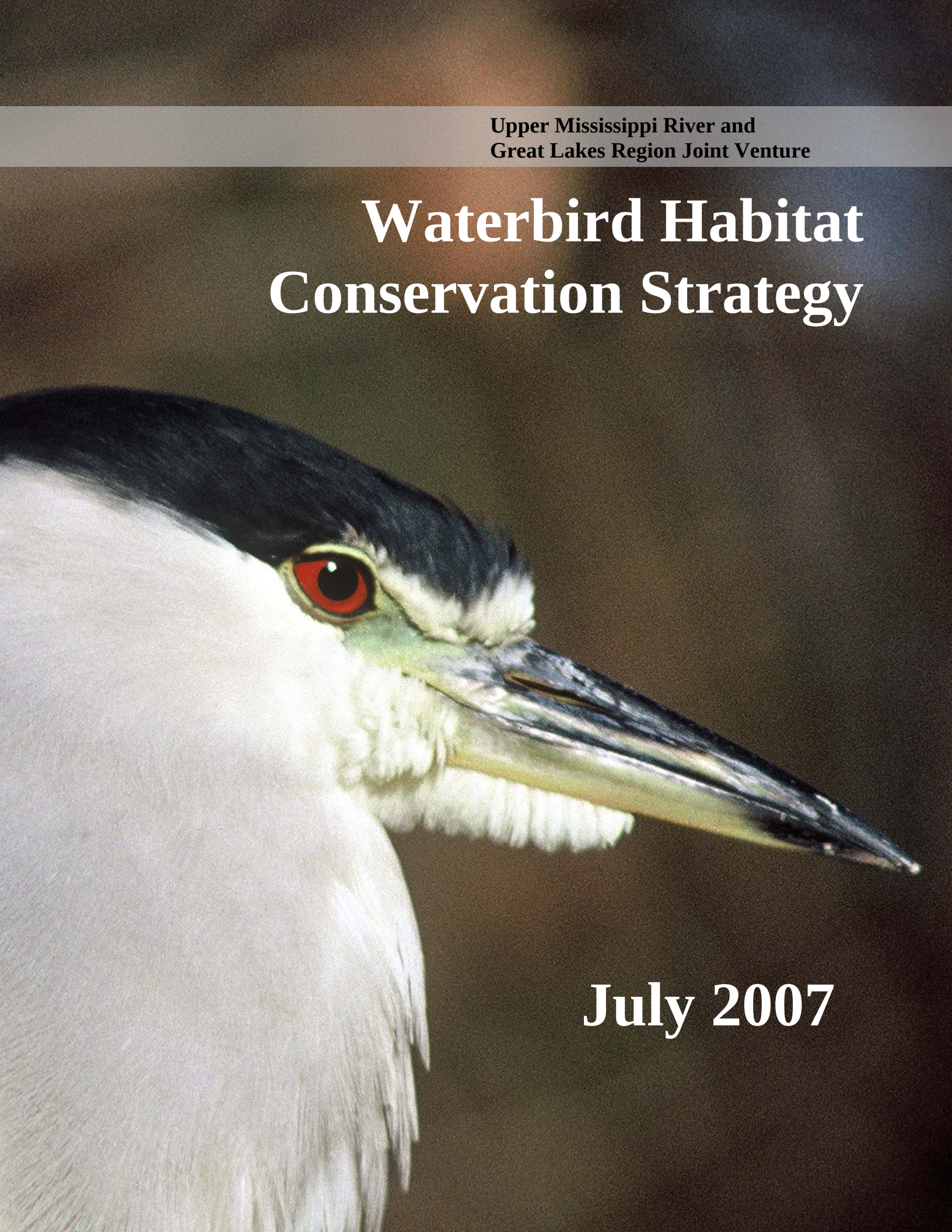
Upper Mississippi River and
Great Lakes Region Joint Venture

Waterbird Habitat Conservation Strategy



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Plan Summary

Bird habitat conservation is typically implemented at local scales, but avian ecologists have recognized the need to integrate continental migratory bird priorities into local habitat recommendations. In this strategy we attempt to "step-down" continental waterbird conservation priorities to the Joint Venture (JV) region and to smaller scales within the region, providing wildlife managers guidance in designing landscapes with greater value to birds. We estimated what, where, when, and how much habitat is needed to increase and sustain populations of priority waterbird species at target levels. The strategy goal is to *"Establish efficient habitat conservation to maintain or increase carrying capacity for populations of priority waterbird species consistent with continental and JV regional goals."*

Population estimates and objectives are continually being refined for waterbirds, and we recognize population estimates used in this strategy may soon be dated. Nonetheless, science-based recommendations were developed to efficiently and effectively increase landscape carrying capacity through waterbird habitat protection, restoration, and enhancement. In addition, this document was developed to complement JV habitat conservation strategies for waterfowl, shorebirds, and landbirds.

In order to scientifically link population and habitat objectives for this diverse bird group, several "JV focal species" were selected for habitat planning and monitoring. Each JV focal species represents a primary cover type used during the breeding season. We assumed habitat actions designed for JV focal species would accommodate populations of other breeding waterbirds within designated guilds. Migration requirements were not assessed due to lack of information; migration habitat planning will be addressed in future iterations of this strategy.

Regional waterbird population and habitat trends, in concert with population estimates and an assessment of limiting factors, provide a biological planning foundation. Planning steps included characterizing and assessing the landscape for JV focal species, modeling population response, identifying conservation opportunities, and developing an initial landscape design with capacity expected to sustain current waterbird populations plus eliminate population deficits. Much of the technical information, including habitat models and decision support maps, appears in JV focal species accounts (Appendix A). Sections on monitoring and research needs, adaptive management, and program coordination are also provided.

Our intent in this JV Waterbird Habitat Conservation Strategy is to establish explicit regional goals for waterbird habitat conservation and identify and use available survey data and new technological tools to efficiently achieve those goals. Lack of population and ecological information for many species was a significant planning challenge. However, we establish a scientific process for habitat objective-setting plus identify assumptions and research needs to improve subsequent iterations of the strategy. This plan is a "living document" that will be refined periodically as knowledge of

regional waterbird conservation improves and new spatial data becomes available and can be incorporated.

Acknowledgements: Bob Russell (U.S. Fish and Wildlife Service) provided waterbird population estimates and distribution information for several poorly surveyed species plus a valuable review of an early version of the strategy. Helpful review comments were also provided by Kelly Millenbah (Michigan State University); Linda Wires and Francie Cuthbert (University of Minnesota); Jennifer Wheeler, Neal Niemuth, Jeff Kiefer, and Gwen Kolb (U.S. Fish and Wildlife Service); John Castrale (Indiana Department of Natural Resources); Mike Eichholz (Southern Illinois University); John Coluccy (Ducks Unlimited, Inc.); and Rachel Bricklin (Eastern Michigan University).

Background and Context

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, bitterns, and cranes; see Appendix B for scientific names). Other waterbirds (loons and grebes) do not fit either group, and solitary, semi-colonial, and colonial social behaviors exist within all recognized groups. Some species, such as the Great Blue Heron and Great Egret, are at the northern edge of their range in the Upper Mississippi River and Great Lakes region. Others breed farther north and depend on the region for migration habitat.

Colonial waterbirds are characterized by strong aggregative behavior. Some species form large nest colonies and roost sites with hundreds or thousands of individuals, making these birds highly 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 within good feeding territories. Conversely, marshbirds are typically inconspicuous and accomplish reproduction and foraging unnoticed. Marshes and wet meadows dominated by stands of mixed-height emergent vegetation are 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 waterfowl, shorebirds, landbirds, and waterbirds. 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 (JVs) 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-group plans to the JV region. The goal of this strategy is to ***"Establish efficient habitat conservation to maintain or increase carrying capacity for populations of priority waterbird species consistent with continental and JV regional goals."***

The North American Waterbird Conservation Plan (NAWCP), Version 1, was developed to provide continental perspective on the status and conservation of colonial-nesting waterbirds (Kushlan et al. 2002). Supplements to the NAWCP are being developed and will include status and conservation guidance on non-colonial waterbirds: marshbirds, loons, and cranes. The NAWCP does not establish population or habitat goals due to the high level of uncertainty associated with continental waterbird populations. However, continental-scale population estimates and a conservation status assessment were completed for colonial and marshbird species.

The NAWCP divides the continent into 16 waterbird planning regions. The Upper Mississippi Valley / Great Lakes (UMVGL, Figure 1) planning region lies in the

middle of North America and provides breeding and migration habitat to over 40 species of waterbirds (Table 1). The UMVGL waterbird region encompasses the following Bird Conservation Regions (BCRs) recognized by the NABCI: 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).

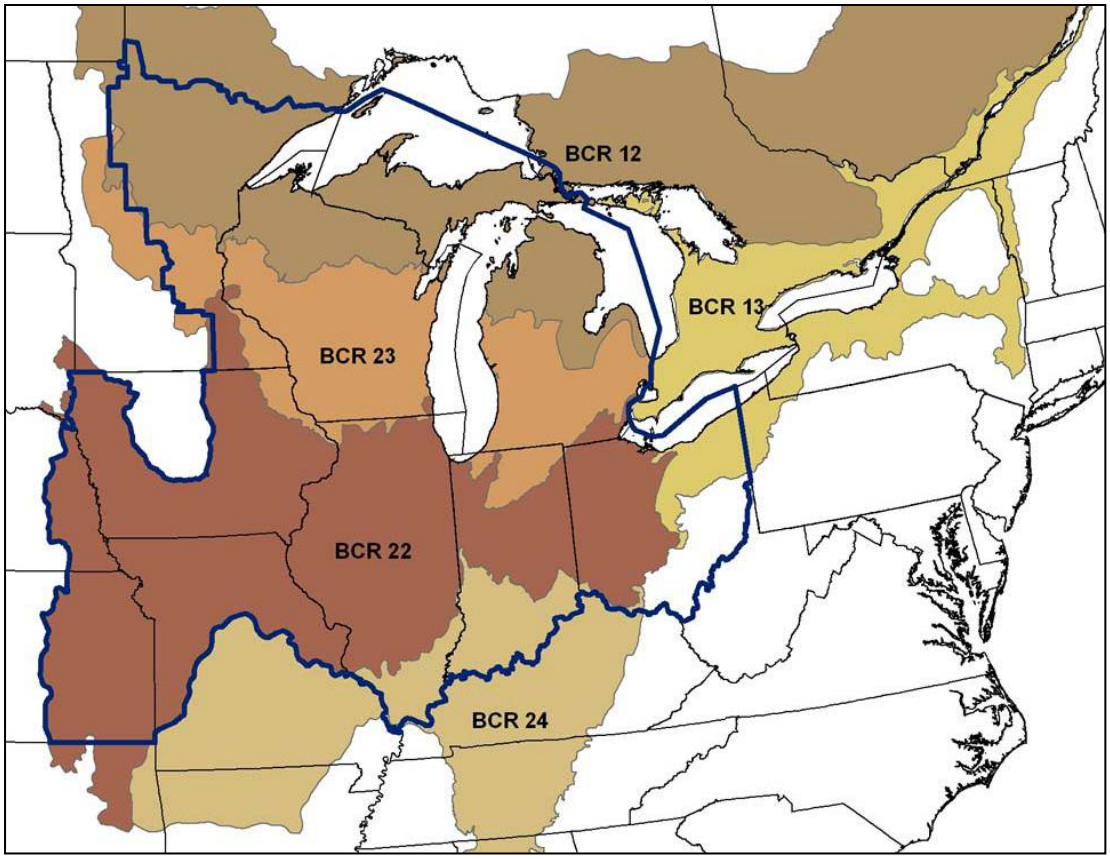


Figure 1. Boundaries for the Upper Mississippi Valley / Great Lakes (UMVGL) waterbird planning region and associated Bird Conservation Regions (BCRs), plus the area encompassed by the Upper Mississippi River and Great Lakes Joint Venture (JV) region (blue line). The JV region largely consists of BCRs 22 (Eastern Tallgrass Prairie), 23 (Prairie Hardwood Transition), and the U.S. portion of 12 (35%, Boreal Hardwood Transition). Portions of BCR 24 (19%, Central Hardwoods), 13 (11%, Lower Great Lakes / St. Lawrence Plain), and 28 (7%, Appalachian Mountains) also are within the JV boundary. Southeast Ohio (part of BCR 28) is not within the UMVGL shorebird region but is part of the JV region.

A UMVGL regional waterbird conservation plan was recently developed (Wires et al., in review). The plan describes 1) occurrence, abundance, and threats to waterbird species that regularly occur in the UMVGL region, 2) population estimates for well surveyed species, 3) historic and current waterbird population trends, 4) habitat preferences, and 5) waterbird conservation, management, and stewardship priorities by BCR. The west side of the UMVGL planning region largely overlaps the JV region (Figure 1). Information in the draft UMVGL plan was especially valuable when developing this JV Waterbird Habitat Conservation Strategy.

Table 1. Seasonal occurrence, relative abundance, and nesting strategy of waterbirds listed by Bird Conservation Region (BCR), taken largely from the Upper Mississippi Valley / Great Lakes Regional Waterbird Plan (Wires et al., in review)[a].

Name	Boreal Hardwood Transition (BCR 12)	Lower Great Lakes / St. Lawrence Plain (BCR 13)	Eastern Tall Grass Prairie (BCR 22)	Prairie Hardwood Transition (BCR 23)	Central Hardwoods (BCR 24)	Nesting strategy[b]
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	b, 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	b		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	b, m	b, m	C
Cattle Egret	b, 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	B, m	C
Yellow Rail	**B**	b, m	m	B, m	m	N
Black Rail			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 Moorhen	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	M	M	N
Parasitic Jaeger	*M*	*M*	*m*	*m*		C/N
Franklin's Gull	*M*	*M*	*m*	*m*	*m*	C
Bonaparte's Gull	*w, 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

Name	Boreal Hardwood Transition (BCR 12)	Lower Great Lakes / St. Lawrence Plain (BCR 13)	Eastern Tall Grass Prairie (BCR 22)	Prairie Hardwood Transition (BCR 23)	Central Hardwoods (BCR 24)	Nesting strategy[b]
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]Seasonal occurrence and relative abundance categories: B = Breeding, M = Migration, W = Wintering. **B, M, W** = high concentrations, region is extremely important to the species relative to most other regions; B, M, W = common or locally abundant, region is important to the 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* = status as breeder, migrant, or wintering bird is known but abundance relative to other regions is not known.

[b]Nesting strategy includes colonial (C) and non-colonial (N) or both (C/N); when the degree of coloniality varies the most typical behavior is listed first.

The JV region has a variety of waterbird nesting, roosting, and foraging habitats, including islands, natural and managed wetlands, lakes and shorelines, reservoirs, rivers and floodplains, gravel bars, beaches, and the Great Lakes. Wetlands and open water associated with Great Lakes and "big rivers" (Mississippi, Illinois, Ohio, and Missouri Rivers) provide much of the important waterbird habitat in the region. Using coarse estimates of continental (Kushlan et al. 2002) and regional (Wires et al., in review) breeding abundance, the area within the JV region accommodates ≥10% of the North American Caspian, Forster's, and Black Tern populations as well as the 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. Besides containing important breeding habitat, the JV region also provides migration corridors, staging areas, and even wintering grounds for some species. Non-breeding season habitat needs are not addressed in this JV strategy, but will be incorporated into future plan iterations. For now, breeding habitat objectives, plus migration habitat objectives for waterfowl and shorebirds, are assumed to accommodate waterbirds during the non-breeding season.

This JV Waterbird Habitat Conservation Strategy complements the NAWCP and UMVGL plans but has a different focus. The goal is to provide a science- and partnership-based action plan for waterbird habitat conservation. Explicit habitat objectives were generated and are directly linked to population objectives. Habitat requirements to meet population goals and a scheme to target conservation actions were developed with simple biological models. The process resulted in identification of information gaps and key research and monitoring needs. This waterbird strategy is a living document and will be adjusted periodically as knowledge of regional waterbird conservation improves.

Population and Habitat Trends

Many waterbird species receive only limited survey coverage and regional population estimates have not been generated from current monitoring data. Their generally low numbers, remote but often concentrated nesting sites (i.e., colonial species), or secretive behavior make the North American Breeding Bird Survey (BBS) an inadequate sampling technique for many species. However, the more vocal and visible waterbirds are regularly recorded on BBS routes, allowing a population trend or index to be established over time. Current trend data reveal individual species both increasing and decreasing during the past 50 years (Table 2).

Table 2. Long term (1966-2005) and short term (1996-2005) population trend estimates (annual % change) for waterbird species that breed within FWS Region 3[a] based on the North American Breeding Bird Survey (BBS, Sauer et al. 2006).

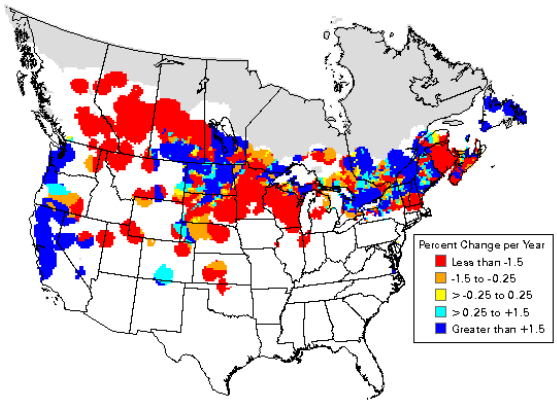
	1966-2005			1996-2005		
Species	Trend	p-value[b]	n[c]	Trend	p-value	n
Common Loon	1.3	0.12	90	2.8	0.10	66
Pied-billed Grebe	-2.7	0.07	86	-6.5	0.37	31
Red-necked Grebe	27.1	0.51	4	15.9	0.50	4
Western Grebe	na	na	na	na	na	na
American White Pelican	21.9	0.09	20	18.6	0.14	17
Double-crested Cormorant	6.0	0.11	58	-11.2	0.06	33
American Bittern	-5.0	0.00	116	6.7	0.28	42
Least Bittern	-6.8	0.25	6	na	na	na
Great Blue Heron	3.1	0.00	542	-1.2	0.22	438
Great Egret	9.7	0.00	61	11.4	0.05	39
Snowy Egret	na	na	na	na	na	na
Little Blue Heron	-0.5	0.91	11	-1.4	0.53	7
Cattle Egret	2.6	0.33	11	-8.2	0.31	8
Green Heron	-0.7	0.21	399	0.1	0.93	239
Black-crowned Night-Heron	0.9	0.50	28	-7.6	0.43	8
Yellow-crowned Night-Heron	-5.2	0.20	3	na	na	na
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	-3.2	0.11	19	43.3	0.12	2
Sora	-2.5	0.10	86	-3.6	0.39	32
Common Moorhen	10.6	0.44	11	na	na	na
American Coot	-5.5	0.00	44	-5.4	0.27	11
Sandhill Crane	9.7	0.00	121	5.9	0.00	115
Ring-billed Gull	3.8	0.16	114	-1.1	0.57	70
Herring Gull	-5.7	0.02	49	5.0	0.73	26
Great Black-backed Gull	na	na	na	na	na	na
Caspian Tern	-14.8	0.05	6	na	na	na
Common Tern	na	na	na	na	na	na
Forster's Tern	3.8	0.22	9	14.5	0.10	4
Least Tern	na	na	na	na	na	na
Black Tern	-5.6	0.00	76	3.6	0.52	25

[a]FWS Region 3 includes the following states: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin.
[b]p-values represent confidence in trend direction with values closer to 0.0 reflecting a greater degree of confidence in the trend; for example, values <0.05 reflect >95% confidence in trend direction.
[c]n = number of BBS routes used for regional trend average. Results based on few (<20) routes may be of questionable value as a regional trend indicator.
[d]na = inadequate survey data to generate a trend estimate.

Standardized survey techniques were recently developed to improve monitoring of marshbirds (Conway 2004) via the Marsh Monitoring Program (MMP). Participants in the MMP have been gathering data on breeding marshbirds at coastal wetlands around the Great Lakes basin since 1995. Their findings suggest significant basin-wide declines in abundance indices (1995-2003) for Pied-billed Grebe, American Bittern, Least Bittern, Sora, Virginia Rail, Common Moorhen, and Black Tern (Crewe et al. 2005).

Like most wildlife populations, waterbird trends largely reflect the abundance of quality habitat, and breeding habitat quality is often related to water levels, precipitation, and recent climatic conditions. Several species that depend on emergent wetlands (e.g., American Bittern) appear to be declining in number, presumably due to habitat change. Marshbird population trends are almost surely linked to loss in quantity (Dahl 2000) and quality of shallow marsh wetlands across the region, especially in areas with intensive agriculture and high human densities (Figure 2a). Conversely, populations of other waterbirds (e.g., Double-crested Cormorant, Ring-billed Gull) have increased in recent decades (Figure 2b), likely due to positive environmental change: lower contaminant levels in breeding habitats, increasing food resources at breeding and non-breeding sites, and higher reproductive rates. In some locations these increasing species have exceeded a "social carrying-capacity" or the threshold where human-bird conflicts are considered unacceptable.

a)



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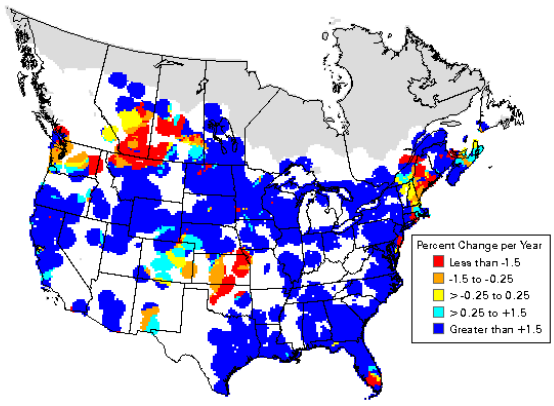


Figure 2. Population trends of a) American Bittern and b) Double-crested Cormorant, 1966-2003. Regions of increasing population change are represented by blue and decreasing population changes by red (Sauer et al. 2004).

Although the area and rate of wetland loss has slowed in recent years, agricultural conversion and urban and rural development continue to reduce the amount of emergent herbaceous wetland (Dahl 2006, Ducks Unlimited 2005) potentially available to waterbirds. Other less direct human-induced changes to the environment may be degrading habitat insidiously. These factors include wetland acidification, spread of exotic plant species, conversion of marsh to open water, climate change, and other threats (Appendix C). Whereas acid precipitation and exotic species are considered universally negative for waterbirds, a warming climate may be causing the observed range expansion northward of several traditionally southern species (e.g., Great and Cattle Egrets). Moreover, islands constructed from dredge spoil, wetland and grassland restoration, and pond/impoundment creation (Dahl 2006) are examples of human influences providing additional waterbird habitat in some areas.

Healthy and productive wetlands, open-water/island complexes, and riparian areas are the foundation for sustainable breeding waterbird populations in the JV region. However, the area also is important during spring and fall when waterbirds are moving between breeding and wintering areas outside the region. During this time they appear to favor Great Lakes coastal areas, big river systems, and larger inland wetlands for staging. Water availability and habitat quality in other areas of the continent can influence reproductive success and size of migrating populations using the JV region during the non-breeding season, thus migration habitat needs may vary annually.

The Great Lakes coastal zone may be the area of greatest importance for combined breeding and migratory waterbird habitat within the JV region. Its vast natural communities are relatively intact in the north part of the region but increasingly influenced by development in the south. Fluctuating water levels in the Great Lakes (Figure 3) result in dynamic waterbird habitat values over time. Changes in water levels

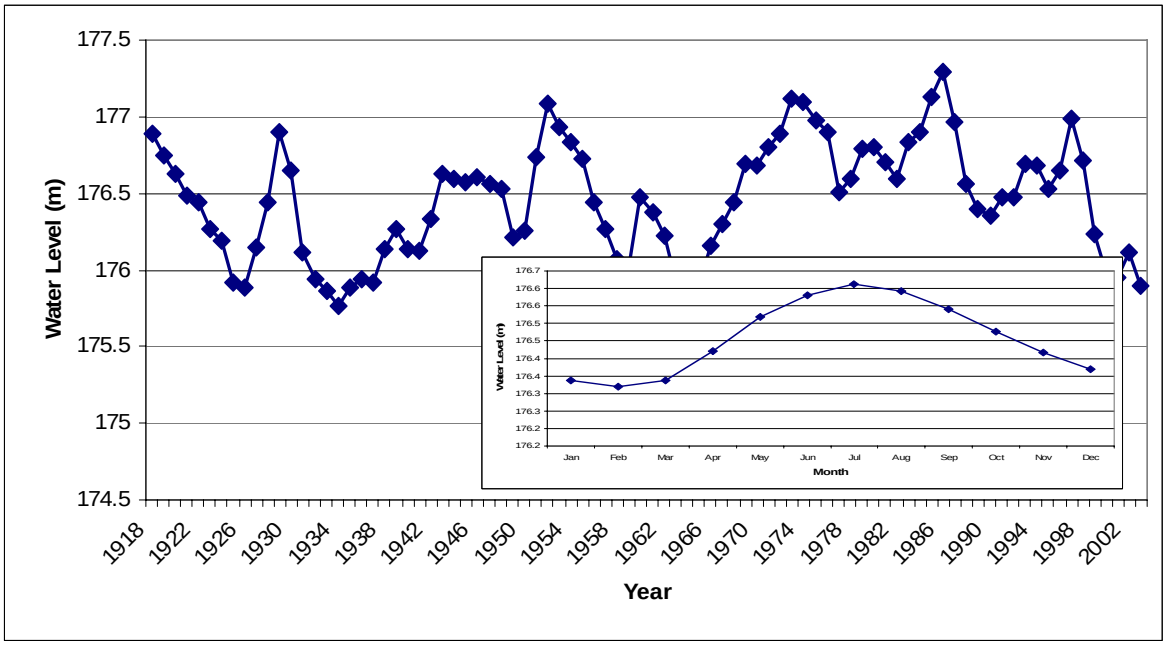


Figure 3. Lake Michigan-Huron yearly average water level from U.S. Army Corps of Engineers (2004), 1918-2003. Inset displays change in average monthly water level, 1918-2003.

encourage change in plant communities (Albert 2003) through lateral displacement (lakeward and landward shifts in plant community location) and horizontal zonation (varied composition / height of adjacent plant stands), which is important to many species of waterbirds. Whether on coastal marshes, interior basins, or riparian zones of the major river systems, water availability is the single greatest influence on distribution and behavior of waterbirds. Movements, foraging and prey availability, breeding, susceptibility to predation, competition, nest site selection, and nesting tenacity of waterbirds all can be influenced by water availability (Niemuth and Solberg 2003).

Habitat quality should be measured not only by the density of birds using a site, but also the level of productivity and survival of those birds (Van Horne 1983). Altered behavior, forage availability, and susceptibility to predation can affect local reproductive success and subsequent population size. Likewise, land use can influence wetland quality and waterbird values. For example, agricultural practices affect the prey base, turbidity, and vegetation characteristics of adjacent wetlands, all of which influence the wetland's quality and ability to support waterbirds.

Biological Foundation

Assembling the biological foundation or underpinnings for waterbird conservation planning included identification of habitat needs and factors believed to be limiting populations. These factors were then translated and quantified into landscape attributes used in biological models describing expected species-habitat relationships. Population goals and "deficits" (population goal – current population = population deficit) were determined and JV focal species were selected for planning emphasis and habitat model development.

Wetland losses from agricultural drainage, urban development, and river channelization have reduced the amount of waterbird habitat while water quality has been impacted by agricultural and industrial runoff and loss of wetland function. Conversely, islands constructed from dredge-material, wetland restoration, and pond and impoundment creation have provided new waterbird habitat in some areas. Fluctuating water levels in the Great Lakes reduce habitat for some species and enhance habitat for others, but are cyclic over long periods (Figure 3) resulting in concomitant change in waterbird habitat values. Short duration water-level change from wind seiche and storm surges may also influence densities of birds in far shore coastal marshes (Whitt 1996).

Several waterbird species predominately breed in the upper portion of the JV region and in neighboring Ontario. Waterbirds migrating from breeding grounds in Canada and northern Michigan, Wisconsin, and Minnesota, typically use interior and Great Lakes coastal marshes for staging and migration. Most waterbirds of concern are probably not traveling over the Great Lakes during migration, but concentrating in corridors around the lakes and on larger inland water bodies close to the coast. Therefore, the Great Lakes coastal zone (i.e., from open lake <2 m deep to sites 50-100 km inland) is likely a waterbird concentration area for migrant waterbirds.

Nesting, feeding, and roosting habitat attributes of many wading birds appear to be intermediate between or overlapping shorebirds and dabbling ducks. For example, during migration, Soras are reported using areas from dry fields to herbaceous wetlands of all sizes (Campbell 1968). Other wading bird species are typically found in shallow emergent wetlands that provide a variety of food resources, from seeds and insects to snails and small fish. Some species use deeper water wetlands near shore (grebes and cormorants) or open-water sites (loons and cormorants). Terns and gulls use a variety of wetland and open-water sites, but typically also require a structure component (e.g., vegetation mats, islands, sand and gravel bars, rock rip-rap, piers, or pilings) for nesting and roosting. These species often congregate where there are concentrations of small (<15 cm) fish in wetlands, river mouths, or near shore waters.

Information on the quantity of habitat required by most waterbird species is not well documented. In addition, the quantity of habitat required by a species varies with the quality of the habitat, and habitat needs change throughout the year. Breeding density estimates exist for some species, which can provide an indicator of the number of individuals a particular cover type is known to support (Wires et al., in review). Using density estimates, published data, and expert opinion of specific site attributes required by each species, biological models can be developed to generate habitat objectives predicted to achieve population objectives. Habitat objectives will be adjusted and refined as our understanding of waterbird needs improves through ongoing and new research.

Planning Framework

Designing landscapes to meet regional bird conservation objectives is a new science which has been described in a "five element process" (Will et al. 2005). Using the elements of this process, biologically-based, spatially explicit, landscape-oriented habitat objectives are developed for sustaining bird populations at goal levels. Conservation partners work together to assess current habitat conditions and ownership patterns, evaluate current species distributions and bird-habitat relationships, and determine where on the landscape habitat conservation effort can be delivered to support explicitly stated population objectives. Objectives must be explicit to help measure performance and develop a foundation for adaptive management.

Specifically, the five elements include 1) landscape characterization and assessment, 2) bird population response modeling, 3) conservation opportunities assessment, 4) optimal landscape design (availability and appropriate juxtaposition of cover types to meet various biological needs), and 5) monitoring and evaluation. Elements in this conceptual process were used to develop waterbird habitat recommendations for this strategy. Population status and goals were identified for all waterbird species commonly breeding in the JV region, but due to limited resources only five JV focal species were emphasized in planning and monitoring. The five element process was applied primarily to these species, with each representing a different cover type and bird guild (Root 1967).

Model-based Decisions

Simple biological models were created using population estimates and deficits, plus reported densities from literature, to translate population objectives into habitat objectives. In addition, digital cover type data and perceived limiting factors were combined to create habitat suitability models for targeting conservation effort. Hierarchical spatial scales for waterbird habitat planning were characterized at nest site, wetland, wetland complex, and landscape levels. However, biological models for waterbirds can and should vary across spatial and temporal scales, as habitat requirements often change with the wetland system and with seasons. Birds may use one cover type for courtship, another for nesting, another for brood rearing, and yet another for post-breeding molt and pre-migration staging. Moreover, availability of suitable wetlands will vary among years depending on precipitation and lake levels. All of these factors potentially could be considered in more sophisticated habitat planning models.

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. We derived population estimates and habitat objectives for each species using the best information currently available, although for some species it was limited. The process of deriving population estimates and habitat objectives with deficient data involves use of assumptions. We recognize the approach over-simplifies reality and some assumptions are not true. However, over time assumptions will be tested and other research completed, filling critical information gaps and resulting in improved methods for estimating populations and habitat needs.

Because there is a general lack of migration habitat information for most waterbirds, this strategy focused on breeding habitat conservation and did not address the needs for migration habitat. In many cases conservation actions for breeding habitat will accommodate some migrating species, but evaluation of this assumption will need to be tested. Migration corridors, migration timing, and duration of stay while staging are not well understood, especially for secretive marshbirds. Landscape and site attributes important to other wetland birds (waterfowl and shorebirds) also provide value to waterbirds, with a particularly strong relationship between marshbirds and dabbling ducks. Therefore, migration habitat for waterbirds was assumed to be adequate at current levels or potentially adequate with implementation of the JV Waterfowl Habitat Conservation Strategy. Finally, we assumed most priority waterbird species were habitat limited and that breeding landscapes (areas with adequate amounts and placement of habitat for the complete breeding season) are the most appropriate scale for conservation planning. The model assumptions below should be tested to increase our understanding of waterbird habitat conservation.

1) The amount of breeding habitat is limiting populations. We therefore need to protect and restore source habitat for priority breeding birds (JV focal species) to increase populations.
2) Habitat quality is even across similar habitats and conservation objectives are best achieved through increasing habitat area. The strategy does not define measurable objectives for increasing quality of existing habitats.
3) Management actions that benefit JV focal species will benefit other species with similar habitat needs.
4) JV regional and State×BCR waterbird population estimates and goals used in the strategy are accurate enough for planning purposes.
5) Population density estimates in the literature are representative of the species occupying medium to high quality habitats in the JV region.
6) In the absence of data on source and sink populations, we assume that areas with similar ecological features and consistently large numbers of breeding pairs (relative to total JV breeding population for species, e.g., >25 pairs) are important areas for protection.
7) Habitat for migrating and wintering waterbirds will be encompassed by areas protected for breeding waterbirds and waterfowl (JV Waterfowl Strategy).
8) Local habitat management actions have the potential to increase regional waterbird populations.

Limiting Factors

Factors influencing population growth for most waterbird species occurring in the JV region are uncertain. Gradual loss and degradation of ephemeral and semi-permanent herbaceous wetlands almost surely limits marshbird populations, particularly the rails. Least Terns (interior population) form colonies on sand bars, islands, or dried mudflats along large rivers. Suitable nest sites often limit populations, and human activities (e.g., recreational boating, water-level manipulation / dam operation) can disturb areas during the Least Tern breeding season (Thompson et al. 1997). Reduction in water quality and declining availability of aquatic food resources potentially limits populations of all waterbirds.

Species such as Double-crested Cormorant and Ring-billed and Herring Gulls do not appear habitat limited on the Great Lakes where most occur. However, within the last century all three species were threatened by one or more of the following: persecution, contaminants, and exploitation. The Ring-billed Gull was essentially extirpated from the Great Lakes and did not re-colonize the region until about the 1950s (L. Wires, University of Minnesota, personal communication). Although currently abundant, the relatively recent history of these birds demonstrates that no species can be considered secure.

Population Status and Goals

Population goals and estimates are essential for determining population deficits which were used to generate habitat objectives. Although deficit calculations were necessary for the approach used, we recognize the high degree of variability and uncertainty associated with many population estimates. JV regional population estimates where derived largely from the draft UMVGL waterbird plan (Wires et al., in review). For poorly surveyed species, population estimates were developed using a combination of state Breeding Bird Atlas data, local survey data, and expert opinion.

Continental priority species were identified using the NAWCP and a recent supplement (http://www.fws.gov/birds/waterbirds/statusassessment/assessment.html) for colonial and non-colonial nesting species, respectively. The UMVGL plan (Wires et al., in review) was consulted for regional 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.

Provisional population goals were set for species occurring in manageable numbers in the JV region with the intent of refining them as more information becomes available. The initial system used was simple: 1) species of high continental concern from the NAWCP and supplemental assessment have a designated goal of 100% increase (current estimate x 2.0), 2) species considered regional priority in the UMVGL plan have a goal of 50% increase (current estimate x 1.5), and 3) all other waterbird species have no population goal (Table 3). For this third group, populations are expected to fluctuate with environmental conditions and should not be a primary target for conservation.

Regional population estimates for most JV waterbird species are provided in the UMVGL plan by BCR. Nearly all of the land area of BCRs 22 and 23 is within the JV boundary, thus total UMVGL plan population estimates for these BCRs were used. Estimates for the area of BCRs 12, 13, 24, and 28 within the JV region were generated by multiplying the total BCR estimate by the proportion of each BCR area within the JV regional boundary. For species without UMVGL-plan population estimates, values were generated by local surveys and expert opinion (Appendix D). Regional breeding population deficits and the distribution of those deficits in State×BCR areas was completed for each of the 13 priority species (Table 3).

Table 3. Population estimates, goals, and deficits[a] by Bird Conservation Region (BCR)[b] for waterbirds breeding in the Upper Mississippi River and Great Lakes Joint Venture (JV) region. The JV region largely consists of BCRs 22, 23, and the U.S. portion of 12 (35% of BCR 12). Portions of BCR 24 (19%), 13 (11%), and 28 (7%) also are within the JV boundary; waterbird estimates for these BCRs are not included when <1% of the JV regional population. Bold names are "JV focal species" emphasized for planning and monitoring.

	Joint Venture population information[c]				Distribution of population deficit (%)
Species and BCR	Estimate source	Estimate	Goal	Deficit	
Common Loon	RP				
BCR 12 (U.S. portion only)		38,518			
BCR 23		3,680			
BCR 22		0			
Total		42,198			
Pied-billed Grebe	EO				
BCR 12		1,440	2,160	720	28
BCR 23		2,380	3,570	1,190	46
BCR 22		1,194	1,791	597	23
BCR 13		56	84	28	1
BCR 24		72	108	36	1
Total		5,142	7,713	2,571	100
Red-necked Grebe	EO				
BCR 12		1,224			
BCR 23		100			
BCR 22		10			
Total		1,334			
American White Pelican	EO				
BCR 12		2,900			
BCR 23		4,200			
BCR 22		0			
Total		7,100			
Double-crested Cormorant[d]	RP				
BCR 12		37,986			
BCR 23		15,595			
BCR 22		8,296			
BCR 13		7,844			
Total		69,721			
American Bittern	EO				
BCR 12		870	1,740	870	64
BCR 23		368	736	368	27
BCR 22		112	224	112	8
BCR 24		14	28	14	1
Total		1,364	2,728	1,364	100
Least Bittern	EO				
BCR 12		245	368	123	11
BCR 23		695	1,043	348	30
BCR 22		1,230	1,845	615	54
BCR 13		35	53	18	2
BCR 24		55	83	28	2
BCR 28		35	53	18	2

Species and BCR	Joint Venture population information[c] Estimate source	Estimate	Goal	Deficit	Distribution of population deficit (%)
Total		2,295	3,443	1,148	100
Green Heron	RP				
BCR 12 (no estimate)					
BCR 23 (no estimate)					
BCR 22		55,500			
BCR 24		10,336			
Total		65,836			
Great Blue Heron	RP				
BCR 12 (no estimate)					
BCR 23 (partial estimate)		24,100			
BCR 22		86,660			
BCR 24		9,442			
Total		120,202			
Great Egret	RP				
BCR 12		268			
BCR 23 (partial estimate)		4,540			
BCR 22		12,475			
BCR 24		879			
Total		18,162			
Snowy Egret	RP				
BCR 12		0			
BCR 23		60			
BCR 22		300			
BCR 24		190			
Total		550			
Little Blue Heron	RP				
BCR 12		0			
BCR 23		0			
BCR 22		1,450			
BCR 24		559			
Total		2,009			
Cattle Egret	RP				
BCR 12		20			
BCR 23		60			
BCR 22		2,040			
BCR 24		4,402			
Total		6,522			
Black-crowned Night-Heron	RP				
BCR 12		987	1,481	494	11
BCR 23		3,600	5,400	1,800	42
BCR 22		3,100	4,650	1,550	36
BCR 13		654	981	327	8
BCR 24		333	500	167	4
Total		8,674	13,011	4,337	100
Yellow-crowned Night-Heron	RP				
BCR 12		0	0	0	0

Species and BCR	Joint Venture population information[c] Estimate source	Estimate	Goal	Deficit	Distribution of population deficit (%)
BCR 23		100	150	50	7
BCR 22		600	900	300	44
BCR 24		656	984	328	48
Total		1,356	2,034	678	100
Yellow Rail	EO				
BCR 12		560	1,120	560	88
BCR 23		80	160	80	13
BCR 22		0	0	0	0
Total		640	1,280	640	100
Black Rail	EO				
BCR 12		4	6	2	5
BCR 23		30	45	15	38
BCR 22		36	54	18	46
BCR 24		8	12	4	10
Total		78	117	39	100
King Rail	EO				
BCR 12		10	20	10	3
BCR 23		89	178	89	25
BCR 22		230	460	230	65
BCR 13		4	8	4	1
BCR 24		21	42	21	6
Total		354	708	354	100
Virginia Rail	EO				
BCR 12		988			
BCR 23		1,866			
BCR 22		572			
BCR 13		160			
Total		3,586			
Sora	RP				
BCR 12		5,467	8,201	2,734	27
BCR 23		9,750	14,625	4,875	48
BCR 22		3,950	5,925	1,975	19
BCR 13		1,117	1,676	559	6
Total		20,284	30,426	10,142	100
Common Moorhen	EO				
BCR 12		260			
BCR 23		580			
BCR 22		1,860			
BCR 13		400			
BCR 24		80			
BCR 28		30			
Total		3,210			
American Coot	EO				
BCR 12		800			
BCR 23		2,615			
BCR 22		1,545			

Species and BCR	Joint Venture population information[c] Estimate source	Estimate	Goal	Deficit	Distribution of population deficit (%)
BCR 13		25			
BCR 24		110			
BCR 28		5			
Total		5,100			
Sandhill Crane	RP				
BCR 12		7,347			
BCR 23		8,244			
BCR 22		300			
Total		15,891			
Whooping Crane	RP				
BCR 12		0	0	0	0
BCR 23		61	125	64	100
BCR 22		0	0	0	0
Total		61	125	64	100
Ring-billed Gull[d]	RP				
BCR 12		117,119			
BCR 23		83,120			
BCR 22		112,762			
BCR 13		117,232			
Total		430,233			
Herring Gull[d]	RP				
BCR 12		30,264			
BCR 23		2,500			
BCR 22		7,192			
BCR 13		4,428			
Total		44,384			
Caspian Tern	RP				
BCR 12		2,398			
BCR 23		6			
BCR 22		300			
BCR 13		658			
Total		3,362			
Common Tern	RP				
BCR 12		2,847	4,271	1,424	56
BCR 23		570	855	285	11
BCR 22		240	360	120	5
BCR 13		1,426	2,139	713	28
Total		5,083	7,625	2,542	100
Forster's Tern	RP				
BCR 12		321			
BCR 23		2,866			
BCR 22		0			
BCR 13		185			
Total		3,372			
Least Tern (interior population)	RP				
BCR 12		0	0	0	0

Species and BCR	Joint Venture population information[c] Estimate source	Estimate	Goal	Deficit	Distribution of population deficit (%)
BCR 23		20	40	20	2
BCR 22		980	1,960	980	77
BCR 24[e]		270	540	270	21
Total		1,270	2,540	1,270	100
Black Tern	RP				
BCR 12		4,200	6,300	2,100	22
BCR 23		14,150	21,225	7,075	75
BCR 22		100	150	50	1
BCR 13		465	698	233	2
Total		18,915	28,373	9,458	100

[a]Population deficit = population goal - current estimate (numbers are individual birds).
[b]Bird Conservation Regions (BCRs): BCR 12 = Boreal Hardwood Transition, BCR 23 = Prairie Hardwood Transition, BCR 22 = Eastern Tallgrass Prairie, BCR 13 = Lower Great Lakes / St. Lawrence Plain, BCR 24 = Central Hardwoods, BCR 28 = Appalachian Mountains.
[c]Breeding population estimates were derived from two sources: RP = Upper Mississippi Valley / Great Lakes Region Waterbird Plan (Wires et al., in review) and EO = expert opinion including use of state Breeding Bird Atlas data and local survey data (Appendix D). Total RP population estimates for BCRs 22 and 23 were designated to the JV region. For BCRs 12, 13, 24, and 28, the proportion (% of BCR area) within the JV region was multiplied by RP estimates for each species to generate JV regional estimates for these BCRs. Population goals and deficits are provided only for species identified as "high" conservation status in continental and regional assessments. Species with high continental concern were assigned a population goal 100% higher then the population estimate (goal = estimate x 2.0), whereas regional priority species were assigned a goal 50% higher than current population estimate (goal = estimate x 1.5). 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 adjust due 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. Population management is being addressed by FWS depredation permits and orders and associated working groups.
[e]Least Tern was not listed in BCR 24 in the draft UMVGL plan but recently 270 adults were documented nesting on the Wabash and Ohio Rivers (Lott 2006) within the JV region.

Focal Species

To meet the challenge of developing a science-based regional habitat conservation strategy for waterbirds, a smaller subset of birds was identified for planning and monitoring emphasis and labeled "JV focal species." The use of focal species is a conservation assessment "shortcut," reducing the number of models required for developing habitat objectives for a full suite (or guild) of species. In effect, a single JV focal species was selected to represent a general cover type used by multiple species of breeding waterbirds. Likewise, monitoring results based on these JV focal species are assumed to reflect the guild of species they represent.

Primary criteria for selecting JV focal species included stable or declining population, a high importance level of the JV region to the continental population, some understanding of factors limiting the population, and a potential to monitor populations. Only species considered continental or regional priority and occurring in manageable

numbers within the JV region were considered. In addition, only species breeding in the JV region were candidates because of the lack of information about distribution and abundance of most waterbirds on migration and wintering areas.

JV focal species were considered habitat limited with needs as strict as or stricter than other waterbird species in the guild they represented. Therefore, meeting the needs of focal species should meet the needs of other species dependent on a designated cover type. Additional criteria in focal species selection included availability of information on breeding population estimates and trends, distribution within the JV region, existing status assessments or management plans, potential for effective monitoring, and inclusion on the list of FWS Division of Migratory Bird Management's focal species for performance measuring. Using the above criteria, five JV focal species were selected:

Yellow Rail. This waterbird represents species dependent on wet meadow with open water. It has somewhat unique wet meadow habitat needs, but habitat associates can include American Bittern, plus Le Conte's Sparrow (*Ammodramus leconteii*) and Sedge Wren (*Cistothorus platensis*). The species occurs in the northern portion of the region where conservation status is high priority.

*King Rail***.** This bird represents species using shallow semi-permanent emergent marsh with variable amounts of open water and variable height vegetation. It serves as a surrogate for American Bittern, Black Rail, Sora, and Sandhill Crane. The species has high conservation need across the region, interest by the Mississippi Flyway Council is growing, and it has been identified as a FWS Migratory Bird Program focal species related to performance measuring. In addition, there will be a range wide conservation plan plus a FWS Region 3 status assessment completed by 2008.

Black Tern. This species represents the waterbird group using semi-permanent deep water emergent marsh. It serves as a surrogate for Forster's Tern, Common Moorhen, and American Coot and has an existing management plan and landscape model for the Prairie Pothole Region.

Common Tern. Dependent on island, lake, or large river and open water communities, this species represents the suite including Ring-billed and Herring Gulls, Caspian Terns, and American White Pelican. It has an existing FWS management plan and status assessment, plus available population estimate for the Great Lakes region. There is a good understanding of habitat requirements, limiting factors, monitoring ability, and conservation need. Common Tern nest sites often require somewhat specialized management (e.g., control of vegetation and competition), but this bird was the best choice for island focal species as the other primary island nesters do not currently have population deficits.

*Black-crowned Night-Heron***.** This waterbird represents species using emergent herbaceous wetland with nearby shrub/forest. Breeding areas often consist of vegetated islands and riparian areas with associated open water. It serves as a surrogate for other

wading birds requiring or tolerant of woody cover and that use similar foraging habitat such as Great Blue Heron, Great Egret, and Green Heron. Conservation status is high in the region. Black-crowned Night-Herons rely more on younger shrubby vegetation then some species in this guild, but later succession stage woody cover used by others is generally abundant across the region.

Several other species have population estimates below goal levels (Table 3) and were considered as focal species. Least Tern was evaluated but ultimately excluded because of the relatively unique breeding needs perceived to limit population growth (sand beach and island nest sites on large rivers with low-disturbance feeding territories). In addition, this endangered species already has a recovery plan with conservation objectives (USFWS 1990). Other species of concern, including American Bittern, Least Bittern, and Black Rail, should be accommodated with habitat conservation objectives established for marshbirds that were selected as JV focal species. The Whooping Crane was not considered habitat limited in the JV region using the current population goal.

Habitat Goals and Objectives

Estimated habitat conservation needs to meet the carrying capacity for goal waterbird populations are identified in the strategy. Habitat objectives are linked to desired population change for JV focal species, and a focus on breeding habitat was necessary as it can be better quantified with existing information and simple models. This approach was essential to target limited science-partner resources in strategy development and to generate measurable objectives, thus setting the stage for evaluation, performance measurement, and adaptive management.

We understand that stating explicit habitat objectives in a conservation strategy does not eliminate ambiguity or potential controversy; in fact just the opposite may result. Opinions vary in how best to step-down continental waterbird priorities to regional and local actions. For example, translating population objectives into habitat objectives was especially challenging for island nesting colonial waterbirds, and this section of the draft strategy received greatest criticism by reviewers. In most cases, colonial waterbird habitat is not discrete; it typically includes an island plus the water environment associated with it. Small islands can provide nesting cover for many birds, but without adequate fish resources, quality breeding habitat can not exist. This potentially limiting factor must be incorporated into habitat conservation decisions for island nesters. Our intention in the approach used for developing habitat objectives was to improve decision making at the regional scale and over the long-term by establishing an adaptive system, and objectives in this strategy are a starting point destined for refinement.

Calculating Habitat Objectives

Based on their use of specific wetland types, islands, and vegetation characteristics during the breeding season, waterbirds can be classified into various species assemblages or guilds. Although some species have more specific habitat

requirements than others, a general landscape design can be formulated to accommodate waterbird groups. Using the information available, we categorized waterbirds by the general wetland type most used during the breeding season (Table 4). More specific characteristics of quality habitat and preferred landscapes have been described for JV focal species in the species accounts (Appendix A).

JV regional habitat objectives calculated for breeding waterbirds were stepped-down to smaller, more manageable units. Habitat objectives were identified to the BCR scale and linked to BCR population objectives (Table 3). We further partitioned habitat objectives into State×BCR areas (polygons) by multiplying the area proportion of each state contained in each BCR, except for the islands category. Islands were based on Common Tern population estimates and deficits by BCR, and then proportioned based on current colony locations and the area of states near the Great Lakes.

Table 4. General community[a] preferences for breeding waterbirds occurring in the Upper Mississippi River and Great Lakes Joint Venture (JV) region. Names in bold are JV focal species, some of which occur in multiple community types.

Wet meadow with open water	Shallow semi-permanent marsh, hemi-marsh	Deep water marsh	Herbaceous wetlands with shrub / forest	Islands with limited vegetation
Yellow Rail	**King Rail**	**Black Tern**	**Black-crowned Night-Heron**	**Common Tern**
Black Rail	Forster's Tern	Common Loon	Great Blue Heron	Double-crested Cormorant
Virginia Rail	Herring Gull	American Coot	Green Heron	American White Pelican
Sora	Red-necked Grebe	Red-necked Grebe	Little Blue Heron	Caspian Tern
American Bittern	Least Bittern	Pied-billed Grebe	Yellow-crowned Night-Heron	Ring-billed Gull
Sandhill Crane	Black Tern	Common Moorhen	Great Egret	Herring Gull
King Rail			Cattle Egret	Great Black-backed Gull
			Snowy Egret	Least Tern
			Double-crested Cormorant	

[a]Wet meadow with open water = seasonal wetlands with herbaceous vegetation mixed with pockets of semi-permanent shallow open water. Shallow semi-permanent marsh, hemi-marsh = marsh <1 m deep with herbaceous cover and persistent standing water most years; typically a mosaic of emergent vegetation and open water. Deep water marsh = open water 0.5-1.5 m deep mixed with areas and borders of emergent vegetation; submerged vegetation common in openings. Marsh with associated shrub/forest = mixed emergent marsh and open water with nearby shrub or forest; typically marsh and woody cover is <0.1 km apart; often a riparian system. Islands with limited vegetation = islands with periodic disturbance or foundation that limits vegetation growth (<40% coverage); typically on the Great Lakes; may include lighthouse structures, confined disposal facilities (CDFs), and other man-made structures.

Maintenance and Protection Objectives

Waterbird habitat protection can be targeted using a map generated from JV focal species models that predict current distribution of birds and habitat across the region (Figure 4). Protection and maintenance objectives were identified by state and BCR (Table 5) based on the habitat needs of current populations of JV focal species. Primary emphasis for conservation of waterbird populations in the JV region must be through protecting 16,000 ha of existing wet meadow and open water important to waterbirds, 9,500 ha of important deep-water marsh, 7,900 ha of herbaceous wetland with associated shrub/forest, and 5,100 ha of shallow semi-permanent marsh. In addition, a minimum of

25 exiting nesting islands and associated open water feeding territories important for island-nesting colonial waterbirds (i.e., Common Tern) must be maintained. Specific locations to target protection effort can be found in species accounts (Appendix A).

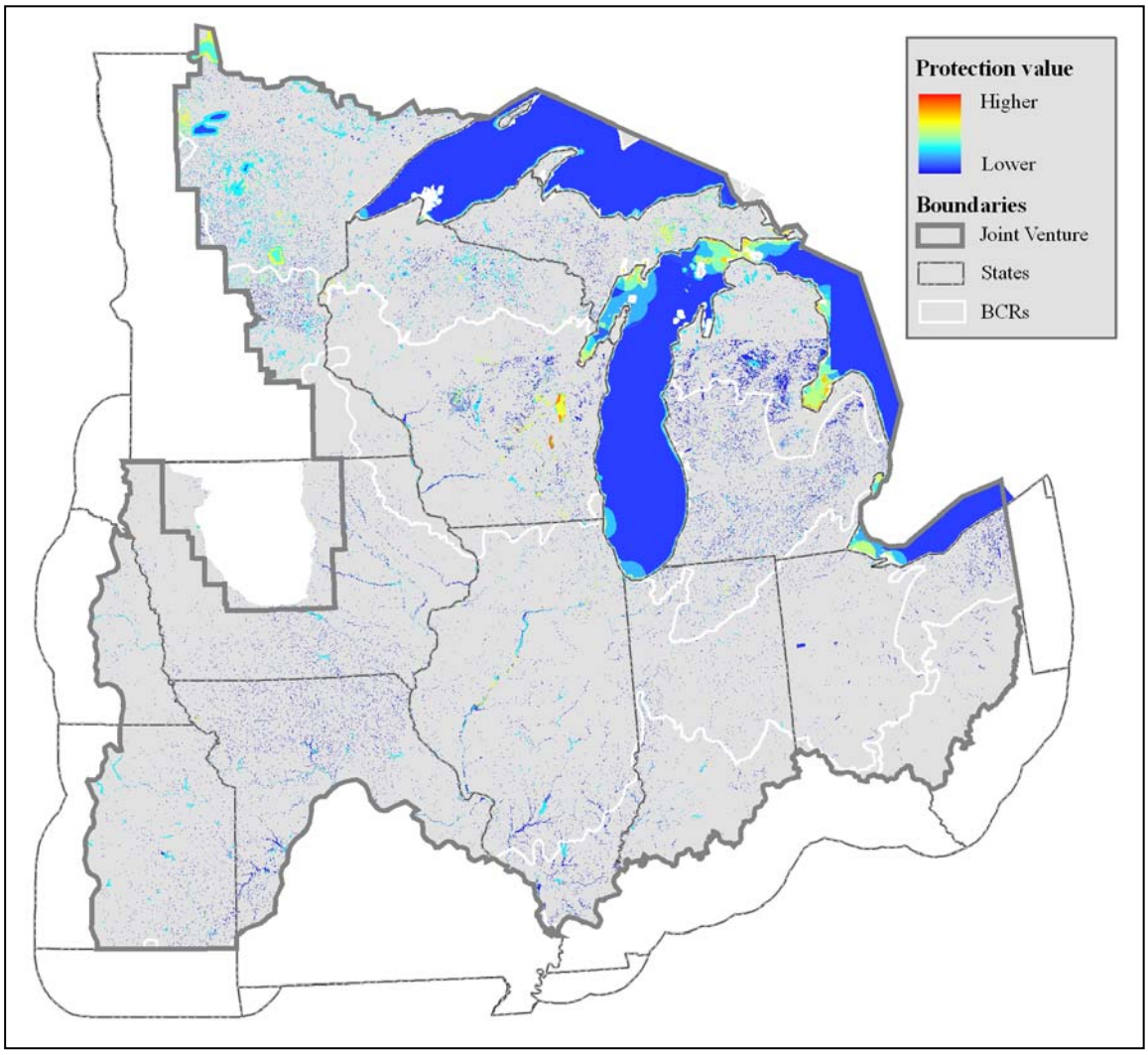


Figure 4. Important waterbird habitat in the Upper Mississippi River and Great Lakes Joint Venture (JV) region based on pooled landscape suitability scores for five JV focal species. Focal species represented waterbird guilds and the primary cover type used for breeding. National Land Cover Data (1992) and bathymetric contour data (2001) from the National Oceanic and Atmospheric Administration were used for cover type analysis.

Common Tern nesting islands can be somewhat different then sites used by other island nesters. However, with the exception of Least Tern, which does not nest on Great Lakes islands, the other species do not appear limited by number of nest sites or structure. Moreover, the other island nesters, again with the exception of Least Tern, do not have population deficits and are therefore not a priority focus for habitat conservation at this time. When using these regional habitat recommendations managers must integrate local information to help identify important waterbird sites especially for Common Terns and Least Terns.

Table 5. Waterbird habitat maintenance and protection objectives by state and Bird Conservation Region (BCR) to meet breeding population goals for the Upper Mississippi River and Great Lakes Joint Venture (JV) region. Objectives are presented in hectares (1 ha = 2.47 acres), except for the islands category. Distribution of protection effort based on JV focal species[a] BCR population estimates and proportion of each state within the BCR, except islands[b].

State	BCR	Wet meadow with open water	Shallow semi-permanent marsh, hemi-marsh	Deep water marsh	Herbaceous wetlands with shrub / forest	Islands with limited vegetation[b]
Iowa	22	0	690	11	592	0
	23	80	51	283	131	0
	Total	80	741	194	723	0
Illinois	22	0	789	12	676	1
	23	40	25	142	65	0
	24	0	102	0	103	0
	Total	40	916	154	845	1
Indiana	22	0	296	5	254	0
	23	120	76	425	196	0
	24	0	195	0	197	0
	Total	120	567	430	647	0
Kansas	22 / Total	0	427	7	366	0
Michigan	12	5,600	57	840	359	8
	22	0	26	0	23	0
	23	240	369	2,052	949	1
	Total	6,180	452	2,892	1,331	9
Minnesota	12	5,320	54	798	341	3
	22	0	66	1	56	0
	23	240	453	849	393	0
	Total	5,560	273	1,648	790	3
Missouri	22 / Total	0	525	8	451	0
Nebraska	22 / Total	0	131	2	113	0
Ohio	13	0	57	233	595	7
	22	0	329	5	282	0
	24	0	0	0	0	0
	28	0	0	0	0	0
	Total	0	386	238	876	7
Wisconsin	12	3,080	31	462	197	3
	22	0	10	0	8	0
	23	940	598	3,325	1,538	2
	Total	4,020	639	3,787	1,744	5
All States	12	14,000	143	2,100	897	14
	13	0	57	233	595	7
	22	0	3,289	50	2,821	1
	23	2,000	1,271	7,075	3,273	3
	24	0	297	0	300	0
	28	0	0	0	0	0
	Total	16,000	5,057	9,458	7,885	25

[a]JV focal species included Yellow Rail (wet meadow with open water), King Rail (shallow semi-permanent marsh), Black Tern (deep water marsh), Black-crowned Night-Heron (herbaceous wetlands with shrub / forest), and Common Tern (islands with limited vegetation).

[b]Value represents number of primary Common Tern nesting islands and associated feeding territories. Distribution of island maintenance and protection based on locations of recently documented Common Tern colonies. Islands with substantial colonies and/or multiple priority species should have higher protection emphasis.

Some of the area required to accommodate current waterbird populations, particularly islands and northern shorelines of the Great Lakes, is already protected through ownership by government agencies or non-government conservation organizations. In the future we plan to develop a digital data layer of all conservation lands with perpetual protection in the JV region. With this information, we can overlay conservation ownership lands with important bird conservation lands and develop a prioritized strategy for acquisition and conservation easements.

Restoration and Enhancement Objectives

The area of habitat restoration and enhancement for each cover type was based on JV focal species population deficits and associated habitat models (Appendix A). We assumed the most effective means to increase a population was to restore the missing habitat required to accommodate that number of individuals. Management is generally more economical when restoration efforts aim to restore cover suited for the site (i.e., consider pre-settlement vegetation, current surrounding cover, and critical/irreversible adjustments to landscape hydrology). Likewise, enhancement work must consider landscape capabilities. Properly located enhancement effort that sets back succession, suppresses invasive plants, or provides a missing element to an otherwise suitable landscape typically results in the greatest return on investment.

Similar to maintenance and protection, the is substantial need for restoration and enhancement of emergent herbaceous wetland types (Table 6). Wet meadow and open water requires the largest restoration area at 16,000 ha, followed by 5,100 ha of shallow semi-permanent marsh, 4,700 ha of deep water marsh, and 3,900 ha of herbaceous wetland with a brush / forest component. Finally, establishment of an additional 13 nesting islands and associated feeding territories (sites suitable for Common Tern colonies) is predicted to achieve the population goal for this JV focal species. General locations to target habitat actions have been identified across the region using a combination of hydric (wetland) soils data and agricultural cover-type designations (Figure 5). In addition, details with more specific locations and recommended management treatments were developed for each JV focal species (Appendix A).

In lieu of creation (i.e., manmade structures), island restoration and enhancement effort should focus on better management at existing sites, including site enrichment, protective structures, predator control, competitor removal, and restrictions on human access at sites with high potential for long-term use and high productivity. A colonial waterbird database for the U.S. Great Lakes has documented of more than 770 sites, mostly islands, used by colonial waterbirds since the 1970s, thus the number of islands does not seem to be a limiting factor for colonial waterbirds (L. Wires, University of Minnesota, personal communication).

At restoration sites and at existing wetlands, the surrounding uplands should be taken into consideration as some waterbird species use uplands for foraging and nesting. Furthermore, uplands covered in native plant communities retain or improve water

quality and create suitable landscape structure for many species of birds. Because habitat enhancement for one species may result in loss of site value for other species, treatments must consider other potential bird use at a site. Species of concern from other bird groups can be found in JV bird-group strategies for waterfowl, shorebirds, and landbirds.

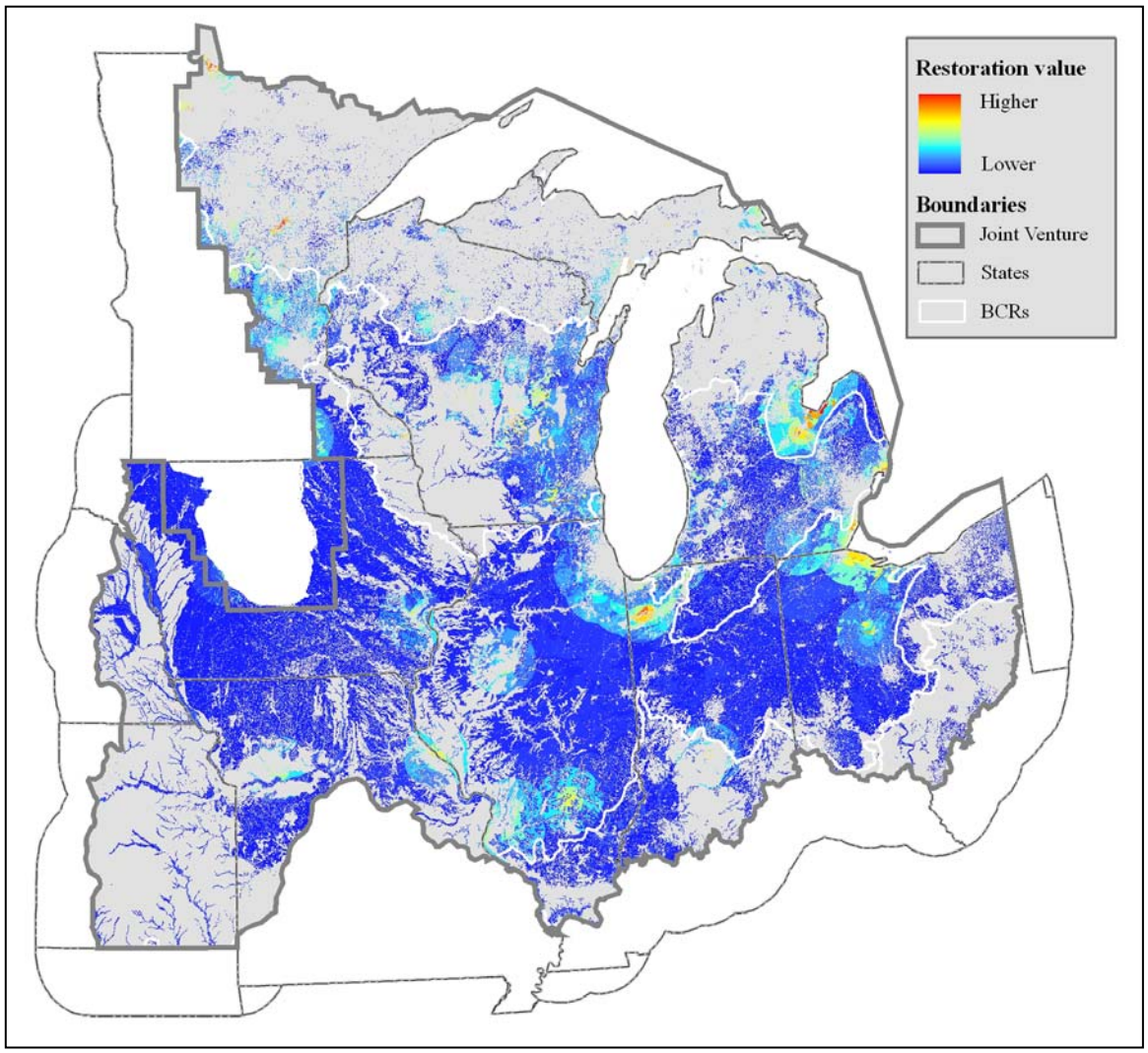


Figure 5. Potential wetland and wetland/grassland restoration locations for waterbird habitat in the Upper Mississippi River and Great Lakes Joint Venture (JV) region. Values were scored based on the percent hydric soils (wet/previous wetland; STATSGO 1991), and distance to current waterbird locations (distance classes <10 km, 10-20 km, 20-50 km, and >50 km). Areas were only scored in existing agricultural cover (NLCD 1992). Gray areas have less potential for high-value waterbird restoration sites (low percent hydric soils and greater distances to existing waterbird populations).

Potential for greatest net increase in waterbird habitat exists in the agriculturally dominated portion of the JV region where most of the wetlands have been drained or altered (Figure 5). Continued development of wildlife-friendly agriculture programs included in the U.S. Farm Bill can significantly impact waterbirds in the region by preserving and restoring wetlands plus adjoining upland cover. Effective waterbird

Table 6. Waterbird habitat restoration and enhancement objectives by state and Bird Conservation Region (BCR) to meet breeding population goals for the Upper Mississippi River and Great Lakes Joint Venture (JV) region. Objectives are presented in hectares (1 ha = 2.47 acres), except for the islands category. Distribution of effort based on JV focal species[a] BCR population deficits and proportion of each state within the BCR, except islands[b].

State	BCR	Wet meadow with open water	Shallow semi-permanent marsh, hemi-marsh	Deep water marsh	Herbaceous wetlands with shrub / forest	Islands with limited vegetation
Iowa	22	0	690	5	296	0
	23	80	51	142	65	0
	Total	80	741	147	361	0
Illinois	22	0	789	6	338	0
	23	40	25	71	33	0
	24	0	102	0	51	0
	Total	40	916	77	422	0
Indiana	22	0	296	2	127	0
	23	120	76	212	98	0
	24	0	195	0	98	0
	Total	120	567	215	323	0
Kansas	22 / Total	0	427	3	183	0
Michigan	12	5,600	57	420	179	4
	22	0	26	0	11	0
	23	580	369	1,026	475	1
	Total	6,180	452	1,446	665	5
Minnesota	12	5,320	54	399	170	1
	22	0	66	1	28	0
	23	240	453	425	196	0
	Total	5,560	273	824	395	1
Missouri	22 / Total	0	525	4	226	0
Nebraska	22 / Total	0	131	1	56	0
Ohio	13	0	57	116	297	1
	22	0	329	3	141	4
	24	0	0	0	0	0
	28	0	0	0	0	0
	Total	0	386	119	438	1
Wisconsin	12	3,080	31	231	99	2
	22	0	10	0	4	0
	23	940	598	1,663	769	0
	Total	4,020	639	1,894	872	2
All States	12	14,000	143	1,050	449	7
	13	0	57	116	297	4
	22	0	3,289	25	1,411	1
	23	2,000	1,271	3,538	1,636	1
	24	0	297	0	149	0
	28	0	0	0	0	0
	Total	16,000	5,057	4,729	3,943	13

[a]JV focal species included Yellow Rail (wet meadow with open water), King Rail (shallow semi-permanent marsh, hemi-marsh), Black Tern (deep water marsh), Black-crowned Night-Heron (herbaceous wetlands with shrub / forest), and Common Tern (islands with limited vegetation).

[b]Distibution of islands with limited vegetation based on BCR population deficits for Common Terns and area of the each state adjoining Great Lakes shoreline (primary management focus area). Islands with potential for larger tern colonies and/or multiple priority species should have higher restoration and enhancement emphasis.

conservation will require collaboration with those implementing federal agriculture programs, and waterbird habitat restoration and protection maps should be used to help target Farm Bill conservation efforts. County-level and site-specific planning will be enhanced with an understanding of area soil characteristics, particularly the location and extent of hydric soils (potential wetland restoration sites). These data are available for the entire JV region through the U.S. Department of Agriculture at www.soils.usda.gov/survey.

Although the rate of wetland loss has slowed significantly in recent years, losses still occur in the JV region, particularly in areas dominated by agriculture and human development pressure. These proposed waterbird habitat restoration and enhancement objectives are "net area" estimates. In other words, any loss of existing waterbird habitat during the plan period will have to be added to plan restoration objectives. Likewise, degradation of existing waterbird habitat must be considered in the habitat accounting process.

Monitoring and Research

Monitoring waterbird populations and habitat is required to determine conservation status, detect population trends, assess health of habitats, and evaluate whether environmental changes and management prescriptions are affecting waterbirds (Kushlan et al. 2002). Surveys that provide measures of environmental or other landscape features believed to affect bird population status offer some opportunity to test hypotheses about population limiting factors. Even more useful are surveys that are tightly integrated with explicit management decisions, where biological prediction and testing are used to learn more about the affects of conservation practices. Abundance surveys, as well as monitoring programs used to estimate vital rates (e.g., survival and productivity surveys), can be used to assess habitat quality. When coordinated with monitoring of natural and management-induced habitat changes, these surveys can also inform management decisions and provide important insights into the mechanisms underlying changes in bird demographics.

Populations of some waterbirds have been thoroughly inventoried but only periodically (every decade). Other survey efforts at specific locations are more frequent and have considerable long-term information albeit at the local level. Collectively, however, waterbird monitoring has been completed using different methodologies over multiple scales, resulting in data sets that are difficult to compare. Relatively few sources of quality monitoring data are available to JV partners at continental and regional scales. Five primary population and habitat surveys were used to develop this strategy.

North American Breeding Bird Survey (BBS). The BBS has been conducted each year since 1966, primarily in June, following the completion of spring migration (Sauer et al. 2006). This survey has 50 stops 0.8 km apart totaling 40 km in length (www.mbr-pwrc.usgs.gov/bbs/). There are 630 routes within the JV region. Considered largely inadequate to represent the distribution of most waterbirds, BBS data for species with

higher visibility (e.g., Black Tern) or vocalization (e.g., American Bittern) are thought to be valuable trend indicators.

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 1976-77 (Scharf et al. 1978, Scharf and Shugart 1998, Cuthbert et al. 2003). 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 results in limited value as a trend indicator. The next survey is scheduled to be completed during 2007-2009, and work is underway to develop efficient approaches for more frequent surveys of areas with greatest importnace, leading to better trend estimates.

Marsh Monitoring Program (MMP). This survey has been gathering data on breeding marshbirds 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 marshbird 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 its 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, some ongoing 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.

Regional Habitat Surveys. Since completion of the last JV Implementation Plan update (USFWS 1998), JV Board members have provided an annual record of major habitat work in each state. Accomplishments were identified by specific focus areas, but measures are coarse (i.e., wetland vs. upland, protection vs. restoration) with no rating of habitat quality for species or groups. Although this information was originally focused on waterfowl habitat, wetland conservation accomplishments directly influence many waterbird species, and information may be useful in habitat assessment at larger scales. Unfortunately follow-up monitoring of these habitats is typically limited or site-specific, thus long-term viability of many sites is unknown. In addition, there is no inventory of annual habitat loss within states. JV partners and staff recognize the need to determine

concomitant habitat loss estimates so that "net change" in habitat for waterbirds can be monitored over time.

Monitoring Needs

Monitoring serves two primary functions. First, monitoring provides data needed to inform management decisions that are based on resource status. Second, analysis of monitoring data can help identify the causes of demographic changes and provide an improved basis for future habitat management decision-making. Four general monitoring issues and needs have been identified at the continental scale. Each has relevance to the JV because of its importance in improving regional waterbird conservation decisions. More details on this information are available in the NAWCP (Kushlan et al. 2002).

1) *Monitoring goal.* The monitoring goal of the NAWCP is to be able to detect >50% population change over 10 years or 3 generations. This goal mirrors one proposed by the World Conservation Union in their criteria for identification of species at risk.
2) *Standard methodologies.* Large-scale monitoring programs must use techniques that allow population and habitat data collected in different locations and across multiple geographic or temporal scales to be compared and combined. A specific need is the ability to sample at large scales using various methods and still meet trend detection goals. Developing and testing monitoring methods and then evaluating their precision and power to detect trends are crucial for effective conservation.
3) *Centralized data storage and access.* The National Bird Population Data Center has developed a data repository to archive data on waterbirds throughout their ranges, regardless of survey locality or survey method. This centralized database is publicly accessible and allows managers to submit and retrieve data over the World Wide Web (http://mbdcapps.fws.gov/). Ultimately, it will be linked to other databases covering specific bird groups and regions.
4) *Filling information gaps.* With a data repository and standard methodologies in place, partners will be able to identify gaps in current population survey efforts and coordinate an integrated network of statistically valid, long-term, waterbird population monitoring programs throughout the region and the continent.

Monitoring Objectives

Specific waterbird monitoring objectives required to improve planning efficiency and effectiveness by the JV are listed below in priority order. Objectives 1-3 will be completed by 2010 and all objectives by 2012.

1) Work with partners to implement the North American Marshbird Monitoring Program. This program, which is under development, will provide a statistically-based sampling framework within which Conway's (2004) protocol will be used.

It will provide critical information on continental marshbird distribution, abundance, and trends (the survey is currently conducted around the Great Lakes).

2) Support the fourth decadal Great Lakes Colonial Waterbird Survey from 2007-2009. Results of the survey will be used to refine protocols, sampling framework, and survey frequency so that species-specific changes in distribution and abundance of Great Lakes colonial waterbirds can be determined with greater accuracy and at lower cost.
3) Work with partners to obtain updated and consistent land cover inventory data (e.g., updated National Wetland Inventory and National Land Cover Data) to track regional changes in the quantity of cover types important to waterbirds. Current digital spatial data available through the NWI date back to the 1970s and 1980s for the JV region, and updates are critical for planning.
4) Work with partners to enhance existing surveys and initiate new ones to monitor, in a standardized manner, the distribution, abundance, and trends of priority colonial waterbird species (e.g., Common, Black, and Forster's Terns, and Black-crowned Night-Herons) in areas outside of the Great Lakes, especially along major river systems.
5) Support development and implementation of surveys and other tools (i.e., banding, telemetry, stable isotope analyses) that provide information on migration stopover sites, key wintering areas, and factors that affect movements and distribution of waterbirds between breeding and wintering areas.
6) Support development and implementation of standardized, systematic 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

Monitoring Responsibilities

JV science partners must lead in establishing and improving regional monitoring strategies that complement and support continental efforts for waterbird habitat conservation. Therefore, monitoring objectives listed above must be completed in a collaborative manner by JV staff, JV Technical Committee, state and federal agencies, non-government organizations, and associated conservation groups that make up the JV partnership. Furthermore, JV partners should continue to explore new relationships and mechanisms to fund regional monitoring priorities and to promote provision of adequate resources for federal migratory bird management agencies to maintain critical monitoring efforts.

As the agencies with trust responsibility for management and conservation of migratory birds, it is incumbent on the FWS, Canadian Wildlife Service (CWS), and Secretaria de medio ambiente y recourses naturals – Semarnat – Mexico (SEMARNAT) to document resource requirements for meeting the objectives of current and proposed North American waterbird monitoring strategies. Federal management agencies, in conjunction with other waterbird stakeholders, should seek to develop and implement

effective programs to monitor absolute abundance of waterbird species. They should also lead in development of a data management infrastructure that provides Internet access to standardized, well-documented, spatially-referenced databases. Finally, federal migratory bird management agencies must provide technical expertise and operational support for the development of regional monitoring strategies as resources permit.

Information and Research Needs

A priority for this strategy was development of spatially-explicit habitat models to guide regional waterbird planning (Appendix A). We used the best available information to identify locations most suitable to waterbirds and to help target conservation delivery. Knowledge gaps, particularly for the secretive marshbirds, hampered development of more rigorous models, but completion of proposed monitoring initiatives will result in an expanded geo-referenced species database for development of superior spatial planning tools. Several specific information and research objectives were also identified during strategy development to improve planning efficiency and effectiveness. They are listed below in priority order and should emphasize JV focal species. Objectives 1-4 will be completed by 2012 and all will be completed by 2016.

Research Objectives

1) Assessment of distribution, abundance, and population trend data to improve population estimates and objectives. These data will be used to refine habitat conservation objectives and to help measure management performance.
2) Identification of critical migration staging areas, migration corridors, and migration timing for species of greatest concern to establish conservation planning for migration habitat.
3) Identification of breeding and winter areas outside the JV region for waterbirds that use the region primarily for migration, and assessment of potential limiting factors in the life cycles of individual species.
4) Determination of habitat and landscape preferences (i.e., area requirements, connectivity, beneficial and hostile adjacent habitats) of waterbird groups, particularly the secretive marshbirds, during breeding and migration periods.
5) Determination of the relationship between particular habitat conservation actions and population responses, plus the potential tradeoffs between species for a given action. Especially important is the need to assess the effects of wetland restoration, enhancement, and management on marshbird abundance and reproductive success.
6) Assessment of the effects and trends of invasive species (e.g., *Phragmites australis*) expansions on breeding and migrant waterbirds. This information will be used to guide wetland management and enhancement.
7) Assessment of the effects of disturbance by humans (e.g., cormorant management activities, researchers, and the public) and predators on colonial waterbird productivity, distribution, and habitat use.

Examples of current priority waterbird research needs specific to JV focal species are listed below (not an exhaustive list). This research will be initiated by 2012.

1) The King Rail is a declining JV focal species for which a rangewide conservation plan will be completed by the FWS before the end of 2008. The plan will include prioritized research needs the JV must help to address.
2) Investigations on the Yellow Rail must determine current distribution of the species in the region (and Upper Midwest), evaluate habitat and landscape factors that influence its occurrence and abundance, evaluate spatial and temporal changes of wetlands used by the species, and assess future risks to those habitats.
3) There is a need to examine nesting patterns and habitat use of Black Tern (and Forster's Tern) in Great Lakes coastal marshes to delineate boundaries and of greatest importance.

Measuring Performance

Measures of presence/absence, density, long-term population size and demographics are needed to assess performance of JV conservation actions. However, the number of waterbirds occupying the region in any given year is not solely dependent on habitat availability and condition within the region. During years with poor wintering conditions, fewer waterbirds may return to breed in the JV region or their reproductive fitness may be depressed. Likewise, with poor breeding habitat and reproduction north of the region, fewer migrants may be found staging in the fall even when habitat availability and conditions are above average.

The JV is committed to increasing knowledge of waterbird ecology and improving understanding of management effectiveness in the region. Activities of JV partners implementing this strategy are expected to increase resources and landscape carrying capacity for waterbirds and, in turn, directly and indirectly impact specific vital rates (e.g., survival, nest success, recruitment). Thus JV performance can be measured by the net change in resources available for waterbirds within the region and in some instances the impact those changes have on vital rates. However, uncontrollable environmental factors must be considered and accounted for when measuring performance.

Net Change in Resources

Resources for waterbirds within the JV region will be maintained by protecting existing quality habitat and increased by restoring and enhancing habitat as prescribed. Habitat conservation will be tracked by JV partners and JV staff, providing the estimated area (by cover type) and general location of protected and restored habitat. Concurrent habitat loss also must be estimated to determine net habitat change. Remote sensing technology typically provides the best means for landscape analysis. However, remotely identifying the quantity of waterbird habitat in a given year will continue to be a challenge due to 1) its dynamic nature, 2) the ability of remote sensors to accurately

depict various wetland types, and 3) the infrequency of updating key spatial data such as NWI and NLCD (10-30 years between updates). Model-based analysis of habitat gains and losses may be necessary to estimate landscape change beyond that reported by JV partners.

Measuring performance for breeding waterbirds might include a comparison of bird demographics inside and outside JV focus areas. JV partners have identified primary and secondary focus areas to deliver conservation (USFWS 1998), and survey data can be segmented into "high partner influence" vs. "low effort/no influence" (control) areas. Assuming similar climatic conditions on neighboring units, waterbird population growth or density should be greater in high influence zones. Portions of the JV region without local-scale breeding surveys may find BBS trend data useful as a coarse measure of population change for some species in high vs. low influence areas.

The impact of JV activities on breeding waterbird populations may also be measured through temporal changes in vital rates, including nest success, brood survival, recruitment, and body weights. Initial research is needed, particularly for the marshbirds, to establish baseline information, with subsequent evaluation to determine if implementation activities are increasing vital rates, and by how much. Meaningful increases in resource availability due to "habitat enhancement" will require estimates of average productivity prior to and after enhancement of key waterbird cover types.

Adaptive Management

The term "adaptive management" implies different things to different people, often depending on their background and the conservation arena within which they work (i.e., research, management, administration). In a broad and inclusive sense, adaptive management is the use of cyclic planning, implementation, and evaluation to improve management performance. Adaptive Resource Management (ARM) provides an explicit framework that ensures monitoring data are relevant and useful in making management decisions. Moreover, it can (and should) provide a means to improve future decision-making through an iterative cycle of biological prediction and testing.

Although adaptive management does not need to be complex, it does require discipline. Critical preconditions for successful ARM include stakeholder consensus about objectives and a commitment to manage adaptively. ARM can increase JV effectiveness and efficiency by improving capacity in all three iterative steps: planning, implementation, and evaluation. Planning, at all levels is based 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 and management actions. For example, implementation of prescribed breeding habitat objectives should eliminate breeding population deficits, which can be determined through monitoring.

Reliable monitoring is necessary to detect population change, thus adaptive management may be especially difficult for some waterbirds. Nonetheless, we incorporate this element into the strategy biological foundation and expect completion of research and monitoring objectives will result in valuable new data to parameterize model values and decision tools. The challenges are many for science-based waterbird conservation, but application of ARM concepts will be a priority in the implementation and refinement of this strategy.

Timetable and Coordination

This Waterbird Habitat Conservation Strategy is part of a broad all-bird JV plan scheduled to be implemented between 2007 and 2022. Although the general all-bird plan has a 15-year time horizon, the technical bird-group conservation strategies will be updated more frequently as part of the plan-implement-evaluate cycle of adaptive management. Waterbird habitat objectives are stated explicitly by State and BCR units (Table 5 and 6) to provide JV partners guidance in waterbird management decisions, and strategy objectives are directly linked to related continental and regional waterbird plans and their conservation priorities. Several plan monitoring and research objectives are identified with completion targets of 2012 and 2016, respectively. Knowledge gained through management actions and conclusion of research, monitoring, and testing of current habitat models and assumptions will dictate the intervals for refinement of this waterbird habitat strategy.

Strategy development and refinement will continue to be the responsibility of the JV Technical Committee. Plan approval and implementation remain the responsibility of the JV Management Board and their associated conservation organizations and state and local partners. Information sharing, outreach, and tracking of accomplishments will be coordinated through the JV Central Office (Minneapolis, MN) whereas GIS spatial data, habitat model development, and collaboration with research and science partners will be the responsibility of the JV Science Office (East Lansing, MI). JV partners have a proven record of achievement following the 1998 JV Implementation Plan, and using the habitat objectives, decision-support tools, and research and monitoring recommendations provided in this strategy, partners will continue to increase conservation efficiency and effectiveness for waterbirds as well as other 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, E. Lansing, Extension Bulletin E-2902. 96pp.

Campbell, L. 1968. Birds of the Toledo area. Toledo Blade Company, Toledo, OH.

Conway, C. J. 2004. Standardized North American marsh bird monitoring protocols. Wildlife Research Report No. 2004-7, USGS Arizona Cooperative Fish and Wildlife Research Unit.

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.

Cuthbert, F.J., J. McKearnan, L.R. Wires and A. Joshi. 2003. Distribution and abundance of colonial waterbirds in the U.S. Great Lakes: 1997-1999. Draft Report to USFWS.

Dahl, T. E. 2000. Status and trends of wetlands in the conterminous United States from 1986 to 1997. U.S. Department of Interior, Fish and Wildlife Service, Washington, D.C. 82pp.

Dahl, T. E. 2006. Status and trends of wetlands in the conterminous United States from 1998 to 2004. U.S. Department of Interior, Fish and Wildlife Service, Washington, D.C. 116pp.

Ducks Unlimited. 2005. Updating the National Wetland Inventory (NWI) for Southern Lower Peninsula of Michigan. Final report submitted to U.S. Fish and Wildlife Service. DU Great Lakes / Atlantic Regional Office, Ann Arbor, MI. 37pp (plus CD).

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. 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, MS. 68pp.

NABCI. 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

NLCD. 1992. National Land Cover Database. *see* Vogelmann, J. E., S. M. Howard, L. Yang, C. R. Larson, B. K. Wylie, and J. N. Van Driel. 2001. Completion of the 1990's National Land Cover Data Set for the conterminous United States. Photogrammetric Engineering and Remote Sensing 67:650-662.

Niemuth, N. D. and J. W. Solberg. 2003. Response of waterbirds to number of wetlands in the Prairie Pothole Region of North Dakota, U.S.A. Waterbirds 26:233-238.

Root, R. B. 1967. The niche exploitation pattern of the blue-gray gnatcatcher. Ecological Monographs 37:317-350.

Sauer, J. R., J. E. Hines, and J. Fallon. 2004. The North American Breeding Bird Survey, results and analysis 1966-2003. Version 2004.1. U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, Maryland, USA.

Sauer, J. R., J. E. Hines, and J. Fallon. 2006. The North American breeding bird survey, results and analysis 1966-2005. Version 2004.2. U.S. Geological Survey,

Patuxent Wildlife Research Center, Laurel, MD. (www.mbr-pwrc.usgs.gov/bbs/bbs.html)

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, MS, 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.

USFWS. 1990. Recovery plan for the interior population of the Least Tern (Sterna antillarum). U.S. Fish and Wildlife Service, Twin Cities, MN. 90pp.

STATSGO. 1991. State soils geographic (STATSGO) data base. U.S. Department of Agriculture, Natural Resources Conservation Service, Miscellaneous Publication Number 1492.

Thompson, B. C., J. A. Jackson, J. Burger, L. A. Hill, E. M. Kirsch, and J. L. Atwood. 1997. Least Tern (*Sterna antillarum*). *In* The Birds of North America, No. 290 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

U.S. Army Corps of Engineers. 1994. Great Lakes water levels. www.lre.usace.army.mil/greatlakes/hh/greatlakeswaterlevels/historicdata/greatlakeshydrographs/

USFWS. 1998. Upper Mississippi River and Great Lakes Region Joint Venture of the NAWMP, 1998 Implementation Plan. U.S. Fish and Wildlife Service, Fort Snelling, MN. 58pp.

Van Horne, B. 1983. Density as a misleading indicator of habitat quality. Journal of Wildlife Management 47:893-901.

Will, T. C, J. M. Ruth, K. V. Rosenberg, D. Krueper, D. Hahn, J. Fitzgerald, R. Dettmers, C. J. Beardmore. 2005. The five elements process: designing optimal landscapes to meet bird conservation objectives. Partners in Flight Technical Series No. 1.

Wires, L. R., S. J. Lewis, G. J. Soulliere, S. Matteson, C. Weseloh, and R. Russell. (in review). Upper Mississippi Valley / Great Lakes Waterbird Conservation Plan. U.S. Fish and Wildlife Service, Fort Snelling, MN. (Draft)

Whitt, M. B. 1996. Avian breeding use of coastal wetlands on the Saginaw Bay of Lake Huron. M.S. Thesis, Michigan State University, East Lansing, MI. 69pp.

Appendix A. Waterbird species accounts with population and cover type information used for habitat planning in the Upper Mississippi River and Great Lakes Joint Venture (JV) region. Population goals and estimates are measured in individual birds. The equation below can be used to calculate average annual change required to reach population goals over specific time periods (see Monitoring and Performance in species accounts).

JV Focal Species (primary author / compiler)	**Last revised**
Black-crowned Night-Heron (Mike Monfils and Greg Soulliere)	July 2007
Yellow Rail (Diane Granfors and Brad Potter)	July 2006
King Rail (Diane Granfors and Greg Soulliere)	February 2007
Common Tern (Greg Soulliere)	July 2007
Black Tern (Greg Soulliere)	April 2006

Calculating Population Growth

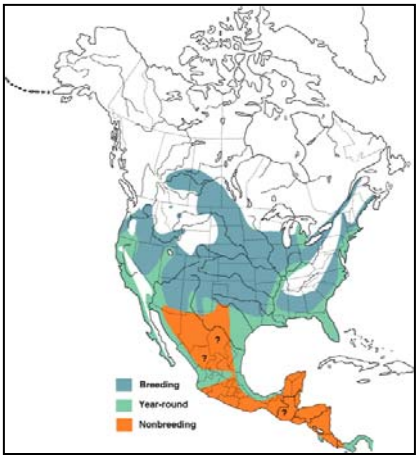
$$FP = CP\,(1 + r)^t$$

$$r = \sqrt[t]{FP/CP} - 1$$

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

Black-crowned Night-Heron (*Nycticorax nycticorax*)
Species Account for Habitat Planning

Joint Venture population deficit based on UMVGLR Waterbird Plan and expert opinion	
Population goal	13,000
Current estimate	8,700
Deficit	4,300



Species range map: Cornell Lab of Ornithology

Breeding habitat requirements
Community types: A wide variety of wetlands: swamps, marshes, lakes, ponds, and rivers, but large marshes with a mix of open water, herbaceous vegetation, and nearby woody cover may be preferred. Nests are typically <3 m from ground in trees and shrubs, occasionally in dense emergent vegetation. Preferred breeding sites have limited predation and human disturbance, particularly islands and large wetland complexes. Shallow weedy pond margins, creeks, and marshes are preferred for foraging; may fly up to 24 km to feeding locations.
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 capable of flight six to seven weeks after hatching.
Area / distance: Nests in colonies; nearest neighbor distances for nests in nine different colonies averaged 1.3 m. The most recent survey (1997-1999) of colonial waterbirds in the Great Lakes revealed 24 Black-crowned Night-Heron colonies and 2,642 pairs (average colony size of 110 pairs) within the JV region. In a prairie pothole study, species was possibly area-dependent, with observations occurring on wetlands >20 ha in size.
Limiting factors: Assumed to be breeding habitat: loss and degradation of wetlands, establishment of invasive exotic plants, loss or succession of nesting cover, and food availability. Storms and predation are key factors impacting nest success; human disturbance also important.

Migration habitat requirement
Community types: Wetlands similar to those used during breeding, especially along the Mississippi River corridor.
Timing: March - April and September - October.
Limiting factors: None; quality feeding and roosting habitat assumed to be adequate within the region.

Population monitoring
Current survey effort: 1) N.A. Breeding Bird Survey (BBS), but likely does not adequately survey this species, 2) Great Lakes Colonial Waterbird Survey (conducted

every 10-years, scheduled for 2007-08), 3) the Marsh Monitoring Program, and 4) state Breeding Bird Atlas projects provide intermittent surveys of occurrence.
Recommended monitoring: Information about the location, size, productivity, and long-term viability of inland (away from Great Lakes shoreline) colonies is needed. Surveys of known and new nesting colonies conducted on a more regular basis (e.g. annually or every 3 – 5 years) would assist assessment of management efforts.

Research to assist planning
Current and ongoing projects: None identified
Research needs: Determine if habitat is limiting population growth and determine area requirements / colony. Need information on habitat requirements and productivity, such as patch or island size, vegetation age and species preferences, landscape context, and effects of predators and human disturbance. The potential impact of growing Double-crested Cormorant populations have on Black-crowned Night-Heron colonies should be explored. Because this species is a predator, periodic monitoring for contaminants is warranted.

Biological model results
Objective: Eliminate regional population deficit through effective and efficient habitat conservation that is considerate of other species of concern.

Calculation: $H = d/c * t$ 3,900 (20 colonies) = 4,300 / 220 * 200

H = minimum new habitat area required to eliminate deficit (ha)
d = regional population deficit (birds)
c = average colony population size (birds)
t = colony breeding territory (ha); assume $\geq$200 ha required for both foraging and nesting

Recommendations
Habitat actions: Maintain (protect) existing nesting habitat quantity and quality (e.g., prevent human disturbance) and add (restore/enhance) >3,900 ha of suitable breeding habitat in an attempt to establish 20 new nest colonies ($\geq$110 pairs each). Distribution and habitat suitability maps (below) can be used to target new colony sites. Considerations to restore, enhance, or create habitat for nesting colonies include: 1) manage trees and shrubs to ensure consistent availability of optimal structure nesting habitat and focus at existing colonies, historic sites if still potentially suitable, and near large wetlands, 2) design dredge-spoil or other created islands to assure site is suitable for a nest colony, and 3) consider localized control of competitors (e.g., Double-crested Cormorants) if determined to be displacing Black-crowned Night-Herons. The estimated area of quality habitat needed to accommodate current populations in the JV region is 11,800 ha (11,818 = 13,000 / 220 * 200).
Monitoring and performance: The Great Lakes Colonial Waterbird Survey conducted every 10-years provides a status assessment of the region's Black-crowned Night-Heron population. More frequent 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., J. McKearnan, L.R. Wires and A. Joshi. 2003. Distribution and abundance of colonial waterbirds in the U.S. Great Lakes: 1997-1999. Draft Report to USFWS.

Davis, W. E., Jr. 1993. Black-crowned Night-Heron (*Nycticorax nycticorax*). *In* The Birds of North America, No. 74 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

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

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

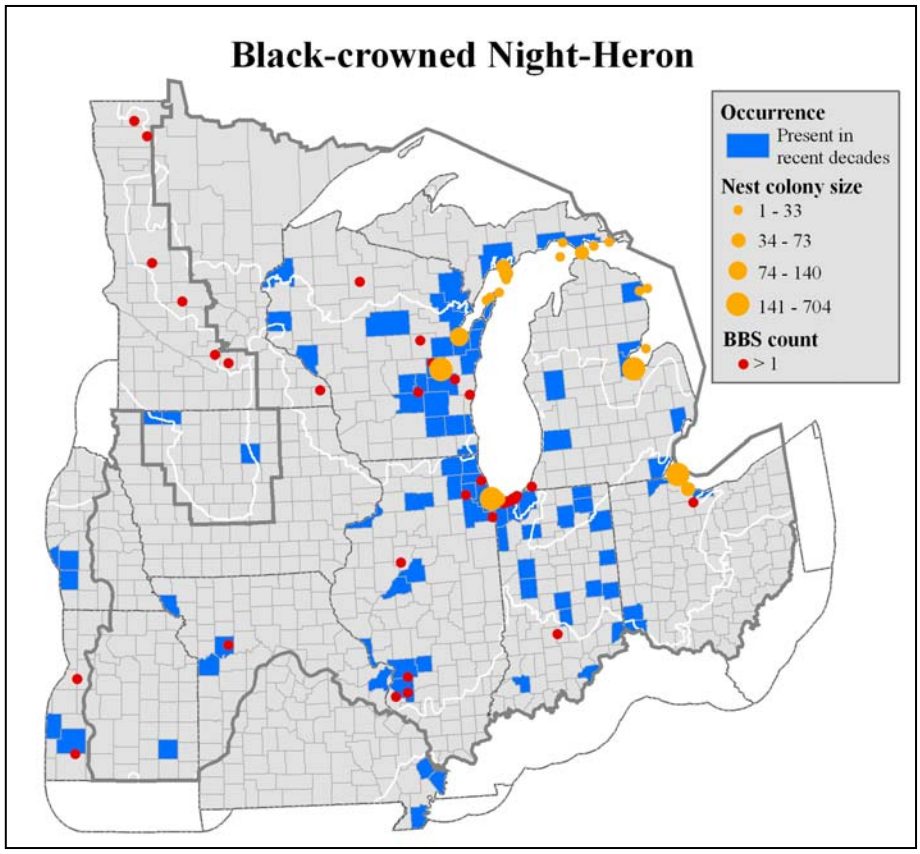
Scharf, W. C., G. W. Shugart, and M. L. Chamberlain. 1978. Colonial birds nesting on man-made and natural sites in the U.S. Great Lakes. Report TR-D-78-10, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, USA. 140pp.

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.

Wires, L. R., S. J. Lewis, G. J. Soulliere, S. Matteson, C. Weseloh, and R. Russell. (in review) Upper Mississippi Valley / Great Lakes Waterbird Conservation Plan. U.S. Fish and Wildlife Service, Fort Snelling, MN. (Draft).

Relative abundance and distribution

Source: Breeding distribution during recent decades (shaded counties) provided via NatureServe when state natural heritage data were available (1970-2005). Colony size and location (orange dots) are based on the Great Lakes Colonial Waterbirds Survey (1997-1999). BBS counts reflect breeding Black-crowned Night-Heron distribution based on road-side inventory techniques (circles = >1 Black-crowned Night-Heron counted along route, 1995-2004). *(Note: These surveys may not capture populations occurring in east-central and southeast Minnesota, northeast Iowa, and western Wisconsin, Bob Russell, FWS-Region 3).*



Landscape Suitability Index (LSI)

Landscape suitability scores for cover types used by breeding and foraging Black-crowned Night-Herons (spatial date from 1992 National Land Cover Dataset, NLCD). Locations along the Great Lakes and inland sites were scored separately due to differences in data. The Great Lakes and inland scores were then combined to create a single LSI output. LSI scores closer to 100 represent greater suitability for Black-crowned Night-Herons.

Great Lakes LSI scores

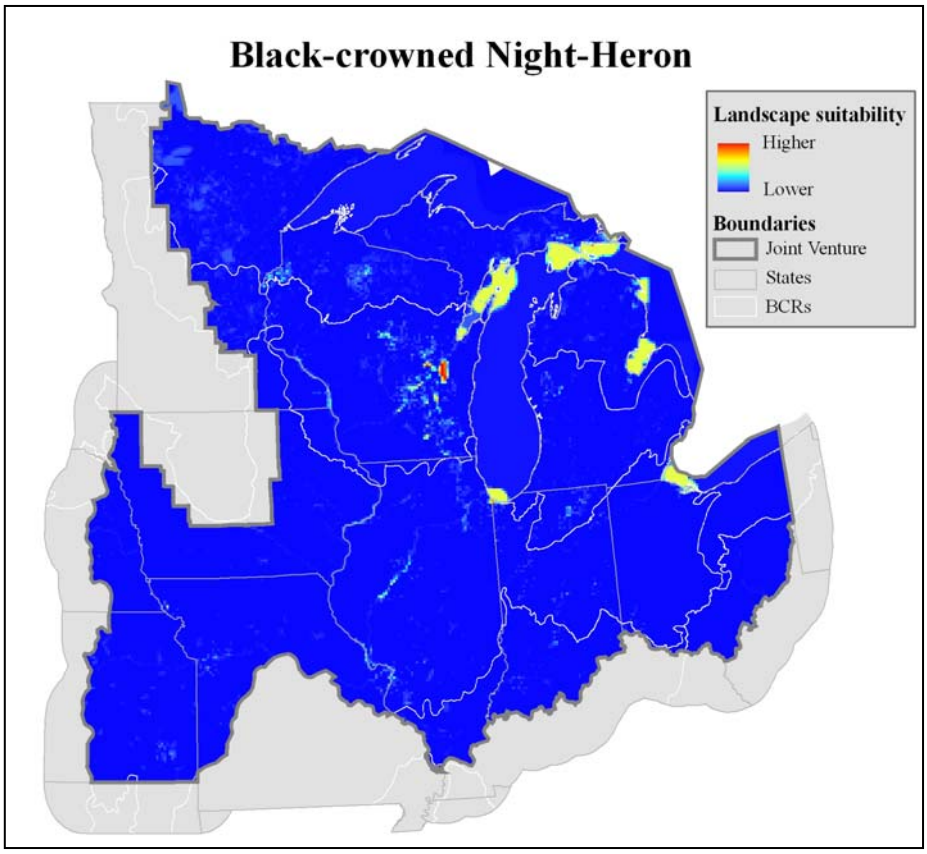
Output options	LSI
Islands <1 km from current colony locations[a]	100
Wetland complexes[b] <24 km from current colony locations	90
Emergent wetlands <24 km from current colony locations	80
Open water <24 km from current colony locations	60
Islands <1 km from past colony locations[c]	50
Wetland complexes <24 km from past colony locations	40
Emergent wetlands <24 km from past colony locations	30
Open water <24 km from past colony locations	10
All other Great Lakes open water	1

[a] Current colony locations are from the Great Lakes Colonial Waterbird Survey, 1997-1999.
[b] Wetland complexes are patches containing both "emergent wetland" and "open water" classes from NLCD (patch size variable, but GIS pixels used in analysis = 30 x 30 m).
[c] Past colony locations are from the Great Lakes Colonial Waterbird Surveys, 1976-1977 and 1989-1990.

Inland LSI scores

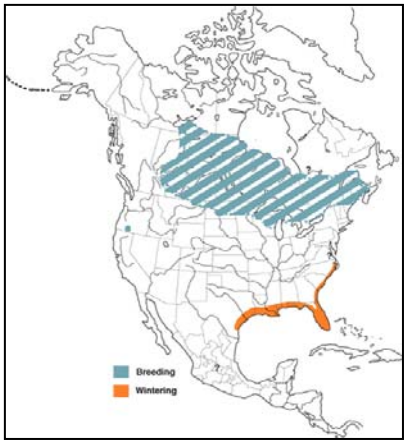
Output options	LSI
Wetland complexes >20 ha within inland counties with historic presence[a]	100
Wetland complexes <20 ha within inland counties with historic presence	80
Emergent wetland within inland counties with historic presence	70
Open water within inland counties with historic presence	40
Wetland complexes >20 ha within Joint Venture region	10

[a] Counties with historic presence are identified by NatureServe or >1 BBS count on routes within the county.


Black-crowned Night-Heron
Landscape suitability
Higher
Lower
Boundaries
Joint Venture
States
BCRs

Yellow Rail (*Coturnicops noveboracensis*)
Species Account for Habitat Planning

Joint Venture population deficit based on UMVGLR Waterbird Plan and expert opinion	
Population goal	1,280
Current estimate	640
Deficit	640



Species range map: Cornell Lab of Ornithology

Breeding habitat requirements
Community types: Wet meadows dominated by woolly / wiregrass sedge *(Carex lasiocarpa)* or fine-stemmed grasses and emergent aquatic plants; uses wetland edges. Water depths at nest site range from saturated ground to 20 cm deep; depth within breeding territory <50 cm. Quality of breeding cover is degraded with encroachment of woody vegetation.
Timing: Arrive late April to May, egg laying late May to early June, incubation is 17 - 18 days, and young fledge at five weeks of age.
Area / distance: Breeding males are somewhat gregarious with overlapping territories. Occupied wetland size can range from 0.5-1,000 ha; densities of calling males range from 0.01-0.08/ha (≥0.02/ha in quality habitat).
Limiting factors: Adequate wet meadow and shallow marsh with *Carex* or other fine-stemmed native emergent plants. Marsh management for deeper water (>50 cm) is not favorable.

Migration habitat requirements
Community types: Probably wet meadow and grassland; not well studied.
Timing: March - May and September - October.
Limiting factors: Area of wet prairie assumed adequate. Potential obstacles during migration; several reports of deaths caused by striking communication towers.

Population monitoring
Current survey effort: Species is a target for proposed FWS range-wide secretive marshbird survey effort; Seney National Wildlife Refuge (NWR) annual marshbird survey; state Breeding Bird Atlas projects in Wisconsin and Michigan and County Biological Survey in Minnesota provide intermittent surveys of occurrence.
Recommended monitoring: Special night surveys can be successful at documenting occurrence and perhaps estimating densities.

Research to assist planning
Current and ongoing projects: Assessment of population density and breeding habitat characteristics at Seney NWR.

Research needs: Identification of breeding areas; density estimates, breeding success and limiting factors in known breeding areas; identification of migration habitat and needs; compatibility of other wildlife management practices with Yellow Rail breeding habitat; population-level effects of communication tower strikes during migration.

Biological model results

Objective: Eliminate regional population deficit through effective and efficient habitat conservation that is considerate of other species of concern.

Calculation: $H = d/(c * 2)$ $16{,}000 = 640 / (0.02 * 2)$

H = minimum new habitat area required to eliminate deficit (ha)
d = regional population deficit (birds)
c = density of calling males (birds / ha of quality habitat)
Assumption: Sex ratio is 1:1 and there is 1 female for every calling male.

Recommendations

Habitat actions: Protect existing habitat area and quality, and add (restore / enhance) ≥ 16,000 ha of breeding habitat (see requirements above) at sites within current and historic breeding range (see distribution and landscape suitability maps for target areas). The frequency of Yellow Rails occupying restored wetlands has not been well documented and special management and monitoring may be required. Restored wetlands often do not contain appropriate vegetation and structure for Yellow Rails. Wetland restoration or creation projects must 1) assure basin topography that achieves appropriate water levels for foraging, 2) be designed to establish persistent stands of sedge and fine-stemmed grasses, and/or 3) be planted with preferred plant species (see references for management techniques). The estimated area of quality habitat needed to accommodate current breeding populations is also16,000 ha (16,000 = 640 / 0.04).

Monitoring and performance: Local monitoring programs may be needed to evaluate management actions with targeted surveys in known and suspected breeding areas. Eliminating the current population deficit requires a 100% population increase or an average of 5% annually over a 15 year period.

References

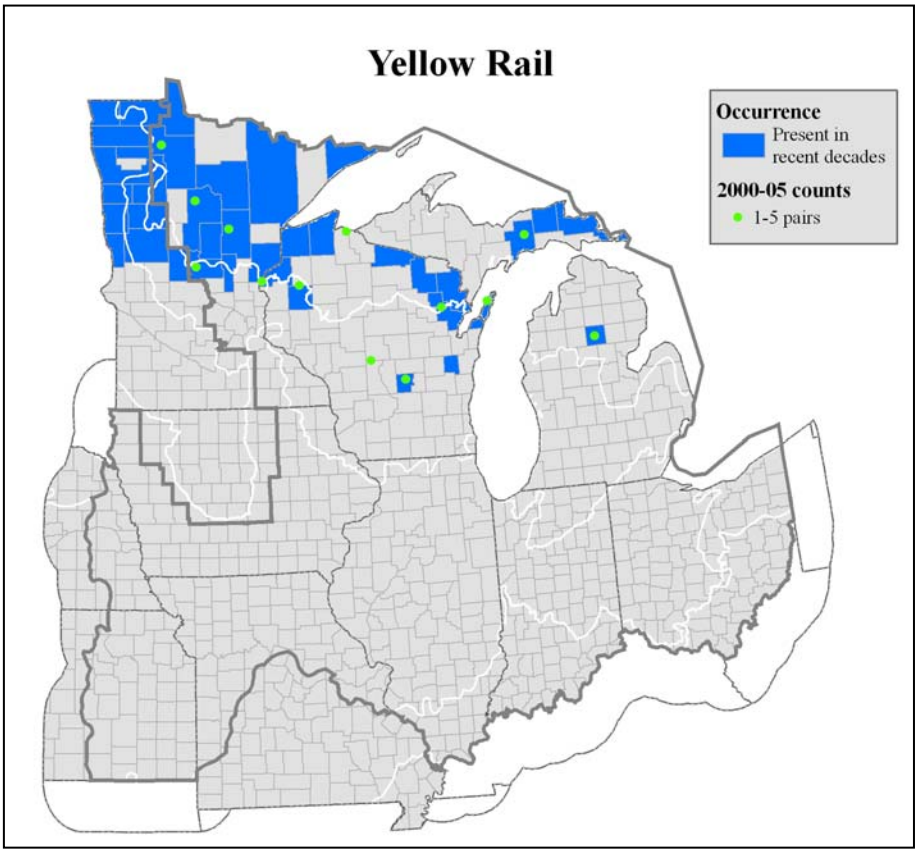
Bookhout, T. A. 1995. Yellow Rail (*Coturnicops noveboracensis*). *In* The Birds of North America, No. 139 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.

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, ND. Northern Prairie Wildlife Research Center Online. http://www.npwrc.usgs.gov/resource/literatr/wetbird/yera/yera.htm (Version 12DEC2003).

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(3):282-288.

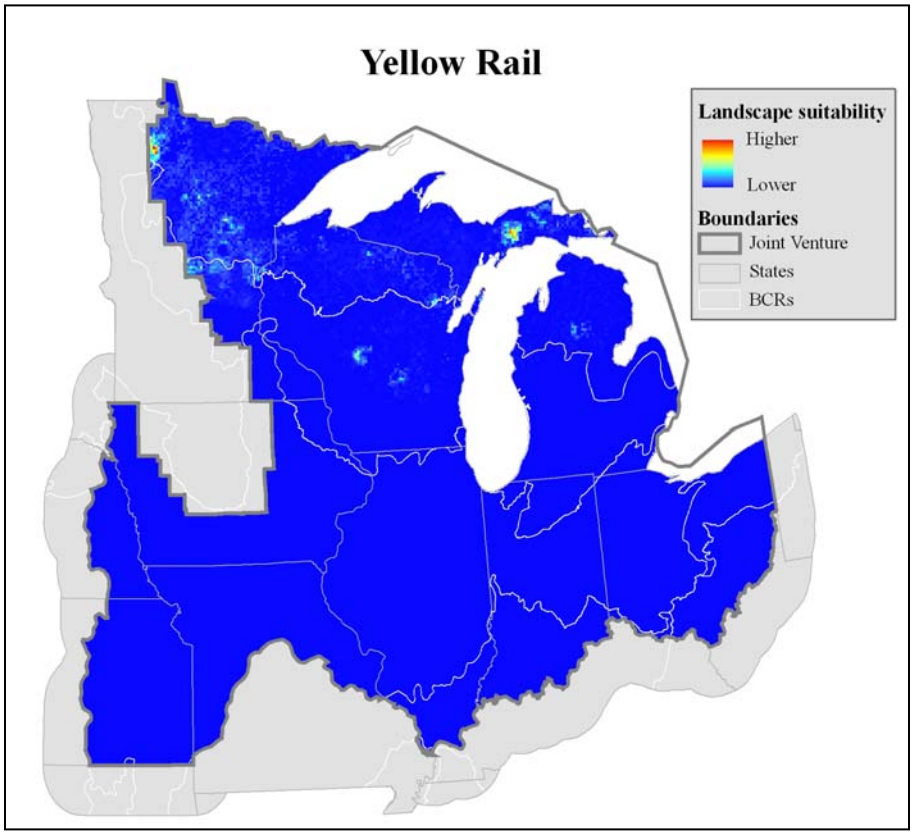
Relative abundance and distribution

Source: Distribution during recent decades (shaded counties) provided via NatureServe when state natural heritage data were available (1970-2005). Breeding locations based on local surveys in recent years (green dots) from Bob Russell, FWS-Region 3.



Landscape Suitability Index (LSI)
Landscape suitability scores for cover types used by breeding Yellow Rails (spatial data from 1992 National Land Cover Dataset, NLCD). LSI scores closer to 1.0 represent greater suitability for Yellow Rails.

Output options	LSI score
Emergent wetlands <20 km from known breeding location	100
Emergent wetlands within counties with historic presence	50
All other emergent wetlands within species traditional breeding range	10



King Rail (*Rallus elegans*)
Species Account for Habitat Planning

Joint Venture population deficit based on UMVGLR Waterbird Plan and expert opinion	
Population goal	708
Current estimate	354
Deficit	354

Species range map: Cornell Lab of Ornithology

Breeding habitat requirements
Community types: Marsh, river floodplain, and wet meadow; prefer water depths <25 cm with cattail, grass, sedge and/or rush, often with scattered shrubs and small trees. Species requires varied micro-topography – hummocks, swales, and dry patches in marsh for nesting, foraging, and brood rearing.
Timing: Arrive April to early May, nest initiation mid-May through June, egg incubation is 21 - 23 days, and young fledge at about 10 weeks of age.
Area / distance: Densities variable; does not appear to be area sensitive, but may be edge intolerant. Nests placed in the interiors of marsh 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 more value. Recent density estimates of 0.07 - 0.22 / ha have been recorded.
Limiting factors: Adequate diverse, shallow herbaceous native-plant wetlands suitable for reproduction, possibly with fluctuating water regimes.

Migration habitat requirements
Community types: Shallow native-plant wetlands; floodplains of large rivers (e.g., Mississippi River) historically important.
Timing: Probably mid-April to early May and September through October; apparently solitary; scattered reports in the JV region through winter.
Limiting factors: No information; feeding and roosting habitat during migration assumed adequate if breeding habitat objectives achieved.

Population monitoring
Current survey effort: Species is a target for proposed FWS range-wide secretive marshbird survey effort. State Breeding Bird Atlases and other intermittent surveys of wildlife areas provide occurrence data.
Recommended monitoring: Standardized secretive marshbird survey in potential and known breeding areas.

Research to assist planning

Current and ongoing projects: King Rail was recently listed as a national focal species by the FWS Division of Migratory Birds, which requires writing and adopting a strategic conservation plan.

Research needs: Survey techniques and sampling scheme to determine breeding distribution, population trend, and demographics for northern populations; impact of habitat isolation and size of available breeding areas on breeding success and demography; foraging ecology; compatibility of waterfowl management with King Rail habitat (assumed to be compatible but not specifically studied).

Biological model results

Objective: Eliminate regional population deficit through effective and efficient habitat conservation that is considerate of other species of concern.

Calculation: $H = d/c$ $\quad 5{,}100 = 354 / 0.07$

H = minimum new habitat area required to eliminate deficit (ha)
d = regional population deficit (birds)
c = recent minimum density estimate (birds/ha)

Recommendations

Habitat actions: Maintain (protect) existing habitat area and quality, and add (restore / enhance) ≥5,100 ha of breeding habitat (see requirements above) at sites within current or historic breeding range (see distribution and landscape suitability maps for target areas). Restoration of shallow native-plant wetlands and wetland complexes should be >20 ha in size. Where ecologically sound and economically feasible, enhance sites by restoring natural water-level fluctuations. Diverse micro-topography should be encouraged during basin restoration or creation. Enhance degraded marsh by converting areas colonized by exotic invasive plants (e.g., Phragmites) back to native species. The estimated area of quality habitat needed to accommodate current breeding populations is also 5,100 ha (5,057 = 354 / 0.07).

Monitoring and performance: King Rails are not adequately monitored by the Breeding Bird Survey, but populations appear to have declined severely in northern breeding grounds. To evaluate the effect of management actions, targeted surveys should be conducted in known and suspected breeding areas. Eliminating the current population deficit requires a 100% population increase or an average of 5% annually over a 15 year period.

References

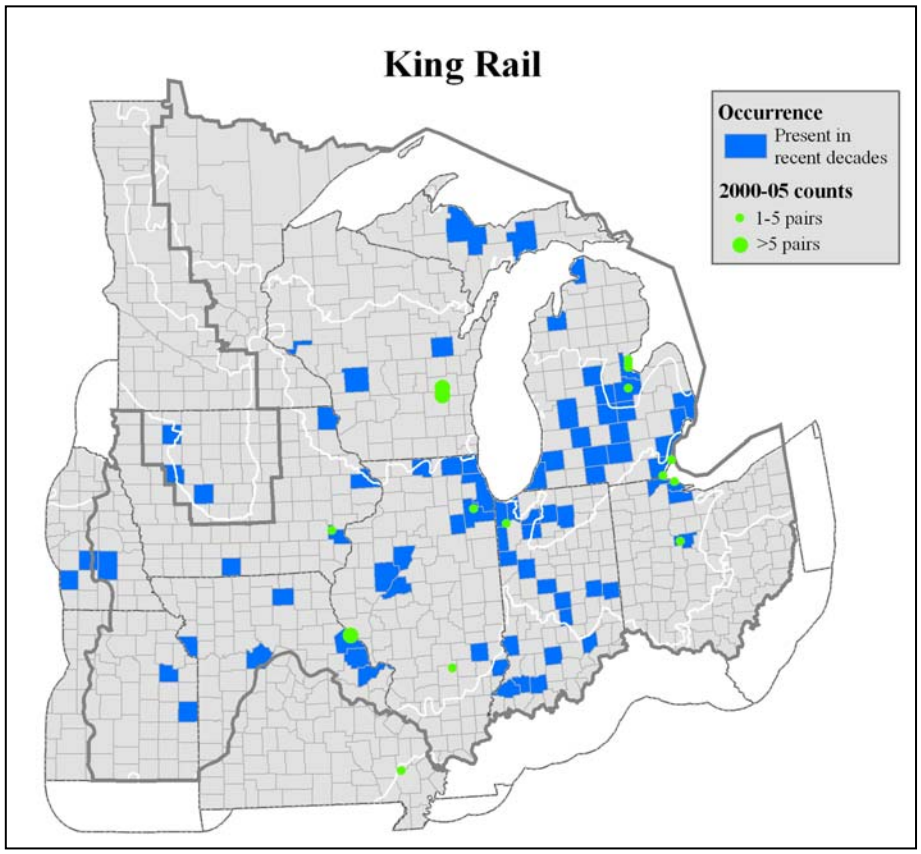
Poole, A. F., L. R. Bevier and C. A. Marantz. (2005). King Rail (*Rallus elegans*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Laboratory of Ornithology; Retrieved from The Birds of North American Online database:

Reid, F. A., B. Meanly, L. H. Frederickson. 1992. King Rail. Pages 181-192 *in* T. C. Tacha and C. E. Braun, eds. Migratory shore and upland game bird management

in North America, International Association of Fish and Wildlife Agencies, Washington, D.C.

Relative abundance and distribution

Source: Distribution during recent decades (shaded counties) provided via NatureServe when state natural heritage data were available (1970-2005). Breeding locations based on local surveys in recent years (green dots) from Bob Russell, FWS-Region 3.

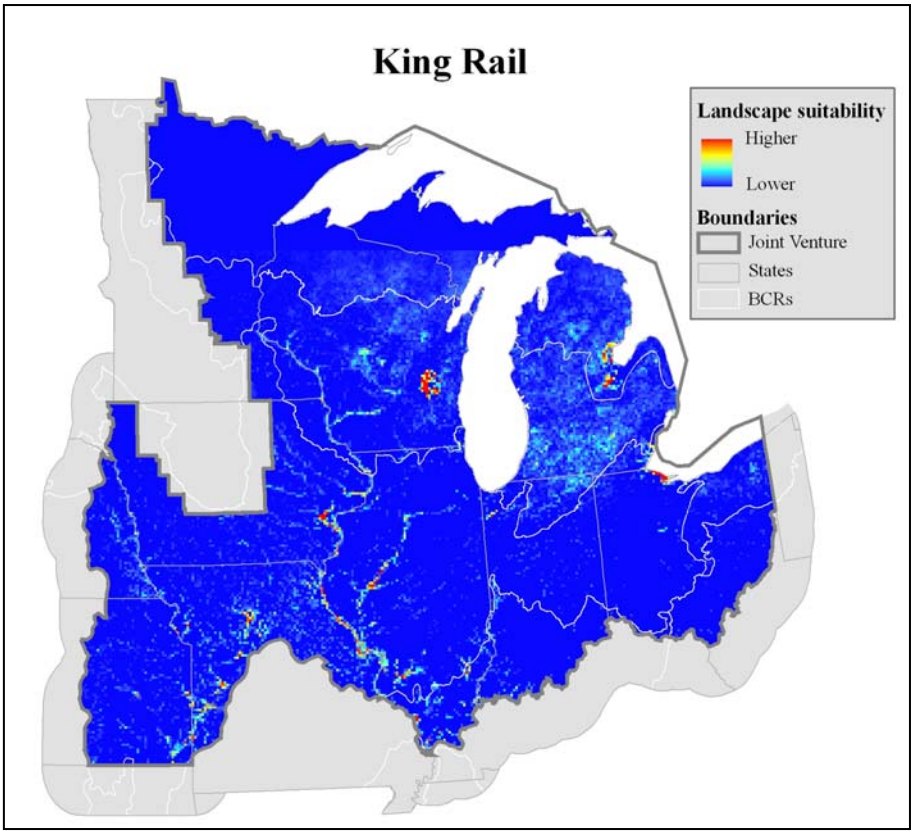


Landscape Suitability Index (LSI)

Landscape suitability scores for cover types used by breeding King Rails (spatial data from 2001 National Land Cover Dataset). Scores closer to 100 represent a greater suitability for King Rails.

Output options	LSI score
Emergent wetlands >20 ha and <20 km from current King Rail breeding locations	100
Emergent wetlands <20 ha and <20 km from current King Rail breeding locations	80
Woody wetlands >20 ha and <20 km from current King Rail breeding locations	50
Woody wetlands <20 ha and <20 km from current King Rail breeding locations	30
Other sites without breeding history but within species traditional breeding range (see below)[a]	0-100

[a]Emergent wetlands >20 ha and <40 km from major river systems (Mississippi, Missouri, Ohio, Scioto, Wabash, Illinois, and Wisconsin) or >20 ha and <20 km from the southern shores of Lake Michigan and Lake Erie were given initial scores of 100; emergent wetlands <20 ha within the same regions were given scores of 80. Woody wetlands >20 ha and <40 km from major river systems or >20 ha and <20km from the southern shores of Lake Michigan and Lake Erie were given initial scores of 50; woody wetlands in the same regions were given scores of 30. All scores for these sites were then weighted by latitude; southern-most locations multiplied by 1.0 to northern latitudes outside the species range which were multiplied by 0.0.



Common Tern (*Sterna hirundo*)
Species Account for Habitat Planning

Joint Venture population deficit based on UMVGLR Waterbird Plan and expert opinion	
Population goal	7,600
Current estimate	5,100
Deficit	2,500

Species range map: Cornell Lab of Ornithology

Breeding habitat requirements

Community types: Areas of the Great Lakes and large inland lakes (>1,000 ha) often with marsh and abundant small (3-10 cm) forage fish available <50 cm from the surface. Nests are located on natural or artificial islands and peninsulas, sometimes on barrier beaches, rarely on floating mats in marshes. Prefers nest sites with sand, gravel, shell, or cobble substrates and scattered vegetation (typically 10-40% coverage) or other protection where chicks can shelter. Sites are often managed or at locations where environmental factors prevent development of woody vegetation; other management has included gull and cormorant removal or exclusion.

Timing: Nests mid-April to late August, most egg-laying in May-July, incubation 21-27 days, and young fledge at about 28 days.

Area / distance requirements: Nests colonially, 0.06–0.5 nests/m^2 but as high as 3.1 nests/m^2 and in colonies up to 300 pairs (more typical is 100 pairs on a 400 m^2 colony site). Most nests are placed <100 m inland from water edge and <4 m elevation above water surface but outside wave-wash zone. Pairs often return to same site. Breeding birds feed within 20 km of colony-sites, much less if colony is small and/or prey locally abundant. They will also feed on small wetlands and ponds. Pairs 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: Adequate suitable colony sites in proximity (<20 km) to abundant forage. Nesting areas must be free of predators with low human disturbance and limited competition from Ring-billed and Herring Gulls; gulls and cormorants can displace Common Terns to less suitable sites subject to greater adverse conditions.

Migration habitat requirement

Community types: Shallow and deep lakes, rivers, and marsh / open-water complexes for feeding; roost on undisturbed beaches and sand flats or on emerged wood and rock structures.

Timing: April – June and August – November; short migration duration.

Limiting factors: None; feeding and roosting habitat assumed adequate in region.

Population monitoring
Current survey effort: Great Lakes Colonial Waterbird Survey (conducted every 10 years, scheduled for 2007-08). State Breeding Bird Atlases also provide distributional data and intermittent surveys are conducted by state agencies, FWS, tribes, and universities.
Recommended monitoring: An annual survey of known nest colonies and periodic inquiry (via conservation partners) of new and restored colonies.

Research to assist planning
Current and ongoing projects: None identified.
Research needs: Most mortality is believed to occur in winter; population dynamics will not be understood until more is learned about foraging ecology, energetics, molt, causes of death, and other limiting factors during winter.

Biological model results
Objective: Eliminate regional population deficit through effective and efficient habitat conservation that is considerate of other species of concern.

Calculation: $H = d/c * t$ 13 islands and associated territories = 2,500 / 200

H = habitat for new nesting colonies to eliminate deficit (colonies)
d = regional population deficit (birds)
c = average colony population size (birds)

Recommendations
Habitat actions: Providing habitat recommendations for island-nesting colonial waterbirds like Common Tern is especially challenging. These birds depend heavily on Great Lakes near-shore sites, where habitat suitability is dynamic. Conditions such as island substrate, wave action, forage abundance, predation, competition, and human disturbance change from year to year, often in relation to water levels of the Great Lakes. The following guidelines should be used in consultation with local experts to ensure efficient use of management resources.

In addition to maintaining and protecting habitat quality associated with exiting colonies, 13 new nest colonies must be established through restoration/enhancement of previously used sites or establishment of suitable cover on created islands within potential breeding habitat ($\geq$100 pairs / site). Quality breeding habitat is described above, and distribution and landscape suitability maps (below) can be used to target protection and restoration effort for colony sites. Protection of exiting colonies should focus on limiting human disturbance and gull colonization, plus substrate maintenance. For potential new or enhanced colony sites, managers should: 1) assist in designing dredge-spoil or other island projects to assure sites are suitable for a nest colony, 2) provide preferred substrate on islands potentially attractive for nesting while minimizing maintenance requirements (e.g., vegetation control), 3) evaluate deterrence and control of Ring-billed and Herring Gulls where they may displace terns (see references for management techniques), and 4) consider feeding territories of existing tern colonies

when locating new projects; required distances between sites may be >10 km depending on colony size and forage availability.

Monitoring and performance: The Great Lakes Colonial Waterbird Survey (conducted every 10 years) will census Common Tern colonies along the Great Lakes shoreline, where most habitat work is likely to occur. However, more frequent surveys are required to better measure population change and habitat management performance. Eliminating the current population deficit requires a 50% increase in population size or an annual average of 3% over a 15 year period.

References

Cuthbert, F.J., J. McKearnan, L.R. Wires and A. Joshi. 2003. Distribution and abundance of colonial waterbirds in the U.S. Great Lakes: 1997-1999. Draft Report to USFWS.

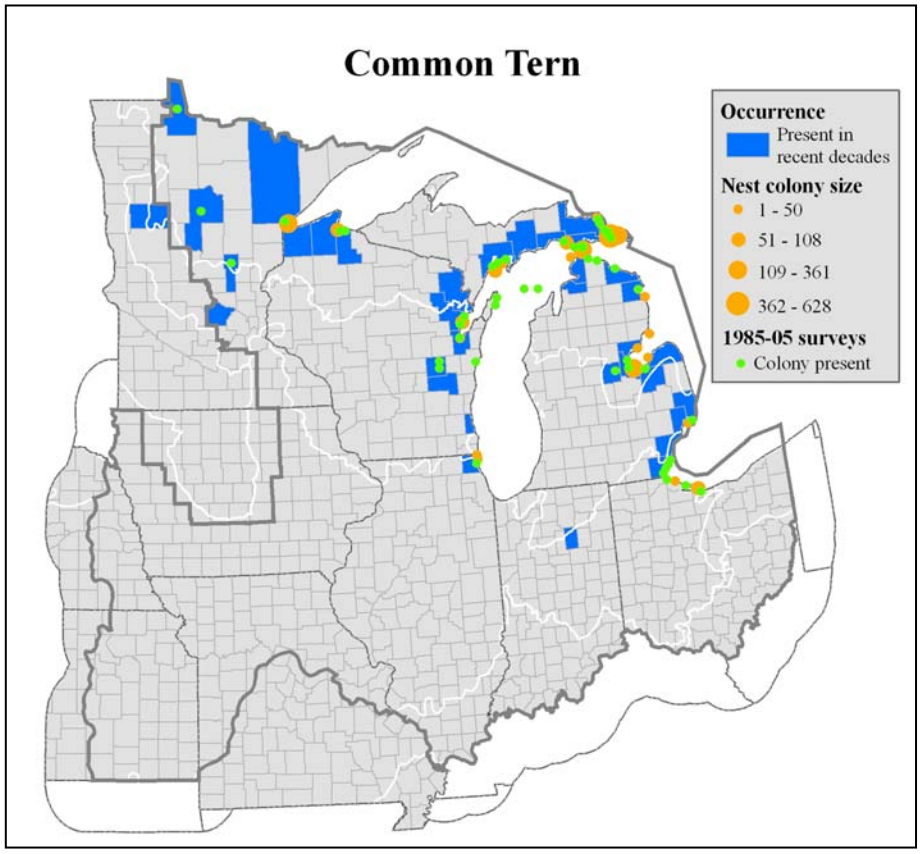
NatureServe. 2005. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.6. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: January 23, 2006).

Nisbet, I. C. T. 2002. Common Tern (*Sterna hirundo*). *In* The Birds of North America, No. 618 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Wires, L. R., S. J. Lewis, G. J. Soulliere, S. Matteson, C. Weseloh, and R. Russell. (in review) Upper Mississippi Valley / Great Lakes Waterbird Conservation Plan. U.S. Fish and Wildlife Service, Fort Snelling, MN. (Draft).

Relative abundance and distribution

Source: Breeding distribution during recent decades (shaded counties) provided via NatureServe when state natural heritage data were available (1970-2005). Colony size and location (orange dots) based on the Great Lakes Colonial Waterbird Survey (1997-1999). Recent colony locations (green dots) based on local survey data (1985-2005) provided by Bob Russell, FWS – Region 3.

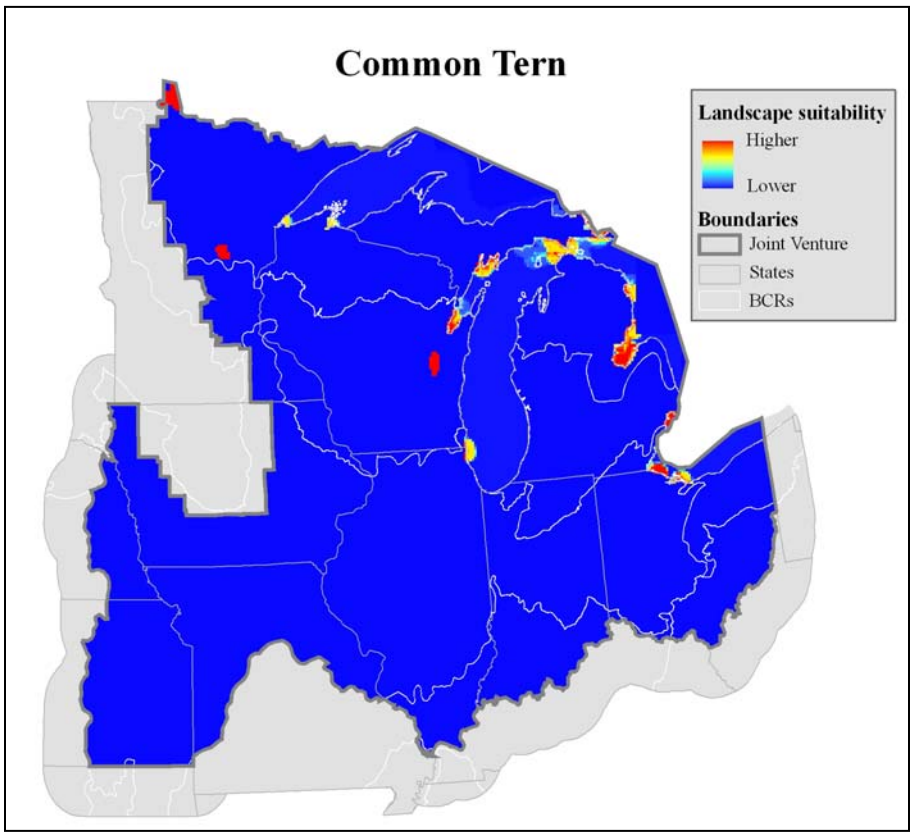


Landscape Suitability Index (LSI)

Landscape suitability scores for areas surrounding current colony locations (1997-1999) and past colony locations (1976-1977 and 1989-1990). High LSI scores (red shade) represent areas currently with high values to maintain and protect whereas lower scores (yellow/green shades) reflect restoration and enhancement opportunity for Common Terns.

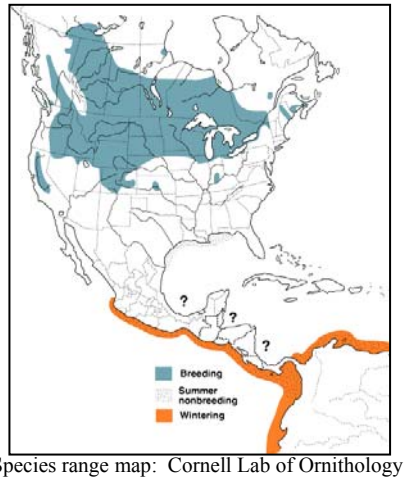
Output options	LSI score
Great Lakes water <10 m in depth[a] and <20 km from existing colony and inland lakes used by existing colonies	100
Great Lakes water ≥10 m in depth and <20 km from existing colony	70
Great Lakes water <10 m in depth and <20 km from past colony	40
Great Lakes water ≥10 m in depth and <20 km from past colony	10
All other Great Lakes water	1

[a]Great Lakes water depth was interpolated from NOAA bathymetric contour file.



Black Tern (*Chlidonias niger*)
Species Account for Habitat Planning

Joint Venture population deficit based on UMVGLR Waterbird Plan and expert opinion	
Population goal	28,400
Current estimate	18,900
Deficit	9,500



Species range map: Cornell Lab of Ornithology

Breeding habitat requirements
Community types: Marshes with extensive stands of emergent vegetation and large areas of open water. Nesting occurs within vegetation on floating plant material or other low structure. Water may be shallow lake, impoundment, slow moving river, or large pond with adequate forage (insects and small fish). Vegetation at nest sites is typically bulrush, cattail, sedge, or wild rice. Preferred sites are mosaics of less dense emergent marsh often due to deeper water (≥1 m depth) or with openings from muskrat activity.
Timing: Nests late May to early August, egg-laying in May to July but mostly early June, incubation 20-24 days, and young fledge in 18-28 days.
Area / distance: Nests semi-colonially in loose groups, typically about 20 pairs (40 individuals) but also singly or in groups as high as 200 pairs. Prefers native-plant marsh complexes ≥20 ha in size, and will use smaller marshes (10 ha) when in close proximity (1-4 km) to other quality habitat (marsh / open water complexes >10 ha in size). Readily selects new nest sites each year in response to water-levels and other factors that influence vegetation conditions and the vegetation / open-water mosaic.
Limiting factors: Adequate productive wetlands with native emergent plants in association with open water (0.5 - 1.5 m water depth) and relatively low wave action at nest sites. Wetland loss and degradation (largely due to dense growths of invasive plants – giant reed / Phragmites, purple loosestrife, and hybrid cattail) are considered primary reasons for this species decline in the region.

Migration habitat requirements
Community types: Shallow and deep lakes, rivers, marsh / open-water complexes, and occasionally nearby cultivated fields.
Timing: May – June and August – October.
Limiting factors: None; quality feeding and roosting habitat assumed to be adequate within the region.

Population monitoring
Current survey effort: 1) N.A. Breeding Bird Survey (BBS), 2) Great Lakes Colonial Waterbird Survey (conducted every 10-years, scheduled for 2007-08), and 3) the Marsh

Monitoring Program. State Breeding Bird Atlases also provide distributional data and intermittent surveys are conducted at state wildlife areas and national forests / refuges.
Recommended monitoring: Current survey effort is inadequate to generate an accurate population estimate for the region. A stratified random sampling approach may be needed to inventory areas with extensive habitat and standardized techniques for areas of limited habitat.

Research to assist planning
Current and ongoing projects: None identified.
Research needs: Better information to assess numbers, trends, and causes for population change; migration corridors, timing, and stopover locations; potential habitat limitations during migration; influence of human disturbance (e.g., boat traffic) at nest colonies; production, recruitment, and survival; foraging range; and characteristics influencing nest site selection at the landscape scale.

Biological model results
Objective: Eliminate regional population deficit through effective and efficient habitat conservation that is considerate of other species of concern.

Calculation: $H = d/c * h$ 4,750 (240 colonies) = 9,500 / 40 * 20

H = minimum new habitat area required to eliminate deficit (ha)
d = regional population deficit (birds)
c = average colony population size (birds)
h = minimum habitat area required / colony (ha)

Recommendations
Habitat actions: Maintain (protect) existing habitat area and quality, and add (restore / enhance) ≥4,750 ha of breeding habitat (see requirements above) at multiple sites within primary current or historic breeding range (see distribution and landscape suitability maps for target areas). Large drained wetlands may be restored and/or existing degraded sites may be managed to restore required native plant and open-water characteristics (see references for management techniques). The estimated area of quality habitat needed to accommodate current breeding populations is 9,450 ha (9,450 = 18,900 / 40 * 20)
Monitoring and performance: BBS data may be inadequate to monitor many aquatic species; however long-term BBS trends for the Black Tern reflect other intermittent survey findings. 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
Dunn, E. H., and D. J. Agro. 1995. Black Tern (*Chlidonias niger*). *In* The Birds of North America, No. 147 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C

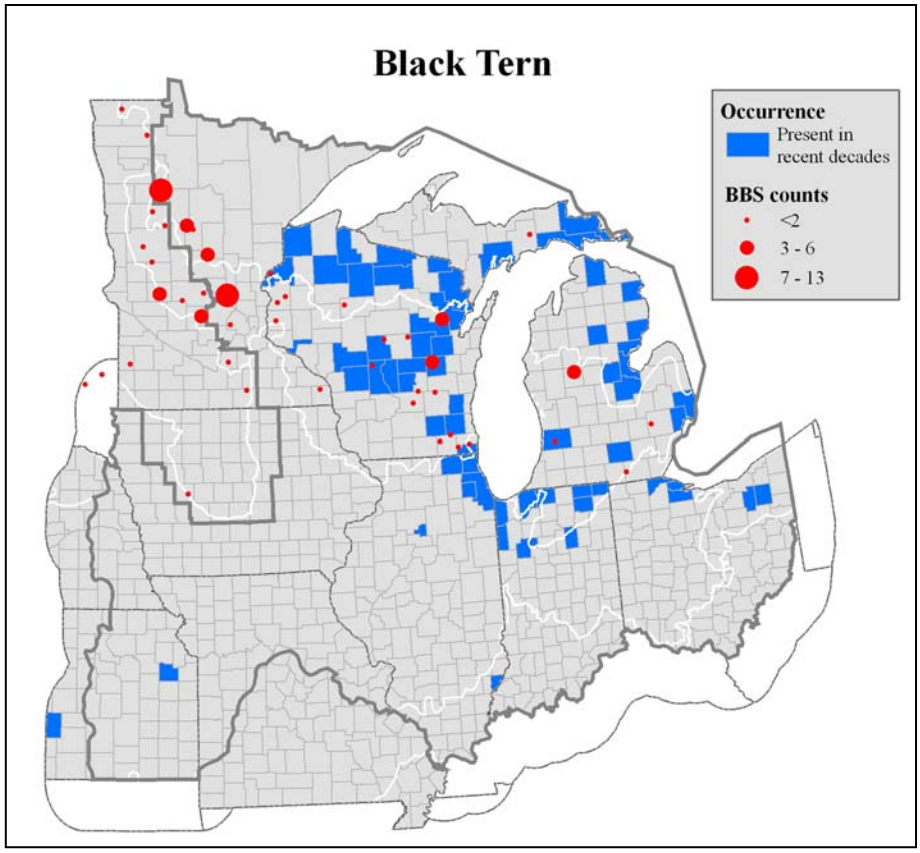
Kudell-Ekstrum, J. and T. Rinaldi. 2004. Conservation assessment for black tern *(Chlidonias niger)*. USDA Forest Service, Eastern Region, Milwaukee, WI. 46pp.

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, CO. 129pp.

Wires, L. R., S. J. Lewis, G. J. Soulliere, S. Matteson, C. Weseloh, and R. Russell. (in review) Upper Mississippi Valley / Great Lakes Waterbird Conservation Plan. U.S. Fish and Wildlife Service, Fort Snelling, MN. (Draft).

Relative abundance and distribution

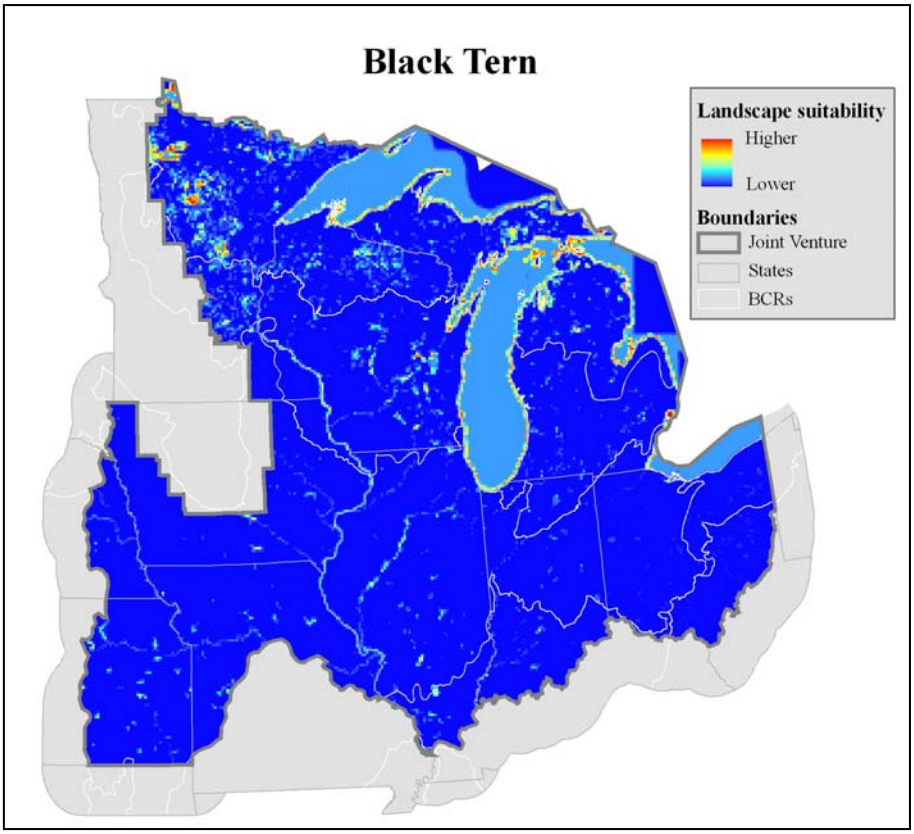
Source: Distribution during recent decades (shaded counties) provided via NatureServe when state natural heritage data were available (1970-2005). BBS counts reflect breeding Black Tern distribution based on this road-side inventory technique (location and average count / route where Black Terns were detected, 1995-2004).



Landscape Suitability Index (LSI)
Landscape suitability scores for cover types used by breeding Black Terns (spatial data from 1992 National Land Cover Dataset, NLCD). LSI scores closer to 1.0 represent greater suitability for Black Terns.

Output options	LSI score
Wetland complexes[a] >20 ha (excluding Great Lakes >4 km offshore)	100
Wetland complexes 10-20 ha <4 km from open water >10 ha	80
Emergent wetland >20 ha	60
Emergent wetland 10-20 ha <4 km from open water >10 ha	40
Open water >20 ha (excluding the Great Lakes)	20
Open water 10-20 ha <4 km from emergent wetland >10 ha	10

[a]Wetland complexes are patches that contain both "emergent wetland" and "open water" classes from NLCD.



Appendix B. Common and scientific names of waterbirds occurring in the Upper Mississippi River and Great Lakes Joint Venture region.

Common name	Scientific name	Species code
Red-throated Loon	*Gavia stellata*	RTLO
Common Loon	*Gavia immer*	COLO
Pied-billed Grebe	*Podilymbus podiceps*	PBGR
Horned Grebe	*Podiceps auritus*	HOGR
Red-necked Grebe	*Podiceps grisegena*	RNGR
Eared Grebe	*Podiceps nigricollis*	EAGR
Western Grebe	*Aechmophorus occidentalis*	WEGR
American White Pelican	*Pelecanus erythrorhynchos*	AWPE
Double-crested Cormorant	*Phalacrocorax auritus*	DCCO
American Bittern	*Botaurus lentiginosus*	AMBI
Least Bittern	*Ixobrychus exilis*	LEBI
Great Blue Heron	*Ardea herodias*	GBHE
Great Egret	*Ardea alba*	GREG
Snowy Egret	*Egretta thula*	SNEG
Little Blue Heron	*Egretta caerulea*	LBHE
Cattle Egret	*Bubulcus ibis*	CAEG
Green Heron	*Butorides virescens*	GRHE
Black-crowned Night-Heron	*Nycticorax nycticorax*	BCNH
Yellow-crowned Night-Heron	*Nyctanassa violacea*	YCNH
Yellow Rail	*Coturnicops noveboracensis*	YERA
Black Rail	*Laterallus jamaicensis*	BLRA
King Rail	*Rallus elegans*	KIRA
Virginia Rail	*Rallus limicola*	VIRA
Sora	*Porzana carolina*	SORA
Common Moorhen	*Gallinula chloropus*	COMO
American Coot	*Fulica americana*	AMCO
Sandhill Crane	*Grus canadensis*	SACR
Whooping Crane	*Grus americana*	WHCR
Parasitic Jaeger	*Stercorarius parasiticus*	PAJA
Franklin's Gull	*Larus pipixcan*	FRGU
Bonaparte's Gull	*Larus philadelphia*	BOGU
Ring-billed Gull	*Larus delawarensis*	RBGU
Herring Gull	*Larus argentatus*	HERG
Great Black-backed Gull	*Larus marinus*	GBBG
Sabine's Gull	*Xema sabini*	SAGU
Thayer's Gull	*Larus thayeri*	THGU
Iceland Gull	*Larus glaucoides*	ICGU
Lesser Black-backed Gull	*Larus fuscus*	LBBG
Glaucous Gull	*Larus hyperboreus*	GLGU
Little Gull	*Larus minutus*	LIGU
Caspian Tern	*Sterna caspia*	CATE
Common Tern	*Sterna hirundo*	COTE
Forster's Tern	*Sterna forsteri*	FOTE
Least Tern	*Sterna antillarum*	LETE
Black Tern	*Chlidonias niger*	BLTE

Appendix C. Threats common to breeding and migrating waterbirds in the Upper Mississippi River and Great Lakes region.

Category	Threats	Examples
Habitat conversion	Industrial, residential, and recreational development causing wetland loss or degradation	Housing Industrial development Golf courses Cell Towers Wind farms Roads
	Wetland and native cover conversion to agriculture lands	Farms / field expansion Plantations
	Dams	Impoundments Beaver Dams
	Dredging and channelization	Changes to riparian corridors
	Incompatible natural resource management	Prescribed burn patterns/frequency Wetland/water-level manipulation Vegetative planting / manipulation Flooding / dam maintenance & removal
Non-consumptive biological resource use	Non-consumptive recreation	Jet-skis, picnicking
	Military maneuvers	Aircraft traffic, heavy artillery training Heavy equipment movements
Pollution	Urban, municipal and industrial pollution	Solid waste Acid rain Oil and gas drilling / mining
	Pesticides and herbicides	Agriculture practices Golf course practices Mosquito control
Biological interactions	Invasive plants and animals (native & exotic)	Expanding ranges Introduced plants Introduced animals Introduced predators Cats & dogs
	Disease, pathogens, and parasites	West Nile virus Leucocytozoonosis Duck plague Newcastle disease Botulism
	Predation and competition	Nest losses
Modification of natural processes	Climate change	Human influenced Natural processes
	Grazing / mowing patterns or other vegetation manipulation	Frequency of mowing High intensity grazing
	Fire regime	Fire suppression
	Hydrologic regimes	Water withdrawal Drains Tiles
	Fragmentation	Transportation infrastructure
Education	Lack of species life history knowledge	Lack of management or inappropriate management due to lack of knowledge
	Social attitudes	Persecution Ignorance Apathy
Unknown	Not yet documented	Not yet documented

Appendix D. Waterbird population estimate information (numbers of individuals) for species with limited survey data in the Upper Mississippi River and Great Lakes Joint Venture (JV) region, compiled by Robert Russell, U.S. Fish and Wildlife Service Migratory Bird Specialist, Ft. Snelling, MN, January 2006.

Few waterbird species are adequately surveyed to confidently generate regional population estimates; estimates of better surveyed species can be found in the Upper Mississippi Valley / Great Lakes Waterbird Conservation Plan (UMVGL Plan, Wires et al., in review). Estimates for poorly surveyed species listed below were developed for the JV region using a system of state Breeding Bird Atlas data, information from local survey efforts, and expert opinion. Population estimates (individual birds) are described by Bird Conservation Region (BCR) within the JV region, individual states within BCR boundaries, and for the total area of the JV region.

Pied-billed Grebe: Breeding Bird Atlases, state bird books, and expert opinion were used to generate estimates. Due to the vocal yet frequently retiring nature of this species and its broad range within the Midwest, a 3x multiplier was used assuming each bird seen at an atlas site represents 2 other birds unseen except for major marshes where a 10x factor was used since multiple pairs are typical for large wetland complexes. This will result in both over-counts and undercounts but seems fair based on continued presence at most of these sites for many years or even decades. The regional estimate likely represents a minimum since the species can be very furtive at times during the breeding cycle.

BCR 12 - **1,440** (MN - 400, WI - 232, MI - 808)
BCR 13 - **56** (OH - 56)
BCR 22 - **1,194** (KS - 48, NE - 44, MO - 200, IA - 156, MN - 40, WI - 4, IL - 440, IN - 88, MI - 20, OH - 154)
BCR 23 - **2,380** (IA - 12, MN - 200, WI - 560, IL - 0, IN - 48, MI - 1,560)
BCR 24 - **72** (IL - 40, IN - 32)
BCR 28 - **4** (OH - 4)
Total JV region population estimate: **5,234**

Horned Grebe: No pairs of Horned Grebe are known to breed in the JV region. Formerly the species was a local summer resident in BCRs 12, 22, and rarely 23. The species breeds just west of BCR 12 in Marshall County, MN (Thief Lake State Wildlife Area).
Total JV region population estimate: **0**

Red-necked Grebe: Breeding Bird Atlases, state bird books, and expert opinion were used to generate estimates. A factor of 2x was used assuming each bird seen at an atlas site represents one other bird unseen (i.e. a pair of breeding birds). The regional estimate likely represents a minimum since the species is rather quiet and unobtrusive during the breeding season. Between 12,000 and 20,000 Red-necked Grebes migrate past Whitefish Point (BCR 12) in Michigan from July through September on their way to unknown

staging areas, perhaps in northern Lake Huron, Canada. This population likely represents birds that largely breed outside the Great Lakes Basin. The MN estimate is a minimum and may be much larger.

BCR 12 - **1,224** (MN - 1,200, WI - 20, MI - 4)
BCR 22 - **10** (IA - 0, MN - 10, WI - 0, IL - 0, MI - 0, OH - 0)
BCR 23 - **100** (MN - 80, WI - 20, MI - 0, IA - 0, IL - 0, IN - 0)
Total JV region population estimate: **1,334**

Eared Grebe: The Eared Grebe breeds only sporadically in the JV region in very low numbers. There are no historical records for breeding, thus the species is believed to be a recent arrival in this region and most breeding records occur in either sewage ponds or natural shallow wetlands.

BCR 12 - **1** (MN - 0, WI - 0, MI - 0-2)
BCR 22 - **1** (IA - 0-2, MN - 0, WI - 0, IL - 0-1, MI - 0, OH - 0)
BCR 23 - **4** (MN - 0, WI - 0-5, MI - 0-2, IA - 0, IL - 0, IN - 0)
Total JV region population estimate: **6**

Western Grebe: The Western Grebe breeds only sporadically in the JV region in very low numbers. Except for the western part of BCR 12, there are no historical records for breeding, thus the species is believed to be a recent arrival in this region and most breeding records occur in either sewage ponds or natural shallow wetlands. The birds presence in this region may be dynamic, in response to occasional drought conditions farther west in the Dakotas and Nebraska.

BCR 12 - **18** (MN - 17, WI - 0-2, MI - 0)
BCR 22 - **5** (IA - 0-4, MN - 0-5, WI - 0, IL - 0, MI - 0, OH - 0)
BCR 23 - **2** (MN - 0-2, WI - 0-2, MI - 0, IA - 0, IL - 0, IN - 0)
Total JV region population estimate: **25**

American White Pelican: This species has increased its range in recent years, moving east in the region. There were an estimated 4,200 in BCR 23 alone **(**3,834 by actual 2005 count at Horicon NWR plus summering birds at Trempeleau NWR and vicinity in Wisconsin**)**.

BCR 12 - **2,900** (WI – 2,890, MI – 10)
BCR 23 - **4,200** (WI - 4,200)
BCR 22 - **0**
Total JV region population estimate: **7,100**

American Bittern: Breeding Bird Atlases, state bird books, and expert opinion were used to generate estimates. Due to the retiring nature of this species and its broad range within the Midwest, a factor of 2x was used assuming each bird seen at an atlas site represents 1 other bird unseen or a mated pair. The regional estimate likely represents a

minimum since the species only calls regularly during the early breeding season and is notoriously hard to census, even when present in some numbers.

BCR 12 - **870** (MN - 240, WI - 150, MI - 480)
BCR 13 - **10** (OH - 10)
BCR 22 - **112** (KS - 4, NE - 8, IA - 34, MO - 12, MN - 4, WI - 2, IL - 20, IN - 10, MI - 6, OH - 12)
BCR 23 - **368** (MN - 100, WI - 112, MI - 150, IA - 0, IL - 2, IN - 4)
BCR 24 - **14** (IN - 10, IL - 4)
BCR 28 - **0** (OH - 0)
Total JV region population estimate: **1,374**

Least Bittern: Breeding Bird Atlases, state bird books, and expert opinion (Frank Durbian, Squaw Creek NWR, MO and Michelle McDowell, Rice Lake NWR, MN) were used to generate estimates. Due to the retiring nature of this species and its broad range within the Midwest, a factor of 5x was used assuming each bird seen at an atlas site represents 4 other birds unseen. This will result in both over-counts and undercounts but seems fair based on continued presence at most of these sites for many years or even decades. 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 some numbers.

BCR 12 - **245** (MN - 40, WI - 30, MI - 175)
BCR 13 - **35** (OH - 35)
BCR 22 - **1,230** (KS - 25, NE - 20, IA - 85, MO - 430, MN - 10, WI - 10, IL - 165, IN - 55, MI - 330, OH - 100)
BCR 23 - **695** (MN - 60, WI - 265, MI - 330, IA - 10, IL - 10, IN - 20)
BCR 24 - **55** (IN - 35, IL - 20)
BCR 28 - **35** (OH - 35)
Total JV region population estimate: **2,295**

Yellow Rail: Breeding Bird Atlases (MI, MN, and WI), state bird books, and expert opinion (Kim Eckert, Jan Green, Michelle McDowell - USFWS) were used to generate estimates. Estimates for Seney NWR were provided by former researchers working on rails at that refuge. For other sites a factor of 10x was used assuming that each calling bird at a site with multiple records over several years with apparently good habitat represents a minimum of 5 males and 5 females. This will result in both over-counts and undercounts but seems fair based on continued presence at most of these sites for many years or even decades. 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 - **560** (WI - 160, MN - 300, MI - 100)
BCR 23 - **80** (WI - 40, MN - 40, MI - 0)
BCR 13 - extirpated, no recent records
BCR 22 - extirpated, no recent records

Total JV region population estimate: **640**

Black Rail: Breeding Bird Atlases, state bird books, and observation records from the journal *North American Birds* were used to generate estimates. For this very rare species a 2x multiplier was used with the assumption each calling male represents a pair. For states with regular or even irregular occurrence but no regular location, a rough, perhaps generous pair estimate was used. The almost annual appearance of this species somewhere in the southern Lake Michigan region in spring, between Milwaukee and NW Indiana, suggests a minimum population be assigned to this area even without recent breeding records.

BCR 12 - **4** (MI - 2, WI - 2, MN - 0)
BCR 13 - **0** (OH - 0)
BCR 22 - **36** (KS - 0, NE - 0, IA - 2, MO - 10, MN - 0, WI - 2, IL - 10, IN - 10, MI - 0, OH - 2)
BCR 23 - **30** (MN - 0, WI - 10, MI - 10, IL - 0, IN - 10, IA - 0)
BCR 24 - **8** (IL - 2, IN - 6, OH - 0)
BCR 28 - **0** (OH - 0)
Total JV region population estimate: **78**

King Rail: Estimates are based on the 2003 report "*Status of King Rails in the Mississippi Flyway"* by Bob Russell (USFWS) and Steve Maxson (MNDNR), written for the Mississippi Flyway Council Technical Section**.** Population estimates in the paper were provided in ranges (i.e., 10-15 pairs), but the mid-point of those ranges is used below.

BCR 12 - **10** (MI - 10, WI - 0, MN - 0)
BCR 13 - **4** (OH - 4)
BCR 22 - **230** (KS - 20, NE - 40, IA - 26, MO - 60, MN - 0, WI -4, IL - 50, IN - 20, MI - 10, OH - 30)
BCR 23 - **89** (MN - 4, WI - 50, MI - 20, IL - 5, IN - 5, IA - 5)
BCR 24 - **21** (IL - 6, IN - 10, OH - 5)
BCR 28 - **0** (OH - 0)
Total JV region population estimate: **354**

Virginia Rail: Breeding Bird Atlases, state bird books, and expert opinion were used to generate estimates. Due to the retiring nature of this species and its broad range within the Midwest, a factor of 4x was used assuming each bird seen at an atlas site represents 4 other birds unseen. This will result in both over-counts and undercounts but seems fair based on continued presence at most of these sites for many years or even decades. The regional estimate likely represents a minimum since the species only sporadically calls during the breeding season and is difficult to census, even when present in some numbers.

BCR 12 - **988** (MN - 500, WI - 152, MI - 336)

BCR 13 - **160** (OH - 160)
BCR 22 - **572** (KS - 8, NE - 20, MO - 20, IA - 28, MN - 40, WI - 16, IL - 196, IN - 24, MI - 20, OH - 200)
BCR 23 - **1,866** (IA - 8, MN - 400, WI - 828, IL - 10, IN - 20, MI - 600)
BCR 24 - **8** (IL - 4, IN - 4)
BCR 28 - **12** (OH - 12)
Total JV region population estimate: **3,614**

Common Moorhen: Breeding Bird Atlases, state bird books, and expert opinion (Frank Durbian, Squaw Creek NWR, Eric Nelson, Upper Mississippi River NWR) were used to generate estimates. Due to the retiring nature of this species and its broad range within the Midwest, a factor of 10x was used assuming each bird seen at an atlas site represents 9 other birds unseen. This will result in both over-counts and undercounts but seems fair based on continued presence at most of these sites for many years or even decades. 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 some numbers.

BCR 12 - **260** (MN - 0, WI - 0, MI - 260)
BCR 13 - **400** (OH - 400)
BCR 22 - **1,860** (KS - 30, NE - 20, MO - 100, IA - 70, MN - 10, IL - 400, IN - 100, MI - 900, OH - 230)
BCR 23 - **580** (IA - 30, MN - 20, WI - 400, IL - 0, IN - 70, MI - 60)
BCR 24 - **80** (IL - 30, IN - 50)
BCR 28 - **30** (OH - 30)
Total JV region population estimate: **3,210**

American Coot: Breeding Bird Atlases, state bird books, and expert opinion were used to generate estimates. Due to the retiring nature of this species and its broad range within the Midwest, a factor of 5x was used assuming each bird seen at an atlas site represents 4 other birds unseen. This species is usually more visible than its Moorhen relative during the breeding season. 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 some numbers. In the southern part of the JV region coots are sporadic breeders during very wet years and absent or nearly so in dry years.

BCR 12 - **800** (MN - 400, WI - 200, MI - 200)
BCR 13 - **25** (OH - 25)
BCR 22 - **1,545** (KS - 100, NE - 60, MO - 55 (100-250 in wet years), IA - 350, MN - 100, WI - 0, IL - 360, IN - 100, MI - 20, OH - 400)
BCR 23 – **2,615** (IA - 25, MN - 400, WI - 1,800, IL - 5, IN - 45, MI - 340)
BCR 24 - **110** (IL - 50 (50-200 in wet years), IN - 60)
BCR 28 - **5** (OH - 5)
Total JV region population estimate: **5,100**