Upper Mississippi River and
Great Lakes Region Joint Venture

Waterbird Habitat Conservation Strategy – 2018 Revision

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Cover: Forster's Terns, photo by Greg Soulliere.

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PLAN SUMMARY

Bird habitat conservation is implemented at local scales, but addressing population-level priorities throughout the annual cycle is critical to effective conservation. In addition, social considerations are appearing in contemporary conservation plans seeking to be more relevant to society and to grow support for bird habitat initiatives. For example, wetland bird habitat restoration in locations that provide society more tangible ecological goods and services (e.g., water filtration, flood-water storage, open space for hunting and birding) could, theoretically, help recruit more conservation supporters. Managing the assembly of biological, political, and social aspects of modern-day bird habitat planning is challenging and the need to be strategic when dedicating conservation resources has never been greater.

Strategic Habitat Conservation (SHC) involves shifting to more thoughtful, accountable, and adaptive actions driven by science. The SHC approach includes assessing, planning, implementing, and evaluating, and it was the foundation for this Joint Venture (JV) Waterbird Habitat Conservation Strategy (Strategy). The Strategy goal is to: *Guide regional conservation that results in habitat to support populations of priority waterbird species and related social values, consistent with continental bird conservation goals.* The target audience includes those involved with planning, developing, and implementing wetland bird conservation at state and Bird Conservation Region (BCR) scales. However, information presented in this Strategy should also help clarify pertinent roles for local-scale managers within a regional context.

Similar to the 2007 JV Waterbird Strategy, this document describes methods used to translate population goals from large-scale planning documents to the Upper Mississippi River and Great Lakes JV region and to smaller areas (State x BCR) within the region. The section titled *Conservation Design* includes new procedures for estimating what, where, when, and how much habitat is needed to increase and sustain populations of priority species at objective levels. Finally, guidance from the North American Waterfowl Management Plan (NAWMP 2012) and related documents was used to integrate social considerations when targeting conservation for wetland birds.

Population estimates and objectives are periodically refined for waterbirds, and we recognize population estimates used in this Strategy may soon be dated. Nonetheless, science-based recommendations were developed to effectively achieve landscape carrying capacity goals through waterbird habitat restoration/enhancement (increasing habitat base) and retention (preserving habitat base). *Species-habitat associations* representing bird guilds and common wetland-community types were articulated, and habitat objectives for breeding JV focal species were linked to population targets. We assumed habitat actions for JV focal species would result in positive population responses by other wetland birds within their designated guilds. The 2007 JV Waterbird Strategy contained only breeding habitat objectives, but this revision includes new information regarding migration chronology and distribution to begin addressing habitat conservation for the non-breeding period. Because waterbird and waterfowl guilds were grouped by common habitat types (National Wetland Inventory Classes), this document is closely linked with the 2017 JV Waterfowl Strategy (www.UpperMissGreatLakesJV.org). Population estimates for non-breeding waterbirds were not yet available. Thus, habitat quantity objectives calculated for non-breeding waterfowl were recommended for waterbird conservation but with recognition of potential temporal differences in migration timing among wetland bird guilds.

Regional waterbird population and habitat trends and the assessment of factors likely to limit population growth provide a biological planning foundation. Planning steps included characterizing distribution and abundance of waterbird habitat and other landscape cover types, estimating waterbird population size and distribution, and assessing abundances and distributions of people across the JV region. Biological models were used to predict focal species habitat needs and to develop an initial landscape conservation design with the capacity to sustain current waterbird populations and eliminate population deficits. Much of the technical information, including species-specific decision support maps and habitat models, appear in JV focal species accounts (Appendix A). Sections regarding monitoring and research needs, increasing conservation efficacy, and JV program coordination and communication are also provided.

This Strategy establishes explicit regional objectives for waterbird habitat conservation and uses available data and new tools to chart a path to objective achievement. Limited population and ecological information for some species, particularly secretive marsh birds, posed a serious planning challenge. However, we used the best science available and followed the same procedure established in our 2007 JV Waterbird Strategy, with a focus on continuous improvement. The process included science-based population and habitat objective-setting, coupled with explicitly stated planning assumptions and identification of research and monitoring needs to guide future evaluation. This Strategy will continue to be adapted as our knowledge of waterbird biological parameters and social values improves.

Primary additions and improvements compared to the 2007 strategy:

1) Habitat delivery evaluation (2007–2014) and refined definitions for habitat retention, restoration, enhancement, operational management, and operational maintenance.
2) Report on primary evaluation projects and verification of early planning assumptions, plus a list of related publications and professional reports.
3) Expanded emphasis on SHC framework: biological planning, conservation design, conservation delivery, and outcome-based evaluation.
4) Improved linkage to JV waterfowl conservation planning and the North American Waterfowl Management Plan (2012).
5) Thorough land-cover (habitat) assessment including recent cover type trends.
6) Use of new data sources: eBird, U.S. Census, and Landscape Conservation Cooperative focus areas.
7) An adjustable decision support model with weighted biological and social parameters and associated conservation delivery map.
8) Greater emphasis on program integration and conservation efficiency, including review of principles key to successful business management and SHC.

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BACKGROUND AND CONTEXT

The Upper Mississippi River and Great Lakes Joint Venture (JV) is one of 22 North American regional bird-habitat partnerships. These self-directed groups include wildlife agencies, non-government organizations, corporations, tribes, and individuals who formally accepted responsibility to implement international bird conservation plans within a specific geographic area (see https://www.fws.gov/birds/management/bird-conservation-partnership-and-initiatives/migratory-bird-joint-ventures.php). The North American Waterbird Conservation Plan (Kushlan et al. 2002) is one of the continental bird plans JVs have committed to implement.

Waterbirds are a diverse assemblage of wetland and open-water species often categorized by their social approaches to nesting, feeding, and roosting. The most common groups are colonial-nesting species (gulls, terns, cormorants, pelicans, herons, and egrets) and non-colonials, many of which are referred to as marsh birds (rails and bitterns). Other waterbirds (loons and grebes) are not easily categorized in this way, and mixed (i.e., semi-colonial) social behaviors also exist within recognized groups. Some species, such as Great Blue Heron, Great Egret, and King Rail (see Appendix B for scientific names), are near the northern edge of their breeding range in the JV region. Conversely, the region overlaps the southern portion of the Yellow Rail breeding range, and this species plus other northern breeders depend on the JV region primarily for migration habitat.

Colonial waterbirds are characterized by strong aggregative behavior during the breeding period. Some species form large nesting colonies and roost sites with hundreds or thousands of individuals, making these birds more conspicuous. Selection of breeding and foraging sites is influenced by their colonial nature and available food resources. Most colonial species appear to minimize predation and competition by nesting on remote islands where forage is adequate. Conversely, marsh birds are typically inconspicuous and accomplish reproduction and foraging largely unnoticed. Marshes and wet meadows dominated by stands of mixed-height emergent vegetation are most often used by this group.

The North American Bird Conservation Initiative (NABCI 2000) addresses conservation needs of all North American bird species through coordinated delivery of habitat conservation for waterbirds, shorebirds, landbirds, and waterfowl. Continental population assessments, species prioritization, and general planning guidelines have been completed for each of these four bird groups in separate North American plans. The proven collaboration and synergistic record of Joint Ventures suggest they provide the best means to implement regional all-bird conservation. A primary role of the JV is to coordinate and facilitate delivery of bird habitat conservation, stepping down continental bird-conservation plans to the JV region. The goal of this Strategy is to: Guide regional conservation that results in habitat to support populations of priority waterbird species and related social values, consistent with continental bird conservation goals.

In this document, we develop explicit regional objectives for waterbird populations and habitats and find complementary relationships with other conservation plans and with human dimension objectives. Like the original JV Waterbird Strategy (Soulliere et al. 2007), we assembled the best available population and spatial data and advanced technological tools to increase planning effectiveness. We relied on the most recent science in our planning process and identified information gaps and assumptions that require investigation to improve subsequent iterations of the plan. This document was written with goals expressed over a 15-year time horizon, but objectives are dynamic and can be refined as knowledge of social science and regional waterbird conservation improves.

Regional Overview

The JV region encompasses all or portions of Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio, and Wisconsin (Figure 1). Unique and important wetland bird habitats are common in this region, which includes the nation's only inland coastal area – the Great Lakes and associated shorelines. Part of this system, and shared with Canada, is the world's largest freshwater delta, where the St. Clair River empties into Lake St. Clair. Vast floodplains and interior wetlands associated with four of the country's major river systems occur in the region: lower Missouri, upper and central Mississippi, Illinois, and Ohio rivers. These immense water features and associated natural resources undoubtedly influenced human settlement patterns and intensity; there were over 60 million people living within the JV region as of 2010 (USCB 2010).

The NABCI has classified landscapes based on features important for bird-conservation planning by sub-dividing the continent into Bird Conservation Regions (BCRs; Bird Studies Canada and NABCI 2014). These planning units are characterized by similar bird communities, habitats, and resource management issues. The JV region is largely covered by BCRs 22 (Eastern Tallgrass Prairie), 23 (Prairie Hardwood Transition), and the U.S. portion of BCR 12 (Boreal Hardwood Transition). Portions of BCR 24 (Central Hardwoods) and 13 (Lower Great Lakes / St. Lawrence Plain) also occur within the JV boundary (Figure 1).

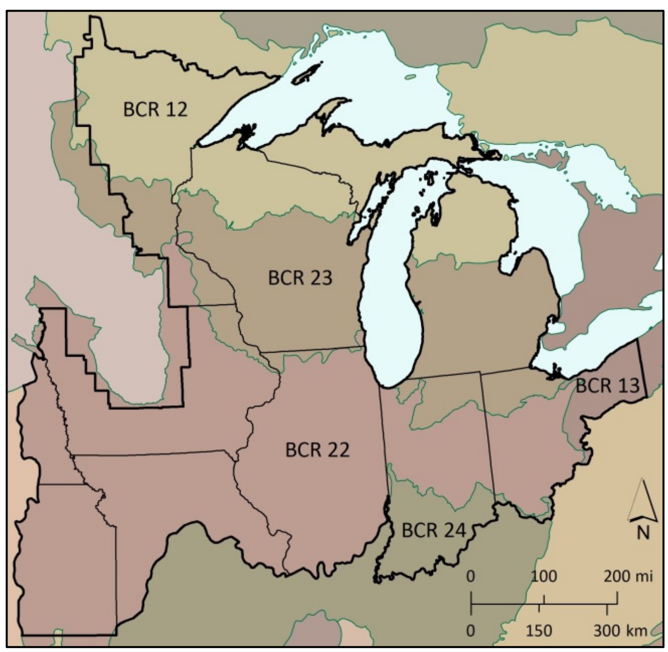


Figure 1. Boundaries of the Upper Mississippi River and Great Lakes Joint Venture region (bolded black line) and associated Bird Conservation Regions (BCRs, color discerned).

Landscape cover types within the JV region vary from heavily forested in the north and east to agriculture-dominated in the south and west (Figure 2). Thousands of glacial lakes, herbaceous and forested wetlands, and beaver ponds in the north part of the region transition into an environment with fewer natural basins and primarily river floodplain wetlands in the south. Wetland conditions change from generally oligotrophic in the far north to mesotrophic and eutrophic in the central and south portions of the region. Vegetation communities more closely resemble historic conditions in the north, whereas human-induced landscape changes have disrupted physical (i.e., hydrology) and ecological (i.e., plant succession) processes in much of the south. Densities of breeding and migrating waterbirds vary considerably across the JV region depending on species. Some species are more abundant near the Great Lakes coastline (e.g., Common and Forster's Terns) compared to inland areas. Other species are likely distributed with respect to wetland loss patterns. For example, the JV region falls near the center of the American Bittern range, yet this species is more abundant in the northern part of the region where large wetland complexes remain more intact.

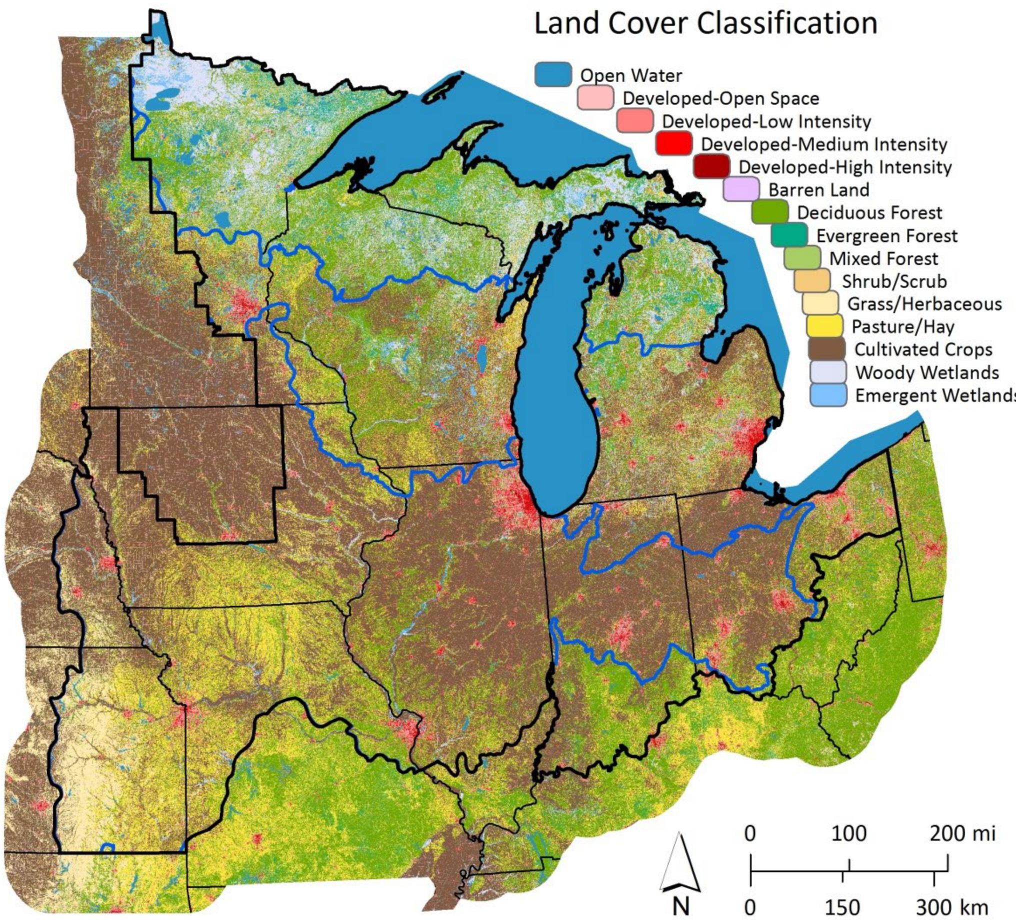


Figure 2. Landscape composition of the Upper Mississippi River and Great Lakes Joint Venture Region (2011 National Land Cover Data; BCR boundaries within the region in blue).

The consequences of an expanding human population and intensively used lands in the southern two-thirds of the region have been long-term loss (Dahl 1990) and degradation of wetlands important to waterbirds. Although wetland quantity has stabilized and even increased in some areas of the JV region during recent years, loss of key wetland types important to waterbirds remains a primary conservation concern. The two most important negative influences on wetland-bird habitat area and quality are row-crop agriculture and urban expansion. Seasonal wetlands and margins of semi-permanent and deep-water wetlands are often the most valuable habitats for wetland birds. However, these wet meadows, lakeplain prairies, and shallow-water transition zones have been replaced by monocultures and *hard edges* of row crops, invasive plants, mature forest, or development in the most human-impacted areas. Along with associated native grassland/herbaceous uplands, shallow wetlands continue to be destroyed or degraded.

Run-off of sediments and nutrients into wetlands is a growing long-term concern where intense agriculture and urbanization result in elevated inputs to rivers and basins. Although wetlands are known for their value in assimilating sediments and nutrients, input thresholds have been exceeded in highly altered landscapes resulting in degraded aquatic systems. Moreover, excess nutrients coupled with altered hydrology (i.e., excavation, partial drainage via tiles and ditches, installation of diking infrastructure and stabilized water-levels) typically shift ecological advantage to invasive species, such as hybrid cattail, reed canary grass, and common reed (also known as *Phragmites*), resulting in a subsequent loss of plant diversity and wetland quality for most birds. Addressing these significant challenges will be necessary for the JV to most effectively sustain or increase regional waterbird populations.

Relationship to Other Wetland Bird Plans

The North American Waterbird Conservation Plan (NAWCP), Version 1, was developed to provide continental perspective regarding status and conservation of colonial-nesting waterbirds (Kushlan et al. 2002). Since its completion, supplements to the NAWCP have been developed describing status and conservation guidance for non-colonial waterbirds (i.e., marsh birds, loons, and cranes). The NAWCP and supplements do not establish population or habitat goals due to the high degree of uncertainty associated with waterbird populations. However, continental-scale population estimates and a conservation status assessment were completed for colonial and marsh bird species. In addition, the NAWCP divided the continent into 16 waterbird planning regions, including the Upper Mississippi Valley / Great Lakes (UMVGL) region, which closely overlaps the JV region. The UMVGL waterbird region encompasses the entire area of BCRs 12, 13, 22, 23, and 24, and the UMVGL Waterbird Conservation Plan (Wires et al. 2010) provided essential information for the development of this Strategy. The UMVGL plan describes 1) occurrence, abundance, and threats to waterbird species that regularly occur in the UMVGL region, 2) population estimates for better-surveyed species, 3) historic and current waterbird population trends, 4) habitat characteristics, and 5) waterbird conservation, management, and stewardship priorities by BCR.

Using coarse estimates of continental (Kushlan et al. 2002) and regional (Wires et al. 2010) breeding population abundance, the JV region accommodates ≥10% of the North American Caspian, Forster's, and Black Tern populations, and about the same proportion of the continental Double-crested Cormorant and Black-crowned Night-Heron populations. In addition, >50% of the continent's breeding Herring and Ring-billed Gulls occur in the region. The JV region also provides vital migration corridors, staging areas, and even wintering locations for some waterbird species.

This Strategy is linked to the NAWCP and the UMVGL waterbird plan but has a different focus. We translate the NAWCP and UMVGL plan information regarding conservation status, demographics, and factors limiting population growth into habitat conservation objectives. Thus, the Strategy provides a regional science- and partnership-based action plan for guiding waterbird habitat conservation. Unlike the 2007 JV Waterbird Strategy, habitat conservation guidance for the non-breeding period is also addressed in this revision. Finally, because waterbird and waterfowl habitats significantly overlap and waterfowl populations (and habitat area requirements) are greater than those of the waterbird group, we integrated portions of the 2017 JV Waterfowl Habitat Conservation Strategy (Soulliere et al. 2017) into this Strategy.

Habitat Delivery and Evaluation, 2007–2014

Habitat conservation is the primary means to achieve bird population objectives. To increase efficacy, JV partners committed to transition from *opportunistic conservation* to science-based (e.g., SHC) and geographically targeted actions (UMRGLR JV 2007). The 2007 JV Waterbird Strategy called for two primary habitat conservation approaches: *maintenance/protection*, resulting in the retention of adequate habitat quantity to support existing waterbird populations, and *restoration/enhancement*, resulting in new quality habitat area that expands landscape carrying capacity to meet population goals. Indeed, restoration/enhancement was considered the habitat delivery mechanism necessary to increase populations by removing habitat deficits (i.e., mitigate the habitat factor limiting population growth). Definitions below were established in 2007 to quantify partner habitat accomplishments. However, due to concern regarding overlap and interpretation of definitions, refinements to each are provided at the end of this section.

Previously used (2007) definitions:

- Protection = protecting area of relatively high value to target bird species or guilds (i.e., JV focal species or guilds) through fee acquisition by a conservation organization or through private-land perpetual conservation easement.

- Restoration = reverting an altered site with low-value cover (i.e., annual row crop, agricultural/drained wetland) to a perennial native-plant community with restored ecological functions and high value for focal bird species or guilds.

- Enhancement = increasing ecological functions and improving quality of degraded bird habitat with practices lasting for extended periods (>10 years). Work might include setting-back succession, controlling invasive plants, improving water quality resulting in increased forage, or other techniques that increase focal species recruitment and or survival.

Tracking conservation actions helps to inform stakeholders regarding bird habitat influenced by the JV, along with providing an estimate of funding expended to accomplish JV Implementation Plan objectives. These general measures are provided to the U.S. Congress each year, fulfilling federal government performance and accountability requirements. The total habitat area JV partners protected, restored, and or enhanced since 2007 has been impressive based on annual accomplishment reporting (Kahler 2015). However, accurately estimating partner influence at increasing bird population abundance (desired JV conservation outcome) resulting from habitat actions remains a pervasive challenge. Our understanding of wetland-bird habitat relationships is improving with JV-supported research and monitoring, but better understanding the effectiveness of habitat conservation in realizing population objectives remains a priority.

Annual JV bird habitat accomplishments since 2007 were identified at the State x BCR scale, but measures were coarse (i.e., wetland vs. upland, protection vs. restoration) with no rating of habitat quality for target species or groups. In addition, outcome-based monitoring of project sites is usually lacking. When evaluation is conducted, it is typically focused on completion of proposed actions rather than long-term sustainability and value to focal species (i.e., evaluation needs to emphasize net outcomes, not just acres). In addition, JV partners identified the need in 2007 for measures of concurrent habitat loss to better weigh impact of conservation efforts. Assessment of concurrent habitat loss was considered necessary so that *net changes* in habitat for wetland birds can be monitored over time.

Based on a 2007–2014 assessment, JV partners reported spending $687 million on 834,000 hectares (2 million acres; 1 ha = 2.5 acres) of bird habitat protection, restoration, and enhancement (Kahler 2015). Wetland-related accomplishments totaled 252,200 ha (630,000 acres), averaged 31,500 ha (78,000 acres) annually, and made up 30% of the total habitat accomplishments (by area) for the JV. Of the total accomplishments reported for wetland bird conservation, most (69%) resulted from enhancement of wetland area already managed by partners (Figure 3). Wetland restoration (i.e., expanding habitat area and carrying capacity) annually accounted for 4,500 ha (11,000 acres, 20%) on average, and area protected accounted for the remaining 11% of reported conservation activity. Although uncommon, the restoration category also included areas where wetlands of high value to birds were *created* at sites lacking this type of land cover historically.

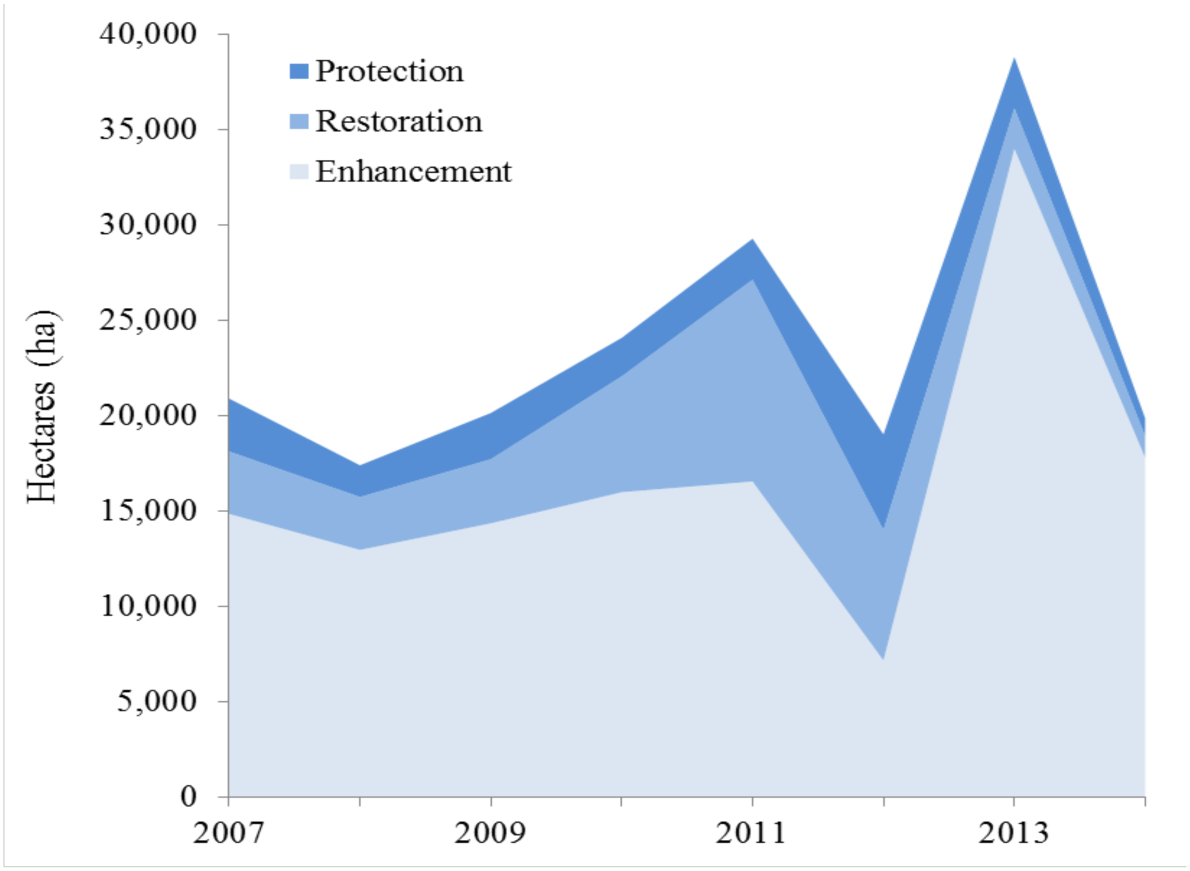


Figure 3. Total area (1 ha = 2.5 acres) and composition of annual wetland-bird habitat accomplishments by conservation action (protection, restoration, and enhancement) reported by Upper Mississippi River and Great Lakes Region Joint Venture partners, 2007–2014.

The amount, distribution, and type of wetland conservation activity has varied annually in the JV region (Kahler 2015). For example, wetland restoration declined proportionately while wetland enhancement increased (Figure 3). Also, based on partner reporting, total area of wetland restored vs. enhanced was similar in the northern half of the region (BCR 12 and 23), whereas wetland enhancement dominated accomplishment reporting in the south (BCR 22; Kahler 2015). Most wetland enhancement reported in BCR 22 was in the *mudflat/shallow* habitat category, suggesting partners may be reporting moist-soil management (i.e., yearly wetland manipulation for annual seed-producing plants) units in their JV conservation accomplishments. Because this type of operational management typically occurs on the same parcels each year and does not provide additional (new) wetland bird habitat compared to previous years, it should not be reported as enhancement.

Future Habitat Delivery and Reporting

There was a growing concern among JV Science Team members that 2007 accomplishment reporting categories were confusing to partners and that conservation activities supporting periodic maintenance vs. those addressing population deficits require more detail. Thus, clarification in reporting categories is provided to better identify and track habitat conservation actions providing long-term value to waterbird populations. As we plan, deliver, and evaluate habitat actions in the future, JV partners must be diligent in their focus on activities that produce positive responses by waterbird focal species and benefits accrued to society while at the same time not diminishing habitat value for other species of high conservation concern. Partners also must be consistent in habitat accomplishment tracking to better relate accomplishments to bird population outcomes (JV goals).

Clearly defined habitat prescriptions coupled with population and habitat monitoring before and after a conservation action is critical to adaptive management. Measuring success in achieving desired objectives can be more challenging in some cover types (e.g., enhancing forests vs. grasslands for birds), thus monitoring focal species response and or system biodiversity is essential. The following revised conservation delivery categories are recommended for future accomplishment reporting to better distinguish efforts protecting habitats currently valuable to wetland birds (*retention*), from those habitat actions that address population deficits by restoring (*restoration*) or substantially improving degraded sites (*enhancement*). Other commonly used habitat management activities not included in JV accomplishment reporting are also defined below. For additional assistance interpreting restoration and enhancement terminology, and considerations related to habitat conservation in highly altered landscapes, the Society of Ecological Restoration (www.ser.org) is a valuable information source.

- Retention = protecting habitat of relatively high value to target species (i.e., JV focal species or guilds) through fee acquisition, perpetual conservation easement, or regulation. Retention typically involves purchase of existing bird habitats on private lands that are vulnerable to future degradation or development and transfer of ownership to a conservation agency or organization, assuring permanent protection. (*Note:* Acquisition of degraded sites with anticipated / planned restoration to quality bird habitat soon after purchase [<5 years] may be included in both retention and restoration categories.)

- Restoration = returning or replacing a lost ecosystem, thus reverting altered sites where ecological function and bird habitat have been compromised to a system with restored ecological functions and high value for focal species or guilds. A common example of habitat restoration is converting an agricultural field with hydric soils to an emergent wetland (e.g., hemi-marsh, wet meadow) and grassland complex.

- Enhancement = improving ecological function and quality of degraded bird habitat with practices lasting for extended periods (>10 years), such as eradicating monoculture stands of invasive plants and replacement with desirable species, cleaning / re-contouring sediment-filled basins, or similar actions to increase water quality and biodiversity. Enhancement elevates long-term carrying capacity for focal species or guilds (i.e., increasing occurrence, recruitment, or survival) but does not reduce biodiversity, ecological functions, and or habitat values for other species of conservation concern.

- Operational management = periodic or annual manipulation of areas under a persistent management regime to achieve desired outcomes for focal species or guilds. Management includes actions considered routine for the location to retain quality bird habitat for the breeding period (e.g., burning established grassland to reduce brush) or non-breeding period (e.g., impoundment drawdown for moist soil management or marsh successional setback).

- Operational maintenance = repair or replacement of infrastructure and or special equipment with limited life expectancy (e.g., dike, pump, water control structure) but necessary to conduct bird habitat management at this location. Closely related to operational management, this type of work typically occurs at areas intensively managed due to altered hydrology and surrounding human-influenced landscapes. Reporting may simply include costs to complete maintenance rather than acres affected.

Only JV related migratory bird habitat retention, restoration, and enhancement activities and costs should be reported annually to the U.S. Congress. However, partners should consider tracking additional conservation measures associated with operational management and maintenance to assess annual costs related to these categories, as well as return on investment (see Business and Conservation section). Habitat management costs can be related to outcome evaluations (via monitoring) at project sites to increase partner effectiveness through adaptive management.

Completed Monitoring and Research

Several monitoring and research needs identified during development of the 2007 JV Waterbird Strategy have been addressed in recent years. These evaluations focused on filling information gaps and testing planning assumptions. Primary accomplishments by JV science partners and others financially supported by the JV are summarized below and results are incorporated into this Strategy (see Appendix C for list of associated reports and publications resulting from JV-supported projects since 2007).

Primary monitoring accomplishments:

1) Completed 19 State × BCR assessments (http://uppermissgreatlakesjv.org/BCRs). These documents were developed to serve not only as *stepped-down* versions of the 2007 JV Implementation Plan but also as a new *bottom-up* landscape review for all primary State × BCR polygons across the JV region. Lists of JV focal species and habitat objectives are presented for protection and restoration based on the 2007 JV Plan. These assessments also quantify available cover types based on National Land Cover Data (NLCD; Xian et al. 2009, Fry et al. 2011) and recent trends in land-cover important to focal species. Amount and location of land currently under protection, primary modes of recent cover type conversion, and conservation implications for each sub-region were also provided.
2) Implemented the Midwest Secretive Marsh Bird Monitoring Program. This survey effort, now conducted in several JV states, provides a statistically-based sampling

framework within which Conway's (2011) marsh bird monitoring protocol is used. Survey results are generating information regarding regional- and state-scale marsh bird distribution and species-specific habitat characteristics. Data may eventually be used to generate population abundance estimates and trends in the JV region.

3) Completed the fourth decadal Great Lakes Colonial Waterbird Survey. Results of this 2007–2009 survey have been combined with previous decadal survey results to determine distribution, abundance, and coarse population abundance trends for colonial waterbirds nesting around the Great Lakes coast and associated wetlands. The effort also resulted in refinement to survey protocols, sampling framework, and recommendations in survey frequency for some species to improve accuracy and reduce cost.
4) Supported development and implementation of surveys and other tools (i.e., banding, telemetry, stable isotope analyses) that provided information regarding migration stopover sites, key wintering areas, and factors affecting movements and distribution of waterbirds between breeding and wintering areas. Various projects have focused on inland sites, near-shore, and open waters of the Great Lakes to determine distribution, abundance, trends, and migration information to assist in conservation targeting as well as evaluating development proposals such as offshore wind power.
5) Collaborated in development of the Integrated Waterbird Management and Monitoring (IWMM; http://iwmmprogram.org) program. In the Atlantic and Mississippi Flyways, the IWMM program has developed monitoring protocols for migrating and wintering waterbirds (waterfowl, shorebirds, and wading birds) and their habitats. This is a landscape-scale effort to help managers provide non-breeding waterbirds the right habitats, in the right places, at the right times.

Primary research accomplishments:

1) Supported research on secretive marsh birds. JV partners developed a Midwest Marsh Bird Working Group, pooled scientific information for this bird guild, and developed a prioritized list of research needed to better link management and monitoring. Recent and ongoing projects have helped evaluate habitat and landscape factors influencing occurrence and abundance of marsh bird species plus assess future risks to key habitats.
2) Supported King Rail research for conservation planning. A range-wide conservation plan for this species was developed with JV assistance, including habitat recommendations and identification of research most important to inform future conservation. Multiple research projects were completed as a result of this effort.
3) Supported research on nesting patterns and habitat use by Black Tern. Populations of this species have declined across the Great Lakes region and understanding what factors limit population growth through the annual cycle is uncertain. JV-supported research has focused on the breeding portion of the Black Tern life cycle.
4) Evaluated habitat and landscape preferences (i.e., area requirements, connectivity, beneficial and hostile adjacent habitats) of waterbird groups, particularly the secretive marsh birds, during breeding and migration periods.
5) Examined the relationship between habitat conservation actions and population responses, plus the potential tradeoffs between species for a given action. Ongoing

research projects are focusing on the effects of wetland restoration, enhancement, and management on marsh bird occurrence. Wetland quality related to inundation (i.e., how much NWI *emergent wetland* actually has adequate water for waterbirds) is also being evaluated.

Science Collaboration

The JV partnership is founded on a cooperative approach to problem-solving and delivery of bird habitat conservation. Working together across government and non-government organizations, we have identified and filled many key information gaps regarding wetland bird ecology and conservation within the JV region, quantified bird population and habitat objectives based on science, and improved the means for targeting conservation delivery. In addition to the knowledge pool provided by waterbird scientists serving on the JV Science Team, we have benefitted from the relationship with the North American Waterfowl Management Plan (NAWMP) Science Support Team (NSST) and the Integrated Waterbird Management and Monitoring (IWMM) Program. The NSST was established to strengthen the biological foundation of the NAWMP and facilitate continuous improvement of its conservation programs. The IWMM program is uniquely focused on non-breeding waterbirds and their habitats. IWMM collaboration among wetland managers and scientists is intended to optimize conservation practices through monitoring, modeling, and development of decision support tools. The JV has led efforts in regional evaluation of bird conservation effectiveness, supported by advice and coordination via the NSST and IWMM programs.

More recently, Landscape Conservation Cooperatives (LCCs) and associated Working Groups have provided science value to JVs regarding regional environmental issues, information sharing, and resources to support scientific evaluation at large scales. With a focus on natural community stressors, such as urban and energy development, ecosystem connectivity, invasive species, and climate change, Working Groups introduced by LCCs have informed partners about social and environmental considerations potentially important to conservation implementers. Initiatives resulting from these and similar efforts can help guide bird habitat protection and restoration so that conservation focus areas also serve to abate flooding, improve water quality, and enhance carbon sequestration, providing ecological goods and services society critical.

STRATEGIC HABITAT CONSERVATION

There has been a conceptual shift in conservation, with planning, implementation, and evaluation now viewed as integrated components of management that seeks to achieve greater long-term value from conservation investments (NEAT 2006). This approach is partner-based, science-driven, and comprises an iterative planning cycle. Conservation plans change over time based on evaluation of costs and benefits of conservation techniques (return on investment), testing key planning assumptions, and monitoring progress toward attaining goals. Monitoring – to thoroughly assess site conditions before proposing actions as well as measuring results of past conservation activity – is essential to assure transparency and accountability within the SHC framework. Strategic conservation for Joint Ventures starts by planning at larger spatial and temporal scales, but it is the cumulative local conservation activities of partners that effectively achieve JV regional goals.

Strategic conservation is necessary to maintain bird populations at human-desired levels with complex and far-ranging threats, such as climate change, urbanization, wetland degradation, and land-cover fragmentation. Some bird species and their habitats are increasing, whereas others are declining at an alarming rate. The need to clearly focus resources and expertise where they can have the greatest positive impact has never been greater. To do so, the JV partnership must: 1) identify population and management objectives for priority species, starting at ecologically meaningful scales, 2) address the most significant conservation challenges limiting population growth for priority species, 3) pool resources and target work to ensure efficient and effective conservation delivery, and 4) measure and evaluate results, including both successes and failures, to continually improve our strategies and conservation actions over time. This Strategy details each of the components of strategic conservation: Biological Planning, Conservation Design, Implementation (habitat delivery), and Monitoring and Research.

BIOLOGICAL PLANNING

Biological planning establishes a foundation for effective bird habitat conservation by describing current conditions and trends, establishing species-habitat relationships, and identifying conservation goals. *Focal species* are selected as representatives for various habitat associations; population objectives developed for focal species are then translated into habitat objectives via biological models. Population response (e.g., abundance, distribution, reproductive success) by focal species provides the primary measure for progress toward achieving biological objectives. Past measures of dollars spent and habitat restored or enhanced are important but incomplete representations of accomplishments. To be fully accountable toward a mission for sustaining waterbird populations, JV partners must also document focal species population response. Clear descriptions of current and desired conditions, effective conservation implementation, and science-based monitoring to measure progress are all necessary to justify and grow support for bird habitat programs.

Focal Species and Habitat Associations

Conservation planners use terms such as *focal* and *surrogate* when developing lists of representative *management umbrella* and *management indicator* species. The umbrella concept assumes that the occurrence of a particular species in a geographic area is indicative of other species with similar habitat requirements, and conservation focused on this species will benefit a guild or suite of species (Zacharias and Roff 2001). Similarly, management indicators are species selected to focus conservation delivery, typically for population recovery and or ecosystem diversity (Caro 2010). Changes in populations of management indicator species are believed to reflect the effects of conservation activities and common environmental influences on other species within the guild represented by the indicator species (see USFWS 2014). Use of *JV focal species* was highlighted for the breeding period where a reduced number of models simplified development of habitat objectives for guilds. As in the 2007 JV Waterbird Strategy, Yellow Rail, King Rail, Black Tern, Black-crowned Night-Heron, and Common Tern were used as breeding JV focal species. Because of improved understanding of waterbird species distribution and habitat characteristics, American Bittern, Sora, and Common Loon were included as new breeding focal species used for habitat planning emphasis (Appendix A). Non-breeding focal species representing distinct habitats were also added to this Strategy revision. The relatively abundant eBird data available for these species was combined with other information to determine spatial and temporal distribution of non-breeding guilds. In addition to American Bittern, Sora, Common Tern, and Common Loon, non-breeding focal species included Sandhill Crane, Great Blue Heron, Pied-billed Grebe, and American Coot.

Focal species used for conservation planning.

Breeding period	Non-breeding period
American Bittern	**American Bittern**
King Rail	**Sandhill Crane**
Sora	**Sora**
Yellow Rail	**Great Blue Heron**
Black-crowned Night-Heron	**Pied-billed Grebe**
Black Tern	**American Coot**
Common Tern	**Common Tern**
Common Loon	**Common Loon**

The criteria for selecting breeding focal species included one or more of the following: 1) relatively high continental or regional conservation concern, 2) importance of regional abundance to continental population size, 3) characteristic of a wetland community type or complex of cover types important to a guild of waterbird species and that can be described by regional spatial data, 4) factors limiting populations are relatively well understood, and 5) a system of population monitoring has been established. Non-breeding focal species also represented guilds of waterbirds dependent on unique wetland types, and these were species with at least one source of monitoring data to help track distribution and abundance during migration and winter. Population trends based on monitoring JV focal species are assumed to reflect the suite of species that they represent within a given complex of cover types (species-habitat associations). However, the assumption that a suite of species will respond similarly to habitat retention, restoration, and enhancement has not been critically evaluated.

Most species of wetland birds use areas with multiple wetland types (e.g., combinations of emergent, aquatic bed, unconsolidated/open water) and the juxtaposition and extent of these wetland types and associated upland cover often determines habitat quality. For spatial data analysis and habitat modeling, simple cover-type combinations comprising typical habitats for each JV focal species were identified. Waterfowl and other waterbirds have extensive overlap in habitat requirements (Potter and Soulliere 2009). Information regarding waterfowl guilds that use common habitats with waterbirds was included in this Strategy to help ensure conservation delivery complements rather than excludes species within common habitat guilds. For instance, habitat *generalists* (e.g., Mallard) typically occupy some of the same breeding areas as species with more diverse habitat requirements (e.g., Common Gallinule or King Rail), but the opposite may not be true. Moreover, slight management adjustments (e.g., timing of wetland inundation) can provide habitat area required by species of higher conservation concern (e.g., secretive marsh birds) at a critical life-cycle period.

The most recent spatial data available from the National Wetland Inventory (NWI; USFWS 2016), supplemented with National Land Cover Data (NLCD; Homer et al. 2015), were used to broadly describe habitat associations required by wetland bird guilds during breeding and non-breeding periods. First, primary wetland bird habitats were grouped into four NWI wetland classes (Table 1): Emergent (including persistent and non-persistent herbaceous vegetation), Forested (deciduous only), Aquatic Bed (open wetlands dominated by submerged aquatic plants), and Unconsolidated (including unconsolidated bottom and shore, which together represented open-water communities). Spatial data at the NWI class level represent wetland area in terms of dominant vegetation and physical geography (Figure 4; FGDC 2013), which are important features of bird habitats and useful for planning at a regional scale.

Habitat associations for bird guilds were further refined by adding secondary attributes, which included both NWI wetland classes and NLCD land cover classes. Combinations of wetland types and key upland features provide the habitat complexes essential for many species. For example, breeding King Rail are most associated with the NWI emergent wetland class, but habitat for this species often includes persistent and non-persistent emergent plants, plus shallow aquatic bed, along with surrounding areas of upland grassland / herbaceous cover and limited forest. Conversely, breeding herons and egrets (forested wetland guild) often use a variety of emergent, aquatic bed, and or scrub-shrub wetlands for foraging but they require proximate deciduous forest and or scrub-shrub nesting cover.

Thus, our five habitat categories should be considered robust combinations of primary wetland types (i.e., NWI classes) and other landscape features (NWI and NLCD cover classes) associated with each species group. This information was used to formulate a general landscape design to accommodate habitat modeling, while recognizing that characteristics of high quality habitats for focal species are actually more complex than these planning categories. Detailed explanations of quality waterbird habitats are provided in breeding focal species accounts (Appendices A), and in analogous sections of the 2017 JV Waterfowl Habitat Conservation Strategy.

Species of Highest Conservation Concern

Continental priority waterbird species were identified in the North American Waterbird Conservation Plan (Kushlan et al. 2002). The Upper Mississippi Valley / Great Lakes Plan (Wires et al. 2010) provided greater detail regarding which and why species are considered regional conservation priorities. Results from the continental assessments suggest Least Tern (interior population), American Bittern, Yellow and King Rail, and Whooping Crane are the highest conservation priority species occurring in the JV region. In addition to these species, the UMVGL plan identifies as high priority (i.e., *high conservation concern* in at least one BCR in the region) Pied-billed Grebe, Least Bittern, Black-crowned and Yellow-crowned Night-Herons, Black Rail, Sora, and Common and Black Terns. Finally, because of its small North American population size, declining regional abundance, and predicted high vulnerability to climate change, the Forster's Tern has increasingly been considered a species of conservation concern (S. Matteson, Wisconsin Dept. of Natural Resources, personal communication).

Table 1. Species-habitat associations for wetland-bird guilds occurring in the Upper Mississippi River and Great Lakes Joint Venture (JV) region during breeding and non-breeding (migration and winter) periods. *Primary* (NWI wetland classes) and *Secondary* (NWI classes and or NLCD upland cover classes) column headings reflect spatial data used in habitat modeling for each guild. Individual species use multiple wetland types and bird groupings are for planning purposes; **bold** names are JV **focal species** emphasized in planning. Multiple focal species were used for a single habitat category to encompass larger geographic areas within the JV region.[a]

Primary →	Emergent		Forested	Aquatic Bed	Unconsolidated Bottom/Shore
Secondary →	Aqautic Bed or Unconsolidated	Aquatic Bed and Grassland/herbaceous	Aqauitc Bed/Emergent or Scrub-Shrub and Deciduous Forest[b]	Emergent and Unconsolidated	Aquatic Bed or Emergent, plus islands
Breeding Waterbirds					
	American Bittern	**King Rail**	**Black-crowned Night-Heron**	**Black Tern**	**Common Tern**
	Least Bittern	**Sora**	Great Blue Heron	Pied-billed Grebe	**Common Loon**
	Common Gallinule	**Yellow Rail**	Great Egret	Red-necked Grebe	Double-crested Cormorant
	American Coot	Black Rail	Snowy Egret	Forster's Tern	American White Pelican
		Virginia Rail	Little Blue Heron		Ring-billed Gull
		Sandhill Crane	Cattle Egret		Herring Gull
		Whooping Crane	Green Heron		Great Black-backed Gull
			Yellow-crowned Night-Heron		Caspian Tern
					Least Tern
Non-breeding Waterbirds					
	American Bittern	**Sora**	**Great Blue Heron**	**Pied-billed Grebe**	**Common Loon**
	Least Bittern	**Sandhill Crane**	Black-crowned Night-Heron	**American Coot**	**Common Tern**
		Cattle Egret	Great Egret	Red-necked Grebe	Double-crested Cormorant
		Yellow Rail	Snowy Egret	Common Gallinule	American White Pelican
		Black Rail	Little Blue Heron	Forster's Tern	Ring-billed Gull
		King Rail	Green Heron	Black Tern	Herring Gull
		Virginia Rail	Yellow-crowned Night-Heron		Great Black-backed Gull
					Caspian Tern
					Least Tern
Breeding Waterfowl					
	Mallard	Blue-winged Teal	Wood Duck	Ring-necked Duck	Common Merganser
	Gadwall	Northern Shoveler	Common Goldeneye	American Black Duck	Red-breasted Merganser
	Green-winged Teal	Canada Goose	Hooded Merganser	Redhead	
				Trumpeter Swan	
Non-breeding Waterfowl					
	Northern Pintail		Wood Duck	Gadwall	Lesser Scaup
	Green-winged Teal		American Black Duck	Canvasback	Greater Scaup
	Mallard			American Wigeon	Surf Scoter
	Blue-winged Teal			Redhead	White-winged Scoter
	Northern Shoveler			Ring-necked Duck	Black Scoter
				Ruddy Duck	Long-tailed Duck
				Snow/Ross' Goose	Bufflehead
				Canada Goose	Common Goldeneye
				Trumpeter Swan	Hooded Merganser
				Tundra Swan	Common Merganser
					Red-breasted Merganser

[a] Cover type categories were developed using NWI and NLCD classifications to better enable conservation planning and monitoring land cover change. More specific descriptions of species habitat requirements for the breeding period can be found in species accounts (Appendices A).

[b] Species in the Forested Wetland guild require upland or wetland deciduous forest for different purposes during breeding (e.g., waterbird rookeries, duck nest cavities) and non-breeding (e.g., waterbird roosting) periods. Also, species in this guild readily use emergent, aqautic bed, and scrub-shrub wetlands for foraging as long as suitable deciduous forest is nearby for nesting and roosting.

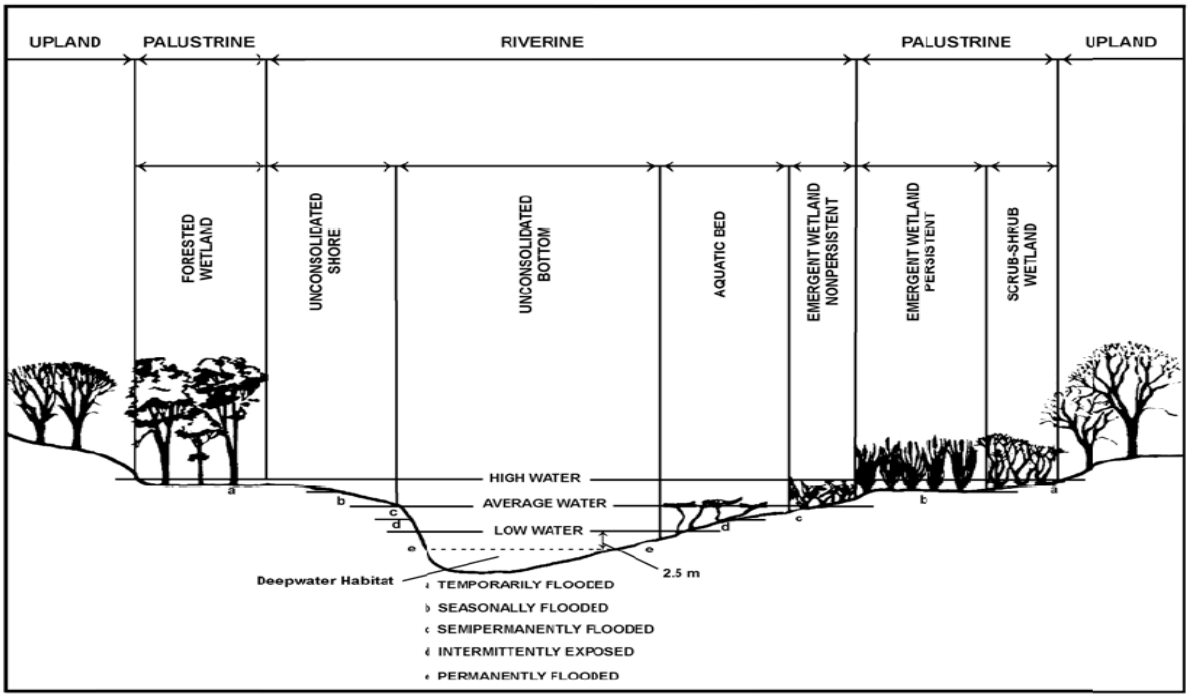


Figure 4. Depiction of wetland classes important to waterbirds within a hypothetical transition between NWI Riverine and Palustrine systems (from Federal Geographic Data Committee 2013).

Population Abundance and Trends

Population abundance estimates and trends are essential for establishing habitat objectives. For example, the calculation of population deficits (goal – current estimate = deficit) was used to generate estimates of new habitat needed (restoration objectives). However, there remains a high degree of variability and uncertainty associated with many waterbird population estimates. The best source for species-specific information within the JV region is the UMVGL plan (Wires et al. 2010); this document provides season of occurrence, relative abundance, and nesting information by BCR (Table 2).

Many waterbird species receive limited survey coverage and results from new monitoring efforts (e.g., Midwest marsh bird surveys, eBird) have not yet been translated into population abundance estimates. Their generally low numbers, remote and sometimes concentrated nesting sites (i.e., colonial species), or secretive behavior make the North American Breeding Bird Survey (BBS, Sauer et al. 2015) inadequate for assessing many waterbird species. However, several of the more vocal and visible waterbird species are recorded on BBS routes, and population indices for these species have been established. Abundance trends based on BBS data have been summarized for the upper Midwest region (FWS Region 3; Table 3). Species with greatest long-term population increase include American White Pelican, Double-crested Cormorant, Great Egret, Sandhill Crane, and Ring-billed Gull. Populations with greatest long-term decline include American Bittern, Green Heron, Black-crowned and Yellow-crowned Night-Herons, Sora, Common Gallinule, and Black Tern (Sauer et al. 2015). Short-term (2004–2013) regional population indices had especially wide BBS credible intervals, yet trend estimates were similar to long-term indices (Table 3).

Table 2. Seasonal occurrence, relative abundance, and nesting strategy of waterbirds listed by Bird Conservation Region (BCR): Boreal Hardwood Transition (BCR 12), Lower Great Lakes/St. Lawrence Plain (BCR 13), Eastern Tallgrass Prairie (BCR 22), Prairie Hardwood Transition (BCR 23), and Central Hardwoods (BCR 24).[a]

	Bird Conservation Region					Nesting
Species name	12	13	22	23	24	strategy
Red-throated Loon	M	w, M	m	m	m	N
Common Loon	B	b, w, **M**	M	B, **M**	w, m	N
Pied-billed Grebe	B	B, w	B, w	B	b, w	N
Horned Grebe	M	M	w, M	M	w, m	N/C
Red-necked Grebe	B, **M**	b, w, **M**	M	b, m		N/C
Eared Grebe	b		M			C/N
Western Grebe	b		m	b, m	m	C
American White Pelican	B, m		w, m	b, m	w, m	C
Double-crested Cormorant	**B**	**B**	B, w, **M**	B, w, M	b, w, m	C
American Bittern	B	b	B, *m*	B	*b, m*	N
Least Bittern	*b*	*b*	*b, m*	*b, m*	*b, m*	N/C
Great Blue Heron	b	*b, w*	B, *w*	B, *w*	*b, w*	C
Great Egret	b, m	b, m	B, m	b, m	b, m, w	C
Snowy Egret			b, m	b, m	b, m	C
Little Blue Heron			b, m	m	m	C
Cattle Egret	m	b, m	b, m	b, m	b, m	C
Green Heron	b	*b*	B	B	B	N/C
Black-crowned Night-Heron	*b, w*	*b, w*	*b, w*	*b, w*	*b, w*	C
Yellow-crowned Night-Heron			b, m		b, m	C
Yellow Rail	B	b, m	m	b, m	m	N
Black Rail			b	b, m	m	N
King Rail	b	B	B	b	b	N
Virginia Rail	b	**B**, *w*	**B**, *m, w*	**B**, *m*	*w*, *m*	N
Sora	**B**	**B**	b, M	**B**, *m*	b, m	N
Purple Gallinule			m		b	N
Common Gallinule	b, *m*	B, *m*	B, *m*	B, *m*	b, *m*	N
American Coot	b, *m*	B, w, m	B, w	B, *m*	b, W	N
Sandhill Crane	**B**	b	b, **M**	**B, M**	M	N
Whooping Crane			m	B, m	m	N
Parasitic Jaeger	*m*	*m*	*m*	*m*		C/N
Franklin's Gull	*m*	*m*	*m*	*m*	*m*	C
Bonaparte's Gull	*m*	*w, m*	*w, m*	*w, m*	*w, m*	C
Ring-billed Gull	**B**, *w*	**B**, *w*	B, *w, m*	**B**, *w*	*w, m*	C
Herring Gull	**B**, *w*	**B**, *w*	b, *w, m*	b, *w, m*	*w, m*	C
Great Black-backed Gull	b, w	b, w	w	w		C
Sabine's Gull	*m*	*m*	*m*	*m*	*m*	C
Thayer's Gull	w	w	w	w		C
Iceland Gull	w	w	w	w		C
Lesser Black-backed Gull		w	w			C
Glaucous Gull	w	w	w	w		C
Little Gull	m	M, w	m	m		C
Caspian Tern	B, *m*	B, *m*	b	B, *m*	*m*	C
Common Tern	B	B	b, *m*	b, *m*	*m*	C
Forster's Tern	b, *m*	b	b, *m*	B, *m*	*m*	C
Least Tern			b, m		b, m	C/N
Black Tern	B	B	b, *m*	B	*m*	C

[a] Information adapted from Wires et al. (2010) but adjusted for recent observations (e.g., eBird) and BCR boundary changes. Seasonal occurrence and relative abundance categories: B = Breeding, M = Migration, W = Wintering; **B, M, W** (bolded) = high concentrations, region is extremely important to species relative to most other regions; B, M, W = common or locally abundant, region is relatively important to species; b, m, w = uncommon to fairly common, region is within species range but species occurs in low abundance relative to other regions; *b, m, w* = species occurs as breeder, migrant, or wintering bird but relative abundance is unknown. Nesting strategy includes colonial (C) and non-colonial (N) or both (C/N, dominate listed first). BCR boundaries for 12, 22, and 23 changed since the Wires et al. (2010) plan was completed, also ratings are based on total BCR area within U.S., but the Upper Mississippi River and Great Lakes Joint Venture region encompasses only parts of BCRs 13 (11%), 22 (92%), 23 (91%), 24 (12%), and 12 (34% in U.S.).

Table 3. Estimates of long term (1966-2013) and short term (2004-2013) population trends (annual % change) for waterbird species that breed within FWS Region 3[a] and were recorded during the North American Breeding Bird Survey (BBS).

	1966-2013			2004-2013		
		95% CI[b]			95% CI[b]	
Species	Trend	Lower	Upper	Trend	Lower	Upper
Common Loon	1.41	0.66	2.12	1.46	-0.11	3.07
Pied-billed Grebe	-1.04	-2.48	-0.37	0	-3.3	4.05
Red-necked Grebe	1.99	-5.42	10.32	2.57	-22.62	20.53
Western Grebe	na[c]	na	na	na	na	na
American White Pelican	14.97	8.7	20.43	13.02	-6.36	30.28
Double-crested Cormorant	7.41	4.03	10.56	7.7	0.7	14.66
American Bittern	-3.28	-4.69	-1.95	-2.89	-7.31	2.44
Least Bittern	-2.19	-7.24	2.73	-0.13	-11.55	11.76
Great Blue Heron	1.1	0.6	1.58	0.62	-0.85	2.05
Great Egret	4.83	2.19	6.85	1.64	-5.31	7.88
Snowy Egret	na	na	na	na	na	na
Little Blue Heron	0.01	-5.23	4.1	-1.92	-18.5	8.3
Cattle Egret	1.91	-10.56	11.2	4.39	-21.89	47.07
Green Heron	-1.38	-1.81	-0.96	-1.97	-3.32	-0.64
Black-crowned Night-Heron	-3.98	-7.08	-1.34	-1.99	-9.41	5.5
Yellow-crowned Night-Heron	-7.79	-19.35	0.94	-6.84	-41.74	42.54
Yellow Rail	na	na	na	na	na	na
Black Rail	na	na	na	na	na	na
King Rail	na	na	na	na	na	na
Virginia Rail	-1.04	-3.25	1.11	0.47	-5.97	7.92
Sora	-1.89	-3.49	-0.41	-1.5	-6.51	3.97
Common Gallinule	-12.44	-18.47	-5.89	-11.26	-22.05	16.26
American Coot	-1.59	-7.45	-1.84	-3.44	-11.73	6.56
Sandhill Crane	10.49	8.67	12.14	9.78	6.75	12.61
Ring-billed Gull	8.72	5.72	14.16	12.79	2.66	33.11
Herring Gull	-2.62	-6.04	0.23	-7.29	-18.05	3.45
Great Black-backed Gull	na	na	na	na	na	na
Caspian Tern	2.47	-13.54	10.68	3.66	-27.62	29.42
Common Tern	na	na	na	na	na	na
Forster's Tern	-0.67	-11.04	5.29	3.33	-9.02	14.46
Least Tern	na	na	na	na	na	na
Black Tern	-6.02	-9.4	-4.33	-5.54	-1.01	-1.58

[a] USFWS Region 3 includes Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. BBS data from Sauer et al. (2015); these data not provided by USFWS region after 2013, but recent analyses are completed by state and BCR (www.mbr-pwrc.usgs.gov/bbs/).

[b] C.I. values represent a "credible interval," a lower (2.5%) and upper (97.5%) bound on estimated percent annual population change (trend). Wide C.I.s associated with a trend estimate typically reflect lower relative abundance and less consistent encounters over time; trend estimates having both negative and positive C.I. values have especially low validity.

[c] na indicates inadequate survey data to generate a trend estimate.

Standardized survey techniques have been developed to improve trend monitoring of secretive marsh birds, such as the Great Lakes Marsh Monitoring Program (MMP) and the North American Marsh Bird Monitoring Protocol (Conway 2011). Participants in the MMP have been gathering data on breeding marsh birds within the Great Lakes basin since 1995 (Crewe et al. 2005). Their findings suggest declines in abundance (1996–2013) across the southern portion of the Great Lakes region for all species of secretive marsh birds (Tozer

2015). The species with the most significant downward trend was the Black Tern. American Coot, Common Gallinule, Sora, Pied-billed Grebe, American Bittern, Virginia Rail, and Least Bittern also declined significantly during this period.

The Great Lakes Colonial Waterbird Survey is completed approximately every 10 years by Canadian and U.S. federal wildlife agencies with assistance from state agencies. This survey, spanning years 1977 to 2009, has attempted to completely census colonial waterbirds breeding on the Great Lakes and adjoining water bodies. Census results for the primary heron and egret species have been reported (Rush et al. 2015): estimates of breeding pairs (nest counts) ranged from 4,000–6,100 for Black-crowned Night-Heron, 250–1,900 for Great Egret and 3,800–6,400 for Great Blue Heron. Across the census period Black-crowned Night-Heron estimates declined in the U.S. (-57%) but increased (+18%) in Canada, whereas the number of Great Egret increased in both the U.S. and Canada. Although a single factor could not be clearly linked to changes observed in each species' distribution, hydrological variation associated with lake-levels, cover-type succession (change in habitat suitability), nest competition with Double-crested Cormorants, and land use changes were all identified as potentially influencing colonial nesting species (Rush et al. 2015).

Species that depend on large emergent wetlands (e.g., American Bittern) appear to be declining in number, presumably due to habitat change. Marsh bird population trends are almost surely linked to loss in quantity (Dahl 1990, 2011) and or quality of shallow marsh wetlands across the region, especially in areas with intensive agriculture and urban development (Figure 5A). Conversely, populations of other waterbirds (e.g., Double-crested Cormorant, Ring-billed Gull) have increased in recent decades (Figure 5B), likely due to positive environmental change, such as lower contaminant levels in breeding habitats and increasing food resources at breeding and non-breeding sites (Wires et al., 2001; Wires et al. 2010). In some locations, these increasing species have exceeded a social carrying-capacity, the theoretical threshold above which human-bird conflicts are considered unacceptable.

Breeding Population Abundance and Objectives

Setting conservation targets is critical to planning (Soulé and Sanjayan 1998, Tear et al. 2005), and considerations to assist JVs in establishing bird population and habitat objectives have been described in detail (Andres et al. 2012). A primary goal of this Strategy is to translate waterbird population objectives into habitat objectives and help JV partners effectively target conservation to achieve those objectives. For species with stable or increasing populations, we assumed abundance of those waterbirds would fluctuate with environmental conditions (e.g., annual precipitation, wetland conditions, and Great Lakes water levels) and they should not be a primary target for conservation delivery. The goal for species of high continental and or regional conservation concern (Kushlan et al. 2002, Wires et al. 2010) is to stop the decline in abundance within the JV region and restore populations to recent (objective) levels. For these species, a 50% increase in population abundance was established as a basis for calculating habitat needs to significantly expand breeding habitat carrying capacity.

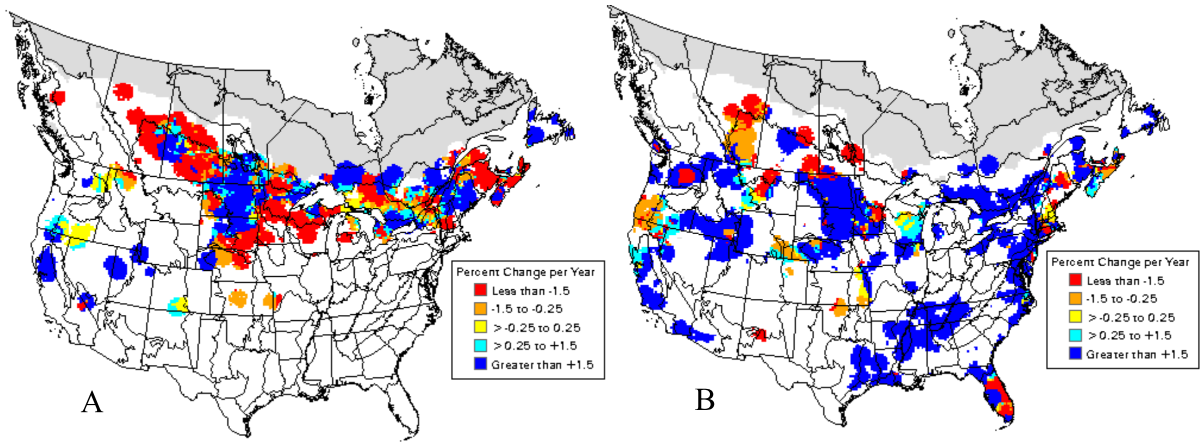


Figure 5. Population trends of (A) American Bittern and (B) Double-crested Cormorant, 1966–2015. Areas of increasing populations are represented in blue and decreasing population in red (Sauer et al. 2017).

Regional population estimates for many waterbird species are provided by BCR in the UMVGL plan (Wires et al. 2010). The proportion (% area) of each BCR within the JV region was multiplied by UMVGL plan abundance estimates for each species to generate JV regional population estimates (Table 4). For species without UMVGL plan population estimates, values were generated based on a combination of state and local-scale surveys and expert opinion (Table 4; Appendix D). Lack of rigorous population estimates for the secretive marsh birds remains an unfortunate shortcoming of this Strategy. However, using the best information available, calculations of breeding population objectives and deficits were compiled for focal species and species of high conservation concern (Table 4). Population estimates and objectives are expected to be refined over time with improvements in monitoring data. The regional Whooping Crane population goal was established under a separate species-specific conservation plan (Fasbender et al. 2015).

Non-breeding Period Abundance

Regional population abundance and distribution estimates during migration and wintering periods are lacking for waterbirds. As a result, eBird data were used to develop occurrence chronology curves depicting species-specific relative abundance during the non-breeding period in the JV region. The primary factors determining selection of non-breeding focal species were availability of eBird data and the value these species provide representing temporal occurrence of the various planning guilds (Table 1).

Biological Models

Biological models provide a means for more effective conservation planning with incomplete knowledge. Using the literature and unpublished expert-based information, we created models to translate population objectives into habitat restoration and retention objectives. In addition, digital cover type data (NWI and NLCD) and perceived limiting factors were combined to create habitat suitability models for targeting conservation effort. A primary challenge with modeling waterbird habitat needs is that they vary spatially and temporally.

Table 4. Breeding population estimates, objectives, and deficits[a] by Bird Conservation Region (BCR)[b] for waterbirds in the Upper Mississippi River and Great Lakes Joint Venture (JV) region. The JV region covers portions of BCR 12 (34%), 22 (92%), 23 (91%), 24 (12%), and 13 (11%). Breeding waterbird abundance estimates for total BCRs and for the proportion of each BCR within the JV region were based on multiple sources (UMVGLP and EO).[c] The *JV region best estimate* was used to derive abundance objectives for species below desired population levels (bold font indicates JV focal species emphasized for planning and monitoring).

	Abundance estimates					
	UMVGLP					
	BCR Total	JV region only	EO (JV region only)	JV region best estimate	Objective	Deficit
Common Loon				41,463		
BCR 12	111,000	37,740		37,740		
BCR 23	4,016	3,655		3,655		
BCR 22	0	0		0		
BCR 13	620	68		68		
BCR 24	0	0		0		
Pied-billed Grebe				11,026	16,539	5,513
BCR 12			2,550	2,550	3,825	1,275
BCR 23	2,400	2,184	5,422	5,422	8,133	2,711
BCR 22	1,200	1,104	2,694	2,694	4,041	1,347
BCR 13	2	0	200	200	300	100
BCR 24	70	8	160	160	240	80
Red-necked Grebe				2,564		
BCR 12	4,000	1,360	2,200	2,200		
BCR 23	2,000	1,820	348	348		
BCR 22	0	0	16	16		
BCR 13	6	1	0	0		
BCR 24	0	0	0	0		
American White Pelican				19,128		
BCR 12	13,600	4,624	1,218	1,218		
BCR 23	3,200	2,912	17,090	17,090		
BCR 22	0	0	820	820		
BCR 13	0	0	0	0		
BCR 24	0	0	0	0		
Double-crested Cormorant[d]				67,454		
BCR 12	111,000	37,740		37,740		
BCR 23	15,600	14,196		14,196		
BCR 22	8,200	7,544		7,544		
BCR 13	71,400	7,854		7,854		
BCR 24	1,000	120		120		
American Bittern				3,146	4,719	1,573
BCR 12			2,020	2,020	3,030	1,010
BCR 23			876	876	1,314	438
BCR 22			226	226	339	113
BCR 13			12	12	18	6
BCR 24			12	12	18	6

	Abundance estimates					
	UMVGLP					
	BCR Total	JV region only	EO (JV region only)	JV region best estimate	Objective	Deficit
Least Bittern				3,790	5,685	1,895
BCR 12			350	350	525	175
BCR 23			1,850	1,850	2,775	925
BCR 22			1,360	1,360	2,040	680
BCR 13			70	70	105	35
BCR 24			160	160	240	80
Green Heron				57,708		
BCR 12	NE	NE				
BCR 23	NE	NE				
BCR 22	55,500	51,060		51,060		
BCR 13	NE	NE				
BCR 24	55,400	6,648		6,648		
Great Blue Heron				67,352		
BCR 12	NE	NE				
BCR 23 (partial estimate)	24,000	21,840		21,840		
BCR 22	43,000	39,560		39,560		
BCR 13		0		0		
BCR 24	49,600	5,952		5,952		
Great Egret				16,700		
BCR 12	780	265		265		
BCR 23 (partial estimate)	4,540	4,131		4,131		
BCR 22	13,000	11,960		11,960		
BCR 13	260	29		29		
BCR 24	2,620	314		314		
Snowy Egret				451		
BCR 12	0	0		0		
BCR 23	60	55		55		
BCR 22	300	276		276		
BCR 13	0	0		0		
BCR 24	1,000	120		120		
Little Blue Heron				1,648		
BCR 12	0	0		0		
BCR 23	0	0		0		
BCR 22	1,400	1,288		1,288		
BCR 13	0	0		0		
BCR 24	3,000	360		360		
Cattle Egret				4,722		
BCR 12	20	7		7		
BCR 23	60	55		55		
BCR 22	2,040	1,877		1,877		
BCR 13	NE	NE				
BCR 24	23,200	2,784		2,784		
Black-crowned Night-Heron				8,176	12,263	4,088
BCR 12	2,820	959		959	1,438	479
BCR 23	3,800	3,458		3,458	5,187	1,729

	Abundance estimates					
	UMVGLP					
	BCR Total	JV region only	EO (JV region only)	JV region best estimate	Objective	Deficit
BCR 22	3,140	2,889		2,889	4,333	1,444
BCR 13	6,000	660		660	990	330
BCR 24	1,750	210		210	315	105
Yellow-crowned Night-Heron				1,057	1,586	529
BCR 12	0	0		0		
BCR 23	100	91		91	137	46
BCR 22	600	552		552	828	276
BCR 13	0	0		0		
BCR 24	3,450	414		414	621	207
Yellow Rail				1,080	1,620	540
BCR 12	600	204	980	980	1,470	490
BCR 23	200	182	100	100	150	50
BCR 22	0	0	0	0		
BCR 13	160	18	0	0		
BCR 24	0	0	0	0		
Black Rail				120	180	60
BCR 12	0	0	8	8	12	4
BCR 23	50	46	32	32	48	16
BCR 22	100	92	72	72	108	36
BCR 13	0	0	8	8	12	4
BCR 24			0	0	0	0
King Rail				290	435	145
BCR 12	20	7	0	0		
BCR 23	100	91	124	124	186	62
BCR 22	225	207	152	152	228	76
BCR 13	40	4	0	0		
BCR 24	50	6	14	14	21	7
Virginia Rail				11,568		
BCR 12	3,040	1,034	5,808	5,808		
BCR 23	1,300	1,183	4,272	4,272		
BCR 22	2,500	2,300	1,280	1,280		
BCR 13	74,100	8,151	160	160		
BCR 24	0	0	48	48		
Sora				20,646	30,969	10,323
BCR 12	13,240	4,502	10,820	10,820	16,230	5,410
BCR 23	13,300	12,103	6,536	6,536	9,804	3,268
BCR 22	3,950	3,634	3,020	3,020	4,530	1,510
BCR 13	13,300	1,463	150	150	225	75
BCR 24	200	24	120	120	180	60
Common Gallinule				4,508		
BCR 12	NE	NE	80	80		
BCR 23	NE	NE	2,240	2,240		
BCR 22	2,060	1,895	1,688	1,688		
BCR 13	NE	NE	400	400		
BCR 24	NE	NE	100	100		

	Abundance estimates					
	UMVGLP					
	BCR Total	JV region only	EO (JV region only)	JV region best estimate	Objective	Deficit
American Coot				9,490		
BCR 12	NE	NE	1,040	1,040		
BCR 23	4,000	3,640	5,810	5,810		
BCR 22	NE	NE	2,470	2,470		
BCR 13	NE	NE	50	50		
BCR 24	4,146	498	120	120		
Sandhill Crane				15,091		
BCR 12	21,400	7,276		7,276		
BCR 23	8,200	7,462		7,462		
BCR 22	300	276		276		
BCR 13	700	77		77		
BCR 24	0	0		0		
Whooping Crane				72	108	36
BCR 12	0	0		0		
BCR 23	79	72		72	108	36
BCR 22	0	0		0		
BCR 13	0	0		0		
BCR 24	0	0		0		
Ring-billed Gull[d]				410,490		
BCR 12	334,600	113,764		113,764		
BCR 23	83,200	75,712		75,712		
BCR 22	112,800	103,776		103,776		
BCR 13	1,065,800	117,238		117,238		
BCR 24	0	0		0		
Herring Gull				52,384		
BCR 12	98,400	33,456		33,456		
BCR 23	3,000	2,730		2,730		
BCR 22	12,800	11,776		11,776		
BCR 13	40,200	4,422		4,422		
BCR 24	0	0		0		
Caspian Tern				3,257		
BCR 12	6,800	2,312		2,312		
BCR 23	10	9		9		
BCR 22	300	276		276		
BCR 13	6,000	660		660		
BCR 24	0	0		0		
Common Tern				5,021	7,532	2,511
BCR 12	8,200	2,788		2,788	4,182	1,394
BCR 23	640	582		582	874	291
BCR 22	240	221		221	331	110
BCR 13	13,000	1,430		1,430	2,145	715
BCR 24	0	0		0		
Forster's Tern				3,046		
BCR 12	920	313		313		
BCR 23	2,800	2,548		2,548		

	Abundance estimates					
	UMVGLP					
	BCR Total	JV region only	EO (JV region only)	JV region best estimate	Objective	Deficit
BCR 22	NE	0		0		
BCR 13	1,680	185		185		
BCR 24	0	0		0		
Least Tern (interior)				1,742	2,613	871
BCR 12	0	0		0		
BCR 23	0	0		0		
BCR 22	1,600	1,472		1,472	2,208	736
BCR 13	0	0		0		
BCR 24[e]		270		270	405	135
Black Tern				17,556	26,334	8,778
BCR 12	12,000	4,080		4,080	6,120	2,040
BCR 23	14,200	12,922		12,922	19,383	6,461
BCR 22	100	92		92	138	46
BCR 13	4,200	462		462	693	231
BCR 24	0	0		0		

[a] Population deficit = population objective - current estimate (numbers are individual birds).
[b] Bird Conservation Regions (BCRs): 12 = Boreal Hardwood Transition, 23 = Prairie Hardwood Transition, 22 = Eastern Tallgrass Prairie, 13 = Lower Great Lakes / St. Lawrence Plain, and 24 = Central Hardwoods.
[c] Breeding population estimates were derived from two sources: UMVGLP = Upper Mississippi Valley / Great Lakes Region Waterbird Plan (Wires et al. 2010; NE = no estimate) and EO (expert opinion, including use of state Breeding Bird Atlas data and local surveys (see Appendix D). The proportion (% of BCR area) of each BCR within the JV region was multiplied by UMVGLP estimates for each species to generate JV regional estimates. Population objectives and deficits are provided only for species identified as *high* conservation status in continental and regional assessments; these species were assigned an abundance objective 50% higher than current population estimates (except Common Loon, which had a stable regional population). Species not listed high priority for continental or regional conservation are not specifically targeted for management in this Strategy, and their numbers are expected to fluctuate in response to environmental change. The regional Whooping Crane population goal was established under a separate conservation strategy for this species.
[d] Species may not be habitat limited and has been identified as a "management concern" due to human-bird conflict. Management is being addressed via FWS depredation permits and associated working groups.
[e] Least Tern was not listed in BCR 24 in the UMVGLP but 270 adults were documented nesting on the Wabash and Ohio Rivers (Lott 2006) within the JV region.

Not only do habitat requirements change among seasons (i.e., courtship, nesting, brood rearing, migration/staging), but the association with wetland types used by many species varies depending on location within the JV region. For example, heron and egret species most commonly associated with emergent and aquatic bed wetlands in northern parts of the region readily use more forested wetlands in BCR 22. Even at the same location, waterbirds typically use complexes of several wetland (and upland) types in close proximity (Table 1).

A key assumption in bird habitat conservation is that the vital rates influencing population growth can be impacted through habitat delivery programs. Identification of population limiting factors and understanding their ecological relationships (via modeling) are essential when developing habitat objectives and conservation strategies. However, lack of population information and accuracy of wetland spatial data can hamper development of rigorous models. For example, the spatial data used in this Strategy (NWI and NLCD), and thus model results, do not reflect biological and environmental variation over time. Our understanding of factors influencing population growth for most waterbird species inhabiting the JV region remains incomplete, therefore planning assumptions were required.

Explicit Planning Assumptions

In this Strategy we define a set of JV focal species to represent the diverse habitats occupied by waterbirds. Our purpose was to provide wildlife managers information on what, where, when, and how much habitat is needed to sustain and increase priority waterbird populations. Population estimates and habitat objectives were derived for each breeding focal species using the best information available. Because information is limited, many modeling assumptions were needed. We recognize this approach over-simplifies reality and some assumptions are not true. However, over time assumptions will be tested and other research and monitoring completed, filling critical information gaps and resulting in improved methods for estimating populations and habitat needs.

Waterbird population abundance and habitat-use during migration and winter remains a JV information need for conservation planning. Breeding habitats in the region may largely support migrating waterbirds, but this notion has not been tested. Likewise, potential migration corridors and duration of stay while staging are not well understood. However, we assume landscape and site attributes important to other wetland birds also provide value to waterbirds, with a particularly strong relationship between waterbird and duck habitats (Table 1). Lacking a means to quantify waterbird non-breeding habitat needs, we assumed habitat to meet non-breeding waterbird objectives could be met via implementation of the 2017 JV Waterfowl Strategy, as non-breeding habitat required by this abundant bird group is believed to be greater than quantities required by waterbirds (see Appendix E). Evaluation of habitat needs and other potential factors limiting waterbird population growth during the full annual cycle are required to better direct habitat activities to breeding vs. non-breeding conservation.

Finally, we also recognize the growing interest for better integration of social values when conducting habitat planning, and we assume both biological and social objectives may be achieved at common locations. The following model assumptions should be tested to increase our understanding of habitat conservation effectiveness for waterbirds and people.

1) The amount of breeding habitat is limiting populations. We therefore need to restore and retain habitats at objective levels for priority breeding birds (JV focal species) to increase and sustain populations.
2) JV focal species and their habitat needs generally reflect the habitat requirements of species in their assigned guilds (Table 1); management actions that benefit JV focal species will benefit other species within the guild.
3) JV regional and State × BCR waterbird population estimates and objectives used in the Strategy are accurate enough for planning purposes.
4) Population density estimates in the literature are representative of the species occupying high quality habitats in the JV region.

5) In the absence of data on source and sink populations, we assume areas with similar ecological features and consistently high densities of breeding pairs are important areas for protection.
6) The area and types of habitat needed for migrating and wintering waterbirds will be encompassed by areas conserved for breeding waterbirds and breeding and non-breeding waterfowl (see 2017 JV Waterfowl Strategy).
7) Local habitat management actions have the potential to increase regional waterbird populations.
8) Waterbird habitats described for conservation focus can provide recreational opportunity (e.g., hunting, bird watching) and ecological services (e.g., water filtration, flood abatement, carbon sequestration) of value to people.

CONSERVATION DESIGN

Conservation Design is both a process (collaborative effort) and a product (a conceptual framework). The approach has been used to help achieve missions and goals of multiple partners while also sustaining complementary ecosystem services for future generations (Campellone et al. 2014, Bartuszevige et al. 2016). Conservation design in this regional Strategy offers a means to quantify and target partner conservation objectives. The process involved combining geospatial data with biological and social information to create decision-support maps predicting areas best suited to support waterbird populations and social objectives. Using these tools, we coarsely assessed current landscape conditions and how those conditions would need to change to achieve specific outcomes. The process and products helped to answer questions about what, where, when, and how much waterbird habitat is required to achieve objectives. Partner consensus around these habitat objectives and commitment to conservation implementation are critical to success.

Understanding focal species habitat requirements is essential to evaluate the ability of landscapes to support populations and to develop habitat delivery. Ideally, conservation design should result in a science-based representation of desired (future) landscape conditions needed to meet objectives. Spatially explicit habitat objectives are based on understanding species-habitat associations, factors limiting population growth, and characteristics of quality habitat that result in high recruitment and survival. The continually changing landscape of the JV region and the varied social, economic, and natural drivers of landscape modification add a challenging level of complexity. Improving our understanding of ecological and social systems can help JV partners respond to system change and retain more abundant and diverse waterbird habitats in the future. Below is an assessment of regional landscape conditions relevant to waterbird planning along with habitat objectives and a means to target conservation delivery to benefit waterbirds and people.

Landscape Planning Units

Bird Conservation Regions (Figure 1) are geographic designations that have similar land-cover types, bird communities, and resource conservation issues (NABCI 2000). They are the fundamental biological units through which the NABCI promotes delivery of landscape-scale bird conservation. BCRs provide a consistent spatial framework for evaluation, planning, and in some instances implementation. By employing broad scale units that are ecologically meaningful to bird populations, conservation efforts can be tailored to support groups of species throughout their range. We used BCRs as primary planning units in this Strategy. Objectives are further subdivided into State × BCR polygons to quantify habitat delivery targets within smaller domains (see Conservation Delivery section).

Land-cover composition, combined with soil characteristics, water chemistry, and wetland hydrology result in functional differences among BCRs that influence distribution and abundance of wetland birds. Understanding these functional differences and trends in key cover types across the JV region is important to making effective conservation decisions.

BCR Functional Differences

Boreal Hardwood Transition (BCR 12).—The northern-most area of the JV region is characterized by coniferous (evergreen) and deciduous forests, nutrient-poor soils, and an extraordinary abundance of lakes, wetlands, and river systems (Table 5). Areas with higher wetland bird use include coastal estuaries, river impoundments (i.e., *pools* on large rivers, *flowages* adjacent to small rivers), wild rice lakes, and beaver ponds. Beaver are important providers of waterfowl habitat in BCR 12 as they diversify hydrology and add nutrients to less productive wetlands, increasing plant and wildlife variety (Wright et al. 2002). Herbaceous wetland, inland open water, and upland forest represent 3%, 7%, and 48% of BCR 12 land cover, respectively (Table 5). Woody wetland also is a principal (25%) cover type but much of it is conifer-dominated with limited waterbird use; deciduous forested wetland and shrub-scrub wetlands comprise 10% of the BCR landscape. At the continental scale, BCR 12 is most important during the breeding period for populations of Double-crested Cormorant, Sandhill Crane, Ring-billed and Herring Gull, and Sora. It is also important for breeding Common Loon, Pied-billed Grebe, Red-necked Grebe, American White Pelican, and Yellow Rail, plus Caspian, Common, and Black Tern (Table 2). The area has moderate value for migration staging, especially for some species of grebes, but monitoring data for the non-breeding period is limited. Waterbird response to wetland restoration may be greatest at sites having higher nutrient clay and loam soils (Soulliere and Monfils 1996). Human density is low compared to other BCRs in the JV region, but recreational activity spikes during summer months especially in areas with lake-front cottages.

Prairie Hardwood Transition (BCR 23).—Prairie, hardwood forest, and savanna once dominated this area, but cropland and developed land have replaced much of the natural land cover, especially grasslands and seasonal and temporary wetlands. Glaciation resulted in numerous shallow lakes and pothole wetlands; even today, 4% of the landscape remains covered by inland lakes and an additional 5% is herbaceous wetland (Table 5). Due to the nutrient rich soils and wetlands, and its proximity to the Great Lakes, most species of waterbirds recorded in the JV region also occur in this BCR. The sub-region is especially important to populations of Sandhill Crane, Ring-billed Gull, Black Tern, and secretive marsh birds, many of which are JV priority species. Although population abundance data are

Table 5. Estimates of landscape and social characteristics important to wetland bird conservation planning in Bird Conservation Regions (BCRs) located in the Upper Mississippi River and Great Lakes Joint Venture region (area estimates in hectares [ha]). Estimates for BCRs 22 and 23 encompass the entire BCR, including portions outside the JV boundary (i.e., 8% of BCR 22, 9% of 23); estimates for BCRs 12, 13, and 24 apply only to those areas within the JV boundary.

	BCR		BCR (JV region only)			Total
	22[a]	23	12	13	24	
Total area (ha)	51,762,267	25,827,603	20,583,051	2,174,150	3,547,207	103,894,278
Primary cover types[a]						
Herbaceous wetland (total)	433,352	1,188,564	656,863	13,534	20,164	2,312,477
Emergent (interior/inland)	383,596	1,115,819	634,493	12,704	18,631	2,165,243
Great Lakes coastal emergent[b]	248	18,497	12,643	48	0	31,437
Aquatic bed (open with submergents)	49,508	54,248	9,727	782	1,533	115,798
Scrub/shrub wetland (decidous/broadleaf)	52,788	474,069	1,051,908	22,493	7,073	1,608,330
Forested wetland (deciduous/broadleaf)	734,890	1,303,592	1,173,330	68,689	113,219	3,393,721
Total wetland (herbaceous and woody)	1,221,030	2,966,225	2,882,101	104,716	140,456	7,314,529
Grassland/herbaceous, hay, and pasture	12,242,050	3,748,567	1,259,628	333,491	512,927	18,096,663
Grassland/herbaceous	4,064,150	520,347	573,110	45,298	77,936	5,280,841
Upland forest (all types)	6,077,593	5,219,278	10,095,671	668,725	1,671,927	23,733,194
Deciduous and mixed upland forest	5,955,359	4,741,484	7,112,091	655,872	1,616,179	20,080,985
Scrub/shrub upland (all types)	79,087	180,833	1,478,420	474	4,466	1,743,280
Cultivated cropland	26,668,500	8,931,760	627,028	575,551	1,206,240	38,009,079
Open water (inland and coastal)[c]	1,118,258	1,366,554	2,321,634	96,670	143,441	5,046,557
Inland waters (unconsolidated bottom)	1,022,319	977,348	1,409,770	49,834	141,908	3,601,179
Coastal zone waters (Great Lakes)	46,431	334,957	902,138	46,055	0	1,329,581
0.5 - 5 m deep	19,819	109,949	337,024	20,601	0	487,392
≤ 0.5 m deep	1,869	39,431	29,393	2,006	0	72,699
Hydric soils[d]	963,104	587,075	27,191	296,863	32,532	1,906,766
Prospective wetland (wet cropland)	783,065	276,383	8,342	19,252	24,310	1,111,352
Other related measures						
Number of inland lakes (≥ 0.5 ha)[e]	22,689	20,657	23,552	1,703	2,728	71,329
Inland lake coverage (ha)[e]	170,200	441,109	497,900	25,476	16,313	1,150,998
Perennial river length (km)[e]	141,639	72,201	63,191	9,042	13,052	299,125
Number of people (residents), 2010[f]	31,743,779	20,560,074	1,875,258	4,584,002	1,482,640	60,245,753
Human density (people/ha)[f]	0.613	0.796	0.091	2.108	0.418	0.585
Number of people (residents), 2000[f]	28,937,401	19,262,360	1,851,778	4,655,292	1,404,258	56,111,089
Population growth (%, 2000 to 2010)[f]	9.7%	6.7%	1.3%	-1.5%	5.6%	7.4%

[a] Area of wetland and open water cover types based on most recent National Wetland Inventory (NWI); other cover type measures are from the 2011 National Land Cover Database (NLCD). Spatial data in metric units (1 ha = 2.5 acres).

[b] *Great Lakes coastal emergent* includes wetland ≤1 km from the Great Lakes coastline; this coastal wetland area is dynamic, changing with long-term cycles in Great Lakes water levels.

[c] *Open water* includes all inland lakes and rivers with unconsolidated bottom, plus open aquatic bed wetlands, plus Great Lakes *coastal zone waters* (open coastal waters ≤ 1 km from shore); bathymetric data used to estimate water depth.

[d] Area with soils somewhat poorly drained and poorly drained to very poorly drained based on Natural Resource Conservation Service - Soil Survey Geographic Database. "Prospective wetland" was the intersection of hydric soils and cropland.

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

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

limited for the non-breeding period, this BCR appears especially valuable to migrating Common Loon, Sandhill Crane, Horned Grebe, and Double-crested Cormorant (Table 2). There are an estimated 276,000 ha (682,000 ac) of restorable wetland presently in cultivated cropland (Table 5). Waterbird response to restorations of emergent-herbaceous and brush-covered wetlands with open water appears generally positive. Current human density and population growth are high relative to other BCRs in the JV region (Table 5).

Eastern Tallgrass Prairie (BCR 22).—This area accounts for the southern half of the JV region, and is almost entirely within the JV boundary. It once contained the most extensive tall-grass prairie of the Great Plains, growing on the most nutrient-rich soils in North America. Deciduous forest dominated eastern sections, which transitioned into a broad and dynamic oak-dominated savanna and then vast prairie in the west. The modern landscape is largely row-crop agriculture (52%) and urbanized areas, but the BCR also contains interspersed woodlands (12%), pasture and hay lands (16%), and grassland/herbaceous land cover (8%). Most of the grassland in the JV region occurs in Kansas and Nebraska, accounting for 56% and 10% of BCR 22 grasslands, respectively (Table 5). Open water accounts for 2% of land cover and herbaceous wetland only 0.8% of the landscape; 90% of the herbaceous wetlands of this region have been drained (Dahl 1990). Remaining wetlands and open water areas are important at the continental scale for Ring-billed Gull and several secretive marsh bird species, including Sora, Pied-billed Grebe, Common Gallinule, and American Coot (Table 2). This BCR also provides migration staging habitat to most of the waterbird species occurring in the JV region. With 783,000 ha (1,900,000 ac) of cultivated cropland located on poorly drained soils, wetland restoration potential is substantial, and wetland community response to restoration, where measured, has been positive in this BCR (Hine et al. 2016). Human densities are high in urban areas but low elsewhere; population growth is highest in this BCR compared to other areas of the JV region (Table 5).

Central Hardwoods (BCR 24).—Only a small area of BCR 24 (southern Indiana) overlaps the JV region. Once dominated by deciduous forest, BCR 24 now includes a mix of agricultural lands and forests, with minor coverages of open water (4%) and herbaceous wetland (0.5%). This BCR is not recognized as continentally important for waterbirds, but a variety of species use the area, especially during the non-breeding period (Table 2). There are an estimated 24,000 ha (60,000 ac) of potentially restorable wetland in BCR 24 within the JV region (Table 5), and human density is relatively low outside of urban centers.

Lower Great Lakes/St. Lawrence Plain (BCR 13).—The area of BCR 13 within the JV region (northeast Ohio) is also relatively small. It was originally dominated by deciduous and mixed-coniferous forests. Now only 31% of the area is classified as upland forest and another 3% is forested wetland (Table 5). Inland open water accounts for 2% of the landscape and herbaceous wetland only 0.6%. There are areas of this BCR (mostly outside the JV region) of high importance to breeding waterbirds, especially Double-crested Cormorants, Virginia Rail, Sora, and Ring-billed and Herring Gulls (Table 2). The area is also continentally important to migrating Common Loon and Red-necked Grebe. There are an estimated 19,000 ha (48,000 ac) of restorable wetlands (Table 5) currently in cropland. This area of the JV region has the highest human population density, but population growth has slowed in recent years.

Land Cover and Habitat Assessment

Breeding population objectives in the 2007 JV Waterbird Strategy were linked to the North American Waterbird Conservation Plan (Kushlan et al. 2002). Associated JV habitat objectives were generated using biological models to calculate the amount of habitat needed to accommodate regional populations at JV objective levels. This objective setting approach is often referred to as *top down* planning. However, because implementation occurs at local scales, planning should also include an assessment of existing species abundances and associated habitats available at smaller scales to complete a *bottom up* complementary planning procedure. During 2012 to 2014, JV Science Office staff conducted land cover and bird habitat evaluations for State × BCR polygons across the JV region (http://uppermissgreatlakesjv.org). These assessments addressed several information needs relevant to conservation design at the State x BCR and JV regional scales:

- Estimated areal extent of land cover classes important to JV focal species.
- Compared area of primary land cover classes to 2007 JV bird habitat objectives, including determination of amount and location of cover types currently protected.
- Examined significant increases and decreases in primary land cover classes likely to influence population trends for associated focal species.
- Reviewed primary modes of land-cover conversion, with a focus on processes that adversely impact carrying capacity for focal species.
- Provided general bird conservation implications for BCR sub-regions based on 2007 JV objectives and assessment findings.

Although land cover area estimates do not translate into estimates of high quality bird habitats, State x BCR assessments provided valuable information regarding land cover important to JV focal species. Evaluation of land cover amounts and conversion trajectories provide a basis for directing / re-directing partner efforts toward specific bird habitat types. Knowledge of whether the JV is gaining or losing priority waterbird habitats and where on the landscape this change is occurring provides a measure of objective achievement and a tool for future conservation planning. Land cover and bird habitat information from State x BCR assessments was updated and compiled at the BCR scale for this Strategy update.

Landscape Change

Recent land-cover change in the JV region was analyzed using 2001 and 2011 NLCD, with a focus on the three primary BCRs (Figure 6). For the northern JV region (BCR 12), where land cover remains largely in native plant communities, the primary cover type transition was from upland forest to shrub/scrub and grassland/herbaceous, plus grassland/herbaceous to shrub-scrub (Figure 6, Table 6). However, the forest industry is relatively active in BCR 12, often setting back forest succession via *clear-cutting* (complete forest harvest of shade intolerant tree species). *Clear-cut* upland deciduous or coniferous forest is briefly dominated by herbaceous vegetation before reverting to shrub, and then back to forest. Of 20 northern Michigan forest stands (>10 ha in size) apparently converted from woodland to grassland / herbaceous between 2001 and 2011, on-site evaluation in 2015 revealed evidence of recent

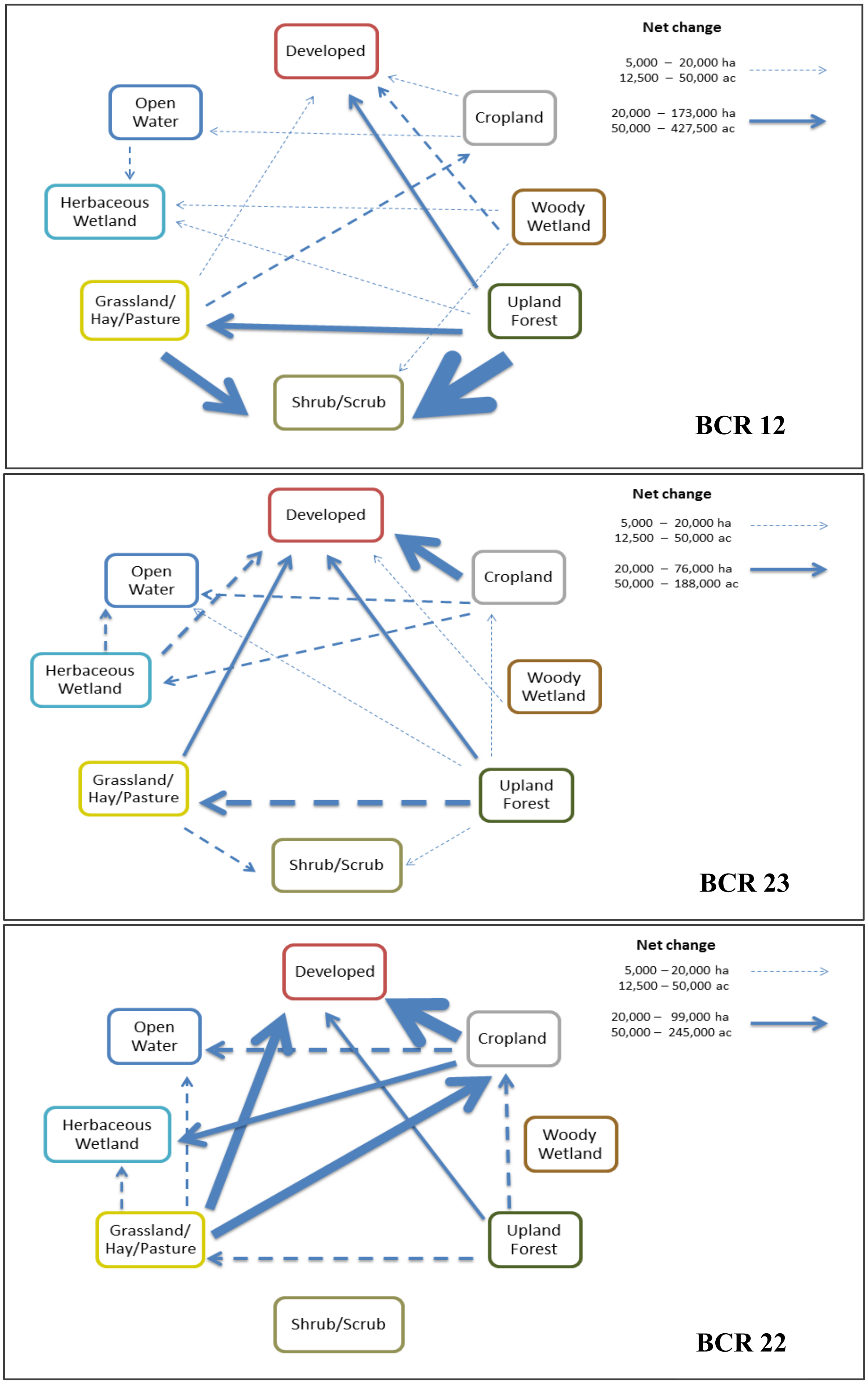


Figure 6. Primary land cover changes (>5,000 hectares) in the north (BCR 12), central (BCR 23), and southern (BCR 22) portions of the Upper Mississippi River and Great Lakes Joint Venture Region based on comparison of 2001 and 2011 National Land Cover Data (NLCD). Arrows indicate change direction and line-pattern and thickness indicate amount of net change. *Note:* Grassland / Hay / Pasture = Grassland/Herbaceous and Hay/Pasture combined, and Cropland = Cultivated Cropland (annual row crops and perennial woody crops / orchards).

clear-cutting and subsequent forest regeneration (shrub/scrub) at 19 stands (G. J. Soulliere, unpublished data). Similarly, the BCR 12 decrease in woody wetland coverage and nearly equivalent increase in herbaceous wetland area (Table 6) may also be related to timber harvest, as removal of forested wetland over-story often results in elevated ground-water tables and colonization by herbaceous wetland plants.

Table 6. Total area and recent net change in primary cover types (+/- ha; 1 ha = 2.5 acres) for Bird Conservation Regions (BCRs) located within the Upper Mississippi River and Great Lakes Joint Venture (JV) region, based on comparison of 2001 and 2011 National Land Cover Data (NLCD).

	BCR		BCR (JV region only)			
	22	23	12	13	24	Total
Total area (ha)	51,762,267	25,827,603	20,583,051	2,174,150	3,547,207	103,894,278
Open water	+31,182	+27,434	-135	-246	+2,460	+60,696
Developed	+189,510	+152,779	+39,654	+15,827	+17,174	+414,944
Upland forest	-56,668	-71,646	-351,844	-15,451	-12,008	-507,617
Shrub/scrub	-2,514	+10,096	+239,548	+2,575	+377	+250,082
Grassland/herbaceous and hay/pasture	-131,752	-31,046	+70,928	+280	-4,711	-96,300
Grassland/herbaceous (only)	-33,345	+2,204	+71,243	+1,398	+1,830	+43,331
Cultivated cropland	-85,740	-93,776	+2,570	-5,052	-6,414	-188,412
Wetland	+48,007	-7,485	-8,631	+155	+1,156	+33,201
Herbaceous wetland	+51,147	+3,011	+58,452	+1,518	+719	+114,848
Woody wetland	-3,140	-10,497	-67,084	-1,363	+437	-81,647

Expansion of developed land (i.e., areas with constructed materials and 20–100% impervious surfaces) occurred at a surprisingly high rate in central and southern portions of the JV region. Bird Conservation Regions 13, 23, 24, and 22 had the greatest proportional change to developed land, with 0.73, 0.59, 0.45, and 0.37 percent of the total BCR area within the JV region converted to developed land during this 10-year period (Table 6). Increases in developed land coverage resulted mostly from conversion of cultivated cropland, grassland/herbaceous and hay/pasture, and upland forest (Figure 6). Much of this land-cover conversion represented urban sprawl, occurring primarily adjacent to and between existing population centers. Some of the greatest losses in bird-friendly land cover occurred in BCR 22, where significant areas of grassland/herbaceous and hay/pasture were converted to cropland and developed land. However, much of the gain in herbaceous wetland and open water also occurred in BCR 22 (Figure 6, Table 6). Conversion of cropland to wetland was especially prominent around large river floodplains in Missouri, Iowa, Nebraska, and Kansas (see State × BCR assessments, http://uppermissgreatlakesjv.org).

In addition to anthropogenic landscape change, plant communities important to wetland birds undergo continual change due to environmental drivers. For example, the extent and inundation of Great Lakes emergent coastal wetland changes with natural cycles in lake water levels. Although considerable differences exist in natural and human influences on coastal wetlands across the Great Lakes basin, the lakes share many similarities in hydrology that directly influence plant communities, causing lake-ward and landward shifts in wetland cover types (Albert 2003). Periodic de-watering and deep flooding of coastal wetlands result in dynamic plant composition and open-water emergent-marsh mosaics. Thus, specific locations have continually changing suitability for various populations of wetland birds.

Great Lakes water levels were below average during 2000–2014, following a long period of relatively high-water during the 1970s–1990s (Figure 7). Whereas high lake levels resulted in contraction of coastal emergent wetlands, the recent extended period of lower lake levels allowed emergent marshes to expand lake-ward in many areas. Water levels rebounded after 2013, inundating reestablished emergent wetlands and creating new marsh bird habitats. Conversely, higher lake levels resulted in loss (at least temporarily) of many small islands, including some important to Caspian and Common Terns (S. Matteson, Wisconsin Dept. of Natural Resources, personal communication). If water levels continue rising and remain high, emergent coastal wetlands will either migrate landward or, in areas with hardened and diked shorelines, contract until the next extended low water period.

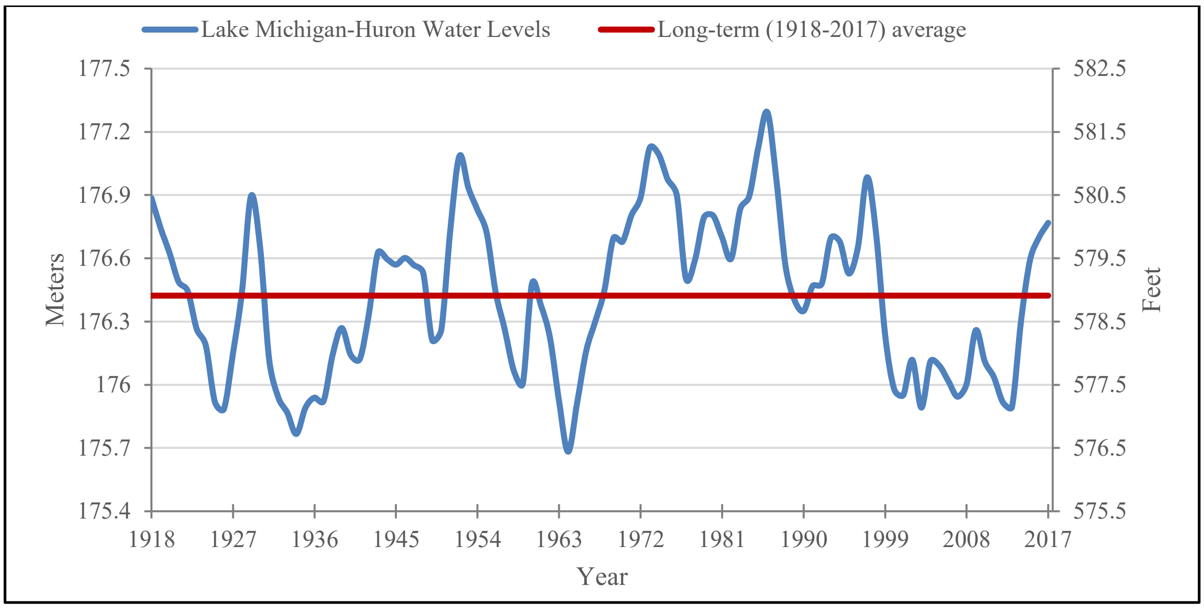


Figure 7. Annual average water level for the Lake Michigan–Huron system (data from U.S. Army Corps of Engineers). Within year fluctuation is typically 0.3 m, with lowest water levels occurring in mid-winter and highest water levels occurring in mid-summer.

Conservation Estate

Conservation lands are areas in public ownership or conservation easement, and the bird habitat they comprise is generally considered protected from development. Primary sources of spatial data available to help measure distribution and abundance of conservation lands in the JV region included the Protected Areas Database of the United States (PAD-US) and the National Conservation Easement Database (NCED). Staff at the JV Science Office *pooled* and *cleaned* these data for compilation errors, then developed a regional map of current conservation lands (Figure 8). Although some of the spatial data reflect areas of acquisition interest (not yet acquired) rather than actual ownership, the resulting image provides a general configuration of protected lands across the region. Most public land is in the north (BCR 12), but there are concentrations of protected land in central and southern areas.

Neighborhoods of significant private land area under perpetual and 30-year conservation easement through the Wetlands Reserve Program (WRP) are also prominent in portions of the region. Conservation Reserve Program (CRP) lands, especially valuable to grassland-nesting birds (Herkert 2007), were not displayed. These easement contracts are more temporary (typically 10–15 years) and CRP lands are often converted back to agriculture (Morefield et al. 2016).

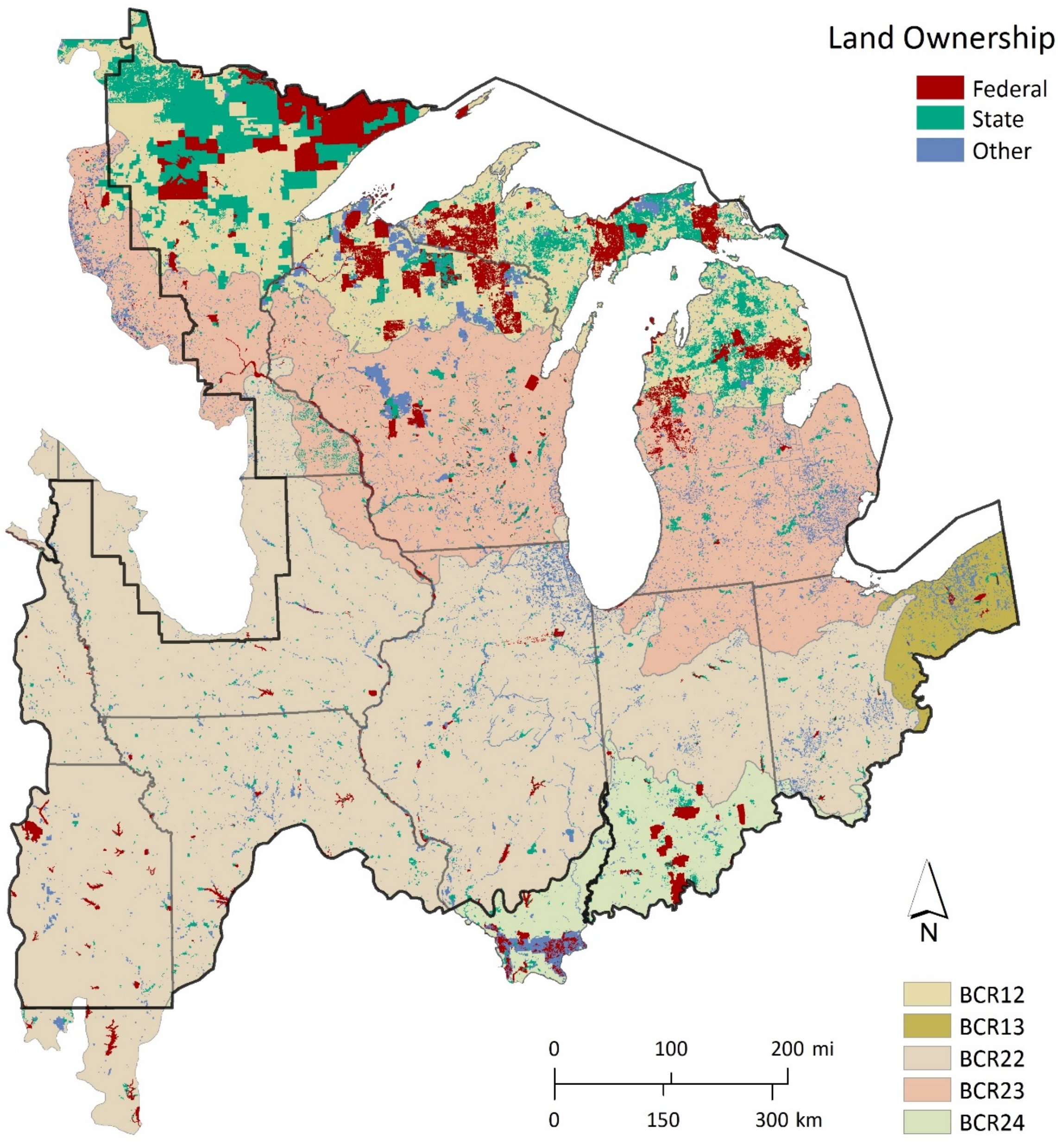


Figure 8. Location of federal, state, or other conservation lands in the Upper Mississippi River and Great Lakes Joint Venture Region. The *Other* ownership category includes private land with perpetual/long-term conservation easements (e.g., Wetlands Reserve Program), conservancy land, and county, township, and city-owned land. *Note:* Some large public-land blocks encompass areas of acquisition interest rather than full ownership.

Habitat Quantity vs. Quality

Bird habitat objectives are typically expressed as quantity values, yet quality – habitat attributes resulting in relatively high recruitment and survival – is an equally important consideration. Habitat quality for wetland birds is most often measured by site characteristics such as plant community diversity, water depth, and sometimes food density. Although uncommon for most waterbird species, habitat quality has also been related to measures of nest success and productivity rates. Assessing bird habitat quality and developing effective conservation prescriptions is complex. Bird population monitoring and demographic data must be combined with information regarding species-specific habitat requirements, landscape ecology, site history, and sound predictions of risk vs. reward for various conservation approaches. Moreover, local-scale implementation must consider site hydrology, soil types and nutrient richness, the dynamic nature of vegetation composition and structure with changing environmental conditions (e.g., precipitation), finer-scale interspersion, and other aspects influencing habitat quality. Ignoring these factors disregards landscape features critical to biological diversity and the long-term carrying capacity of an area for wetland birds. For example, seasonal or temporary wetlands may appear to have limited value for waterbirds during dry periods (annually or multi-year) yet these same areas can provide exceptional forage diversity (seeds, plants, and or aquatic invertebrates) and protective cover during wet phases. Even semi-permanent wetlands may become partially or completely dewatered during extended periods of drought, only to become high quality sites when water is restored. As we consider the wetland quantity vs. quality question at the JV regional scale, it is important to consider the uniqueness and dynamic nature of wetlands and their surrounding landscapes. Wetland characteristics, relative abundance, value to birds, and effective conservation approaches vary considerably across the region.

Several methods are available to estimate the abundance and distribution of potential waterbird habitats. The most comprehensive cover type data for regional planning are NWI for wetlands and NLCD for uplands. Unfortunately, both spatial data sources include error, with omission and commission rates for NWI well documented (Johnston and Meysembourg 2002, Matthews et al. 2016). We assume the habitat needs of most wetland birds must be met by wetlands that are inundated with surface water. However, there is currently no measure of inundation rate from wetland spatial data, at the time the image was taken or over long periods of time. A means to convert NWI wetland area to *available habitat area* by adjusting for inundation amounts and timing would help the assessment of available habitat in the JV region. Moreover, determining wetland plant composition compared to the habitat needs of JV focal species or guilds would also refine assessment of habitat quality. We know, for example, that bulrush (% cover) has been associated with greater abundances of several marsh bird species and molting or migrating dabbling ducks, whereas other species were more associated with cattail-dominated coastal marshes of similar size (Monfils et al. 2014, 2015). However, digital spatial data (i.e., NWI, NLCD) used for planning identifies these communities simply as *emergent wetland* and does not distinguish their varied habitat quality for bird guilds.

Factors Affecting Habitat Quality

Some of the most extensive research relating fish and wildlife abundance to change in wetland conditions in North America has been conducted along the Illinois River. Long-term monitoring and evaluation of this once ecologically diverse system has revealed a wealth of information regarding the influence of human alterations on bird populations (Havera et al. 2003), providing insight to wetland conservation issues across the southern half of the JV region (BCR 22). For example, habitat quality for wetland birds declined with conversion of the landscape to agriculture during the 20th century (Bellrose et al. 1983). Degradation and loss of native emergent marsh and aquatic bed was documented along with concurrent declines in marsh birds and diving ducks. However, long-term monitoring revealed that decline in emergent and deep-water communities was offset by increases in non-persistent emergent-vegetation wetlands. Water quality and plant diversity declined causing a reduction in overall wetland bird habitat quality, but energetic carrying capacity for some species of waterfowl was similar when measured over three time periods dating back to 1939, as moist-soil plant communities replaced aquatic bed wetlands (Stafford et al. 2007, 2010). In other words, loss of wetland quality does not necessarily translate to forfeiture of habitat value for all target species. Moreover, in areas with intensively managed water levels, managers may need to evaluate trade-offs for one species over another in their prescriptions. Managers must consider multiple factors related to habitat quality such as composition of surrounding landscape (i.e., relative abundance/uniqueness of potential habitat area), conservation status of wildlife (i.e., targeting species of concern vs. common species), and social values such as hunting and bird watching.

The ever-changing landscape of invasive species is perhaps one of the most significant and complex challenges affecting management for wetland bird habitat quality. Evaluation and control of invasive species has consumed significant resources across the JV region, especially related to common carp (Bajer et al. 2009), narrow-leaf and hybrid cattail (Tuchman et al. 2009), common reed (Higman and Campbell 2009), introduced snails (Hermann and Sorenson 2009), and others. Many invaders are now so ubiquitous they probably should be considered enduring components of the landscape as they may not be *controllable* at large scales without biological agents. Moreover, large wetland systems can retain a high level of diversity and value to birds even when partially colonized by invasive plants, and the net impact on wetlands from non-native plants can be difficult to quantify (Meyer et al. 2010, Schlaepfer et al. 2011).

Common reed and hybrid cattail have been two invasive plant species of considerable management focus in recent years, especially in the northern portion of the JV region. Altered hydrology (e.g., earthwork in wetlands, stabilized water levels) and nutrient runoff from agricultural areas are most often associated with expansion of invasive cattail and common reed (Albert and Minc 2004, Boers and Zedler 2008). Widespread use of herbicide has largely resulted in temporary or unsatisfactory outcomes, except where the environmental conditions favoring these species changed (Carlson et al. 2009). Area managers have had mixed results with dredging, herbicide, fire, cutting below water surface, and deep flooding in diked wetlands to create openings in dense stands of vegetation to increase bird habitat quality (e.g., Schummer et al. 2012, Hagy et al. 2014). For example, extended periods of flooding to suppress common reed in impoundments frequently creates conditions suitable for dense monoculture stands of hybrid cattail (Boers and Zedler 2008). Local control of common reed has succeeded at some locations and is often a result of multiple site-dependent techniques and partner collaboration (see http://www.greatlakesphragmites.net/management).

Periodic dewatering through drought or active water-level management of impoundments is required for long-term wetland productivity, higher plant diversity, and overall value to wetland birds. When use by wetland birds was compared in several diked and open (non-diked) Great Lakes coastal wetlands in Michigan, there was little difference during the breeding period (Monfils et al. 2014) and duck use was greater during late summer and autumn for marshes that remained influenced by changing lake levels (Monfils et al. 2015). Lower bird use of diked wetlands was attributed to long-term stabilized water levels at these sites and loss of plant diversity. Although common reed had less coverage in continuously flooded units, loss of dynamic water levels resulted in dense monoculture stands of cattail and no net increase in habitat quality to wetland birds. Conversely, coastal diking and intense water-level management was necessary to restore and retain emergent marshes along portions of western Lake Erie, where hardened shorelines related to agricultural and urban development prevented landward and lakeward marsh movement in response to water-level change (Gottgens et al. 1998). In this highly altered hydrological state, impounded marshes and associated water control were necessary to provide suitable habitat for wetland-dependent wildlife (Sherman et al. 1996). However, the presence of invasive species complicates management of impounded wetlands because drawdowns needed to promote growth of desirable native plants also create opportunities for aggressive colonization by undesirable species.

Adapting to System Change

This Strategy seeks to provide the best information available regarding waterbird population abundance and distribution at the JV regional and BCR scales as well as factors most likely to influence bird population trends. Understanding land-cover change, especially expansion of developed lands, can help predict where uninhabitable vs. habitable areas for birds will likely occur in the future. Regional land use data coupled with biological and social information can be used by state-level planners to evaluate where and how they may best contribute to larger scale conservation efforts. However, beyond the many threats and opportunities already identified in this document, there are other potential sweeping influences to consider when developing long-term conservation prescriptions, and these influences have high levels of uncertainty.

Government entities devote substantial resources to understanding trends that affect the economy, food supply, health, safety, and many other dimensions important to human well-being. Likewise, conservation scientists have recognized the need to track social and environmental trends and even to employ *futuring* (Rowland et al. 2014) or scenario planning to increase decision effectiveness in situations of high uncertainty and low controllability. Examples of conservation challenges with high uncertainty within the JV region include impacts from exotic and invasive species, flood intensity and duration, human land use, and climate change. Changing climate patterns – warmer winters, higher amounts of precipitation, and amplified storm intensity (SWCS 2003) – will require wildlife agencies to prioritize management options to address influences of climate change in order to maintain native plant and wildlife diversity as well as quality of life for people who value nature.

Considering extensive historical conversion of native bird habitats to cultivated cropland (Figure 2), and continuous urbanization in large portions of the region (Figure 6), the risk to bird habitats from climate influence seems a distant priority. On the other hand, strategic conservation plans should identify and work to understand long-term threats (and opportunities) that may affect goal achievement. For example, building resilience of ecological communities (i.e., ability to withstand disturbances and recover quickly) is a growing conservation theme, and new research is beginning to address bird vulnerability to climate change (Marra et al. 2014, Nijhis 2014). Some research findings predict less severe winters will result in increases in relative use of the JV region by non-breeding waterfowl (Notaro et al. 2016) and perhaps other wetland bird species. The bird conservation community will need to gradually incorporate these projected changes in ecosystems, biodiversity, and bird species distribution and abundance into planning.

Application and refinement of strategic planning and perhaps *scenario planning* in natural resources management is warranted given the challenges represented by climate change and its interaction with other stressors. A recent publication, *Considering Multiple Futures: Scenario Planning to Address Uncertainty in Natural Resource Conservation* (Rowland et al. 2014), thoroughly explains core elements of scenario planning, providing several real-life examples. This planning technique has helped environmental professionals prepare for an uncertain future by analyzing multiple parameters and associated potential outcomes before selecting a conservation path. The approach is especially relevant when environmental uncertainty will influence long-term policy and agency investment choices (Wiseman et al. 2011). Like strategic planning, scenario planning seeks to stimulate imagination and create a vision(s) beyond the bounds of past trends and one presumed future. Many consider these scenarios to be strictly non-predictive tools to explore and learn about consequences of plausible futures. Others suggest scenarios be used to develop models that could be brought into an adaptive management context, where predictions and monitoring would be appropriate.

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

Habitat Goal and Objectives

The goal of this Strategy is to: *Guide regional conservation that results in habitat to support populations of priority waterbird species and related social values, consistent with continental bird conservation goals.* Habitat objectives are science-based calculations of the habitat quantity needed to support desired populations. Ideally, the SHC approach should result in assessable population and habitat objectives, setting the stage for improved performance measurement, evaluation, and adaptive management. Habitat objectives generated for breeding JV focal species are assumed to reflect the needs of all breeding waterbirds commonly occurring in the region. We lacked non-breeding waterbird population abundance estimates and habitat requirements, thus habitat targets for associated non-breeding waterfowl guilds (Table 1) were assumed adequate for this period.

JV partners will need to employ an array of habitat conservation tools, particularly habitat *retention* and *restoration*, to maintain and increase the amount of high quality habitat needed to support wetland bird populations (see Pages 11–12 for definition of habitat actions). Habitat conservation targets for breeding waterbirds were established using models informed by factors likely to limit population growth, typically abundance of high quality habitat. Optimal breeding habitat was described and the habitat area required per breeding pair was calculated for eight breeding focal species (Appendix A). Breeding population deficits (population abundance objective – current abundance = deficit) provided the basis for habitat restoration objectives. Breeding habitat retention objectives were based on predicted needs of populations once abundance objectives are achieved. Breeding habitat restoration and retention objectives were distributed across the JV region as described in the Conservation Delivery section based on waterbird distribution/abundance and social objectives. Information from the 2017 JV Waterfowl Strategy was used for quantifying non-breeding habitat delivery valuable to migrating and wintering waterbirds.

Breeding Habitat Objectives

At 37,300 ha, the calculated restoration objective was highest for the emergent habitat category (Table 7). Conservation implementers must remember, however, the emergent focal species American Bittern can occur in simplified (lower diversity) emergent wetlands as long as they are large, whereas the other emergent focal species occupying this wetland type require more unique (Yellow Rail) and/or diverse (King Rail) wetland complexes (see species-specific needs in Appendix A). The habitat restoration target for species requiring aquatic bed wetlands (represented by Black Tern) was 4,400 ha, and for mixed forested wetlands (represented by Black-crowned Night-Heron) the objective was 3,800 ha. The forested habitat objective denotes wetland area only; most species in this guild also require proximate areas of scrub-shrub and/or mature deciduous forest, typically in uplands but sometimes in wet areas (structure for rookeries).

There was no restoration objective for the unconsolidated bottom and shore habitat category, as breeding Common Loon populations and their open-water habitats (northern inland lakes) are relatively stable. However, at 498,000 ha, the retention objective was greatest for this category (Table 7); high water clarity, abundant forage fish, and limited nest disturbance are primary features of high quality habitat. Emergent wetland was the planning category with the second highest retention objective of 111,900 ha (Table 7), resulting from habitat needs of American Bittern and Sora. The aquatic bed habitat retention objective for breeding Black Terns and other species dependent on this community type totaled 13,200 ha, whereas the retention objective for forested and mixed cover-type wetlands important to the focal species Black-crowned Night-Heron was 11,200 ha (Table 7, Appendix A).

Table 7. Breeding waterbird habitat objectives in the Upper Mississippi River and Great Lakes Joint Venture (JV) region. Restoration objectives were generated from JV focal species population deficits (population abundance objective - current abundance = deficit) whereas retention objectives reflect the estimated habitat needed to support populations at objective levels. Habitat planning categories represent primary cover types used by eight focal species; objectives are for wetland area only (excludes upland nesting cover). Habitat area expressed in hectares (1 ha = 2.5 acres).

	Habitat area required (ha)[a]	
Habitat categories	Restoration	Retention
Emergent wetland (American Bittern and rails combined)	37,300	111,900
Emergent with aquatic bed (American Bittern only)	*20,000*	*60,000*
Emergent with aquatic bed and upland herbaceous (Sora, Yellow, and King Rai	*17,300*	*51,900*
Aquatic bed, with emergent and unconsolated (Black Tern)	4,400	13,200
Forested, with aqautic bed or emergent/scrub-shrub (B-c Night-Heron)	3,800	11,200
Unconsolidated bottom/shore (Common Loon, Common Tern)[b]		498,000
Total	45,500	634,300

[a] See Appendix A for descriptions of high quality habitat (high recruitment and survival) for each focal species and methods used to translate population objecitves into habitat objectives. Focal species were used to represent guilds of wetland birds common to distinct wetland community types and wetland/upland complexes.

[b] Unconsolidated bottom/shore (e.g., lakes with high water clarity) objective reflects estimated habitat needs for Common Loon. Common Tern require similar breeding habitat but highest priority need (the factor most limiting) was expressed in *number of colony nest sites* (objective = 13 restored and 38 retained nest colonies); see Appendix A for species-specific island and open-water requirements for Common Tern.

Non-breeding Habitat

Some wildlife agencies have expressed interest in managing for non-breeding waterbird habitat, but we lack a science-based means to quantify objectives. Because of their greater diversity, abundance, wide distribution across the JV region, significant habitat-area requirements, and overlap in habitat requirements with waterbirds, we assumed habitat conservation objectives for non-breeding waterfowl (Appendix E; also see Potter and Soulliere 2009) could adequately support regional non-breeding waterbird populations. However, these potential habitats must be available when non-breeding waterbirds occur in the region, primarily during migration stopover periods. Thus we determined temporal distribution within the JV region for breeding and non-breeding focal species (Figure 9) to facilitate local conservation planning for guilds, particularly inundation timing at managed wetlands. Based on eBird data, abundance during fall was somewhat variable for focal species, with occurrence peaks ranging from August for Black Tern and King Rail to late October for Common Loon and American Coot. Fall abundance for the three rail species combined peaked in late September, but ranged from August to October, depending on species (Figure 9). Relative abundance was higher for waterbirds during spring migration, with most species peaking in abundance during April through late May.

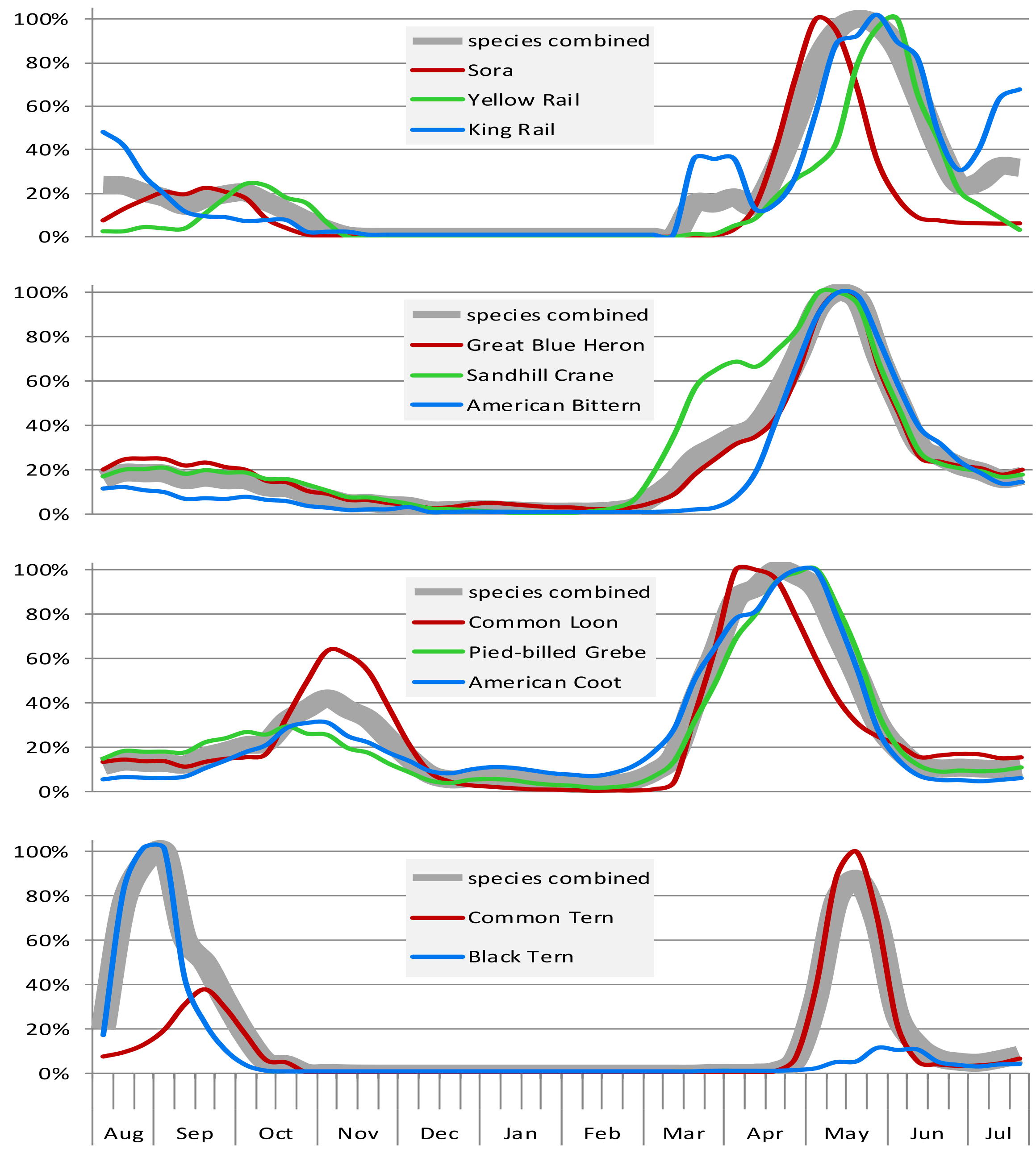


Figure 9. Occurrence chronology of waterbirds in the Upper Mississippi River and Great Lakes region based on eBird data, 2007–2016. Counts for Bird Conservation Regions 12, 22, and 23 were summed by week, standardized within groups (species combined curves), and depicted with a 3-week moving average to display timing of relative abundance. *Note:* Black-crowned Night-Heron, a breeding focal species, was excluded from the analysis due to lack of eBird data.

Provision of inundated wetlands suitable for non-breeding waterbirds is important during these primary occurrence periods, and management actions may be most critical in the relatively wetland-poor BCR 22. Direction for placement of non-breeding habitat valuable to waterbirds can be found in the *Targeting Conservation* section, and we recommend following the 2017 JV Waterfowl Strategy regarding amounts of each habitat type needed to meet non-breeding waterfowl (and waterbird) habitat objectives (see Appendix E).

Targeting Conservation for Waterbirds and People

A model-based approach was used to develop decision support maps for targeting habitat delivery in the 2007 JV Waterbird Strategy. These maps were grounded in breeding waterbird biology with little attention to social considerations. The waterfowl conservation community was first to emphasize in a continental planning document (NAWMP 2012) the importance of being relevant to the public and to address the needs of people through habitat delivery. Indeed, support from traditional (hunters) and non-traditional stakeholders is considered essential to sustain our system of wetland conservation (NAWMP 2014). However, we have limited understanding of the general public's interest in wetlands and associated bird populations and habitats. This type of information has only recently been identified as a high priority need, and an extensive national-scale survey of hunters, birders, and the general public was implemented in 2017. Initial results of these surveys (see https://nawmp.org) were reviewed, along with other sources of partner information regarding ecological services of public concern in the Midwest region, and unique applications describing how social objectives might be incorporated into wetland conservation planning and delivery (Devers et al. 2017).

Integrating conservation actions that balance objectives for wetland bird populations (biological) and people (social) represents a key future challenge to JVs. However, the task may be simplified if we view habitat – quantity, quality, and location – as the primary means to achieve both bird and people objectives. Decision support tools (DSTs) that target habitat conservation to benefit birds and people require reliable and pertinent scientific information. The DSTs should also consider scale because priorities for decision makers may vary among regional, state, and local jurisdictions. Finally, the process should result in a mutual and easily understood prioritization system that uses common terminology and a forum for partner communication. An existing JV planning tool to target conservation for waterfowl and people (Soulliere and Al-Saffar 2017) was adapted here for waterbirds.

Decision Support Tool

A mixed-model DST was developed to integrate biological and social objectives and allow transfer of knowledge while making the decision process transparent, understandable, repeatable, and adjustable over time with new information or changing priorities. Beyond current waterbird distributions, this prioritization system accounts for pertinent habitat features, and social values relevant to the JV region. The process also allows adding or deleting alternative criteria, depending on the decision context. Conservation issues, objectives, and measurable criteria were identified and weighted by perceived importance in a decision matrix (Table 8). *Weights* represent the relative value decision makers place on different objectives. Periodic stakeholder refinement of objectives and criteria to prioritize conservation will require deliberation of potential trade-offs between managing for biological vs. social outcomes (Wainger and Mazzotta 2011, Richardson et al. 2015). The mixed-model DST provides a means to achieve both waterbird and social objectives.

Table 8. Upper Mississippi River and Great Lakes Region Joint Venture (JV) conservation planning issues, objectives, objective weights, spatial data, and measureable attributes used to prioritize landscapes for waterbird habitat retention and restoration at the JV regional scale.[a] Stakeholder-derived weights are applied to attribute spatial data for generating decision support maps used to focus resources for more effective goal achievement.

Conservation issue (JV goal)	Objective	Weight	Spatial data (model-based maps)	Measurable attribute
Populations and species				
Breeding habitat limitation (improve breeding population trend).	Maximize focal species recruitment through conservation of high quality breeding habitats.	0.3	Density and distribution of key breeding waterbird habitats (breeding focal species combined).	Breeding data for demographics and population trends.
Non-breeding habitat limitation (improve non-breeding habitat conditions).	Maximize focal species carrying capacity, survival, and body condition with habitat focus on cross-seasonal effect and spring fitness.	0.3	Waterbird counts relative to wetland coverage (county-level eBird + IWMM National Wildlife Refuge counts, normalized by county size and % wetland coverage).	Science-based estimate of non-breeding habitat carrying capacity, body condition analysis, and tracking/marking data to determine location and survival trends.
Conservation supporters and social values				
Resource users - bird watchers.	Maximize waterbird viewer retention and recruitment.	0.1	Waterbird (focal species) viewer locations and frequency of reports based on eBird data.	Trends in waterbird viewers from eBird data and number of active birders (FWS data).
Resource users - other recreationists.	Maximize outdoor recreationist retention and recruitment.	0.1	Human distribution and distance (average 50 km) relative to potential habitat areas.	Recreationist days afield (FWS data) and or model-based prediction of new outdoor recreation days (net) and trend.
Water quality and flood abatement.	Minimize nutrient and sediment runoff detrimental to system ecology (i.e., Gulf Hypoxia focus) and reduce flood damage.	0.1	Mississippi River sub-basins (8-digit HU) with impairment due to polluted/nutrified runoff (high cultivated cropland / development coverage).	Water quality/nutrient monitoring at key river stations (ETPBR LCC guidance) and flood insurance claims (number, cost, area).
Great Lakes coastal wetland function and lake / tributary water quality.	Maximize health, function, and biological diversity of Great Lakes coastal zones (coastal wetland and lake focus).	0.1	Coastal sub-basins (8-digit HU) with impairment due to nutrient/sediment runoff, pollution, and wetland loss (high cultivated cropland / development coverage).	Great Lakes Restoration Initiative coastal wetland integrity measures and or nearshore measures of water quality and biological diversity.
Total		1.0		

[a] Weighted spatial data is combined to identify priority landscapes for conservation; this information can be filtered with hydric soils and cover type data (i.e., STATSGO - poorly drained and NLCD - cropland) to target habitat restoration in areas with historic wetland coverage.

Spatial data for waterbird *populations and species* objectives (Table 8) emphasized potential limitations in breeding and non-breeding habitats. Habitat density and distribution maps for the eight breeding focal species were combined to identify areas having the most important waterbird breeding habitats for retention and expansion (Figure 10A; from combined maps in Appendix A). To address habitat limitations during migration-staging and winter periods, we used county-level eBird and Integrated Waterbird Management and Monitoring (IWMM; 20

National Wildlife Refuges) data for non-breeding focal species (Table 1). These regional data sets were limited for several species but provide a basis for assessing distribution of non-breeding waterbirds. We assumed habitat area was more limited for non-breeding waterbirds where counts per wetland were highest. In each county, we appraised average eBird (2007–2016) and IWMM (2010–2017) waterbird counts relative to county size and percent coverage of wetlands important to distinct non-breeding guilds: Emergent, Forested, Aquatic Bed, and Unconsolidated Bottom and Shore (Table 1). Count *neighborhoods* (from kernel density analysis; see Soulliere and Al-Saffar 2017) were ranked by the density of waterbirds per wetland area, emphasizing non-breeding expanses with highest counts relative to wetland coverage (Figure 10B). By combining these spatial data, areas having high importance during both breeding and non-breeding periods were identified (Figure 10C), and the total area of greatest waterbird importance (balanced for breeding and non-breeding focus) across the region was also generated (Figure 10D).

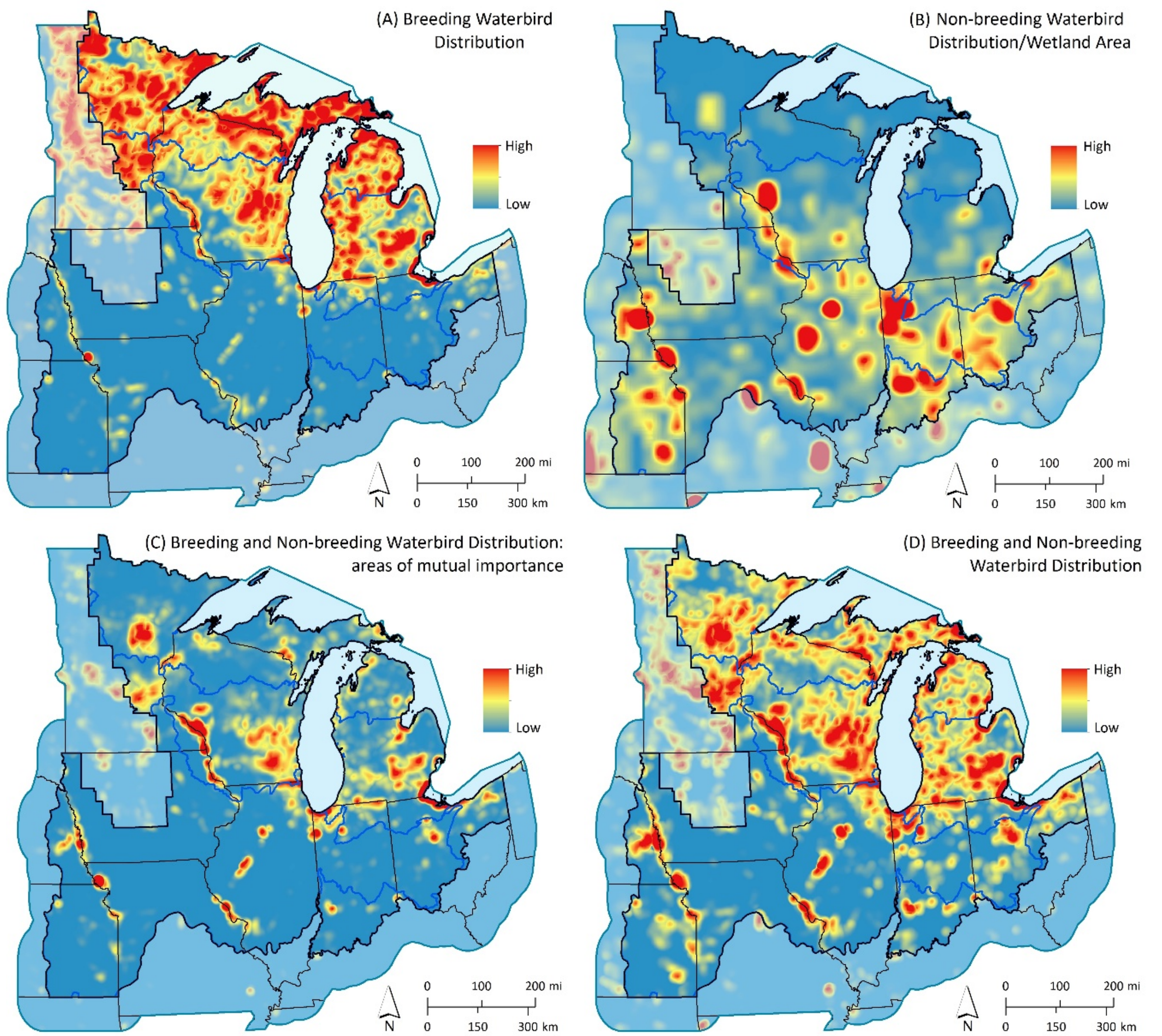


Figure 10. Estimated density and distribution of important breeding habitats for waterbirds (A), distribution of areas with most important non-breeding habitats and limited wetland coverage (B), areas of mutual importance for breeding and non-breeding distribution (C), and the combined distributions of breeding and non-breeding waterbird habitats of greatest biological importance (D).

Spatial analysis for *conservation supporters and social values* (Table 8) involved data related to bird watching and other outdoor recreation, human populations, and areas where land use (e.g., Jarchow et al. 2012) has impaired the ecological goods and services associated with wetlands. Areas of greatest importance to waterbird watchers were determined from eBird data (2007–2016; see Table 1 for focal species). GPS locations and frequency of waterbird observation records were used to depict high and low density neighborhoods based on a kernel density analysis (Figure 11A). We assumed conservation activity in these neighborhoods should be a primary focus to increase birdwatcher retention and recruitment. To identify areas of potential importance to general outdoor recreation, we based the kernel density analysis on U.S. census data – density and proximity of people. A map was generated depicting human population *hotspots* across the JV region and buffered neighborhoods of 50 km on average around population centers (Figure 11B). This extension from urban areas to surrounding bands of undeveloped land represents the predicted geographic distribution of greatest wetland-bird recreational opportunity (Devers et al. 2017). Thus, we expect potential conservation landscapes of average distance ≤50 km from where people reside (i.e., population centers) to receive greatest use by current and new outdoor recreationists if waterbirds and their habitats are available and accessible to the public.

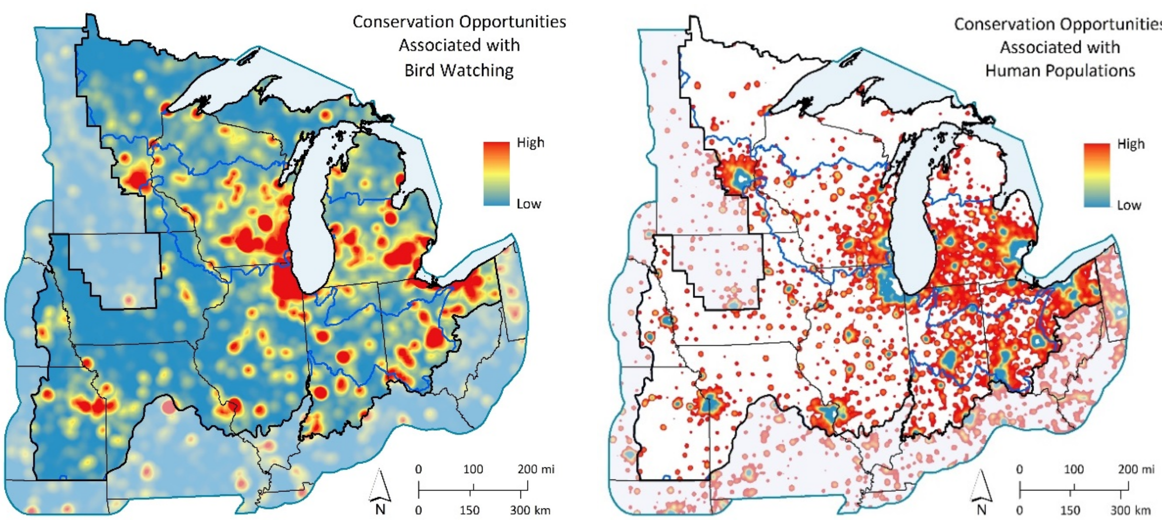


Figure 11. Distribution of waterbird viewing activity (A) and areas associated with human-population centers expected to receive greatest use by outdoor recreationists if accessible waterbird habitats are available (B).

Finally, two additional categories for supporters and social values were included, both related to *goods and services* provided by waterbird habitat. The condition of landscapes and the ecological communities within them is strongly related to levels of human activity (Brown and Vivas 2005), and in this JV region cultivated cropland and developed land account for the greatest landscape alteration (Figure 2). With assistance from JV science partners, spatial data were generated to depict impaired sub-basins most contributing to Gulf hypoxia via the Mississippi River and to altered sub-basins negatively influencing ecological systems along the coasts of the Great Lakes. Retaining and improving system health in the Gulf of Mexico and the Great Lakes portend great economic (e.g., commercial fisheries), recreational (e.g., sport fishing and hunting), and general tourist-related implications within and beyond the JV region. Sediment and nutrient inputs and flooding far exceed natural levels in highly altered landscapes, and restoration of wetlands and associated upland plant communities can help naturalize riverine and coastal aquatic systems while integrating biological and social objectives.

With strategic placement of conservation delivery, bird-habitat related goods and services can include flood abatement, fish nurseries, open space, biological diversity, carbon sequestration, and many others. Hydrologic regions were reviewed for landscape development intensity at the sub-basin scale (8-digit hydrologic unit, Natural Resources Conservation Service) and ranked by degree of alteration. Mississippi River impaired sub-basins due to agricultural land-use had already been ranked (Conservation Fund 2016). However, we refined and expanded this process using the NLCD (2011) and spatial data from the National Agricultural Statistics Service (NASS 2016). Sub-basin conservation need was based on combined land coverage by cultivated cropland and development within both the Mississippi River/Gulf Hypoxia and Great Lakes Hydrologic Regions (Figure 12A and B, respectively).

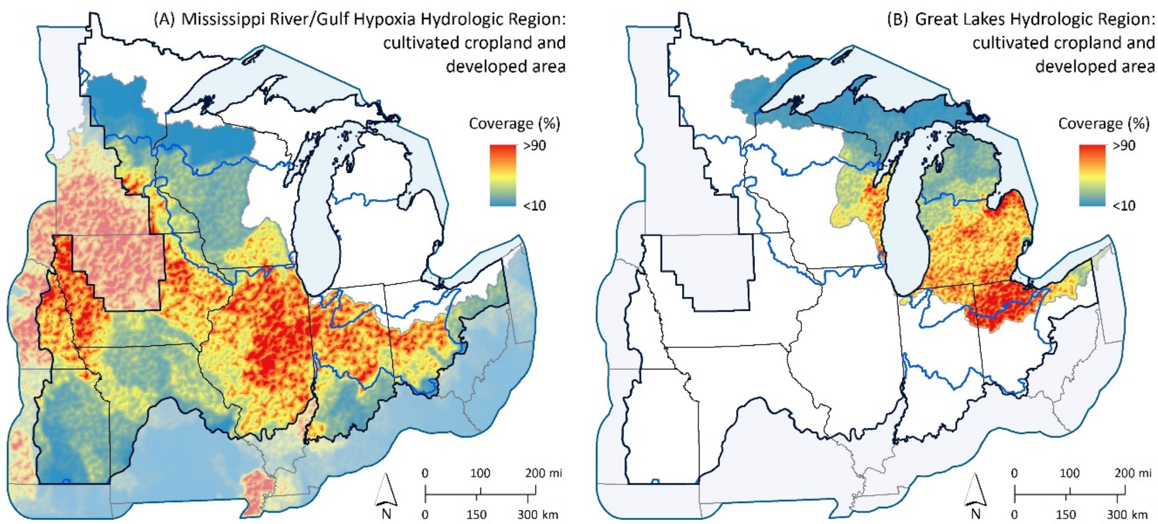


Figure 12. Sub-basins ranked by greatest coverage of cultivated cropland and development, contributing to Gulf hypoxia (A) and impairments to coastal areas of the Great Lakes (B).

By combining these six model-based maps weighted via stakeholder input (our JV Management Board), a mixed-model DST was generated to target conservation that integrates biological and social objectives (Figure 13). This decision-support model was developed to be adjustable over time and scalable for varied planning extents. For example, JV partners can collectively refine weights and or parameters to generate new regional conservation targeting maps as biological and social priorities change. In addition, this framework allows individual partners to down-scale the matrix and map with adjustments to better meet state-level priorities within JV regional conservation priority areas. Results of the DST should be used to distribute habitat delivery for waterbirds and people within the 20 State x BCR polygons (Figure 1) of the JV region. Predicted amounts of habitat needed to meet waterbird population abundance objectives are provided in the *Conservation Delivery* section.

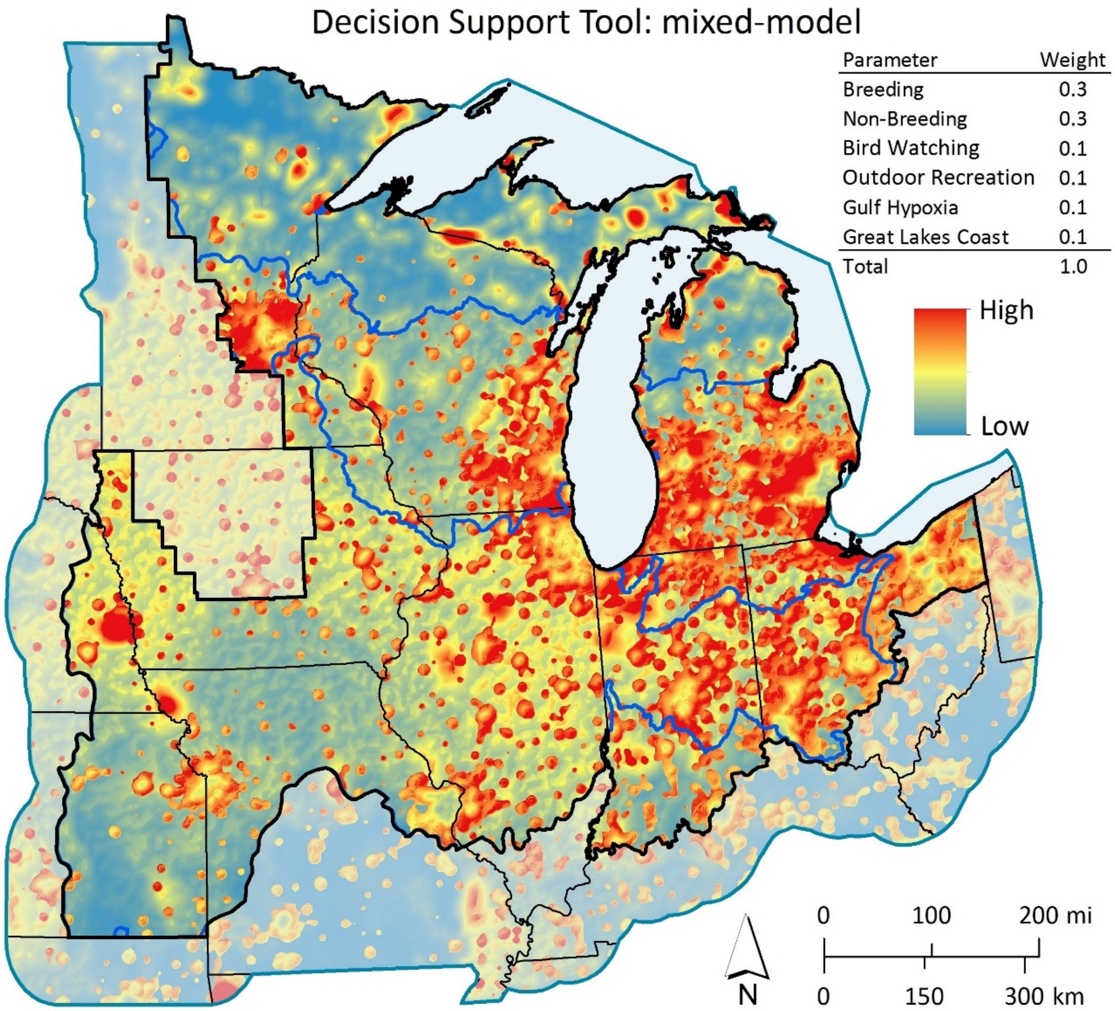


Figure 13. Decision support tool (DST) to target waterbird habitat conservation in the Upper Mississippi River and Great Lakes Joint Venture (JV) region. The DST is an integration of biological and social objectives using model-based maps weighted by regional waterbird stakeholders. State and BCR boundaries (black and blue lines) designate the State x BCR polygons linked to JV waterbird habitat retention and restoration objectives (see Table 9 in Conservation Delivery).

CONSERVATION DELIVERY

Review of past JV conservation efforts was described earlier in the section titled *Habitat Delivery and Evaluation 2007–2014*. Although overall waterbird habitat accomplishments across the JV region were substantial based on this assessment (Kahler 2015), recommendations for improvement were provided in this Strategy. A primary recommendation for future JV conservation delivery emphasizes the need for measurable population response by focal species. Following this theme, we clarified definitions of habitat conservation categories (see *Future Habitat Delivery and Reporting* section). Fundamentally, bird habitat *retention* focuses on supporting current waterbird populations, whereas *restoration* and *enhancement* are necessary to increase habitat carrying capacity for those species below objective levels. Habitat restoration resulting in sustainable wetland communities with diverse native plants (or at least desirable plants) can provide resources during both breeding and non-breeding periods. Enhancement of existing degraded habitat remains an important management tool, but conservation outcomes should focus on activities having long-term (>10 years) benefits for meaningful change to habitat carrying capacity for waterbirds. Because birds are highly mobile and readily occupy new habitats, all three conservation actions – retention, restoration, and enhancement – can be targeted to also provide value to people. Using the regional decision support model (Figure 13) and waterbird habitat restoration and retention objectives below, habitat delivery actions should achieve objectives for both waterbird populations and potential conservation supporters.

Habitat Restoration and Enhancement

Breeding waterbird habitat restoration and enhancement objectives calculated at the regional scale (Table 7) were divided into BCRs, states, and State × BCR polygons (Table 9). Habitat restoration produces the greatest added value to wetland bird populations when habitat quantity is the factor limiting population growth. However, managers must also strive to retain habitat quality through various techniques while considering return on investment. Generally, high quality habitats include wetlands and wetland-upland complexes with features resulting in increased reproductive success, survival, or body condition (quality breeding habitat described in Appendix A). Best approaches to restoring and enhancing habitat suitable for breeding wetland birds will vary by species and area. However, steps for scientifically assessing the current and potential value of larger habitat delivery sites for wetland birds have been summarized (Appendix F).

Although there are exceptions, wetland communities in the relatively remote BCR 12 are more intact with fewer wetland restoration and enhancement opportunities compared to other areas in the JV region. One of those exceptions is the need for habitat restoration or enhancement to improve Yellow Rail habitat, particularly use of fire and other means to control brush encroachment and set back succession in large sedge-dominated wetlands. In general, however, greater biological and social values will result from waterbird habitat restoration in the southern two-thirds of the JV region. Thus, relative to current focal species distribution, BCR 12 received less habitat restoration emphasis compared to other BCRs (Table 9). Habitat restoration and enhancement actions to best achieve biological and social values can be further targeted within BCRs and State × BCR sub-regions using results of the decision support tool (Figure 13).

Table 9. Habitat restoration and retention objectives for breeding waterbirds in the Upper Mississippi River and Great Lakes Joint Venture (JV) region by state and Bird Conservation Region (BCR). Values for each category represent high quality habitat for associated bird guilds in wetland area only (upland forest and herbaceous nesting cover not included) presented in hectares (1 ha = 2.5 acres).[a] See Appendix E for non-breeding habitat objectives.

		Emergent		Forested		Aquatic Bed		Unconsolidated
State and BCR		Restore	Retain	Restore	Retain	Restore	Retain	Retain
Iowa	22	3,368	4,348	343	732	397	410	--
	23	279	746	28	147	33	301	1,356
Illinois	22	4,752	6,136	484	1,033	561	578	--
	23	130	349	13	69	15	141	634
Indiana	22	1,671	2,158	170	363	197	203	--
	23	554	1,484	56	292	65	599	2,697
	24	1,364	1,737	139	291	161	161	--
Kansas	22	2,536	3,274	258	551	299	308	--
Michigan	12	2,962	23,230	302	490	349	1,146	169,595
	23	2,799	7,500	285	1,473	330	3,025	13,627
Minnesota	12	3,178	24,930	324	526	375	1,230	182,007
	22	298	385	30	65	35	36	--
	23	1,003	2,688	102	528	118	1,084	4,883
Missouri	22	3,183	4,110	324	692	376	387	--
Nebraska	22	852	1,099	87	185	100	104	--
Ohio	13	836	494	85	907	99	343	996
	22	1,524	1,967	155	331	180	185	--
	23	494	1,322	50	260	58	533	2,403
Wisconsin	12	1,774	13,913	181	294	209	686	101,578
	23	3,744	10,031	381	1,970	442	4,046	18,225
Total by BCR								
	12	7,914	62,074	806	1,310	934	3,062	453,180
	13	836	494	85	907	99	343	996
	22	18,184	23,476	1,853	3,954	2,145	2,211	--
	23	9,002	24,120	917	4,738	1,062	9,728	43,824
	24	1,364	1,737	139	291	161	--	--
Total JV region		37,300	111,900	3,800	11,200	4,400	15,345	498,000

[a] Distribution of retention objectives across State x BCR polygons based on current distribution of breeding JV focal species (average for American Bittern, Yellow Rail, King Rail, and Sora used for Emergent habitat derivation across sub-regions); distribution of restoration objectives based on area size of each sub-region, resulting in less emphasis in BCR 12 where wetland and open-water habitats remain most secure. Due to limited current distribution of Black Tern (focal species for Aqautic Bed) in BCR 22, the original Aquatic Bed retention objective for BCR 22 polygons was lower than the restoration objective so original values were summed (BCR 22 only), resulting in a higher total retention value for Aquatic Bed than indicated in Appendix A Black Tern account (13,200 + 2,145 = 15,345). There was no restoration objective for the Unconsolidated category; habitat retention will be location specific and related to maintaining water quality and forage base, low disturbance, and or other factors important to Common Loon and Common Tern (focal species) conservation.

Restoring wetlands at locations where they once existed is a valuable component of the site-prioritization process. Areas that have experienced wetland loss can be determined with available tools, including historic aerial photography and current spatial data identifying hydric soils (Figure 14A). Designing wetland restorations or development of habitat complexes to fulfil the needs of waterbirds should be informed with information provided for focal species and associated guilds (Appendix A). Reverting poorly drained cropland (Figure 14B) back to wetland and reestablishment of natural plant cover at cropped riparian areas can also contribute to improving water quality. Restoration of upland cover surrounding wetlands and associated rivers is typically the most appropriate action for restoring degraded aquatic systems.

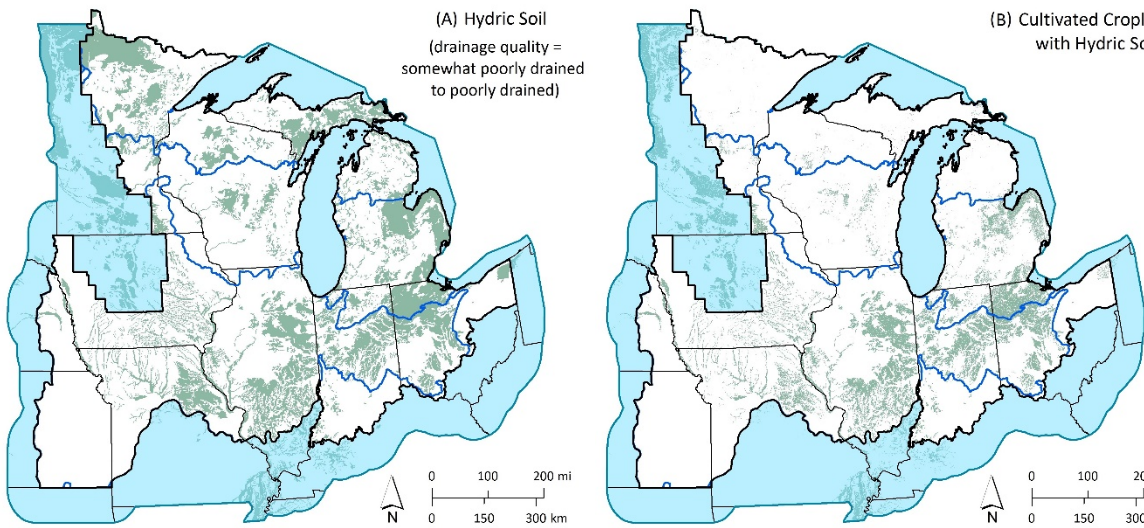


Figure 14. Locations (in green) exhibiting poorly drained to somewhat poorly drained soils (A), and the same hydric-soil locations where current land use is cultivated cropland (B). Local-scale soils data is available from U.S. Department of Agriculture (www.soils.usda.gov/survey).

Plant community restoration is typically more economical when vegetation most suited for the site is restored (i.e., consider pre-settlement conditions, current surrounding land cover, and modifications to landscape hydrology), but alternative wetland types may also be appropriate in highly-altered landscapes or depending on post-restoration management. Likewise, enhancement planning must consider landscape capabilities (see Appendix F). Properly located enhancement efforts that set back succession, suppress invasive plants, and provide a missing habitat element to an otherwise suitable landscape most often result in the greatest return on investment. The combined use of spatial data for hydric soils, cultivated cropland, and the regional decision support model (Figure 13) should lead to greater efficacy achieving habitat restoration objectives.

Habitat Retention

Breeding waterbird habitat retention (i.e., protection via acquisition/easement, regulation, or other measures) objectives were also identified at the regional scale (Table 7). *Retention* seeks to maintain existing habitat features and sustainable ecosystems, but also recognizes that healthy plant and wildlife communities will change over time. Habitat retention is an essential part of the JV conservation portfolio to assure population persistence, and the JV Science Team will continue refining tools that help target the most important (i.e., high survival, high recruitment) areas for waterbird habitat retention. Regional retention objectives for waterbird habitat categories were divided into BCRs, states, and the State × BCR polygons (Table 9) based on focal species distribution. Waterbird habitat retention to best achieve biological and social values should be further targeted within each polygon using results of the decision support tool (Figure 13).

Significant habitat area required to support breeding waterbird populations is currently protected through ownership by government agencies and non-government conservation organizations. Development of a digital GIS layer of conservation lands (Figure 8) identified vast protected areas, especially in the north portion of the JV region. Opportunity and need for greater habitat retention in the middle and southern portions of the region was evident. Armed with this information, partners can compare current ownership patterns with lands considered high importance for bird conservation, and develop an ordered approach for acquisition and conservation easements. Parcels adjacent to existing smaller conservation lands (e.g., <5,000 ha) may be weighted for higher protection priority in order to expand the size of wetland-bird habitat complexes. Conversely, existing large (e.g., >10,000 ha) tracts of wetland bird habitat in public ownership may be considered adequate to meet area waterbird and social needs, allowing focus of limited acquisition funding to other strategic locations. Bird habitats, particularly coastal areas proximate to human population centers, are considered to have the highest likelihood of public use by potential conservation supporters (areas ≤50 km from homes; Devers et al. 2017).

Conservation Delivery Considerations

As JV partners plan, implement, and deliver waterbird habitat conservation, they must be diligent in their emphasis on activities that produce positive population responses for focal species along with benefits to society. At many locations, expanding public ownership of bird habitat will be increasingly difficult, as operational management and maintenance of existing sites takes precedence given budget constraints. Planners will need to assess tradeoffs and net-return on investment when comparing new acquisition and restoration opportunities to existing management and maintenance. Some wetland restoration can be designed with a low-maintenance focus while still achieving acceptable waterbird response. For example, conservation of passively managed sites may provide high waterbird values only part of the time, but their acquisition may be justified by intermittent values for waterfowl, or upland game, or flood retention and water filtration. Wetland (and associated grassland/forest upland) retention, restoration, and enhancement, should be integrated as much as possible with existing partner management systems and be consistent with conserving native plant and wildlife communities important to each organization.

Because habitat treatments for one species may result in loss of site value for other species, managers must anticipate those species of highest conservation concern potentially using a site. Areas with limited wetlands, and where wetland availability is greatly influenced by water-level management, could serve as a habitat *bottleneck* for non-breeding waterbirds. A key consideration at these sites will be management timing for species during migration periods. We assume the provision of habitat to meet waterfowl objectives (Appendix E) can also support non-breeding waterbirds, perhaps with adjustment in management timing

(Figure 9) at some locations. Finally, if habitat conservation can be targeted to provide ecosystem services (e.g., water quality improvement, flood abatement), local human communities also benefit, making bird habitat conservation relevant to a larger number of people and potential conservation supporters.

Clearly defined conservation prescriptions coupled with population and habitat monitoring pre- and post-management is critical to learning and adaptive management. Thus, consistent monitoring of focal species response, site biodiversity, and or other meaningful indicators of conservation success is essential. Because funds for monitoring are often limited, JV partners may need to seek common evaluation goals and pool resources to develop robust monitoring programs with broad (beyond birds) applications. A primary interest in this JV planning effort is to identify target areas and landscape prescriptions that provide high long-term benefit for wetland birds and people. Land values and other economic factors will need to be incorporated for local scale decisions.

Business and Conservation

The objectives in this Strategy are focused on habitat restoration and retention to meet the needs of waterbird populations and people, with little emphasis on agency land maintenance and management costs. Because primary conservation funding (e.g., hunter-related contributions) is generally not increasing, partners must consider efficiencies and perhaps non-traditional means for objective achievement. Outcome-based monitoring, concentration on long-term investment return, disciplined focus, and other principles common to successful businesses have also been recognized as keys to success in public sectors (Collins 2005). In recent years, conservation *Business Plans* have been promoted to help define and validate wildlife management approaches, as the language of business is shared by many stakeholders in our commercial economy. Moreover, attention to successful business concepts and policy (see Wheelen and Hunger 1995) in conservation reflects a growing interest to quantify impacts of wildlife management activities and provide evidence to stakeholders that investments yield intended results.

Grant administrators are also increasingly requiring estimates of return on investment along with potential ecological and economic risks faced in attempting to achieve anticipated gains. It is imperative that JV partners offer clear rationale for why specific conservation methods represent a good investment and the most logical path forward in achieving objectives. A fiscally disciplined approach to planning and implementation also allows invested individuals to better understand the conservation targets and how those targets can be achieved. The following concepts provide additional foundation for more effective use of financial and human resources to deliver bird habitat conservation:

- *Strengths, Weaknesses, Opportunities, and Threats (SWOT) Analysis.*–This investigation is conceptually simple, but can be challenging without adequate stakeholder engagement. To improve decisions and help assure long-term success with conservation efforts, partners should assess internal (organizational) strengths and weaknesses while at the same time appraising external (political/social environment) opportunities and threats to successful project implementation. For example, large wetland restoration opportunities may experience limitations in expertise to adequately assess site hydrology, fluvial ecology, and engineering design. However, these challenges can typically be overcome by taking advantage of the extensive scientific and technical network within the JV and outside the traditional wildlife management community. Likewise, working with expert consultants may be necessary to address public concerns over a habitat conservation proposal (e.g., establishment of a new conservation area).

- *Net return on investment.*–Wildlife professionals often forecast gross returns (e.g., predicted gains in a desirable species habitat) from proposed project investments, whereas successful business professionals thoroughly assess expected *net* return (important gains and losses). For example, before developing and releasing a new product, business professionals evaluate how a potential offering will affect use and sales of existing products – what value to the company will be lost relative to potential gains. In wildlife habitat delivery, before developing a project proposal, a site's current and predicted future value (with no new investment) must be considered. Most sites have at least some wildlife value, including cornfields, golf courses, and even dense stands of common reed. At some locations common reed can have critical water-filtering and erosion-prevention properties, not to mention provision of quality cover for some game species such as white-tailed deer and ring-necked pheasants. Thus, when evaluating conservation actions in a business context, proposals should be based on the amount of net-increase in site value. This is done by quantifying predicted tradeoffs, such as lost values to non-target species of plants, wildlife, and people, with alternate actions (including no action).

- *Success potential (risk of failure).*–Wildlife professionals tend to be optimists when predicting how proposed habitat delivery projects will function and positively influence target populations. In a successful business, however, proposals of significant investment are met with unsympathetic review by owners / shareholders (represented by a Board of Directors) with risk of failure being thoroughly vetted before project investment occurs. Risk assessment requires a detailed understanding of the current situation. In the case of a wetland-bird habitat proposal, scientifically sound monitoring of populations can provide a measure of site baseline conditions. However, when population abundance and habitat monitoring are linked at a location, system knowledge can substantially improve along with accuracy in predicting outcomes (and risks) of various conservation actions at that site or ecologically similar locations.

- *Opportunity cost.*–Before investing personnel and financial resources in a project, business leaders carefully assess their options, knowing the decision they make will affect resources available for other opportunities. In other words, significant investment (cost) in one project results in dedicated resources becoming unavailable for alternate, perhaps better, opportunities. A common wildlife agency example might be use of passive (low cost) vs. intensive (high cost) management. Whereas hunter-harvest success may be highest with intensive management of a site, use of passive management may result in higher biological value (e.g., marsh bird reproduction and biodiversity) and adequate social value (e.g., unpredictable hunting opportunities but good public wildlife viewing and water filtration). The passive choice in this example can free-up resources to take advantage of conservation opportunities at other locations. Planners and managers are increasingly using a process of Structured Decision Making (SDM) to help examine and weigh tradeoffs between large habitat proposals and conservation approaches.

- *Sunk cost.*–In economics and business decision-making, a sunk cost has already been incurred and cannot be recovered. Sunk costs often are used by wildlife professionals to justify additional spending at a proposal location, often following an unexpected low return on a previous project investment (see *Success potential* above). However, past expenditures have little relevance to project proposals in a business context. Rather, use of unbiased estimates of net return on future investment should be the proposal-assessment focus. Ignoring sunk costs helps concentrate proposal evaluation strictly on the merits of future proposed habitat delivery. Moreover, some wildlife agencies have identified the need to begin outcome-based monitoring of past project locations, and examples of decommissioning costly wetland-management infrastructure have resulted from this type of monitoring.

- *Legacy cost.*–Closely related to opportunity cost and sunk cost, legacy costs are the resources committed years into the future because of past decisions. For example, the decision to build a road, a bridge, or a dike system, is not a one-time commitment of resources. Indeed, the establishment of significant infrastructure related to a bird conservation project results in (a legacy of) land-owner commitment of financial and human resources to that site and infrastructure. Ultimately, conservation proposals must be developed and evaluated with full consideration to short-term vs. long-term – sometimes perpetual – obligation of resources related to maintenance and operational costs. Legacy costs can result in a significant reduction in the amount of personnel time and financial resources available for new, and possibly more productive or necessary, conservation activities in the future. Because long-term maintenance costs typically fall on wildlife agencies and associated conservation-grant entities, wildlife professionals must be especially considerate of these potential circumstances.

Successful organizations regularly assess outcomes through cost/benefit analyses, and they practice continuous quality improvement by refining or eliminating tasks determined to have low added value to a program. This approach releases human and financial resources to deliver initiatives that better fit changing needs so that establishments remain competitive and profitable. A current and largely unrealized priority of the conservation community is the effective integration of human dimensions into conservation planning. Improved understanding of how our community is perceived by stakeholders and the general public – what they understand and what they like, what they don't understand and what they don't like – seems especially pertinent for growing program support. Successful businesses and organizations are relevant to society, often adjusting and marketing programs to retain public backing (financially and politically) and assuring long-term program sustainability. If what we do is not relevant to a public increasingly disconnected from the natural world (but who desire clean air, abundant drinking water, and un-flooded basements), long-term support for wetland bird conservation will erode. We have much to learn about social science, and this Strategy begins moving us in a direction of achieving greater relevance to current and future conservation stakeholders.

Measuring Performance

JVs have begun developing conceptual models to describe how habitat conservation actions influence vital rates. Most now consider annual life-cycle models as the basis for monitoring and identifying critical life history needs (i.e., breeding vs. migration vs. wintering habitat) for focal species, and they have recommended framing accomplishments in terms of changes in demographic parameters (Devers et al. 2009). However, our JV region is very large and complex, supporting waterbirds during breeding, migration, and winter periods. Conservation planning and measuring performance has necessarily been more extensive (vs. intensive), but improving understanding of conservation and environmental influences on regional waterbird demographics remains a priority.

Activities of JV partners implementing this Strategy are expected to increase landscape carrying capacity for waterbirds and, in turn, directly and indirectly impact specific vital rates. At the regional scale, JV performance should include a measure of net change in suitable habitat available for waterbirds and the potential impact those changes have on vital rates. However, uncontrollable environmental factors (e.g., precipitation, climate change) must be considered and included in the accounting process when measuring performance. Measures of occurrence, density, and change in population demographics may serve to assess performance of JV conservation actions for some species. However, the number of wetland birds occupying the region in any given year is not solely dependent on habitat condition within the region. For example, several years of poor habitat north (breeding) and south (wintering) of the JV region will surely influence species abundance. Thus, regional waterbird population objectives are best viewed as a long-term target and a practical means to quantify waterbird habitat objectives.

Net Change in Resources

Areas important for wetland birds and people within the JV region will be retained by protecting existing high quality habitat and increased by restoring and enhancing habitat as prescribed. Habitat conservation definitions have been refined (i.e., retention, restoration, and enhancement; see *Future Habitat Delivery and Reporting*), and partners have the capacity for estimating area of cover types and general location of protected and restored habitats. However, concurrent habitat loss also must be estimated to evaluate net landscape change, and this measure will be coarsely tracked using NLCD in 5-year intervals. Although NLCD updates can be used to generally estimate cover type change, these spatial data do not measure species-specific habitat quantity or quality. Nevertheless, we assume transition in area for given cover types provides a reasonable trend indicator for various bird habitats. Remote sensing technology typically provides the best means for regional landscape analysis, but the following challenges remain: 1) wetland bird habitat is dynamic whereas spatial data are static, 2) wetland types and vegetation composition may not be accurately distinguished,

3) wetland inundation and wetland-bird habitat quality are uncertain, and 4) updates to NWI, our most valuable resource for assessing wetland extent, are infrequent.

Adaptive Management

The SHC approach used in this Strategy embodies adaptive management in a broad and inclusive sense with cyclic planning, conservation design, implementation, and outcome based evaluation (based on monitoring to establish baseline conditions). Thus, SHC provides an explicit framework linking conservation and monitoring, one that ensures monitoring data are relevant and useful in refining conservation decisions over time. Monitoring and data analysis provide a means to improve future decision-making through an iterative cycle of biological prediction and evaluation. Consequently, JV partners must manage in the face of uncertainty – with the goal of reducing it. SHC provides a framework for deliberate actions and evaluation, leading to increased JV effectiveness and efficiency.

Planning is grounded on a set of assumptions, often embodied in implicit or explicit models like those used in the waterbird species accounts (Appendix A). These models predict how waterbirds should respond to habitat changes following conservation actions. For example, implementation of prescribed breeding habitat objectives should theoretically eliminate breeding population deficits, which can subsequently be assessed through coordinated monitoring. Rigorous, reliable monitoring is necessary to detect population change; thus adaptive management may be especially difficult for some waterbird conservation with current low intensity monitoring. Nonetheless, we incorporate this element into the Strategy's biological foundation and expect completion of research and monitoring objectives will result in valuable new data to re-parameterize models and decision tools. The challenges are many for science-based waterbird conservation, but application of SHC concepts will be a priority in the implementation and future refinement of this Strategy.

MONITORING AND RESEARCH

Research and monitoring projects in bird conservation are often linked. For purposes of this Strategy, most monitoring includes efforts designed and implemented to measure progress toward meeting population and habitat objectives (i.e., status, trends, and performance measurement). Research, in contrast, is designed to answer specific questions that arise from uncertainties or assumptions inherent in conservation planning. Habitat quality can be assessed by monitoring density of focal species, physical or environmental characteristics (e.g., vegetation related to quality habitat), and or vital rates (e.g., survival and production). Habitat use surveys that measure responses of vital rates to environmental conditions offer an opportunity to test hypotheses about factors that limit populations. Even more beneficial are surveys closely integrated with explicit management decisions, where biological prediction and testing are used to learn about the effects of conservation practices.

Data from coordinated regional and local-scale surveys of waterbird populations and habitats were used to develop this Strategy. The planning effort was also informed by quantitative and qualitative survey data regarding human population distribution and social values related to ecological goods and services provided by natural landscapes. Important sources of monitoring data are described below.

North American Breeding Bird Survey (BBS).–The BBS has been conducted annually since 1966, primarily in June after spring migration. The BBS is a roadside survey conducted by wildlife professionals and volunteer birders. There are 600 routes within the JV region; routes are 40 km in length with 50 stops that are 0.8 km apart. The BBS may not adequately represent most waterbirds because of their low detectability and the survey's proximity to roads. However, population trends based on the BBS for several waterbird species are considered quite valuable in this JV region.

eBird.–Launched in 2002 by the Cornell Lab of Ornithology and National Audubon Society, eBird provides rich data sources for basic information regarding bird abundance and distribution at a variety of spatial and temporal scales. These data can be used to create migration and wintering chronology curves and to assess relative abundance across states and BCRs. A goal of eBird is to maximize the utility and accessibility of the vast numbers of bird observations made each year by professional and recreational bird watchers. Observations from each participant are collated in an international network of eBird users. These data are then shared with a global community of stakeholders, including educators, land managers, ornithologists, and conservation planners. Information available through eBird (especially a more targeted eBird sampling scheme) could become the foundation for a better understanding of bird distribution across the western hemisphere.

Great Lakes Colonial Waterbird Survey.–Coordinated by the FWS, this monitoring effort has been conducted along the Great Lakes coastline every 10 years beginning in 1976–1977 (Scharf et al. 1978), with the last survey completed during 2007–2009. Survey teams reach bird colonies by float plane or boat and count nests at the peak of incubation and prior to hatch. With complete coverage of Great Lakes coastline and islands, the inventory provides an excellent database for island-nesting colonial species. However, the 10-year sample timeframe limits its value as a trend indicator. Research associated with this survey found that selecting a few key colonial-nesting areas for more frequent monitoring can lead to better trend indices (Wires et al. 2013).

Midwest Secretive Marsh Bird Survey.–Established in the Midwest in 2012, this effort expanded from Wisconsin to several other states, although monitoring intensity (routes covered) has declined in some areas recently due to lack of funding support. The survey follows a national marsh bird monitoring protocol (Conway 2011), with point counts consisting of 5-minute passive listening periods followed by audio broadcast periods of secretive marsh bird calls (1-minute broadcast series per focus species). Scientists recognize the value of providing a regional framework for collaborative marsh bird research compatible with large-scale monitoring. However, there has been only limited use of survey data in conservation planning and its value to produce population status and trend information in the Midwest has not been realized.

Marsh Monitoring Program (MMP).–This survey has been gathering data on breeding marsh birds at a variable number of wetlands within the Great Lakes basin since 1995 (Crewe et al. 2005). The goal of the program is to monitor marsh bird population trends in the region by recording all bird observations within 100 m of survey points during a given time period. However, the MMP has been hampered by turnover in survey routes which may limit its ability to detect change in wetland bird abundance and population shifts associated with fluctuating lake levels and subsequent changes in plant communities. The MMP does not have a statistically-based sampling framework, so it is unclear how representative these data are for the region. Coarse density estimates may be developed for regularly recorded species.

State Population Surveys.–Several state agencies within the JV region have conducted presence/absence surveys when developing state Breeding Bird Atlases, or when considering a site for Important Bird Area (IBA) status. These data are often useful to document the presence of a species but are rarely completed in a manner to provide density estimates. There are, however, periodic efforts by states to conduct point counts at random locations, which may result in density estimation and better monitoring of population trends. In addition, local surveys and data collection associated with research projects can provide valuable demographic information.

Integrated Waterbird Management and Monitoring (IWMM).–The IWMM program is uniquely focused on non-breeding waterbirds (encompassing waterfowl, shorebirds, and wading birds) and their habitats. This collaboration among wetland managers and scientists is intended to optimize conservation practices through monitoring, modeling, and development of decision support tools. Rigorous, standardized monitoring protocols of the IWMM (see National Protocol Framework of the USFWS Inventory and Monitoring Program) have been piloted at select National Wildlife Refuges and other locations in the eastern half of the U.S. The monitoring approach can provide management-relevant indices of abundance, identify population trends and relationships between non-breeding waterbirds and habitat conditions, and generate comparative measures across participating units. In addition, local scale survey data may be pooled and used to answer regional and flyway-scale questions such as what, where, and how much habitat may be needed to achieve carrying capacity objectives. Analyses of use days, timing of site use, and habitat characteristics of greatest value to waterbirds may also help inform planning for the non-breeding period. Likewise, species-specific habitat data can help assess trade-offs between management for different groups of waterbirds, and to develop management prescriptions that support multiple species.

Regional Habitat Surveys.–Less emphasis has been placed on direct monitoring of waterbird habitat in the JV region. Since completion of the 1998 JV Implementation Plan, JV Board members have provided an annual report of major bird habitat accomplishments by JV partners in each state. Reporting is now segmented into wetland and upland categories and grouped by protection, restoration, and enhancement. Although partners have reported accomplishments that contribute toward their stated focus area objectives, the measure remains coarse with general category definitions (*wetland* and *upland*) and no rating of habitat quality for waterbird focal species. In addition, JV partners and staff recognize the need to estimate concurrent habitat loss to monitor *net change* in waterbird habitat over time. Progress has been made with net-change assessment using the frequently (5-year intervals) updated and continually improving NLCD. JV states also have been updating NWI data in recent years, providing contemporary estimates of the distribution and abundance of wetlands potentially important to waterbirds.

Ecological Goods and Services (EGS).–Local scale efforts to assess EGS values that natural communities provide to people have been established during recent decades. However, regional scale partnerships with an EGS focus are relatively new and an area of emphasis for some conservation partnerships (e.g., Landscape Conservation Cooperatives). New EGS information and technical tools with approaches to mitigate human-caused stress on regional landscapes can provide a unique value to bird-habitat JVs now integrating social considerations into bird conservation planning. Moreover, university researchers and staff at several state and federal agencies use monitoring to track how social communities value different ecological goods and services provided by grasslands, forests, rivers, and wetlands.

U.S. Census and Stakeholder Surveys.–Monitoring trends in human population growth and distribution along with participation rates in outdoor activities (e.g., hunting, birdwatching, and other recreation) are an increasing focus to bird conservation planning. The USFWS, U.S. Census Bureau, and other partners assess trends in human distribution and outdoor recreation at approximate 5-year intervals (https://www.census.gov/programs-surveys/fhwar). Additionally, periodic surveys of hunters, birders, and the general public can help determine desired products, satisfaction, and level of conservation knowledge for stakeholder groups. Conservation partners in the U.S. and Canada conducted a comprehensive bi-national opinion survey of hunters, birders, and the general public to examine attitudes toward wetlands and waterfowl. These efforts were completed in 2017 to help inform the 2018 NAWMP update. Finally, several state agencies within the JV region conduct regular constituent surveys for hunting, wildlife viewing, and other outdoor recreation (e.g., Illinois Hunter Harvest Survey). Smaller scale human dimensions surveys can provide more targeted information than national efforts, plus state agencies often have flexibility to tailor portions of the survey, including questions to evaluate local management initiatives.

Monitoring Needs

Joint Venture partners, especially state and federal agencies responsible for migratory bird conservation, have led many of the population abundance and habitat survey efforts listed above. We anticipate that wildlife agencies will continue this work and expand effort in key areas, including human dimensions, as resources are made available. Implementation of expanded standardized population abundance surveys (e.g., Midwest Secretive Marsh Bird Survey) coupled with updated and refined spatial data (e.g., revised NWI and NLCD) will provide opportunities to develop improved geo-referenced breeding waterbird databases for conservation planning. Access to population data is essential and the Avian Knowledge Network (AKN; see Midwest Avian Data Center) has become the hub for centralized data management and sharing across North America. JV partners will benefit by entering relevant monitoring data into the AKN (http://www.avianknowledge.net/) and using the resources available through this network.

Some waterbird monitoring needs can be met by expanding or refining existing surveys, in addition to improved access and use of these data. Science partners must continue to identify and improve regional monitoring strategies that complement and support regional and continental waterbird habitat conservation. Furthermore, JV staff participation on technical committees and related initiatives will maintain connection between biological and social monitoring efforts important to future wetland-bird conservation planning. Monitoring objectives listed below will likely be completed in a collaborative manner by the JV Science Team, state and federal agencies, university researchers, non-government organizations, and associated conservation groups that comprise the JV partnership. These comprehensive objectives were considered the highest priority for measuring JV performance and to build knowledge for refining future Strategy revisions. Specific JV waterbird monitoring priorities have been developed (http://www.uppermissgreatlakesjv.org/Priorities.htm) and will be periodically updated.

Priority Monitoring Objectives

1) *By 2021, determine efficacy of the Midwest Marsh Bird Monitoring Program at current level of breeding-population survey effort. Assessment must include detection probabilities and determination of adequate sampling effort needed to generate BCR-level (and or state/regional) population estimates during the breeding period. This program has potential to provide critical information on marsh bird distribution, abundance, trends, responses to management, and a framework to help develop region-wide research to inform planning, including assessment of focal species representation of marsh bird guilds.*

2) *By 2021, support the next Great Lakes Colonial Waterbird Survey and or related smaller-scale breeding-population survey efforts conducted with greater frequency. Recent analysis suggests surveying key locations more frequently can improve trend data for colonial waterbirds, allowing the more intensive Great Lakes wide survey to be conducted less often (e.g., 15–20 year intervals). These data are important for species-specific changes in distribution and abundance and for providing JV performance measures for this bird group. In addition, explore standardized monitoring approaches for colonial waterbird species of high conservation concern (e.g., Common, Black, and Forster's Terns, and Black-crowned Night-Herons) at interior areas away from the Great Lakes shore.*

3) *By 2025, devise methods for using land cover inventory data (e.g., National Land Cover Data, National Wetland Inventory) to better track regional changes in the quantity and quality of habitats important to breeding and non-breeding waterbirds. NLCD has been used, without rigorous evaluation, to generate trends in cover types and to predict potential landscape change important to future waterbird planning. Some JV states lack a current NWI, the primary data source for wetland bird planning. These and alternate spatial data sources should be evaluated for planning value, including ability to distinguish key habitat features such as wetland inundation.*

4) *By 2025, support development and implementation of standardized, systematic non-breeding waterbird surveys in near-shore and open waters of the Great Lakes to determine distribution, abundance, trends, and migration chronology. One application of this information will be to evaluate proposals for offshore wind power development. Improved understanding of migration corridors, stopover locations, and wintering sites will contribute to life-cycle modeling. Expanded implementation of the IWMM program will be emphasized in the JV region for evaluation of non-breeding habitat conservation delivery.*

Research Needs

We believe regional landscapes are the appropriate scale for conservation planning to achieve population objectives and to ensure the needs of breeding and non-breeding wetland birds are met under a wide range of environmental conditions. A priority for this Strategy was to develop spatially-explicit habitat models to guide regional waterbird conservation. The best available information was used to identify locations currently most suitable for breeding waterbirds and to help target future conservation delivery for birds and people. Knowledge gaps hindered development of more rigorous models, but completion of proposed monitoring and research initiatives will produce an expanded database to support development of improved spatial planning tools. General research objectives are listed below, with emphasis on JV focal species and the social benefits of wetland bird habitats. More specific waterbird research priorities have been identified for each objective (http://www.uppermissgreatlakesjv.org/priorities.htm) and will be periodically updated.

Priority Research Objectives

1) *By 2020, develop an evaluation protocol to assess net benefits to waterbirds and people of recently completed (2005–2020) wetland restoration and enhancement projects. Benefits will include both biological (e.g., population response) and social (e.g., hunting/viewing opportunity, ecological goods and services). The focus of this performance-measure effort will be on large scale wetland conservation projects in the JV region including for example those funded by the North American Wetlands Conservation Act (NAWCA), Great Lakes Restoration Initiative (GLRI), and or Natural Resources Conservation Service where objectives are explicitly stated and readily available from grant proposals so that performance can be empirically measured.*

2) *By 2022, research will be underway to develop and refine models that predict how populations of priority breeding waterbird species (JV focal species / species of high conservation concern) respond to habitat change, particularly human development, intensified agriculture, and variation in precipitation and wetland inundation during the breeding period. Habitat quality and population assessment, linking changing habitat characteristics with occurrence, density, and demographic rates (i.e., reproduction and survival), will be primary foci.*

3) *By 2022, develop research to improve the integration of social objectives into wetland and waterbird conservation within the context of implementing continental conservation plans with Human Dimensions goals (e.g., NAWMP) in the JV region. Focus will be on improved understanding of motivations for wetland conservation supporters along with quantifying the value of ecological goods and services potentially provided by strategically placed wetland bird habitat. Evaluation should include benefits and tradeoffs associated with geographic placement of conservation projects to achieve biological and social objectives.*

4) *By 2025, research will be underway to evaluate the value of current (and potential) non-breeding habitat for waterbirds. Assessment will include testing the assumption that breeding habitat is of greater importance to priority species compared to non-breeding habitat. This effort should also include whether non-breeding habitat carrying capacity may be significantly influenced by conservation delivery, and whether our presumption that BCR 22 is a biological bottleneck for migrating waterbirds birds is correct. Research should fill information gaps regarding factors that influence waterbird carrying capacity during the non-breeding period to allow development of useful life-cycle models.*

COMMUNICATIONS AND OUTREACH

The JV is a diverse partnership serving an even more diverse network of stakeholders interested in bird habitat. Developing internal and external communications is essential to keep JV partners informed, engaged, and coordinated, as well as to cultivate support from key constituents. The process requires identification of relevant target audiences, key messages, and appropriate methods of information dissemination. Evaluating the effectiveness of communications also is challenging, as public (and partner) attitudes, opinions, and behaviors are not easily tracked.

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

A primary product of JV outreach is information that influences the actions of others. We must be effective and compelling at communicating JV goals and strategies to conservation stakeholders including the public and elected officials. The JV communications program consists of both internal and external communications. The aim of internal communication is to share information among existing partners, particularly members of the JV Management Board and Science Team, and to facilitate completion of JV habitat conservation, monitoring, and research initiatives. The goal of external communications is to provide recommendations to management bodies, recruit new JV partners, and raise awareness and support for bird conservation among stakeholders and policy-makers. Coordination of information sharing and product marketing through various communication approaches is critical to reach public and private entities that may have greater resources to affect bird habitats than current partners. To fulfill these goals the JV has established the following priorities:

Internal communications

1) Provide general information and other potentially valuable communication (i.e., publications, interviews, agency accomplishment reports) to JV partners via the Upper Mississippi River and Great Lakes Region Joint Venture webpage (www.UpperMissGreatLakesJV.org).
2) Maintain and share in a timely manner meeting minutes from Management Board and Science Team / Technical Committee gatherings.
3) Develop annual JV progress reports with habitat accomplishments by cover type and periodic reports describing JV science advances.
4) Develop short summary documents with visual appeal to market key messages related to this Strategy and the JV All-bird Implementation Plan.
5) Maintain a current list (with contact information) of JV partners, including Management Board, Science Team, and Technical Committee members and other primary partners not represented in these groups.
6) Maintain a current list of habitat, monitoring, and research priorities associated with achieving JV Implementation Plan goals.
7) Develop and maintain a current list of completed and on-going research projects including abstracts containing vital reference information from each.
8) Provide up-to-date accounts for JV focal species used for planning, including ecological information, population and habitat objectives, and conservation decision tools.

External communications

1) Exchange scientific and coordination (human resources, budget, etc.) information and collaborate on priority bird planning, monitoring, and research with associated JVs.
2) Collaborate with university, non-government organization scientists, and state wildlife agency scientists (game and nongame) on priority bird planning, monitoring, and research at the regional and continental scales, with a priority focus on the Midwest marsh bird / waterbird community.

3) Provide information (e.g., presentations) regarding JV bird conservation priorities and planning tools to stakeholders and interest groups.
4) Collaborate on workshops, symposia, and similar gatherings, providing current scientific information to wildlife managers, agency species experts, policy-makers, and other stakeholders regarding bird habitat conservation in the JV region.
5) Participate in evolving communication and outreach initiatives related to NABCI and other interests experienced in effectively marketing bird conservation.
6) Provide above listed materials and other potentially valuable communications to external groups via use of contemporary social media platforms and the JV webpage (www.UpperMissGreatLakesJV.org).

Target audiences and communication responsibilities

Internal target audiences for communications include:
1) JV Management Board.
2) JV Science Team (Technical Committee and Ad hoc Bird-group Sub-committee members).
3) Migratory Bird Program staff of the USFWS.

External target audiences include:
1) Other habitat JVs: Prairie Pothole, Atlantic Coast, Rainwater Basin, Playa Lakes, Central Hardwoods, Lower Mississippi Valley, Gulf Coast, East Gulf Coastal Plain, Appalachian Mountains, and Eastern Habitat and Prairie Habitat (both in Canada).
2) State wildlife agencies, non-government conservation organizations (NGOs), and LCCs located in the JV region (key contacts not on Management Board).
3) Integrated Waterbird Management and Monitoring Program (IWMM) Steering Committee.
4) Species management groups including the USFWS Endangered Species Program, the Mississippi Flyway Council and associated technical committees, and state agency species biologists.
5) Primary land management groups including the USFWS National Wildlife Refuge System, U.S. Forest Service, U.S. National Park Service, U.S. Army Corps of Engineers, and state agency and other conservation land managers.
6) Coordinators for the Waterbirds for the Americas, NAWMP, Partners In Flight, U.S. Shorebird Conservation Plan, and North American Bird Conservation Initiative (NABCI).
7) State and federal conservation policy-makers.
8) Hunters, birders, other conservation supporters, and members of the general public seeking bird conservation information for the JV region.

Communications and outreach related to partner coordination and habitat implementation are maintained through ongoing professional channels. The JV webpage (www.UpperMissGreatLakesJV.org) will be maintained with regular updates related to meetings, conservation initiatives, plans and strategies, and scientific reports. Facebook and other social media avenues may be used to promote JV work, and the value of bird habitat to hunters, birders, and the general public. Management Board members and JV staff also will collaborate in hosting gatherings to share information, particularly related to JV conservation plans and related efforts. Science and planning documents, including reporting on monitoring and research supported by the JV, will also be produced and available. Science partners will be required to provide professional reports for JV-supported projects, plus they will be encouraged to publish study results in peer-reviewed scientific journals and present information at professional meetings.

TIMETABLE AND COORDINATION

This revised Strategy is one part of an all-bird Joint Venture conservation effort, but arguably wetland bird conservation has embodied the JV, providing a foundation for the partnership. The all-bird 2007 JV Implementation Plan had a 15-year time horizon, with the expectation that objectives would be updated as bird-group strategies for waterbirds, waterfowl, shorebirds, and landbirds were revised due to new information. The waterfowl management community has provided leadership in the integration of conservation objectives for birds and people through the NAWMP, a continental plan that is revised every 5–8 years. The extensive revision of the NAWMP (2012), accompanied with new research findings to inform regional waterbird planning, prompted this Strategy revision. The *Conservation Delivery* portion of the document was developed with a 15-year time horizon (2018–2033). However, our Strategy is linked to other regional and national plans, thus significant future revisions before 2033 may be required.

Because of the similarity in bird habitat, this Strategy was revised in tandem with the 2017 JV Waterfowl Strategy, which also follows a 15-year timeframe. Waterbird habitat objectives are stated explicitly by state and BCR units, and current decision support tools are provided at the regional scale in the *Conservation Design* and *Delivery* sections. Objectives identified in the *Monitoring and Research* section of the Strategy have earlier completion targets, ranging out to 2025. Substantial knowledge gained through JV conservation evaluation, monitoring, and research may also define the next interval for updating this document.

Refinement of JV conservation plans and strategies has been the responsibility of the JV Science Team, whereas implementation has been completed by agencies and organizations represented by the JV Management Board and their extended partner networks. Partner coordination, communication and outreach, and tracking habitat accomplishments have been led by the JV Coordination Office (Bloomington, MN). Managing GIS spatial data, conservation model development, and collaboration with the research community has been the responsibility of the JV Science Office (East Lansing, MI). The Joint Venture has an established record of achievement following the 1998 and 2007 JV Implementation Plans. Using the habitat objectives, decision-support tools, and research and monitoring recommendations provided in this Strategy, partners should continue to increase conservation efficiency and effectiveness for waterbirds and other wetland bird groups.

LITERATURE CITED

Albert, D. A. 2003. Between land and lake: Michigan's Great Lakes coastal wetlands. Michigan Natural Features Inventory, Michigan State University, East Lansing, Extension Bulletin E-2902. 96pp.

Albert, D. A., and L. D. Minc. 2004. Plants as regional indicators of Great Lakes coastal wetland health. Aquatic Ecosystem Health and Management 7:233–247.

Andres, B. A., B. L. Altman, A. M. Bartuszevige, C. J. Beardmore, R. Dettmers, D. T. Jones-Farrand, E. J. Laurent, R. S. Mordecai, J. M. Tirpak, W. Vermillion, and J. A. Wheeler. 2012. Considerations for establishing bird population and habitat objectives to further conservation within habitat Joint Ventures. Partners in Flight Technical Series No. 6. Partners in Flight website: http://www. Partnersinflight.org/pubs/ts/06-PopObjectivesGuidance.pdf.

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

Bajer, P. G., G. Sullivan, and P. W. Sorensen. 2009. Effects of rapidly increasing population of common carp on vegetative cover and waterfowl in a recently restored Midwestern shallow lake. Hydrobiologia 632:235–245.

Bellrose, F. C., S. P. Havera, F. L. Paveglio, Jr., and D. W. Steffeck. 1983. The fate of lakes in the Illinois River Valley. Illinois Natural History Survey Biological Notes 119. Champaign, Illinois, USA. 27 pp.

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

Boers, A. M., and J. B. Zedler. 2008. Stabilized water levels and *Typha* invasiveness. Wetlands 28:676–685.

Brown, M. T., and M. B. Vivas. 2005. Landscape development intensity index. Environmental Monitoring and Assessment 101:289–309.

Campellone, R., A. Bartuszevige, T. Chouinard, J. Lujan, T. Miewald, B. Murry, R. Nelson, K. O'Hara, A. Poe, and A. Robertson. 2014. Minimum Standards for Conservation Design at Landscape-Scales (Landscape Conservation Design): Recommendations from the Landscape Conservation Design Minimum Standards Working Group to the U.S. Fish and Wildlife Service – Office of Science Applications.

Carlson, M. A., K. P. Kowalski, and D. A. Wilcox. 2009. Promoting species establishment in a *Phragmites*-dominated Great Lakes coastal wetland. Natural Areas Journal 29:263–280.

Caro, T. 2010. Conservation by Proxy: Indicator, Umbrella, Keystone, Flagship and Other Surrogate Species. Island Press, Washington, D.C., USA.

Collins, J. C. 2005. Good to great and the social sectors: A monograph to accompany good to great. Published by Harper Business, New York, New York, USA. 35pp.

Conservation Fund. 2016. Mississippi River Basin/Gulf Hypoxia Initiative Conservation Blueprint v 1.02. Report to U.S. Fish and Wildlife Service.

Conway, C.J. 2011. Standardized North American marsh bird monitoring protocol. Waterbirds 34: 319-346.

Crewe, T. L., S. T. A. Timmermans, and K. E. Jones. 2005. The marsh monitoring program annual report, 1995–2003: annual indices and trends in bird abundance and amphibian occurrence in the Great Lakes basin. Produced for Environment Canada – Ontario Region by Bird Studies Canada. 88pp.

Dahl, T. E. 1990. Wetlands: losses in the United States 1780's to 1980's. U. S. Department of the Interior, Fish and Wildlife Service, Washington, D.C., USA. 13pp.

Dahl, T. E. 2011. Status and trends of wetlands in the conterminous United States from 2004 to 2009. U.S. Department of Interior, Fish and Wildlife Service, Washington, D.C., USA. 107pp.

Devers P., G. Balkcom, J. L. Coppen, J. Dubovsky, D. Howerter, T. Jones, and S. Slattery. 2009. Final Report of the Alternative Performance Metrics Workshop. North American Waterfowl Management Plan Science Support Team Technical Report No. 2009–1. 9pp.

Devers P. K., A. J. Roberts, S. Knoche, P. I. Padding, and R. Raftovich. 2017. Incorporating human dimension objectives into waterfowl habitat planning and delivery. Wildlife Society Bulletin 41:405–415.

Fasbender, P., D. Staller, W. Harrell, B. Brooks, B. Strobel, and S. Warner. 2015. The eastern migratory population of Whooping Cranes: FWS vision for the next 5-year strategic plan. 8pp.

[FGDC] Federal Geographic Data Committee. 2013. Classification of wetlands and deep-water habitats of the United States. FGDC-STD-004-2013. Second Edition. Wetlands Subcommittee, Federal Geographic Data Committee and U.S. Fish and Wildlife Service, Washington, D.C., USA.

Fry, J., G. Xian, S. Jin, J. Dewitz, C. Homer, L. Yang, C. Barnes, N. Herold, and J. Wickham. 2011. Completion of the 2006 National Land Cover Database for the Conterminous United States. Photogrammetric Engineering and Remote Sensing 77:858–864.

Gottgens, J. F., B. P. Swartz, R. W. Kroll, and M. Eboch. 1998. Long-term GIS-based records of habitat changes in a Lake Erie coastal marsh. Wetlands Ecology and Management 6:5–17.

Hagy, H. M., S. C. Yaich, J. W. Simpson, E. C. Carrera, D. A. Haukos, W. C. Johnson, C. R. Loesch, F. A. Reid, S. E. Stephens, R. W. Tiner, B. A. Werner, and G. S. Yarris. 2014. Wetland issues affecting waterfowl conservation in North America. Wildfowl SI4:343–367.

Havera, S. P., K. E. Roat, and L. L. Anderson. 2003. The Thompson Lake/Emiquon story: the biology, drainage, and restoration of an Illinois River bottomland lake. Illinois Natural History Survey Publication 25. iv + 40 pp.

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

Herrmann, K. K., and R. E. Sorensen. 2009. Seasonal dynamics of two mortality-related trematodes using an introduced snail. Journal Parasitology 95:823–828.

Higman, P., and S. Campbell. 2009. Meeting the challenge of invasive plants: a framework for action. Michigan Natural Features Inventory Report 2009–11.

Hine, C. S., H. M. Hagy, M. M. Horath, A. P. Yetter, R. V. Smith & J. D. Stafford. 2016. Response of aquatic vegetation communities and other wetland cover types to floodplain restoration at Emiquon Preserve. Hydrobiologia. doi:10. 1007/s10750-016-2893-5.

Homer, C. G., J. A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N. D. Herold, J. D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing 81:345–354.

Jarchow, M. E., I. Kubiszewski, G. L. D. Larsen, G. Zdorkowski, R. Costanza, S. R. Gailans, N. Ohde, R. Dietzel, S. Kaplan, J. Neal, M. R. Petrehn, T. Gunther, S. N. D'Adamo, N. McCann, A. Larson, P. Damery, L. Gross, M. Merriman, J. Post, M. Sheradin, and M. Liebman. 2012. The future of agriculture and society in Iowa: four scenarios. International Journal of Agricultural Sustainability10:76–92.

Johnston, C. A., and P. Meysembourg. 2002. Comparison of the Wisconsin and National Wetlands Inventories. Wetlands 22:386–405.

Kahler, B. M. 2015 Upper Mississippi River and Great Lakes Region Joint Venture bird habitat conservation accomplishments. Final report (unpublished) to U.S. Fish and Wildlife Service, Bloomington, Minnesota, USA.

Kushlan, J. A., M. J. Steinkamp, K. C. Parsons, J. Capp, M. A. Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliot, R. M. Erwin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J. E. Saliva, B. Sydeman, J. Trapp, J. Wheeler, and K. Wohl. 2002. Waterbird conservation for the Americas: the North American waterbird conservation plan, version 1. Waterbird conservation for the Americas, Washington, DC., USA. 78pp.

Lott, C. A. 2006. Distribution and abundance of the interior population of the Least Tern (*Sterna antillarum*), 2005: a review of the first complete range-wide survey in the context of historic and ongoing monitoring efforts. Dredging Operations and Environmental Research Program Technical Notes Collection, U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi. 68pp.

Marra, P. P., L. A. Culp, A. L. Scarpignato, and E. B. Cohen. 2014. Full annual cycle climate change vulnerability assessment for migratory birds of the Upper Midwest and Great Lakes region (final report to the Upper Midwest and Great lakes Landscape Conservation Cooperative). The Smithsonian Conservation Biology Institute, Migratory Bird Center, Washington, D.C. [online] URL: www.migratoryconnectivityproject.org/climate-change-vulnerability.

Matthews, J. W., D. Skultety, B. Zercher, M. P. Ward, and T. J. Benson. 2016. Field verification of original and updated National Wetlands Inventory maps in three metropolitan areas in Illinois, USA. Wetlands 36:1155–1165.

Meyer, S. W., S. S. Badzinski, S. A. Petrie, and C.D. Ankney. 2010. Seasonal abundance and species richness of birds in common reed habitats in Lake Erie. Journal of Wildlife Management 74:1559–1567.

Monfils, M. J., P. W. Brown, D. B. Hayes, G. J. Soulliere, and E. N. Kafcas. 2014. Breeding bird use and wetland characteristics of diked and undiked coastal marsh in Michigan. Journal of Wildlife Management 78:79–92.

Monfils, M. J., P.W. Brown, D.B. Hayes, and G.J. Soulliere. 2015. Post-breeding and early migrant bird use and wetland conditions of diked and undiked coastal wetlands in Michigan. Waterbirds 38:373–386.

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

[NASS] National Agricultural Statistics Service. 2016. National Agricultural Statistics Service, 2016 Cultivated Layer. U.S. Department of Agriculture. https://www.nass.usda.gov/.

[NABCI] North American Bird Conservation Initiative. 2000. The North American Bird Conservation Initiative in the United States: a vision of American bird conservation. North American Bird Conservation Initiative Website. www.nabcius.org/aboutnabci/NABCIfndtn.pdf

[NEAT] National Ecological Assessment Team. 2006. Strategic habitat conservation. Final report of the NEAT. U.S. Geological Survey and U.S. Department of Interior, Fish and Wildlife Service.

[NAWMP] North American Waterfowl Management Plan. 2012. North American Waterfowl Management Plan 2012: People conserving waterfowl and wetlands. Canadian Wildlife Service, United States Fish and Wildlife Service, Secrataria de Medio Ambiente y Recursos Naturales.

[NAWMP] North American Waterfowl Management Plan. 2014. Revised objectives: an addendum to the 2012 North American Waterfowl Management Plan. Canadian Wildlife Service, United States Fish and Wildlife Service, Secrataria de Medio Ambiente y Recursos Naturales.

Nijhuis M. 2014. A gathering storm for North American birds. The Audubon Report (314), Special Issue: birds and climate change. Pages 24-32.

Notaro, M., M. Schummer, Y. Zhong, S. Vavrus, L. Van Den Elsen, J. Coluccy, and C. Hoving. 2016. Projected influences of changes in weather severity on autumn-winter distributions of dabbling ducks in the Mississippi and Atlantic flyways during the twenty-first century. PLoS ONE 11(12): e0167506.

Potter, B. A., and G. J. Soulliere. 2009. Breeding waterfowl habitat objectives accommodate other marsh birds in the Upper Mississippi River and Great Lakes Joint Venture Region. Poster and extended abstract for Fifth North American Duck Symposium, Toronto, Ontario, Canada.

Richardson, L., J. Loomis, T. Kroeger, and F. Casey. 2015. The role of benefit transfer in ecosystem service valuation. Ecological Economics 115:51–58.

Rowland, E. R., M. S. Cross, and H. Hartmann. 2014. Considering multiple futures: Scenario planning to address uncertainty in natural resource conservation. U.S. Fish and Wildlife Service, Washington, D.C., USA.

Rush, S.A., C. Pekarik, D.V. Weseloh, F. Cuthbert, D. Moore, and L. Wires. 2015. Changes in heron and egret populations on the Laurentian Great Lakes and connecting channels, 1977-2009. Avian Conservation and Ecology 10(1):7. http://dx.doi.org/10.5751/ACE-00742-100107.

Sauer, J. R., J. E. Hines, J. E. Fallon, K. L. Pardieck, D. J. Ziolkowski, Jr., and W. A. Link. 2015. The North American Breeding Bird Survey, Results and Analysis 1966–2013. Version 01.30.2015. U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, Maryland, USA.

Sauer, J. R., D. K. Niven, J. E. Hines, D. J. Ziolkowski, Jr, K. L. Pardieck, J. E. Fallon, and W. A. Link. 2017. The North American Breeding Bird Survey, Results and Analysis

1966 - 2015. Version 2.07.2017 USGS Patuxent Wildlife Research Center, Laurel, Maryland, USA.

Scharf, W. C., G. W. Shugart, and M. L. Chamberlain. 1978. Colonial birds nesting on man-made and natural sites in the U.S. Great Lakes. Report TR-D-78-10, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, USA. 140pp.

Schlaepfer, M. A., D. F. Sax, and J.D. Olden. 2011. The potential conservation value of non-native species. Conservation Biology 25:428–437.

Schummer, M. L., J. Palframan, and E. McNaughton. 2012. Comparisons of bird, aquatic macroinvertebrate, and plant communities among dredged ponds and natural wetland habitats at Long Point, Lake Erie, Ontario. Wetlands 32:945–953.

Sherman, D. E., R. W. Kroll, and T. L. Engle. 1996. Flora of a diked and an undiked southwestern Lake Erie wetland. Ohio Journal of Science 96:4–8.

[SWCS] Soil and Water Conservation Society. 2003. Conservation implications of climate change: soil erosion and runoff from cropland. Soil and Water Conservation Society, Ankeny, Iowa, USA.

Soulé, M. E., and M. A. Sanjayan. 1998. Conservation targets: Do they help? Science 279:2060–2061.

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

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

Soulliere, G. J, and M. J. Monfils. 1996. Waterbird use of a constructed wetland complex in eastern Upper Michigan (Year 3). Michigan Department of Natural Resources, Wildlife Division Report 3262, Lansing, Michigan, USA.

Soulliere, G. J., B. A. Potter, D. J. Holm, D. A. Granfors, M. J. Monfils, S. J. Lewis, and W. E. Thogmartin. 2007. Upper Mississippi River and Great Lakes Region Joint Venture Waterbird Habitat Conservation Strategy. U.S. Fish and Wildlife Service, Fort Snelling, Minnesota, USA. Bloomington, Minnesota, USA.

Stafford, J. S., M. M. Horath, A. P. Yetter, C. S Hine, and S. P. Havera. 2007. Wetland use by mallards during spring and fall in the Illinois and Central Mississippi River Valleys. Waterbirds 30:394–402.

Stafford, J. D., M. M. Horath, A. P. Yetter, R. V. Smith, and C. S. Hine. 2010. Historical and contemporary characteristics and waterfowl use of Illinois River Valley wetlands. Wetlands 30:565–576.

Tear, T. H., P. Kareiva, P. L. Angermeier, P. Comer, B. Czech, R. Kautz, L. Landon, D. Mehlman, K. Murphy, M. Ruckelshaus, J. M. Scott, and G. Wilhere. 2005. How much is enough? The recurrent problem of setting measurable objectives in conservation. BioScience 55: 835–849.

Tozer, D. C. 2015. Marsh bird occupancy dynamics, trends, and conservation in the southern Great Lakes basin: 1996 to 2013. Journal of Great Lakes Research http://dx.doi.org/10.1016/j.jglr.2015.10.015.

Tuchman N., D. Larkin, P. Geddes, R. Wildova, K. Jankowski, and D. Goldberg. 2009. Patterns of environmental change associated with Typha x gluaca invasion in a Great Lakes coastal wetland. Wetlands 29:964–975.

[UMRGLR JV] Upper Mississippi River and Great Lakes Region Joint Venture. 2007. Upper Mississippi River and Great Lakes Region Joint Venture Implementation Plan (compiled by G. J. Soulliere and B. A. Potter). U.S. Fish and Wildlife Service, Fort Snelling, Minnesota, USA.

[USCB] U.S. Census Bureau. 2010. Population Change for Counties in the United States and for Municipios in Puerto Rico: 2000 to 2010. www.census.gov/2010census

[USFWS] U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. http://www.fws.gov/wetlands/

[USFWS] U.S. Fish and Wildlife Service. 2014. Selecting surrogate species for Strategic Habitat Conservation in the Upper Midwest Great Lakes geography. Bloomington, MN. Writing Team: N. Powers, M. Brouder, S. Blomquist, B. Potter, J. Dingledine, C. Deloria, G. Soulliere, T. Kerr, and K. Steiger-Meister.

Wainger, L. A., and M. Mazzotta. 2011. Realizing the potential of ecosystem services: a framework for relating ecological changes to economic benefits. Environmental Management 48:710–733.

Wheelen, T. L., and J. D. Hunger. 1995. Strategic management and business policy. Addison-Wesley Publishing Company, Inc., Reading, Massachusetts, USA. 1,217pp.

Wilkins, E. J., and H. M. Miller. 2018. Public views of wetlands and waterfowl conservation in the United States–Results of a survey to inform the 2018 update of the North American Waterfowl Management Plan: U.S. Geological Survey Open-File Report 2017–1148, 134 p.

Wires L. R., F. J. Cuthbert, D. R. Trexel and A. R. Joshi. 2001. Status of the Double-crested Cormorant (*Phalacrocorax auritus*) in North America. Final Report to USFWS.

Wires, L. R., S. J. Lewis, G. J. Soulliere, S. W. Matteson, D. V. Weseloh, R. P. Russell, and F. J. Cuthbert. 2010. Upper Mississippi Valley / Great Lakes Waterbird Conservation Plan. A plan associated with the Waterbird Conservation for the Americas Initiative. Final report to the U.S. Fish and Wildlife Service, Fort Snelling, MN, USA.

Wires, L. R., F. J. Cuthbert and T. Arnold. 2013. Advancing Great Lakes colonial waterbird monitoring priorities: sampling and collaboration. U.S. Fish and Wildlife Service, Fort Snelling, Minnesota, USA.

Wiseman, J., C. Biggs, L. Rickards, and T. Edwards. 2011. Scenarios for Climate Adaptation Guidebook for Practitioners. Victoria Centre for Climate Adaptation Research (VICCAR). University of Melbourne, Carlton, Victoria, Australia. 76 pp. http://www.vcccar.org.au/publication/research-paper/scenarios-for-climate-adaptation

Wright, J. P., C. G. Jones, and A. S. Flecker. 2002. An ecosystem engineer, the beaver, increases species richness at the landscape scale. Oecologia 132:96–101.

Xian, G, C. Homer, and J. Fry. 2009. Updating the 2001 National Land Cover Database land cover classification to 2006 by using Landsat imagery change detection methods. Remote Sensing of Environment 113:1133–1147.

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

APPENDICES to Upper Mississippi River and Great Lakes Region Joint Venture Waterbird Habitat Conservation Strategy – 2018 Revision

Appendix A. Accounts for breeding focal species used for habitat planning in the Upper Mississippi River and Great Lakes Joint Venture (JV) Region. JV focal species represent bird–habitat associations and the groups (guilds) of wetland birds using these common cover types. Habitat objectives generated for focal species were assumed to reflect habitat requirements for all waterbirds occurring in the JV region during the breeding period. Population estimates and objectives in accounts represent individual birds.

Species common name (account primary authors)	Latest revision
Common Loon (Rachael Pierce)	September 2017
American Bittern (Rachael Pierce and Greg Soulliere)	September 2017
Black-crowned Night-Heron (Chris Tonra)	September 2017
Yellow Rail (Anna Sidie-Slettedahl)	September 2017
King Rail (Brian Loges)	September 2017
Sora (Greg Soulliere)	September 2017
Common Tern (Rachael Pierce, Linda Wires, Greg Soulliere)	September 2017
Black Tern (Greg Soulliere)	September 2017

Decision support maps (Mohammed Al-Saffar)

Waterbird distribution during breeding period	September 2017
Predicted density and distribution of suitable habitats for breeding	September 2017

Formula for calculating population growth

$$FP = CP\,(1 + r)^t$$
$$r = \sqrt[t]{FP/CP} - 1$$

FP = Future population (objective)
CP = Current population
r = rate of increase (growth / year)
t = time periods (years)

Population Estimates and Objectives

Breeding population parameters used in focal species accounts were derived from a combination of the Upper Mississippi Valley / Great Lakes Waterbird Conservation Plan (UMVGLWCP; Wires et al. 2010) for species surveyed at regional scales, and a combination of state atlas data, smaller-scale surveys, and expert opinion (Appendix D). Abundance estimates from the UMVGLWCP were provided for each Bird Conservation Region (BCR). When BCR and JV regional boundaries did not align, estimates were downscaled to match the BCR area within the JV boundary. Considering lack of precision in abundance estimates for most waterbird species, population objectives for focal species were kept simple: "maintain" current abundance for species with stable or increasing population trends and "increase by 50%" those species with relatively small populations and or declining trends. Establishing an objective to increase abundance by 50% helps quantify habitat restoration needs while providing partners a measurable population target. When a focal species' regional population estimate is below the JV objective, a "deficit" was calculated and this value is the basis for the habitat restoration objective. Habitat retention objectives reflect the predicted habitat needed to support focal species populations at objective levels (i.e., current population + deficit = abundance objective). Data sources useful in tracking populations are listed and recommendations for improved abundance estimates are also provided.

Explanation for decision support maps

Waterbird distribution during breeding period: Species distribution maps during the breeding period were generated for JV focal species using recent data from four surveys: Great Lakes Colonial Waterbird Survey (2007–2010), Great Lakes Marsh Monitoring Program (Bird Studies Canada, Nature Counts 2005–2016), North American Breeding Bird Survey (BBS, 2007–2016), and eBird (2007–2016). Data from eBird (http://ebird.org/content/ebird/) were assembled by primary breeding and non-breeding months (below) to increase understanding of distribution in the JV region throughout the annual cycle. For each focal species, all applicable survey data were used to generate maps of species occurrence locations during the breeding period. Non-breeding occurrence data were used in the non-breeding portion of the Strategy text.

Focal species	Breeding months[a]	Non-breeding months[b]
Common Loon	6, 7, 8	10, 11, 12, 1, 2, 3, 4
American Bittern	5, 6, 7	9, 10, 11, 12, 1, 2, 3
Black-crowned Night-Heron	6, 7	9, 10, 11, 12, 1, 2, 3
Yellow Rail	6, 7, 8	9, 10, 11, 12, 1, 2, 3, 4
King Rail	5, 6, 7	9, 10, 11, 12, 1, 2, 3
Sora	6, 7	9, 10, 11, 12, 1, 2, 3, 4
Common Tern	6, 7	9, 10, 11, 12, 1, 2, 3, 4
Black Tern	6, 7	9, 10, 11, 12, 1, 2, 3, 4

[a] Recorded occurrence localities (point or route from various surveys) within JV region during these months are assumed to reflect a landscape with suitable breeding habitat.

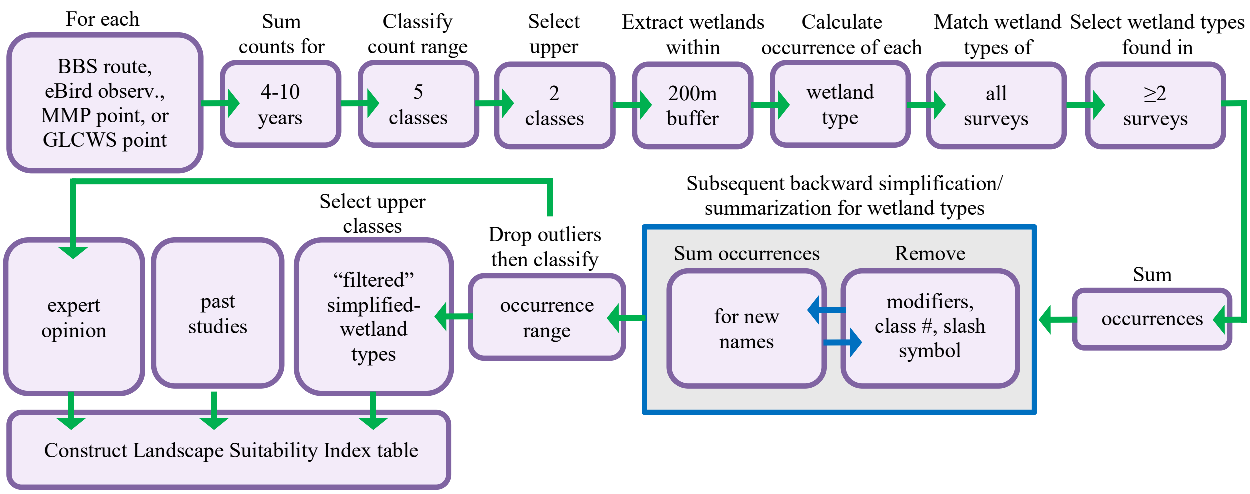
[b] Occurrence localities (eBird only) within JV region during these months are assumed to reflect landscapes with suitable non-breeding habitat.

Predicted density and distribution of suitable habitats for breeding (kernel density models): For each location of a focal species (route, observation, or point), the number of individuals were summed for each survey (i.e., BBS, eBird) for the block of years analyzed. This resulted in a range of counts across all locations and these counts were sorted into five groups (highest number of individuals to lowest) using quantile classification. Locations with the highest counts (i.e. those in the upper 40th percentile) were selected and the wetland attributes within a 200m buffer surrounding these species-specific concentration points were determined. The type and number of wetland polygons around areas of high species occurrence were extracted from the most recent National Wetlands Inventory for each state (downloaded from NWI in 2016). Results of the wetland analysis were compared among the different bird surveys conducted, the attribute types were matched, and extracted wetland attributes were combined into one dataset, excluding attributes that occurred in less than two surveys. A final list of wetland attributes associated with species occurrence was generated and their frequencies from ≥2 surveys were summed.

NWI wetland attributes for each waterbird species were compressed and simplified, typically to the wetland system and class (e.g. Palustrine, Emergent). Quartile classification was then used to exclude outliers (attributes with relatively low frequencies), and then quantile classification was used to group the remaining wetland attributes based on frequency range. A table describing Landscape Suitability Index (LSI) was constructed using the most frequently occurring wetland attributes, knowledge from species-specific literature, and expert opinion. Each LSI table consists of five levels of predicted habitat suitability, with categories based on wetland type, size, and distance to other key habitat components. Attribute categories with high to highest occurrence frequencies (top 2 of 5) were selected for each focal species as the habitat associations most used during the breeding period.

The distribution of predicted suitable habitats for breeding was determined for each species across the entire JV region. Areas surrounding the region were also included in this analysis, resulting in a predicted breeding habitat map for the JV region, a buffer area ≥100 km around the region, and entire states within USFWS Region 3. Data processing required this work area to be divided into 77 parts using a rectangular grid. For each focal species, wetlands with the uppermost suitability (i.e., upper 40th percentile = top two categories in species LSI tables) were extracted from NWI data in sub-basins in which the species was found to be breeding. To identify the breeding distribution, sub-basins (8-digit Hydrologic Units (HUs) located within ≤200 m of species occurrence localities were extracted from the Watershed Boundary Dataset (NRCS, USGS, and EPA 2004). Wetland types in the first (highest) LSI category were assigned a score of 1.0 and wetlands in the second category were assigned a score of 0.8. Extracted habitats from the 77 parts were then merged to produce one dataset consisting of multiple polygons of various sizes, representing predicted highest suitability for breeding across the entire work area. Each polygon was converted to a set of multiple random points encompassed by the polygon boundary and then all points were used in a kernel density analysis. Kernel function was used to produce a generalized surface to each raster cell, smoothly tapered to the end of its surrounding neighborhood, using the number of available points within each cell, their weights (0.8 or 1.0), and ~19 km bandwidth (average inner-radius of median size sub-basins within the work area).

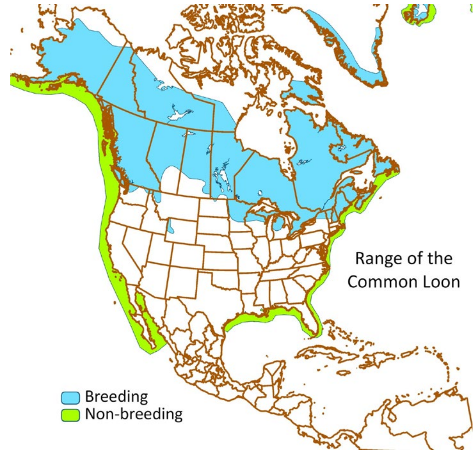
The kernel density analysis produced a smooth 1 km cell-size floating-point raster that depicts the density and distribution of the extracted suitable habitats across the region. Locations with the highest density of suitable habitats were highlighted in the output maps. We assumed these aggregation-delineated "hotspots" with the most potential habitat would support the greatest focal species breeding densities.



Information sources
Species accounts were based on published references (listed), model results from occurrence data, and pooled knowledge of JV Waterbird Committee members. Individual habitat measures and descriptions (e.g., optimal habitat) were not cited. Wetland categories were from the Federal Geographic Data Committee (FGDC 2013, Classification of wetlands and deep-water habitats of the United States (FGDC-STD-004-2013, Second Edition. Wetlands Subcommittee, Federal Geographic Data Committee and U.S. Fish and Wildlife Service, Washington, D.C., USA).

Common Loon *(Gavia immer)*

Joint Venture breeding population objective, estimate, and deficit based on regional abundance surveys	
Breeding abundance objective	Maintain
Population estimate (2010)	41,500
Deficit	0



Range map: BirdLife International
Picture: Cornell Lab of Ornithology

Focal species guild

Common Loon serves as a focal species representing the extensive open-water habitat type (Unconsolidated Bottom and Shore classes in NWI). These areas must have high water clarity, islands for nesting, and must also include some aquatic bed and emergent wetland border. Compared to Common Tern (second open-water focal species), loons are more associated with inland lakes, especially those in the northern portion of the region where human populations are relatively low. Other species in this habitat guild include American White Pelican, Caspian Tern, and non-breeding sea ducks. The Great Lakes region (including areas outside JV boundary) supports more than half of the U.S. Common Loon breeding population and is identified as an important conservation area.

Habitat requirements

Community types: Found in a variety of freshwater systems, but prefers lakes with clear water, an abundance of small fish (10–15 cm), numerous small islands, and an irregular shoreline. Prefers nesting on islands, including muskrat lodges, beaver lodges, and floating bog mats, adjacent to water with a steep drop-off for an underwater approach. Loons typically forage in water <5 m in depth. Migration staging areas must have abundant prey; migrants congregate on large waterbodies, such as the Great Lakes and Mississippi River.
Timing: Spring migration peaks in early May, but breeding can occur anytime between April and June; timing is partially latitude dependent. Loons produce only one brood per season, beginning with two eggs that hatch after 27–28 days of incubation. Young are precocial but dependent on parents until 8 weeks of age.
Area/distance: Loon pair density varies by lake extent and configuration, with pairs typically found on lakes ≥24 ha in size. However pairs have been recorded on lakes as small as 4 ha. Loons generally occupy the nearshore areas of lakes; use of deeper locations depends on forage availability.

Limiting factors

These visual predators require clear water for foraging; turbid lakes with moderate suspended solids (i.e., >28 Nephelometric Turbidity Units) are not used by breeding pairs. Loons are vulnerable to lead, mercury, and other organic pollutants; some years many loons succumb to botulism in the region (e.g., northern Lake Michigan). Loons are also sensitive to even low degrees of human disturbance and shoreline development, and they are slow to colonize new areas. Wave action from recreational boating and other rapid water-level fluctuations can cause nest failure.

Population monitoring

Current survey efforts: Several long-term standardized monitoring programs are focused on loons: 1) Lake Superior State University and Michigan Loon Preservation Association both conduct surveys in Michigan, 2) federal surveys conducted in National Parks and National Wildlife Refuges, 3) Loon Watch in Wisconsin, 4) Minnesota Loon Monitoring Program, and 5) Canadian Lakes Loon Survey in Ontario. Incidental observations of loons are recorded during the decadal Great Lakes Colonial Waterbird Survey along with the annual North American Breeding Bird Survey (BBS), but these surveys provide limited coverage of this species' breeding range. More recently, eBird has provided a means to use abundant birder records, especially for determining migration chronology.

Recommended monitoring: Standardized monitoring should be maintained and expanded in states with abundant loons but with inadequate population indices (e.g., Michigan). Monitoring data should be centralized, perhaps in the Midwest Avian Data Center (a node of the Avian Knowledge Network) or a database developed specifically for the Common Loon. Migration monitoring stations can be created to develop geographic linkages among breeding, migratory and wintering populations.

Research to assist planning

Current and ongoing projects: Unaware of major ongoing research projects in the JV region.

Research needs: Improved understanding of how large-scale mechanisms, such as lake acidification, mercury and lead pollution, algal blooms and related Microcystins, and botulism, affect population vital rates; identification of potential sink populations across the breeding range and develop geographic linkages among breeding, migratory, and wintering populations to improve full life-cycle modeling and planning; development of a web-based data warehouse, such as the Midwest Avian Data Center, to enhance networking within the conservation community.

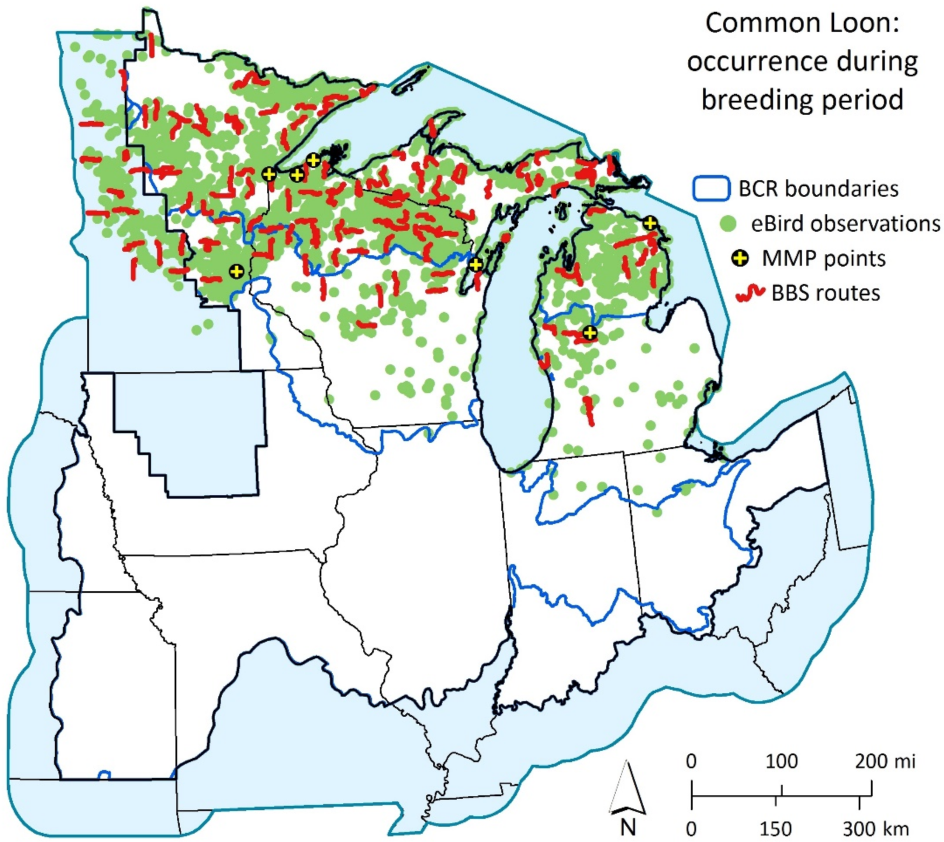
Habitat objectives

The primary conservation focus in the North American Common Loon Conservation Plan, as well as the JV, is to maintain the distribution and density of current breeding populations. Loons will likely benefit from the extensive habitat objectives established for diving ducks and sea ducks in the JV Waterfowl Strategy. However, loon population restoration of historically occupied areas (i.e., locations with growing human populations and related disturbance) may be largely unachievable through habitat actions. A map of potentially suitable habitats can be used to explore population restoration opportunities through passive conservation (e.g., limiting human disturbance, artificial nesting platforms). Only habitat retention objectives were established.

Retention calculation: $Hp = Ob/2 \times C$ $498{,}000 = 41{,}500/2 \times 24$

Hp = breeding habitat area required to sustain population objective (ha)
Ob = regional abundance objective (individual birds; Ob/2 = pair objective)
C = minimum optimal habitat required for each pair (ha)

Optimal breeding habitat (from information above) includes lakes and large-river reservoirs with high water clarity, open water expanses ≥24 ha in size, with irregular shorelines, numerous small islands, abundant fish, and low disturbance. Larger lakes can provide high quality habitat when they contain secluded embayments with limited human disturbance.

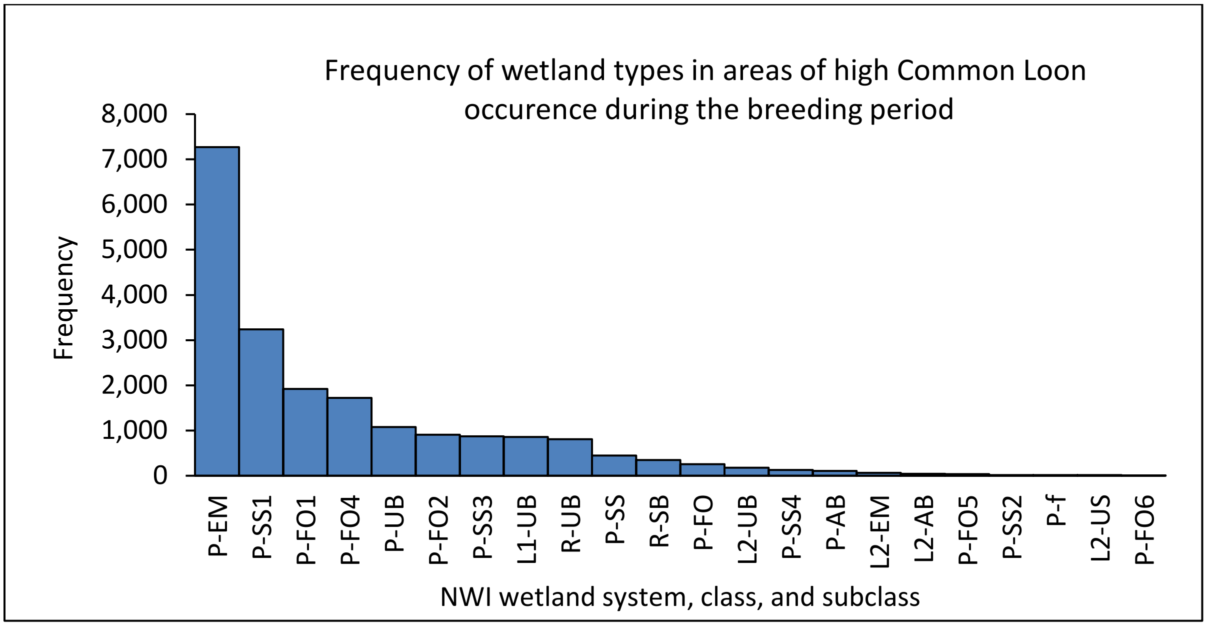


Population distribution

Occurrence across the JV region during the breeding period was determined using data from several sources collected over multiple years during June–August: Breeding Bird Survey (2007–2016), eBird (2007–2016), and Great Lakes Marsh Monitoring Program (2005–2016). *Note:* Individuals observed (eBird) in the south half of the JV region during summer were assumed to be first-year non-breeders and thus observations in BCR 22 were omitted from the map.

Wetland Associations and Landscape Suitability Index (LSI)

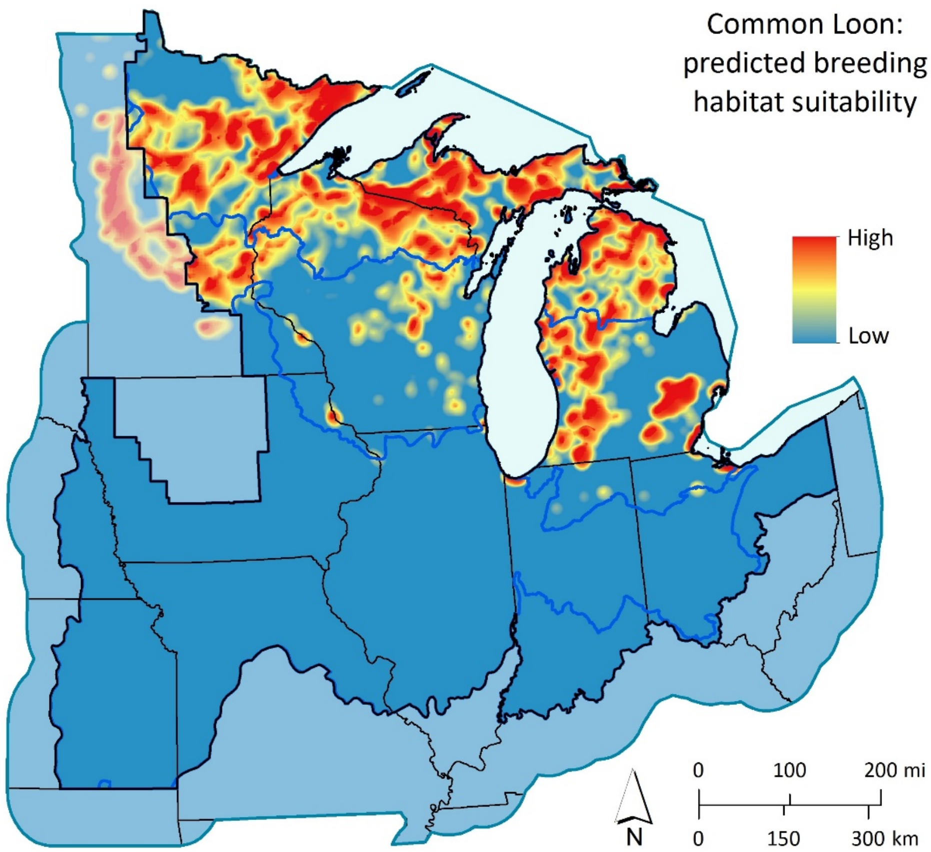
Cover type attributes associated with Common Loons were categorized using NWI spatial data from areas surrounding (≤200 m) occurrence points recorded during the breeding period. Spatial data were considered at the NWI System, Class, Subclass, and Modifier levels but were eventually compressed and simplified to wetland system and class. Habitat suitability for waterbirds relates to key cover types and their juxtaposition. A Landscape Suitability Index (LSI) was established based on results of the NWI analysis for occurrence locations, species-specific habitat literature, and expert opinion. Habitat within the LSI is weighted from 1 (most suitable) to 0.2 (least suitable).



National Wetlands Inventory (NWI 2016) System (P = Palustrine, L = Lacustrine, R = Riverine), Subsystem (1 = Limnetic, 2 = Littoral), and Class (AB = Aquatic Bed, EM = Emergent, FO = Forested, SS = Scrub-Shrub, SB = Streambed, UB = Unconsolidated Bottom, US = Unconsolidated Shore). See Federal Geographic Data Committee (2013) report for subclass classification and special modifiers.

Cover types (NWI classes)	LSI Score
L-UB wetlands, 20–100 ha, and <1 km from P-EM and/or P-SS wetlands, >10 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	Higher
L-UB wetlands, 20–100 ha, and <1 km from P-EM and/or P-SS wetlands, 1–10 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	
L-AB wetlands, 20–100 ha, and <1 km from P-EM and/or P-SS wetlands, >10 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	
L-UB and/or L-AB wetlands, 100–10,000 ha, and <1 km from P-EM and/or P-SS wetlands, within species breeding range.	
Other L-UB and/or L-AB wetlands, 100–10,000 ha, within species breeding range.	Lower

Density and distribution of breeding habitats
Using kernel density analysis, distribution of the most suitable habitats (top two habitat categories in LSI table) for Common Loon was depicted across the JV region and surrounding areas (figure below). Areas with relatively high LSI scores are also predicted to be beneficial for other breeding wetland birds using this habitat type.



Recommendations

Habitat actions: Large-scale land management practices (e.g., agriculture and development) and environmental policy that helps maintain lakes with high water-quality and areas of low human disturbance may have the greatest influence on Common Loon habitat across the species' current range. At the local scale, water level fluctuations and wave action / disturbance should be a management focus. For reservoirs with hydrological flexibility, loon nests are most successful when water levels do not increase more than 15 cm or decrease more than 30 cm during the nesting period. For reservoirs where this is not possible, floating nest platforms are a management tool that can improve nest success. Local boating regulations can limit watercraft speed and restrict access to nesting areas. Alternatively, signage at boat ramps and high-risk territories (floating signs) can be effective in reducing disturbance. Because species habituation to some disturbance is known to occur, site-specific evaluation should be used to determine different management strategies and garner public support for high quality loon habitat.

<u>Monitoring and performance:</u> A combination of BBS, state Breeding Bird Atlases, and other long-term monitoring can be used as abundance indices to measure progress toward meeting the regional objective of a stable population.

References

Evers, D. C. 2007. Status assessment and conservation plan for the Common Loon (Gavia immer) in North America. BRI Report 2007-20. U.S. Fish and Wildlife Service, Hadley, Massachusetts, USA.. BNA 2010

Evers, D. C., J. D. Paruk, J. W. Mcintyre and J. F. Barr. 2010. Common Loon (Gavia immer), The Birds of North America Online, P. G. Rodewald, editor. Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/313 doi:10.2173/bna.313

Ewert, D. N. 1982. Spring migration of loons at Whitefish Point, Michigan. The Jack Pine Warbler 60:135-143.

Gostomski, T. J. and P. W. Rasmussen. 2001. Results of the 2000 Common Loon Survey in Wisconsin. Passenger Pigeon 63(1&2):15-25.

Kenow, K. P., M. W. Meyer, D. C. Evers, D. C. Douglas, and J. Hines. 2002. Use of satellite telemetry to identify Common Loon migration routes, staging areas and wintering range. Waterbirds 25:449-458.

Rudko, A.M. 2010. Using GIS to model Common Loon (*Gavia immer*) habitat. American Society for Photogrammetry and Remote Sensing 2010 Annual Conference. San Diego, California, USA.

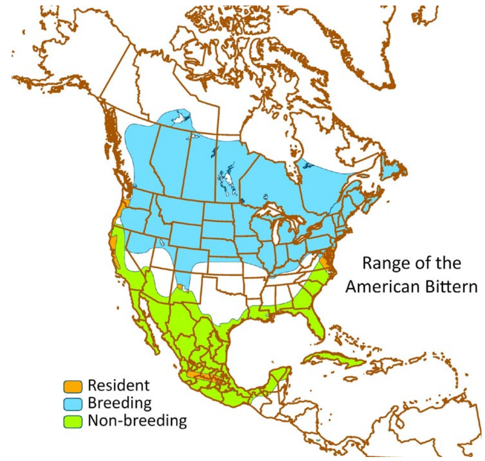
MLMP (Minnesota Loon Monitoring Program). 2002. Results of the Minnesota Loon Monitoring Program (MLMP) 1994-2002. Unpublished Report, Minnesota Division of Ecological Services, Minneapolis, Minnesota, USA.

Vogel. H. 2013. Effects of Lead Fishing Tackle on Loons in New Hampshire, 1989-2011. Report of the Loon Preservation Committee. http://www.loon.org/ingested-lead-tackle.php.

Zimmer, G. E. 1979. The status and distribution of the common loon in Wisconsin. University of Wisconsin.

American Bittern *(Botaurus lentiginosus)*

Joint Venture breeding population objective, estimate, and deficit based on local abundance surveys and expert opinion	
Breeding abundance objective (50% increase)	4,800
Population estimate (2016)	3,200
Deficit	1,600



Range map: BirdLife International
Picture: Cornell Lab of Ornithology

Focal species guild
American Bitterns are most associated with the NWI class *Emergent Wetland*, but these wetlands must include areas of shallow open water. Because sites of high use are typically a mosaic of emergent herbaceous cover and open water, they are often referred to as hemi-marsh. Although American Bittern do not require an upland component, they have been known to nest in adjacent uplands. Other breeding species in this hemi-marsh guild include Common Gallinule, Least Bittern, and several species of breeding and non-breeding dabbling ducks.

Habitat requirements
Community types: Freshwater wetlands with dense, tall emergent persistent vegetation dominated by cattail, bulrush, sedge, smartweed, and bur-reed interspersed with open water and often aquatic bed. Shrub-scrub wetlands are also used when available in mixed shallow open-water settings, especially where amphibians, small fish, and other foods are abundant. Water depth in breeding areas is usually shallow (<20 cm). Species typically nests over water (5–20 cm in depth) but sometimes on upland edges; herbaceous cover 1–2 m tall is most selected, especially cattail/bulrush marsh. Migration routes through the region are unknown, but marshes along major river corridors and Great Lakes coastal zones are likely important to this species. Species may also use upland grasslands during nonbreeding period.
Timing: Nesting begins soon after arrival on breeding areas, ranging from early March to early May depending on latitude. Eggs hatch in late April to early June following 24–28 day incubation period. Young leave nest when 1–2 weeks old, but age at fledging is unknown; species' Eurasian counterpart fledges in 50–55 days. Fall migration occurs between September and November; birds associated with the Great Lakes coast often depart later.
Area / distance: Inhabits emergent wetlands of larger size, commonly >10 ha, especially wetland mosaics of emergent, unconsolidated, and or aquatic bed ≥25 ha and with patchiness and edge. Species is solitary and territorial; abundance is positively correlated with wetland area.

Limiting factors
Population decline has been greatest in central North America, where wetland loss has also been greatest. Wetland degradation has also reduced American Bittern breeding habitat, particularly sedimentation and elevated nutrient levels related to

land management in surrounding uplands. Where expansion of common reed and woody cover into emergent wetland is extensive, habitat quality often has declined.

Population monitoring

Current survey effort: Population trend can be assessed through a combination of multiple surveys: North American Breeding Bird Survey (BBS), Midwest Secretive Marsh Bird Survey, and the Great Lakes Marsh Monitoring Program. State Breeding Bird Atlases also provide distributional information, and local scale research may provide measures of recruitment and habitat use. More recently, eBird has offered a means to help compile distributional information for areas frequented by birders.

Recommended monitoring: Although adequate for trend determination, current surveys have not resulted in precise population estimates. Combining annual marsh-bird survey data among Midwest states may lead to regional model-based breeding population estimates. Coupling these results with information from other survey efforts (BBS and eBird) will help inform conservation decisions.

Research to assist planning

Current and ongoing projects: Research is being conducted to better understand marsh bird use, including American Bitterns, of wetlands with natural and altered hydrology in BCR 12. Another study is comparing marsh bird use of impounded and un-impounded wetlands in the Great Lakes region. In addition, marsh bird monitoring data from primary breeding states in the region will be used to generate model-based population estimates.

Research needs: Species response to habitat restoration and enhancement in both breeding and non-breeding areas would inform management. Likewise, refining population demographic information and developing a life-cycle model will help better target conservation. Understanding compatibility of habitat management for waterfowl and secretive marsh birds is needed at both breeding and migration-stopover locations.

Habitat objectives

Restore and maintain regional carrying capacity to achieve breeding population objective through effective and efficient habitat conservation considerate of other species of concern.

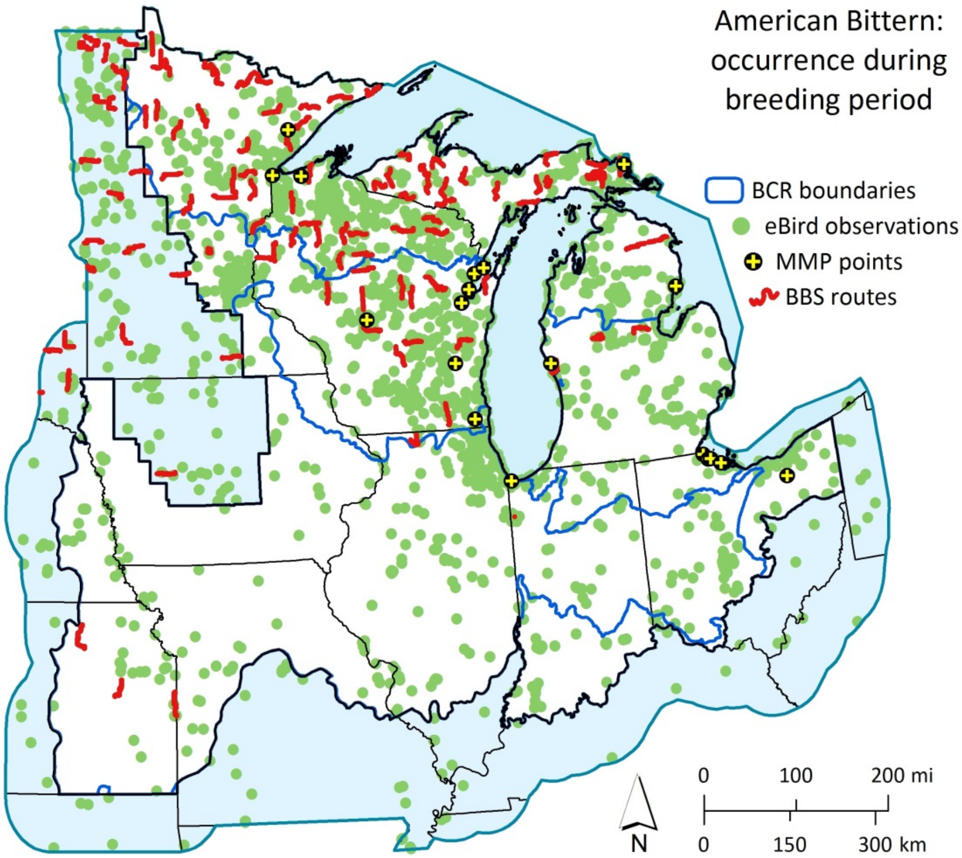
Restoration calculation: $Hr = D/2 \times C$ $20{,}000 = 1{,}600/2 \times 25$

Hr = new breeding habitat area required to eliminate deficit (ha)
D = regional population deficit (individual birds; D/2 = pair deficit)
C = minimum optimal habitat required for each pair (ha)

Retention calculation: $Hp = Ob/2 \times C$ $60{,}000 = 4{,}800/2 \times 25$

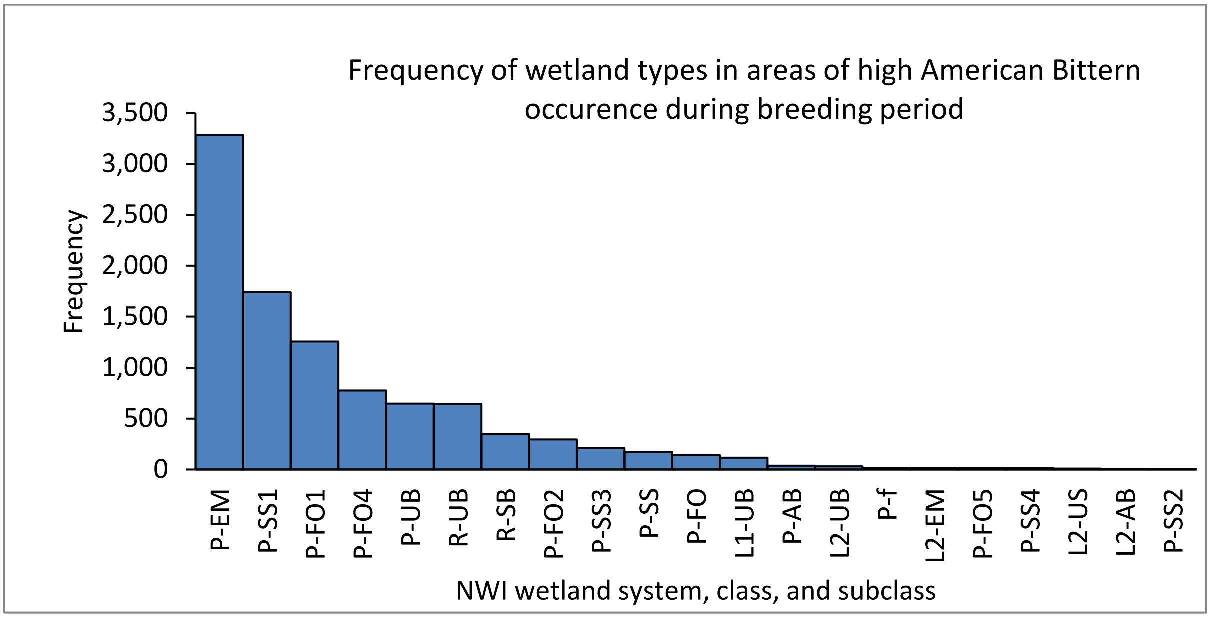
Hp = breeding habitat area required to sustain population objective (ha)
Ob = regional abundance objective (individual birds; Ob/2 = pair objective)
C = minimum optimal habitat required for each pair (ha)

Optimal breeding habitat (from information above) consists of large (≥25 ha) semi-permanent wetland mosaics with emergent herbaceous vegetation and areas of open water and or aquatic bed. Stands of emergent plants are tall (1–2 m), >5 ha in size, with dense patches and vegetation edges, plus with water depth of 10–50 cm.



Population distribution
Occurrence across the JV region during the breeding period was determined using data from several sources collected over multiple years during May–July: Breeding Bird Survey (2007–2016), eBird (2007–2016), and Great Lakes Marsh Monitoring Program (2005–2016).

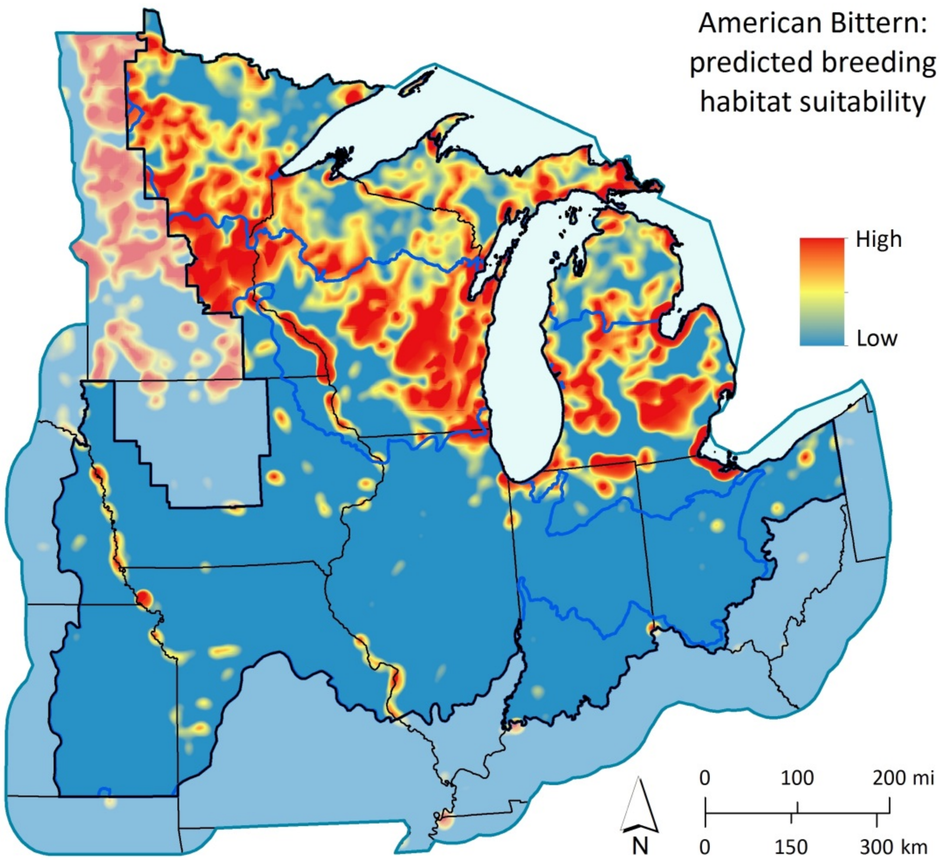
Wetland Associations and Landscape Suitability Index (LSI)
Cover type attributes associated with American Bitterns were categorized using NWI spatial data from areas surrounding (≤200 m) occurrence points recorded during the breeding period. Spatial data were considered at the NWI System, Class, Subclass, and Modifier levels but were eventually compressed and simplified to wetland system and class. Habitat suitability for American Bitterns relates to key cover types and their juxtaposition. A Landscape Suitability Index (LSI) was established based on results of the NWI analysis for occurrence locations, species-specific habitat literature, and expert opinion. Habitat within the LSI is weighted from 1 (most suitable) to 0.2 (least suitable).



National Wetlands Inventory (NWI 2016) System (P = Palustrine, L = Lacustrine, R = Riverine) Subsystem (1 = Limnetic, 2 = Littoral), and Class (AB = Aquatic Bed, EM = Emergent, FO = Forested, SS = Scrub-Shrub, SB = Streambed, UB = Unconsolidated Bottom, US = Unconsolidated Shore). See Federal Geographic Data Committee (2013) report for subclass classification and special modifiers.

Cover types (NWI classes)	LSI Score
PL-EM wetlands, >50 ha, and <1 km from L-UB and/or P-UB and/or R-UB wetlands, >10 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	Higher
PL-EM wetlands, 2–50 ha, and <1 km from L-UB and/or P-UB and/or R-UB wetlands, >10 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	
Other PL-EM and/or P-SS wetlands, >50 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	
Other PL-EM and/or P-SS wetlands, 2–50 ha, within species breeding range.	
PL-EM and/or P-SS wetlands, 2–10 ha, within species breeding range.	Lower

Density and distribution of breeding habitats
Using kernel density analysis, distribution of the most suitable habitats (top two habitat categories in LSI table) for American Bittern were depicted across the JV region and surrounding areas (figure below). Areas with relatively high LSI scores are also predicted to be beneficial for other breeding wetland birds using this habitat type.



Recommendations
Habitat actions: Retain current sites having high population abundance as these locations typically reflect higher habitat quality (high survival and recruitment). However, habitat quality within large wetlands used by this species will vary over time due to environmental conditions. For example, Great Lakes water-level fluctuations will influence the depth, extent, and plant composition of large coastal wetlands. However, varying water regimes over time lead to the interspersion of open water and emergent vegetation, as well as maintain the productivity of the food base.

Restoration is required to add ≥40,000 ha of quality habitat within the current breeding range, and a keen understanding of local wetland ecology will be important when developing restoration/enhancement strategies. Addressing watershed and land use issues to stem run-off of sediments and nutrients into adjacent wetlands is important to maintain wetland health, plant diversity, and reduce the prevalence of invasive species like *Phragmites*. Grassland buffers (up to 200 m) may benefit water quality in adjacent wetlands as well as provide nesting cover. Grassland buffers should be maintained over time by rotational grazing, periodic mowing, or a burning regime that is conscientious of timing in regard to the nesting season.

Restoration of native plants in existing degraded wetlands and reducing the extent of invasive species (e.g., *Phragmites*) may be necessary. Along with addressing land use and watershed issues related to water quality, potential upstream seed sources should also be considered when managing local *Phragmites* infestations to reduce the likelihood of a different invasive becoming established. In some instances, biocontrol methods may be a suitable tool to assist with restoring native plant communities and increasing plant diversity. The estimated area of high quality breeding habitat needed to support populations at JV objective levels is ≥120,000 ha. As JV partners work toward expanding habitat capacity to achieve the population abundance objective, habitat loss for this species must also be considered in the accounting process.

<u>Monitoring and performance:</u> The BBS provides a rudimentary means to monitor long-term population trend of American Bittern at the JV regional scale. Use of the Midwest Secretive Marsh Bird Survey, coupled with local-scale monitoring, may lead to improved trend detection and perhaps an ability to generate model-based population estimates. Meeting the population objective requires a 50% population increase, therefore conservation actions should result in a 50% increase in BBS and or other population indices, and an average annual 3% increase over 15 years.

References

Brown, M., and J. J. Dinsmore. 1986. Implications of marsh size and isolation for marsh bird management. Journal of Wildlife Management 50:392-397.

Glisson, W. J., R. S. Brady, A. T. Paulios, S. K. Jacobi, and D. J. Larkin. 2015. Sensitivity of secretive marsh birds to vegetation condition in natural and restored wetlands in Wisconsin. Journal of Wildlife Management, 79(7), 1101–1116.

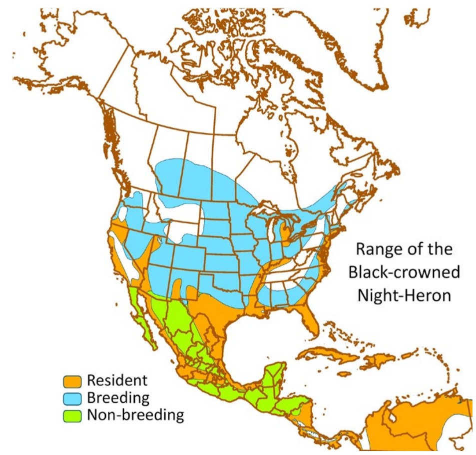
Lowther, P. E., A. F. Poole, J. P. Gibbs, S. M. Melvin and F. A. Reid. 2009. American Bittern (*Botaurus lentiginosus*), The Birds of North America, P. G. Rodewald, editor. Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/amebit DOI: 10.2173/bna.18

Tozer, D. C. 2016. Marsh bird occupancy dynamics, trends, and conservation in the southern Great Lakes basin: 1996 to 2013. Journal of Great Lakes Research 42:136–145.

Wires, L. R., S. J. Lewis, G. J. Soulliere, S. W. Matteson, D. V. “Chip” Weseloh, R. P. Russell, and F. J. Cuthbert. 2010. Upper Mississippi Valley / Great Lakes Waterbird Conservation Plan. A plan associated with the Waterbird Conservation for the Americas Initiative. Final Report submitted to the U.S. Fish and Wildlife Service, Fort Snelling, MN, USA.

Black-crowned Night-Heron *(Nycticorax nycticorax)*

Joint Venture breeding population objective, estimate, and deficit based on regional abundance surveys	
Breeding abundance objective (50% increase)	12,300
Population estimate (2010)	8,200
Deficit	4,100



Range map: BirdLife International
Picture: Cornell Lab of Ornithology

Focal species guild

Black-crowned Night-Heron, like other herons and egrets in this waterbird guild, are colonial breeders that generally require woody cover for nesting and nearby wetland foraging locations. The group is most closely associated with NWI class *Forested Wetland*. However, herons and egrets use a variety of wetland cover types, and wetland types important to the guild vary from north to south in the JV region. Forested wetlands most used by these waterbirds have aquatic bed, emergent, and or scrub-shrub wetland components, and upland deciduous forest is typically part of the landscape complex. Cavity nesting ducks often occur in the same locations, requiring mature deciduous trees near wetlands suitable for brood rearing.

Habitat requirements

Community types: Uses a variety of forested, scrub-shrub, and emergent herbaceous wetlands, but large shallow (<0.5 m deep) herbaceous and open-water marshes with nearby woody cover are preferred. Nests are typically <3 m from ground (sometimes higher) in trees and shrubs, occasionally in dense emergent vegetation. Preferred breeding sites have limited human disturbance, and are often located on islands and large wetland complexes with patches of early- to mid-successional forest. An "opportunistic forager," this species consumes a wide variety of aquatic vertebrates and invertebrates. It feeds largely at shallow weedy pond margins, creeks, and marsh borders. Areas with short (<25 cm tall) and patchy vegetation are frequently used, and it may fly up to 24 km to feeding locations. During migration, species is common along the Mississippi River corridor, using wetlands similar to breeding areas. Recent satellite tracking and Motus automated telemetry tracking indicates the Lake Erie population moves to the Atlantic Flyway and primarily winters in Florida, with smaller numbers in the Carolinas and Cuba.

Timing: Species has a long breeding season: egg-laying occurs from late April to early July; incubation 23–26 days, young leave nest after two weeks and are capable of flight 6–7 weeks after hatching. Species sometimes found overwintering in portions of the JV region, in some cases close to breeding colonies. Migration occurs March–April and September–November.

Area / distance: Nest colonies in the Great Lakes region average 110 pairs with nest spacing between nests averaging ≥1.3 m. Species may be area dependent, more often using wetlands >10 ha in size and favoring wetland complexes >200 ha for nesting and foraging.

Limiting factors

Amount of quality breeding habitat is assumed to be the habitat element most limiting population growth. In particular, loss and degradation of wetland margins due to establishment of invasive plants (*Phragmites* and hybrid cattail) has reduced foraging habitat. In some areas, loss of early successional forest and scrub-shrub near quality foraging areas has resulted in habitat decline. Storms, predation, and human disturbance are key factors reducing nest success. Habitat destruction and competition for nest sites with Double-crested Cormorants has become a problem in western Lake Erie. Climate-change vulnerability assessment suggests that the greatest risk to the migratory portion of the population may be drying trends in winter foraging habitats.

Population monitoring

Current survey effort: This species is recorded during the North American Breeding Bird Survey (BBS), but this survey does not adequately cover important areas within the breeding range. The decadal Great Lakes Colonial Waterbird Survey provides valuable census information, but abundance estimates are only for birds occupying coastal areas. The Great Lakes Marsh Monitoring Program and state Breeding Bird Atlas projects also provide intermittent survey data (recent updates in 2011 for Michigan, 2016 for Ohio, and expected in 2020 for Wisconsin). Distribution and occurrence timing can also be examined via eBird records.

Recommended monitoring: Information about location, size, productivity, and long-term viability of inland (away from Great Lakes) colonies is needed. Surveys of colonies conducted on a more regular basis (e.g., <5 year intervals) would assist assessment of management efforts.

Research to assist planning

Current and ongoing projects:

Ohio State University/Ohio Division of Wildlife (2015-present) are examining post-fledging survival, migratory behavior and connectivity, breeding success, response to cormorant control, and foraging habitat use in western Lake Erie. The Black Swamp Bird Observatory has conducted a long-term banding effort of chicks on West Sister Island, Lake Erie, and the Detroit Zoo has been banding nestlings at a colony on site.

Research needs: Better information on breeding habitat requirements and productivity, such as impact of patch or island size, vegetation species and structure preferences at colonies, landscape context, and effects of predators and human disturbance. Demographic information may be used to develop a life-cycle model. The impact on night-heron colonies resulting from various methods used to control Double-crested Cormorant abundance should be assessed; initial evaluation demonstrated a negative relationship between night-heron colony growth and cormorant control. In addition, this species appears to accumulate eco-toxins, so monitoring may be necessary to assess population-level influence. Examining impacts of algal blooms on Lake Erie populations is needed as well, as this may impact prey species for several large colonies.

Investigation of dependence on anthropogenic food resources (e.g., fishing waste) and potential resulting human-wildlife conflicts may be warranted.

Habitat objectives
Two factors are assumed to be most limiting species population growth: 1) suitable foraging habitat near nesting colonies; and 2) undisturbed colony sites with proper nesting substrate. The total habitat area estimated to meet carrying capacity needs for regional Black-crowned Night-Heron populations was based on average colony size (110 pairs) and predicted forage area requirements (minimum 200 ha of shallow wetland and shorelines / colony).

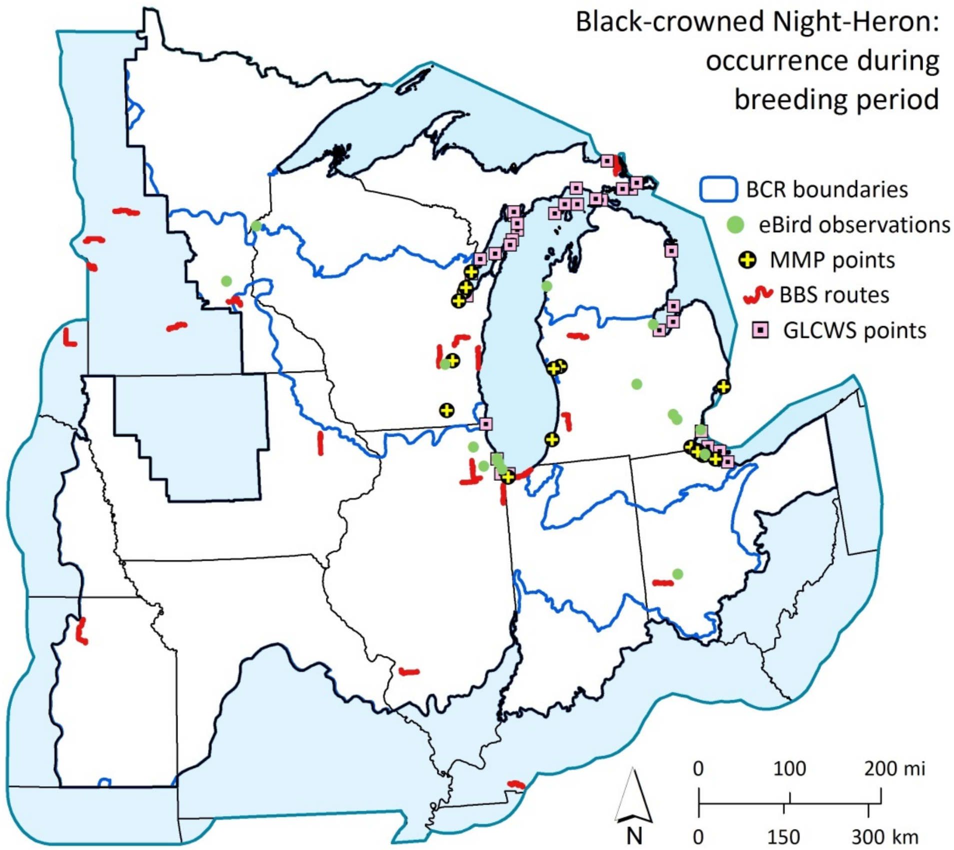
<u>Restoration Calculation:</u> $Hr = D/C \times T$ 3,800 ha = 4,100/220 × 200 (for 19 colonies)

Hr = new breeding habitat area required to eliminate deficit (ha)
D = regional population deficit (birds)
C = average colony population size (110 pairs, 220 individuals)
T = colony territory (ha)

<u>Retention calculation:</u> $Hp = Ob/C \times T$ 11,200 ha = 12,300/220 × 200 (for 56 colonies)

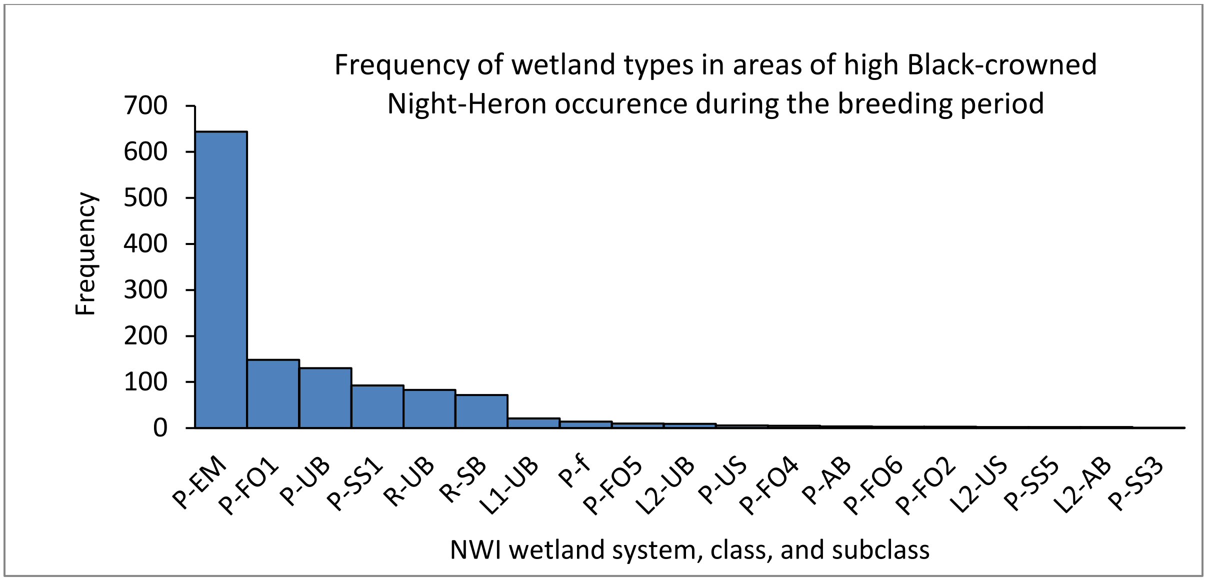
Hp = breeding habitat area required to support population objective (ha)
Ob = regional abundance objective (individual birds; Ob/2 = pair objective)
C = average colony population size (110 pairs, 220 individuals)
T = colony territory (ha)

Optimal habitat (from information above) consists of patchy young growth forest or other dense woody nest cover in close (<1 km) proximity to large (>200 ha) diverse complexes of shallow emergent and or scrub-shrub wetland with open shallow margins, abundant food, and relatively little disturbance.



Population distribution
Occurrence across the JV region during the breeding period was determined using data from several sources collected over multiple years during the months June and July: Breeding Bird Survey (2007–2016), eBird (2007–2016), Great Lakes Marsh Monitoring Program (2005–2016), and the Great Lakes Colonial Waterbird Survey (2007–2010).

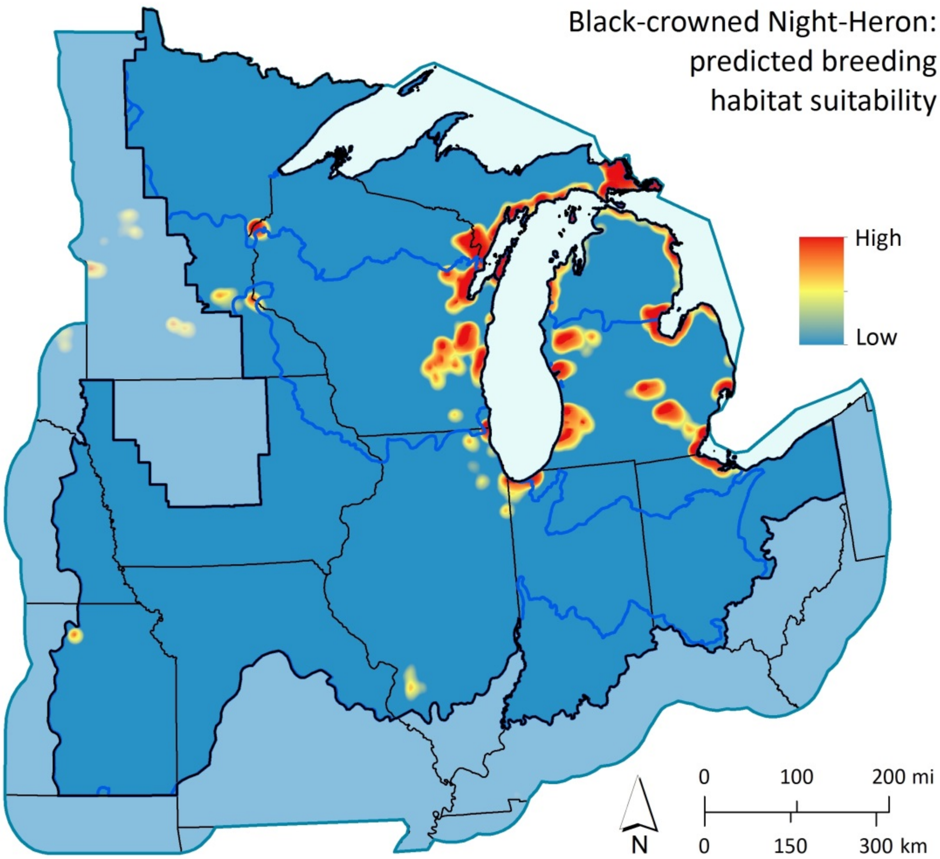
Wetland Associations and Landscape Suitability Index (LSI)
Cover type attributes associated with Black-crowned Night-Herons were categorized using NWI spatial data from areas surrounding (≤200 m) occurrence points recorded during the breeding period. Spatial data were considered at the NWI System, Class, Subclass, and Modifier levels but were eventually compressed and simplified to wetland system and class. Habitat suitability for waterbirds relates to key cover types and their juxtaposition. A Landscape Suitability Index (LSI) was established based on results of the NWI analysis for occurrence locations, species-specific habitat literature, and expert opinion. Habitat within the LSI is weighted from 1 (most suitable) to 0.2 (least suitable).



National Wetlands Inventory (NWI 2016) System (P = Palustrine, L = Lacustrine, R = Riverine) Subsystem (1 = Limnetic, 2 = Littoral), and Class (AB = Aquatic Bed, EM = Emergent, FO = Forested, SS = Scrub-Shrub, SB = Streambed, UB = Unconsolidated Bottom, US = Unconsolidated Shore). See Federal Geographic Data Committee (2013) report for subclass classification and special modifiers.

Cover types (NWI classes)	LSI Score
P-EM and/or P-US wetlands, >10 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	Higher
P-SS and/or P-FO wetlands, >10 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	
P-EM and/or P-US and/or P-SS and/or P-FO wetlands, 5–10 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	
Other P-EM and/or P-US and/or P-SS wetlands, >10 ha, within species breeding range.	
Other P-EM and/or P-US and/or P-SS wetlands, 5–10 ha, within species breeding range.	Lower

Density and distribution of breeding habitats
Wetlands with predicted highest suitability for breeding (top two habitat categories in the LSI table) and within areas known to have breeding colonies of Black-crown Night-Herons (see breeding occurrence map) were extracted from the NWI. Using kernel density analysis, distribution of the most suitable habitats for Black-crowned Night-Heron were depicted across the JV region and surrounding areas (figure below). Areas with relatively high LSI scores are also predicted to be beneficial for other breeding wetland birds using this habitat type.



Recommendations
Habitat actions: Our understanding of Black-crowned Night-Heron ecology continues to evolve and the success of habitat actions to retain and restore nest colonies is unpredictable. In most areas with a history of breeding night-herons, provision of quality foraging habitat (i.e., shallow zones with abundant and diverse foods) should be emphasized. In other areas, where forage is ample and accessible, the need for improved nesting habitat with low human disturbance may be most important. An estimated area of ≥3,800 ha of foraging habitat proximate to suitable nesting cover will be required to support an additional 19 breeding colonies of average size. Considerations to restore, enhance, or create habitat for nesting colonies where more intensive management is an option: 1) manage trees and shrubs (during non-breeding season) to ensure optimal vegetation structure for nesting in close proximity to

forage – forest cuttings of about 1 ha at West Sister Island (Lake Erie) supported 300–400 breeding pairs within a few years; 2) design dredge-spoil or other created islands to assure site is suitable for a nest colony, and 3) assess whether other avian competitors are displacing Black-crowned Night-Herons. Restoration efforts that focus on providing native-plant emergent marsh and scrub-shrub wetland should increase habitat value to guild species beyond night-herons. Habitat quality at individual wetlands will vary over time due to annual environmental variation, and larger complexes of diverse wetlands can better support populations under these conditions. The total estimated area of quality breeding habitat needed to support populations at JV objective levels is ≥11,200 ha. As JV partners work toward expanding habitat capacity to achieve the population abundance objective, habitat loss for this species must also be considered in the accounting process.
Monitoring and performance: The Great Lakes Colonial Waterbird Survey (every 10+ years) coupled with the BBS can provide a rough trend indicator of population growth. More frequent coastal surveys and surveys of inland sites would better measure population change and habitat management performance. Eliminating the population deficit requires a 50% increase or an average of 3% annually over a 15 year period.

References

Brown, M., and J. J. Dinsmore. 1986. Implications of marsh size and isolation for marsh bird management. Journal of Wildlife Management 50:392-397.

Cuthbert, F. J., and L. Wires. 2013. The fourth decadal U.S. Great Lakes Colonial Waterbird Survey (2007–2010): results and recommendations to improve the scientific basis for conservation and management. Final Report to U.S. Fish and Wildlife Service, Bloomington, Minnesota, USA.

Hothem, R. L., B. E. Brussee, and W. E. Davis, Jr. 2010. Black-crowned Night-Heron (*Nycticorax nycticorax*), The Birds of North America, P. G. Rodewald, editor. Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/bcnher DOI: 10.2173/bna.74

Levengood, J. M., L. Wiedenmann, T. W. Custer, D. J. Schaeffer, C. W. Matson, M. J. Melancon, D. J. Hoffman, J. W. Scott, J. L. Talbott, G. O. Bordson, and J. W. Bickham. 2007. Contaminant exposure and biomarker response in embryos of black-crowned night-herons (Nycticorax nycticorax) nesting near Lake Calumet, Illinois." Journal of Great Lakes Research 33: 791–805.

Marra, P. P., L. A. Culp, A. L. Scarpignato, and E. B. Cohen. 2014. Full annual cycle climate change vulnerability assessment for migratory birds of the Upper Midwest and Great Lakes region (final report to the Upper Midwest and Great lakes Landscape Conservation Cooperative). The Smithsonian Conservation Biology Institute, Migratory Bird Center, Washington, D.C. [online] URL: www.migratoryconnectivityproject.org/climate-change-vulnerability.

Monfils, M. J. 2004. Special animal abstract for *Nycticorax nycticorax* (Black-crowned Night-Heron). Michigan Natural Features Inventory, Lansing, Michigan, USA.

Scharf, W.C. 1991. Species account for Black-crowned Night-Heron (*Nycticorax nycticorax*). Pages 116–117 *in* R. Brewer, G. A. McPeek, and R. J. Adams, Jr., editors. The Atlas of Breeding Birds in Michigan. Michigan State University Press, East Lansing, USA.

Scharf, W. C., G. W. Shugart, and M. L. Chamberlain. 1978. Colonial birds nesting on man-made and natural sites in the U.S. Great Lakes. Report TR-D-78-10, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, USA. 140pp.

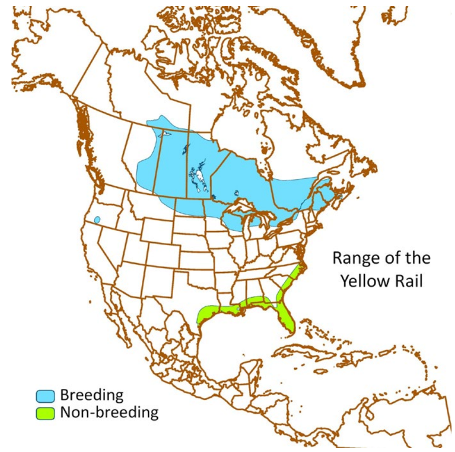
Scharf, W. C. and G. W. Shugart. 1998. Distribution and abundance of gull, tern, and cormorant nesting colonies of the U.S. Great Lakes, 1989 and 1990 (W. W. Bowerman and A. S. Roe, Eds.). Publication No. 1, Gale Gleason Environmental Institute, Lake Superior State University Press, Sault Ste. Marie, MI, USA. 44pp.

Shieldcastle, M. C. and L. Martin. 1999. Colonial waterbird nesting on West Sister Island National Wildlife Refuge and the arrival of Double-crested Cormorants. USDA Animal and Plant Health Inspection Service Technical Bulletin No. 1879:115.

Wires, L.R., S.J. Lewis, G.J. Soulliere, S.W. Matteson, D.V. “Chip” Weseloh, R.P. Russell, and F.J. Cuthbert. 2010. Upper Mississippi Valley / Great Lakes Waterbird Conservation Plan. A plan associated with the Waterbird Conservation for the Americas Initiative. Final Report submitted to the U.S. Fish and Wildlife Service, Fort Snelling, Minnesota, USA.

Yellow Rail *(Coturnicops noveboracensis)*

Joint Venture breeding population objective, estimate, and deficit based on local abundance surveys and expert opinion	
Breeding abundance objective (50% increase)	1,650
Population estimate (2016)	1,100
Deficit	550



Range map: BirdLife International
Picture: Cornell Lab of Ornithology

Focal species guild

Yellow Rail, together with King Rail and Sora, were the focal species selected to represent birds dependent on NWI class *Emergent Wetland* near shallow open water and grassland/herbaceous uplands. Yellow Rail characterizes species breeding in northern portions of the region and it is considered a habitat specialist, choosing shallow saturated wetlands dominated by sedge. Other northern breeding species associated with this guild include Sandhill Crane, Whooping Crane, and Virginia Rail.

Habitat requirements

Community types: Large, non-forested wet meadows dominated by sedge or fine-stemmed grasses and rushes < 1 m tall, with a layer of senescent vegetation and soils that remain flooded to saturated through the brood-rearing period. Species also may inhabit wet hay fields and grassy meadows near emergent wetlands. Rarely found in wetlands dominated by cattail. Typical wetland water depth at nest sites is <15 cm; water depth at locations with calling males also normally <15 cm, but as deep as 46 cm. Quality of breeding habitat diminishes with woody vegetation encroachment. Migration habitat has not been well studied, but species is known to use wet meadow and grassland, suggesting tolerance for greater habitat diversity during the non-breeding period.

Timing: Arrives at breeding locations late April to early May; egg laying early June to mid-July, incubation is 16-18 days, and young fledge at 35 days. Southbound migration from JV region begins in September.

Area / distance: Species presence positively related to amount of large (>20 ha) marshes and fens on the landscape. Breeding male territories are 6–10 ha in size, sometimes overlapping.

Limiting factors

Populations appear most limited by breeding habitat degradation, primarily change in vegetation structure due to loss of natural disturbance regimes (e.g., fire suppression resulting in conversion to scrub-shrub). Conversion in plant composition may result from long-term drought. Human manipulation of wetland hydrology for agricultural purposes has also reduced habitat quality in some areas.

Population monitoring
Current survey effort: Species is a primary target for the Midwest Secretive Marsh Bird Survey in northern Wisconsin, Michigan, and Minnesota; however, this effort uses morning/evening surveys resulting in few Yellow Rail detections. State Breeding Bird Atlas projects in Wisconsin and Michigan, the County Biological Survey in Minnesota, and eBird provide intermittent records of occurrence.
Recommended monitoring: Yellow Rail detection is highest in the middle of the night, so special night surveys better document occurrence. Automated recorders are useful for detecting calling males in remote areas. An expanded and refined monitoring effort could help identify key breeding areas and improve density estimates to inform regional habitat models.

Research to assist planning
Current and ongoing projects: Ongoing projects to help understand Yellow Rails include assessment of population density and breeding habitat characteristics at Seney NWR, marsh bird response to hydrologic alteration and restoration of wetlands in the Boreal Hardwood Transition (BCR 12), and using multiple stable isotopes to investigate migratory connectivity.
Research needs: Understanding characteristics of quality breeding habitat would help assess management compatibility with other wetland species using common habitats, and identification of migration habitat and chronology is needed along with population-level effects of communication tower strikes during migration.

Habitat objectives
Restore and maintain regional carrying capacity to achieve breeding population objective through effective and efficient habitat conservation considerate of other species of concern.

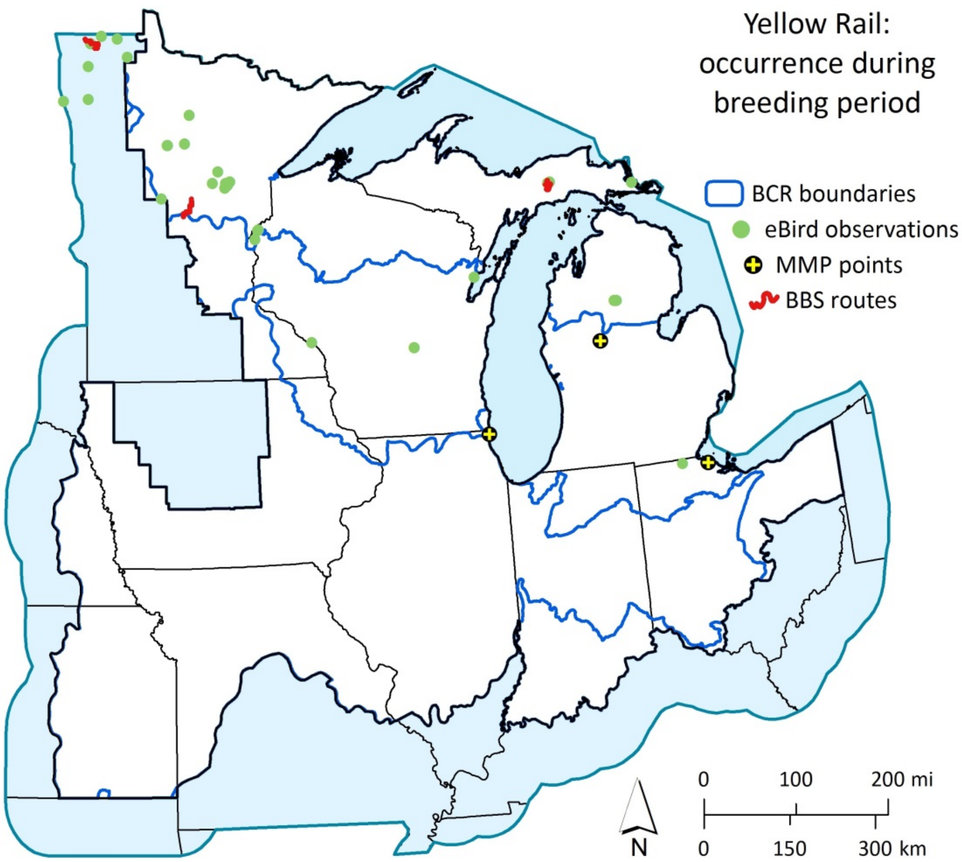
Restoration calculation: $Hr = D/2 \times C$ $5{,}500 = 550/2 \times 20$

Hr = new breeding habitat area required to eliminate deficit (ha)
D = regional population deficit (individual birds; D/2 = pair deficit)
C = minimum optimal habitat required for each pair (ha)

Retention calculation: $Hp = Ob/2 \times C$ $16{,}500 = 1{,}650/2 \times 20$

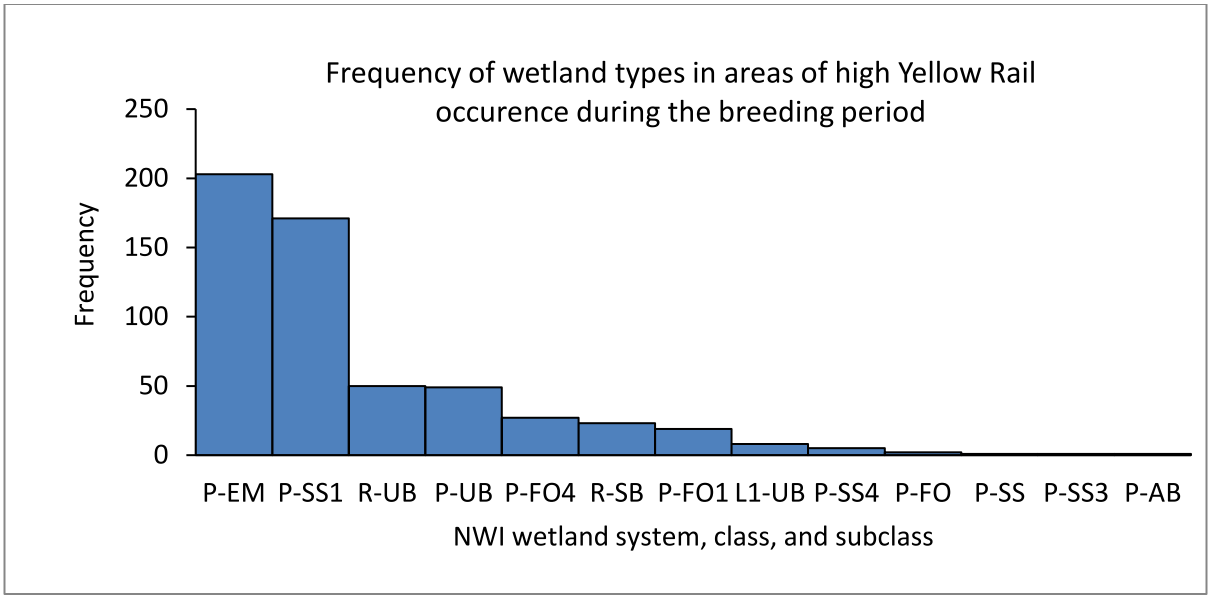
Hp = breeding habitat area required to sustain population objective (ha)
Ob = regional abundance objective (individual birds; Ob/2 = pair objective)
C = minimum optimal habitat required for each pair (ha)

Optimal breeding habitat (from information above) is extensive (>20 ha) emergent herbaceous wetland dominated by sedges and rushes <1 m tall, with saturated soil and or shallow (<15 cm) water depth, and located in areas where fire is an acceptable management practice. Larger wetland complexes can support multiple breeding pairs.



Population distribution
Occurrence across the JV region during the breeding period was determined using data from several sources collected over multiple years during the months June–August: Breeding Bird Survey (2007–2016), eBird (2007–2016), and Great Lakes Marsh Monitoring Program (2005–2016).

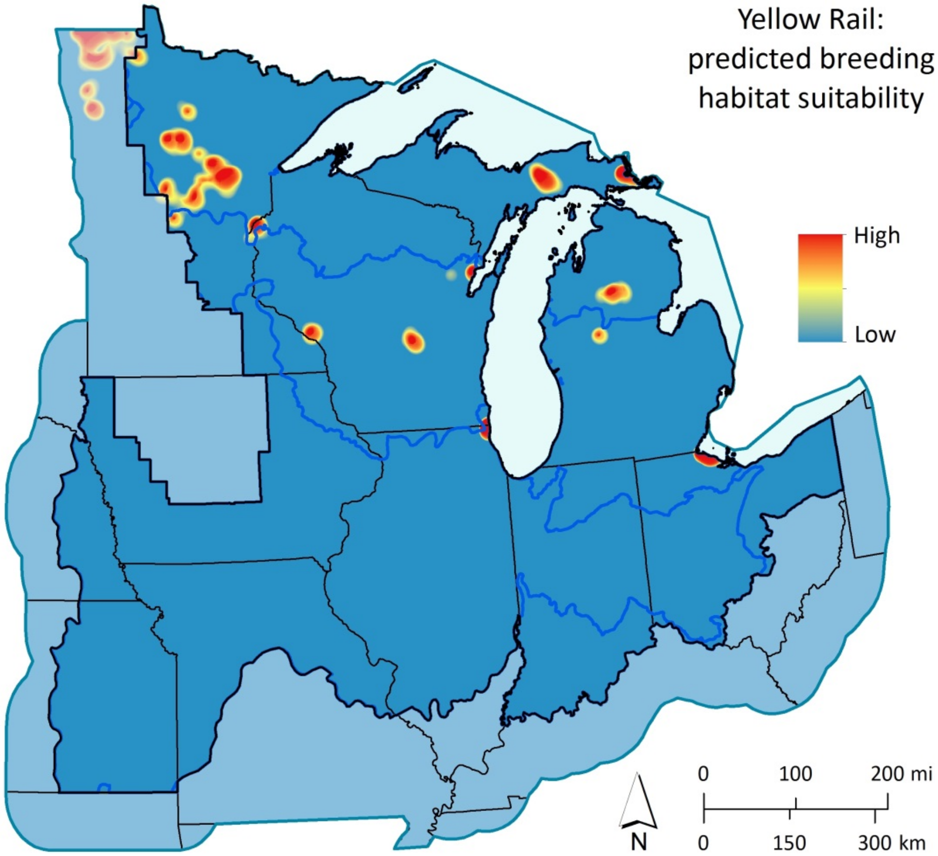
Wetland Associations and Landscape Suitability Index (LSI)
Cover type attributes associated with Yellow Rails were categorized using NWI spatial data from areas surrounding (≤200 m) occurrence points recorded during the breeding period. Spatial data were considered at the NWI System, Class, Subclass, and Modifier levels but were eventually compressed and simplified to wetland system and class. Habitat suitability for waterbirds relates to key cover types and their juxtaposition. A Landscape Suitability Index (LSI) was established based on results of the NWI analysis for occurrence locations, species-specific habitat literature, and expert opinion. Habitat within the LSI is weighted from 1 (most suitable) to 0.2 (least suitable).



National Wetlands Inventory (NWI 2016) System (P = Palustrine, L = Lacustrine, R = Riverine) Subsystem (1 = Limnetic, 2 = Littoral), and Class (AB = Aquatic Bed, EM = Emergent, FO = Forested, SS = Scrub-Shrub, SB = Streambed, UB = Unconsolidated Bottom, US = Unconsolidated Shore). See Federal Geographic Data Committee (2013) report for subclass classification and special modifiers.

Cover types (NWI and NLCD classes)	LSI Score
P-EM wetlands, >20 ha, and <1 km from PR-UB, >1 ha, and >1 km from forest and/or development, within sub-basins (8-digit HU) with recent breeding occurrence.	Higher
Other P-EM wetlands, >20 ha, and >1 km from forest and/or development, within sub-basins (8-digit HU) with recent breeding occurrence.	
P-EM wetlands, 5–20 ha, and >1 km from forest and/or development, within sub-basins (8-digit HU) with recent breeding occurrence.	
Other P-EM and/or P-SS wetlands, >20 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	
Other P-EM and/or P-SS wetlands, 5-20 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	Lower

Density and distribution of breeding habitats
Wetlands with predicted highest suitability for breeding (top two habitat categories in LSI table) were extracted from the NWI. Using kernel density analysis, distribution of the most suitable habitats for Yellow Rail was depicted across the JV region and surrounding areas (figure below). Areas with relatively high LSI scores are also predicted to be beneficial for other breeding wetland birds using this habitat type.



Recommendations

Habitat actions: Retain current habitat within sites having greatest population abundance, as this metric typically reflects higher habitat quality (high survival and recruitment). Restoration and enhancement will be required to add ≥5,500 ha of high quality habitat within the current breeding range, particularly in locations with recent breeding-period detections. Restoration and or enhancement should include restoring hydrology to ensure saturated soils and shallow wetlands through the brood-rearing period, removal of woody vegetation, and control of invasive herbaceous species. These processes should occur in combination with fire, and focus on areas previously occupied by this species. Restored wetlands in breeding areas often do not result in quality habitat for Yellow Rails due to 1) inappropriate basin topography and water depths for foraging, and 2) lack of persistent stands of sedge and fine-stemmed grasses. Ongoing management of existing and restored habitats might include disturbance, such as prescribed fire every 2–5 years, to maintain required characteristics. Shallow flooding of fine-leaved emergent vegetation in spring can benefit a wide range of species, including foraging and nesting ducks, but later in the year the conditions preferred by Yellow Rails would not support duck broods. Hence, the timing, location, and amount of flooding in managed areas will result in trade-offs among wetland species. Naturally fluctuating wetlands are most desirable and typically allow for burning in dry years and breeding habitat in wet years. The estimated area of quality breeding habitat needed to

support populations at JV objective levels is ≥16,500 ha. As JV partners work toward expanding habitat capacity to achieve the population abundance objective, habitat loss for this species must also be considered in the accounting process.
Monitoring and performance: Yellow Rail is not adequately monitored to generate population estimates in the region, but targeted surveys could improve understanding of distribution and outcomes of conservation actions at local scales. This information, coupled with data from the Midwest Secretive Marsh Bird Survey, could lead to a more meaningful estimate of population trend. Eliminating the current population deficit requires a 50% population increase or an average of 3% annually over a 15–year period.

References

Austin, J. E., and D. A. Buhl. 2013. Relating Yellow Rail (*Coturnicops noveboracensis*) occupancy to habitat and landscape features in the context of fire. Waterbirds, 36(2):199–213.

Bookhout T. A., and J. R. Stenzel. 1987. Habitat and movements of breeding yellow rails. Wilson Bulletin, 99:441–447.

COSEWIC. 2009. COSEWIC assessment and status report on the Yellow Rail *Coturnicops noveboracensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 32 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

Goldade, C. M., J. A. Dechant, D. H. Johnson, A. L. Zimmerman, B. E. Jamison, J. O. Church, and B. R. Euliss. 2002. Effects of management practices on wetland birds: Yellow Rail. Northern Prairie Wildlife Research Center, Jamestown, North Dakota, USA. Northern Prairie Wildlife Research Center Online. http://www.npwrc.usgs.gov/resource/literatr/wetbird/yera/yera.htm (Version 12DEC2003).

Gough, G. A., J. R. Sauer, and M. Iliff. *Patuxent Bird Identification Infocenter.* 1998. Version 97.1. Patuxent Wildlife Research Center, Laurel, Maryland, USA. http://www.mbr-pwrc.usgs.gov/id/framlst/infocenter.html

Leston, L., and T. A. Bookhout. 2015. Yellow Rail (*Coturnicops noveboracensis*), The Birds of North America Online, A. Poole, editor. Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/139 doi:10.2173/bna.139

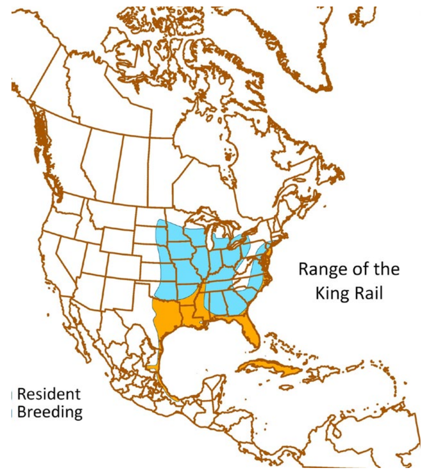
Martin, K. A. 2012. Habitat suitability of the Yellow Rail in south-central Manitoba. Thesis, University of Manitoba, Winnipeg, Canada.

Sidie-Slettedahl, A. M. 2013. Evaluating the use of autonomous recording units to monitor yellow rails, Nelson's sparrows, and Le Conte's sparrows. Thesis, South Dakota State University, Brookings, USA.

Robert, M., B. Jobin, F. Shaffer, L. Robillard, and B. Gagnon. 2004. Yellow rail distribution and numbers in Southern James Bay, Québec, Canada. Waterbirds 27:282–288.

King Rail *(Rallus elegans)*

Joint Venture breeding population objective, estimate, and deficit based on local abundance surveys and expert opinion	
Breeding abundance objective (50% increase)	450
Population estimate (2016)	300
Deficit	150



Range map: BirdLife International
Picture: Cornell Lab of Ornithology

Focal species guild
King Rail, along with Yellow Rail and Sora, was chosen to represent breeding waterbirds using the NWI class *Emergent Wetland* with open water and grassland/herbaceous upland. King Rail breed primarily in southern and central portions of the JV region compared to the northern breeding Yellow Rail. Virginia Rail and Sandhill Crane are guild associates commonly found breeding in King Rail habitat where breeding ranges overlap.

Habitat requirements
<u>Community types:</u> Shallow semi-permanent and seasonally flooded emergent herbaceous wetlands and grasslands interspersed with areas of open water (unconsolidated bottom and aquatic bed). Requires diverse emergent vegetation 0.5–1.5 m tall (mostly <1 m tall) and prefers water depths 10–30 cm for nesting and foraging and <15 cm deep for brood rearing. Breeding locations have low woody cover and high vegetation-water interspersion, typically with varied micro-topography, hydrology and elevation conditions (i.e., geologic history), and related high plant heterogeneity. Site diversity may also result from water-level fluctuation at riverine and Great Lakes coastal wetlands, drawdown and partial re-flooding of moist-soil management units, soil disturbance (e.g., moist soil management regimes), or other events that setback plant community succession. Site diversity typically results in a variety of forage, but crayfish are the most important single food.
<u>Timing:</u> Arrives as early as March, nest initiation mid-May through June, but can be earlier during mild springs. Nesting may extend into August with the potential for double brooding in southern parts of the JV region. Egg incubation is 21–23 days and young fledge at 10 weeks.

<u>Area / distance:</u> Breeding densities variable; does not appear to be area sensitive, but most detections in the region occur in large wetland complexes. Species may be edge intolerant where herbaceous vegetation transitions into woody. Nests located within interiors of marshes and moist-soil management units have had higher success than those on edges. Larger wetlands generally have greater diversity and typically less edge/unit area; wetlands >20 ha are assumed to be of greater value during the breeding period.

Limiting Factors

Nest success and brood survival appear low in highly altered (water regimes) and fragmented wetlands across the southern portion of the region. Availability of diverse, shallow herbaceous native-plant wetlands and meadow suitable for nesting and brood-rearing is assumed the most limiting factor to population growth.

Population monitoring

Current survey effort: Several states (WI, MI, OH, and MO) in the region are participating in the Midwest Secretive Marsh Bird Survey, although detection locations are limited for this rare species. The Great Lakes Marsh Monitoring Program and eBird have offered a means to determine population distribution in areas lacking dedicated surveys. State Breeding Bird Atlases and local-scale research also provide distributional information.

Recommended monitoring: Current surveys have not resulted in precise population estimates. Expanding the Midwest Secretive Marsh Bird Survey, perhaps with a focus on past King Rail breeding areas, may provide a means to generate regional model-based breeding population estimates. Information from the Midwest Secretive Marsh Bird Survey and other studies in the region could inform the methodology, sample design, and survey effort needed to assess King Rail population size and trends. King Rail data should be contributed to conservation planners and managers via the Midwest Avian Data Center.

Research to assist planning

Current and ongoing projects: Research is currently being conducted to better understand King Rail habitat use and response to call-back survey techniques in Ohio. Ongoing satellite-based telemetry will continue to inform migration timing and use of stop-over areas. Ongoing projects should lead to a better understanding of species' distribution and selected habitats, potentially useful in generating a model-based regional population estimate.

Research needs: Validation efforts for recently developed LSI models should be revisited as detections from research and monitoring increase. Information is limited regarding migration paths, habitat use, duration of stay at stopover locations, and non-breeding period survival. Demographic information is needed to develop a life-cycle model and test the assumption that breeding habitat most limits population growth.

Habitat objectives

Restore and maintain regional carrying capacity to achieve breeding population objective through effective and efficient habitat conservation considerate of other species of concern.

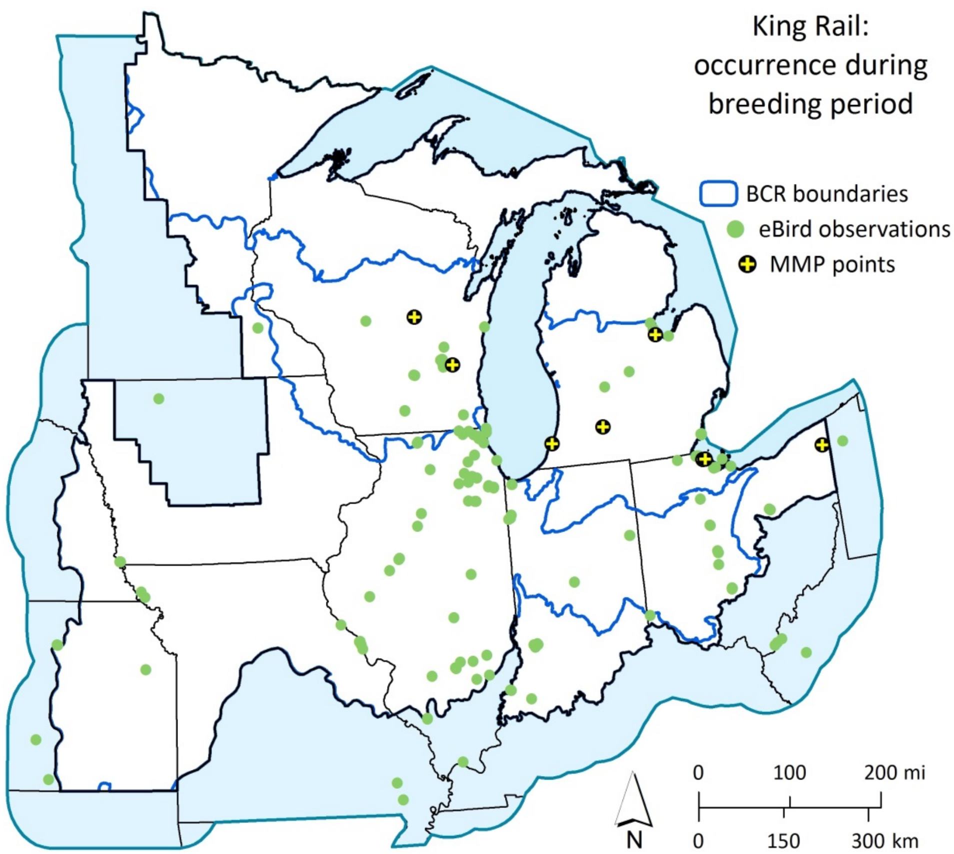
Restoration calculation: $Hr = D/2 \times C$ $1{,}500 = 150/2 \times 20$

Hr = new breeding habitat area required to eliminate deficit (ha)
D = regional population deficit (individual birds; D/2 = pair deficit)
C = minimum optimal habitat required for each pair (ha)

Retention calculation: $Hp = Ob/2 \times C$ $4{,}500 = 450/2 \times 20$

Hp = breeding habitat area required to sustain population objective (ha)
Ob = regional abundance objective (individual birds; Ob/2 = pair objective)
C = minimum optimal habitat required for each pair (ha)

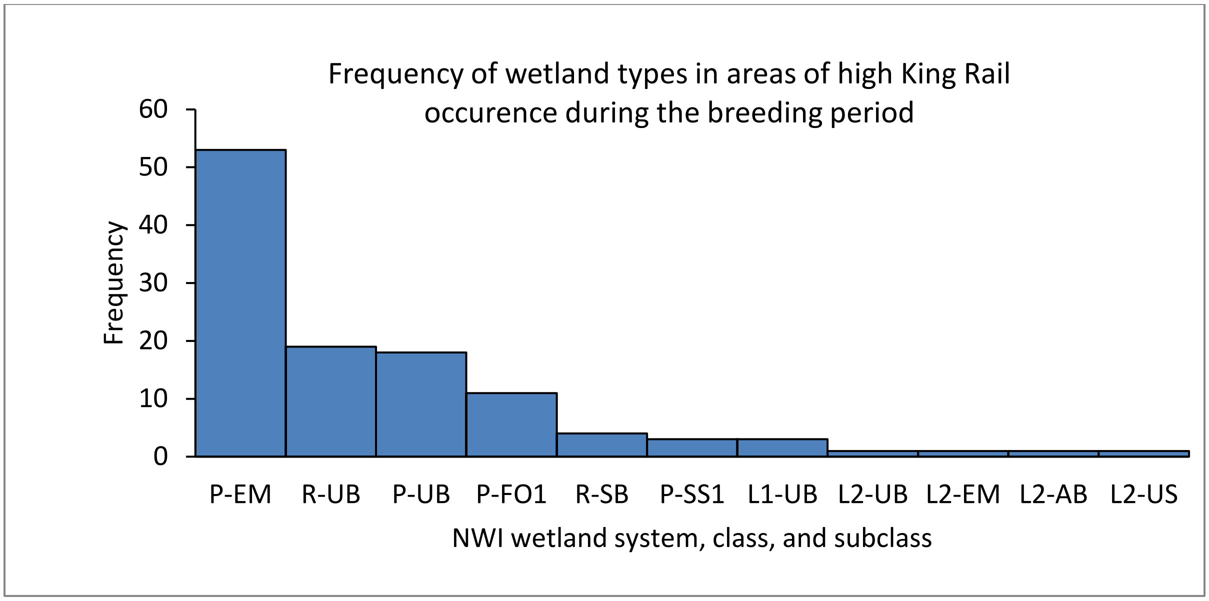
Optimal breeding habitat (from information above) includes seasonal and semi-permanent wetlands with high interspersion of shallow open water (<30 cm deep) and emergent herbaceous vegetation of various heights (mostly <1 m tall). Sites should include at least 4 ha of herbaceous emergent wetland mixed with areas of open water, but larger (>20 ha) wetland complexes can help assure required habitat diversity and potentially support multiple breeding pairs.



Population distribution
Occurrence across the JV region during the breeding period was determined using data from two sources collected over multiple years during the months May–July: eBird (2007–2016) and Great Lakes Marsh Monitoring Program (2005–2016).

Wetland Associations and Landscape Suitability Index (LSI)

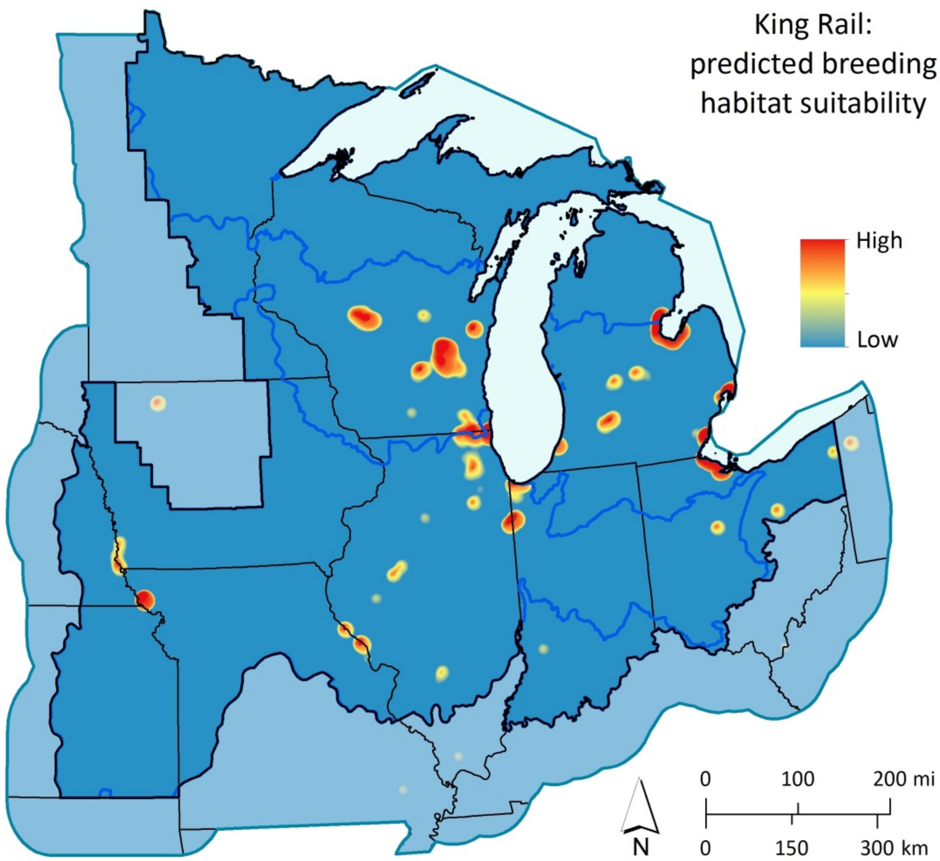
Cover type attributes associated with King Rails were categorized using NWI spatial data from areas surrounding (≤200 m) occurrence points recorded during the breeding period. Spatial data were considered at the NWI System, Class, Subclass, and Modifier levels but were eventually compressed and simplified to wetland system and class. Habitat suitability for waterbirds relates to key cover types and their juxtaposition. A Landscape Suitability Index (LSI) was established based on results of the NWI analysis for occurrence locations, species-specific habitat literature, and expert opinion. Habitat within the LSI is weighted from 1 (most suitable) to 0.2 (least suitable).



National Wetlands Inventory (NWI 2016) System (P = Palustrine, L = Lacustrine, R = Riverine) Subsystem (1 = Limnetic, 2 = Littoral), and Class (AB = Aquatic Bed, EM = Emergent, FO = Forested, SS = Scrub-Shrub, SB = Streambed, UB = Unconsolidated Bottom, US = Unconsolidated Shore). See Federal Geographic Data Committee (2013) report for subclass classification and special modifiers.

Cover types (NWI classes)	LSI Score
P-EM wetlands, >20 ha, and <1 km from P-UB/AB and/or R-UB/AB, >1 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	Higher
L-EM and/or R-EM wetlands, >20 ha, and <1 km from P-UB/AB and/or R-UB/AB, >1 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	
P-SS wetlands, >20 ha, and <1km from P-UB/AB and/or R-UB/AB, >1 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	
P-EM and/or L-EM and/or R-EM wetlands, >5 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	
Other P-EM, L-EM, and/or R-EM wetlands, >5 ha, and <1 km from P-UB/AB and/or R-UB/AB, >1 ha, within species breeding range.	Lower

Density and distribution of breeding habitats
Wetlands with predicted highest suitability for breeding (top two habitat categories in LSI table) were extracted from the NWI. Using kernel density analysis, distribution of the most suitable habitats for King Rail was depicted across the JV region and surrounding areas (figure below). Areas with relatively high LSI scores are also predicted to be beneficial for other breeding wetland birds using this habitat type.



Recommendations
Habitat actions: Retain current habitat, with sites having greatest population abundance typically reflecting higher habitat quality (high survival and recruitment). Restoration and enhancement will be required to add ≥1,500 ha of high quality habitat within current breeding range, particularly in locations with recent breeding-period detections. Enhancement of existing degraded wetlands through vegetation management, such as control of woody or invasive species, is a logical focus. Diverse micro-topography should be encouraged during basin enhancement or creation. Where water level control is possible, water regimes in units managed for breeding King Rails should have receding depth through the summer to provide pockets of shallow water <15 cm for prey to concentrate and King Rail broods to forage successfully in mid to late summer. Management actions undertaken to

benefit both waterfowl and King Rail require careful design and efforts to balance needs and benefits to both groups. The estimated area of quality breeding habitat needed to support populations at JV objective levels is ≥4,500 ha. As JV partners work toward expanding habitat capacity to achieve the population abundance objective, habitat loss for this species must also be considered in the accounting process.

Monitoring and performance: King Rail is not adequately monitored to generate population estimates in the region, but targeted surveys are being conducted in known and suspected breeding areas. This information, coupled with data from the Midwest Secretive Marsh Bird Survey and Breeding Bird Atlases, may lead to establishing a more meaningful population trend. Eliminating the current population deficit requires a 50% population increase or an average of 3% annually over a 15-year period.

References

Bolenbaugh J. R., T. Cooper, R. S. Brady, K. L. Willard and D. G. Krementz. 2012. Population Status and Habitat Associations of the King Rail in the Midwestern United States. Waterbirds 35:535–545.

Cooper T. R. (Plan Coordinator). 2008. King Rail Conservation Plan, Version 1. U.S. Fish and Wildlife Service, Fort Snelling, Minnesota. 121pp.

Darrah A. J., and D. G. Krementz. 2009. Distribution and habitat use of King Rails in the Illinois and Upper Mississippi River Valleys. Journal of Wildlife Management 73:1380–1386.

Darrah A. J., and D. G. Krementz. 2011. Habitat use of nesting and brood-rearing King Rails in the Illinois and Upper Mississippi River Valleys. Waterbirds 34:160–167.

Fournier, A. M. V., and K. Willard. 2015. King Rail nesting and brood rearing ecology in managed wetlands: Final Report USFWS Division of Migratory Birds Webless Program.

Johnson D. H., J. P. Gibbs, M. Herzog, S. Lor, N. Niemuth, C. Ribic, M. Seamans, T. Shaffer, W. G. Shriver, S. V. Stehman, and W. T. Thompson. 2009. A sampling design framework for monitoring secretive marshbirds. Waterbirds 3:203–215.

Krementz D.G, K. L. Willard, M. Carrol, and K. M. Dugger. 2016. King Rail (*Rallus elegans*) nesting and brood-rearing ecology in a managed wetland in Oklahoma, USA. Waterbirds Vol. 39 No. 3.

Meanley, B. 1953. Nesting of the King Rail in the Arkansas rice fields. The Auk 70:261–269.

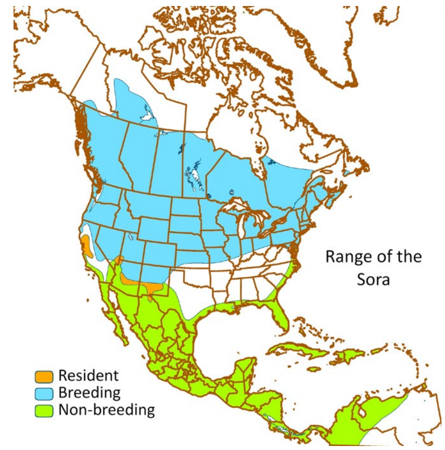
Pickens, B. A., and S. L. King. 2012. Predicting the spatial distribution of king rails in an agricultural landscape. Condor 114:113–122.

Pickens, B. A., and B. Meanley. 2015. King Rail (*Rallus elegans*), The Birds of North America, P. G. Rodewald, editor. Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/kinrai4

Reid, F. A., B. Meanly, L. H. Frederickson. 1992. King Rail. Pages 181-192 *in* T. C. Tacha and C. E. Braun, editors. Migratory shore and upland game bird management in North America, International Association of Fish and Wildlife Agencies, Washington, D.C., USA.

Joint Venture breeding population objective, estimate, and deficit based on local abundance surveys and expert opinion

Breeding abundance objective (50% increase)	30,900
Population estimate (2016)	20,600
Deficit	10,300



Range map: BirdLife International
Picture: Cornell Lab of Ornithology

Species focal guild

Sora, King Rail, and Yellow Rail are most associated with NWI class *Emergent Wetland*. All three were chosen as focal species to represent the waterbird guild dependent on emergent wetland with open water and associated grassland/herbaceous cover. Whereas Yellow Rail is a relative habitat specialist in the northern part of the JV region, the Sora is more general in its habitat requirements and widespread across the JV region. Guild associates found using similar habitats include Virginia Rail and Sandhill Crane. The emergent wetland portions of Sora habitat are also used by American Bittern, whereas Canada Geese and Blue-winged Teal are often found at wetlands along with Sora when upland grasslands (teal) and or small islands and other dry nesting substrate (geese) are available.

Habitat requirements

<u>Community types:</u> Primarily freshwater wetlands with shallow and intermediate water depths, dominated by emergent vegetation, especially cattail. Seasonal to semi-permanent wetlands with sedges, bur-reed, and bulrush also used for breeding; wetland edges may include moist-soils plant species. Breeding Sora feed primarily on seeds of wetland plants and on invertebrates; wild rice is a favorite food in late summer and fall. Compared to other secretive marsh birds, Sora breeding territories may include more woody cover along with greater amounts of invasive reed canary-grass, as long as areas of interspersed emergent plants and open water are present. Soras also use wetland edges and uplands, including agricultural fields adjacent to wetlands during brood-rearing and post-breeding dispersal. Highest breeding densities are in shallow, shoreward portions of wetlands where water level instability produces diverse mosaics of robust and fine-leaved emergent vegetation. This habitat preference may be related to the diversity of plant seeds and other forage; floating and submerged residual vegetation may also increase habitat quality by providing substrate for invertebrates near the water surface and accessible to Sora. Mean water depth at breeding territories is 40 cm ± 15, and range 0–90 cm; mean vegetation height is 130 cm ± 40, and mean number of stems/m^2 in territories is 120 cm ± 80. Water depth at nest sites ranges from 5–40 cm and most often is about 20 cm.

<u>Timing:</u> Nest initiation is late April to mid-May, egg-laying in May and June, incubation 16–19 days, and young fledge at 4 weeks of age. Species moves from smaller breeding wetlands to larger wetlands

with abundant food in August and September. Migration appears related to timing of frost, with birds moving south from primary breeding areas between August and September.
Area / distance: Sora are not area-sensitive and have been found to nest in wetlands as small as 0.5 ha; however, they are more likely to nest in wetland complexes >5 ha. Documented densities of breeding Sora in the region have ranged from 0.1–1.6 birds / ha. Although territorial, Sora nests can be closely spaced (12–25 m) in high quality habitat. Sora also practice interspecific territorial defense against Virginia Rail, but nests of Sora, Virginia Rail, and King Rails can occur in the same wetlands. Sora and Virginia Rail nests have been recorded 2–30 m apart. Home range size in high quality breeding habitat appears to be <1 ha, with documented brood-rearing home ranges as small as 0.2 ha ± 0.02.

Limiting factors
Population declines appear greatest in central North America, likely reflecting the degree of wetland loss in this region. Wetland degradation related to siltation, eutrophication, and other forms of pollution have also reduced Sora habitat. Soras readily occupy sites with *Phragmites* and hybrid cattail, but large mono-culture stands of these invasive species reflect poor quality habitat. Migrating Sora are killed following collisions with communication towers and overhead wires, but these sources of mortality are considered less important than habitat loss.

Population monitoring
Current survey effort: Population trends can be assessed through a combination of multiple surveys: Midwest Secretive Marsh Bird Survey, Great Lakes Marsh Monitoring Program, and the BBS. State Breeding Bird Atlases also provide distributional information, and local scale research has provided measures of recruitment and habitat use. Use of eBird data has also been valuable in determining species distribution and occurrence timing, especially in areas lacking dedicated surveys.
Recommended monitoring: Although adequate for trend determination, current surveys have not resulted in precise population estimates. Expanding annual marsh bird surveys, and coupling results with other survey efforts (BBS and eBird) plus local-scale research, may provide a means to generate regional model-based breeding population estimates.

Research to assist planning
Current and ongoing projects: Research is being conducted to better understand Sora use of wetlands with natural and altered hydrology in BCR 12. Another study is comparing marsh bird use of impounded and un-impounded wetlands in the Great Lakes region. In addition, marsh bird monitoring data from primary breeding states in the region will be used to generate model-based population estimates. Compatibility of waterfowl and rail habitat management at migration-stopover locations has recently received attention in Missouri.
Research needs: Species response to habitat restoration and enhancement in both breeding and non-breeding areas would inform management. Likewise, refining population demographic information and developing a life-cycle model can result in conservation that is more effectively targeted.

Habitat objectives

Restore and maintain regional carrying capacity to achieve breeding population objective through effective and efficient habitat conservation considerate of other species of concern.

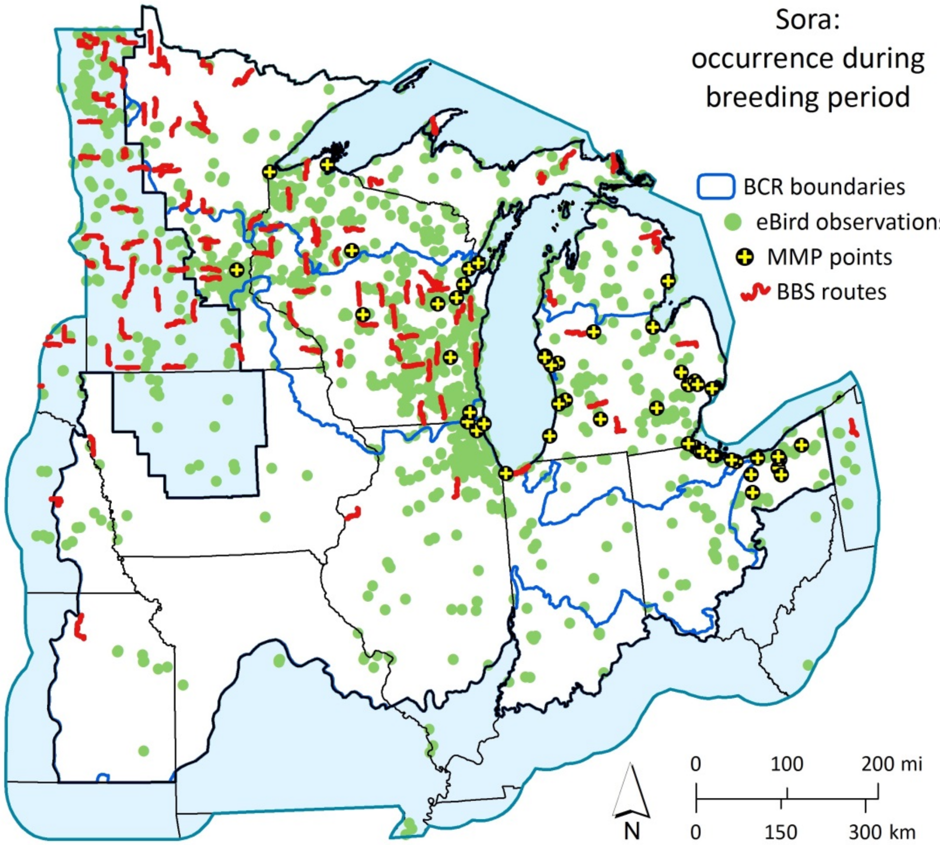
Restoration calculation: $Hr = D/2 \times C$ $10{,}300 = 10{,}300/2 \times 2$

Hr = new breeding habitat area required to eliminate deficit (ha)
D = regional population deficit (individual birds; D/2 = pair deficit)
C = minimum optimal habitat required for each pair (ha)

Retention calculation: $Hp = Ob/2 \times C$ $30{,}900 = 30{,}900/2 \times 2$

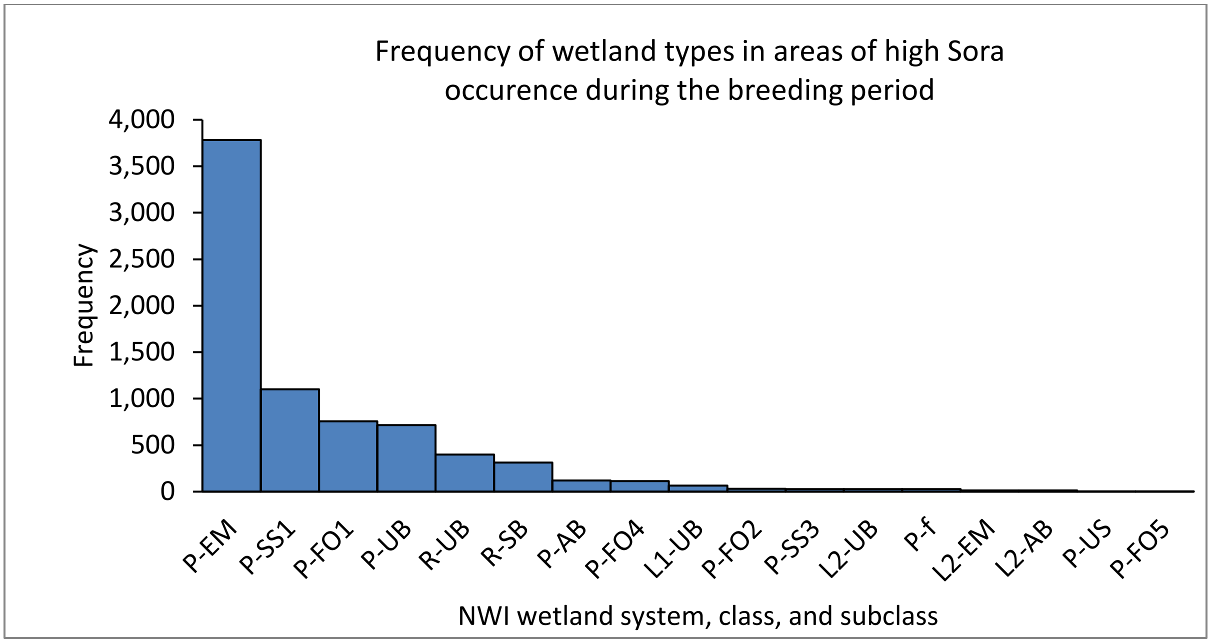
Hp = breeding habitat area required to sustain population objective (ha)
Ob = regional abundance objective (individual birds; Ob/2 = pair objective)
C = minimum optimal habitat required for each pair (ha)

Optimal breeding habitat (from information above) includes a mix of seasonal and semi-permanent herbaceous wetlands within a shallow (<0.5 m deep) open-water mosaic, including interspersion of cattail and other native emergent species 0.5–1.5 m tall, and with some areas of low to moderate stem density. Sites should include at least 1–2 ha of herbaceous emergent wetland mixed with areas of open water, but larger (>20 ha) wetland complexes can support multiple breeding pairs. Where water-level management is possible, periodic gradual drawdowns that encourage horizontal zonation of wetland vegetation can improve habitat quality.



Population distribution
Occurrence across the JV region during the breeding period was determined using data from various sources collected over multiple years during the months June and July: Breeding Bird Survey (2007–2016), eBird (2007–2016), and Great Lakes Marsh Monitoring Program (2005–2016).

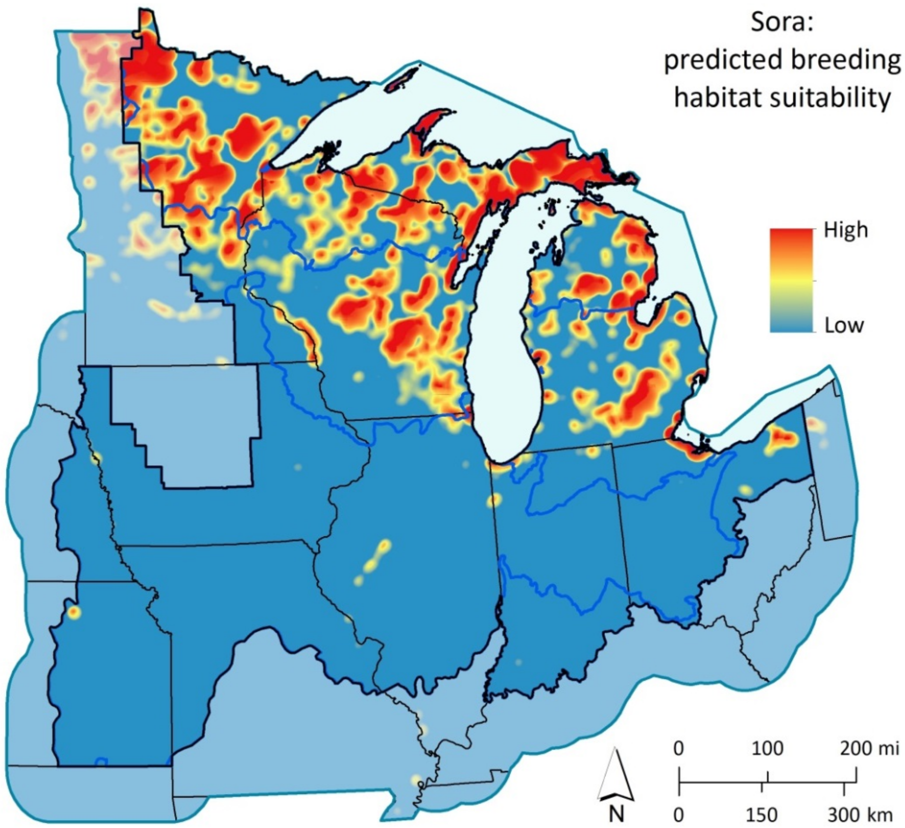
Wetland Associations and Landscape Suitability Index (LSI)
Cover type attributes associated with Sora were categorized using NWI spatial data from areas surrounding (≤200 m) occurrence points recorded during the breeding period. Spatial data were considered at the NWI System, Class, Subclass, and Modifier levels but were eventually compressed and simplified to wetland system and class. Habitat suitability for waterbirds relates to key cover types and their juxtaposition. A Landscape Suitability Index (LSI) was established based on results of the NWI analysis for occurrence locations, species-specific habitat literature, and expert opinion. Habitat within the LSI is weighted from 1 (most suitable) to 0.2 (least suitable).



National Wetlands Inventory (NWI 2016) System (P = Palustrine, L = Lacustrine, R = Riverine) Subsystem (1 = Limnetic, 2 = Littoral), and Class (AB = Aquatic Bed, EM = Emergent, FO = Forested, SS = Scrub-Shrub, SB = Streambed, UB = Unconsolidated Bottom, US = Unconsolidated Shore). See Federal Geographic Data Committee (2013) report for subclass classification and special modifiers.

Cover types (NWI classes)	LSI Score
P-EM wetlands, >20 ha, and <1 km from P-AB/UB and/or L-AB/UB and/or R-AB/UB wetlands, >1 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	Higher
P-SS wetlands, >20 ha, and <1 km from P-AB/UB and/or L-AB/UB and/or R-AB/UB wetlands, >1 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	
P-EM and/or P-SS wetlands, 5–20 ha, and <1km from P-AB/UB and/or L-AB/UB and/or R-AB/UB wetlands, >1 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	
P-EM and/or P-SS wetlands, >20 ha, and >1 km from P-AB/UB and/or L-AB/UB and/or R-AB/UB wetlands, within species breeding range.	
P-EM and/or P-SS wetlands, 5–20 ha, and >1 km from P-AB/UB and/or L-AB/UB and/or R-AB/UB wetlands, within species breeding range.	Lower

Density and distribution of breeding habitats
Wetlands with predicted highest suitability for breeding (top two habitat categories in LSI table) were extracted from the NWI. Using kernel density analysis, distribution of the most suitable habitats for Sora was depicted across the JV region and surrounding areas (figure below). Areas with relatively high LSI scores are also predicted to be beneficial for other breeding wetland birds using this habitat type.



Recommendations

Habitat actions: Restoration and enhancement will be required to add ≥10,300 ha of quality habitat within current breeding range. Restoration of native emergent marsh and enhancement of existing degraded wetlands will need to occur at local and watershed scales. Vegetation management can improve spatial distribution of open water and emergent vegetation over time. However, addressing regional factors such as siltation and nutrient run-off from the surrounding watershed will be a necessary step to sustain the long-term wetland health and habitat quality vital to breeding populations of Sora. Habitat quality at individual wetlands will vary over time due to annual variation in environmental conditions, and large (>20 ha) complexes of diverse emergent wetlands can better support populations under these conditions. The estimated area of quality breeding habitat needed to support populations at JV objective levels is ≥30,900 ha. As JV partners work toward expanding habitat capacity to achieve the population abundance objective, habitat loss for this species must also be considered in the accounting process.

Monitoring and performance: The BBS provides a coarse approach to monitoring long-term Sora population trend at the JV regional scale. Abundance estimates and trends may be produced at smaller scales using the Midwest Secretive Marsh Bird Survey protocol. Eliminating the current population deficit requires a 50% population increase, therefore conservation actions should result in a 50% increase in the BBS index, or an average annual increase of 3% over a 15 year period.

References

Brown, M., and J. J. Dinsmore. 1986. Implications of marsh size and isolation for marsh bird management. Journal of Wildlife Management 50:392–397.

Glisson, W. J., R. S. Brady, A. T. Paulios, S. K. Jacobi, and D. J. Larkin. 2015. Sensitivity of secretive marsh birds to vegetation condition in natural and restored wetlands in Wisconsin. Journal of Wildlife Management 79:1101–1116.

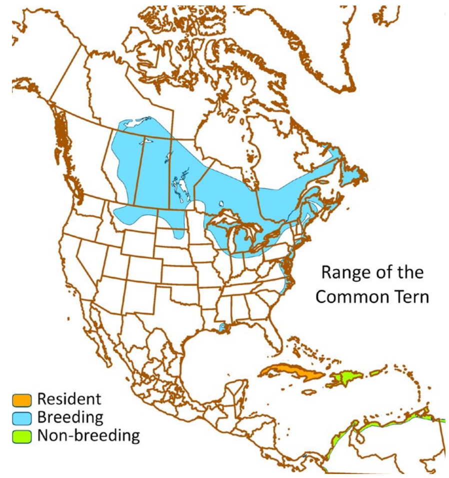
Melvin, S. M., and J. P. Gibbs. 2012. Sora (*Porzana carolina*), The Birds of North America, P. G. Rodewald, editor. Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/sora.

Tozer, D. C. 2016. Marsh bird occupancy dynamics, trends, and conservation in the southern Great Lakes basin: 1996 to 2013. Journal of Great Lakes Research 42:136–145.

Wires, L. R., S. J. Lewis, G. J. Soulliere, S. W. Matteson, D. V. Weseloh, R. P. Russel, and F. J. Cuthbert. 2010. Upper Mississippi Valley / Great Lakes waterbird conservation plan. U.S. Fish and Wildlife Service, Fort Snelling, Minnesota, USA.

Common Tern *(Sterna hirundo)*

Joint Venture breeding population objective, estimate, and deficit based on regional abundance surveys	
Breeding abundance objective (50% increase)	7,500
Population estimate (2010)	5,000
Deficit	2,500



Picture: Cornell Lab of Ornithology
Species range map: BirdLife International

Common Tern was chosen as a focal species to represent large open water communities (NWI classes *Unconsolidated Bottom and Shore*), typically lakes and large river impoundments with shallow and deep zones and high water clarity. Compared to the Common Loon (also an open-water focal species), Common Tern is more associated with Great Lakes and other large lakes subject to significant shoreline wave action. They are the most widespread tern in North America and are considered of low conservation concern at the continental scale. However, a reduction in breeding pairs and distribution in the Great Lakes region has resulted in higher priority status within the JV region. Common Terns are colonial nesters that require undisturbed islands (natural or artificial) for breeding. Other island-nesting species in this guild include Caspian Tern, Ring-billed, Herring, and Great Black-back gulls, Double-crested Cormorant, and American White Pelican.

Habitat requirements

Community types: Shallow zones of the Great Lakes and large (>500 ha) inland lakes often fringed with areas of emergent wetland and aquatic bed; nearby small wetlands and ponds with high water clarity are also used when feeding. Abundant small (3–10 cm) forage fish must be available <50 cm from the water's surface and near nesting colonies (within about 20 km). Nests are located on natural or artificial islands and peninsulas, sometimes on barrier beaches, and rarely on floating mats in marshes. Species selects nest sites with sand, gravel, or cobble substrates and often scattered vegetation (10-40% coverage) or other protection such as rocks or logs where chicks can find shelter from wind. Natural nesting areas typically have limited vegetation due to being wave-swept during storms. Common Terns often roost on undisturbed beaches and sand flats or on emerged wood and rock.

Timing: Arriving at breeding areas about mid-April, this species nests through summer to late August, with most egg-laying in May–July, incubation 21–27 days, and young fledged at about 28 days. Autumn migration is August – November.

Area / distance requirements: Nests in colonies, typically 0.06–0.5 nests/m^2 but as high as 3.1 nests/m^2, and in groups up to 300 pairs (average is ~100 pairs on a 400 m^2 colony site). Most nests are placed <100 m inland from shore and <4 m elevation above water surface but outside wave-wash zone. Breeding birds feed <20 km from colonies. Pairs demonstrate high site fidelity, and they may defend linear feeding territories 150–250 m wide along shoreline. Territories require perches, such as floating structure, emerged rocks, posts, and docks.

Limiting factors

Evidence suggests the Great Lakes population is limited by adequate suitable colony sites with low disturbance and in close proximity (<20 km) to abundant food. Suitable nesting habitat has declined due to human development and recreational activity on barrier beaches and islands. Nesting areas must also be free of predators and with limited competition; gulls can displace Common Terns to less suitable sites. Common Terns are susceptible to environmental toxins such as botulism, shellfish poisoning, PCBs, DDE, and mercury.

Population monitoring

Current survey efforts: Great Lakes Colonial Waterbird Surveys (conducted every 10 + years) provide the best information on population trends for the region. Michigan, Wisconsin and Minnesota conduct annual or biannual monitoring at all important inland areas. State Breeding Bird Atlases also provide information on distribution of colony sites and intermittent surveys are conducted by state agencies, FWS, tribes, and universities. Data available through eBird can be used to determine timing of occurrence and locations.
Recommended monitoring: A scheme to coordinate monitoring more frequently (~ 3 year interval) at high priority sites on the Great Lakes is needed. Site occupancy is inconsistent between decadal census intervals where old sites are often abandoned and new sites are colonized. Additionally, monitoring should also occur during migration and winter as there are important information gaps for these periods.

Research to assist planning

Current and ongoing projects: Great Lakes breeding-colony researchers (Strand and Matteson since 1983, Arnold and Oswald since 2008) have been investigating age at first reproduction, population structure, condition-specific survival, breeding success, chick development, habitat selection, and responses to heat stress, disease, predation, and human disturbance. Results will provide data for population modeling and will provide context regarding how management approaches can be tailored for site-specific differences and intraspecific variability among regions. There is also an effort to deploy geo-locators on adult Common Terns at Interstate Island in the Duluth-Superior Harbor and at Ashland (WI). This project will identify staging and overwintering locations of Common Terns breeding on the Great Lakes along with migration and wintering chronology.
Research needs: Most mortality is believed to occur in winter; population dynamics will not be understood until more is learned about winter foraging ecology, energetics, molt, and survival.

Habitat objectives

The factor assumed most limiting to species population growth is suitable undisturbed colony sites in open-water locations with adequate forage. Total habitat area to meet carrying capacity needs for the regional Common Tern populations were calculated based on average colony population size and territory requirements. However, habitat at the colony (or potential colony) site should be the focus for most conservation actions.

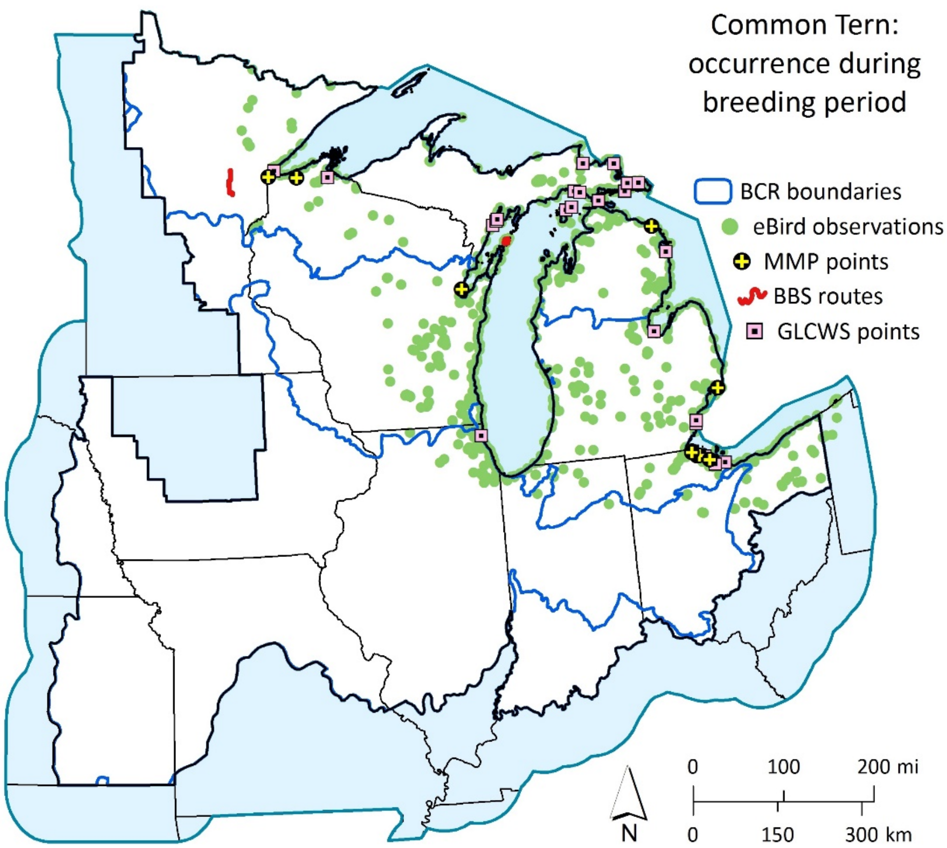
Restoration Calculation: Hr = D/C × T   1,040 km^2 water = 2,500/200 × 80 (for 13 colonies)

Hr = new breeding habitat area required to eliminate deficit (km^2)
D = regional population deficit (birds)
C = average colony population size (100 pairs, 200 individuals)
T = colony territory (ha); island (≥400 m^2) + open water (≥80 km^2 = 5 km radius)

Retention calculation: Hp = Ob/C × T   2,000 km^2 water = 5,000/200 × 80 (for 25 colonies)

Hp = breeding habitat area required to sustain population objective (km^2)
Ob = regional abundance objective (individual birds; Ob/2 = pair objective)
C = average colony population size (100 pairs, 200 individuals)
T = colony territory (ha); island (≥400 m^2) + open water (≥80 km^2 = 5 km radius)

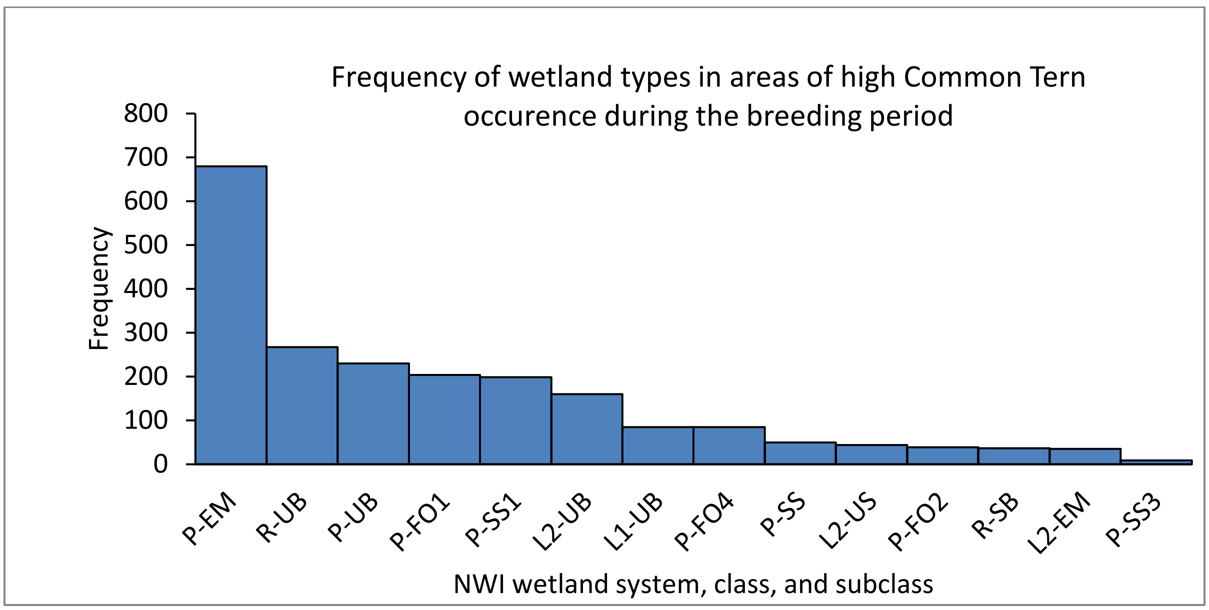
Optimal breeding habitat (from information above) includes undisturbed nest colonies, typically on small islands, surrounded by open water with high clarity, abundant forage, and often with an aquatic bed and or emergent marsh component. Colony substrate is sand, gravel, and or cobble with limited vegetation.



Population distribution
Occurrence across the JV region during the breeding period was determined using data from several sources collected over multiple years during the months June and July: Breeding Bird

Survey (2007–2016), eBird (2007–2016), Great Lakes Marsh Monitoring Program (2005–2016), and Great Lakes Colonial Waterbird Survey (2007–2010). *Note:* Records from the GLCWS and MMP identify breeding colonies; eBird points reflect birder observations during the breeding period but some were likely migrating birds (most observations in BCR 22 were omitted from map).

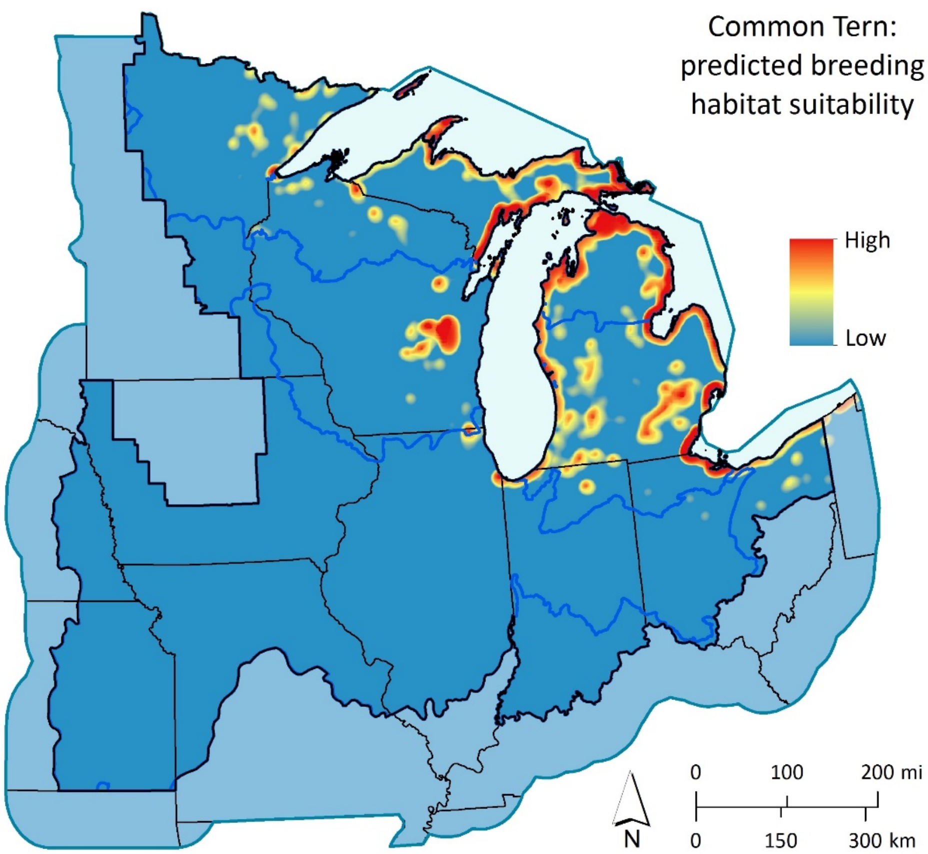
Wetland Associations and Landscape Suitability Index (LSI)
Cover type attributes associated with Common Terns were categorized using NWI spatial data from areas surrounding (≤200 m) occurrence points recorded during the breeding period. Spatial data were considered at the NWI System, Class, Subclass, and Modifier levels but were eventually compressed and simplified to wetland system and class. Habitat suitability for waterbirds relates to key cover types and their juxtaposition. A Landscape Suitability Index (LSI) was established based on results of the NWI analysis for occurrence locations, species-specific habitat literature, and expert opinion. Habitat within the LSI is weighted from 1 (most suitable) to 0.2 (least suitable).



National Wetlands Inventory (NWI 2016) System (P = Palustrine, L = Lacustrine, R = Riverine) Subsystem (1 = Limnetic, 2 = Littoral), and Class (AB = Aquatic Bed, EM = Emergent, FO = Forested, SS = Scrub-Shrub, SB = Streambed, UB = Unconsolidated Bottom, US = Unconsolidated Shore). See Federal Geographic Data Committee (2013) report for subclass classification and special modifiers.

Cover types (NWI classes)	LSI Score
L-UB wetlands, <10 m in depth, and <10 km from P-EM wetlands, within sub-basins (8-digit HU) with recent breeding occurrence.	Higher
L-UB wetlands, <10 m in depth, and >10 km from P-EM wetlands, within sub-basins (8-digit HU) with recent breeding occurrence.	
Other L-UB and/or P-UB and/or R-UB wetlands, >10 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	
Other L-UB and/or P-UB and/or R-UB wetlands, >10 ha, within species breeding range.	
L-UB and/or P-UB and/or R-UB wetlands, 5–10 ha, within species breeding range.	Lower

Density and distribution of breeding habitats
Wetlands with predicted highest suitability for breeding (top two habitat categories in LSI table) were extracted from the NWI. Using kernel density analysis, distribution of the most suitable habitats for Common Tern were depicted across the JV region and surrounding areas (figure below). Areas with relatively high LSI scores are also predicted to be beneficial for other breeding wetland birds using this habitat type.



Recommendations

Habitat actions: Providing habitat recommendations for island-nesting colonial waterbirds is especially challenging. These birds depend heavily on near-shore sites in the Great Lakes where habitat suitability is dynamic. Conditions such as island size and substrate, wave action, food abundance, predation, competition, and human disturbance can change annually, often in relation to lake water levels. Therefore, the amount of habitat needed is also dynamic because of the many factors influencing quality. Based on above calculations, carrying capacity for 13 new colonies must be established and a total 25 breeding colonies must be retained to meet JV regional objectives. However, colonization by this species is uncertain, and habitat calculations provide only a starting point as we learn more about management response. The following general guidelines should be used in consultation with local experts to assure efficient use of conservation resources.

Existing and abandoned colonies: Enhancement of colony sites is generally more efficient than creating new sites. Management can include vegetation and substrate manipulation, installation of protective structures (exclosures), predator control, competitor deterrence or removal, and restriction of human access.

Potential colonies: New colonies might be established by strategic placement and or configuration of dredge-spoil islands and adding preferred substrate on islands otherwise suitable for nesting. Consider feeding territories of existing tern colonies when locating habitat projects; distances between colonies should generally be >5 km. Also, the need for periodic substrate management should be part of the decision for locating new colonies.

Monitoring and performance: The Great Lakes Colonial Waterbird Survey (conducted every 10+ years) censuses Common Tern colonies along the Great Lakes shoreline, where most habitat conservation is likely to occur. However, surveys conducted more frequently are required to better measure population change and habitat management performance. Some large colonies appear to have very low productivity, and monitoring factors influencing productivity is necessary to improve understanding of population limitations. Eliminating the current population deficit requires a 50% increase in population size or an annual average of 3% increase over a 15 year period.

References

Courtney, P. A. and H. Blokpoel. 1983. Distribution and numbers of Common Terns on the lower Great Lakes during 1900-1980: a review. Colon. Waterbirds 6:107-112.

Cuthbert, F. J., and L. Wires. 2013. The fourth decadal U.S. Great Lakes Colonial Waterbird Survey (2007–2010): results and recommendations to improve the scientific basis for conservation and management. Final Report to U.S. Fish and Wildlife Service, Bloomington, Minnesota, USA.

Cuthbert, F. J., L. R. Wires, and K. Timmerman. 2003. Status Assessment and Conservation Recommendations for the Common Tern (*Sterna hirundo*) in the Great Lakes Region. U.S. Department of the Interior, Fish and Wildlife Service, Ft. Snelling, Minnesota, USA.

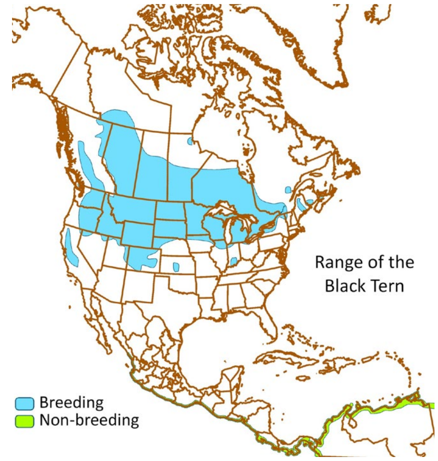
Dicostanzo, J. 1980. Population dynamics of a Common Tern colony. Journal of Field Ornithology 51:229–243.

Hall, C. S. 1999. The diet, reproductive performance and management of Common and Arctic Terns in the Gulf of Maine. Thesis, University of Massachusetts, Amherst, USA.

Morris, R. D., C. Pekarik, and D. J. Moore. 2012. Current status and abundance trends of Common Terns breeding at known coastal and inland nesting regions in Canada. Waterbirds 35:194–207.
Nisbet, I. C., J. M. Arnold, S. A. Oswald, P. Pyle, and M. A. Patten. 2017. Common Tern (*Sterna hirundo*), The Birds of North America, P. G. Rodewald, editor. Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: https://birdsna.org/Species-Account/bna/species/comter.
Soulliere, G. J., B. A. Potter, D. J. Holm, D. A. Granfors, M. J. Monfils, S. J. Lewis, and W. E. Thogmartin. 2007. Upper Mississippi River and Great Lakes Region Joint Venture Waterbird Habitat Conservation Strategy. U.S. Fish and Wildlife Service, Fort Snelling, Minnesota, USA.
Wires, L. R., and F. J. Cuthbert. 2001. Prioritization of waterbird colony sites for conservation in the U.S. Great Lakes. Final Report to USFWS.
Wires, L. R., S. J. Lewis, G. J. Soulliere, S. W. Matteson, D. V. "Chip" Weseloh, R. P. Russell, and F. J. Cuthbert. 2010. Upper Mississippi Valley / Great Lakes Waterbird Conservation Plan. A plan associated with the Waterbird Conservation for the Americas Initiative. Final Report submitted to the U. S. Fish and Wildlife Service, Fort Snelling, Minnesota, USA.

Black Tern *(Chilidonias niger)*

Joint Venture breeding population objective, estimate, and deficit based on regional abundance surveys	
Breeding abundance objective (50% increase)	26,400
Population estimate (2010)	17,600
Deficit	8,800



Range map: BirdLife International
Picture: Cornell Lab of Ornithology

Focal species guild

Black Tern is a focal species representing NWI class *Aquatic Bed*, but it also requires emergent wetland for nesting and shallow open water for foraging. It is found where wetlands have high biological diversity, especially landscapes with many shallow and clear inland lakes and along shallow coasts of the Great Lakes. Guild associates include Forster's Tern, Pied-billed Grebe, Red-necked Grebe, American Coot, Common Gallinule, and several species of breeding and non-breeding waterfowl.

Habitat requirements

Community types: Large areas of shallow open water mixed with extensive stands of emergent herbaceous vegetation and occasionally scrub-shrub wetland. Nesting occurs within vegetation, typically on floating plant material or organic muck mats. Breeding sites may be shallow lakes, impoundments, wide expanses of a slow-moving river, or complexes of large ponds, as long as sites have high water clarity and adequate forage (insects and small fish). Habitat suitability appears to be determined more by landscape structure at a larger scale (wetland complex) than local vegetation conditions within wetlands, and black terns selectively choose wetlands located in high-density wetland landscapes. Vegetation at nest sites is typically bulrush, cattail, or sedge. Preferred sites are mosaics of less dense emergent marsh with deeper water (≥1 m depth) or with openings from muskrat activity. Black Terns use lakes, rivers, marsh / open-water complexes, sewage lagoons, and occasionally cultivated fields during migration.

Timing: Nests mid-May to early August, and egg-laying is May to July but mostly early June. Incubation period is 20–24 days, with fledging in 18–28 days. Fall migration is August to October.

Area / distance: Nests semi-colonially in loose groups, typically about 20 pairs but also singly or in groups as high as 200 pairs. Prefers bulrush marsh and open water complexes ≥20 ha in size, but will use smaller wetlands (5–10 ha) when near (<4 km) other quality habitat (open-water marsh complexes >10 ha in size). Readily selects new nest sites in response to annual water-level change, the extent and configuration of floating mats, and other factors influencing vegetation conditions (e.g., stem density) and the vegetation / open-water mosaic.

Limiting factors
One of the greatest concerns at the continental scale is loss of quality breeding habitat. This species does not breed before age 2, normally remaining in southern wintering areas until returning when sexually mature. Survival during sub-adult period is an uncertain population influence. Nesting birds are sensitive to wetland size and plant and landscape composition, requiring diverse native-plant emergent wetlands with limited surrounding agriculture or forest cover. Nest loss and failed recruitment can occur due to storm-related wave action and or human disturbance (e.g., boating). In addition, some large colony sites (e.g., Horicon Marsh NWR) have been vulnerable to nest predation and therefore may be population sinks rather than sources. Black-crowned Night-Heron predation of tern chicks has led to years of low productivity at Horicon (WI). Wetland loss and degradation, largely due to dense growths of invasive plants (*Phragmites* and hybrid cattail), are also considered primary contributors to this species' decline. However, large areas of apparently suitable breeding habitat remains unoccupied, leading to growing concern regarding migration and wintering locations potentially limiting population growth. Non-breeding survival appears low for some populations, but there are no known limiting factors during migration.

Population monitoring
<u>Current survey effort:</u> 1) North American Breeding Bird Survey (BBS), 2) Great Lakes Colonial Waterbird Survey (conducted every 10 + years), 3) Great Lakes Marsh Monitoring Program, 4) Midwest Secretive Marsh Bird Survey, and 5) eBird offer various means to track regional trends in abundance and distribution. An exhaustive Wisconsin population survey of colony sites during 2014-2018 will provide comprehensive data on population abundance, distribution, and habitat selection. State Breeding Bird Atlases also provide distribution data, and some local-scale monitoring has provided measures of recruitment.
<u>Recommended monitoring:</u> Although adequate for basic trend determination, current large-scale surveys such as BBS have not resulted in precise population estimates. Local-scale surveys have been developed to produce higher precision estimates of population trend. Increasing the frequency of the Great Lakes Colonial Waterbird Survey with a greater focus on marsh-nesting terns and expanding survey efforts to monitor interior colonies may provide a means to generate regional model-based breeding population estimates.

Research to assist planning
<u>Current and ongoing projects:</u> University of Minnesota researchers recently examined colony-occupancy data to determine what habitat-related changes have been most associated with changes in site use (colonization vs. abandonment) in the Great Lakes region. Great Lakes Audubon is leading an evaluation of breeding Black Tern survival and recruitment on Lake St. Clair, the largest Great Lakes colony, and at other known breeding locations in Michigan and Wisconsin. Ongoing research will help determine landscape and local-scale habitat features important to colony establishment and maintenance as well as nest success and recruitment.
<u>Research needs:</u> Improved demographic information during all seasons would benefit development of a life-cycle model, and use of telemetry can lead to a better understanding of migration and wintering areas. The life-cycle model and sensitivity analysis of primary population influences (e.g., summer recruitment vs. winter survival) will help determine factors most limiting population growth and where to effectively target conservation. Filling

these information gaps can also inform scenario planning to assess mitigation of potential population stressors (e.g., development, climate change, invasive plants). Validation of the current regional habitat model will be required.

Habitat objectives

Restore and maintain regional carrying capacity to achieve population objective through effective and efficient habitat conservation that is considerate of other species of concern.

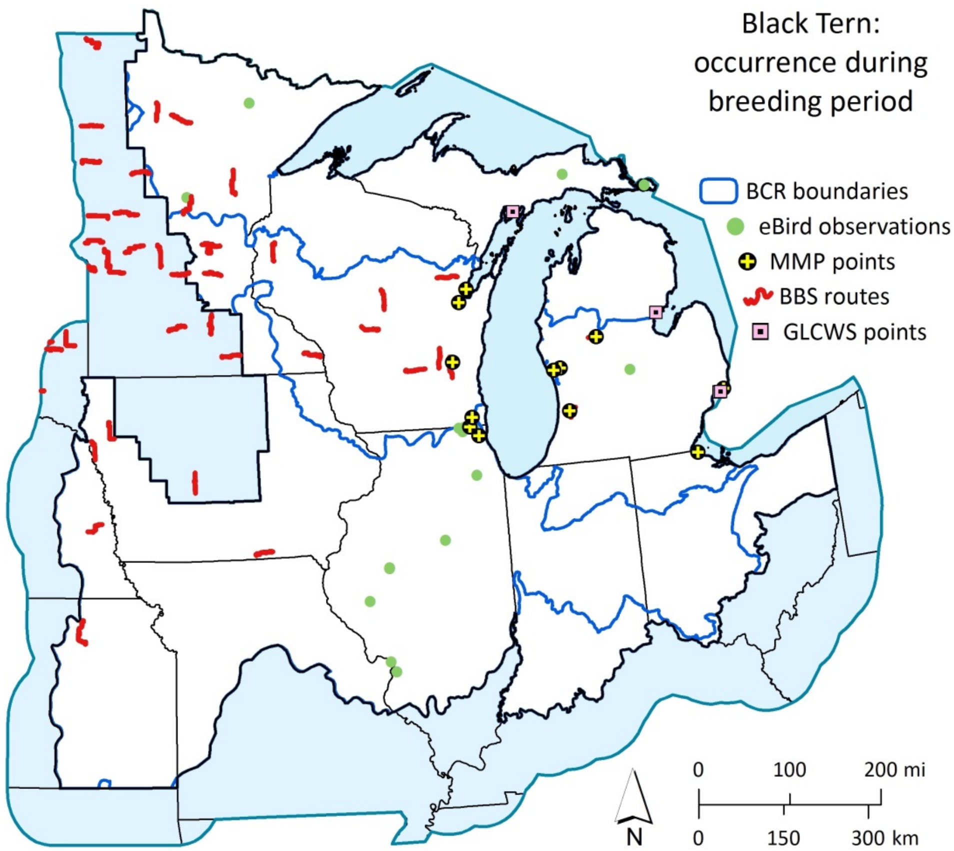
Restoration calculation: $Hr = D \times C$ $4{,}400 = 8{,}800 / 40 \times 20$ (for 220 new colonies)

> Hr = new breeding habitat area required to eliminate population deficit (ha)
> D = regional population deficit (and 40 birds/colony)
> C = minimum optimal habitat required for each 40-bird colony (ha)

Retention calculation: $Hp = Ob \times C$ $13{,}200 = 26{,}400 / 40 \times 20$ (for 660 total colonies)

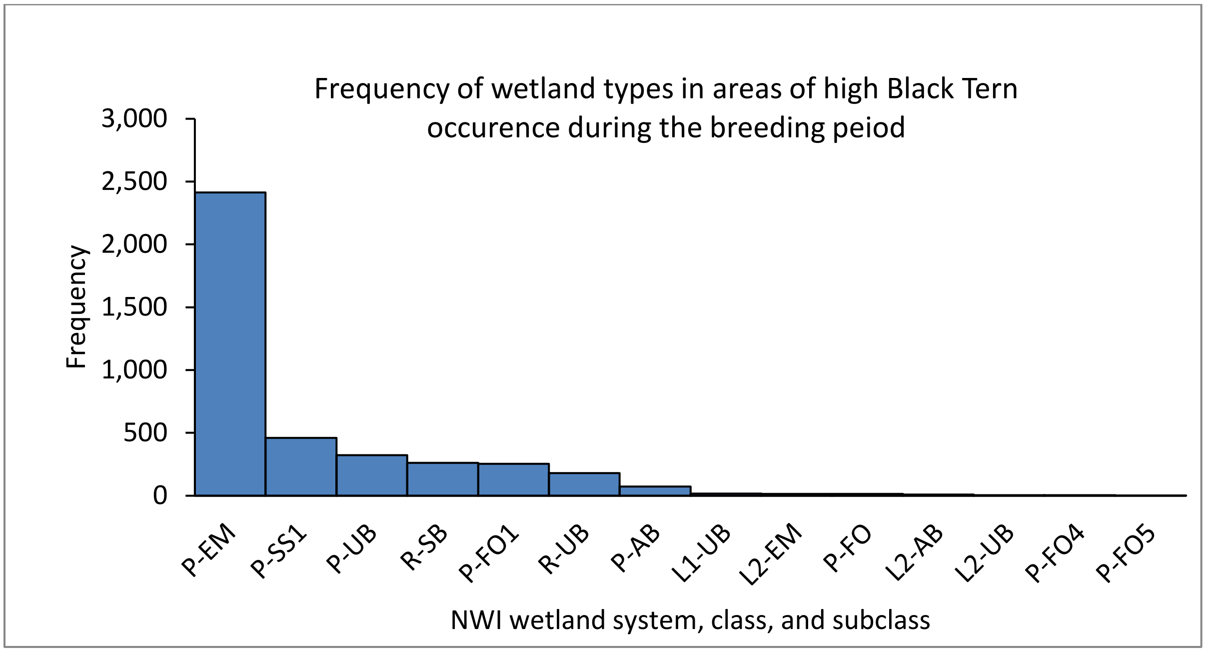
> Hp = breeding habitat area required to sustain population objective (ha)
> Ob = regional abundance objective (and 40 birds/colony)
> C = minimum optimal habitat required for each 40-bird colony (ha)

Optimal breeding habitat (from information above) includes large ≥20 ha complexes of aquatic bed and shallow (≤1.5 m deep) open water mixed with patchy (or fringed by) areas of emergent marsh. Bulrush marsh of moderate depth (0.5–1.5 m deep) is most used by nesting terns. Other hemi marsh (50:50 ratio of emergent plant cover to open-water) complexes, having diverse native plant composition, open water, and abundant forage are also used. Dense stands of *Phragmites* and or hybrid cattail are not typically used by breeding Black Terns.



Population distribution
Occurrence across the JV region during the breeding period was determined using data from several sources collected over multiple years during the months of June and July: Breeding Bird Survey (2007–2016), eBird (2007–2016), Great Lakes Marsh Monitoring Program (2005–2016), and Great Lakes Colonial Waterbird Survey (2007–2010).

Wetland Associations and Landscape Suitability Index (LSI)
Cover type attributes associated with Black Terns were categorized using NWI spatial data from areas surrounding (≤200 m) occurrence points recorded during the breeding period. Spatial data were considered at the NWI System, Class, Subclass, and Modifier levels but were eventually compressed and simplified to wetland system and class. Habitat suitability for waterbirds relates to key cover types and their juxtaposition. A Landscape Suitability Index (LSI) was established based on results of the NWI analysis for occurrence locations, species-specific habitat literature, and expert opinion. Habitat within the LSI is weighted from 1 (most suitable) to 0.2 (least suitable).

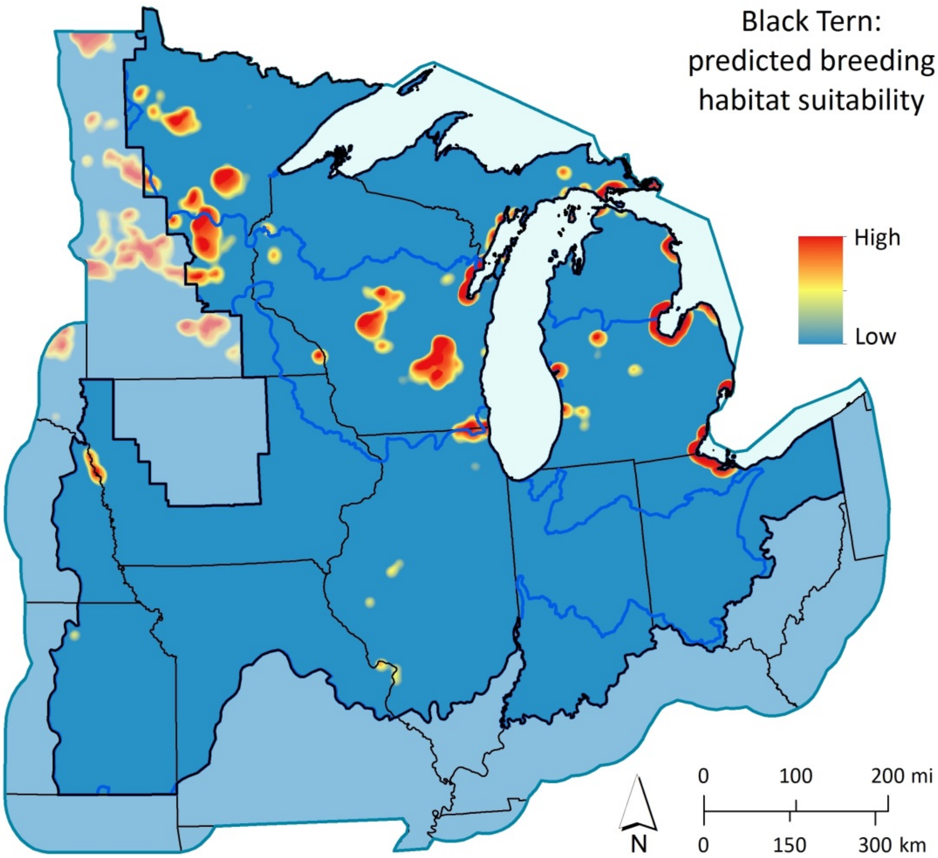


National Wetlands Inventory (NWI 2016) System (P = Palustrine, L = Lacustrine, R = Riverine) Subsystem (1 = Limnetic, 2 = Littoral), and Class (AB = Aquatic Bed, EM = Emergent, FO = Forested, SS = Scrub-Shrub, SB = Streambed, UB = Unconsolidated Bottom, US = Unconsolidated Shore). See Federal Geographic Data Committee (2013) report for subclass classification.

Cover types (NWI classes)	LSI Score
P-EM wetlands, >20 ha, and <1 km from L-AB/UB and/or P-AB/UB and/or R-AB/UB wetlands, >10 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	Higher
L-EM and/or R-EM wetlands, >20 ha, and <1km from L-AB/UB and/or P-AB/UB and/or R-AB/UB wetlands, >10 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	
P-EM and/or L-EM and/or R-EM wetlands, >20 ha, and 1–4 km from L-AB/UB and/or P-AB/UB and/or R-AB/UB wetlands, >10 ha, within sub-basins (8-digit HU) with recent breeding occurrence.	
Other P-EM and/or L-EM and/or R-EM wetlands, >20 ha, and <4 km from L-AB/UB and/or P-AB/UB and/or R-AB/UB wetlands, >10 ha, within species breeding range.	
P-EM and/or L-EM and/or R-EM wetlands, 10–20 ha, and <4 km from L-AB/UB and/or P-AB/UB and/or R-AB/UB wetlands, >10 ha, within species breeding range.	Lower

Density and distribution of breeding habitats

Wetlands with predicted highest suitability for breeding (top two habitat categories in LSI table) were extracted from the NWI. Using kernel density analysis, distribution of the most suitable habitats for Black Tern were depicted across the JV region and surrounding areas (figure below). Areas with relatively high LSI scores are also predicted to be beneficial for other breeding wetland birds using this habitat type.



Recommendations

Habitat actions: Retain habitat areas with existing colonies and target conservation where future development may encroach on colony locations. Sites with consistently high population abundance typically reflect higher habitat quality and should be emphasized, but managing to minimize predation (maintain high survival and recruitment) may be necessary. Restoration and enhancement will be required to add ≥4,400 ha of quality habitat within current breeding range. Restoration of native emergent marsh and enhancement of existing degraded wetlands through vegetation management (e.g., improved interspersion) would be a logical focus, especially in areas of recent colony abandonment. Addressing issues with sedimentation and nutrient run-off from the adjacent land and surrounding watershed is important to stem the decline of existing habitat quality for this species. Habitat quality at individual wetlands will vary over time due to annual variation in environmental conditions. Large complexes of diverse emergent marsh and open-water wetlands can better support populations under these conditions. The estimated area of high quality breeding habitat needed to support populations at JV objective levels is ≥13,200 ha. As JV partners work toward expanding habitat capacity to achieve the population abundance objective, habitat loss for this species must also be considered in the accounting process.

Monitoring and performance: In the absence of a precise population index, the BBS (coupled with Midwest Secretive Marsh Bird Survey) may be used to provide a basic regional Black Tern population trend to determine if the population in moving toward the JV breeding population objective. Eliminating the current population deficit requires a 50% population increase. Therefore, management actions should result in a 50% increase in the BBS index or an average annual increase of 3% over a 15 year period.

References

Cuthbert, F. J., and L. Wires. 2013. The fourth decadal U.S. Great Lakes Colonial Waterbird Survey (2007–2010): results and recommendations to improve the scientific basis for conservation and management. Final Report to U.S. Fish and Wildlife Service, Bloomington, Minnesota, USA.

Heath, S. R., E. H. Dunn, and D. J. Agro. 2009. Black Tern (*Chlidonias niger*), The Birds of North America Online, A. Poole, editor. Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/147doi:10.2173/bna.147

Kudell-Ekstrum, J., and T. Rinaldi. 2004. Conservation assessment for black tern *(Chlidonias niger)*. USDA Forest Service, Eastern Region, Milwaukee, Wisconsin, USA. 46pp.

Matteson, S. W., M. J. Mossman, and D. A. Shealer. 2012. Population decline of Black Terns in Wisconsin: a 30-year perspective. Waterbirds 35:185–193.

Monfils, M. J., D. B. Hayes, B. M. Kahler, and G. J. Soulliere. 2014. Evaluating marsh bird habitat use at multiple scales to inform conservation design. Michigan Natural Features Inventory, Report Number 2014-03, Lansing, Michigan, USA.

Putnam, C. 2014. A second year study of Black Terns nesting at St. Clair Flats, MI. Report to Detroit Audubon.

Sauer J. R., J. E. Hines, J. E. Fallon, K. L. Pardieck, D. J. Ziolkowski, Jr., and W. A. Link. 2014. The North American Breeding Bird Survey, Results and Analysis 1966– 2013. Laurel, Maryland: USGS Patuxent Wildlife Research Center.

Shuford, W. D. 1999. Status assessment and conservation plan for the black tern (*Chlidonias niger surinamensis*) in North America. U.S. Department of Interior, Fish and Wildlife Service, Denver, Colorado. 129pp.

Soulliere, G. J., B. A. Potter, D. J. Holm, D. A. Granfors, M. J. Monfils, S. J. Lewis, and W. E. Thogmartin. 2007. Upper Mississippi River and Great Lakes Region Joint Venture Waterbird Habitat Conservation Strategy. U.S. Fish and Wildlife Service, Fort Snelling, Minnesota, USA.

Wires, L. R., S. J. Lewis, G. J. Soulliere, S. W. Matteson, D. V. “Chip” Weseloh, R. P. Russell, and F. J. Cuthbert. 2010. Upper Mississippi Valley / Great Lakes Waterbird Conservation Plan. A plan associated with the Waterbird Conservation for the Americas Initiative. Final Report submitted to the U.S. Fish and Wildlife Service, Fort Snelling, Minnesota, USA.

Wyman, K. E. and F. J. Cuthbert. 2017. Black tern (*Chlidonias niger*) breeding site abandonment in U.S. Great Lakes coastal wetlands is predicted by historical abundance and patterns of emergent vegetation. Wetlands Ecology and Management 1-14. DOI: 10.1007/s11273-017-9537-z

Appendix B. Common and scientific names of wildlife and plants occurring in the Upper Mississippi River and Great Lakes Joint Venture region and referenced in Strategy text.

Waterbirds	
Red-throated Loon	*Gavia stellata*
Common Loon	*Gavia immer*
Pied-billed Grebe	*Podilymbus podiceps*
Horned Grebe	*Podiceps auritus*
Red-necked Grebe	*Podiceps grisegena*
Eared Grebe	*Podiceps nigricollis*
Western Grebe	*Aechmophorus occidentalis*
American White Pelican	*Pelecanus erythrorhynchos*
Double-crested Cormorant	*Phalacrocorax auritus*
American Bittern	*Botaurus lentiginosus*
Least Bittern	*Ixobrychus exilis*
Great Blue Heron	*Ardea herodias*
Great Egret	*Ardea alba*
Snowy Egret	*Egretta thula*
Little Blue Heron	*Egretta caerulea*
Cattle Egret	*Bubulcus ibis*
Green Heron	*Butorides virescens*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Yellow-crowned Night-Heron	*Nyctanassa violacea*
Yellow Rail	*Coturnicops noveboracensis*
Black Rail	*Laterallus jamaicensis*
King Rail	*Rallus elegans*
Virginia Rail	*Rallus limicola*
Sora	*Porzana carolina*
Common Gallinule	*Gallinula chloropus*
American Coot	*Fulica americana*
Sandhill Crane	*Grus canadensis*
Whooping Crane	*Grus americana*
Parasitic Jaeger	*Stercorarius parasiticus*
Franklin's Gull	*Larus pipixcan*
Bonaparte's Gull	*Larus philadelphia*
Ring-billed Gull	*Larus delawarensis*
Herring Gull	*Larus argentatus*
Great Black-backed Gull	*Larus marinus*
Sabine's Gull	*Xema sabini*
Thayer's Gull	*Larus thayeri*
Iceland Gull	*Larus glaucoides*
Lesser Black-backed Gull	*Larus fuscus*
Glaucous Gull	*Larus hyperboreus*
Little Gull	*Larus minutus*
Caspian Tern	*Sterna caspia*
Common Tern	*Sterna hirundo*
Forster's Tern	*Sterna forsteri*
Least Tern	*Sterna antillarum*
Black Tern	*Chlidonias niger*

Waterfowl	
Snow Goose, Greater	*Anser (Chen) caerulescens atlanticus*
Snow Goose, Lesser	*Anser (Chen) caerulescens caerulescens*
Ross's Goose	*Anser (Chen) rossii*
Atlantic Brant	*Branta bernicla*
Cackling Goose	*Branta hutchinsii*
Canada Goose, Temperate breeding	*Branta canadensis maxima*
Canada Goose, Sub-arctic breeding	*Branta canadensis interior*
Mute Swan (Feral)	*Cygnus olor*
Trumpeter Swan (Interior)	*Cygnus buccinator*
Tundra Swan (Eastern)	*Cygnus columbianus*
Wood Duck	*Aix sponsa*
Gadwall	*Mareca (Anas) strepera*
American Wigeon	*Mareca (Anas) americana*
American Black Duck	*Anas rubripes*
Mallard	*Anas platyrhynchos*
Blue-winged Teal	*Spatula (Anas) discors*
Northern Shoveler	*Spatula (Anas) clypeata*
Northern Pintail	*Anas acuta*
Green-winged Teal	*Anas (crecca) carolinensis*
Canvasback	*Aythya valisineria*
Redhead	*Aythya americana*
Ring-necked Duck	*Aythya collaris*
Greater Scaup	*Aythya marila*
Lesser Scaup	*Aythya affinis*
Common Eider	*Somateria mollissima*
Surf Scoter	*Melanitta perspicillata*
White-winged Scoter	*Melanitta fusca*
Common Scoter (Black Scoter)	*Melanitta nigra*
Long-tailed Duck	*Clangula hyemalis*
Bufflehead	*Bucephala albeola*
Common Goldeneye	*Bucephala clangula*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Red-breasted Merganser	*Mergus serrator*
Ruddy Duck	*Oxyura jamaicensis*
Other wildlife species	
Ring-necked Pheasant	*Phasianus colchicus*
White-tailed Deer	*Odocoileus virginianus*
Fingernail clam	*Sphaeriidae*
Zebra Mussel	*Dreissena polymorpha*
Quagga Mussel	*Dreissena rostriformis*
Crayfish	*Astacoidea*
Plants	
Reed Canary Grass	*Phalaris arundinacea*
Common Reed	*Phragmites australis*
Cattail and Hybrid Cattail	*Typha spp. and Typha glauca*
Sedges	*Cyperaceae*
Rushes	*Juncaceae*
Bulrush	*Scirpus spp.*

Appendix C. Reports and publications associated with JV evaluation needs identified in the 2007 Upper Mississippi River and Great Lakes Region Joint Venture Waterbird Habitat Conservation Strategy. Only projects with JV financial support or direct collaboration from JV staff members were included.

Climate and Birds Advisory Team. 2016. **Avian climate response models and managing landscapes for bird communities: the Climate and Birds Advisory Team sessions.** (CBAT authors – E. Babij, J. Broska, S. Finn, K. Freund, N. Hoffman, T. Jones, S. Veloz, T. Miewald, M. Rubenstein, G. Soulliere, J. Takekawa, S. Traxler, and C. Wilsey). Final report to U. S. Fish and Wildlife Service Science Applications and National Audubon Society Science Division. Falls Church, Virginia and San Francisco, California, USA. 30 pp.

Cuthbert, F. J., and L. Wires. 2013. **The fourth decadal U.S. Great Lakes Colonial Waterbird Survey (2007-2010): Results and recommendations to improve the scientific basis for conservation and management.** Final Report submitted to the U.S. Fish and Wildlife Service.

Cuthbert, F. J., and K. E. Wyman. 2016. **Historical and current Black Tern habitat relationships in the Great Lakes region.** Final report to U.S. Fish and Wildlife Service, Bloomington, Minnesota, USA.

Koch, K. E., T. Will, G. J. Soulliere, B. Bartush, R. Mordecai, and R. Brady. 2010. **Framework for the Midwest Coordinated Bird Monitoring Partnership: 2010–2012.** U.S. Fish and Wildlife Service, Fort Snelling, Minnesota, USA.

Larkin, D. J., R. S. Brady, B. M. Kahler, K. E. Koch, D. G. Krementz, M. J. Monfils, G. J. Soulliere, W. B. Webb. 2013. **Collaborative research on secretive marsh birds in the Midwest regions: linking monitoring and wetland management.** Upper Mississippi River and Great Lakes Region Joint Venture. Technical Report Number 2013-1.

Monfils, M. J. 2009. **Bird use of diked and undiked coastal wetlands in Michigan.** Dissertation, Michigan State University, East Lansing, USA.

Monfils, M. J., D. B. Hayes, B. M. Kahler, and G. J. Soulliere. 2012. **Evaluating relationships between habitat variables and marsh bird use of Great Lakes coastal wetlands at multiple scales**. Michigan Natural Features Inventory, Report Number 2012-07, Lansing, USA.

Monfils, M. J., P. W. Brown, D. B. Hayes, G. J. Soulliere, and E. N. Kafcas. 2014. **Breeding bird use and wetland characteristics of diked and undiked coastal marsh in Michigan.** Journal of Wildlife Management 78(1):79–92.

Monfils, M. J., D. B. Hayes, B. M. Kahler, and G. J. Soulliere. 2014. **Evaluating marsh bird habitat use at multiple scales to inform conservation design**. Michigan Natural Features Inventory, Report Number 2014-03, Lansing, USA.

Monfils, M. J., P. W. Brown, D. B. Hayes, and G. J. Soulliere. 2015. **Post-breeding and early fall migrant bird use and characteristics of diked and undiked coastal marsh in Michigan.** Waterbirds 38(4):373–386.

Potter, B. A., and G. J. Soulliere. 2009. **Breeding waterfowl habitat objectives accommodate other marsh birds in the Upper Mississippi River and Great Lakes Joint Venture Region.** Poster and extended abstract for Fifth North American Duck Symposium, Toronto, Ontario, Canada.

Potter, B. A., B. M. Kahler, and G. J. Soulliere. 2010. **Development of decision support tools for the Wabash River and Sugar Creek Floodplain Initiative.** Report prepared for the Indiana Department of Natural Resources.

Powers, N., M. Brouder, S. Blomquist, B. Potter, J. Dingledine, C. Deloria, G. Soulliere, T. Kerr, and K. Steiger-Meister. 2014. **Selecting surrogate species for strategic habitat conservation in**

the Upper Midwest Great Lakes geography. U.S. Fish and Wildlife Service, Midwest Region Technical Report, Bloomington, Minnesota, USA.
Stafford, J. D., M. M. Horath, A. P. Yetter, R. V. Smith, and C. S. Hine. 2007. **Historical and contemporary characteristics of Illinois River Valley wetlands: a geospatial database for conservation planning and evaluation.** Illinois Natural History Survey, Technical Report 2007 (51).
Thogmartin, W. E., B. A. Potter, and G. J. Soulliere. 2011. **Bridging the conservation design and delivery gap for wetland bird habitat conservation in the Midwestern United States.** Journal of Conservation Planning 7:1–12.
Wires, L. R., S. J. Lewis, G. J. Soulliere, S. W. Matteson, D. V. "Chip" Weseloh, R. P. Russell, and F. J. Cuthbert. 2010. **Upper Mississippi Valley / Great Lakes Waterbird Conservation Plan. A plan associated with the Waterbird Conservation for the Americas Initiative.** Final Report submitted to the U.S. Fish and Wildlife Service, Fort Snelling, Minnesota, USA.
Wyman, K. E., and F. J. Cuthbert. 2016. **Validation of landscape suitability indices for Black Terns (*Chlidonias niger*) in the U.S. Great Lakes region.** Condor 118:613–623.
Wyman, K. E., and F. J. Cuthbert. 2017. **Black tern (*Chlidonias niger*) breeding site abandonment in U.S. Great Lakes coastal wetlands is predicted by historical abundance and patterns of emergent vegetation.** Wetlands Ecology and Management 1-14.

Appendix D. Population abundance estimates for species with limited survey data, primarily secretive marsh birds, in the Upper Mississippi River and Great Lakes Joint Venture (JV) region. These very coarse estimates and related information provide a baseline for planning while improved population assessment techniques are being developed. Compiled by Robert Russell, U.S. Fish and Wildlife Service Migratory Bird Specialist (retired), Bloomington MN, July 2016.

Few waterbird species are adequately surveyed to generate accurate regional population estimates; estimates of better surveyed species can be found in the 2010 Upper Mississippi Valley / Great Lakes Waterbird Conservation Plan. Estimates for poorly surveyed species listed below were developed for the JV region using several sources, such as state Breeding Bird Atlas data, information from local surveys, and expert opinion. Population estimates (pairs) are assigned to areas of Bird Conservation Regions (BCRs) within the JV region, by states within BCR boundaries of the JV region, and for the total area of the JV region.

Pied-billed Grebe: Due to this species' wide-spread range across the Midwest, a 3x multiplier was used that assumed each bird seen at an atlas site represented two other unseen birds. For large marshes, a 10x factor was used since multiple pairs are typical for large wetland complexes. The regional estimate likely represents a minimum, since the species can be very secretive during the breeding season and can inhabit very small wetlands.
BCR 12 – **1,275** (MN–278, WI–259, MI–738)
BCR 13 – **100** (OH–100)
BCR 22 – **1,347** (KS–48, NE–45, MO–200, IA–180, MN–50, WI–12, IL–440, IN–88, OH–284)
BCR 23 – **2,711** (IA–55, MN–400, WI–560, IL–10, IN–48, MI–1,638)
BCR 24 – **80** (IN–80)
Total JV population estimate: **5,513 pairs**

Horned Grebe: Possible breeding was noted in the Boundary Waters (Superior National Forest) with a sighting of a recently fledged young (2008). Formerly this species was a local summer resident in BCRs 12, 23, and rarely 22. The species mostly breeds just west of BCR 12 in Marshall County, Minnesota (Thief Lake State Wildlife Area and Agassiz National Wildlife Refuge).
Total JV region population estimate: **1–5 pairs**.

Red-necked Grebe: A regular breeder in BCRs 12 and 23. Estimates in Minnesota reflect results of a citizen-science survey (MN DNR, 2008 - unpublished). However, many lakes where the species had been recorded in the past were not surveyed in this effort. Therefore, recorded numbers were tripled to reflect that omission. Rush Lake in BCR 23 (Wisconsin), formerly a major breeding site, has undergone restoration work in recent years but has not subsequently been surveyed. High water levels in the western third of BCR 12 the past two to three decades may be adversely affecting regional populations.
BCR 12 – **1,100** (MN–1,068, WI–20, MI–12)
BCR 22 – **8** (KS–0, NE–0, MO–0, IA–2, MN–6, WI–0, IL–0, IN–0, OH–0)
BCR 23 – **174** (IA–0, MN–162, WI–12, IL–0, IN–0, MI–0, OH–0)
Total JV population estimate: **1,282 pairs.**

Eared Grebe: The Eared Grebe breeds sporadically in the JV region in very low numbers. There are no historical records for breeding; therefore the species is believed to be a recent arrival in the region. Most breeding records occur in either sewage treatment ponds or natural shallow wetlands. No significant change has been detected in recent years although high water levels in western BCR 23 may be limiting breeding activity in that part of its range. This species may become a more common breeder in the JV region.
BCR 12 – **1** (MN–0, WI–0, MI–0-1)
BCR 22 – **2** (KS–0, NE–2, MO–0, IA–0, MN–0, WI–0, IL–0, IN–0, OH–0)
BCR 23 – **5** (IA–0, MN–0, WI–0-3, MI–0-2, IL–0, IN–0, MI–0, OH–0)
Total JV region population estimate: **8 pairs.**

Western Grebe: The Western Grebe is also a sporadic breeder in the JV region occurring in very low numbers. Except for the western part of BCR 12, there are no historical records for breeding and the species is believed to be a recent arrival in most of the region. Breeding records occur in either sewage ponds or natural shallow wetlands. Species' presence may be in response to occasional drought conditions farther west in the Dakotas and Nebraska. Small increases in BCRs 22 and 23 in Minnesota are likely attributable to MN DNR's shallow lake restoration program (e. g., Geneva Lake).
BCR 12 – **4** (MN–4, WI–0, MI–0)
BCR 22 – **12** (KS–0, NE–2, MO–0, IA–0, MN–10, WI–0, IL–0, IN–0, OH–0)
BCR 23 – **8** (IA–0, MN–6, WI–2, IL–0, IN–0, MI–0, OH–0)
Total JV region population estimate: **24 pairs.**

American White Pelican: This species has increased its range in recent years, moving eastward to the Great Lakes and Upper Mississippi River Valley. Since 2007, colonies have become established on the Mississippi River in Illinois and Iowa, on two islands in Green Bay (Lone Tree and Cat), as well as on spoil banks at Horicon NWR in Wisconsin. Colonies were also established on Little Gull Island in Bay de Noc and Little Charity Island in Saginaw Bay, Michigan. A Great Lakes survey in 2012 in Wisconsin found 818 pairs in Green Bay, but by 2015 numbers in the lower bay had grown to 8,246 pairs. The population in Minnesota has also grown substantially, with several lakes (Leech Lake, Swartout Lake, Lake of the Woods, Minnesota Lake, Pigeon Lake, Lake Johanna, and Marsh Lake) found to have large colonies in 2015.
BCR 12 – **657** (MN–617, WI–0, MI–40)
BCR 22 – **890** (KS–0, NE–0, MO–0, IA–400, MN–490, WI–0, IL–10, IN–0, OH–0)
BCR 23 – **15,349** (IA–0, MN–7,097, WI–8,246, IL–0, IN–0, MI–6, OH–0)
Total JV region population estimate: **16,896 pairs.**

American Bittern: Although vocal early in the breeding season, this species is crepuscular with its calls, and diurnal surveys may largely miss vocalizations. Values should be considered minimum estimates. The recent Minnesota Breeding Bird Atlas found a higher than expected population in the Arrowhead Region of northeast Minnesota, even in small wetlands. With many suitable wetlands not readily accessible by atlas crews, the population in that area may be double or even triple the BCR estimate. A decline noted in Michigan

may be attributed to the decreased coverage when completing the second Breeding Bird Atlas and not an actual population decline.
BCR 12 – **1,010** (MN–500, WI–150, MI–360)
BCR 13 – **6** (OH–6)
BCR 22 – **113** (KS–4, NE–8, MO–12, IA–26, MN–4, WI–2, IL–32, IN–13, OH–12)
BCR 23 – **438** (IA–8, MN–200, WI–112, IL–2, IN–6, MI–100, OH–10)
BCR 24 – **6** (IN–6)
Total JV population estimate: **1,573 pairs**

Least Bittern: Due to the broad range of this species within the Midwest, a multiplication factor of 5x was used (assumed each bird recorded at an atlas site represented 4 additional birds). The regional estimate likely represents a minimum since the species only sporadically calls during the breeding season and is notoriously hard to census, even when present in high numbers. Least Bitterns also breed in very small wetlands not often visited by survey crews. Populations appear stable.
BCR 12 – **175** (MN–40, WI–20, MI–115)
BCR 13 – **35** (OH–35)
BCR 22 – **680** (KS–25, NE–20, MO–200, IA–75, MN–30, WI–10, IL–165, IN–55, OH–100)
BCR 23 – **935** (IA–30, MN–125, WI–410, IL–10, IN–20, MI–330, OH–10)
BCR 24 – **80** (IN–80)
Total JV population estimate: **1,905 pairs**

Yellow Rail: This species may readily move locally from site to site, seeking adequate water levels and suitable habitat, and confounding surveys during the breeding season. Data is inadequate to generate a population trend in the region with only a few new occurrence sites located per decade. Long-occupied sites like Crex Meadows State Wildlife Area in Wisconsin appear to have declining numbers, but this seems to be balanced by newly discovered populations elsewhere. Birds were found at Sherburne NWR in Minnesota following a recent very wet spring, but they did not return the following year. Brush invasion may be a factor inhibiting the population in the Seney National Wildlife Refuge in Michigan's Upper Peninsula**,** requiring periodic controlled burns. For other sites, a multiplication factor of 5x was used assuming that each calling male represents a minimum of 5 males and 5 females. The regional estimate likely represents a minimum since the species calls for only a short period of time in late spring and early summer.
BCR 12 – **490** (MN–300, WI–110, MI–80)
BCR 13 – extirpated, no recent records
BCR 22 – extirpated, no recent records
BCR 23 – **50** (IA–0, MN–40, WI–10, IL–0, IN–0, MI–0, OH–0)
Total JV population estimate: **540 pairs**

Black Rail: In addition to Breeding Bird Atlases, state bird books, and eBird, observations noted in the journal *North American Birds* were used to generate estimates for this secretive species. For states with regular or even irregular occurrence, a rough pair estimate was developed. The almost annual appearance of this species somewhere in the southern Lake Michigan region from Berrien County, Michigan, around to Milwaukee, Wisconsin, suggests a breeding population somewhere to the north. These migrants have occurred here for many

decades, but their source is still unknown. Goose Pond State Wildlife Area in Indiana has proven to be a nearly annual source of spring migrant records. However, efforts to document these birds in June as a breeding population have failed. Observers believe water levels may be too "flashy" to support this species as they favor extremely shallow waters in short-grass marshes and spring runs. The wetland complex around Farina, Fayette County, Illinois, recently held several pairs of spring and summer birds, and this site should be more closely monitored. Confidence in estimates for this species is especially low.
BCR 12 – **4** (MN–0, WI–2, MI–2)
BCR 13 – **4** (OH–4)
BCR 22 – **36** (KS–0, NE–0, MO–10, IA–4, MN–4, WI–2, IL–10, IN–4, OH–2)
BCR 23 – **16** (IA–0, MN–2, WI–10, IL–0, IN–2, MI–0, OH–2)
BCR 24 – **0** (IN–0)
Total JV population estimate: **60 pairs**

King Rail: Estimates are based on the 2003 report *Status of King Rails in the Mississippi Flyway* written for the Mississippi Flyway Council Technical Section. Population estimates in the paper were provided as ranges (i.e., 10–15 pairs), but the mid-point of those ranges was used in the initial population estimate. Raised awareness of the conservation needs of this species has led to considerable research over the past decade and towards a more accurate Midwest estimate.
BCR 12 – **0** (MN–0, WI–0, MI–0)
BCR 13 – **0** (OH–0)
BCR 22 – **76** (KS–2, NE–0, MO–20, IA–6, MN–0, WI–4, IL–36, IN–6, OH–2)
BCR 23 – **62** (IA–7, MN–6, WI–24, IL–2, IN–6, MI–11, OH–6)
BCR 24 – **7** (IN–7)
Total JV population estimate: **145 pairs**

Virginia Rail: Due to the broad range of this species within the Midwest, a multiplication factor of 4x was used that assumed each bird recorded at an atlas site represented 3 additional birds. The regional estimate likely represents a minimum since the species only sporadically calls during the breeding season and is difficult to survey, even when present in high numbers.
BCR 12 – **2,904** (MN–1,584, WI–840, MI–480)
BCR 13 – **80** (OH–80)
BCR 22 – **640** (KS–20, NE–28, MO–20, IA–56, MN–120, WI–16, IL–200, IN–100, OH–80)
BCR 23 – **2,136** (IA–36, MN–400, WI–956, IL–10, IN–28, MI–620, OH–50)
BCR 24 – **24** (IN–24)
Total JV population estimate: **5,784 pairs**

Sora: Due to the broad range of this species within the Midwest, a multiplication factor of 3x was used that assumed each bird recorded at an atlas site represented 3 additional birds. The regional estimate likely represents a minimum since the species only sporadically calls during the breeding season and is difficult to survey, even when present in high numbers. This species is not well represented by atlas data, as multiple occurrences within a block can result in under-estimates.
BCR 12 – **5,410** (MN–2,080, WI–2,430, MI–900)

BCR 13 – **75** (OH–75)
BCR 22 – **1,510** (KS–3, NE–15, MO–9, IA–198, MN–360, WI–20, IL–620, IN–210, MI–30, OH–45)
BCR 23 – **3,268** (IA–20, MN–540, WI–1,845, IL–12, IN–80, MI–519, OH–252)
BCR 24 – **60** (IN–60)
Total JV population estimate: **10,323 pairs**

Common Gallinule: This species has a wide range across the Midwest, and a multiplication factor of 10x was used that assumed each bird recorded at an atlas site represented 9 additional birds. The regional estimate likely represents a minimum since the species only sporadically calls and is notoriously hard to survey, even when present in high numbers. The species appears to be having minor population resurgence at more northern sites and some formerly abandoned sites now being recolonized. Whether this is due to a moderating climate or better management of existing sites or a combination of factors is unknown.
BCR 12 – **40** (MN–0, WI–0, MI–40)
BCR 13 – **200** (OH–200)
BCR 22 – **844** (KS–30, NE–20, MO–100, IA–74, MN–10, WI–10, IL–400, IN–70, MI–10, OH–130)
BCR 23 – **1,120** (IA–20, MN–40, WI–410, IL–0, IN–70, MI–430, OH–150)
BCR 24 – **50** (IN–50)
Total JV population estimate: **2,254 pairs**

American Coot: Due to the broad range of this species within the Midwest, a multiplication factor of 5x was used that assumed each bird recorded at an atlas site represented 4 additional birds. This species is usually more conspicuous during the breeding season than its relative, the Common Gallinule. The regional population estimate likely represents a minimum since the species only sporadically calls during the breeding season. In the southern part of the JV region, coots are sporadic breeders during very wet and/or cool years and nearly absent during dry and/or warm years. There has been a significant decline in the number of breeding sites across the northern part of the JV region since the 2007 estimate, but numbers at major sites (5+ pairs) have increased as the birds seem to be concentrating at high quality wetlands.
BCR 12 – **520** (MN–200, WI–200, MI–120)
BCR 13 – **25** (OH–25)
BCR 22 – **1,235** (KS–60, NE–45, MO–55 (100-250 in wet years), IA–365, MN–125, WI–20, IL–400, IN–105, OH–60)
BCR 23 – **2,905** (IA–30, MN–400, WI–1,900, IL–5, IN–50, MI–400, OH–120)
BCR 24 – **60** (IN–60)
Total JV population estimate: **4,745 pairs**

Appendix E. Waterfowl habitat restoration and retention objectives (Tables E-1 and E-2, respectively) from the Upper Mississippi River and Great Lakes Region Joint Venture Waterfowl Habitat Conservation Strategy – 2017 Revision, by state and Bird Conservation Region. Values for each category represent high quality habitat for associated bird guilds in wetland area only and presented in hectares (1 ha = 2.5 acres). This information can be used to supplement JV regional waterbird habitat planning, especially during the non-breeding period; non-breeding waterbird habitat objectives were not quantified due to lack of non-breeding population and habitat data.

Table E-1. Estimated wetland restoration requirements by State and Bird Conservation Regions (BCR) reflecting waterfowl *habitat deficits*, the estimated area of new habitat needed to increase landscape carrying capacity if breeding and non-breeding population objectives are to be acheived in the Upper Mississippi River and Great Lakes Joint Venture (JV) region. Values reflect breeding (B) vs. non-breeding (N) habitat needed in each wetland category for each State x BCR sub-region (see 2017 JV Waterfowl Strateegy for more details). Values are wetland area only, presented in hectares (1 ha = 2.5 acres).[a]

		Emergent		Forested		Aquatic Bed	Unconsolidated (open water)
State and BCR[a]		B	N	B	N	N (only)	N (only)
Iowa	22	6,937	2,079	2,140	496	4,988	11,132
	23	4,376	172	728	41	412	921
Illinois	22	9,789	2,933	3,019	700	7,038	15,709
	23	2,046	80	340	19	193	431
Indiana	22	3,442	1,031	1,062	246	2,475	5,524
	23	8,703	342	1,447	82	820	1,831
	24	186	842	833	201	2,020	4,508
Kansas	22	5,224	1,565	1,611	373	3,755	8,382
Michigan	12	--	--	--	--	--	--
	23	43,979	1,728	7,314	412	4,145	9,252
Minnesota	12	--	--	--	--	--	--
	22	614	184	189	44	441	985
	23	15,760	619	2,621	148	1,486	3,316
Missouri	22	6,557	1,965	2,023	469	4,714	10,522
Nebraska	22	1,754	526	541	125	1,261	2,815
Ohio	13	5,218	516	416	123	1,238	2,763
	22	3,138	940	968	224	2,256	5,036
	23	7,754	305	1,290	73	731	1,631
Wisconsin	12	--	--	--	--	--	--
	23	58,820	2,311	9,782	551	5,544	12,375
Total		184,300	18,136	36,325	4,328	43,518	97,132

[a]Habitat restoration objectives disributed across BCRs 23, 22, 13, and 24 based on current distribution of breeding ducks (B) and by sub-region area size for non-breeding habitat (N); habitat restoration objectives not distributed to BCR 12.

Table E-2. Estimated wetland retention requirements to support breeding and non-breeding waterfowl population abundance objectives in the Upper Mississippi River and Great Lakes Joint Venture (JV) region by state and Bird Conservation Region (BCR). Values represent breeding (B) vs. non-breeding (N) habitat needed in each wetland category for each State x BCR sub-region (See 2017 JV Waterfowl Strategy for more details). Values are wetland area only (upland nest cover not included) presented in hectares (1 ha = 2.5 acres).[a]

		Emergent		Forested		Aquatic Bed		Unconsolidated (open water)
State and BCR		B	N	B	N	B	N	N (only)
Iowa	22	21,868	6,660	6,686	23,372	--	14,616	79,663
	23	13,794	551	2,274	1,933	3,620	1,209	6,588
Illinois	22	30,858	9,398	9,434	32,979	--	20,624	112,411
	23	6,451	258	1,063	904	1,693	565	3,081
Indiana	22	10,851	3,305	3,318	11,597	--	7,253	39,529
	23	27,433	1,095	4,522	3,844	7,199	2,404	13,102
	24	587	2,697	2,602	9,465	--	5,919	32,260
Kansas	22	16,466	5,015	5,034	17,598	--	11,005	59,982
Michigan	12	81,338	5,857	16,430	20,553	101,193	12,853	70,054
	23	138,632	5,535	22,853	19,425	36,380	12,148	66,209
Minnesota	12	87,290	6,285	17,632	22,057	108,598	13,794	75,181
	22	1,935	589	591	2,068	--	1,293	7,048
	23	49,680	1,984	8,190	6,961	13,037	4,353	23,727
Missouri	22	20,670	6,295	6,319	22,090	--	13,815	75,296
Nebraska	22	5,530	1,684	1,691	5,910	--	3,696	20,143
Ohio	13	16,448	1,653	1,301	5,801	15,600	3,628	19,773
	22	9,893	3,013	3,025	10,573		6,612	36,039
	23	24,444	976	4,029	3,425	6,415	2,142	11,674
Wisconsin	12	48,717	3,508	9,841	12,310	60,609	7,698	41,958
	23	185,415	7,403	30,565	25,980	48,657	16,247	88,552
Total		798,300	73,762	157,400	258,842	403,000	161,872	882,269

[a]Distribution of JV breeding habitat retention objectives (B columns) across State x BCR polygons based on current distribution of breeding ducks; distribution of non-breeding habitat (N columns) based on area of sub-region, resulting in greatest emphasis in BCR 22. Upland herbaceous nesting cover is also required (≥1 ha upland cover/wetland ha) for breeding guilds dependent on emergent wetland (Emergent-B column).

Appendix F. Site assessment framework for scoping wetland restoration projects for Strategic Habitat Conservation.

Large wetland restoration projects typically employ conservation grant funding along with significant match in the form of financial and human resources from partner organizations. The following steps serve as examples for conducting more thorough site suitability assessments for conservation projects, improving the scientific basis for project proposals and helping assure best use of technical information when completing conservation grant applications. These steps also are intended to improve decision-making in a business context. The best conservation investment at some locations may be to take no action, resulting in more resources to focus on other potential opportunities with higher net return on investment. Return on investment should consider both biological factors (e.g., waterbird recruitment and survival) and social factors (e.g., hunting, viewing, and ecological goods and services). See Strategy section "Targeting Conservation for Waterbirds and People" for more details.

Initial Inventory and Planning

1. Evaluate wetland occurrence within proposed project boundary as well as hydrologically connected surroundings – use latest NWI, soils, and cover type images.
2. Review relevant Natural Features Inventory for known rare species and community occurrences at site and surrounding landscape.
3. Complete a site assessment with a wetland scientist or restoration ecologist using NWI and other cover type information; this should include walking / traversing representative portions of the proposal area and recording characteristics important to proposal assessment:
    a. Record topography, current vegetative and wetland plant coverage, and inundation, plus rare species and community occurrences, but consider current hydrology, the dynamic nature of areas connected to rivers and lakes, and how proposal site will change with fluctuating environmental conditions, particularly levels of precipitation.
    b. Evaluate site and surrounding soil types, area hydrology, and primary anthropogenic influences on hydrology (ditches, roads/trails, lake connections) – county soils maps provide extensive soils information including ponding / water holding capacity, chemistry (acidic vs. basic), and predicted wildlife values.
4. Evaluate fish/wildlife population data and other biological survey data collected at site and nearby sites (if available), providing a larger scale perspective for potential proposal area.
5. Evaluate history of land cover, past and recent land management influencing flora and fauna, and current land use, to predict wetland and wildlife community conditions likely to occur long-term (20–50 years) with and without a potential conservation action.
6. Assess site for potential archaeological or cultural historic significance that may influence project decisions, typically working with state experts (e.g., State Historic Preservation Office).

7. Using above information, develop initial predictions of potentially restorable wetland area, wetland type, and wetland quality (based on common wetland functions and values) for preliminary project design. A group of expert wetland and wildlife scientists collaborating for a few hours should be able to develop a valuable rapid prototype model with outcome predictions (restoring degraded wetland functions and values would be a typical theme).
8. If predicted net change in functioning wetland quantity (area) and quality (e.g., value to wetland birds) is considered substantially positive based on initial rapid-prototype model, complete next steps in collecting technical information and filling information gaps.

Filling Technical Information Gaps

1. If wildlife population (occurrence) or demographic (recruitment, survival) data do not exist for the site or nearby areas, determine what survey data would be needed to better assess outcomes resulting from a proposed project (e.g., outcomes might be focal species population response to habitat change). Monitoring projects should be designed collaboratively with biologists and statisticians to ensure data can be used for effective decision making.
2. A hydrogeomorphic study should be completed for large, potentially costly restoration proposals. This effort will be expensive (up front), but understanding inter-relationships between soils/topography/hydrology/and dynamics of contiguous aquatic and terrestrial systems can save significantly on long-term costs over a poorly designed project completed without this key information.
3. Review regional, state, and or local plans for wildlife conservation, environmental goods and services (e.g., water filtration, erosion control, open space), recreation, and other factors identified as important, and develop site-specific objectives in the context of larger scales and surrounding.
4. Engage wetland regulation experts early in proposal development to determine if proposed project includes potential obstacles or features that require modifications to meet local, state, and federal rules.

Conservation Design

1. Using objective variables (e.g., breeding waterfowl populations, water quality values), current relevant biological data (e.g., wildlife population abundance for focal or surrogate species), social data (e.g., current and potential hunter / bird viewer days), and cover-type spatial data, develop a decision support system to help determine if project will achieve identified objectives.
2. Based on original and new planning information (survey data and hydrologic study) evaluate whether preliminary project design is a cost effective means to achieve objectives (e.g., adequate net positive change for focal species and human populations).
3. Quantify science-based estimates of short-term and long-term population response (i.e., JV focal species) to potential project; habitat improvements for some wildlife species invariably result in habitat loss for others – habitat cannot simultaneously be improved for all species of wildlife.

4. Compare costs and predicted outcome tradeoffs (consequences) of this proposed project to other potential projects under consideration to assess opportunity costs among multiple projects.
5. Reengage pool of wetland and wildlife scientists (#7 above) to review and debate potential alternative projects and consequences in the context of biological planning and conservation design steps above, and recommend a plan of action (or no action) for review site.

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