more important role than climate conditions in vegetation composition. The forests and savannas support various communities such as the arboreus savannas, flooded and seasonally flooded savannas, dune savannas, high plain savannas, sandy savannas, gallery forests, palm forests (*Mauritia flexuosa*) and swamp vegetation (Romero et al., 2004). The predominant vegetation is composed of C4 grass especially from the Poaceae and Cyperaceae families, in association with some dispersed woody plants.

The Caribbean coast of Colombia extends 1,700 km from the Gulf of Urabá to the Gulf of Venezuela. The topography of the Caribbean region is predominantly low and flat; however, parts of the territory, specifically the departments of Córdoba, Bolívar, and Cesar, include the foothills of the three Andean mountain ranges that traverse Colombia (Ortiz-Royero and Rosales 2012). The climate is dry with strong winds December to April, transitional in May - July, and the rainy season occurs August to November. These three climatic periods may change both in duration and in intensity due to the influence of the American Monsoon system, low-level atmospheric wind currents, and the El Niño and La Niña events (Andrade and Barton 2000). The economy of the Caribbean region is based mainly in the exploitation of coal, natural gas and salt, and agriculture (bananas, rice, coffee and oil palm), including livestock production across the region.

Little is known about Bobolink habitat use and detailed distribution during its passage through the Caribbean and Bermuda, between North and South America. Input from biologists and others in that region was not solicited for this Plan. However, these brief migration stops during oceanic crossings may well be critical for Bobolinks; they may rely on predictable resources in the region. Research to understand their ecology is needed in order to determine threats and conservation needs of Bobolink in this region.

Co-occurring Bird Species Likely to Benefit from Bobolink Conservation

The wide variety of open habitats occupied by Bobolink during the non-breeding season are also occupied by a diversity of co-occurring bird species. In addition to grasslands that vary from xeric to mesic, Bobolinks may inhabit wetlands, crops, and savannas. As a result, they share these habitats with waterbirds, shorebirds, and songbirds of open habitat, from flycatchers to sparrows (Appendix D).

In the Colombia Llanos, Bobolinks, called *chisgas* by farmers, have been observed using rice fields located close to the Cravo Sur River in the Yopal municipality, the largest town in Casanare department. These rice fields are also habitats for waterbirds such as Horned Screamer (*Anhima cornuta*), Black bellied whistling duck (*Dendrocygna autumnalis*), and Scarlet Ibis (*Eudocimus ruber*); songbirds such as Yellow-hooded Blackbird (*Chrysomus icterocephalus*), Ruddy-breasted Seedeater (*Sporophila minuta*); and Neotropical migrants such as Dickcissel (*Spiza americana*), Blue-winged Teal *(Anas discors*) and Solitary Sandpiper.

Bobolinks also use the coast of Colombia and Venezuela before and after crossing the Caribbean. Light-level geolocator data have not provided the precise locations of birds, and observational records are more useful to determine some of the precise locations and the habitats used. Farmers from the Caribbean coast know the Bobolink as *canario bobo*, where it is considered a pest in rice, especially in the department of Cordoba. Bobolinks were reported in a wetland surrounded by mangrove forest in the Magdalena river delta, Magdalena department in September 2013. Likewise, Bobolinks have been found in rice fields situated in the Sinú river delta (Cordoba department) where they share this habitat with shorebirds (e.g., Least Sandpiper [*Calidris minutilla*], Greater Yellowlegs [*Tringa melanoleuca*], and Short-billed Dowitcher [*Limnodromus griseus*]), wading birds such as Little Blue Heron (*Egretta caerulea*) and Bare-faced Ibis (*Phimosus infuscatus*), endemic or near-endemic birds (Northern Screamer [*Chauna chavaria*], Chestnut-winged Chachalaca [Ortalis garrula]), and songbirds such as Fork-tailed Flycatcher [*Tyrannus savana*] and Pied Water-Tyrant [*Fluvicola pica*]).

The eastern lowlands of Bolivia, particularly in the north, are sparsely populated and include grasslands, wetlands and savannas. The vast, remote northern region, known as the Beni Savanna, consists of native grasses in seasonally inundated savannas. The seasonal flow of water is a critical underlying characteristic that maintains the ecosystems of the Beni. The region produces more beef than any other part of Bolivia (Killeen et al. 2008). It is also the only home of the endemic, Critically Endangered Blue-throated Macaw or *barba azul* (*Ara glaucogularis*). Like the Bobolink, other long-distance migratory bird species such as the Buff-breasted Sandpiper (*Tryngites subruficollis*) track southward along the eastern edge of the Andes, migrating through these savannas before detouring east to their wintering grounds in Argentina. Intentional, annual, massive fires across this region decimate critical habitat for the Blue-throated Macaw, but the impacts on migratory birds are unknown.

To the south of the Beni is the Department of Santa Cruz, also host to grazed lands that are on average more intensive than operations in the Beni. The non-forested parts of the landscape, however, are dominated by intensive crop production, mostly rice and soybean (Killeen et al. 2008). Here, Bobolinks share rice fields with waterbirds such as Wattled Jacana (*Jacana jacana*) and Purple Gallinule (*Porphyrio martinicus*), and adjacent grassy habitats with grassland birds ranging from Rheas (*Rhea americana*) to seedeaters (*Sporophila spp*.; Appendix D).

Part of the Pampas grasslands of the Southern Cone of South America, the grasslands and agricultural lands in northeastern Argentina provide essential and sometimes critical habitat for resident and migratory birds. The majority of the Bobolink population winters in this region, and overlapping bird species range from rare endemic songbirds, resident waterbirds that also use rice, and other long-distance migrants that breed in North America. At the northern border, the Formosa province supports extensive cattle ranches that support Bobolinks. Southeast from there, along the Paraná River, lie extensive rice fields where the largest flocks of Bobolinks have been found, and where many of the same waterbird species that use rice in Bolivia can be found. In addition, resident birds include several species of seedeaters, as well as two Vulnerable species, Saffron-cowled Blackbird (*Xanthopsar flavus*) and Strange-tailed tyrant (*Alectrurus risora*; Appendix D).

Context for Conservation in the Llanos

Using geolocators, we have learned only recently the significance of the Llanos region for Bobolink in both the fall and spring. Originally, approximately 75% of the Llanos consisted of savanna grassland ecosystems (Etter et al. 2010). However, the region is now considered the new agricultural frontier of Colombia, and will likely continue to have a greater role in the national economy. Interest in and extraction of petroleum resources is on the rise, and national development policies include an expansion in crops for both food and biofuels (Etter et al. 2010). New practices such as intensive grazing using exotic forages, and new land use such as plantations of oil palm, rubber, timber, and high-input crops (rice, soy, corn), are changing ecological processes including fire regimes and soil water retention (Amézquita et al. 2004). In Venezuela, where Bobolinks concentrate most in the fall, the future of land use is uncertain due to political instabilities; however, land is currently used less intensively than in previous decades due to the intentional reduction in agricultural production through government policies.

In response to emerging land use changes in the Colombian Llanos, an ecological network of protected and managed areas is being proposed (Figure 2–15). The network consists of core protected areas, recommended surrounding areas to add to core areas, and corridors connecting these areas (Romero-Ruiz et al. 2012). Lands most at risk of conversion due to impending changes, specifically agricultural development, are being mapped as proposed regions to include in such a network. Lands protected would include a variety of ecosystems, including savannas, wetlands, and forests. Many of the proposed sites overlap with the southbound and especially the northbound Bobolink routes, although the use of these sites by Bobolinks is still largely unknown.

Guidelines for best management practices and for evaluating forested and pastoral agroecosystems have already been developed for regions in Colombia that include Bobolink migration grounds (Ruiz-Guerra et al. 2016). Various options are offered using valuations that include product costs that have traditionally been externalized, and the long-term value of ecosystem services. In addition, best management practices (BMPs) have already been developed for various types of agricultural enterprises. Dissemination, refinement, and developing support for following BMPs, along with employing such valuation schemes at the

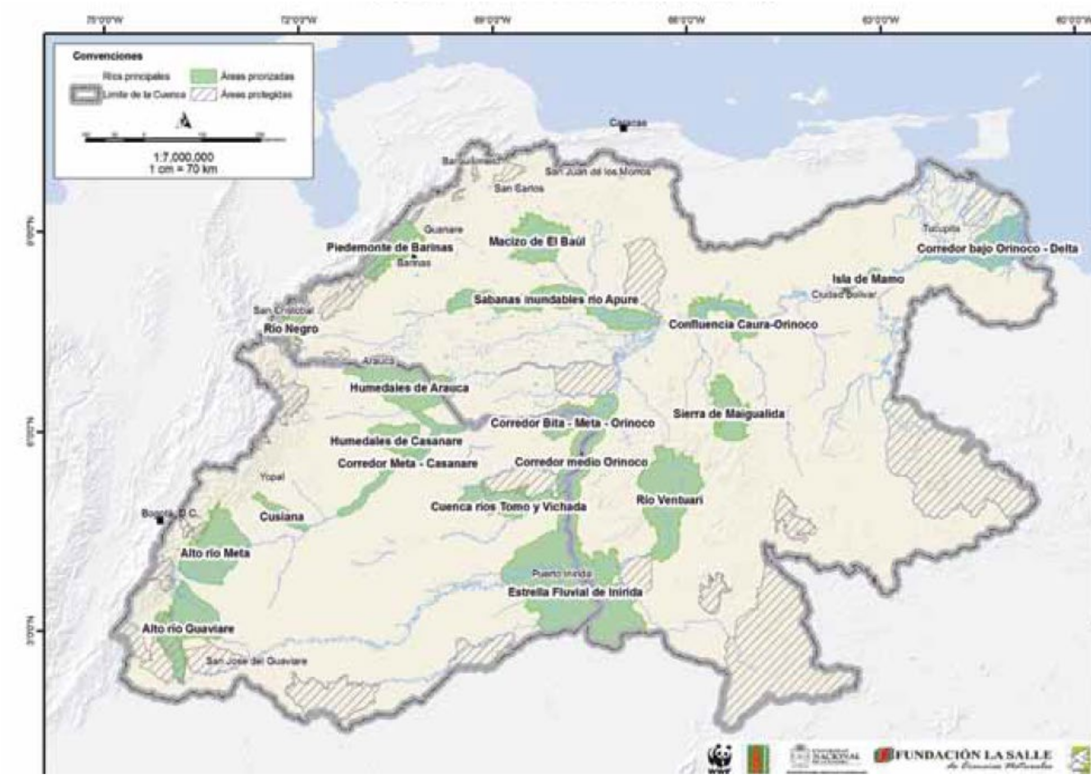
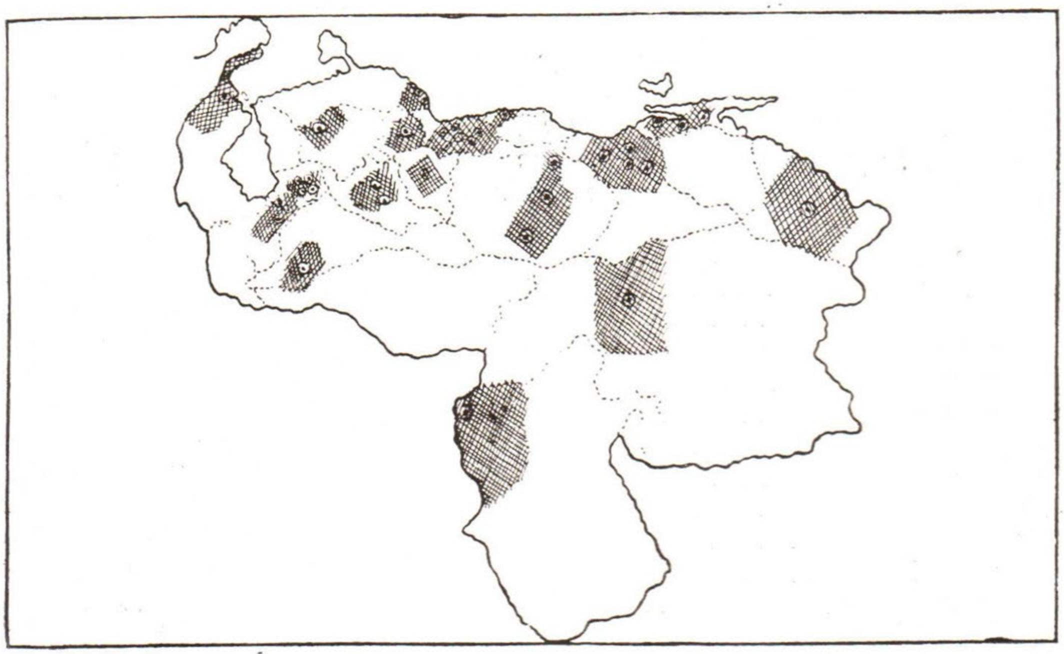


__Figure 2– 15.__ Proposed key sites for biodiversity conservation in Orinoco Basin in Colombia and Venezuela (Lasso et al. 2010).

frontier of agricultural expansion, would facilitate a much reduced impact on biodiversity. Bobolinks can be one of many conservation targets to include in the development, implementation, and evaluation of practices and valuations.

In Venezuela, little is known about the regional distribution, habitat use, and diet of Bobolinks, making it challenging to assess threats in the country. Limited observation suggests a shift in the fall distribution in the country in the last several decades. At the Parque Nacional Henri Pittier along the Caribbean coast in the state of Aragua, Schäfer and Phelps (1954) recorded hundreds of Bobolinks in September and October of 1950-1954. However, the species was never recorded there from 1989 to 2015 (Lentino et al. 2009, Lentino 2016). This change may be a response to a westward shift in the distribution of rice during a similar time frame (Figure 2–16). There are a few records that suggest that some Bobolinks may remain in the country throughout the winter. The species has been documented in rice fields, but unlike the Dickcissel, has not been documented as an important pest (M. Lentino pers. comm.). Regardless, Bobolinks can occur with Dickcissels where they present a problem for rice producers. Repellents with the potential to reduce seed predation by Dickcissel showed promise (Avery et al. 2001) but were never field tested in Venezuela (M. Lentino pers. comm.). Primarily, however, we need a better understanding of locations and habitat use of Bobolink in Venezuela, particularly during their long stop in the country during the southbound migration.

a)



Principales zonas atacadas por el arrocero.

b)

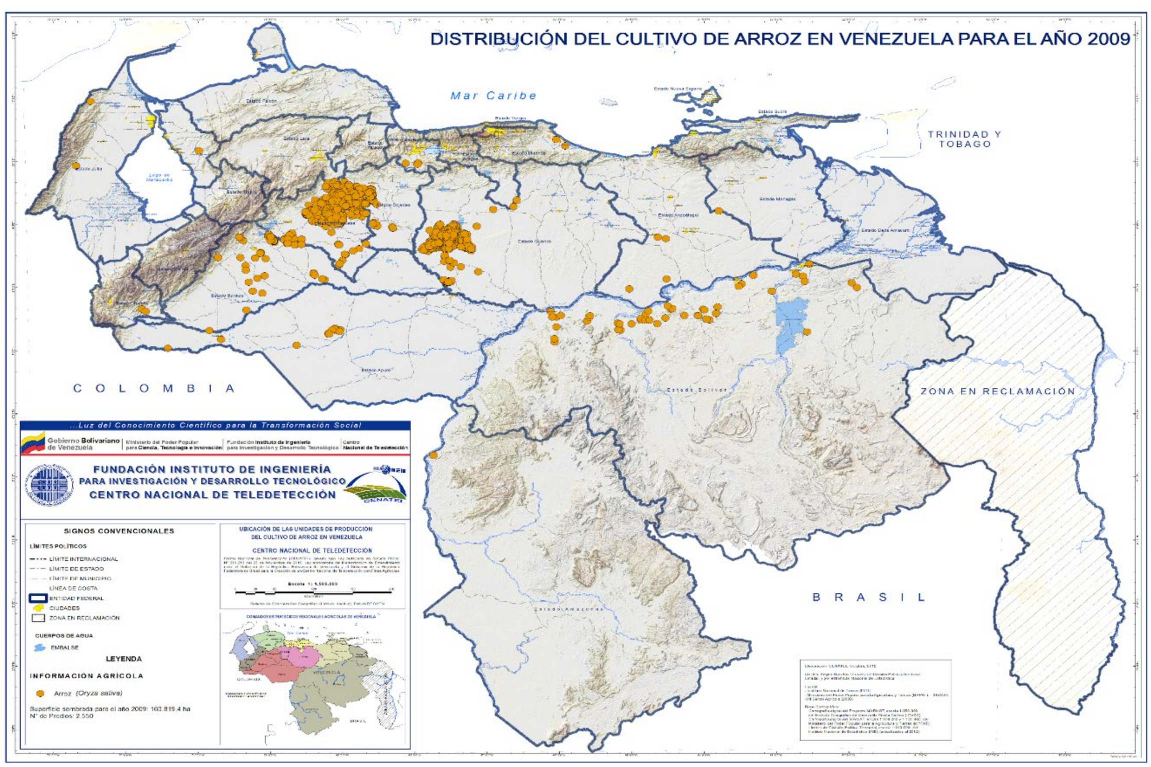


Figure 2– 16. *Areas of rice cultivation in Venezuela in (a) 1945-47 and (b) 2009 (M. Lentino, Parque Nacional Henri Pittier).*

Conservation Strategies and Actions

For the enterprise of grassland conservation to be successful, ultimately pursuing more than one path will be necessary. Therefore, in this section of the Plan, we include strategies and solutions that address the needs of this long-distance migrant developed through two distinct efforts: 1) Bobolink Plan Workshops, undertaken specifically to gather input for the development of this Plan; and 2) the 2015 Midwest Grasslands Network seminar convened to offer ideas for scaling up conservation efforts to achieve landscape-level outcomes for grassland birds (Anderson et al. 2015).

Strategies Developed Through Bobolink Plan Workshops

To determine conservation strategies that addressed Bobolink needs throughout its annual cycle, diverse input was obtained through five Bobolink Plan Workshops held across the western hemisphere (Appendix A). More than one hundred strategies were identified by workshop participants, along with an initial set of corresponding actions. Then, to organize ideas gathered and to provide a basis for continued conservation planning, the Open Standards (OS) framework was used. Time constraints precluded us from following the entire OS process; however, in addition to identifying and prioritizing threats to Bobolinks and co-occurring species, we carried out the important steps of developing conservation strategies, and determining actions within those strategies. Major strategy themes were identified, and related strategies were nested under them. Appendix E includes and describes the complete list of strategies identified for each major region/country in the Plan, and their associated conservation actions (see Appendix E). Most strategies are organized into strategy themes for the breeding range (Canada and the United States) and each major region occupied by Bobolinks during the non-breeding season: Colombia and Venezuela, Bolivia, and Argentina and Paraguay. Although strategies vary with geographic and land-use context, stakeholders from Canada to Argentina are unified by a common focus on sustainable agricultural land use.

The next step in the OS framework is to select and prioritize conservation strategies and rank them in terms of how effective they may be in reducing a threat. South American countries accomplished this subsequent task, except when there was uncertainty about how strategies might reduce a threat, or if they were a very low priority. In Figure 2–17, we use diagrams created through Miradi (4.04) for each major conservation region to link general themes to the threats and contributing factors they address and to detailed strategies within those themes. In addition, we indicate the effectiveness of some strategies selected for south America.

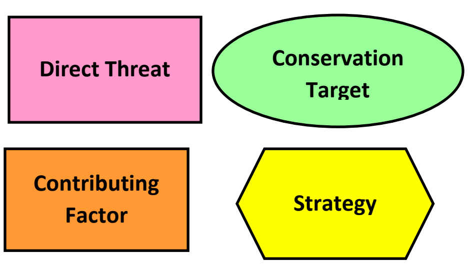
➢ *Strategy Themes for Canada and the USA*

1. Support grazing systems that provide the vegetative structure and levels of disturbance that are compatible with successful grassland bird nesting.
2. Use prescribed fire to prevent succession of grasslands into shrublands where appropriate.
3. Develop and promote economically viable mowing schedules that allow birds to fledge young.

4. Increase public awareness of the effects of pesticides on birds and people.
5. Maintain hay and pasture and/or convert crops to hay or pasture.
6. Strengthen, profile, and improve U.S. Farm Bill conservation programs to increase, sustain, and enhance quality grassland acreage and Bobolink habitat.
7. De-incentivize conversion and promote best practices by strengthening existing private conservation initiatives and supporting agricultural producers that provide quality grassland habitat.
8. Enact legislation to fund grassland conservation and BMPs.
9. Determine, develop, and promote means for biofuel production that provide grassland bird habitat without negative impacts to native ecosystems.
10. Incorporate climate change mitigation and adaptation into grassland bird conservation.
11. Engage a broader range of stakeholders and interests.
12. Strengthen and disseminate messages about the value of grasslands for human health.
13. Build a coherent vision for grassland conservation that advances regional objectives and incorporates measurable objectives.
14. Minimize impacts of alternative energy development.
15. Understand full-cycle Bobolink demographics (linked to habitat quality).

Figure 2– 17** (on following pages)**.** Miradi diagrams displaying threats, factors contributing to threats, and strategies to address threats for (a) U.S. and Canada, (b) Colombia and Venezuela, (c) Bolivia, and (d) Argentina and Paraguay. Individual threat rankings were assessed independently (not relative to other threats). Strategies were not ranked for U.S. and Canada; strategies were ranked for regions in South America except when it was uncertain how a strategy might reduce a threat or if strategies were very low priorities. **Conservation actions within each of the strategies in these diagrams are presented in Appendix F.

KEY TO DIAGRAMS



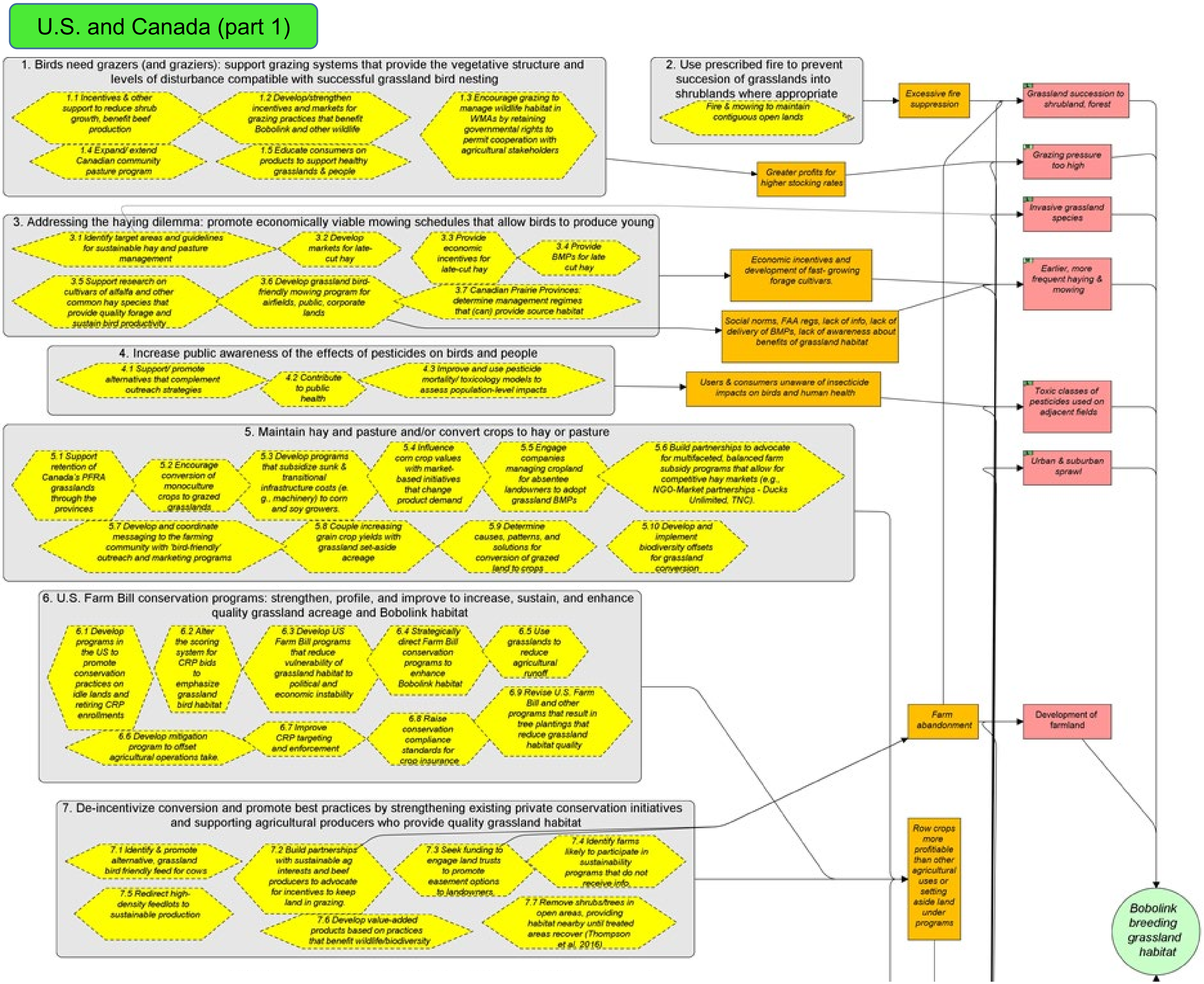
***Rankings**:* threats and strategies (the latter for South American regions only) are ranked within the Miradi diagram.

For threats (pink rectangles), letters in small colored boxes in the upper left corner indicate the level of the threat.

For strategies (yellow hexagons) in South American regions only, letters in small ovals in the left corner indicate how effective a strategy may be in reducing a threat.

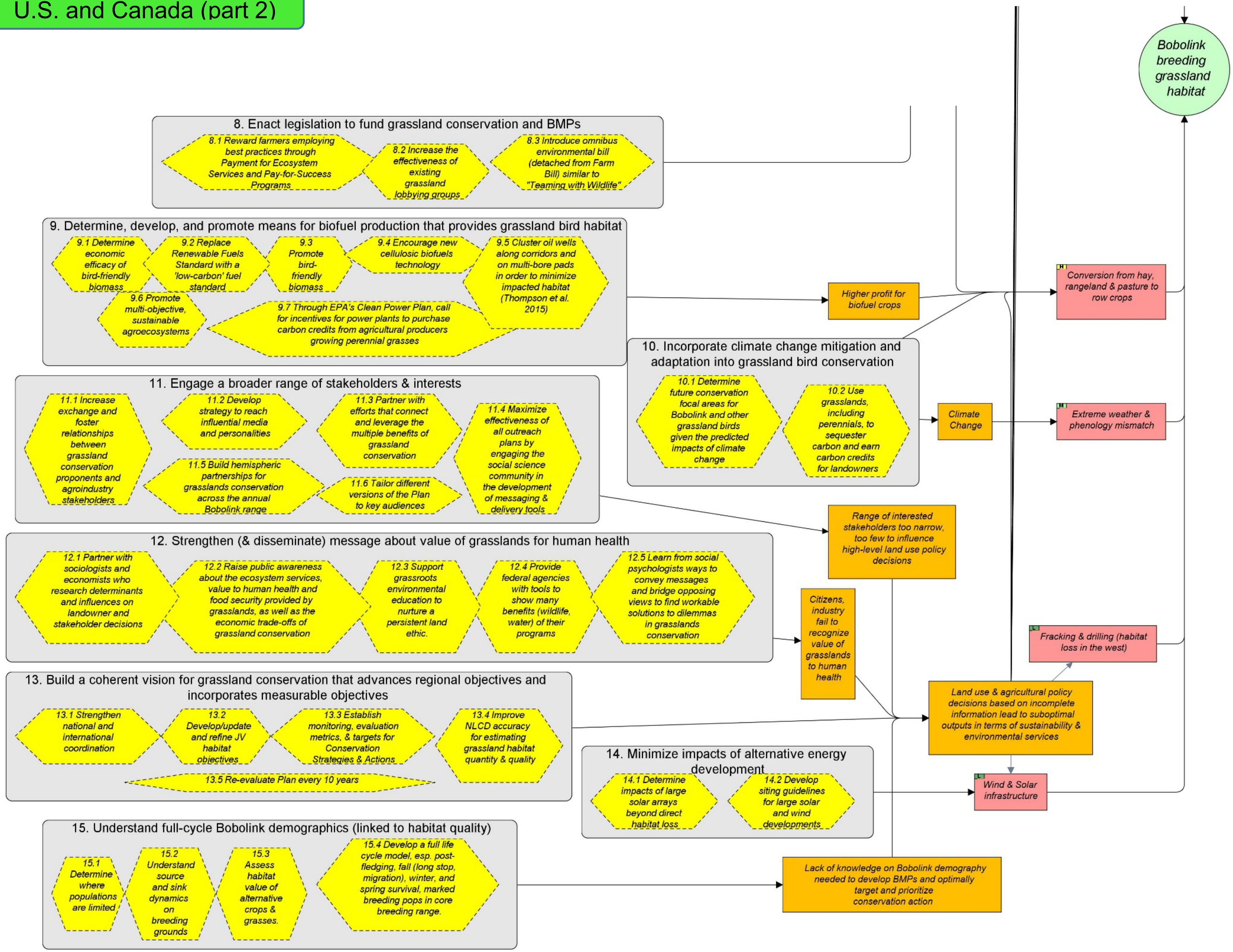
	Threats		***Strategies***
low:	dark green with "L"	less effective:	yellow with "L"
medium:	light green with "M"	effective:	light green with "E"
high:	yellow with "H"		

a)



U.S. and Canada (part 1)
1. Birds need grazers (and graziers): support grazing systems that provide the vegetative structure and levels of disturbance compatible with successful grassland bird nesting
1.1 Incentives & other support to reduce shrub growth, benefit beef production
1.2 Develop/strengthen incentives and markets for grazing practices that benefit Bobolink and other wildlife
1.3 Encourage grazing to manage wildlife habitat in WMAs by retaining governmental rights to permit cooperation with agricultural stakeholders
1.4 Expand/ extend Canadian community pasture program
1.5 Educate consumers on products to support healthy grasslands & people
2. Use prescribed fire to prevent succession of grasslands into shrublands where appropriate
Fire & mowing to maintain contiguous open lands
Excessive fire suppression
Grassland succession to shrubland, forest
Greater profits for higher stocking rates
Grazing pressure too high
Invasive grassland species
3. Addressing the haying dilemma: promote economically viable mowing schedules that allow birds to produce young
3.1 Identify target areas and guidelines for sustainable hay and pasture management
3.2 Develop markets for late-cut hay
3.3 Provide economic incentives for late-cut hay
3.4 Provide BMPs for late cut hay
3.5 Support research on cultivars of alfalfa and other common hay species that provide quality forage and sustain bird productivity
3.6 Develop grassland bird-friendly mowing program for airfields, public, corporate lands
3.7 Canadian Prairie Provinces: determine management regimes that (can) provide source habitat
Economic incentives and development of fast- growing forage cultivars.
Earlier, more frequent haying & mowing
Social norms, FAA regs, lack of info, lack of delivery of BMPs, lack of awareness about benefits of grassland habitat
4. Increase public awareness of the effects of pesticides on birds and people
4.1 Support/ promote alternatives that complement outreach strategies
4.2 Contribute to public health
4.3 Improve and use pesticide mortality/ toxicology models to assess population-level impacts
Users & consumers unaware of insecticide impacts on birds and human health
Toxic classes of pesticides used on adjacent fields
5. Maintain hay and pasture and/or convert crops to hay or pasture
5.1 Support retention of Canada's PFRA grasslands through the provinces
5.2 Encourage conversion of monoculture crops to grazed grasslands
5.3 Develop programs that subsidize sunk & transitional infrastructure costs (e. g., machinery) to corn and soy growers.
5.4 Influence corn crop values with market-based initiatives that change product demand
5.5 Engage companies managing cropland for absentee landowners to adopt grassland BMPs
5.6 Build partnerships to advocate for multifaceted, balanced farm subsidy programs that allow for competitive hay markets (e.g., NGO-Market partnerships - Ducks Unlimited, TNC).
5.7 Develop and coordinate messaging to the farming community with 'bird-friendly' outreach and marketing programs
5.8 Couple increasing grain crop yields with grassland set-aside acreage
5.9 Determine causes, patterns, and solutions for conversion of grazed land to crops
5.10 Develop and implement biodiversity offsets for grassland conversion
Urban & suburban sprawl
6. U.S. Farm Bill conservation programs: strengthen, profile, and improve to increase, sustain, and enhance quality grassland acreage and Bobolink habitat
6.1 Develop programs in the US to promote conservation practices on idle lands and retiring CRP enrollments
6.2 Alter the scoring system for CRP bids to emphasize grassland bird habitat
6.3 Develop US Farm Bill programs that reduce vulnerability of grassland habitat to political and economic instability
6.4 Strategically direct Farm Bill conservation programs to enhance Bobolink habitat
6.5 Use grasslands to reduce agricultural runoff
6.6 Develop mitigation program to offset agricultural operations take
6.7 Improve CRP targeting and enforcement
6.8 Raise conservation compliance standards for crop insurance
6.9 Revise U.S. Farm Bill and other programs that result in tree plantings that reduce grassland habitat quality
Farm abandonment
Development of farmland
7. De-incentivize conversion and promote best practices by strengthening existing private conservation initiatives and supporting agricultural producers who provide quality grassland habitat
7.1 Identify & promote alternative, grassland bird friendly feed for cows
7.2 Build partnerships with sustainable ag interests and beef producers to advocate for incentives to keep land in grazing
7.3 Seek funding to engage land trusts to promote easement options to landowners
7.4 Identify farms likely to participate in sustainability programs that do not receive info.
7.5 Redirect high-density feedlots to sustainable production
7.6 Develop value-added products based on practices that benefit wildlife/biodiversity
7.7 Remove shrubs/trees in open areas, providing habitat nearby until treated areas recover (Thompson et al. 2016)
Row crops more profitable than other agricultural uses or setting aside land under programs
Bobolink breeding grassland habitat

a) U.S. and Canada (part 2)



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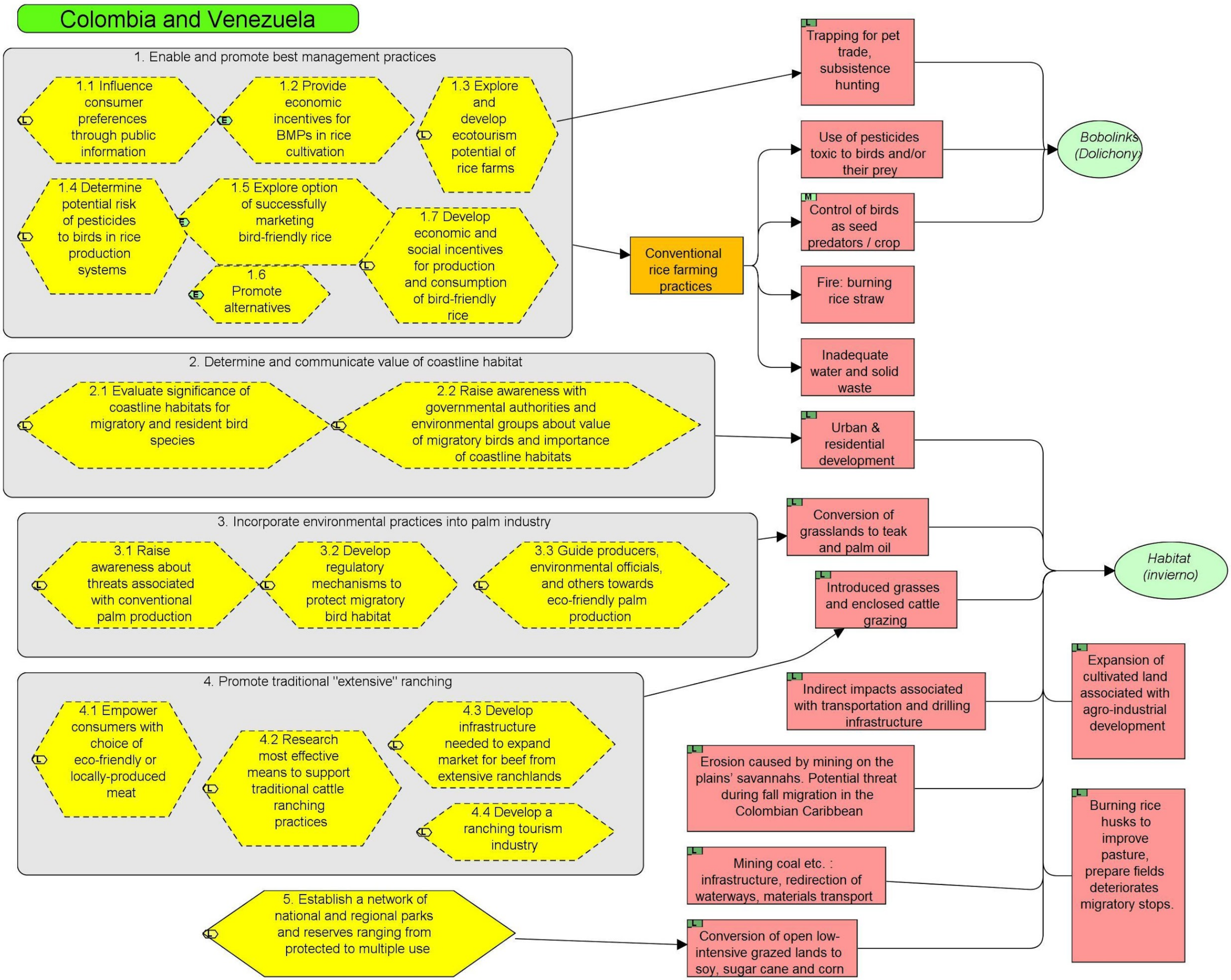
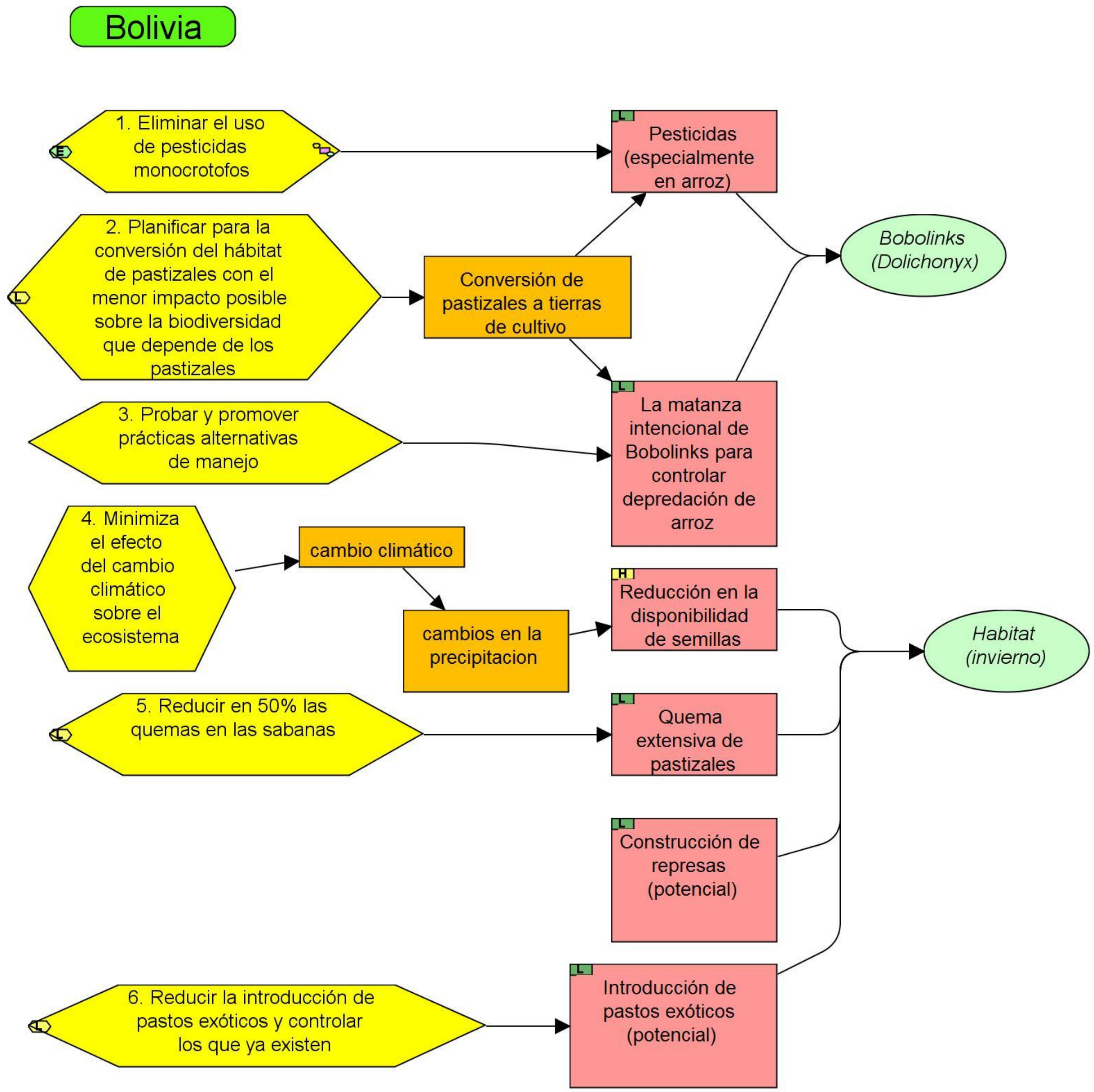


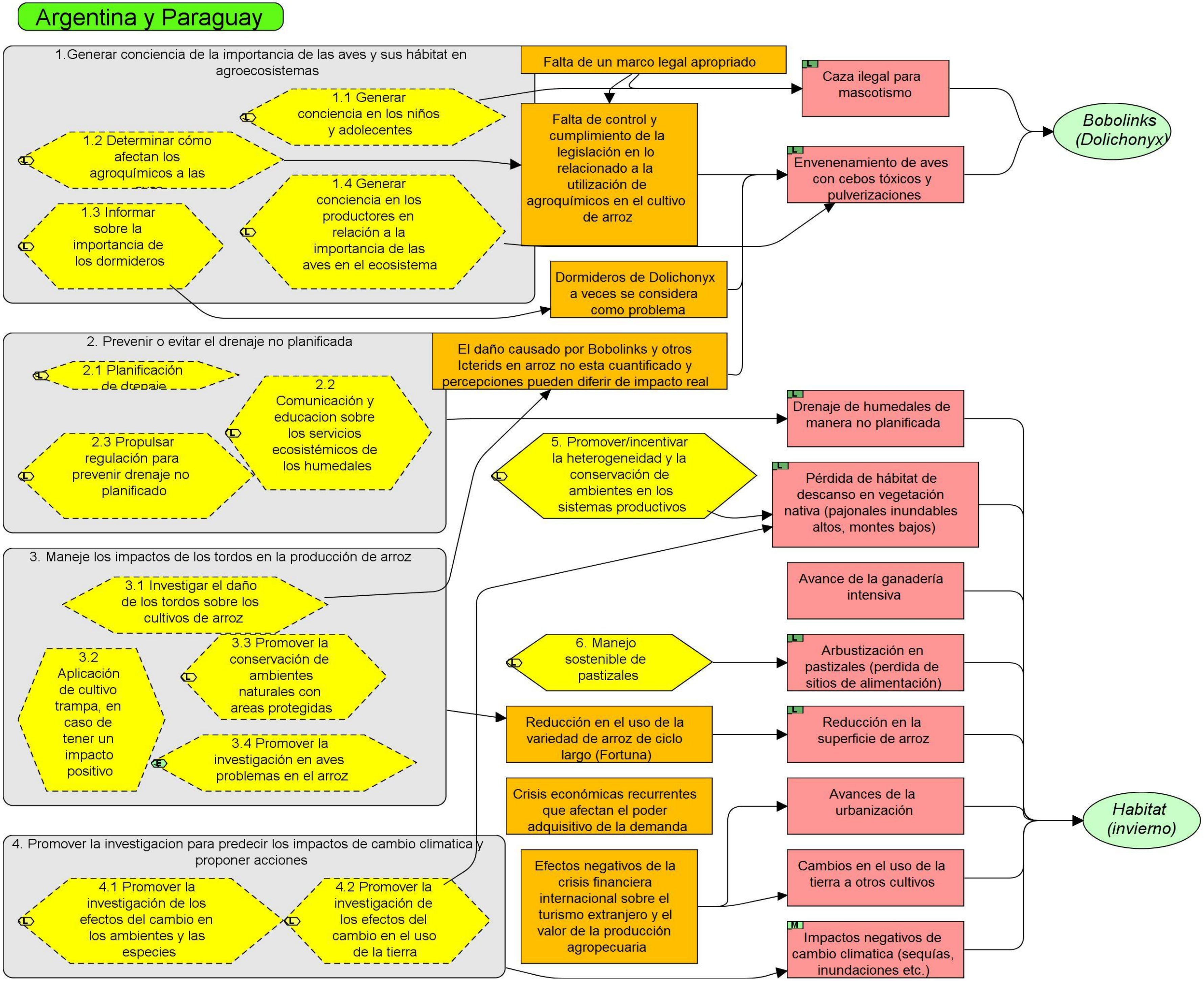
Colombia and Venezuela
1. Enable and promote best management practices
1.1 Influence consumer preferences through public information
1.2 Provide economic incentives for BMPs in rice cultivation
1.3 Explore and develop ecotourism potential of rice farms
1.4 Determine potential risk of pesticides to birds in rice production systems
1.5 Explore option of successfully marketing bird-friendly rice
1.6 Promote alternatives
1.7 Develop economic and social incentives for production and consumption of bird-friendly rice
2. Determine and communicate value of coastline habitat
2.1 Evaluate significance of coastline habitats for migratory and resident bird species
2.2 Raise awareness with governmental authorities and environmental groups about value of migratory birds and importance of coastline habitats
3. Incorporate environmental practices into palm industry
3.1 Raise awareness about threats associated with conventional palm production
3.2 Develop regulatory mechanisms to protect migratory bird habitat
3.3 Guide producers, environmental officials, and others towards eco-friendly palm production
4. Promote traditional "extensive" ranching
4.1 Empower consumers with choice of eco-friendly or locally-produced meat
4.2 Research most effective means to support traditional cattle ranching practices
4.3 Develop infrastructure needed to expand market for beef from extensive ranchlands
4.4 Develop a ranching tourism industry
5. Establish a network of national and regional parks and reserves ranging from protected to multiple use
Conventional rice farming practices
Trapping for pet trade, subsistence hunting
Use of pesticides toxic to birds and/or their prey
Control of birds as seed predators / crop
Fire: burning rice straw
Inadequate water and solid waste
Urban & residential development
Conversion of grasslands to teak and palm oil
Introduced grasses and enclosed cattle grazing
Indirect impacts associated with transportation and drilling infrastructure
Erosion caused by mining on the plains' savannahs. Potential threat during fall migration in the Colombian Caribbean
Mining coal etc. : infrastructure, redirection of waterways, materials transport
Conversion of open low-intensive grazed lands to soy, sugar cane and corn
Expansion of cultivated land associated with agro-industrial development
Burning rice husks to improve pasture, prepare fields deteriorates migratory stops.
Bobolinks (Dolichonyx
Habitat (invierno)

c)



Bolivia
1. Eliminar el uso de pesticidas monocrotofos
2. Planificar para la conversión del hábitat de pastizales con el menor impacto posible sobre la biodiversidad que depende de los pastizales
3. Probar y promover prácticas alternativas de manejo
4. Minimiza el efecto del cambio climático sobre el ecosistema
5. Reducir en 50% las quemas en las sabanas
6. Reducir la introducción de pastos exóticos y controlar los que ya existen
Conversión de pastizales a tierras de cultivo
cambio climático
cambios en la precipitacion
Pesticidas (especialmente en arroz)
La matanza intencional de Bobolinks para controlar depredación de arroz
Reducción en la disponibilidad de semillas
Quema extensiva de pastizales
Construcción de represas (potencial)
Introducción de pastos exóticos (potencial)
Bobolinks (Dolichonyx)
Habitat (invierno)

d)



Argentina y Paraguay
1.Generar conciencia de la importancia de las aves y sus hábitat en agroecosistemas
1.1 Generar conciencia en los niños y adolecentes
1.2 Determinar cómo afectan los agroquímicos a las
1.3 Informar sobre la importancia de los dormideros
1.4 Generar conciencia en los productores en relación a la importancia de las aves en el ecosistema
Falta de un marco legal apropriado
Falta de control y cumplimiento de la legislación en lo relacionado a la utilización de agroquímicos en el cultivo de arroz
Dormideros de Dolichonyx a veces se considera como problema
Caza ilegal para mascotismo
Envenenamiento de aves con cebos tóxicos y pulverizaciones
Bobolinks (Dolichonyx)
2. Prevenir o evitar el drenaje no planificada
2.1 Planificación de drenaje
2.2 Comunicación y educacion sobre los servicios ecosistémicos de los humedales
2.3 Propulsar regulación para prevenir drenaje no planificado
El daño causado por Bobolinks y otros Icterids en arroz no esta cuantificado y percepciones pueden diferir de impacto real
Drenaje de humedales de manera no planificada
5. Promover/incentivar la heterogeneidad y la conservación de ambientes en los sistemas productivos
Pérdida de hábitat de descanso en vegetación nativa (pajonales inundables altos, montes bajos)
3. Maneje los impactos de los tordos en la producción de arroz
3.1 Investigar el daño de los tordos sobre los cultivos de arroz
3.2 Aplicación de cultivo trampa, en caso de tener un impacto positivo
3.3 Promover la conservación de ambientes naturales con areas protegidas
3.4 Promover la investigación en aves problemas en el arroz
Avance de la ganadería intensiva
6. Manejo sostenible de pastizales
Arbustización en pastizales (perdida de sitios de alimentación)
Reducción en el uso de la variedad de arroz de ciclo largo (Fortuna)
Reducción en la superficie de arroz
Crisis económicas recurrentes que afectan el poder adquisitivo de la demanda
Avances de la urbanización
Habitat (invierno)
4. Promover la investigacion para predecir los impactos de cambio climatica y proponer acciones
4.1 Promover la investigación de los efectos del cambio en los ambientes y las especies
4.2 Promover la investigación de los efectos del cambio en el uso de la tierra
Efectos negativos de la crisis financiera internacional sobre el turismo extranjero y el valor de la producción agropecuaria
Cambios en el uso de la tierra a otros cultivos
Impactos negativos de cambio climatica (sequías, inundaciones etc.)

Solutions at Broad Scales

Replicating small scale successes across the landscape and enacting new, long-term solutions that can be applied at larger scales are critical to stabilizing populations of a wide-ranging species like Bobolink. Below we discuss current and new opportunities to address Bobolink population declines and inherently grassland conservation issues at broad geographic scales as they relate to the specific strategy themes or individual strategies identified in Appendix E.

Birds Need Grazers (Strategy Theme 1)

Creating grazing systems that also sustain grassland bird communities surfaces as one of the most feasible approaches to reduce threats to grassland bird habitat. Grazing, as opposed to other practices impacting grasslands (e.g., development, row crop cultivation), provides a way to maintain grassland bird habitat that also benefits humans. Using appropriate cattle stocking densities, grazing can provide heterogeneity in the vegetation structure that in turn provides habitat for a diversity of bird species. Appropriate grazing is also beneficial to environmental quality and wildlife, increases range quality, and serves as a means to produce high quality beef for consumers.

Maintaining grassland habitat through grazing regimes without the negative effects of high-density grazing practices on birds can collectively be referred to as Conservation Grazing. A comprehensive management strategy that includes appropriate livestock stocking densities (those that are parsimonious with grassland structure needs of targeted bird species), provision of rest-rotation systems, prescribed fire, and invasive plant control would create suitable habitat for several species of grassland birds, including Bobolink (Brennan and Kuvlesky 2005). Furthermore, increasing plant species richness and reducing grazing pressure on agricultural grasslands may stabilize biomass production through periods of climate extremes, and thus bring additional benefits to farmers (De Keersmaecker et al. 2016).

Grazing compatibility with grassland bird habitat requirements differs in regions such as the Midwest versus the Great Plains, in part because of the scale of land holdings and proportion of land in private versus public ownership. Appropriate management strategies will vary with climate conditions, grass species, and landscape configuration as well. Recommended practices provided in region-specific resources (e.g., Ontario Soil and Crop Improvement Association) are often applicable to other regions, however, and can be adapted to suit local needs and conditions.

Initiatives to support grazing and livestock production practices that provide quality grassland bird habitat from Canada to Argentina range from management to market incentives (Appendix F). The success of these programs is based in part on the idea of a conservation stewardship ethic among ranchers. In Saskatchewan, recent surveys indicate a growing willingness among ranchers to protect species at risk and a general stewardship ethic with respect to native prairie (Henderson 2014).

Addressing the Haying Dilemma (Strategy Theme 3)

The timing and frequency of hay mowing presents challenges to nesting grassland birds like Bobolinks. One approach is to delay mowing schedules long enough to enable higher chick fledging rates. However, the feasibility of this strategy is limited by forage quality losses that can result from delayed having and the type of livestock being raised. The nutritional needs of milking cows usually limit the ability of dairy operations to participate in delayed mowing programs, as the foregone income is high. Hay for beef operations and horses is more amenable to delayed haying, as the hay required can often be of somewhat lower nutritional value compared to hay need for dairy. However delaying mowing long enough to meet Bobolink reproductive needs still comes at some nutritional cost for most operations. Conversely, in the face of increasing climate instability, lowering the frequency of mowing can increase resilience of grasses to drought during regrowth. This can lead to benefits to farmers (De Keersmaecker et al. 2016) but may be outweighed by shorter-term financial sacrifices.

At a broad scale, weather, soils, and geographic location affect hay plant phenology and growth rates. The type of farming operation (e.g., dairy versus beef), topography, and the species of grasses and forbs all define constraints of a farm. Whether the farmer is the owner operator or tenant can also impact overall haying operations.

Climate and growing days associated with geographic location pose the broadest constraints on mowing schedules. Farther east in the range, delayed haying can be a feasible option for maintaining productive Bobolink habitat each year. In Nova Scotia, a minor delay of ~1.5 weeks in cutting can secure some increases in fledging rates for Bobolink and other species while maintaining feasibility for farmers (Nocera et al. 2005). In Ontario, particularly in northern regions, Brown and Nocera (2017) found that forage quality (most importantly, crude protein) is compromised only minimally when the first haying date is delayed until mid-July. They conclude that non-dairy operations can support successful fledging of Bobolinks with minimal impact on forage quality, especially in central and northern regions. Conversely, in the western part of the breeding range, especially in the Canadian prairies, there are not enough growing days to allow for delayed cut strategies to be effective, even with financial compensation. However, the slower grass growth in this region means that oftentimes many hayfields are not cut until mid-July (C. Artuso, pers. comm.). Rotations of unmowed fields or sections of fields may also provide a viable option, but more research is needed.

Oftentimes creative, tailored solutions to delay cutting on a farm exist. Farmers may be willing to sacrifice or be compensated for a portion of their hayfields where Bobolink nesting density is highest. Farmers who are not able to hay all of their fields at once can leave the field that has the most Bobolinks for last, especially in wetter summers when haying may be delayed. In regions where losses in hay nutritional quality are greater, incentives are often needed to carry out the substantial delays in mowing required (Perlut et al. 2011). In the U.S., farms that qualify can enter the Environmental Quality Incentives Program (EQIP) and be compensated for implementing a delayed haying program. This program has been used successfully in Vermont to provide a subsidy for farmers who conduct their first cut before 1 June and wait 65 days before the second cut to allow birds to complete their nest cycle. However, in Ontario, Bobolinks did not return to nest after the first cut (Diemer and Nocera 2016), so for that region the recommended approach is to utilize a delayed first cut that somewhat compromises hay protein content. Whether methods to improve the nutritional value of late-harvested forage crops, such as mineral supplementation, are economically feasible depends on the production goals of individual farms (Nocera et al. 2005). Online resources are often available that explain region-specific options for managing hayfields (e.g., Ontario (Kyle and Reid 2016) and Vermont).

Although delayed or less frequent mowing is an effective means to provide quality nesting habitat, these practices can also promote the expansion of unwanted invasive plant species. Additional control measures preventing the establishment and spread of invasive plants may need to be an integral part of delayed or reduced mowing regimes. In Illinois, late-season burns (after 1 Oct) have been effective against some invasive plants (J. Herkert pers. comm.). In order to control some invasive species, burning earlier in the season but late enough to avoid affecting nests and fledglings may be necessary.

In regions where delayed haying is not an option, planting some acreage of warm-season grasses for hay to complement the typical cool season grasses may provide a viable alternative for both production and habitat (C. Artuso pers. comm.). The protein content of warm-season grasses peaks later in the season compared to cool-season grasses, potentially providing suitable forage that is cut later in the season with minimal compromising of cattle nutrition. The economic implications of replacing cool-seasons with warm-seasons needs to be addressed.

Haying can be an effective management tool on idled grasslands such as those in CRP. Response of nesting grassland birds to haying once every one to four years varies by species, geography, and the number of years since the last haying. In North Dakota, Bobolink density was similar to or greater in hayed compared to idled CRP fields within the first four years of haying (Igl and Johnson 2016). This suggests the potential for some haying in CRP to play a role in the conservation of Bobolink breeding habitat.

Conservation programs in Europe have demonstrated that delayed mowing at a broad scale can have effects on grassland birds at the population level. In Scotland, one Agri-Environment Scheme (EAS) option that required delayed mowing was identified as essential to the population increases observed in Corn Buntings (*Emberiza calandra*; Perkins et al. 2011). In contrast, in high-yield agricultural lands in England, delayed mowing regimes increased fecundity of a multi-brooded species, the skylark (*Alauda arvensis*), but they were still sink habitats. At best, fecundity in delayed-mowed fields nearly rivaled that of unmowed fields. The authors recommended that resources may be most effective if used towards increasing fecundity on existing highest-quality nesting habitat, in part by providing quality foraging habitat to increase the number of nestlings. Effectiveness of this strategy, however, is based on the assumption that food availability is limiting fecundity. (Buckingham et al. 2015).

Finally, altering mowing equipment has been suggested as another means to reduce nesting mortality from haying. Raising mowing bars for higher cutting heights, however, has not been shown to be effective (Buckingham et al. 2015).

U.S. Farm Bill Conservation Programs (Strategy Theme 6)

The Farm Bill includes voluntary conservation programs that comprise essential avenues for grassland bird conservation, historically providing the most important collection of legislation affecting grassland conservation on private lands in the United States. Farm Bill programs offer technical assistance and/or financial incentives to enhance or restore grassland habitat. However, some programs under the Farm Bill have contributed to grassland conversion by providing crop insurance subsidies that indirectly incentivize conversion of grassland to cropland. Thus, Farm Bill programs can work against each other, simultaneously incentivizing conversion and conservation of grasslands in the same state (USGAO 2007).

Farm Bill legislation and the conservation title have evolved considerably since its inception in 1985, with the most recent version passed in 2014. NABCI partners produced a substantial guide document, *2014 Farm Bill Field Guide to Fish and Wildlife Conservation* (NABCI, U.S. Committee 2015), providing both historical and current information about Farm Bill programs and their potential impact on birds. Substantial details about programs are described in the document, and thus they will not be full described here. The document outlined four main areas of Farm Bill Conservation Programs:

- Conservation Reserve Program (CRP). Due to the vast acreage affected, the CRP has been one of the most important Farm Bill programs for grassland birds. It compensates farmers, over the course of a 10 or 15-year contract, for establishing conservation cover on ecologically significant working lands. A variety of sign-up incentives and program initiatives have occurred since the first CRP sign-up in 1985, with varying degrees of benefit for Bobolink depending on the type of cover established (ex. Grassland vs trees) and configuration (ex. Filter strips along waterway edges vs whole fields). A critical component of Farm Bill legislation is the CRP acreage cap, which controls how many acres can be under contract within the program across the U.S. This cap has fluctuated over time, from a high of 45 million acres established by the 1990 Farm bill to ultimately 24 million acres at the end of FY18 as directed in the 2014 bill.

  Mid-contract management of CRP lands (e.g. prescribed burning, haying, grazing, inter-seeding, etc.) has potentially significant wildlife benefits. For Bobolinks specifically, periodic disturbance of CRP lands may provide better quality breeding habitat through reduced thatch and grass height. Expanded ability to hay and graze CRP throughout the contract period (e.g. CRP Grasslands program from the 2014 Farm Bill), through practices established in a management plan, has the potential to both increase suitability for Bobolinks and feasibility for producers to enroll in the program.

- Easements. Several easement programs that protect both working grasslands and, for Bobolinks in particular, wetlands and adjacent conservation cover, provide avenues for establishing grassland cover across the U.S.

- Working Lands Programs. Many iterations of working lands programs that rewarded voluntary conservation practices through cost-sharing, have the potential to provide benefits to grassland birds. For example, in the 2014 Farm Bill, the Environmental Quality

Incentives Program (EQIP) and Conservation Stewardship Program (CSP) provide cost share for practices such as grazing plans and specific wildlife habitat enhancement practices, such as pollinator plantings. EQIP may be especially useful to help maintain expiring CRP lands in grass cover through prescribed grazing practices.

- Partnerships. New in 2014, the Regional Conservation Partnership Program (RCPP) uses partnerships with public and private entities to leverage USDA Farm Bill funding opportunities while addressing conservation needs such as water quality, at-risk species habitat, and soil erosion. Several projects utilizing RCPP to focus on landscape scale grassland conservation on working lands were initiated through RCPP since the program's inception.

Two key farm bill provisions that have intermittently been a part of previous Farm Bills were utilized in the 2014 legislation. The Sodsaver provision is intended to reduce losses of native grasslands to crops. However, the provision only applied to six states in the Northern Great Plains most affected by recent native grasslands conversion. Although the region covered by the measure overlaps with much of the core Bobolink breeding range in the US, it does not include about two-thirds of grasslands that were converted in recent years (Lark et al. 2015). The 2014 Farm Bill also re-linked conservation compliance of Highly Erodible Land Conservation and Wetland Conservation to crop insurance premiums in an attempt to fix the unintended consequences of Farm Bill Programs as they relate to grassland conversion.

Habitat established through many Farm Bill conservation programs remains vulnerable to row crop market fluctuations. Farm Bill programs are often hampered and out-funded by production subsidies (USGAO 2007, Stubbs 2014). For example, when corn and soybean prices increased in 2008-2013, millions of CRP acres were planted to crops and native grasslands that had never been plowed were converted to corn production while high crop prices prevailed. The success of future Farm Bill conservation programs will need to address the financial relevancy of program subsidies to be competitive with crop markets.

Changes in CRP acreage have the potential to impact a significant portion of Bobolink populations across their range. For example, in the Prairie Potholes (BCR 11) approximately 11% of the Bobolink population occurs in CRP or adjacent non-CRP lands (Drum et al. 2015*a*), however this still means the larger portion of their population exists on other types of grasslands. Recent Bobolink population decreases in BCR 11 are likely tied to grassland conversion to crops beyond that occurring in CRP (R. Drum pers. comm.). Thus BCR 11 demonstrates one example of the need to focus on other grasslands in addition to CRP.

Directing Farm Bill financial assistance to priority areas where environmental benefits are greatest could increase program efficacy. Linking resources such as the Environmental Working Group's spatial Farm Subsidy Database (Farm Bill payouts by county) with environmental layers would help determine the proportion of payments going to priority areas, defined based on the resource of interest. In this case, layers depicting occurrence of Bobolink and other grassland bird species could be a first step in determining how well payouts are matching up spatially with the conservation target.

Supporting Ecosystem Services in Agricultural Production (Strategy 8.1)

Payment for ecosystem services (PES) has become a commonly used term in the conservation arena. The value of natural capital, the assets automatically provided by nature that benefit humans, is difficult to calculate with precision. But it may be adequate to offset opportunity costs to landowners, especially if services such as carbon storage and flood risk mitigation are included (Newton et al. 2012). The service provided by pollinators alone in the U.S. is estimated to be worth several billion dollars (Salzman 2005). In agriculture, the rewards of conserving natural capital include reducing risk, decreasing synthetic inputs, and increasing long-term productivity and resiliency. The Natural Capital Project is a partnership of institutions and organizations that provides resources to help valuate and incorporate environmental services into policy and business planning and decisions. Carbon sequestration by grasslands is an example of a potential market for a PES approach.

The valuation of and potential mitigation for environmental services such as water quantity and quality, flood control, soil productivity, and biodiversity has received considerable debate. Input from conservation scientists is critical to define and apply mitigation offsets, and socioeconomic considerations need to be inherently included in offsetting (Vassiére et al. 2017). Incentive-based policy approaches may preclude the need for offsets, although unintended consequences such as a shift in the commodity crop produced (geographical or crop type), and trickle-down cost effects to the consumer need to be included in analyses of incentive-based policies.

Financial incentive approaches have been used successfully in Farm Bill conservation-related programs such as CRP and WRP, and long-term benefits of environmental stewardship can be demonstrated (Horton et al. 2017). However, direct market-based rewards for environmental stewardship have generally not been strong enough to adequately incentivize producers or consumers. In addition, the short-term nature of farmer decisions usually cannot incorporate the less tangible, indirect, and non-immediate rewards of environmental stewardship. Incentives or penalties for actual, measurable habitat or other environmental service protection or destruction, respectively, can ensure that the intended goal of a policy is met. Pay-for-success (PFS), an approach used to tie payments to the achievement of measurable outcomes by reimbursing projects only after they demonstrate environmental benefits, is gaining traction.

Biofuel Production that Provides Grassland Bird Habitat (Strategy Theme 9)

Cellulosic biofuels, or ethanol produced from plant cellulose, provides a potential means to increase grassland cover and thus grassland bird habitat. The 2007 Energy Independence and Security Act required approximately 21 million gallons of blended biofuels to come from cellulosic materials rather than glucose or starch-rich row crops (McGuire and Rupp 2013). However, technological and financial feasibility of cellulosic biofuel has lagged that of corn-based ethanol.

Perennial feedstocks for biofuel production (e.g., switchgrass, *Panicum virgatum*) theoretically could replace lands currently in corn and soybean cultivation. Perennial feedstocks provide potential conservation benefits via positive effects on greenhouse gas balances, ecosystem services and improved habitats (reviews in Robertson et al. 2012, Wright and Wimberly 2013), including grassland bird habitat (Blank et al. 2014, Meehan et al. 2010). Furthermore, developing alternative land uses for CRP land such as biofuel production could provide an economic incentive to keep land in perennial grass cover, thus maintaining the environmental benefits of the program (Adler et al. 2009).

Increased grassland cover on the landscape has the potential to benefit Bobolink at multiple scales. At a broad scale, concentrating acreage of perennial biomass crops may enhance grassland birds' use of smaller patches by maintaining an open landscape (Renfrew and Ribic 2008, Robertson et al. 2012). Perennial grass biofuels could provide substantial quantities of grassland bird habitat. Grassland fields that incorporate a heterogeneous vegetation structure, including mixes with forbs, have the greatest benefits for grassland birds, and have value as biofuel crops (Blank et al. 2014).

Biomass yields are highest on grasslands with high abundance and low diversity of warm-season native grasses (Adler et al. 2009), and monocultures (e.g., giant miscanthus (*Miscanthus x giganteus*), switchgrass (*Panicum virgatum*)) are favored for efficient biomass production due to their characteristically tall and dense structure. However, monocultures often do not provide quality bird habitat, and their value to grassland birds is low compared to unharvested CRP grasslands (Vandever and Allen 2015). In addition, general intensity and uniformity of cellulosic cropping results in structural and successional homogeneity that does not provide the vegetative structure required by most grassland bird species (Robertson et al. 2012). But switchgrass does present some advantages over other monocultures, particularly when planted in combination with other warm season grasses, and can provide habitat for nesting and migratory Bobolinks (Murray et al. 2003, Robertson et al. 2011, 2012). However, switchgrass has proven to be less economical than corn stover (Brechbill and Tyner 2008).

To provide habitat for Bobolinks and other grassland specialists, switchgrass needs to be mixed with other species, including forbs, to provide structural diversity. Although these changes may effect biomass production value, various means to compensate for lost production, similar to foregone income with delayed hay harvests, could be used for biomass grasses that also benefit birds.

Bobolink density has been shown to be highest in low-diversity, cool-season (i.e., C3) fields—up to 75 times greater than in high diversity fields (Delisle and Savidge 1997, Vogel 2011)—and it is predicted that conversion of rowcrop and unharvested CRP switchgrass fields to switchgrass fields managed for biofuels could slightly increase Bobolink densities in some areas (e.g., Iowa; Murray et al. 2003). However, uncertainties include questions about the effects of biofuel grass monoculture on insect prey base (Robertson et al. 2012) and the potential for non-native biofuel crops to become invasive (Fletcher et al. 2011). The potential fitness benefits provided by these habitats also need study.

The ultimate impact of cellulosics on grassland bird populations would depend largely on what lands biomass production would replace. It is widely believed that the next-generation of cellulosic biofuels, if realized, will likely be targeted towards 'marginal' grasslands currently deemed unsuitable for corn production (Robertson et al. 2012), with the Northern Great Plains holding some of the greatest potential for the production of cellulosic biomass (McGuire and Rupp 2013). Substantial concern has arisen over the potential negative impacts of cellulosic crop production (Fargione et al. 2009) on lands formerly suitable for breeding grassland birds, and this concern has been verified by recent land use changes.

Land deemed 'marginal' for agriculture has also been identified as having high potential for conversion to woody biomass crops such as poplar (*Populus spp*.), one of the fastest growing sectors in biomass production due to high yield and short rotation schedules (Zalesny et al. 2012, Headlee et al. 2013). It has been suggested that poplar biomass could eventually represent a significant component of the total biofuels produced in the USA (Zalensny et al. 2012), across a large portion of the country including the Northeast and Tallgrass Prairie regions (Fletcher et al. 2011). Overall, the production of woody crops on agricultural lands is expected to expand to 346 million Mg of dry biomass annually by 2030 (Headlee et al. 2013), with highest growth in the south and west regions of Minnesota, and the southeast and central regions of Wisconsin (Zalensny et al. 2012).

The rapid growth of the agroforestry industry will add to the complexity of managing multi-purpose agricultural landscapes. For grassland birds, woody crops would reduce the suitability of existing grasslands or grass-based crops if they are grown in predominantly agricultural or grassland landscapes (Bakker 2008) by creating edges, obstructing visibility, and eliminating the perceived 'openness' of the landscape. Addressing competing priorities in multi-purpose agricultural landscapes has resulted in guidance for how to site and manage biomass production in ways that benefit wildlife, including grassland birds (e.g., McGuire and Rupp 2013).

A relatively new biofuels model being piloted by Roeslein Alternative Energy, LLC involves the production of renewable natural gas from hog manure produced at concentrated animal feeding operations (CAFOs). Native prairie vegetation is grown with the intent of being rotationally harvested and added to anaerobic digesters that process hog manure, resulting in methane gas that is chemically converted to natural gas. The additional prairie biomass added to the digester increases the amount of renewable natural gas produced with this technology. Roeslein, based in Missouri, hopes to expand this technology to other places in the Midwest.

Carbon Sequestration on Agricultural Lands (Strategy 10.2)

At the Paris 2015 U.N. Climate Change Conference, carbon storage in agricultural systems was recognized as an important strategy to address climate change. Carbon farming promotes large-scale agriculture using perennial grasses in systems to help sequester carbon in soils and organic matter (Toensmeier 2016). Soil carbon storage is effectively increased through practices such as maintaining year-round plant cover (Kane 2015), which creates opportunities to increase the quantity and quality of grassland habitat as an immediate response to climate change.

Reduced tillage systems and cover crops are often promoted as carbon-sequestering practices.

However, in the absence of tilling there may be a heavy reliance on chemical inputs to control weeds. Furthermore, recent studies have cast doubt on the degree to which these systems store carbon (summarized in Kane 2015). Thus, a common carbon-sequestering activity like reduced tillage/increased herbicide use may have indirect, undesirable consequences on farmland birds like Bobolinks. Cover crop methods sometimes involve resting fields after establishing small grains or alfalfa, which may have the potential to provide benefits to Bobolinks if the established cover is either minimally disturbed or entirely undisturbed during the breeding season.

Through a grant from the USDA, Ducks Unlimited is rewarding ranchers for sequestering carbon. Ranchers voluntarily set aside grassland in a permanent conservation easement that allows them to grow hay and graze animals while prohibiting tillage or land use conversion. Once the carbon in the soil is measured and formally registered, organizations or companies can buy the resulting carbon credits. The more carbon the set-asides sequester, the more credits that are earned. The easements are passed on to the USFWS (through their Grassland Easement Program), and the carbon credits are bundled and resold to finance more conservation. Grasslands sequester three to six times less carbon per acre than forest, but more available open acreage and lower costs per acre make them competitive in the carbon market.

Rotational grazing is an example of an agricultural practice that, if carried out appropriately (see Birds Need Grazers section), can store carbon while benefitting grassland birds. A study in Georgia showed that conversion of row crops to rotational grazing lands in dairy systems resulted in rapid soil carbon accumulation and a dramatic increase in water retention (Machmuller et al. 2015).

New Cultivars and Cropping Systems (Strategies 3.5 and 15.3)

New crop cultivars present potential means to creatively meet the sometimes contradicting needs of agricultural production and grassland birds (Strategy 3.5). Ongoing research seeks to identify forage cultivars and mixtures that can be harvested on a schedule compatible with bird breeding phenology, without significant reduction in quality as forage. An alfalfa plant that is high-yielding enough to require only one or two cuts per year could allow enough time for Bobolinks to nest. An example is the development of cultivars of yellow-flowered alfalfa (*Medicago sativa* ssp. *falcata*) that are adapted to a one-cut haying system in South Dakota (Boe et al. 1998). These cultivars can be harvested in mid- to late-July and thus show promise for providing improved habitat for nesting gamebirds and songbirds compared to conventional alfalfa varieties (Boe et al. 1998).

In Europe, cereal grain has been suggested as a potential, alternative source habitat for skylarks (Buckingham et al. 2015). Small grains may serve the same purpose for Bobolinks, as they nest at low densities in some small grain fields (reviewed in Dechant et al. 2001). Winter wheat may be the most suitable, commonly grown cereal grain on the breeding grounds because it provides early season cover, and it is harvested relatively late in the summer.

Perennial crops (e.g., Strategy 15.3) may offer opportunities to benefit grassland birds while also providing the ecosystem services that drive their development. Perennials have deeper roots, require less tillage, and support more microbial biomass compared to annuals. The Land Institute has been developing commercial cultivars of perennials that can be grown in polycultures. The use of perennials is part of a regenerative agriculture strategy, promoted as one solution to climate change (Strategy 10.2). The strategy entails closed nutrient loops, greater biological diversity, and greater reliance on internal rather than external resources (Rodale Institute 2015*b*). Although development of perennial cultivars for food is focused on transforming annual grains such as wheat, rice, and even corn (Glover et al. 2010), promotion of any perennials that provide similar structure to grassland habitat has the potential to impact Bobolinks.

No-till farming can provide some habitat for other grassland birds, if herbicide application and seeding are delayed. No-till methods for row crops like corn and soybeans are increasing in practice and may offer some benefits to nesting grassland birds (Basore et al. 1986, VanBeek et al. 2014), but the potential for these areas to serve as ecological traps needs further investigation (Best 1986). Nest survival in no-till row crops is low but relatively the same as survival in other nearby linear habitats, and delayed planting and limited early herbicide application could provide potential solutions to nest loss in row crop fields (VanBeek et al. 2014).

Life Cycle Assessment for Agricultural Products (Strategy 12.2)

Originally developed in manufacturing in the 1960s to manage increasingly global budgets, Life Cycle Assessment (LCA) evolved to quantify potential environmental impacts along the supply and consumption chain. It accounted for impacts such as pollution, waste disposal, and energy efficiency, and broadened into a scientific quantification of environmental sustainability, and for other sectors such as agriculture. LCAs are based on international standards and used in the government sector (e.g., regulations and labelling), private industry (e.g., companies adopting environmentally sound practices) and non-profits (e.g., consumer advocacy).

LCA differs from typical spatial-based ecological assessments in that it assesses impacts along the entire production and consumption chain of a product. For agricultural products, for example, impacts off of a farm (e.g., supplemental feed produced elsewhere) are included along with the direct land use impacts on a farm. Assessments that do not consider impacts on ecosystem characteristics such as biodiversity can lead to erroneous valuations (Teillard et al. 2016). The USDA provides an LCA Digital Commons database that supplies parameters to use in assessments.

Including biodiversity in LCA assessments requires that ecologists become involved in LCA model development (Teillard et al. 2016) to improve modeling and prediction of impacts on ecological systems. Bobolinks and other grassland birds are highly dependent on and impacted by land use decisions that are driven primarily by economic valuations. In those circumstances, their conservation will ultimately rely on incorporating biodiversity or other ecological characterizations into product valuations such as LCAs. Furthermore, ecologists need to improve oversimplified relationships in these models, define nonlinear relationships, incorporate effects of landscape metrics and ecosystem services, and derive spatially explicit assessments at different scales for on-farm and off-farm impacts. Additionally, biodiversity measures alone do not necessarily reflect ecological value in these systems, and other measures may be needed. For example, a crop under Integrated Pest Management (IPM) may have more diverse insect life, but may have few if any grassland birds of conservation concern.

Ecologists need to establish communication opportunities with LCA experts to bring ecosystem services into the valuation process, and find reconciliation between agriculture growth and conservation. LCAs need to incorporate and communicate complex functions of ecosystems. Given the nearly total dependence of grassland birds on agricultural lands, their long-term conservation will require that the impacts of production take into account impacts on their populations. Grassland conservationists have an opportunity to take the lead on contributing ecological underpinnings to the LCA process.

➢ *Strategies for South American Countries*

Workshops in South American countries occurred at different times and with different levels of available technical resources. Although countries identified broad strategies, not all countries scored or ranked them, and those that did utilized different processes. Thus conservation strategies in South America are in various stages of prioritization and implementation. It is anticipated that distribution of the Plan and especially expectation of support (financial and otherwise) will catalyze the next step of selecting the most promising actions to move toward implementation.

Colombia and Venezuela

1. Enable and promote best management practices.
2. Determine and communicate the value of coastline habitat.
3. Incorporate environmental practices into the palm industry.
4. Promote traditional extensive ranching.
5. Establish a network of protected areas.

Bolivia

1. Eliminate the use of monocrotophos pesticide.
2. Minimize the impact of pasture conversion on the biodiversity of pasture-dependent species.
3. Test and promote alternative management practices.
4. Minimize the effects of climate change on ecosystems.
5. Reduce burning in the savannas by 50%.
6. Reduce the introduction of exotic pests and control those that have already been introduced.

Argentina and Paraguay

1. Increase awareness of the importance of birds and their habitats in agroecosystems.
2. Prevent or avoid unplanned drainage.
3. Manage impacts of birds on rice production.
4. Promote research to predict effects of climate change and promote actions.
5. Promote/incentivize heterogeneity and conservation of habitat within production systems.
6. Carry out sustainable pasture management.

Common Themes for Bobolink and Other Species: Conservation in the Llanos

Controlling Bobolink Damage in Rice

Conflicts and threats associated with Bobolink foraging occur wherever significant populations overlap spatially and temporally with rice that is in the milk or soft stage that Bobolinks prefer. Concurrent with a loss of over half the Bobolink population over the last 50 years, the impact of their foraging on rice has been perceived as much reduced from past decades (Renfrew and Saavedra 2007). Actual rice consumption by Bobolinks varies within a farm, among farms, and among regions. Even within a farm, Bobolinks may select only one or two fields for foraging, leaving the rest entirely untouched. They appear to prefer some varieties of rice over others (Renfrew and Saavedra 2007, López-Lanús et al. 2007); for example, they may prefer varieties that provide a strong enough structure to allow them to perch at the top of the plant and forage on the seed below (López-Lanús and Marino 2010).

The severity of avian seed predation can be perceived as being greater than the actual crop loss (Basili and Temple 1999). Avian seed predation in crops has been found to be very low for sunflowers as well (Avery 2002). In two studies in Santa Fe, Argentina, 8% of rice harvest was lost in fields where Icterid (including Bobolink) flocks foraged (Marino et al. 2010). Two other studies found that only 2-5% of rice is lost from Bobolink seed predation (G. Marino, unpubl. data). Some farmers accept this loss as a part of doing business, as it is far less than losses from other organisms such as pest insects and fungus.

Species in the blackbird family (Icteridae) have posed a problem to crop farmers in North America and South America alike. While Bobolinks and other Icterids may be a problem for some rice farmers in South America (e.g., Marino et al. 2010), Red-winged Blackbirds and even Rusty Blackbirds cause problems in the southern states of the U.S. Generally, rice is no longer available to Bobolinks in North America. However, new rice plantations that offer edible seed during the post-breeding season in North America have found that a year or two after establishment, Bobolinks begin to appear and pose problems (R. Renfrew pers. obs.). This suggests that where milk-stage rice overlaps with the presence of Bobolinks (to what spatial extent is unknown), there may be conflicts.

Farmers on both sides of the equator have often used similar strategies to reduce crop seed predation by birds. Practices employed include visual deterrents such as shiny tape and smoke, and sound deterrents such as firecrackers and intermittent sonic and ultrasonic blasts. Some farmers have claimed, however, that scaring the birds from a preferred field often results in the birds scattering to several other fields. In Argentina perches were added to fields to encourage raptors that might deter songbirds from entering or remaining in crops (Marino et al. 2010).

Some forms of seed repellents have been shown to be effective against blackbirds (e.g., Avery et al. 2001), including caffeine treatments (Werner et al. 2007). The efficacy of chemical treatments on mature rice have been equivocal to limited (e.g., Marino et al. 2010, Werner et al. 2010). Anthraquinone (AQ), a biopesticide derived from natural compounds, has been effective as a deterrent for Red-winged Blackbirds in laboratory trials and in the field during rice seed planting. Treatments of rice during ripening (when Bobolinks feed), however, have not been effective (reviewed in Linz et al. 2011). AQ at relatively high concentrations on rice seed has been an effective deterrent for Dickcissel in lab trials (review in DiLiberto and Werner 2016). More field trials are needed to test the efficacy of AQ on various crops, including rice, and for several avian pest species. Farmers in some South American countries may lack access to the same chemical deterrents used in North America – a barrier that would need to be addressed should effective deterrents be developed.

Another approach to control avian seed depredation is the use of decoy fields (e.g., Linz et al. 2011). Because Bobolinks often revisit the same fields year after year (e.g., Renfrew and Saavedra 2007), under this approach the birds would be allowed to forage in preferred fields, and no scare tactics would be used, minimizing the scattering of the birds. The farmer who owns those field(s) is compensated by the other farmers in the area for the resulting losses in crop productivity. This spreads the burden of loss across all farmers, and saves the cost of using control measures. Furthermore, this strategy gives farmers more choices, as they do not need to avoid planting varieties that are preferred by the birds. This strategy has not been formally tested for its efficacy in controlling avian seed depredation in rice fields. In sunflower fields it was determined to be a cost-effective option only when seed predation resulted in >12% crop loss. The placement of decoy fields needs to take into account historic patterns of the birds and proximity to non-decoy fields, among other factors (Linz et al. 2011).

Considering all possible methods of controlling avian predation, Linz et al. (2011) conclude that for mobile species such as blackbirds, evasion methods (by manipulating lands surrounding crops) such as decoy crops, habitat management, and changing crop phenology are ultimately the most effective strategies to alleviate crop depredation. These methods may be further enhanced if effective crop repellents are developed.

Across its stages of development, from planting to harvest, rice fields provide habitat for a wide diversity of bird species (Blanco et al. 2006). Best management practices developed with rice producers stand to benefit the entire rice production system. In South America, bird conservation organizations are working directly with rice producers and industry groups. Aves Argentinas works with producers to develop and promote research on birds that use rice, develop products that benefit producers and the environment, and conduct outreach in local communities. Calidris, another bird conservation organization, is doing similar work in

Colombia, and promotes best management practices they develop in tandem with rice producers.

The Pesticide Treadmill

Over the decades, groups of pesticides have been introduced, banned, and then replaced by other groups. Different pesticides have different levels of toxicity to birds based on their mode of action, chemical properties, rates of application, mode of uptake, and interactions with the environment, among several other factors. Oftentimes a pesticide is introduced, the case against its use builds as organisms are harmed, another pesticide is introduced to replace it, evidence builds to show that it too is toxic, and then it too is removed from the market, to be replaced by another alternative.

After they were found to be highly toxic to many organisms, organochlorines such as DDT were replaced by organophosphates (OPs). Although these newer pesticides were less persistent in the environment, some were acutely toxic to birds. Approval for an OP called monocrotophos (MCP) was never sought in the U.S., but it has been used in other countries around the world. It has been problematic for birds in South America, including Bobolinks (see Pesticides in Threats section, Ch. 1). MCP was banned in Argentina and replaced by a less toxic OP, but it is still used in Bolivia, Venezuela, and Colombia, among other countries in South America and other parts of the world. Farmworkers also suffer ill effects of MCP, and those concerns are what prompted a temporary ban on MCP in Bolivia in 2009. However, according to the Agricultural Department of Santa Cruz, Bolivia (Servicio Departamental Agropecuario de Sanidad e Inocuidad Agroalimentaria de Santa Cruz; SEDACRUZ), the ban was not enforced or extended (R. Renfrew, pers. obs.).

The role of any given pesticide in agriculture, particularly one found to be toxic to non-target organisms, is usually complex. As the above example demonstrates, the pattern of the use of pesticide regulation is often cyclical in nature, and new pesticides can be as problematic as the old ones they were intended to replace. For Bobolink, neonicotinoids may pose a much lower direct threat compared to the organophosphates that they are replacing. However, they also may compromise organisms that play an essential role in the web of life, and have indirect effects on birds.

Achieving long-term, sustainable means to combat pests in crops is possible through approaches that take advantage of IPM and alternative techniques and products that restore an ecological balance in agricultural systems. These approaches can ultimately benefit farmers, farmworkers, and the natural systems that agricultural producers rely on. But implementing them on a significant scale requires a paradigm shift that comes with many practical challenges and short-term sacrifices.

For rice producers in South America, where the potential for exposure to pesticides may be greatest during a Bobolink's annual cycle, options vary by country. Technical resources vary dramatically from one country to another, and from one culture to another. Oftentimes lacking their own before-market safety tests, South American countries look to the U.S. regulatory process as a guide for their own standards for pesticide use. Limited capacity of extension services can restrict the amount of information on proper use and safety, affecting farmers' profits, farmworkers' health, and environmental impacts. Outreach can naturally address all of these issues together. In Colombia, for example, planning is underway to provide rice farmers with the opportunity to learn about and employ best management practices that reduce reliance on pesticides, improve soils, reduce runoff, and improve water quality. Directly and indirectly, these practices will ultimately benefit birdlife and farmers alike.

Strategies Developed Through Midwest Grasslands Network Seminar

In 2015, the Midwest Grasslands Network held a conservation deliberation in concert with the University of Minnesota Department of Food, Agricultural and Natural Resource Sciences to determine possible solutions to enact broad-scale grassland conservation in the Midwest region. The seminar included a semester-long series of presentations and discussions and brought participants together from a variety of disciplines to integrate insights from multiple perspectives (see Appendix B). The seminar produced the following creative solutions (Anderson et al. 2015).

Reduce the Negative Impacts of the Renewable Fuel Standard

In the U.S., the Renewable Fuel Standard (RFS) is a national policy that requires all transportation petroleum to contain a percentage of renewable fuels. Percentage requirements increase each year until 2022, at which point the program expects a total of 36 billion gallons of renewable fuel to be included as transportation fuel. Currently, the most common form of renewable fuel being used is corn ethanol, resulting in increased demand, increases in corn prices, and consequently a conversion of grasslands to corn crops.

This strategy takes a national policy approach to halt the conversion of grasslands by adjusting the RFS. One approach is to change renewable fuel requirements to de-emphasize ethanol and instead emphasize cellulosic ethanol and native biofuels. A second approach is to subsidize alternative biofuel and cellulosic ethanol production for both the agricultural and processing levels of production to make it more viable. Specific elements of this approach include: retrofitting ethanol production infrastructure to process cellulosic sources; earmarking tax dollars for technical support and subsidies for grassland conservation; and adjusting renewable fuel value estimates to reflect the true impacts (updated emissions estimates, land conversion, etc.) from corn ethanol production.

Bundle Ecosystem Service Payments

This option addresses the problematic and direct association of high crop prices with high grassland conversion. The goal of this approach is to account for the value of ecosystem services provided by grasslands, help offset the opportunity costs of maintaining grasslands, and incentivize the maintenance and restoration of grasslands through ecosystem service payments (ESPs). Organizations interested in protecting different ecosystem services provided by grasslands (e.g. carbon storage and water quality) pool funds to provide higher, more competitive payments to farmers. These partnerships can be established among existing organizations and social networks that have already established trusted relationships. Payment agreements should be structured to incentivize long-term enrollment as a means of encouraging retention despite market fluctuations. Such incentives might include higher rents for longer terms or bonuses for lengthier participation. Criteria for how to prioritize parcels will differ depending on the services of interest, and must be negotiated among buyers who are partnering to pool funds.

Make Use of Social Systems

To enact most conservation strategies, adequate social capital in the form of trust, information, and resources is essential. The following recommendations aim to foster social capital and learning networks and to address public perceptions of grassland ecosystems. This is especially important as our sense of normal and healthy declines in the face of increasingly degraded ecosystems.

Social networks can be effective mechanisms for promoting conservation actions and increasing interest in grassland ecosystems. Efforts to engage these networks should build on the land ethic and ecologically-oriented values of farmers; crosswalk and strengthen extant networks—especially those serving farm owners, operators, government agencies, and conservationists; plan infrastructure and support for self-governance and conflict management; focus on new landowners who are more likely to adopt new land management practices; communicate a pluralistic, place-based narrative that includes the history, evolutionary significance, aesthetic attributes, and ecosystem services of grasslands; and use art as a communication tool to influence behaviors and advance landscape stewardship.

Manage Rights-of-way on Private Lands

Energy corridors represent a growing yet underutilized opportunity for building grassland connections. Although these relatively narrow strips of land are generally not suitable as grassland bird breeding habitat, they can provide corridors between prairie patches and larger tracts of grassland habitat. This land is more readily available for grassland restoration compared to acquiring large tracts of land through purchase or conversion away from currently economically productive uses.

Energy companies that own vast networks of pipelines for the transport of fuels serve as a case study. Pipelines maintain a right-of-way with a minimum of 18 m wide, but average right of ways are closer to 30 m wide. This habitat could be useful for nesting grassland birds when it is adjacent to grasslands. Potential habitat should be mapped, researching compatible and competing uses researched, and best management recommendations and strategies developed that benefit both the conservation potential of the land and the economic needs of the corporation. At the least, this habitat can provide foraging habitat and corridors for grassland birds, as well as provide other environmental services such as pollinator habitat.

Maintain Grasslands

Grasslands require measured disturbance (fire, mowing, or grazing) to be maintained, as well as continued ethical and/or economic incentives to sustain these activities. Fostering cooperation between neighboring operations to economize labor-intensive practices (e.g., prescribed burning, cooperative ranching to institute larger rotational grazing schemes) may expand opportunities to adopt conservation measures. In addition, scaling up The Nature Conservancy's Grass Bank and similar programs would allow more farmers to graze on large holdings in exchange for carrying out practices on those lands that benefit the soils and wildlife. Finally, continued outreach to landowners and managers about bird-friendly maintenance techniques will be an ongoing need.

Controlled burning is often an alternative to fire suppression. Sometimes coupled with grazing (including by bison), it can also serve as an important grassland bird management tool. These tools, together or alone, can provide a mosaic of heterogeneous vegetation structure that provides habitat for a suite of grassland bird species (Fuhlendorf et al. 2006, Lueders et al. 2006), including on the wintering grounds (Hovick et al. 2014, 2015).

The ideal spatial and temporal combination of burning and grazing treatments depends on the desired habitat structure and bird community. Hovick et al. (2015) found that grassland bird diversity and abundance in large grassland landscapes were greater in more heterogeneous landscapes that were created by using a combination of burning and grazing regimes that resulted in a mosaic of vegetation structure. However, Pillsbury et al. (2011) found that in fragmented landscapes, characteristics of the surrounding matrix overrode effects of patch burning and grazing treatments. In that study Bobolinks occurred at greater densities in patches that were only burned, rather than some combination of burned and grazed, although the stocking density of cattle used is an important variable in any such study.

In the short term, Bobolinks generally respond positively to burning, although in the short term burn treatments can result in lowered Bobolink densities (Herkert et al. 1996). Ideal burn frequencies vary from one to three years depending on regional and site characteristics (reviewed in Dechant et al. 2001). Responses in the eastern part of the breeding range appear to be similar to the Midwest. In an eight-year study on a sandplain grassland in Maine, densities of Bobolinks were lower one year post-burn and then increased and remained high for several years (Vickery et al. 1999*b*). It is important to note that although one goal of ecological burning on high-priority areas such as CRP has sometimes been to increase native warm-season grass cover, Bobolinks can prefer cool season grasses (e.g., Runge et al. 2004, Vogel 2011).

Leverage Emerging Opportunities

In addition to the formal approaches described above for grassland conservation strategy, we also recognize that unique and time sensitive situations sometimes arise that present opportunities to benefit grassland birds. Therefore, we recommend conservationists frequently scan the horizon for new opportunities, and try to find creative and timely ways to take advantage of them. To illustrate, we describe several scenarios which represent emerging opportunities for grassland conservation (see Appendix G).

Next Steps

Link Actions to Goals and Form Action Teams

We recommend that grassland stewards and policy-makers in each major conservation region in North America complete the Open Standards process and then organize teams to carry out strategic priorities. In particular, representatives from different regions and sectors ought to gather at the earliest opportunity to:

- rank the full set of proposed strategies (Appendix E) based on feasibility and potential impact[1] (U.S. and Canada only);
- define additional supporting actions;
- for a subset of high priority actions, develop results chains[2] that develop explicit links to desired outcomes to ensure that goals can be met;
- evaluate the relationship between conservation actions and human well-being[3];
- tabulate current information on institutional roles and responsibilities for strategies and actions;
- identify critical gaps and any redundancies in grassland conservation initiatives; and
- form strategy-specific action teams based on where resources and interests align.

[1]As with other large-scale efforts to conserve representative species and their habitats, progress will depend on the capacity of coordinating bodies - such as interagency partnerships and agricultural associations - to provide leadership and communication support. Therefore, feasibility and impact ranking should include an assessment of current coordination capacity.

[2] The Miradi diagrams presented in Fig 2–17 allow the final steps in the OS process to be completed by partners within each country for strategies they choose to pursue. The most important step is the creation of results chains on a selected subset of priority conservation strategies. Results chains are a detailed logical series of outcomes or effects that link strategies to the desired conservation goal. The process of developing results chains requires that assumptions be made about how strategy implementation leads to impact on the conservation target, and that these assumptions are made explicit. It also requires that each strategy be linked to immediate and interim outcomes, and that those outcomes be linked to the direct threat on the species of interest and achieving the conservation goal. In other words, the OS process requires that conservation planning be accountable for enacting strategies that can measurably address threats

[3] An additional step in the OS process is to evaluate the contributions to and impacts of conservation actions on human well-being (CMP 2012). Human wellbeing targets are influenced by the status of conservation targets and the ecosystem services that depend on conservation. Results chains therefore show how meeting conservation targets also provides ecosystem

services that support human well-being. Given that the fate of grassland birds largely depends on decisions driven by forces outside of conservation, this part of the process would make explicit the benefits to humans associated with grasslands conservation.

Build Partnerships at the Hemispheric Scale

The influence of a more formal grassland-based partnership at the hemispheric scale on policy or societal norms could potentially impact millions of acres of grassland. While coordination and collaboration among partners at this scale may appear a daunting task, networks already exist for other species and suites of species, providing both an example and a potential framework. The Western Hemisphere Shorebird Reserve Network (WHSRN) has led the way in the Americas for partnering between North and South America to address conservation for several shorebird species. Decades of collaborative conservation planning, research, and conservation projects on the ground demonstrate that the hemispheric collaboration needed for long-distance migratory bird species is entirely within reach for grassland birds.

Initial efforts to collaborate across the hemisphere to conserve grasslands laid an important foundation for continued partnering. A draft Prairies to Pampas Grassland Bird Business Plan was created based on input from representatives from seven countries in 2013, and provided an important step in bringing countries together to share threats and potential solutions to grasslands conservation. Recent efforts in South America to bring countries together again and draft a cohesive strategy will carry this concept further. To continue to lay this groundwork towards formalizing and strengthening hemispheric coordination, a next step would be to take inventory of the various institutions and their initiatives, including priority sites and species, and illustrate the common ground and reinforcing activities between north and south American conservation priorities and efforts. In the light of high priority threats that impact overlapping priority resident and migratory species, potential collaborations and projects can then be identified.

The efficacy of international partnerships will rely on the coherence and strength of its constituents. Although a broad, hemispheric partnership is desirable, its success will require a strong foundation of committed, engaged, and coordinated bodies within each of the participating countries. In North America, the continued decline in grassland habitat has prompted a broader realization of the need for better coordination and leveraging among grassland conservation programs. In South America, the Southern Cone Grasslands Alliance (Appendix B) has provided focus and coordination for much of the Bobolink's wintering range, and Bolivia has joined that effort. The Alliance has also begun coordinating with Colombian organizations. The resulting network will cover most of the Bobolink non-breeding range in the continent, and the largest tracts of grasslands in South America.

Develop a Full Annual Cycle Model for Bobolink

Development of a fully integrated population model that can discriminate where in the full annual cycle population growth may be limited is an important next step for Bobolink. This may require additional monitoring to determine key demographic parameters. Uncertainty remains about the relative contributions to Bobolink population declines by factors operating on the breeding grounds in North America, the wintering areas in South America, and the migration areas between them. A detailed full annual cycle evaluation, including an analysis of vital rates such as productivity, recruitment, and survival would shed light on where and when to direct conservation efforts most efficiently. Obtaining seasonal survival estimates during the non-breeding season on a species like Bobolink, given its complex movements and occurrence in remote areas, is challenging at best. Opportunities to address basic information gaps about distribution and timing, habitat use, movements, and local threats will bring us closer to being able to at least conceptually understand the potential or actual relative contribution of threats to survival rates.

The Monitoring Avian Productivity and Survivorship (MAPS) and Monitoring Overwinter Survival (MoSI) programs use a standardized methodology and could provide a deeper understanding of full annual cycle dynamics. MAPS is comprised of a network of more than 350 monitoring stations across North America that capture and band birds during the summer breeding season. The MoSI Program operates in the Neotropics to examine within-winter survival, habitat use, and habitat quality. Most stations operate in forests, woodlands, and riparian areas, and a shift in capture methods to accommodate grassland species would be required. This would not greatly affect how an analysis of vital rates such as productivity and survivorship are carried out, although calculations for effort and some other parameters would be altered (D. F. DeSante, pers. comm.). The Institute for Bird Populations is currently developing protocols to monitor birds in grassland habitats.

Obtaining data on population changes at regional and finer scales needed to inform population models can be challenging for multiple reasons. The Northeast Bird Monitoring Handbook (Lambert et al. 2009) is a resource that provides general monitoring design principles. Long-term monitoring projects are notoriously difficult to fund but the spread of citizen science provides a means for collecting large amounts of data year after year, or every few years. Some but not all states/provinces have long-term monitoring programs. Funds are needed to step up monitoring in some regions, coordinate protocols across political boundaries, coordinate volunteers, and oversee bioinformatics.

Move Forward with Conservation Strategies Derived from the Plan

On the ground implementation of the strategies and actions identified in this Plan will inevitably necessitate multiple decisions at many different spatial and temporal scales. Initiative and contributions from a broad suite of traditional and novel partners will be critical. Many of those partners will be undertaking visionary grassland conservation actions in pursuit of other benefits, without even recognizing explicitly the long-term consequences for individual bird species and their populations. Therefore, knowledgeable regional planners will play a key role in selecting and implementing the most appropriate actions. These individuals must be able to incorporate local and regional ecology, the threats posed, and the socioeconomics—as well as the unique values and capacities of viable partners, both traditional and non-traditional.

Successfully implementing a plan that incorporates so many partners across such a broad range will require careful strategic planning. To guide this process, particularly in North America, partners would benefit from a coordinated implementation strategy that lays out the objectives to be accomplished, allocates resources and or identifies resource needs, designates responsibilities, defines and schedules milestones to the extent possible, and defines metrics and the process for evaluating success. In South America, implementation may be more straightforward, as priority strategies were selected as part of the planning process in some countries. Some projects related to these strategies are already underway and may simply require more support.

Tasks Prerequisite to Development of a Formal Implementation Strategy

1. Distribute the Plan (via hard copies, web links, webinars, and meeting presentations) to national and especially state and regional scale conservation planners who can make use of its biological content and grassland conservation strategies in support of their own work and who can promote its content and tools through their existing networks.
2. Apportion responsibility in the U.S. and Canada for meeting 30-year range-wide population goals for Bobolink through commitment to coordinated setting of sequential population objectives at the scale of Bird Habitat Joint Ventures. The Bobolink Population Objectives Tool provides a mechanism for achieving this.
3. At the Joint Venture regional scale in the U.S. and Canada, translate Bobolink population objectives into habitat objectives for protecting, managing, enhancing, and/or restoring grassland. Synchronize Bobolink habitat objectives with grassland objectives for other wildlife species by removing redundancy and modeling collective impact.
4. Assemble an international team—or reactivate the Bobolink Conservation Working Group—to more formally consider the best mechanism, structure, and tools for implementing Bobolink conservation strategies within the context of hemispheric grassland conservation.
5. Select the suite of strategies and actions from the Plan, both for breeding and non-breeding geographies, that are most appropriate for the relevant ecological and partner landscapes at regional and sub-regional scales. Wherever possible, facilitate coordination among neighboring partnerships.
6. In the U.S. and Canada, local and regional partnerships need to be constantly scanning the conservation horizon and examining how they might best participate in and amplify broader-scale geographic and conceptual opportunities. They can select one or more of the broad initiatives described in this Plan (e.g., Eastern Tallgrass Prairie Landscape Conservation Cooperative Gulf Hypoxia Initiative) which can provide frameworks, tools, and/or goals under which regional or sub-regional Bobolink and/or grassland habitat objectives might be embedded.
7. Incorporate elements of the Plan into other documents (e.g., a hemispheric grasslands conservation business plan), and identify and contribute to broad initiative objectives (e.g., certain water quality strategies) that simultaneously meet Bobolink grassland habitat objectives.

8. Through larger-scale coalitions that bring together diverse sets of locally-engaged partners—for example, those involved with private lands management in agriculturally-dominated landscapes—replicate local successes at scales sufficient to affect bird populations.
9. In North America, using tools such as those in the Conservation Atlas for Midwest Grasslands and with a broad array of partners, develop spatially-explicit grassland landscape conservation designs that can also serve as Grassland Bird Conservation Areas for Bobolink and other bird species.
10. Identify conservation agents (e.g. extension agents) and primary audiences (e.g., private landowners, public land managers, corporate landholders) necessary to implement appropriate conservation strategies and actions at all relevant scales from regional to local. Use local workshops to identify partner and audience needs and concerns, and using the insights of social science, identify relevant communication strategies and social networks appropriate to primary audiences. Using the content and tools presented in the Plan as source material, develop simplified versions of the Plan or re-statements of select content in alternative framing or language appropriate to the relevant agents and their primary audiences.
11. Deliver and coordinate selected grassland conservation and actions at multiple scales.
12. At regional and sub-regional scales in North America, monitor success of strategies and actions using goal outcome metrics (e.g., Bobolink population trends on breeding grounds, threat reduction on non-breeding grounds). Rangewide population monitoring will likely continue via BBS trend estimates, but alternative focused survey methodologies will need to be developed to assess changes in response to management actions in an adaptive (strategy modification) framework. Involvement of partners (including citizen science landowners) in monitoring is the ideal. Management funding reserved for monitoring outcomes and citizen science actions are needed to sustain adaptive monitoring activity.
13. Based on monitoring results, adjust and modify grassland conservation strategies and actions.
14. Continue to communicate results to partners at all scales to reinforce sustainability of grassland conservation; continue outreach to partners to assess what new or modified information is desired based on current and future partner stewardship capacity

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APPENDIX A. Workshops Generating Input for the Bobolink Conservation Plan

Bobolink Plan—vetting Plan outline and approach
The Wildlife Society Annual Conference
Milwaukee, Wisconsin, USA
August 7, 2013

Rosalind Renfrew, Vermont Center for Ecostudies — workshop leader
David Sample, WI Department of Natural Resources
James Herkert, IL Department of Natural Resources
Andy Paulios, Wildlife Biologist, WI Department of Natural Resources
Jim Giocomo, USFWS Oaks and Prairies Joint Venture
Christine Ribic, USGS WI Cooperative Wildlife Research Unit, UW – Madison
Douglas Johnson, USGS Northern Prairie Wildlife Research Center
Daniel Schneider, WI Department of Natural Resources
Chris Lituma, Department of Forestry, Wildlife, and Fisheries, University of Tennessee
John Dadisman, WI Department of Natural Resources
Ben Zuckerberg, Department of Forest and Wildlife Ecology, UW – Madison
Sarah McGuire, Graduate Student, Trent University
Lisa McCauley, Department of Forest and Wildlife Ecology, UW - Madison
Carolyn Schmitz, Department of Forest and Wildlife Ecology, UW - Madison

Prairies to Pampas Business Plan
Fifth International Partners in Flight Meeting
Snowbird, Utah, USA
August 26-28, 2013

Rosalind Renfrew, Vermont Center for Ecostudies — workshop leader
Carlos Ruiz, Asociación Calidris
Bennett Hennessy, Armonía Bolivia
Adrian Di Giacomo, CONICET, Argentina
Miguel Matta, Central University of Venezuela
Rob Clay, Birdlife International
Jim Giocomo, USFWS Oaks and Prairies Joint Venture
Christine Ribic, USGS Wisconsin Cooperative Wildlife Research Unit
Tom Will, USFWS Region 3
Katie Koch, USFWS Region 3
Jon McCracken, Bird Studies Canada
Jon Hayes, Oaks and Prairies Joint Venture
Tara Imlay, Wildlife Preservation Canada
Robin White, U.S. Geological Survey
Andy Hinickle , Audubon of New York

Kim Peters, Massachusetts Audubon
David Wiedenfeld, American Bird Conservancy
Mike Parr, American Bird Conservancy

Bobolink Plan Workshop
2014 Midwest Bird Conservation and Monitoring Workshop
Port Washington, Wisconsin, USA
August 4-5, 2014

Tom Will, USFWS Region 3 — workshop leader
TJ Benson, Illinois Natural History Survey
Ryan Drum, USFWS
Danielle Ethier, University of Guelph
Andrew Forbes, USFWS
Dan Lambert, High Branch Conservation Services
Judy Pollock, Audubon Chicago Region
Rosalind Renfrew, Vermont Center for Ecostudies
Christine Ribic, USGS
David Sample, Wisconsin DNR
Bruce Ehresman, Iowa DNR
James Herkert, IL Department of Natural Resources
Karen Johnson
Michael North, Minnesota DNR
Rachael Pierce, USFWS
Wayne Thogmartin, USGS
Bill Mueller, Western Great Lakes Bird and Bat Observatory
Kim Peters, Vermont Center for Ecostudies
Jim Giocomo, USFWS Oaks and Prairies Joint Venture
Lisa MacAuley, University of Wisconsin - Madison

Bobolink Plan Workshop
Joint Northeast/Southeast Partners in Flight conference
Virginia Beach, Virginia, USA
October 7, 2014

Tom Will, USFWS Region 3 — workshop leader
Jon Atwood, Massachusetts Audubon
Greg Butcher, USDA Forest Service
Randy Dettmers, USFWS Region 5
Mitch Hartley, Atlantic Coast Joint Venture / USFWS
Stu Mackenzie , Bird Studies Canada
Will Smith, USFWS
Nathan Tarr, National GAP

Nellie Tsipoura, New Jersey Audubon
Dave Younkman, American Bird Conservancy

Bobolink Plan Workshop
Bogotá, Colombia
October 5-7, 2015

Carlos Ruiz, Asociación Calidris – workshop leader
Miguel Lentino, Fundacion Phelps (Venezuela)
Jorge Velásquez, Instituto Alexander von Humboldt
Giovanni Cárdenas, Red Viva
Jhon Infante, Fundación Yoluka
Diana Macana, Fundación Ixobrychus
Johana Zuluaga, Fundación Ixobrychus
Noemi Moreno, Asociación Bogotana de Ornitología
Pedro Camargo, Asociación Bogotana de Ornitología
Yanira Cifuentes-Sarmiento, Asociación Calidris
Juan Carlos Fernández, Fundación Científica ARA MACAO (Venezuela)

Bobolink Plan Workshop
Buenos Aires, Argentina
October 29-30, 2015

Gustavo Marino, Aves Argentinas – workshop leader
Alexis Cerezo, Aves Argentinas
Hernan Casañas, Aves Argentinas
Ayelén Muchiutti, Aves Argentinas
Natalia Casado, Aves Argentinas
Andrea Goijman, Instituto Nacional de Tecnología Agropecuaria (INTA) Castelar
Inés Pereda, Aves Argentinas
Belen Poliserpi, INTA Castelar
Noelia Calamari, INTA EEA Paraná
Sebastián Dardanelli, INTA EEA Paraná
Rodrigo Lorenzón, Universidad Nacional del Litoral - Consejo Nacional de Investigaciones Científicas y Tecnológicas (UNL-CONICET)
Adrián Galimberti, UNL-CONICET
Mariano Codesido, Universidad de Buenos Aires

Bobolink Plan Workshop
Santa Cruz, Bolivia[1]
November 3, 2015

Rodrigo W. Soria Auza, Asociación Armonía – workshop leader
[1] Participant list not available for Bolivia workshop

APPENDIX B. A Non-exhaustive Listing of Conservation Plans, Tools, and Programs that Directly or Indirectly Support Bobolink Habitat on the Breeding and Wintering Grounds

Grassland Bird Conservation Plans

Due to regional and finer-scale differences such as land use, grassland bird habitat and population trends, threats, and cultural norms, conservation plans specific to a region are important. They can break down and tailor objectives and strategies to the county level, where most implementation occurs. It is challenging, however, to coordinate these plans across a geographic scale as large as the breeding range of Bobolink. Below are examples of regional plans to address the conservation needs of grassland birds that can serve as references for coordination, future planning, and ideas for conservation strategies.

> *Ontario Grassland Bird Conservation Action Plan*
> McCracken et al. (2009)

This plan is still in draft form and not publicly available, but it has been updated in recent years, and reflects the conservation needs and priorities for a suite of grassland bird species. Recommended conservation actions include habitat restoration, development of BMPs, maximizing the efficacy of existing incentives towards grassland bird goals, developing new incentives, and targeting actions appropriately and opportunistically. The plan also identifies research needs, including: identification of focal areas; socioeconomic analyses that compare the effects of implementing different BMPs and incentives; impacts of some threats; potential impacts of emerging technologies associated with biomass energy; and the relative importance of some habitats. Policy objectives laid out in the plan focus on coordinating with existing policy and exploration of new policy to support practices that sustain grassland bird populations. Outreach actions aim to strengthen public awareness and appreciation, work more closely with farmers and landowners, and promote ecotourism opportunities. Finally, the plan includes monitoring actions needed to track population changes, and uptake and efficacy of conservation actions.

> *Ontario Recovery Strategy and Roundtable for Bobolink and Eastern Meadowlark*
> McCracken et al. (2009)

Ontario has been arguably leading the way in addressing the needs of grassland birds in the context of continued agricultural productivity and profitability. Its leadership has been the result, in some measure, of legislation that prompted actions to address declining grassland bird populations. In Canada in 2010, the Bobolink was listed as a nationally Threatened species by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), triggered by dramatic, unabated declines. This was followed shortly thereafter by formal listing under Ontario's Endangered Species Act (ESA), which requires the province to develop a Recovery Strategy (RS). A team representing scientific and conservation government agencies, universities, and non-governmental organizations developed the RS in consultation with dozens of experts, including governmental agronomists, academia, and non-governmental organizations representing farm and conservation interests.

The purpose of the RS was to stabilize population sizes to obtain a no net loss goal, consistent with the Partners in Flight planning document for Ontario's Bird Conservation Region 13(Ontario Partners in Flight 2008). Although stabilizing populations at roughly present-day levels over a 10-year period would have resulted in downlisting to a lower category of risk when the species is next re-assessed, this option was deemed impossible because of the nature and number of threats. Instead, an alternative was adopted: slow the current average annual rate of population decline from an average of three to four percent annually to an average of one percent over the first 10 years (equivalent to an overall loss of 10%), then aim to achieve population stability (no decline) after 2023. This approach embeds a short-term goal within the longer-term goal of achieving population stability. This same approach was adapted for the Bobolink Conservation Plan.

In a separate yet supporting process to the RS, the province formed a roundtable panel to recommend more specific activities, in part to aid in the finer details of implementing the RS. Their mission was to explore means to establish and/or provide funding for stewardship incentives, applied research projects, and outreach and extension services. Panel members were from conservation organizations, agricultural organizations, the wind industry, the aggregate industry, developers, and municipalities. The provincial agencies that oversee natural resources and agriculture provide secretariat support. Some of the specific options explored by the roundtable include overall-benefit permitting, safe harbor provisions, and exemptions for agricultural activities.

The process used to develop the RS, its resulting framework, and the roundtable all provide a working example and a foundation for the Bobolink Conservation Plan. This Plan and its development not only integrates with the RS, but uses many of the resources, strategies, and resulting concepts that emerged from their multi-year, multi-stakeholder process.

While the RS was being developed, the province of Ontario passed a 3-year exemption for agricultural activities impacting Bobolinks (e.g., haying), so that farmers would not be in violation of the ESA. This exemption was later extended for a further 10 years.

Prairie Pothole JV 2005 Implementation Plan—Section V: Landbirds

As a region that supports an estimated 30% of the global Bobolink population, the Prairie Potholes is key to reaching Bobolink population goals. This JV Plan cited a fairly stable Bobolink population in 1975–2005, and Bobolink was not a priority species. However, the plan cites the PIF concept of "keeping common birds common," and emphasizes the need to maintain populations, a challenge amidst losses in grassland habitat. The region prioritizes implementation of the BCA model in priority conservation areas. For the tallgrass region, specifications for BCAs are based on needs of Greater Prairie Chicken.

Canadian Prairie Habitat Joint Venture
(Continental Assessment Report 2009, Implementation Plan 2007-2012)

The PHJV is a vast, 158 million acre prairie and parkland landscape in Alberta, Saskatchewan, Manitoba and the Peace Parkland region of British Columbia. PHJV is "a working landscape: it is primarily privately owned and dominated by agricultural production. PHJV partners must ensure that their programs are relevant to farmers and rural communities. Flexible and diverse options, such as conservation easements, land purchases, leases, tax incentives, crop-choice incentives and other landowner-friendly alternatives, combined with landscape-scale policy and stewardship initiatives, are all key to program success." Landscape objectives include conversion of cropland to hayland or tame pasture, and had demonstrated success between 2007-2011. The JV hosted the National Ecological Goods and Services Technical Meeting in 2009 in Ottawa, focusing on results of Canadian pilot projects and other studies. In attendance were over 100 participants from agriculture and environmental sectors, representing 62 organizations. Their stated Bobolink population objective is to increase the population estimated at the time at 267,100 to 334,410. The plan states that there is a need for Integration of other bird groups, including "information and analysis to assess overlap and related benefits between PHJV waterfowl habitat actions and other bird group habitat issues." They also have a long-term (25-year) plan that commenced in 2001 and will conclude in 2026.

Saskatchewan Prairie Conservation Action Plan

The Saskatchewan Prairie Conservation Action Plan (SK PCAP) engages 30 agencies and organizations representing producers, industry, provincial and federal governments, environmental non-government organizations, and research and educational institutions working towards a common vision of prairie and species at risk conservation in Saskatchewan. The partnership has proven to be an important forum for guiding conservation and management efforts within Saskatchewan's Prairie Ecozone. The Plan serves to: increase communication and collaboration amongst partners, thereby reducing duplications; address gaps in native prairie research/activities and programming; guide the development of programs and policies that reward sustainable use and promote ecological health and integrity including species at risk recovery; and improve public understanding of native prairie and species at risk.

Northern Great Plains Grassland Landscapes Plan

The National Fish and Wildlife Foundation (NFWF) is funding a 10-year (2023) project to develop a grassland bird conservation goal for the Northern Great Plains (NGP), identify priority restoration/conservation sites, and design a monitoring program to report on progress. These early action proposals will guide the Foundation's greater efforts to restore, protect, and enhance grassland resources in the NGP. NFWF's grant-making program in the Northern Great Plains will assist partners to design and implement outcome-based, sustainable grassland conservation projects in high biodiversity areas. Activities will contribute towards a program goal of developing a network of large-scale grasslands that are managed to sustain functional native plant and animal communities and healthy human communities.

CMS Migratory Grassland Bird Action Plan for Southern South America
Convention on Migratory Species

This plan lays out actions to address habitat and other needs of endemic and wintering migratory grassland birds in Bolivia, Argentina, Brazil, Paraguay, and Uruguay (CMS 2010). It is a memorandum of understanding that laid the foundation for some of the projects being carried out by the Southern Cone Grasslands Alliance (below). The goals include protection, management, program development, addressing information gaps, supporting policy and international cooperation, and outreach to increase awareness of and appreciation for grasslands. Actions include but are not limited to: the creation of protected areas, agricultural market incentives; promotion of native grasses in ranching operations; basic research and bird monitoring, including the illegal pet trade; integrating and coordinating data management internationally; and promotion and other outreach. Each action has an associated level of difficulty, the specific institutions involved, outcomes/measures of success, and a timeline.

Species Conservation Plans

Conservation plans for species that co-occur with Bobolink also benefit Bobolink populations. Common themes among recommended conservation actions that emerge from the plans below are provided in chapter 2.

Upland Sandpiper Conservation Plan
Vickery et al. (2010)

This was the first full life cycle conservation plan for an avian grassland obligate. It includes conservation needs and research gaps on breeding, migration, and wintering grounds. The plan amplified awareness about the non-breeding distribution and potential concerns during the wintering period, and since the plan was produced the answers to a few of the information gaps have been pursued. Proposed conservation actions are general, and those that are also covered in the Bobolink Conservation Plan include: providing incentives to maintain large, private grazed lands in North and South America; and managing grasslands appropriately on protected public lands in the U.S. Midwest. Like other grassland bird plans, they recommend habitat management to provide a mosaic of vegetation structure. Management recommendations in South America include adopting BMPs that reduce pesticide use and adjust burning regimes.

Status Assessment and Conservation Plan for the Henslow's Sparrow
Cooper (2012)

This plan addressed conservation on both the breeding and wintering grounds. The objectives and the actions in the plan are based on input at a 2007 workshop, with updates on any progress on the specified actions since the workshop. Actions in the plan also benefit Bobolink and may overlap with actions in this Plan including: promoting CRP; maximizing conservation on public lands; establishing non-traditional partnerships, including the cellulosic biofuel industry.

The plan recommends an Eastern Grassland Bird Working Group to carry out actions in the plan through the PIF *Five Elements Process* (Will et al. 2005).

> *Grasshopper Sparrow Status Assessment and Conservation Plan*
> Ruth (2015)

This plan reports on the status of the species and provides a high-level framework of recommended actions to address conservation and research needs throughout the life cycle. Recommended actions that also can apply to Bobolink conservation include: supporting CRP and other Farm Bill programs that benefit grassland birds and their appropriate management; subsidies for delayed haying and idling land; directing easement programs to large tracts of land; establishing protected public rangelands; and removing invasive plants. As in this Plan, the authors promote management for a mosaic of vegetation structure to support a diversity of grassland bird species, and the collection of demographic data across the breeding range and throughout the life cycle. Research and monitoring needs that also pertain to Bobolink include the need to better quantify and monitor suitable or potentially suitable grassland habitat, and amending BBS protocols to better survey populations.

> *National Wild Pheasant Conservation Plan*
> Midwest Pheasant Study Group (2012)

For each of six habitat management regions, this plans describes challenges and opportunities for pheasant conservation, and lays out population and habitat goals. It also assesses the status and needs of pheasant at the state level, and lays out objectives and actions as well as research needs. Although pheasant habitat needs differ somewhat from Bobolink, there are actions in this plan that benefit multiple species including Bobolink, including: increasing CRP acreage; targeting CRP strategically to maximize benefits; promoting delayed haying; developing and managing cellulosic biofuel crops; and mid-contract management of CRP.

Initiatives, Programs, and Projects

Many programs, mostly multi-stakeholder consortiums of several organizations, are directly or indirectly addressing the conservation needs of declining grassland birds by securing, restoring, or improving habitat. Although an exhaustive list would require a lengthy document, some of the primary programs that are or could affect Bobolink habitat are described, ranging from worldwide to regional, from coordination and planning to implementation. Providing an online directory of grassland conservation efforts could foster collaboration and exchange of ideas.

From the Prairies to the Pampas: Hemispheric Coordination

Until recently, North and South American grasslands ecologists and conservationists have largely responded to threats to grassland communities in their respective countries in isolation. From Canada to Argentina, each country faces challenges under unique circumstances, yet there are some underlying threats that are shared among countries and even between continents. Grassland conversion to croplands, unsustainable grazing, and energy and mining are common threats. It has long been recognized that the conservation of grasslands can be strengthened by building consortiums, exchanging ideas, supporting other initiatives, leveraging funds by unifying similar efforts, and working at a broad scale.

To begin developing a coordinating framework, representatives from eight countries met for three days at the 2013 Partners in Flight conference in North America. Their charge was to begin drafting a business plan that would identify and prioritize threats and conservation projects for grasslands across the Americas. The Bobolink was established as one of 18 focal grassland species. Focal species included endemics from both hemispheres, as well as short and long-distance migratory bird species. The *Prairies to Pampas* draft plan provided groundwork and enabled initial discussions, but additional engagement was needed, especially from South American partners.

More recently, South American organizations have now taken the lead in further promoting the concept of hemispheric coordination. The Southern Cone Grasslands Alliance (below) and SAVE Brasil, with support of Birdlife International and NMBCA funds, have held discussions to determine how best to proceed. In November 2015 representatives from Canada, the U.S., Colombia and Bolivia presented their work in grasslands during part of an Alliance gathering. In 2016 BirdLife Americas Partners prioritized hemispheric grasslands as 1 of 5 focal strategic programs, and created a working group to be led by SAVE Brasil. Representatives of several countries will meet again before the close of 2016, again as part of an Alliance gathering, to clarify the needs and roles of a hemispheric body, which are provided in this plan under full life cycle conservation strategies and actions. The momentum developed through these efforts is an encouraging sign that partnerships and collaboration between North and South American grasslands conservationists continue to strengthen.

Americas Flyways Framework

The Americas Flyways Framework is an emerging international entity that may serve as one means for carrying out some of the strategies from a Prairies to Pampas Business Plan and/or the Bobolink Conservation Plan. The Convention on the Conservation of Migratory Species of Wild Animals (CMS) was formed as a global platform for a United Nations Environment Program (UNEP) environmental treaty that deals with the conservation and sustainable use of migratory animals and their habitats. CMS provides international coordination of conservation measures throughout the range of migratory species. Under CMS the Bobolink has been added to the list of species requiring special international conservation efforts (see http://www.cms.int).

The Programme of Work on Migratory Birds and Flyways adopted in 2014 by CMS parties includes actions for migratory bird protection. Although many of the measures are aimed primarily at migratory waterbird and raptor species, there are actions intended for migratory species in general, such as the identification of critical habitats, sites, and ecological networks. Although Bobolink is not considered a global priority species, it may stand to benefit in some regions from these actions. Other actions relate to protection of all bird species, and those that could apply to Bobolink conservation include the prevention of bird poisoning and the prevention of illegal killing, trapping, and trade. The specific actions under the latter category apply to other regions and species, but they establish a standard for migratory bird protection in general. Awareness raising through a communication strategy, addressing information gaps, and developing support tools are also included as actions that are needed, and partnerships are emphasized.

In 2014, a resolution provided for the establishment of an Americas Flyways Framework (AFF) for the purpose of assisting governmental and non-governmental entities in the conservation of migratory birds and their habitats in the flyways of the Western Hemisphere. The AFF is the result of a collaboration between the CMS Flyways Working Group and the WHMSI task force, charged with developing an action plan for migratory bird conservation in the Americas. A Task Force is now being formed to coordinate the development and implementation of an Action Plan to achieve the AFF targets. This includes international cooperation and mobilization of resources to support a range of concerted conservation actions and provisions for priority species and their habitats. The Task Force consists of government representatives of CMS Parties in the Americas and other interested parties and observers from organizations working on flyway conservation in the region. Tasks for the Americas Flyways region includes the implementation of an MOU and Action Plan for Southern South American Grassland Birds and Their Habitats, which includes Bolivia, Argentina, and Paraguay.

IUCN World Commission on Protected Areas—Grasslands Specialist Group
International Union for the Conservation of Nature

The mission of this multinational group is to "reverse the trend of biodiversity loss in the grasslands biome." Their focus is to identify and create protected areas and to encourage policies that prevent conversion of grassland to other forms of agriculture. The group implements the Temperate Grasslands Conservation Initiative (TGCI), which supports and reports on grassland conservation needs, initiatives, and accomplishments at the global scale. They focus on the large-scale conservation of native grasslands through protection of preserves and working lands.

TGCI focal regions that overlap with the Bobolink range include the Northern Great Plains Ecoregion and the Southern Cone grasslands. The Northern Great Plains project is currently developing a plan for shortgrass and mixed grass regions in the U.S. and Canada. The goal of the project is to "coordinate existing partners and existing programs to engage them collaboratively in the common goal of restoring the ecological health of the Northern Great Plains." The South American plan geographic scope includes, among other grasslands systems on the continent, the pampas and campos grasslands of Argentina, Brazil, Paraguay, and Uruguay. Their interest is to address "issues such as sustainable management and green commerce, formal protection, policy building, climate change adaptation and mitigation strategies, and development of financial mechanisms for conservation."

Southern Cone Grasslands Alliance

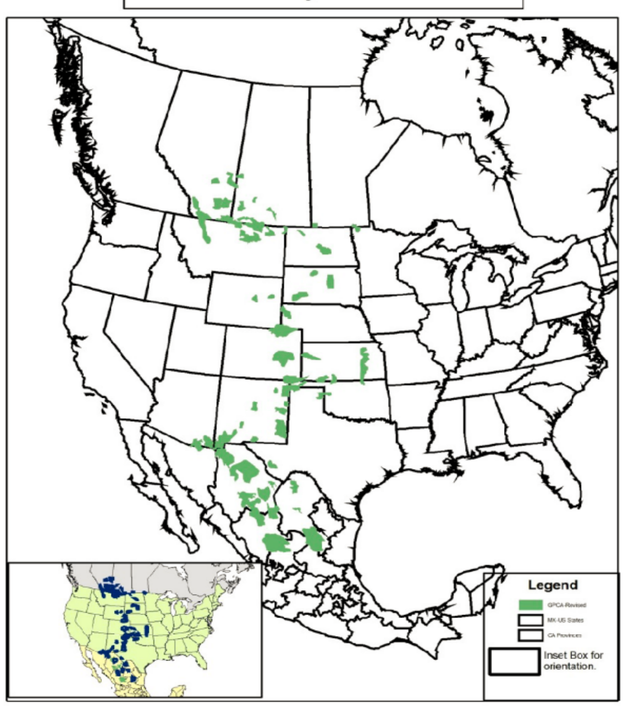
The Alliance is a consortium led by Birdlife International that seeks to mainstream biodiversity conservation within the agricultural sector in the Pampas grasslands. The Alliance has a multi-sector platform, led by a board of producers and conservationists. Working with ranchers, they developed and implemented best management practices for grazing of natural grasslands that combine production with biodiversity conservation. Coupled with this effort, they have been promoting national and regional policies that support market and fiscal-based incentives for natural grasslands conservation. The Alliance developed a certification scheme for natural grasslands beef that is produced following bird-friendly management. Ranches certified under this scheme now have their beef on store shelves in European markets, where the product is being actively promoted. The innovative program is an example that Canadian and U.S. organizations are actively seeking to reproduce in North America.

North American Grasslands Alliance (Commission for Environmental Cooperation)

The Commission for Environmental Cooperation (CEC) developed a framework for grassland conservation in North America ranchlands since establishing an initial, coarse framework in the early 2000's (Gauthier et al. 2003). Although the program has been inactive in recent years, its contributions continue to help guide grasslands conservation planning and programs in the Northern Great Plains and on the wintering grounds of some grassland birds in the southwestern U.S. and Mexico, specifically the Chihuahuan Desert grasslands.

The Strategic Plan for North American Cooperation in the Conservation of Biodiversity led to the identification of 55 grassland priority conservation areas within North America's central grasslands (CEC and TNC 2005). Together, these sites comprise 26,686,000 ha, or approximately 32% of the total area of native grasslands within the biome (McCracken 2005). Although Bobolink was not one of the bird species considered when the CEC established their Grassland Priority Conservation Areas, some of the areas overlap with the Bobolink's breeding range and habitat.

Grassland Priority Conservation Areas



In 2012, the CEC formed the North American Grasslands Alliance, a consortium of government agencies, rancher groups, non-government organizations and other interest groups that focuses primary on ranchlands associated with beef production. These groups participated in three workshops to develop a framework for grasslands conservation focused on ranchlands in the Great Plains. The framework lays a foundation with strategic priorities to achieve the Alliance's vision of "environmentally healthy and productive ecosystems that sustain working landscapes, conserve biodiversity, and support vibrant rural communities" (CEC 2013). An important principle is that natural capital needs to be valued appropriately in policy, financial and land use decisions, and that the ecological costs of not stewarding the land must be determined and accounted for. It recognizes the long-term mutual benefit in retaining appropriately managed ranchlands for both conservation and profitable beef production.

Many of the framework's priorities and associated goals apply to agricultural sectors and land uses outside of beef production. This Plan often parallels if not solely relies on the Alliance's framework for beef-related issues. For other agricultural sectors and land uses, the framework provides elements that can be echoed in and integrated with the Bobolink Plan. Furthermore, CEC, in collaboration with the Bird Conservancy of the Rockies (BCR), is addressing the full life cycle conservation needs of grassland birds that breed in the Northern Great Plains and winter in the Chihuahuan Desert of southwestern U.S. and Mexico. Although they address a suite of species with different distributions, threats, and opportunities from the Bobolink, their projects can be considered one of the first examples of full life cycle conservation for grassland bird species. BCR developed the Chihuahuan Desert Grassland Bird Conservation Plan, detailing science-based management recommendations for each target species within the CEC priority conservation areas within the southwestern U.S. and Mexico (Pool et al. 2012).

Projects initiated from CEC's 2013 *Catalyzing North American Grasslands Conservation and Sustainable Use Through Partnerships* includes: 1) the establishment of on-the-ground pilot projects of beneficial management practices (BMPs) to demonstrate positive linkages between beef cattle production and conservation of native grasslands; and 2) compilation of statistics on the North American cattle ranching industry, beef cattle trade, and grasslands.

NABCI International subcommittee

The CEC Alliance has been considered a potential framework for facilitating NABCI's role and the role of western North America organizations in general in trinational and hemispheric grassland bird conservation. NABCI has been focusing on trinational migratory bird conservation between Canada, the U.S., and Mexico, and intends to extend their coordinating role to contribute to hemispheric coordination through this subcommittee.

Association of Fish and Wildlife Agencies (AFWA)

AFWA is an advocacy and coordination group representing state wildlife agencies. In September 2016, the Association of Fish and Wildlife Agencies (AFWA) Bird Conservation Committee established a Work Group. Their tasks include prioritizing grassland bird conservation to AFWA, begin development of a National Conservation Needs grant RFP to address grassland bird conservation needs currently identified by conservation partners and to operationally address potential new recommendations from the above evaluation, and to encourage prioritization of grassland bird conservation in budgeting of federal agencies. Finally, they aim to summarize grassland bird coordination and conservation efforts. This plan provides an initial although not exhaustive compilation of some of the current, major conservation-related initiatives.

In 2016-2018, AFWA intends to pursue four main tasks:

1. develop and submit a resolution that outlines the crisis in grassland bird conservation and the need to prioritize it.
2. facilitate evaluation and develop synopsis of existing efforts and partnerships.
3. develop an NCN to submit to AFWA support grassland bird priorities identified by the group.
4. encourage budgeting for bird conservation within federal agencies.

Northern Bobwhite Conservation Initiative (NBCI)

NBCI consists of wildlife agencies and conservation organizations within the National Bobwhite Technical Committee, charged with restoring bobwhite quail populations. Their strategic plan lays out the framework for conservation, including ranked areas with potential for management for bobwhite in each BCR (The National Bobwhite Technical Committee 2011). In order to facilitate conservation at local levels that ultimately scale up to the national level in a coordinated way, they also provide a Coordinated Implementation Program (CIP), a guide to states for applying those rankings to the local level. Bobwhite require grasslands, and conservation efforts can simultaneously benefit both bobwhite and other grassland bird species such as Bobolink where their ranges overlap. To maximize conservation dollars, better coordination among programs and initiatives, including identifying regions of overlap, is needed to implement multi-species conservation.

Midwest Grassland Bird Technical Subcommittee

The subcommittee is a group of grassland bird ecologists and conservationists from learning institutions, state and federal agencies, and NGOs. They promote grassland bird conservation and serve science needs for effective conservation. It provides technical advice for management, monitoring and restoration of grassland birds. Importantly, the group promotes consistency in monitoring, encourages data sharing, and promotes a regional approach to developing targeted Farm Bill practices with incentives for participation.

Midwest Grasslands Network

The mission of the Network is to create and sustain a network of grassland landscapes to support bird conservation objectives and the ecological, economic, and societal benefits of grasslands (native prairie, hayfields, and pasture). Steered by representatives from NGOs, academia, and state and regional government agencies in the U.S., the intention is to reach out to other grassland stakeholders.

The Network stems from the Grassland Bird Working Group of the Midwest Coordinated Bird Monitoring Partnership. In 2012 the group carried out a structured decision-making (SDM) workshop to develop an initial, hypothetical model for a grassland bird species that incorporated facts and assumptions about breeding, migration, and winter demographics. The exercise highlighted the severe limits on our ability to build useful models due to fundamental gaps in our knowledge. These gaps include threats and stressors, life history needs, survival rates, and landowner perceptions, attitudes and socioeconomic constraints. The Midwest Migratory Bird Program of FWS Region 3 recognized a need to scale up grassland conservation in order to slow or halt declines in grassland bird populations, and established funding to create the Network.

The goal of the Network is to establish conservation landscapes that can help to sustain grassland bird populations. It is intended to serve as a road map that connects the independent efforts already in place in the region (i.e., JVs, LCC, states, federal and NGO partners, social science, farm policy, ag economics), and provide means to work together to balance land use objectives and make a real place for grassland bird conservation at the metaphoric table. Phase I of the Network created two important contributions to the Bobolink Conservation Plan.

The Conservation Atlas for Midwest Grassland Birds is an online support tool for conservation planners and practitioners in the Midwest Region of the U.S. It supports grasslands conservation planning by integrating spatial information about grasslands, grassland birds, and conservation focus areas. Audiences for the map include political office holders, conservation and sustainable agriculture NGOs, the American Farm Bureau, and administrators and program staff of the Natural Resources Conservation Service and Farm Service Agency. The tool helps to align the efforts of organizations and agencies working in different parts of the region and at different scales, and enables collaboration with other grassland stakeholders operating at the landscape scale.

The Atlas is served by Data Basin, an open-access mapping and analysis platform used by other conservation planning atlases to synthesize and serve spatial information relating to wildlife habitat, ecosystem services, and conservation opportunities. The Atlas focuses on grassland values in three FWS Joint Venture regions: Eastern Prairie Potholes, Upper Mississippi Region Great Lakes, and Central Hardwoods. It serves as a resource for people working on grassland issues throughout the core focal region, providing layers drawn from several sources with information on current conservation assets such as existing grass on the landscape (NLCD), state grassland bird conservation areas (protected areas, focal areas, easements, grassland bird conservation areas), and bird survey data for nine grassland bird species (from eBird, the Avian Knowledge Network, and the Breeding Bird Survey).

A clearinghouse for other initiatives such as the LCC's MRB-GHI, Data Basin allows users to view, create, and save maps, as well as discover and download spatial data. The Atlas provides an opportunity to explore wildlife habitat values in relation to other ecosystem services and other initiatives. Wildlife or bird-based priorities can be viewed in relation to priorities identified by other environmental sectors. Users can also learn who else is working on similar issues in their region and where. Finally, Data Basin provides a public guides and case studies forum for considering conservation strategies in the context of spatial information.

The Atlas can guide where to focus conservation efforts, and the Midwest Grasslands Network recognized the need to couple that with conservation strategies. Successful grassland conservation needs to take effect at larger scales and in permanent ways in order to halt the long-term declines of grassland bird populations. In 2015 the Network convened a seminar *Change Strategies for the Future of Grassland Birds in the Midwest* to offer ideas for scaling up conservation efforts to achieve landscape-level outcomes for grassland birds.

The interdisciplinary seminar was hosted at the University of Minnesota. Thirty graduate students, faculty, and conservation professionals convened weekly to deliberate on a fundamentally challenging problem: how to replicate local conservation successes at a scale sufficient to reverse or halt the precipitous declines of grassland birds in the Midwest. Students then integrated insights from ecology, sociology, economics, public policy, and natural resource management into a set of change strategies for the future of grassland birds (Anderson et al. 2015). This synergistic approach seeks to spur innovation in sustaining prairies and surrogate grasslands, and the many services that they provide.

Seminar participants decided on a goal of retaining an existing 6 million acres (2.4 million ha) of Midwest grasslands, restoring an additional 6 million acres, and maintaining all 12 million acres (4.8 million ha) in perpetuity. Five general strategies encompass a range of recommendations for increasing and maintaining clustered and connected grass on the landscape (Anderson et al. 2015), and are included as conservation strategies and actions in this Plan.

Joint Ventures and Landscape Conservation Cooperatives

Both joint ventures and landscape conservation cooperatives have partnership foundations. Joint ventures evolved as a result of the 1986 North American Waterfowl Management Plan. While many joint ventures are coordinated by USFWS, some are coordinated by other NGO's or non-profits. These regional partnerships have been the model for cooperative migratory bird habitat management across North America; joint ventures now cover all of the United States and nearly all of Canada and Mexico. Key organizations in the geographic area of the joint venture comprise a management board that provides guidance and direction for all-bird management in their region.

The following ***Migratory Bird Joint Ventures*** cover Bobolink breeding range, and plans identifying grassland habitat needs that could impact Bobolink among other grassland species are provided:

Joint Venture	Plan
Playa Lakes	Landbird Team Report, Landscape Conservation Design Pilot for BCR 18 Portion of Nebraska
Northern Great Plains	Implementation Plan
Central Hardwoods	None found

Rainwater Basin	Landbird Plan, Implementation Plan
Prairie Potholes	Implementation Plan, Communications Plan
Prairie Habitat	Implementation Plan 2007-2012
Appalachian	Strategic Communications Plan
Eastern Habitat	Ontario Recovery Strategy
Intermountain West	Implementation Plan
Upper Miss Great Lakes	Landbird Habitat Conservation Strategy, Implementation Plan
Atlantic Coast	None found

Landscape conservation cooperatives (LCCs) were recently developed by the U.S. Department of Interior with the signing of Secretarial Order No. 3289 in 2010. LCCs bridge the gap between science and management to address complex, landscape level environmental challenges through collaboration. Twenty-two LCCS now cover nearly the entire geographic area of the U.S. and have selected specific landscape level issues their partners will address. LCCs that have at least part of their region overlapping with part of the Bobolink breeding range (Figure 2_6) include:

The Upper Midwest and Great Lakes LCC develops decision support tools for conservation planners and managers. Their work has included the development of focal conservation areas for forests, coastal areas, aquatic habitats, and urban areas. They are developing similar focal areas within their region for grassland habitats. One of their major efforts is to coordinate state wildlife action plans (SWAPs). In a 2016 workshop, SWAP coordinators across the Midwest identified grasslands as a significant landscape level problem that could benefit from multi-state cooperation.

Eastern Tallgrass Prairie and Big Rivers LCC has a variety of focal projects that aim to address grasslands. The prairie reconstruction initiative examines uncertainties in the prairie reconstruction process. The agroecology focal area is related to the larger multi-LCC Mississippi River Basin Gulf Hypoxia project (see below) and pursues research projects related to conservation practices in agricultural systems, landowner motivations to participate in conservation practices, and mapping/modeling efforts.

Plains and Prairie Potholes LCC developed focal areas that include grasslands and human dimensions of land use change related to grassland loss.

Great Plains LCC focal area aims to address landscape level grassland planning efforts specifically related to climate change.

Other LCCs that include parts of the Bobolink breeding range are the North Atlantic, Great Northern, Great Basin, and Southern Rockies LCCs.

Mississippi River Basin / Gulf Hypoxia Initiative is composed of seven LCCs joined together to respond to nutrient loads in the Gulf of Mexico from Midwest states and the Mississippi Alluvial Valley, and to minimize exacerbation of these loads from large-scale conversion of grasslands in the Great Plains. Based on a multi-stakeholder input process they have identified key science and management needs for a sustainable ecosystem/floodplain landscape that provides multiple benefits for agricultural productivity, water quality, and wildlife conservation. They have developed decision support tools using a Precision Conservation approach, evaluating strategies and formulating an optimal multifunctional landscape based on the user's values and production systems. The Precision Conservation Blueprint includes layers in Data Basin and a report, depicting prioritized agricultural conservation areas that represent the most cost-effective and receptive places for implementing practices with multiple benefits. Priority watersheds were identified based on nutrient export to the Gulf of Mexico, wildlife habitat value (including grassland birds), social capacity for uptake of practices (based on social and economic factors) and optimal siting of conservation practices using stakeholder input on desirable water quality, economic, and ecological impacts. Bobolink was one of several focal wildlife species used to help determine critical wildlife value habitats.

Conservation Planning Atlases (CPA) are part of the Conservation Biology Institute's Data Basin Team has partnered with multiple Landscape Conservation Cooperatives (LCCs) to develop CPAs. The North Atlantic LCC has developed a CPA under this program, and their region overlaps with the eastern part of the Bobolink breeding range. The Great Basin LCC, overlapping with the extreme western portions of the Bobolink breeding range, also has atlas products available.

Habitat Conservation and Delivery—Some Examples

Grassland Bird Conservation Areas

Grassland Bird Conservation Areas (GBCAs) are established in areas identified as priority for grassland bird conservation based on their ability to provide suitable habitat. Originally described by Sample and Mossman (1997), GBCAs are established in landscapes with relatively large patches of grasslands in open, grassy landscape matrices, which best support area-sensitive grassland bird species. GBCAs consist of a protected grassland core with a surrounding matrix of grasslands that may or may not be protected. Oftentimes GBCAs are part of a network of focal areas, for example the National Bobwhite Conservation Initiative (NBCI) has GBCAs that vary from several hundred acres to 300,000 acres (120,000 ha) in size.

GBCAs may be categorized into different tiers based on certain characteristics, ranked by their value to grassland birds and relative to the available habitat and land use in the region. For example, in the PPJV region, all GBCAs consist of a grassland core with a surrounding 1-mile wide matrix. Core areas are at least 95% grassland, at least 50 m from woody vegetation, and may contain up to 30% wetland habitat. Type 1 GBCAs have a core of at least 640 acres (260 ha) of grassland at least 1 mile wide, and the matrix and core together are at least 40% grassland. Type 2 GBCA cores are at least 160 acres (65 ha) at least ½ mile wide, and the matrix and core are at least 30% grassland. Type 3 are at least 55 acres (22 ha) of grassland core that is at least ¼ mile wide, with a matrix and core composed of at least 20% grassland.

In the former tallgrass region of the Midwest, a working lands approach utilizes new non-traditional partners and conservation actions to benefit the full suite of grassland bird species. As a first step, partners are organizing around a focal landscape composed of GBCAs that include a changing mosaic of grassland habitat types and quality. In Wisconsin, for example, by using a land sparing and sharing approach, the Southwest Wisconsin Grassland and Stream Conservation Area consists of state-purchased core areas surrounded by private lands that engage in complementary management. These are placed in regions considered prime for grassland bird conservation because they have large amounts of grassland habitat, few woodlands, and a relatively low proportion of prime agricultural soil. Most of the land has been used as pasture.

GBCAs of at least 10,000 acres (4050 ha) each have been designated in IL (8) and in Iowa (8; 1 overlaps with NBCI Focus Area). The size of core areas ranges from 320-5,000 acres (130 - 2000 ha) in IL, and in IA and WI are can be over 2,000 acres (800 ha). They are also being established in IN (CHJV and IBAs), MN (HAPET), MO (NBCI), WI, and NY. The PPJV also uses the GBCA concept for grassland bird conservation. There are certain criteria for establishment of a GBCA, depending on the state. For example, in IL the ideal goal is to establish GBCAs in landscapes that are at least 40% grassland and less than 10% wooded or developed. In Iowa, at least 25% must be in grass, and in WI 40-60% is in grass, and there is less than 20% trees/hostile habitat.

The success of GBCAs is measured using bird population estimates (WI), bird abundance or trends (IL) and/or in terms of acreage protected, restored, or enhanced (IL). Iowa uses the presence of SGCN and nesting success, but is interested in using population estimates that are tiered to regional goals. NBCI focal areas estimate the number of quail per unit area. Research through the Midwest Coordinated Bird Monitoring Partnership is evaluating whether the GBCA concept leads to source populations of the focal species. This question will be addressed regionally.

Ontario Soil and Crop Improvement Association

While the U.S. has the Farm Bill to implement some forms of conservation on agricultural lands, Canada has other entities and programs that deliver conservation. The Ontario Soil and Crop Association (OSCIA), a non-profit organization that supports farmers, is an example of an organization that provides tools to help farmers improve their practices for the benefit of their operations as well as for the environment and long-term sustainability. It operates all the way up the production chain, from farmer to consumer. In response to the listing of Bobolink in the province, Ontario's and Canada's Species At Risk programs support practices designed specifically to support Bobolink populations in Ontario. OSCIA's Grassland Stewardship Program provides incentives for best management practices, and provides support tools such as *Farming with grassland birds* (Kyle and Reid 2016), a guide to haying and grazing practices that reduce risks to grassland birds and provide more habitat.

Ontario Grassland Initiative Program (GSI)

As one outcome of the Ontario Bobolink Roundtable deliberations, the GSI program is set to roll out in Ontario in 2017. It involves the description, identification, enrollment, management and conservation of high-quality grassland habitat for Bobolink, Eastern Meadowlark and other declining grassland bird species. Under this program, at least 30,000 hectares (74,000 acres) of high-quality grassland habitat (including prairie, hayfields and pasture) will be protected over the next 20 years in Ontario. The GSI is also intended to provide other environmental benefits and ecological services such as carbon sequestration, pollinator habitat, biodiversity, and soil health.

Task-based elements of the GSI include:

1. defining, identifying and mapping lands according to their potential conservation value;
2. determining and establishing appropriate criteria for eligibility and enrolment of lands;
3. enrolling qualifying lands;
4. establishing, populating and maintaining a database registry of enrolled lands;
5. educating and working with landowners to develop and implement beneficial conservation management practices and actions on enrolled lands;
6. establishing effective incentive mechanisms for enrolling lands and engaging landowners (e.g., voluntary stewardship, recognition and awards, monetary incentives, tax relief, business/agricultural opportunity/benefit);
7. implementing education and outreach programs to raise awareness and to engage landowners, stakeholders and the public;
8. evaluating highest potential lands according to the feasibility and cost of enrolment in relation to their conservation value, economic impacts and stakeholder buy-in, and strategically prioritizing GSI investment and on-the-ground activities accordingly;
9. identifying and enrolling appropriate public and private lands as part of the GSI;
10. monitoring and reporting on relevant metrics necessary to evaluate the ongoing progress and success of the GSI and its conservation outcomes; and
11. adaptively managing the program as necessary, based on monitoring and evaluation of outcomes to achieve the best-value solutions.

Land Stewardship Project

Grazing practices that build up soil fertility, store carbon, and increase water filtration can result in quality habitat for birds. The Land Stewardship Project researches and promotes economical practices for ranchers that are environmentally sustainable. For example, they provide ranchers with seed mixes to establish diverse cover crops in a rotational system that provides a suite of benefits to the farmer and to the environment, such as reduced reliance on inputs, increased water filtration, drought resistance, and habitat for pollinators, at a low financial risk to farmers. The program includes tours of the pilot projects, transferring the knowledge and experience to others in the farming community.

South of the Divide Conservation Action Program (SODCAP)

Initiated in 2014, the South of the Divide Conservation Action Program Inc. (SODCAP Inc.) is a partnership of government and stakeholders in Saskatchewan with the charge of implementing the South of the Divide Multi-Species Action Plan for At Risk, Threatened, and Endangered species. This multispecies plan promotes cooperative programs that prioritizes habitat management for these species in an economically sustainable manner. SODCAP Inc. is overseen by a variety of government, non-profit, and agricultural associations, and industry promote projects that include Results-based Agreements, Grass Banking, Habitat Management Agreements, and restoration. Bobolink has not been specifically incorporated into these projects but stands to benefit from their outcomes.

Prairie Farm Rehabilitation Administration (Canada)

Canada's Prairie Farm Rehabilitation Administration (PFRA) is currently at a critical turning point. It had been a federal program that included more than 700,000 ha of pasture land in Alberta, Manitoba and Saskatchewan. After 77 years of successful operations, the lands were recently turned over to provincial control. The objectives of the program had been to "manage a productive, bio-diverse rangeland and promote environmentally responsible land use practice"; and to "utilize the resource to complement livestock production." The Manitoba provincial government has expressed strong interest in maintaining the program and provided funding for the newly formed Association of Manitoba Community Pastures (AMCP). The Range Management Implementation Committee (RIMG) was also formed to consider the overall management of these pastures and to their ensure ecological integrity. The committee includes provincial government agencies, crown corporations, and environmental non-profits organizations. The Saskatchewan government has proposed divesting of the land, creating enormous concern that pastured grasslands will be converted to other land uses. Saskatchewan holds the largest percentage of the PFRA pastures (over 750,000 acres or 300,000 ha, including some of the largest patches of native prairie anywhere in the Americas).

USFWS Partners for Fish and Wildlife Program

Probably the largest voluntary private lands program in the U.S. aside from the collective Farm Bill programs, the Partners for Fish and Wildlife Program (PFW) provides federal financial and technical assistance. It supports voluntary habitat restoration on private lands to benefit migratory birds, threatened, endangered, and other declining species. The Partners Program accomplishes restoration by leveraging partnerships with private landowners, non-Federal agencies, conservation organizations, schools and other entities with an interest in wildlife. Each region has a strategic plan that identifies geographic focus areas for a variety of species, including grassland dependent species in some cases. The program emphasizes conservation practices directed at restoring habitats which include, but are not limited to, wetlands, riparian areas, bottomland hardwoods, upland forests, native grasslands, savannahs and brushlands.

Multifunctioning Landscapes: a Minnesota Experiment

Dakota County, Minnesota is an example of delivering conservation in a package designed for multiple stakeholders. The goal is to create profitable, multi-resource management practices on private lands that restore the natural processes of the landscape. It will include regional parks, multi-purpose greenways, natural areas, shoreland, and agricultural areas. The county is one of the most ecologically diverse counties in Minnesota and home to more than 400,000 people. It encompasses fully developed and rapidly developing suburbs as well as rural townships with 230,000 acres (93,000 ha) of agricultural land. Funds from a voter-approved bond referendum has allowed the County to acquire conservation easements and to assist other entities to acquire land, totaling more than 11,000 acres (4450 ha). The county is using these lands and the mosaic around them to create an agricultural conservation reserve. A preliminary analysis using hydrology, land cover, soils, and parcel ownership has identified an initial study area where natural resources, land management practices, economics, and regulatory, legal and other issues would be assessed. They aim to achieve their goal by advancing the concept of ecosystem services and markets while protecting and improving water quality and wildlife habitat, enhancing the area's longstanding agricultural tradition and economy, integrating public and private benefits, and facilitating prioritization of public and private financing and other resources.

APPENDIX C. Provincial and State Status and Breeding Bird Atlas Results for Bobolink

SCGN: Species of Greatest Conservation Need. Conservation status ranks (NatureServe) are based on a one to five scale, ranging from critically imperiled (S1) to demonstrably secure (S5). B = applies to breeding season, N = applies to non-breeding season, NR = not ranked.

S1: Critically Imperiled—Critically imperiled because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state/province.

S2: Imperiled—Imperiled because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the state/province.

S3: Vulnerable—Vulnerable due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation from the state/province.

S4: Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.

S5: Secure—Common, widespread, and abundant.

State or Province	Status	Natural Heritage/ NatureServe Rank	Atlas 1	Atlas 2	Proportion change in # priority blocks occupied	Atlas Periods	SGCN	Comments
CANADA								
Alberta	Sensitive	S2S3						
British Columbia	SC	S3B						BLUE LIST: At risk
Manitoba		S4B						
Ontario	T	S4B	*	*	-0.28 *	81-95, 01-05		* Change expressed as change in % probability of observation (of 1748 and 2177 blocks in atlas 1 and 2, respectively)
Newfoundland		S2B						
Prince Edward Island		S3B						

State or Province	Status	Natural Heritage/ NatureServe Rank	Atlas 1	Atlas 2	Proportion change in # priority blocks occupied	Atlas Periods	SGCN	Comments
New Brunswick	Sensitive	S3B						
Quebec		S3						
Nova Scotia	Vulnerable	S3S4B						
Saskatchewan		S5B						
UNITED STATES								
Colorado		S3B					X	Science Forum designation "Species of Most Concern"
Connecticut	SC	S4B					X	State goal - Increase the statewide population from 7,900 to 12,000 individuals.
Idaho		S4B						
Illinois		S4					X	
Indiana		S4B	202	144	-0.29	85-90, 05-11		
Iowa		S4B	184	194	0.05	85-90, 08-12	X	
Kansas	SINC	S1B					X	Tier I - highest importance, State status SINC= 'Species in Need of Conservation'
Kentucky	SC	S2S3B					X	
Maine		S4B					X	Tier II
Massachusetts		S3S4B	334	471	0.41 (0.1*)	74-79, 07-11	X	*Atlas reports 9.9% increase in proportion of surveyed blocks occupied
Michigan		S5B	2312	1482	-0.36	83-88, 02-08	X	
Minnesota		SNRB					X	

State or Province	Status	Natural Heritage/ NatureServe Rank	Atlas 1	Atlas 2	Proportion change in # priority blocks occupied	Atlas Periods	SGCN	Comments
Missouri		S3					X	
Montana	SC	S3B					X	Tier III
Nebraska		S4						
New Hampshire		S4B					X	
New Jersey	T	S2B, S3N					X	
New York		S5B	3465	3178	-0.08		X	
North Dakota		SNRB					X	
Ohio	SC	S4	442	261	-0.41	82-87, 06-11	X	
Oregon		S2B					X	Population declines, small scattered colonial populations, sensitivity to water and some agricultural practices
Pennsylvania		S4B	1526	1739	0.14	83-89, 04-09	X	
Rhode Island		S3B					X	
South Dakota		S4B						
Utah	SC	S2B					X	Tier II
Vermont		S5B	156	147	-0.06	76-81, 03-07	X	
West Virginia		S2B					X	On state "rare, threatened and endangered" list
Wisconsin	SC	S3S4B					X	

State or Province	Status	Natural Heritage/ NatureServe Rank	Atlas 1	Atlas 2	Proportion change in # priority blocks occupied	Atlas Periods	SGCN	Comments
Wyoming		S2					X	Tier II - Population size or distribution is restricted or declining but extirpation is not imminent

APPENDIX D. Species Co-occurring with Bobolink in South America

Based on current knowledge, the species listed in the table below are known to overlap with Bobolink during its multi-week stops in South America. NT indicates a status of Near Threatened. Some species or family names are different for Colombia because they follow the classification and nomenclature of The South American Classification Committee of the American Ornithologists' Union (SACC).

Family	Species (SACC Name)	STATUS	English Common Name	Wintering Grounds Countries	Llanos and Caribbean Coast	Neotrop-Nearctic Migrant?	Neotrop-Austral Migrant
RHEIDAE	*Rhea americana*		Greater Rhea	AR, PY, BO			
TINAMIDAE	*Nothura maculosa*		Spotted Nothura	AR, PY			
CRACIDAE	*Ortalis garrula*	Endemic	Chestnut-winged Chachalaca		CO		
CRACIDAE	*Ortalis ruficauda*		Rufous-vented chachalaca		CO		
ANHIMIDAE	*Anhima cornuta*		Horned Screamer		CO, VE		
ANHIMIDAE	*Chauna chavaria*	NT	Northern Screamer		CO		
ANATIDAE	*Dendrocygna viduata*		White-faced Whistling-Duck		CO, VE		
ANATIDAE	*Dendrocygna autumnalis*		Black-bellied Whistling-Duck		CO, VE		
ANATIDAE	*Dendrocygna bicolor*		Fulvous Whistling-Duck		CO, VE		
ANATIDAE	*Amazonetta brasiliensis*		Brazilian Teal		CO, VE	res[1] & mig[2]	
ANATIDAE	*Anas discors*		Blue-winged Teal		CO, VE	res (CO) & mig	
COLUMBIDAE	*Columbina minuta*		Plain-breasted Ground Dove		VE		
COLUMBIDAE	*Columbina talpacoti*		Ruddy Ground Dove		CO, VE		
COLUMBIDAE	*Zenaida auriculata*		Eared Dove		CO, VE		
COLUMBIDAE	*Columbina squammata*		Scaled Dove		VE, CO		
COLUMBIDAE	*Patagioenas cayennensis*		Pale-vented Pigeon		CO		
CUCULIDAE	*Crotophaga ani*		Smooth-billed Ani		CO, VE		
CUCULIDAE	*Crotophaga sulcirostris*		Groove-billed Ani		CO, VE		

Family	Species (SACC Name)	STATUS	English Common Name	Wintering Grounds Countries	Llanos and Caribbean Coast	Neotrop-Nearctic Migrant?	Neotrop-Austral Migrant
CUCULIDAE	*Crotophaga major*		Greater Ani		CO		
ARAMIDAE	*Aramus guarauna*		Limpkin		CO, VE		
RALLIDAE	*Coturnicops notatus*		Speckled Rail	AR, PY, BO			
RALLIDAE	*Aramides cajaneus*		Gray-necked Wood-Rail		CO		
RALLIDAE	*Laterallus albigularis*		White-throated Crake		CO		
RALLIDAE	*Porzana albicollis(Mustelirallus albicollis)*		Ash-throated Crake	AR, PY, BO			
RALLIDAE	*Porphyrio martinica*		Purple Gallinule		CO, VE		
RALLIDAE	*Porphyrio flavirostris*		Azure Gallinule		VE		
BURHINIDAE	*Burhinus bistriatus*		Double-striped Thick-knee		CO, VE		
CHARADRIIDAE	*Charadrius semipalmatus*		Semipalmated Plover		CO, VE	mig	
RECURVIROSTRIDAE	*Himantopus mexicanus*		Black-necked Stilt	AR, PY, BO	CO, VE	res (VE) & mig	
CHARADRIIDAE	*Pluvialis (dominica) dominica*		American Golden-Plover	AR, PY, BO		mig	
CHARADRIIDAE	*Vanellus cayanus*		Pied Lapwing		CO, VE		
CHARADRIIDAE	*Vanellus chilensis*		Southern Lapwing		CO		
CHARADRIIDAE	*Charadrius collaris*		Collared Plover	AR, PY, BO	VE		
SCOLOPACIDAE	*Bartramia longicauda*		Upland Sandpiper	AR, PY, BO	VE	mig	
SCOLOPACIDAE	*Micropalama himantopus (Calidris himantopus)*		Stilt Sandpiper	AR, PY, BO	CO	mig	
SCOLOPACIDAE	*Calidris minutilla*		Least Sandpiper		CO, VE	mig	
SCOLOPACIDAE	*Calidris melanotos*		Pectoral Sandpiper	AR, PY, BO		mig	
SCOLOPACIDAE	*Calidris pusilla*	NT	Semipalmated Sandpiper		CO, VE	mig	
SCOLOPACIDAE	*Limnodromus griseus*		Short-billed Dowitcher		CO	mig	
SCOLOPACIDAE	*Gallinago delicata*		Wilson's Snipe		CO, VE	mig	
SCOLOPACIDAE	*Gallinago paraguaiae*		South American Snipe	AR, PY, BO	VE		mig
SCOLOPACIDAE	*Actitis macularius*		Spotted Sandpiper		CO, VE	mig	

Family	Species (SACC Name)	STATUS	English Common Name	Wintering Grounds Countries	Llanos and Caribbean Coast	Neotrop-Nearctic Migrant?	Neotrop-Austral Migrant
SCOLOPACIDAE	*Tringa solitaria*		Solitary Sandpiper	AR, PY, BO	CO	mig	
SCOLOPACIDAE	*Tringa melanoleuca*		Greater Yellowlegs	AR, PY, BO	CO	mig	
SCOLOPACIDAE	*Tringa flavipes*		Lesser Yellowlegs	AR, PY, BO	CO	mig	
SCOLOPACIDAE	*Tryngites subruficollis*	NT	Buff-breasted Sandpiper		CO, VE	mig	
JACANIDAE	*Jacana jacana*		Wattled Jacana		CO, VE		
LARIDAE	*Larus cirrocephalus*		Grey-headed Gull	AR, PY, BO			
LARIDAE	*Larus maculipennis*		Brown-hooded Gull	AR			
LARIDAE	*Sterna trudeaui*		Snowy-crowned Tern	AR, PY, BO			
LARIDAE	*Sternula superciliaris*		Yellow-billed Tern		CO, VE		
LARIDAE	*Phaetusa simplex*		Large-billed Tern		CO, VE		
LARIDAE	*Gelochelidon nilotica*		Gull-billed Tern		CO, VE	res & mig	
CICONIIDAE	*Ciconia maguari*		Maguari Stork	AR, PY, BO	CO, VE		
CICONIIDAE	*Jabiru mycteria*		Jabiru	AR, PY, BO	CO, VE		
CICONIIDAE	*Mycteria americana*		Wood Stork	AR, PY, BO	CO, VE		
PHALACROCORACIDAE	*Phalacrocorax brasilianus*		Neotropic Cormorant		CO, VE	res & mig	
ARDEIDAE	*Botaurus pinnatus*		Pinnated Bittern		CO, VE		
ARDEIDAE	*Tigrisoma lineatum*		Rufescent Tiger-Heron		CO, VE		
ARDEIDAE	*Ardea herodias*		Great Blue Heron		CO	mig	
ARDEIDAE	*Ardea cocoi*		Cocoi Heron		CO, VE		
ARDEIDAE	*Ardea alba*		Great Egret		CO, VE	res (VE) & mig	
ARDEIDAE	*Syrigma sibilatrix*		Whistling Heron		CO, VE		
ARDEIDAE	*Egretta thula*		Snowy Egret		CO, VE	res (VE) & mig	
ARDEIDAE	*Egretta caerulea*		Little Blue Heron		CO		
ARDEIDAE	*Egretta tricolor*		Tricolored Heron		CO	res & mig	
ARDEIDAE	*Butorides virescens*		Green Heron		CO	mig	

Family	Species (SACC Name)	STATUS	English Common Name	Wintering Grounds Countries	Llanos and Caribbean Coast	Neotrop-Nearctic Migrant?	Neotrop-Austral Migrant
ARDEIDAE	*Butorides striata*		Striated Heron		CO, VE		
ARDEIDAE	*Ixobrychus involucris*		Stripe-backed Heron	AR, PY, BO	VE		
ARDEIDAE	*Nycticorax nycticorax*		Black-crowned Night-Heron		CO, VE		
ARDEIDAE	*Nyctanassa violacea*		Yellow-crowned Night-Heron		CO, VE		
ARDEIDAE	*Ardeola ralloides*		Squacco Heron	AR, PY, BO			
ARDEIDAE	*Bubulcus ibis*		Cattle Egret		CO, VE	res (VE) & mig	
THRESKIORNITHIDAE	*Eudocimus albus*		White Ibis		CO, VE	res (VE) & mig	
THRESKIORNITHIDAE	*Eudocimus ruber*		Scarlet Ibis		CO, VE		
THRESKIORNITHIDAE	*Plegadis falcinellus*		Glossy Ibis		CO, VE	res & mig	
THRESKIORNITHIDAE	*Cercibis oxycerca*		Sharp-tailed Ibis		CO, VE		
THRESKIORNITHIDAE	*Phimosus infuscatus*		Bare-faced Ibis		CO, VE		
THRESKIORNITHIDAE	*Theristicus (caudatus) caudatus*		Buff-necked Ibis	AR, PY, BO	CO, VE		
THRESKIORNITHIDAE	*Platalea ajaja*		Roseate Spoonbill		CO, VE	res (CO) & mig	
THRESKIORNITHIDAE	*Harpiprion caerulescens*		Plumbeous Ibis	AR, PY, BO			
CATHARTIDAE	*Cathartes aura*		Turkey Vulture		CO, VE	res & mig	
CATHARTIDAE	*Cathartes burrovianus*		Lesser Yellow-headed Vulture		CO, VE		
CATHARTIDAE	*Coragyps atratus*		Black Vulture		CO, VE		
PANDIONIDAE	*Pandion haliaetus*		Osprey		CO, VE	mig	
ACCIPITRIDAE	*Heterospizias meridionalis (Buteogallus meridionalis)*		Savannah Hawk	AR, PY, BO	CO, VE		
ACCIPITRIDAE	*Elanus leucurus*		White-tailed Kite		CO, VE		
ACCIPITRIDAE	*Rostrhamus sociabilis*		Snail Kite		CO, VE		
ACCIPITRIDAE	*Busarellus nigricollis*		Black-collared Hawk		CO, VE		
ROSTRATULIDAE	*Nycticryphes semicollaris*		South American Painted-snipe	AR, PY, BO			
STRIGIDAE	*Asio flammeus*		Short-eared Owl	AR, PY, BO			

Family	Species (SACC Name)	STATUS	English Common Name	Wintering Grounds Countries	Llanos and Caribbean Coast	Neotrop-Nearctic Migrant?	Neotrop-Austral Migrant
ALCEDINIDAE	*Megaceryle torquata*		Ringed Kingfisher		CO, VE		
ALCEDINIDAE	*Chloroceryle amazona*		Amazon Kingfisher		CO, VE		
ALCEDINIDAE	*Chloroceryle americana*		Green Kingfisher		CO, VE		
FALCONIDAE	*Herpetotheres cachinnans*		Laughing Falcon		CO, VE		
FALCONIDAE	*Caracara cheriway*		Crested Caracara		CO, VE		
FALCONIDAE	*Milvago chimachima*		Yellow-headed Caracara		CO, VE		
FALCONIDAE	*Falco sparverius*		American Kestrel		CO, VE		
FALCONIDAE	*Falco columbarius*		Merlin		VE	mig	
FALCONIDAE	*Falco peregrinus*		Peregrine Falcon		VE	mig	
PSITTACIDAE	*Eupsittula pertinax*	Pest in rice	The brown-throated parakeet		CO		
DONACOBIDAE	*Donacobius atricapilla*		Black-capped Donacobius		CO, VE		
FURNARIIDAE	*Certhiaxis cinnamomeus*		Yellow-chinned Spinetail		CO, VE		
FURNARIIDAE	*Synallaxis albescens*		Pale-breasted Spinetail	AR, PY, BO	CO, VE		
TYRANNIDAE	*Serpophaga nigricans*		Sooty Tyrannulet	AR, PY, BO			
TYRANNIDAE	*Polystictus pectoralis*		Bearded Tachuri	AR, PY, BO			
TYRANNIDAE	*Pseudocolopteryx sclateri*		Crested Doradito	AR, PY, BO			
TYRANNIDAE	*Pseudocolopteryx flaviventris*		Warbling Doradito	AR, PY			
TYRANNIDAE	*Culicivora caudacuta*	Vulnerable	Sharp-tailed Tyrant	AR, PY, BO			
TYRANNIDAE	*Hymenops perspicillata*		Spectacled Tyrant	AR, PY, BO			
TYRANNIDAE	*Xolmis cinerea*		Tyrant Flycatcher	AR, PY, BO			
TYRANNIDAE	*Fluvicola pica*		Pied Water-Tyrant		CO, VE		
TYRANNIDAE	*Arundinicola leucocephala*		White-headed Marsh-Tyrant		CO, VE		
TYRANNIDAE	*Alectrurus risora*	Vulnerable	Strange-tailed Tyrant	AR, PY			
TYRANNIDAE	*Machetornis rixosa*		Cattle Tyrant		CO, VE		
TYRANNIDAE	*Myiozetetes cayanensis*		Rusty-margined Flycatcher		CO, VE		
TYRANNIDAE	*Myiozetetes similis*		Social Flycatcher		CO, VE		

Family	Species (SACC Name)	STATUS	English Common Name	Wintering Grounds Countries	Llanos and Caribbean Coast	Neotrop-Nearctic Migrant?	Neotrop-Austral Migrant
TYRANNIDAE	*Pitangus sulphuratus*		Great Kiskadee		CO, VE		
TYRANNIDAE	*Tyrannus melancholicus*		Tropical Kingbird		CO, VE		
TYRANNIDAE	*Tyrannus savana*		Fork-tailed Flycatcher	AR, PY, BO	CO, VE		res & mig
TYRANNIDAE	*Tyrannus dominicensis*		Gray Kingbird		CO, VE	res & mig	
HIRUNDINIDAE	*Alopochelidon fucata*		Tawny-headed Swallow	AR, PY, BO			
HIRUNDINIDAE	*Progne tapera*		Brown-chested Martin		CO,VE		res & mig
HIRUNDINIDAE	*Progne chalybea*		Gray-breasted Martin		CO, VE		
HIRUNDINIDAE	*Tachycineta albiventer*		White-winged Swallow		CO, VE		
HIRUNDINIDAE	*Tachycineta leucorrhoa*		White-rumped Swallow	AR, PY, BO			
HIRUNDINIDAE	*Riparia riparia*		Bank Swallow		VE	mig	
HIRUNDINIDAE	*Hirundo rustica*		Barn Swallow	AR, PY, BO	CO, VE	mig	
HIRUNDINIDAE	*Petrochelidon pyrrhonota*		Cliff Swallow	AR, PY, BO		mig	
TROGLODYTIDAE	*Troglodytes aedon*		House Wren		CO		
MOTACILLIDAE	*Anthus lutescens*		Yellowish Pipit	AR, PY, BO			
MOTACILLIDAE	*Anthus furcatus*		Short-billed Pipit	AR, PY, BO			
MOTACILLIDAE	*Anthus chacoensis*		Pampas Pipit	AR			
MOTACILLIDAE	*Anthus correndera*		Correndera Pipit	AR, PY, BO			
MOTACILLIDAE	*Anthus hellmayri*		Hellmayr's Pipit	AR, PY, BO			
THRAUPIDAE	*Paroaria nigrogenis*		Masked Cardinal		CO, VE		
THRAUPIDAE	*Sicalis columbiana*		Orange-fronted Yellow-Finch		CO, VE		
THRAUPIDAE	*Sicalis flaveola*		Saffron Finch		CO, VE		
THRAUPIDAE	*Volatinia jacarina*		Blue-black Grassquit		CO, VE		
THRAUPIDAE	*Donacospiza albifrons*		Long-tailed Reed Finch	AR, PY, BO			
THRAUPIDAE	*Sicalis luteola*		Grassland Yellow-Finch	AR, PY, BO			
THRAUPIDAE	*Emberizoides herbicola*		Wedge-tailed Grass-Finch	AR, PY, BO	CO, VE		
THRAUPIDAE	*Emberizoides ypiranganus*		Lesser Grass-Finch	AR, PY, BO			

Family	Species (SACC Name)	STATUS	English Common Name	Wintering Grounds Countries	Llanos and Caribbean Coast	Neotrop-Nearctic Migrant?	Neotrop-Austral Migrant
THRAUPIDAE	*Embernagra platensis*		Great Pampa-Finch	AR, PY, BO			
THRAUPIDAE	*Sporophila minuta*		Ruddy-breasted Seedeater		CO, VE		
THRAUPIDAE	*Sporophila intermedia*		Gray Seedeater		CO, VE		
THRAUPIDAE	*Sporophila nigricollis*		Yellow-bellied Seedeater		CO, VE		
THRAUPIDAE	*Sporophila lineola*		Lined Seedeater		VE		
THRAUPIDAE	*Sporophila leucoptera*		White-bellied Seedeater	AR, PY, BO			
THRAUPIDAE	*Sporophila hypoxantha*		Tawny-bellied Seedeater	AR, PY, BO			
THRAUPIDAE	*Sporophila ruficollis*		Dark-throated Seedeater	AR, PY, BO			
THRAUPIDAE	*Sporophila palustris*	Endangered	Marsh Seedeater	AR, PY, BO			
THRAUPIDAE	*Sporophila hypochroma*		Rufus-rumped Seedeater	AR, PY, BO			
THRAUPIDAE	*Sporophila cinnamomea*	Vulnerable	Chestnut Seedeater	AR, PY			
THRAUPIDAE	*Sporophila crassirostris*		Large-billed Seed-Finch		VE		
THRAUPIDAE	*Sporophila collaris*		Rusty-collared Seedeater	AR, PY, BO			
THRAUPIDAE	*Sporophila angolensis*		Chestnut-bellied Seed-Finch		VE		
CARDINALIDAE	*Spiza americana*		Dickcissel		CO,VE	mig	
THRAUPIDAE	*Coryphospingus pileatus*		Grey Pileated Finch		CO, VE		
EMBERIZIDAE	*Ammodramus humeralis*		Grassland Sparrow	AR, PY, BO	CO, VE		
EMBERIZIDAE	*Ammodramus aurifrons*		Yellow-browed Sparrow		CO, VE		
PARULINAE	*Geothlypis aequinoctialis*		Masked Yellowthroat	AR, PY, BO			
ICTERIDAE	*Gymnomystax mexicanus*		Oriole Blackbird		CO, VE		
ICTERIDAE	*Chrysomus icterocephalus*		Yellow-hooded Blackbird		CO, VE		
ICTERIDAE	*Agelaius thilius*		Yellow-winged Blackbird	AR, PY, BO			
ICTERIDAE	*Agelaius ruficapillus*		Chestnut-capped Blackbird	AR, PY, BO			
ICTERIDAE	*Xanthopsar flavus*	Vulnerable	Saffron-cowled Blackbird	PY			
ICTERIDAE	*Pseudoleistes guirahuro*		Yellow-rumped Marshbird	AR, PY, BO			
ICTERIDAE	*Pseudoleistes virescens*		Brown-and-yellow Marshbird	AR			

Family	Species (SACC Name)	STATUS	English Common Name	Wintering Grounds Countries	Llanos and Caribbean Coast	Neotrop-Nearctic Migrant?	Neotrop-Austral Migrant
ICTERIDAE	*Molothrus bonariensis*		Shiny Cowbird	AR, PY, BO	CO, VE		
ICTERIDAE	*Quiscalus lugubris*		Carib Grackle		CO, VE		
ICTERIDAE	*Quiscalus mexicanus*		Great-tailed Grackle		CO		
ICTERIDAE	*Sturnella militaris*		Red-breasted Meadowlark		CO, VE		
ICTERIDAE	*Sturnella superciliaris*		White-browed Meadowlark	AR, PY, BO			
ICTERIDAE	*Sturnella magna*		Eastern Meadowlark		VE		
ESTRILDIDAE	*Lonchura malacca*		Tricolored Munia		VE		
PLOCEIDAE	*Ploceus cucullatus*		Village Weaver		VE		
TURDIDAE	*Turdus ignobilis*		Black-billed Thrush		CO		

1 = resident species
2 = migrant species

APPENDIX E. Strategies for Bobolink Conservation for Each Major Region/Country in the Plan, and Associated Conservation Actions

This is not an exhaustive list, but rather a menu of possibilities. Strategies without conservation actions are not necessarily lower priority than those with actions.

North America

Strategic Theme:

1. Birds need grazers (and graziers): support grazing systems that provide the vegetative structure and levels of disturbance compatible with successful grassland bird nesting

Strategies:

1.1 Provide incentives and other support that minimize shrub growth and also benefit beef production

1.2 Develop/strengthen incentives and markets for grazing practices that benefit populations of Bobolink and other wildlife

Actions:

1.2.1 Develop value-added products for beef produced on ranchlands that cultivate refuges to benefit pollinators, grasslands birds, and water quality

1.2.2 Support industry efforts to market grass-fed beef in Canada and the U.S.

1.2.3 Expand market to more chain restaurants and stores

1.2.4 Partner with organizations that support beneficial ranching practices, e.g., Land Stewardship Project, American Grassfed Association (certifies grass-finished beef) and Wild Farm Alliance (supports farming that benefits biodiversity)

1.2.5 Explore means to provide price subsidies for grass-finished beef for health and conservation benefits that complement grass-finished promotions

1.2.6 Support efforts to establish clear labeling that distinguishes 100% grass-fed (includes grass-finished) from other beef

1.2.7 Develop and promote certification schemes for sustainable beef with multiple benefits to ecosystem and beef producers, such as Audubon's Conservation Ranching Program and companies such as Wild Sky beef

1.3 Encourage grazing as a wildlife management tool in WMAs by retaining governmental rights to permit cooperation with agricultural stakeholders

1.4 Expand/extend Canadian community pasture program to promote practices that support Bobolinks

1.4.1 Promote complementary pastures, where grazing is focused on cold-season grass early in the season and native grass is grazed later in the season

1.5 Educate consumers about products that support healthy grassland ecosystems and human health

1.5.1 Educate consumers about differences between grass-fed, grass-finished, organic, natural etc. and their implications for support of grassland systems

1.5.2 Promote practices that benefit grasslands and human health, with a focus on human health benefits

2. Use prescriptive fire to prevent succession of grasslands into shrublands where appropriate

2.1 Promote prescribed fire and shrub mowing to maintain contiguous open lands

3. Address the haying dilemma: develop and promote economically viable mowing schedules that allow birds to produce young

3.1 Identify target areas and guidelines for sustainable hay and pasture management

3.1.1 Initiate and support research to identify landscapes and soils appropriate for establishing 'bird friendly' hayfields

3.1.2 Assess current practices and temporal trends in haying practices via meta-analysis of published reports

3.1.3 Use regional breeding phenology data from across the breeding range to establish local or regional guidelines on mowing dates

3.1.4 Determine how breeding habitat quality decreases over time under late cutting regimes to inform optimal frequency of management for maintaining habitat quality

3.1.5 Determine extent to which Bobolinks are able to relocate and nest successfully after displaced by early-season mowing

3.2 Develop markets for late-cut hay

3.2.1 Promote other uses for hay that do not require frequent haying through agricultural extension

3.2.2 Establish criteria for ‘bird-friendly hay' designation via wildlife-based marketing incentives program, similar to Bird-Friendly Coffee. (e.g., Credit Value Conservation Authority)

3.3.3 Follow example of pollinator conservation efforts to establish ‘prairie shares'; members pay farmers to set aside and manage land as grassland bird habitat

3.3 Provide economic incentives for late-cut hay

3.3.1 Advocate for the inclusion of delayed haying schedules into current mitigation programs (e.g., mitigation credits transferable to farms employing sustainable practices)

3.3.2 Develop/expand programs to compensate landowners for foregone income from delayed haying

3.4 Provide information on best practices for late-cut haying

- 3.4.1 Establish farmer/landowner support networks to share management tools and promote incentive options
- 3.4.2 Develop effective control methods for invasive plants under delayed haying regimes
- 3.4.3 Provide partner staff within NRCS to implement and oversee bird-friendly practices
- 3.4.4 Provide focal areas and management recommendations to NRCS staff

3.5 Support research on cultivars of alfalfa and other common hay species that provide quality forage and sustain bird productivity

- 3.5.1 Assess the value of double-cut cultivars (e.g., red clover) as breeding habitat, either alone or as part of mixed-species hayfields.
- 3.5.2 Assess the utility, feasibility and habitat value of grass species that can be harvested at a taller height (i.e., higher blade clearance)
- 3.5.3 Promote warm-season grass hay as a late-mow alternative

3.6 Implement grassland bird-friendly mowing practices on airfields, public, and corporate lands

- 3.6.1 Disseminate results of New Jersey Audubon study of optimal airfield grass height
- 3.6.2 Sell program stressing increases in airport safety and highlighting airfields that successfully manage for grassland birds
- 3.6.3 Develop a MOW LESS program for corporate properties, parks, and local government

3.7 In Canadian Prairie Provinces, determine management regimes that are or can provide source habitat

- 3.7.1 Determine whether the region serves as a source due to many late-hayed fields in wet versus dry years
- 3.7.2 Explore warm-season grasses as a means for creating later-cut fields and stakeholder willingness to adopt

4. Increase public awareness of the effects of pesticides on birds and people

4.1 Support/promote alternatives that complement outreach

4.2 Contribute to public health outreach

- 4.2.1 Disseminate information on nitrate/atrazine rural well-contamination and its effects on urban areas
- 4.2.2 Disseminate information on the effects of hormones from runoff on human growth
- 4.3 Improve and use pesticide mortality/toxicology models to assess population-level impacts

5. Maintain hay and pasture and/or convert crops to hay or pasture

5.1 Support retention of Canada's PFRA grasslands through the provinces

5.2 Encourage conversion of monoculture crops to grazed grasslands

5.2.1 Develop programs that mimic grazing brokerage companies, for example 'matchmaking' services that link landowners with other value-based methods of land management (e.g. Southwest Badger Resource Conservation and Development Council in WI, Wallace Center [Winrock International])

5.3 Develop programs that subsidize sunk and transitional infrastructure costs (e.g., machinery) to corn and soy growers.

5.4 Influence corn crop values with market-based initiatives that change product demand

5.4.1 Develop and implement marketing program aimed at promoting human health by reducing corn syrup and other corn-derived products.

5.5 Work with national companies that manage cropland for absentee landowners to incorporate grasslands objectives into management schemes

5.6 Build partnerships to advocate for multifaceted, balanced farm subsidy programs that allow for competitive hay markets (e.g., NGO-Market partnerships - Ducks Unlimited, TNC)

5.7 Develop and coordinate messaging to the farming community with 'bird-friendly' outreach and marketing programs

5.7.1 Incorporate bird-friendly practices into messaging in current new-farmer incentive programs (e.g., Tufts University New Entry Sustainable Farming Project)

5.8 Couple increasing grain crop yields with grassland set-aside acreage

5.9 Determine causes, patterns, and solutions for conversion of grazed land to crops

5.9.1 Identify factors driving westward shift of Canadian beef production

5.9.2 Determine subsidies/futures necessary to make it economically feasible for farmers to remain in grazing

5.10 Develop and implement biodiversity offsets for grassland conversion

5.10.1 Mimic European program that uses development mitigation funds to support long-term sustainability plans and practices for farms

5.10.2 Target mitigation revenue for private lands conservation

5.10.3 Mitigate between breeding and non-breeding grounds losses

6. U.S. Farm Bill conservation programs: strengthen, profile, and improve to increase, sustain, and enhance quality grassland acreage and Bobolink habitat

6.1 Develop programs in the U.S. to promote conservation practices on idle lands and retiring CRP enrollments

6.1.1 Lobby members of the Agriculture and Conservation Committee to redirect CRP funds to support bird-friendly practices on working lands

6.1.2 Propose to extend delayed mowing EQIP-type incentives to CRP lands

6.1.3 Develop grazing brokerage programs between landowners and producers who also connect with NRCS programs (e.g., the Southwest Wisconsin Grazing Broker Program of the Southwest Badger Resource Conservation and Development Council). Include technical assistance.

6.2 Alter the scoring system for CRP bids to emphasize grassland bird habitat

6.3 Develop U.S. Farm Bill programs that reduce vulnerability of grassland habitat to political and economic instability

6.3.1 Lobby for expanded time period covered under EQIP and CRP contracts

6.3.2 Pursue a program that links incentives and practices to fluctuating commodity prices rather than to fixed dollar incentives

6.3.3 Develop grassland incentives that are competitive with crop rental rates

6.3.4 De-couple CRP lands that are beneficial to grassland birds from market fluctuations

6.4 Strategically direct U.S. Farm Bill conservation programs in areas of actual or potential Bobolink habitat

6.4.1 Provide NRCS staff and partners with focal area maps that enable them to prioritize lands that can support Bobolinks under CRP, EQIP, and ACEP. Focal areas based on 1) habitat potential for Bobolinks and (2) socioeconomic opportunity (cost, willing partners, proximity to community support, etc)

6.4.2 Provide in-house NRCS technical support staff to advise and support landowners. Place these service providers strategically, where service is most needed and impact can be greatest.

6.4.3 Work with NRCS to strategically place permanent and 30-year easements under ACEP in Bobolink focal areas

6.4.4 Expand lands eligible for continuous CRP signups to upland, less linear habitats

6.5 Use grasslands to reduce agricultural runoff

6.5.1 Widen waterway buffer strip requirements to increase grassland habitat and to reduce nitrogen runoff

6.5.2 Create grassland/wetland storage banks for water runoff from tiled (flat) topography

6.5.3 Identify areas (watersheds) where application of select conservation practices will reduce nutrient runoff relative to Gulf hypoxia

6.5.4 Establish permanent set-aside grassland cover for hillsides and other marginal lands, to protect against conversion when crop prices rise

6.6 Develop and implement a mitigation program to offset agricultural operations take

6.7 Improve CRP targeting and enforcement

6.7.1 Provide expertise within NRCS to identify best locations and practices for CRP enrollments and monitor outcomes

6.8 Raise conservation compliance standards for crop insurance

6.8.1 Extend conservation requirement (currently highly erodible lands and wetlands) to include other conservation measures beneficial to grassland birds

6.8.2 Reduce conservation measures compliance allowance from 5 years to 2 years in order to receive crop insurance

6.9 Revise U.S. Farm Bill and other programs that result in tree plantings that reduce grassland habitat quality

6.9.1 Replace NRCS mandate to plant trees for biofuel in grassland landscapes with support for prairie plantings

7. De-incentivize conversion and promote best practices by strengthening existing private conservation initiatives and supporting agricultural producers who provide quality grassland habitat

7.1 Identify alternative feed stocks for dairy and beef that are 'bird-friendly'

7.1.1 Initiate research on feedstock varieties that could potentially serve as economically viable alternatives to alfalfa

7.1.2 Assess the feasibility of using supplements to mitigate potential nutritional deficits imposed by planting bird-compatible feedstocks

7.2 Build partnerships with sustainable ag interests and beef producers to advocate for incentives to keep land in grazing

7.3 Seek funding to engage land trusts to promote easement options to landowners

7.4 Identify farms most likely to participate in sustainability programs that often do not receive essential information.

7.4.1 Advocate including locations of small farmers in agricultural censuses

7.4.2 Identify farm owners who are less profit-driven; e.g., so-called hobby farmers who have farms for aesthetic, tax write-off or personal reasons

7.5 Redirect high-density, feedlot systems towards more sustainable management systems

7.5.1 Design messaging strategy focused on improving environmental and economic benefits (e.g., water quality, soil) and align with existing farmer outreach programs

7.6 Develop value-added products based on practices that benefit wildlife/biodiversity

7.6.1 Broker relationship between farmers, processors, and retailers for value-added products from farms setting aside acreage for grassland birds and other environmental services

7.7 Remove shrubs/trees in open areas, providing habitat nearby until treated areas recover (Thompson et al. 2016)

8. Enact legislation in U.S. to fund grassland conservation and BMPs

8.1 Reward farmers employing best practices through Payment for Ecosystem Services and Pay-for-Success Programs

8.2 Increase the effectiveness of existing grassland lobbying groups

8.2.1 Develop and implement a network strategy to increase communication, align actions and objectives, and combine messaging

8.3 Introduce omnibus environmental bill (detached from Farm Bill) similar to Teaming with Wildlife bill

9. Determine, develop, and promote means for biofuel production that provides grassland bird habitat

9.1 Determine economic efficacy of bird-friendly biomass

9.1.1 Determine prairie mix tradeoffs between biological forb benefits vs. biofuel cash returns

9.1.2 Determine economic and other barriers to bird-friendly biomass biofuel

9.2 Replace Renewable Fuels Standard with a low-carbon fuel standard

9.3 Promote bird-friendly biomass energy

9.3.1 Support efforts to develop dedicated biomass energy (land under contracts) via native warm-season polycultures (e.g., Midwest Conservation Biomass Alliance partnership)

9.3.2 Support Northern Missouri AD project – development of digesters at CAFOs so fields used for manure spraying are converted to biomass fields that are managed sustainably (including for birds). Need 200,000 acres over 4 counties for biomass plant (1-2% of landscape)

9.3.3 Promote dedicated biomass crops grown for bioenergy feedstock (cellulosic) that include adequate diversity in structure and composition

9.3.4 Replace ethanol subsidies with measures that provide foregone income for bird-friendly biomass

9.3.5 Develop appropriate incentive levels to promote Bobolink-friendly seed mix

9.4 Encourage new cellulosic biofuels technology

9.4.1 Summarize current R&D limitations and feasibility of grass biomass

9.4.2 Enhance R&D support

9.4.3 Support policy to incentivize the ecosystem services of perennial biomass crops

9.4.4 Harvest grasses in wildlife refuges to use for methane production

9.5 Cluster oil wells along corridors and on multi-bore pads in order to minimize impacted habitat (Thompson et al. 2015)

9.6 Develop a strategy for promoting multi-objective, sustainable agroecosystems

9.6.1 Bundle multiple ecosystem services (monarchs and native pollinators, Bobolinks and other grassland birds, water quality) into landscape planning and messaging

9.7 Through EPA's Clean Power Plan, call for incentives for power plants to purchase carbon credits from agricultural producers growing perennial grasses (Midwest Conservation Biomass Alliance)

10. Incorporate climate change mitigation and adaptation into grassland bird conservation

10.1 Determine future conservation focal areas for Bobolink and other grassland birds given the predicted impacts of climate change

10.1.1 Predict changes in distribution in response to climate change (UW-Madison collaborative climate change modeling project, Audubon Society climate change project)

10.1.2 Adjust conservation planning based on predicted distributions

10.2 Use grasslands, including perennials, to sequester carbon and earn carbon credits for landowners

10.2.1 Expand the Climate Action Reserve's pilot program that establishes long-term grassland easements for carbon credits

11. Engage a broader range of stakeholders and interests

11.1 Increase exchange and foster relationships between grassland conservation proponents and agroindustry stakeholders

11.1.1 Add grassland conservation perspective to agroindustry by participating in multi-stakeholder associations that include industry leaders (eg, BSC joined Canadian Roundtable for Sustainable Beef)

11.1.2 Identify new avenues for engaging with corporate agricultural industry leaders

11.2 Develop strategy to reach influential media and personalities

11.2.1 Pitch a TV series that is set in prairie/grasslands

11.3 Partner with efforts that connect and leverage the multiple benefits of grassland conservation

11.3.1 With partners, identify high-priority and focal areas to maximize all interests for policy audience, in ways that benefit grassland bird habitat

11.3.2 Bring together partners with land cover data, identify regions that address different needs and functions (e.g., highly productive lands, highly erodible lands that provide wildlife habitat; efforts underway with USGS, UMESC, Purdue & Oregon State)

11.3.3 Partner with the Mississippi River Basin-Gulf Hypoxia (MRB/GH) Initiative to develop and implement outreach to hypoxia-affected communities (e.g., economically), to encourage Gulf politicians to demand retribution from

Midwest politicians

11.3.4 Partner with MRB/GH Initiative to facilitate high-profile public actions (e.g., state fairs) by affected communities (e.g., shrimpers)

11.3.5 Partner with MRB/GH Initiative to market downstream recreational value (fishing in particular); link healthy fisheries to healthy grasslands

11.4 Maximize effectiveness of all outreach plans by engaging the social science community in the development of messaging and delivery tools

11.5 Build hemispheric partnerships for grasslands conservation across the annual Bobolink range

11.5.1 Promote the conservation needs of Bobolinks and other migratory grassland bird species through representation on NABCI International Subcommittee

11.5.2 Participate in CMS and engage with the Americas Flyways Framework to coordinate and pursue actions beneficial to grassland birds

11.6 Tailor different versions of the Plan to key audiences

12. Strengthen and disseminate message about value of grasslands for human health

12.1 Partner with sociologists and economists who research determinants and influences on landowner and stakeholder decisions

12.2 Raise public awareness about the ecosystem services, value to human health and food security provided by grasslands, as well as the economic trade-offs of grassland conservation

12.2.1 Communicate to voters and consumers the externalized costs and trade-offs of grassland and agricultural products via Life Cycle Assessments

12.2.2 Develop communications strategy to highlight the value of grasslands biotic integrity and biodiversity

12.2.3 Determine future economic loss to farming because of insufficient nutrient substrate (i.e., due to soil loss) and benefits of grasslands to minimizing loss

12.2.4 Provide government agencies with tools that allow them to define multiple benefits (wildlife, water) of their programs

12.2.5 Develop communications strategy to highlight the value of grasslands biotic integrity and biodiversity

12.3 Support grassroots environmental education aimed at nurturing a persistent land ethic

12.3.1 Support youth outdoor appreciation programs

12.3.2 Integrate grasslands focus into Initiative Outdoor programs

12.3.3 Enlist religious group support (community churches) in developing an environmental ethic

12.4 Provide federal agencies with tools that allow them to define multiple benefits (wildlife, water) of their programs

12.5 Learn from social psychologists ways to convey messages and bridge opposing views to find workable solutions to dilemmas in grasslands conservation

13. Build a coherent vision for grassland conservation that advances regional objectives and incorporates measurable objectives

13.1 Strengthen national and international coordination

13.1.1 Promote the conservation needs of grassland bird species through representation on NABCI Private Lands Subcommittee and International Committee

13.1.2 Complete a Prairies to Pampas hemispheric grasslands conservation business plan or similar plan

13.2 Develop/update and refine JV habitat objectives

13.3 Establish monitoring, evaluation metrics, and targets for Conservation Strategies and Actions

13.3.1 For migration and winter, develop measures that are specific to conservation actions (e.g., level of pesticide use, acres of rice using BMPs)

13.3.2 For the breeding season, develop measures of habitat loss and gain, regional and rangewide population response

13.3.3 Determine appropriate scale: Predict efficacy of strategies towards reaching population objectives given selected levels of implementation, and/or how much a given strategy or set of strategies would need to be implemented in order to reach population objectives

13.4 Improve NLCD accuracy for estimating grassland habitat quantity and quality

13.5 Re-evaluate Bobolink Conservation Plan every 10 years

14. Minimize impacts of alternative energy development

14.1 Determine impacts of large solar arrays beyond direct habitat loss

14.2 Develop siting guidelines for large solar and wind developments

15. Understand full life cycle Bobolink demographics (linked to habitat quality)

15.1 Determine where populations are limited

15.1.1 Determine annual survival across the breeding range

15.1.2 Determine non-breeding seasonal survival during post-fledging stage, during fall and spring migration, and on wintering grounds

15.1.3 Identify factors affecting above seasonal survival estimates

15.1.4 Determine carry-over effects, particularly the effects of wintering habitat quality on timing of spring migration and subsequent breeding productivity, and the influence of stops on movement to and survival on wintering grounds

15.1.5 Determine the relative quality and use of non-breeding habitats

15.2 Understand source and sink dynamics on breeding grounds

15.2.1 Determine immigration and emigration rates of populations, and dispersal distances between populations

15.3 Assess the habitat value of alternative crop/grass fields

15.3.1 Identify the value of perennial grass 'strips' programs to breeding birds (Iowa State University Extension and Outreach, Neil Smith National Wildlife Refuge)

15.3.2 Determine habitat value of perennial grains to grassland birds (the Land Institute, Washington State University, Michigan State University, others)

15.4 Develop a full life cycle model, especially post-fledging, fall (long stop, migration), winter, and spring survival, marked breeding populations in core breeding range

15.4.1 Evaluate potential population limitations

15.4.2 Predict population response under different conservation scenarios

15.4.3 Inform immigration and emigration models (i.e., among BCRs) based on population changes in individual BCRs over the BBS survey period

South America: Colombia and Venezuela

Strategy Theme:

1. Enable and promote best management practices

Strategies:

1.1 Influence consumer preferences through public information campaigns

Actions:

1.1.1 Promote eco-friendly rice, the benefits of its consumption

1.1.2 Reveal the impacts of insecticides on the Bobolink and Dickcissel to rice consumers and producers

1.1.3 Publicity campaigns to raise awareness of the benefits of BMP implementation in rice as a means to improve the image of rice farmers in some regions of the country

1.1.4 Hold demonstrations at farms with beneficial practices

1.2 Provide economic incentives for BMPs in rice cultivation

1.2.1 Involve rice producers, mills, ministries and associations (Fedearroz) in the search for alternatives in order to implement best management practices, including economic incentive schemes for producers using little or no synthetic inputs, especially pesticides

1.3 Explore ecotourism potential of rice farms

1.3.1 Evaluate the potential for rice farms to be accessible opportunities for open-habitat birdwatching

1.3.2 Provide economic incentives that provide more reward for ecotourism than for pet trade market

1.4 Determine the potential risk of pesticides to birds in rice production systems

1.4.1 Interview toxicologists and agronomists to determine pesticides with the greatest potential risks

1.4.2 Survey producers to determine what synthetic agrochemicals are being used, application practices, challenges in pest control

1.5 Explore option of successfully marketing bird-friendly rice

1.5.1 Explore the mechanisms and steps necessary for the creation and consolidation of a national and international market for bird-friendly rice

1.6 Promote alternatives

1.6.1 Build capacity for best management/integrated pest management for conventional growers

1.6.2 Offer alternatives to synthetic agrochemicals for pest control

1.6.3 Create exchange opportunities for improved management techniques

1.7 Develop economic and social incentives for production and consumption of bird-friendly rice

1.7.1 Develop a bird-friendly rice certification program

2. Determine and communicate value of coastline habitat

2.1 Evaluate significance of coastline habitats for migratory and resident bird species

2.1.1 Conduct standardized presence/abundance surveys at regular intervals throughout the year to determine habitats used during different seasons

2.1.2 Establish banding stations to collect morphometric data on migrants during migration periods

2.2 Raise awareness especially with governmental authorities and environmental groups about the value of migratory birds and the role and importance of coastline habitats

2.2.1 Engage/create a citizen science community to track existing and planned projects in the context of the habitats being impacted

2.2.2 Develop and carry out media strategy as an integral part of the bird survey and banding efforts

2.2.3 Develop school outreach program for banding stations

3. Incorporate environmental practices into palm industry

3.1 Raise awareness about threats associated with conventional palm production

3.1.1 Conduct outreach to palm farmers and environmental agencies

3.1.2 Demonstrate how palm plantations serve as corridors for feral cats

3.2 Develop regulatory mechanisms to protect migratory bird habitat

3.2.1 Petition to require that some habitat is set aside for migratory birds as part of farm development plans

3.2.2 Draft regulations that support the use of eco-friendly practices

3.3 Guide producers, environmental officials, and other actors towards eco-friendly palm production

3.3.1 Design certification program for palm farmers who adopt best management practices, including the protection and restoration of native grasslands and savannahs

4. Promote traditional extensive ranching

4.1 Empower consumers with choice of eco-friendly or locally-produced meat from the Plains

4.1.1 Establish labeling and marketing strategy for meat produced on extensive ranches

4.2 Research most effective means to support traditional cattle ranching practices (Plains Work—Trabajo del Llano) as a means to conserve the biodiversity and culture of the plains

4.2.1 Identify traditional practices such as rotation of cattle

4.2.2 Examine farm certification, marketing, and product development strategies that have worked for Southern Cone Alianza de Pastizal and adapt to Colombia

4.2.3 Approach producers to learn about the barriers to adopt or maintain practices that conserve biodiversity

4.3 Develop the infrastructure needed to offer consumers beef produced via extensive ranching on the Cesanare Plains

4.3.1 Conduct feasibility study of establishing refrigeration and slaughterhouse facilities in key locations

4.3.2 Develop temporary marketing alternatives with ranchers until adequate conditions exist for slaughter in the plains

4.4 Develop a ranching tourism industry that features traditional practices such as milking, lasso, and branding

5. Establish a network of national and regional parks and reserves ranging from protected to multiple use

5.1 Establish a Llanos National Park

5.2 Establish regional parks and private reserves that provide recreational opportunities such as hunting and fishing, and sustainable economic activities such as compatible ranching

5.3 Delineate areas of significance for resident and migratory birds (for example, Important Bird Areas, Ramsar sites, UNESCO biosphere reserve, Western Hemisphere Shorebird Reserve Network)

South America: Bolivia

Estrategías:

1. Eliminar el uso de pesticida monocrotofos

Acciones:

- 1.1. Concienciación (talleres, producción de materiales educativos/informativas, preparación y difusión de cuñas radiales, otros
- 1.2 Educación y promoción para el uso de productos alternativos a los pesticidas
- 1.3 Reuniones con las autoridades que controlan la importación de productos agroquímicos (APIA)
- 1.4 Revisión de las leyes sobre agroquímicos permitidos y no permitidos
- 1.5 Control (monitoreo) del las pesticidas que están siendo utilizados en el campo

2. Planificar para la conversión del hábitat de pastizales que tenga el menor impacto posible sobre la biodiversidad que depende de los pastizales

- 2.1 Identificar las áreas más apropiadas para los nuevos cultivos que no sean importantes para el Dolichonyx oryzivorus (Bobolink) y otros especies
- 2.2 Participar en el proceso de designación del uso de tierras para transformación de pastizal a cultivo
- 2.3 Monitorear los sitios importantes para la biodiversidad de aves que dependen de los pastizales

3. Proveer y promover prácticas de manejas alternativas

- 3.1 Determinar el daño actual al arroz
- 3.2 Utilice cultivos de trampa en los sitios que prefieren los Dolichonyx. Otros granjeros en la zona pagan al dueño los ingresos perdidos.

4. Minimiza el efecto del cambio climático sobre el ecosistema

- 4.1 Entender más sobre donde están las fuentes de agua y la dinámica de estos para nutrir de humedad a los pastizales en las épocas críticas.
- 4.2 Proteger las fuentes de agua para el ecosistema (ríos y lagunas)

5. Reducir en 50% las quemas en las sabanas
    5.1 Concienciación (talleres y charlas para reflexionar sobre los daños que las quemas causan a las especies y al ecosistema), elaboración de material informativo
    5.2 Capacitación a ganaderos en el uso de alternativas de manejo de tierras sin fuegos (ejm. rotación de potreros)
    5.3 Enseñar el uso de medidas de control para evitar fuegos descontrolados
6. Reducir la introducción de pastos exóticos y controlar los que ya existen
    6.1 Promover mercados para la carne de pastizales naturales (sin pastos exóticos)
    6.2 Realizar un estudio sobre el efecto de los pastos exóticos sobre la biodiversidad local
    6.3 Determinar las diferencias nutricionales de los pastos del cono sur, los pastos tropicales y los pastos exóticos

South America: Argentina and Paraguay

Estrategías Generales:

1. Generar conciencia de la importancia de las aves y sus hábitat en agroecosistemas

Estrategías:

1.1 Generar conciencia en los niños y adolescentes sobre la necesidad de que las aves y la fauna en general se encuentren en libertad

Acciones:

1.1.1 Brindar charlas/talleres/cursos en escuelas, trabajando con alumnos de todas las edades, para generar conciencia sobre la importancia de mantener a las aves en su ambiente natural

1.2 Determinar cómo afectan los agroquímicos a las aves

1.2.1 Revisar bibliografía de los productos agroquímicos que se utilizan en cultivos de arroz y sus efectos sobre aves silvestres para evaluar lo que podría suceder con el charlatan

1.2.2 Investigar los efectos crónicos o subletales (en aves de pastizal) de los agroquímicos utilizados y los umbrales de respuesta

1.2.3 Investigar sobre los efectos indirectos de los agroquímicos en la cadena trófica que pueden repercutir en las poblaciones de aves de pastizal

1.2.4 Generar y aplicar medidas de mitigación a partir de la investigación (prohibir los agroquímicos que tengan una incidencia negativa)

1.2.5 Investigar los efectos indirectos de los agroquímicos en la cadena trófica que pueden repercutir en las poblaciones de aves de pastizal

1.3 Informar sobre la importancia de los dormideros en ambientes naturales

1.3.1 Campaña de comunicación

1.3.2 Colocar carteleria, o realizar algún tipo de distinción de los campos que mantienen los dormideros

1.4 Generar conciencia en los productores en relación a la importancia de las aves en el ecosistema

1.4.1 Visitas a campos arroceros para recorrer los lotes con los productores y presentarles la gran biodiversidad que tienen y los efectos beneficiosos que las aves producen en su campo

2. Prevenir o evitar el drenaje no planificada

2.1 Planificación de drenaje

2.1.1 Zonificar-mapear las zonas

2.1.2 Educación y promoción para el uso de productos alternativos a las pesticidas

2.1.3 Crear áreas protegidas en zonas claves

2.2 Comunicación/educación sobre los servicios ecosistémicos de los humedales

2.2.1 Campaña de comunicación

2.3 Propulsar regulación para prevenir drenaje no planificado

2.3.1 Generar un ordenamiento territorial (haciendo referencia a la ley de humedales)

2.3.2 Llevar acabo el plan de ordenamiento considerando incentivos o penalizaciónes

3. Maneje los impactos de los tordos en la producción de arroz

3.1 Investigar el daño de los tordos sobre los cultivos de arroz

3.2 Aplicación de cultivo trampa, en caso de tener un impacto positive

3.3 Promover la conservación de ambientes naturales

3.3.1 promover y generar la creación de áreas protegidas

3.4. Promover la investigación en aves problemas en el arroz

3.4.1 Investigar la potencialidad del Fortuna como cultivo ¨trampa¨

4. Predecir los impactos de cambio climática y proponer acciones

4.1 Promover la investigación de los efectos del cambio en los ambientes y las especies

4.1.1 Modelar los efectos del cambio climático en los ambientes (localmente)

4.1.2 Modelar los efectos del cambio climático para la especie (con los datos anteriores)

4.1.3 Proponer acciones de mitigación en base a los modelos generados

4.1.4 Llevar a cabo las acciones diseñadas a partir de los modelos generados, y monitoreo de acciones de mitigación aplicadas

4.2. Promover la investigación de los efectos del cambio en el uso de la tierra

4.2.1 Modelar los efectos del cambio en el uso de la tierra (localmente)

4.2.2 Modelar los efectos del cambio del uso de la tierra para la especie (con los datos anteriores)

4.2.3 Proponer acciones de mitigación en base a los modelos generados

5. Promover/incentivar la heterogeneidad y la conservación de ambientes en los sistemas productivos

5.1 Campaña de comunicación

6. Manejo sostenible de pastizales

6.1 Aplicar ganadería sostenible de pastizal: aplicar prácticas de manejo hídrico, quemas prescriptas, y cargas adecuadas

APPENDIX F. Initiatives and Strategies to Support Grazing and Livestock Production Practices that Provide Quality Grassland Bird Habitat.

- The Nature Conservancy's Grass Bank program in the U.S. and Canadian Great Plains allows ranchers to graze on TNC conserved lands at reduced fees in exchange for conducting conservation practices on their own land with demonstrable benefits.
- In the northeastern U.S., grassland bird conservationists have worked with dairy farmers to modify dairy herd grazing regimes in a way that improves habitat (Brennan and Kuvlesky 2005; Perlut et al. 2006).
- Market-based strategies to conserve grasslands have recently been taking root in North America, modeled after programs in the Southern Cone of South America such as the Grasslands Alliance. The Alliance has worked with ranchers in Argentina, Brazil, Paraguay, and Uruguay to develop a beef certification program and sustainable beef product compatible with grassland bird needs, complete with a marketing program.
- Audubon's Conservation Ranching Program is developing bird-friendly beef practices in the Great Plains.
- Environment Canada's Species At Risk Partnership on Agricultural Land (SARPAL) is funding a multi-stakeholder program in Manitoba to provide an incentive package for beef-producers to engage in bird-friendly practices.
- The Global Roundtable for Sustainable Beef and the Canadian Roundtable for Sustainable Beef have a focus on sustainable intensification and inclusion of environmental non-profits in their activities, and will be key to large scale success of market-based strategies.

APPENDIX G. Emerging Opportunities

Unique and often time-sensitive opportunities for grassland conservation are rare, but when they occur, they must be seized. These are opportunities to benefit grassland birds, given that conservationists find ways to respond quickly and find their place in the appropriate discussions and processes. Many conservation strategies and actions presented in this Plan reflect these opportunities, and here we highlight a few of them. This is by no means a comprehensive list, and many other cutting-edge approaches are presented as actions in the Plan. For many new approaches, funding for multi-stakeholder efforts with a new set of partners will be essential. Ongoing scanning of new opportunities, and a timely response to take advantage of them, will add significantly to successes in grassland conservation.

- In 2012, Canada's Prairie Farm Rehabilitation Administration (PFRA) federal pasture program was ended, and the management of millions of grassland acres in the program were placed into the provincial hands of Alberta, Manitoba, and Saskatchewan. There have been debates about how to use the land and who should have say, with multiple interests at stake including conservation of grasslands. Manitoba is moving to sustain this successful program, but the province of Saskatchewan has expressed interest in divesting from the property, causing great concern that over 300,000 ha of habitat could be converted to incompatible land uses. The situation presents a great risk; alternatively, it could be a rare opportunity to carry out conservation at the broadest of scales in ways that maximize conservation benefits while serving a variety of stakeholders. Operating at these scales enables planners to address the increasing problem of fragmentation, often driven by factors operating at a level and with a complexity that makes them difficult if not impossible to influence. The vast, unfragmented habitat in PRFA has been a stronghold for grassland birds, and Saskatchewan is at a critical juncture in deciding how to use these lands.
- Carbon offsets have become a household term in the conservation world. Carbon insetting could provide even stronger incentives for companies looking to reduce their carbon footprint. Under carbon insetting, companies offset a portion of their carbon emissions by changing their practices within their own supply chains. This not only offsets carbon emissions through sequestration, but it does so in a way that directly benefits the resiliency of the company. It supports and strengthens supply chains, and restores or sustains the ecosystems and human systems where their products are grown. This practice has been carried out for tree plantings, but application of this concept to grasslands could be explored.
- Conservation easements can be risky even when language exists to protect the easement in the event of a change in ownership. Sometimes the new owner, as an inheritor or purchaser, has not bought into the concept of maintaining the protection of the land afforded by the easement. Some landowners wishing to protect their lands may not enter an easement because of this risk. To increase the chances of retaining conservation easements when ownership is transferred, land trusts pool resources in order to have the ability to defend a challenge. The Terrafirma Risk Retention Group, for example, runs a

program that collects premiums from land trusts to pool funds for the eventuality that a lawsuit must be filed to defend an easement. This kind of insurance can discourage landowners from violating easements, because they wish to avoid entering a legal battle.

- Land trusts play an important role in the conservation of prairies and restoration grasslands, and these efforts may be able to expand. For example, the Trust for Public Land brokers and/or funds agreements that include conservation objectives with ranchers and other landowners. They are nimble enough to operate in the place of the NRCS when arrangements need to be handled quickly, and this is already happening in the Prairie Potholes. Most of the funding for these efforts come from federal sources such as the Neotropical Migratory Bird Conservation Act, which funds large projects that help to conserve areas with high ecological significance. Land trusts will continue to play an important role in prairie preservation, and there may be opportunities to expand their role as a means to conserve ecologically important grasslands.
- Grasslands ecologists and conservationists generally agree that to halt grassland bird population declines, there is a need to innovate and to form new partnerships. For example, potential partners could include entities that pursue funding from the Agriculture and Food Research Initiative (AFRI) peer-reviewed competitive grants program for fundamental and applied agricultural sciences. The National Institute of Food and Agriculture (NIFA) awards these grants to support research in six Farm Bill categories, including bioenergy, natural resources, and environment, as well as agriculture economics and rural communities, among others.

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