Upper Mississippi River Bottomland Forest Avian Stewardship Plan

The Audubon Center at Riverlands
The U.S. Army Corps of Engineers, St. Louis District,
Rivers Project Office

US Army Corps of Engineers®
St. Louis District

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Acknowledgments

Authors/Editors:

Emma Young	University of Missouri St. Louis, Department of Biology
Ken Buchholz	National Audubon Society, Audubon Center at Riverlands
Charlie Deutsch	U.S. Army Corps of Engineers, St. Louis District
Jean Favara	National Audubon Society, Audubon Center at Riverlands
Lane Richter	U.S. Army Corps of Engineers, St. Louis District
Dan Scheiman	National Audubon Society, Audubon Arkansas
Tara Hohman	National Audubon Society, Audubon Center at Riverlands

Contributors:

Robert Cosgriff	U.S. Army Corps of Engineers, St. Louis District
Melanie Driscoll	National Audubon Society, Gulf Coast Conservation/Mississippi Flyway
Katy Fechter	U.S. Army Corps of Engineers, St. Louis District
Susan Flader	University of Missouri Columbia, Professor Emerita
Kristin Hall	National Audubon Society, Audubon Minnesota
Derek Ingvalson	U.S. Army Corps of Engineers, St. Paul District
Melinda Knutson	U.S. Fish and Wildlife Service
Dr. Robert Marquis	University of Missouri St. Louis, Department of Biology
Kathryn McCain	U.S. Army Corps of Engineers, St. Louis District
Nicole Michel	National Audubon Society, Science Division
Sarah Miller	U.S. Army Corps of Engineers, St. Louis District
Lynn Neher	U.S. Army Corps of Engineers, St. Louis District
Andrew Schimpf	U.S. Army Corps of Engineers, St. Louis District
Tim Schlagenhaft	National Audubon Society, Audubon Minnesota
Ryan Swearingin	U.S. Army Corps of Engineers, St. Louis District
Randall Urich	U.S. Army Corps of Engineers, St. Paul District

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Table of Contents

List of Tables and Figures

Tables

Figures

I. Executive Summary

Introduction

The U.S. Army Corps of Engineers (hereafter Corps) has a mission to manage and conserve natural resources, consistent with ecosystem management principles, while providing quality public outdoor recreation experiences that contribute to the quality of American life. On the Upper Mississippi River System (UMRS) the Corps monitors and manages a diverse array of wildlife on over 150,000 acres of forests, wetlands and grasslands. These public lands are managed in partnership with many; including non-governmental organizations and state and federal agencies.

More locally the Corps' Rivers Project Office, in West Alton, MO manages approximately 49,000 acres of floodplain habitat in the St. Louis District from Saverton, MO downstream to Cairo, IL and on the lower 80 miles of the Illinois River.

The mission of the National Audubon Society (NAS) and the Audubon Center at Riverlands (hereafter Audubon) is to conserve and restore natural ecosystems, focusing on birds, other wildlife, and their habitats for the benefit of humanity and the earth's biological diversity. Audubon's years of successes include ecosystem-wide conservation focused on protection and restoration of the nation's most special places from Alaska's Tongass to Sagebrush country and the Louisiana Coast. Audubon is now using 100-plus years of experience to ensure a sustainable future for the Mississippi River and its birds and other wildlife.

Opened in 2011, the Audubon Center at Riverlands is a key component of NAS's Upper Mississippi Program and a unique partnership with the Corps' Rivers Project Office. The Center is located in the 3,700-acre Riverlands Migratory Bird Sanctuary, which was established in 1988 and is owned and managed by the Corps. The Center and the Sanctuary are located on the Mississippi River near the confluence with the Missouri River and 18 miles from the confluence with the Illinois River. The Audubon and Corps partnership provides a powerful platform to use science, education, and advocacy to protect these vital natural resources.

Toward this end, in 2012 Audubon and the Corps jointly initiated an avian monitoring program for bottomland forests on 49,000 acres of public lands managed by the Corps' St. Louis District. These lands are interspersed along 180 miles of the Mississippi and Illinois rivers from the Sanctuary in West Alton north to Saverton, Missouri. This area includes the Great Rivers Confluence Important Bird Area (IBA), the Lincoln Alluvial Complex IBA, and the Ted Shanks Alluvial Complex IBA, all of which were identified by the Audubon Missouri IBA Technical Report in 2006 as critical for monitoring and protecting birds. Human encroachment, adverse land management and agricultural practices, invasive species and other unstainable development have significantly reduced these once vast bottomland forest systems.

Purpose

The purpose of this plan is to serve as a regional bird-focused addendum to the Upper Mississippi River Systemic Forest Stewardship Plan (SFSP; Guyon et al. 2012) for the partnership between Audubon and the Rivers Project Office. The SFSP was developed by through a partnership with the Corps foresters and biologists as well as state natural resource agencies, the U.S. Fish and Wildlife Service and non-governmental organizations as a collaborative framework to address forest management, monitoring and science needs across various agency boundaries. The plan addresses current terrestrial habitat conditions on the Upper Mississippi River System as well as threats, data needs and desired future conditions for forests. The SFSP generally provides an adaptive management framework with standardized management objectives and recommended priority actions that can be implemented across the Upper Mississippi River System floodplain.

As an addendum to the SFSP, this plan focuses exclusively on forest bird populations, as the habitat management practices described in the SFSP are forest-focused. This plan builds upon the goals outlined by the SFSP by identifying a strategy to conserve forest bird populations starting with lands managed by the Rivers Project Office, while also accomplishing forestry goals, to be undertaken by the Corps and Audubon. Adaptive management of bottomland forests and associated habitats is central to this strategy, and also supports the goals of the SFSP. This plan represents the Corps' and Audubon's shared goal to conserve bird populations in Mississippi River bottomland forests. It further reflects the strategic goal of the NAS to manage, protect, and restore more than 1 million acres of habitat in watersheds throughout the nation.

Notably, while this document does make avian-specific forest management recommendations, it is not intended to serve as an in-depth forest management document. The reader is referred to the Systemic Forest Stewardship Plan (Guyon et al. 2012) for general forest management guidelines currently utilized by the Corps

Designated Project Area

The project area for this plan is the St. Louis District, a portion of the full Upper Mississippi River Systems defined in the SFSP (Guyon et al. 2012, p. viii):

> "[The] project area is designated as the Upper Mississippi River System (UMRS) 500-year floodplain, regardless of ownership. … The lateral extent of the 2.6 million acre UMRS floodplain ecosystem generally encompasses the river valley lands from bluff to bluff, and consists of a mosaic of land and water that contains bottomland forests, grasslands, islands, backwaters, side channels and wetlands."

The Corps' portion of the UMRS is broken up into three districts: St. Paul, Rock Island, and St. Louis (Figure 1). Within these districts the river is further separated into river pools; pools are defined as areas of water that are impounded between two sequential navigation dams (see Figure 2 for an example of local pools in the St. Louis District). For more detail on the natural and land use history of the UMRS, see Figure 3 and refer to the SFSP (Guyon et al. 2012).

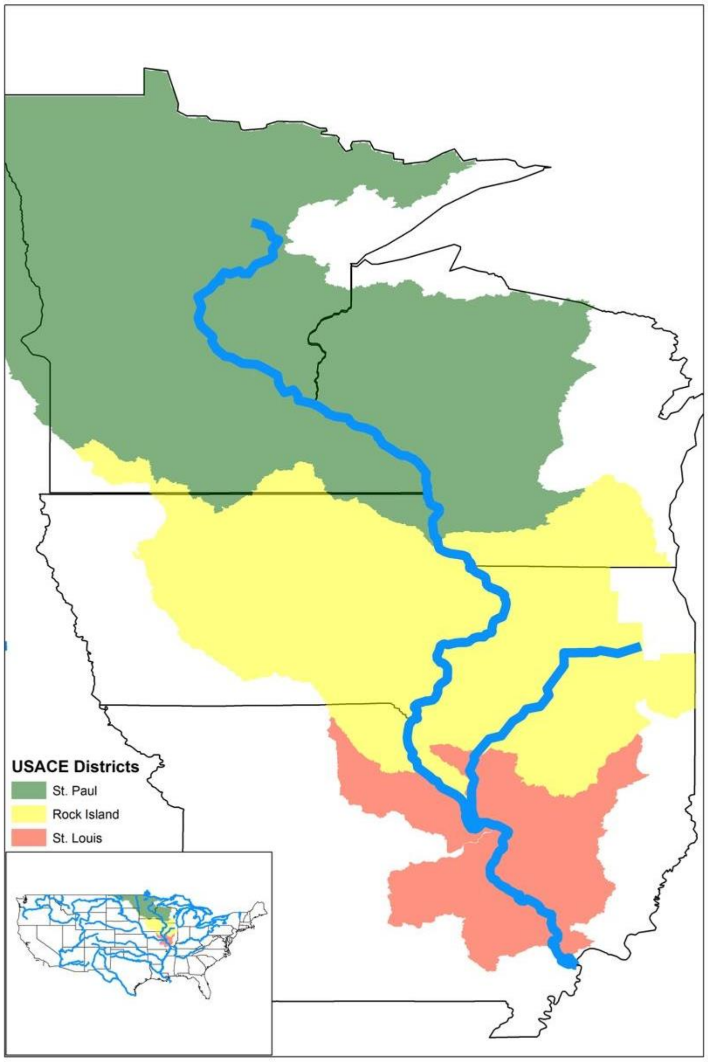

Figure 1. The UMRS project area and the three Corps districts.

Plan Objectives

This plan seeks to achieve avian-focused forest management in the St. Louis District with the following aims:

- Identify focal bird species of ecological importance and monitoring value
- Identify data gaps and research objectives
- Set habitat goals and objectives that align with those of the Systemic Forest Stewardship Plan (Guyon et al. 2012) while also improving bird habitat
- Define methodologies to collect robust, standardized datasets
- Commit to a policy of adaptive management

- Outline the shared conservation goals between Audubon and the Corps that guide the collaboration and result in a unified strategy focused on bird conservation
- Outline a timeline for developing a framework to leverage partnerships throughout the UMRS to implement avian conservation projects.

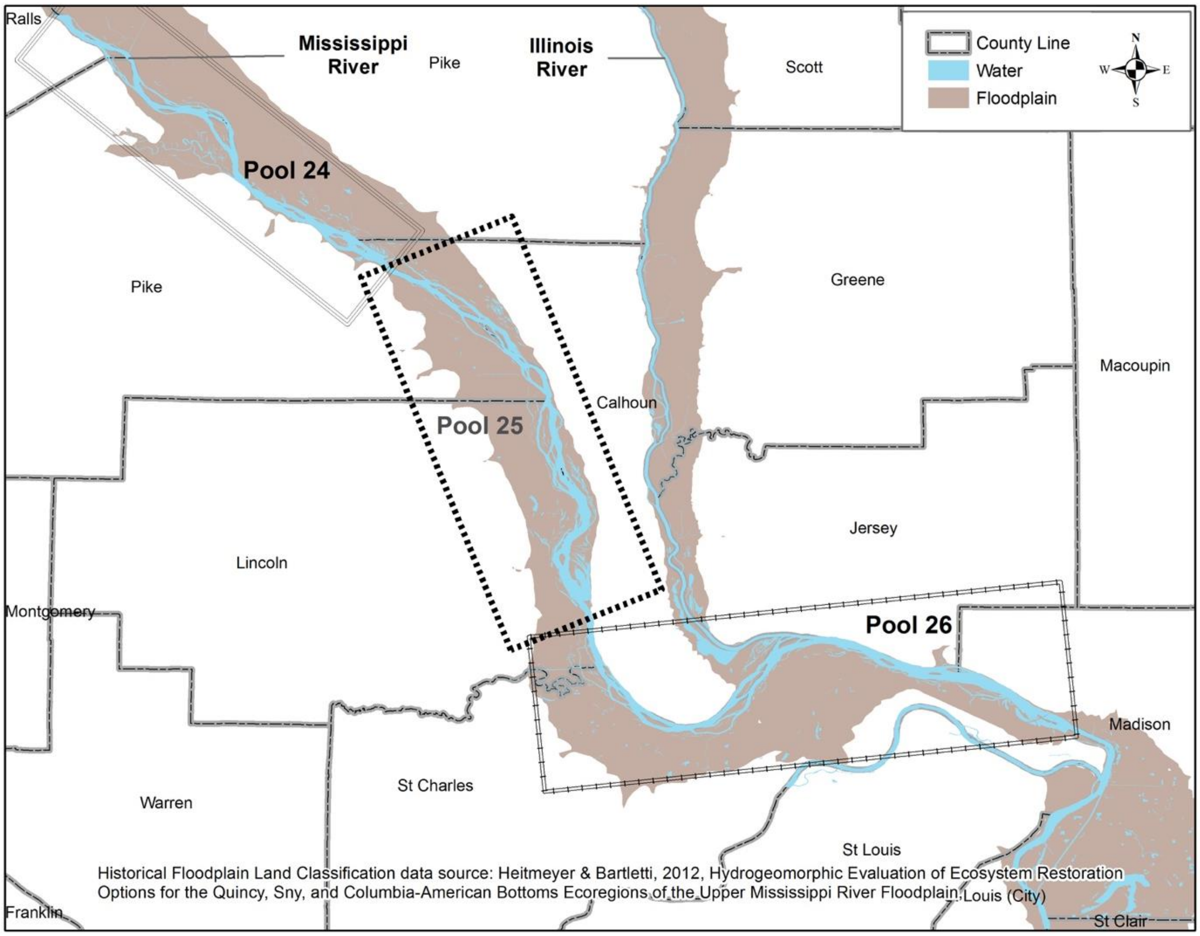

Figure 2. Map of three Mississippi River pools in the St. Louis U.S. Army Corps of Engineers District. Pool 24 is the area of impounded water between Lock and Dam 22 at Saverton, MO and Lock and Dam 24 at Clarksville, MO. Pool 25 is the area of impounded water between Lock and Dam 24 at Clarksville, MO, and Lock and Dam 25 at Winfield, MO. Pool 26 is the area of impounded water between Lock and Dam 25 at Winfield, MO, and Lock and Dam 26 in Alton, IL.

Recommended Priority Actions

1. Modeling of bird-habitat relationships to include integration of the current forest vegetation survey data set with the avian survey data set.
2. Continue collecting avian point count data in order to create a more robust population estimate for focal species and overall analysis of bird population changes and trends.

3. Estimate local and system-wide population sizes for focal species and determine priority areas for forest restoration projects based on these populations.
4. Depending on the status of focal species populations, determine if current Corps forest management practices align with avian habitat needs in priority areas; if they do, identify priority areas and focus management on those priority areas. If they do not, identify and implement the necessary changes prior to additional forest management actions.
5. Determine if the current forest stand monitoring protocol combined with the current bird survey protocol and survey point count locations will provide the desired quality of information to inform adaptive management and guide land management decisions.
6. Analyze avian point count data every three years (Knutson et al. 2016) to assess and inform future conservation activities in the St. Louis District.
7. Leverage partnerships to bolster avian population data and conservation actions system-wide.

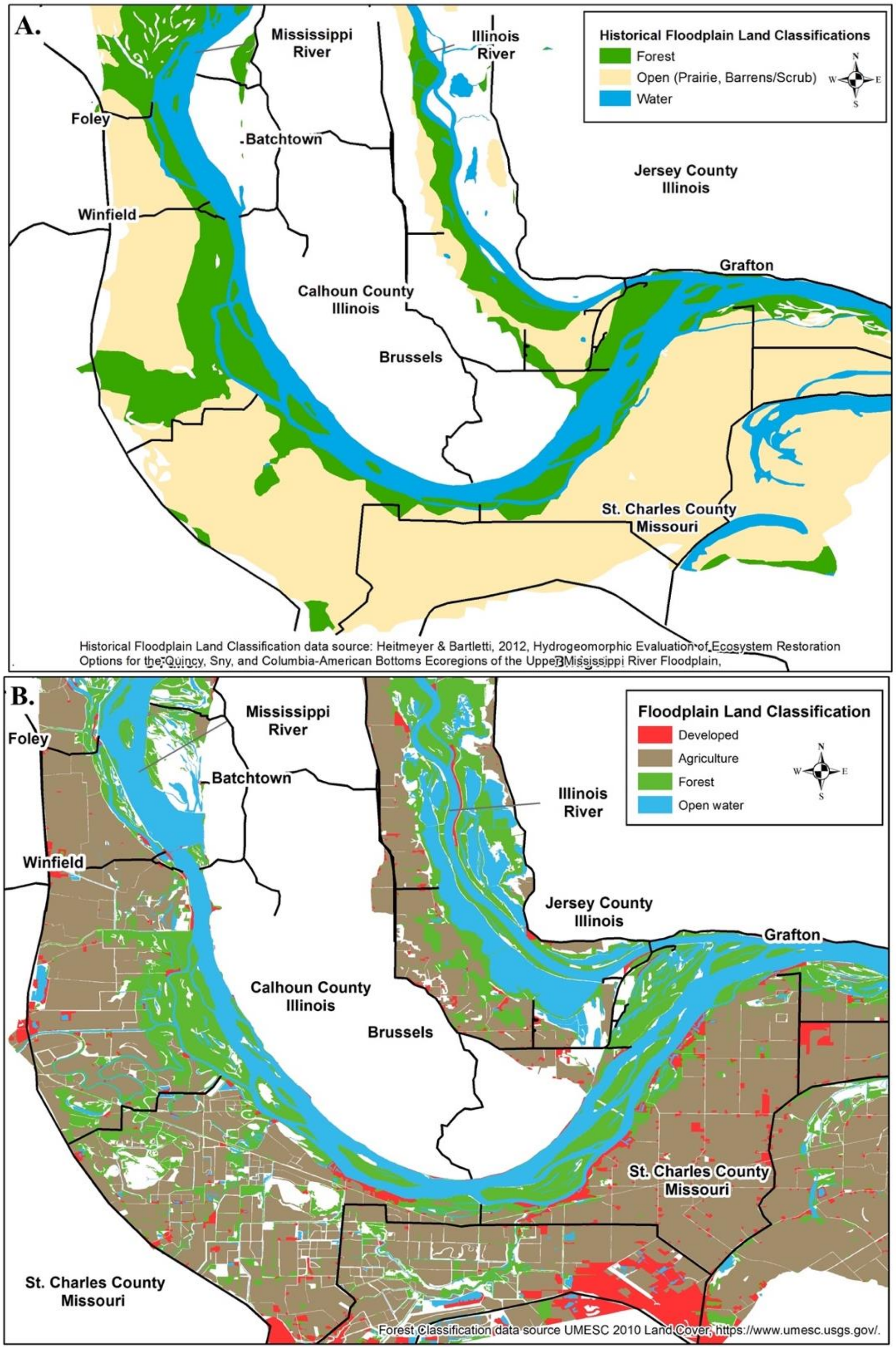

Figure 3. An example of **A.** historic and **B.** current land cover distributions on the UMRS in the U.S. Army Corps of Engineers, St. Louis District.

II. Avian Stewardship in Bottomland Forests on the Upper Mississippi River System

A. Background and Context

This plan complements the Upper Mississippi River Systemic Forest Stewardship Plan (SFSP; Guyon et al. 2012) by providing a framework for use of adaptive management techniques to foster bottomland forest bird populations. The SFSP thoroughly outlines a framework for forest conservation and management, but at a regional level irrespective of specific wildlife conservation goals. The framework for the plan proposed here is based on that of the Upper Mississippi River and Great Lakes Region Joint Venture Landbird Habitat Conservation Strategy (LHCS; Potter et al. 2007), but is tailored to the St. Louis District river 500-year floodplain as defined in the SFSP. This area includes Corps land as well as other public and private holdings that are a large part of the floodplain composite. The LHCS is a comprehensive plan that addresses avian conservation regionally, but does not frame goals with respect to forest health and restoration, and does not focus on the UMRS specifically. This plan aims to step-down the population and habitat goals given at the Bird Conservation Region (BCR) level in the LHCS to the geographic scope of the Rivers Project Office, and to use bird population goals and habitat needs to help measure the success and refine the strategy of the SFSP. The SFSP identifies and quantifies goals and objectives to meet desired forest conditions at multiple spatial scales, outlined in Tables 11, 12 and 13 in that document (Guyon et al. 2012, p. 80-82). Once we identify specific habitat objectives for each focal bird species, it is necessary to ensure that the SFSP goals match those for focal species whenever possible.

A.1. Justification

Bird monitoring has been used as an indicator of habitat health or ecological thresholds (response to habitat disturbance or change) in prairie (Browder et al. 2002), marsh (DeLuca et al. 2004), wetland (Desgranges et al. 2006), forest (Canterbury et al. 2000, O'Connell et al. 2000), and riparian areas (Bryce et al. 2002) among others. Birds are often used as indicators because they are found in virtually every habitat type, they are a relatively well known taxon, and they can be easily detected visually or audibly. Birds collectively depend on a wide range of food types (e.g. insects, fruits, seeds), and some occur near the top of the food chain and are therefore sensitive to changes in the habitats on which they depend. Because birds are well known by many professionals and citizens alike, projects may be designed around this knowledge to establish a cost-effective bird monitoring program.

In addition to indicating habitat quality, avian monitoring can also be used to assess and direct habitat restoration efforts. Populations of common species can be used to assess overall maintenance and restoration success, while rare species can be used to indicate priority restoration areas or high quality habitats in need of protection and further enhancement. A population increase of selective or area-sensitive species could indicate that management efforts are aiding sensitive populations; likewise, a decrease or no change in populations over time could highlight the need for different management strategies. As such, forest stewardship and avian stewardship are closely linked, and can be of use to project managers when considered as two parts of a single project as opposed to separate entities.

A.2. System-wide Population Conservation Issues and Threats

Threats to bird populations on the UMRS are both direct and indirect. Indirect threats are primarily related to nesting and foraging habitat loss, alteration, and degradation. Historic development, logging, and a current limitation on conservation areas from human habitation and farming have created isolated habitat patches that are difficult for bird populations to colonize and move between (Robinson et al. 1995). In the remaining patches, altered hydrology, loss of diversity, and invasive plant species create even-aged, homogenous forests that lack the resources required for stable bird populations. These factors can also impact direct threats to nesting birds, namely predation and nest parasitism, which can undermine the stability of source populations even in large forest fragments. Forest and hydrological management on the UMRS can help to address and mitigate these threats to local bird populations.

A.2.a. Altered Flood Regime

One of the largest and most irreversible impacts on the UMRS has been anthropogenic change to the natural hydrological system for the benefit of commercial navigation, agriculture and residential areas. River channelization, dams, dikes, and levee systems have caused a shift in the duration, frequency, and severity of floods. Although initial lock and dam installation allowed for variation in pool depth, water levels are presently generally limited to six inches of depth variation in either direction during non-flood conditions. The management of water levels affects all bottomland habitats, which are subjected to any combination of summer drought, prolonged inundation, erosion/deposition, or a shift in flooding season. An altered flood regime can reduce forest cover, groundcover, and tree species and structural diversity, while increasing opportunities for invasive plant species colonization. Prolonged inundation specifically is a major threat to mast tree species communities such as oak and hickory. Loss of natural low water conditions during the growing season are especially critical and prevent natural regeneration and survival of seedlings in areas that were historically bottomland forest. Additionally, many bird species depend on regular small flood events for increased availability of invertebrate prey (e.g. Rusty Blackbird, *Euphagus carolinus*), as well as for protection from predators, which is reduced in the presence of deep floodwaters (Cooper et al. 2009). As the natural hydrology is unlikely to be restored under the current lock and dam system, it is important to take these changes into consideration in any conservation or management plan.

A.2.b. Patch Isolation and Fragmentation

Bottomland forest habitat on the UMRS was expansive prior to European settlement, but total coverage was dramatically reduced by farming and urbanization in the 19th and 20th centuries (Figure 3, Guyon et al. 2012, USGS 1999, Yin and Nelson 1995). Theiling et al. (2000) estimate that certain pools lost between 27 and 66 percent of their pre-settlement forest cover by 1989. Although these forests were once naturally distributed as patches in a matrix of shrublands, wetlands, and grasslands, modern forest fragments are often patches in a homogenous landscape. Remaining forested areas are becoming increasingly fragmented, and often see a resulting decrease in avian species richness, abundance, and breeding success (Robinson et al. 1995, Brawn and Robinson 1996, Sauer et al. 2017). Research suggests that forest patch size must be at least 9,900 acres to support stable breeding populations of priority bird species in the Mississippi Alluvial Valley, although some species are considerably more sensitive, and additional study is needed (Mueller et al. 1999). Many managed habitats thought to sustain healthy bird populations may actually be population sinks due to low nesting success, and are sustained by individuals travelling from source areas (Brawn and Robinson 1996). Additionally, habitat areas considered suitable for nesting are likely overestimated due to variation in site-specific factors, such as changes in elevation and drainage (Benson et al. 2011).

A.2.c. Changes in Tree Species Composition

The historical bottomland forests of the UMRS were comprised of a diverse array of tree species. Alteration of the natural hydrology for agricultural purposes has considerably reduced the diversity of trees in remaining forest patches (Yin and Nelson 1995). Populations of ecologically and economically valuable hardwoods such as oak and hickory have decreased significantly and have been replaced by more flood tolerant species such as silver maple (*Acer saccharinum*) (Knutson and Klaas 1998). These stands are now comprised of only a few shade- and flood-tolerant species, which create an even-aged, closed canopy system with low structural diversity (Guyon et al. 2012**)**. These conditions inhibit re-growth of successional tree species such as cottonwood (*Populus deltoides*) and river birch (*Betula nigra*), and preclude the establishment of other native understory vegetation. Although tree species diversity is not currently considered a direct determinant of bird species composition in a given habitat, research has shown that structural diversity, including trees of various heights, presence of snags and cavities, and density of understory vegetation, can influence the presence of nesting and foraging birds (Twedt and Portwood 1997, Twedt and Loesch 1999, Wilson and Twedt 2005, Wakeley et al. 2007, Twedt et al. 2010).

A.2.d. Invasive Species

Major species of concern as outlined by Guyon et al. (2012) include reed canary grass (*Phalaris arundinacea*), johnsongrass (*Sorghum halepense*), European buckthorn (*Rhamnus cathartica*), various species of honeysuckle (*Lonicera* spp.), white mulberry (*Morus alba*), black locust (*Robinia pseudoacacia*), garlic mustard (*Alliaria petiolata*), Japanese knotweed (*Polygonum cuspidatum*), oriental bittersweet (*Celastrus orbiculata*), Japanese hops (*Humulus japonicus*), crown vetch (*Coronilla varia*), bur cucumber (*Sicyos angulatus*), and trumpet creeper (*Campsis radicans*). These species are problematic in that they mainly create dense understory vegetation, preventing heterogeneous forest regeneration by native species. This is of great concern in future forests, as current stands are approaching maturity and lack adequate seedling recruitment for canopy replacement, which may lead to replacement by invasive understory plants (Guyon et al. 2012). Within current forest, Also of concern is the invasion of emerald ash borer (*Agrilus planipennis*). Green ash is the second most dominant species within the current floodplain system. If these invasions persist, forest coverage will continue to decline, and those remaining will lack the structural diversity and native species required for avian nesting and foraging. Invasive plants also indirectly impact bird populations by reducing arthropod availability for insectivores (Tallamy 2004).

A.2.e. Predation and Nest Parasitism

Predation and nest parasitism are the main direct threats to nestlings. Both increase with forest fragmentation (Robinson et al. 1995). Brown-headed Cowbirds (*Molothrus ater*) are able to fully saturate small forest patches, threatening nests in the forest interior as well as on the edge; forests need an interior approximately 400 m from edge habitat in order to buffer against cowbird parasitism (Grettenberger 1991, Robinson et al. 1995). Predation also can increase with alterations to the natural flood regime (Hoover 2006, Cooper et al. 2009, Hoover 2009) and proximity to invasive plant species (Schmidt and Whelan 1999).

B. Biological Foundation

B.1. Planning Framework

This plan adopts the planning framework given in the LHCS. Potter et al. (2007) also identify information needs and tasks that are key to success for land bird conservation. Applicable information that needs to be reframed for the St. Louis District are:

1. Identify important breeding (source populations) and migratory habitat patches for species of conservation concern.
2. Use biological models to link population goals with habitat objectives.
3. Prioritize areas where habitat should be restored or maintained to meet population objectives.
4. Clearly identify the habitat needs of focal species at multiple spatial scales (landscape to local) so that site-specific management contributes to species needs across all scales.
5. Identify the consequences of specific land management actions on species of conservation concern

B.2. Focal Forest Cover Types

The General Wetland Vegetation Classification System (GWVCS) is a 31-class land cover/land use classification system developed and used by the Upper Mississippi River Restoration Program. It was developed from year 2000 color infrared aerial photography and was designed primarily for use in systemic level studies. It represents an integrated, coarser scale version of a 151-class system that can be used for more focused studies. A full description of the development of the GWVCS and all 31 land use/land cover types it encompasses can be found in the General Classification Handbook for Floodplain Vegetation in Large River Systems (Dieck and Robinson 2004). The following are brief descriptions, adapted from Dieck and Robinson 2004, of the terrestrial UMRS vegetation types most relevant to this report. For an example of relevant land cover class distribution in the St. Louis District, see Figure 4. The forest types listed below and used throughout this document are not differentiated by age or maturity.

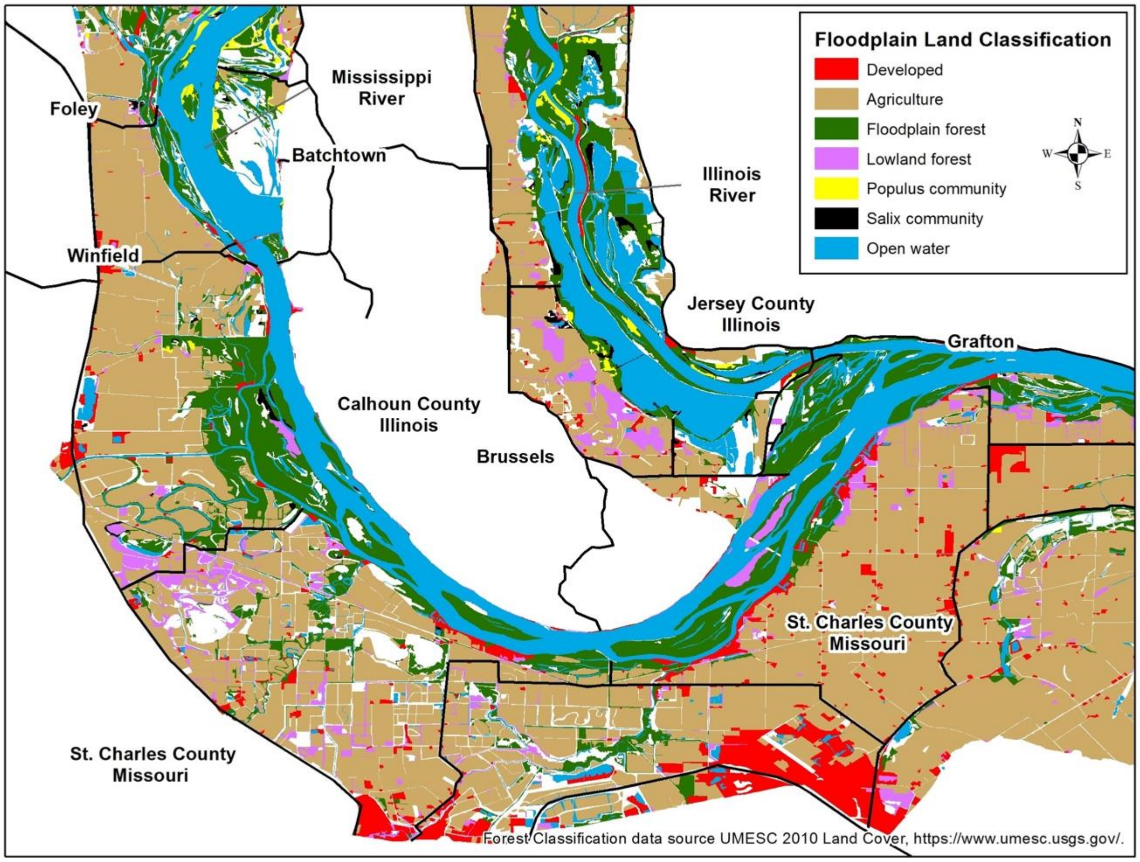

Figure 4. Distribution of the four focal forest cover types in the St. Louis U.S. Army Corps of Engineers District.

B.2.a. Floodplain Forest (FF)

Floodplain forest represents areas on islands, near the shoreline, or around lakes, ponds, and backwaters where more than 10 percent of the forest floods seasonally, meaning that water is present for most of the growing season. These forests are predominantly comprised of silver maple, but also include elm (*Ulmus ameriana*), cottonwood, black willow (*Salix nigra*), and river birch. This general class is typically found growing at or near the water table where it becomes inundated from spring flooding and high-water events.

B.2.b. Lowland Forest (LF)

Lowland forest represents areas along the riverbanks and within the floodplain that are drier than floodplain forest sites where more than 10 percent of the forest floods temporarily, meaning that water is only present early in the growing season. Common trees include pecan (*Carya illinoiensis*), hickories (*Carya* spp.), river birch, sycamore (*Platanus occidentalis*), and red/black oaks (*Quercus* spp.). This general class is most common in southern reaches of the Upper

Mississippi and Illinois River Systems, and is typically found growing on moist, well-drained soils.

B.2.c. *Populus* Community (PC)

Populus community (cottonwood) represents lowland areas where vegetation is comprised of greater than 50 percent cottonwood and may include other floodplain and lowland forest types. In this forest type, greater than 10 percent of the forest floods seasonally, meaning that water is present in the cottonwood stand for most of the growing season. This general class is typically a pioneering species of disturbed areas and is generally found growing on moist soils. *Populus* communities are tall and often grow monotypically, as well as adjacent to or along with floodplain forest or lowland forest types.

B.2.d. *Salix* Community (SC)

Salix community represents areas near the shoreline or around lakes, ponds, and where more than 10 percent of the forest floods seasonally, meaning that water is present for most of the growing season. These forests or shrub communities are comprised of greater than 50 percent willow (*Salix spp.*) and may include other floodplain forest types. This general class typically grows with an emergent, grass, and/or forb understory on moist and saturated soils.

B.3. Focal Forest Bird Species

To focus conservation goals and streamline management projects across the St. Louis District, it is necessary to select a subgroup of focal bird species that will represent all birds that use this district's forest habitats. From the many species dependent on these habitats, we selected a subset of nine focal species for intensive study and monitoring. These species were chosen because they use one or more of the focal forest cover types that comprise the UMRS, have specific habitat requirements, and/or are of regional conservation concern. A combination of common and rare species was specifically chosen to maximize monitoring efforts; the absence of common species is a critical sign of forest degradation, just as the presence of rare species is important for management prioritization. Similarly, declines in common species prior to or following forest management activity will be detectable using point count data. Focal species that are dependent on specific habitat types and/or are of conservation concern can characterize the habitat needs of more common, generalist species while still representing the key cover types (Table 1). We accessed population data for these species through the Breeding Bird Survey (BBS; Sauer et al. 2017). No population trend estimates exist for the UMRS bluff-to-bluff corridor or St. Louis District, and thus current population trends for focal species have been estimated at a national scale, as well as for both BCRs that cover the district (Regions 22 and 23; Table 2), as delineated by the Commission for Environmental Cooperation. National and regional trends, however, may not reflect local population trends of these focal species. The nine focal species are:

1. Red-shouldered Hawk (*Buteo lineatus*)
2. Red-headed Woodpecker (*Melanerpes erythrocephalus*)
3. Willow Flycatcher (*Empidonax traillii*)

4. Warbling Vireo (*Vireo gilvus*)
5. Cerulean Warbler (*Setophaga cerulea*)
6. Prothonotary Warbler (*Protonotaria citrea*)
7. American Redstart (*Setophaga ruticilla*)
8. Yellow-breasted Chat (*Icteria virens*)
9. Indigo Bunting (*Passerina cyanea*)

Table 1. Land cover types used by breeding populations of the nine focal bird species in the St. Louis District.

Common name	Floodplain Forest	Lowland Forest	*Populus* Community	*Salix* Community
Red-shouldered Hawk	X	X		
Red-headed Woodpecker	X	X	X	
Willow Flycatcher				X
Warbling Vireo	X	X	X	
Cerulean Warbler	X	X	X	
Prothonotary Warbler	X	X	X	
American Redstart	X	X	X	X
Yellow-breasted Chat	X	X	X	X
Indigo Bunting	X	X	X	X

Table 2. National population trends of this plan's focal bird species (% change/year) for the entire United States, BCR 22 (Eastern Tallgrass Prairies), and BCR 23 (Prairie Hardwood Transition). Together, BCR 22 and BCR 23 encompass the St. Louis District, although the regions are not specific to the river system. All trends presented as recorded by the BBS (Sauer et al. 2017).

	Trend, 1966-2015			**Trend, 2003-2015**		
Common name	United States	BCR 22	BCR 23	United States	BCR 22	BCR 23
Red-shouldered Hawk	2.73	7.90	1.71	2.71	11.35	3.61
Red-headed Woodpecker	-2.35	-4.25	-4.95	-0.53	-3.15	-3.59
Willow Flycatcher	-1.25	-0.55	-0.74	-0.69	-0.44	-0.70
Warbling Vireo	0.53	1.10	-0.99	0.49	-0.13	-0.75
Cerulean Warbler	-2.63	-5.81	-2.20	-1.31	-3.24	-1.38
Prothonotary Warbler	-1.10	2.64	0.98	-0.17	4.54	1.02
American Redstart	-1.15	0.83	2.79	0.56	4.10	3.17
Yellow-breasted Chat	-0.62	-0.64	-4.24	-0.78	-1.38	-2.52
Indigo Bunting	-0.74	-0.08	-0.35	-1.06	-0.60	-0.06

B.3.a. Status and Habitat Requirements for Focal Species

Red-shouldered Hawk

The Red-shouldered Hawk is a focal species because it is area-sensitive, requiring large tracts of mature forest (Bednarz and Dinsmore 1981). This makes it an ideal umbrella species for conservation efforts, and because it uses floodplain and lowland forest (Table 1). NAS considers this species to have reduced but stable populations in the upper Midwest and parts of the Atlantic Coast (Kaufman 2016), and it is listed as endangered in the states of Illinois and Iowa, of special concern in Minnesota, and threatened in Wisconsin. Although Red-shouldered Hawks are not typically captured in point count protocols, their presence or absence is an important indicator of forest quality, and they are often observed as flyovers. Additionally, this species will respond effectively to territorial callback during the breeding season, and thus can be detected effectively with callback protocols.

The Red-shouldered Hawk currently has a positive population trend at the national level, increasing by 2.73% per year (Table 2). The St. Louis District provides both breeding and non-breeding habitat for this species (Stravers and McKay 1994, Guyon et al. 2012). This habitat includes mature forest tracts that are greater than 500 acres. A given patch must include both floodplain and upland forest and be within 200 yards of ponds or small streams, but more than 500 yards from the main river channel. Barber et al. (1998) recommend preserving super-emergent trees around nesting sites. This species can use maple-dominated forest (Knutson et al. 1996). Conservation needs include large forest tracts near water or small marsh and wet meadow habitats (Bednarz and Dinsmore 1981), and a combination of lowland and upland forest within single patches. A seasonal distribution map for the Red-shouldered Hawk across North and South America can be found in Appendix B.

Red-headed Woodpecker

The Red-headed Woodpecker is a focal species because it requires hard mast species and mature trees, and because it reliably uses floodplain and lowland forest, and is an occasional occupant of *Populus* forest (Table 1). It is not considered area-sensitive. This species is listed as Near Threatened by the International Union for Conservation of Nature (IUCN) and the state of Missouri, and as a species of conservation concern by the U.S. Fish & Wildlife Service (USFWS) and the state of Minnesota.

The Red-headed Woodpecker currently has a negative population trend at the national level, decreasing by 2.35% per year (Table 2). The St. Louis District provides both breeding and non-breeding habitat for this species. This habitat includes oak savannahs, prairie-forest transitions, and bottomland forest (Potter et al. 2007). This species is a cavity nester, requiring natural cavities in mature trees that are 2-24 meters off the ground. It also requires hard mast species for feeding during winter months. It will occur in small forest fragments, but is more often found in fragments larger than 3.7 acres. Conservation needs include mature trees with natural cavities and increase in mast species. A seasonal distribution map for the Red-headed Woodpecker across North and South America can be found in Appendix B.

Willow Flycatcher

The Willow Flycatcher is a focal species because it is a common resident in young *Salix* forest (Table 1). It is not considered area-sensitive. It is listed as a species of conservation concern by the USFWS. Although this species is not commonly observed in the St. Louis District, it is an important indicator species for young, newly-improved stands that are the focus of future Corps management efforts. An important caveat for this species is that it only uses young *Salix* stands; the data available for this cover type pools all stand ages, and thus may overrepresent the amount of suitable habitat.

The Willow Flycatcher currently has a negative population trend at the national level, decreasing by 1.25% per year (Table 2). The St. Louis District provides breeding and migratory habitat for this species. This habitat includes wet, shrubby areas, standing water, and often groups of willow trees (Potter et al. 2007). Conservation needs for the Willow Flycatcher include shrubby woodlands and forest edge habitat with standing water. A seasonal distribution map for the Willow Flycatcher across North and South America can be found in Appendix B.

Warbling Vireo

The Warbling Vireo is a focal species because it is a common resident in floodplain, lowland, and *Populus* forest (Table 1). Because it is easily detected in mature riparian forests, populations are easily monitored and a local change in this species population may be an indicator that less detectable species may need extra effort to monitor for trend assessment. This species is not currently listed as a species of conservation concern at the state, region, or national level.

The Warbling Vireo currently has a positive population trend at the national level, increasing by 0.53% per year (Table 2). The St. Louis District provides breeding and migratory habitat for this species. This habitat is limited to riparian areas (Thogmartin et al. 2009), generally mature, deciduous forest with proximity to water (both upland and lowland) including both floodplain forest and cottonwood stands (Kirsch et al. 2013). This species generally nests in trees greater than 30 ft. in height (Karr 1968). Habitat needs for the Warbling Vireo include mature, deciduous trees with proximity to standing water. A seasonal distribution map for the Warbling Vireo across North and South America can be found in Appendix B.

Cerulean Warbler

The Cerulean Warbler is a focal species because it is area-sensitive, requiring large tracts of mature forest. This makes it an ideal umbrella species for conservation efforts, and because it can be found in floodplain, lowland, and *Populus* forest (Table 1). Due to its sensitivity, this species is listed as Vulnerable by the IUCN, threatened in Illinois and Wisconsin, and as a priority species or species of conservation concern by the USFWS and the states of Minnesota and Missouri. Although this rare species is not often detected at high enough rates to make confident population assessments, its presence or absence from an area serves as an indicator of forest quality; where even a few individuals are detected, stand improvement efforts can be prioritized.

The Cerulean Warbler currently has a negative population trend at the national level, decreasing by 2.63% per year (Table 2) and is listed as a priority species by NAS (NAS 2012). The St. Louis District provides breeding and migratory habitat for this species. This habitat is limited to forests with well-developed canopy and understory (Robbins et al. 1992) in heavily forested landscapes (Potter et al. 2007, Thompson et al. 2012). The amount of forest in a given area directly correlates with Cerulean Warbler abundance, and at least 50% forest cover in a 10-km radius is required for this species (Thompson et al. 2012). Within a forest patch, Cerulean Warblers require 85% canopy cover with occasional gaps (Potter et al. 2007). This species can use maple-dominated forest (Knutson et al. 1996). Habitat needs include large tracts of mature forest with canopy gaps and well-developed mid- and understories. A seasonal distribution map for the Cerulean Warbler across North and South America can be found in Appendix B.

Prothonotary Warbler

The Prothonotary Warbler is a focal species because it is an area-sensitive species that is averse to both excessive flooding and xerification, making it an ideal umbrella species for floodplain forest obligates. It uses floodplain, lowland, and *Populus* forests (Table 1). This species is listed as a species of conservation concern by the USFWS. As this species is one of the few warblers that will use nest boxes, establishment of nest boxes in appropriate habitats may also positively impact population levels.

The Prothonotary Warbler currently has a negative population trend at the national level, decreasing by 1.10% per year (Table 2) and is listed as a priority species by NAS (NAS 2012). The St. Louis District provides breeding and migratory habitat for this species. Breeding habitat is limited to mature forested wetlands with standing water (Potter 2007), little change in topography, sparse groundcover, 50-75% canopy cover, and a canopy that is 12-40 m in height (Potter et al. 2007, Hoover 2006). Duration of standing water during the breeding season is positively correlated with nesting success (Hoover 2006). This species can use maple-dominated forest (Knutson et al. 1996), but it is area-sensitive, and is generally found in forest tracts larger than 247 acres. It requires flooded forests for breeding (Potter et al. 2007), and experiences elevated fecundity over deep water (Hoover 2006). Conservation needs for the Prothonotary Warbler include mature open forest or forested wetlands with seasonal flooding (flooding must be seasonal; suitable nest sites are lost in excessive flooding), and large forest tracts. Plugging wetland gullies to prevent draining is useful in the conservation of forested wetlands (Hoover 2009) and could benefit Prothonotary Warblers. A seasonal distribution map for the Prothonotary Warbler across North and South America can be found in Appendix B.

American Redstart

The American Redstart is a focal species because it is a common resident in floodplain, lowland, and *Salix* forest, and can also be detected in *Populus* forest (Table 1). It is not considered area-sensitive. Because it is commonly detected in these areas, American Redstarts can be monitored for local decline or absence to prioritize threats to other less common species. This species is not currently listed as a species of conservation concern at the state, region, or national level.

The American Redstart currently has a negative population trend at the national level, decreasing by 1.15% per year (Table 2). The St. Louis District provides breeding and migratory habitat for this species. This habitat includes intact upland and floodplain forest (Knutson et al. 2006), with floodplain forest being more important during the height of breeding season (Knutson et al. 1996). This species can also be found in second growth forest, deciduous woodlands, shrublands, and *Salix* Forest. Conservation needs include intact, heterogeneous floodplain forest interspersed with shrubby patches. A seasonal distribution map for the American Redstart across North and South America can be found in Appendix B.

Yellow-breasted Chat

The Yellow-breasted Chat is a focal species because it is a common resident in shrublands and low, dense vegetation associated with early successional forests. As such, it can be reliably detected in the early successional stages of all four cover types (Table 1). It is not considered area-sensitive but avoids nesting in edge habitat (Potter et al. 2007). Because it is easily detected in young riparian forests, populations are easily monitored and a local change in this species population may be an indicator of a significant change in forest successional stage. This species is listed as a priority species by the Central Hardwoods Joint Venture.

The Yellow-breasted Chat currently has a negative population trend at the national level, decreasing by 0.62% per year (Table 2). The St. Louis District provides breeding and migratory habitat for this species (Potter et al. 2007). This habitat includes old-field areas (abandoned agricultural fields with a high percentage of herbaceous vegetation and shrubby trees) and occasionally in shrublands at the edge of shallow interior sloughs (Potter et al. 2007, Lane Richter, personal comm). This species is considered to be somewhat area sensitive; it is most often detected in patches larger than 12 acres, and rarely detected in patches smaller than 1 acre. A seasonal distribution map for the Yellow-breasted Chat across North and South America can be found in Appendix B.

Indigo Bunting

The Indigo Bunting is a focal species because it is a common resident in Lowland and *Salix* forest, and can be detected in all four focal cover types (Table 1). It is not considered area-sensitive but is negatively impacted by fragmentation (Donovan and Flather 2002). Because it is easily detected in mature riparian forests, a local decline in this species may be an indicator that less detectable species may need extra effort to monitor for trend assessment. This species is not currently listed as a species of conservation concern at the state, region, or national level.

The Indigo Bunting currently has a negative population trend at the national level, decreasing by 0.74% per year (Table 2). The St. Louis District provides breeding and migratory habitat for this species. This habitat includes bushy or shrubby habitat edges where forest meets field; this species is disturbance-dependent (Woodward et al. 2001). Conservation needs for the Indigo Bunting are few, but include transitional habitat areas and forest edge. A seasonal distribution map for the Indigo Bunting across North and South America can be found in Appendix B.

B.3.b. Population Estimates for the UMRS

The bluff-to-bluff corridor of the UMRS is not currently surveyed as part of the BBS or any other national program. Accessing bottomland forests and riparian islands is difficult, especially during the breeding season when point counts are conducted. As such, available BBS data can only be used to broadly characterize bird populations in the project area. To make district-specific population estimates for our focal species, an extensive literature search was performed for published population densities in the four focal cover types within the Midwestern region. We used this information to estimate population sizes based on the detailed land cover data provided by U.S. Geological Survey - Upper Midwest Environmental Sciences Center (USGS-UMESC) imagery; these data consist of a combined 2.75 million acres of river floodplain from the Mississippi and Illinois Rivers, and are comprised of Corps land, other public holdings, and private land. Population estimates based on this land cover data are in Table 3. For a detailed summary of calculation methods and assumptions see Appendix C.

Table 3. Mean population estimates for the nine focal bird species occurring in the four focal forest types in the St. Louis Corps District. Coverage area of focal forest types was calculated using USGS-UMESC coverage data for the Mississippi and Illinois River floodplains. Population estimates were made using published data; for detailed methodology and citation information, see Appendix C. Standard deviations are provided in parentheses for estimates comprised of multiple published values. Hyphens indicate forest types in which a given focal species does not reliably occur.

Common name	Floodplain Forest	Lowland Forest	*Populus* Community	*Salix* Community
Red-shouldered Hawk	8,832	886 (± 364)	-	-
Red-headed Woodpecker	41,622	6,075 (± 6,374)	15 (± 21)	-
Willow Flycatcher	-	-	-	779
Warbling Vireo	872,934	27,426	3,760 (± 2127)	-
Cerulean Warbler	23,643 (± 20,691)	1,921 (± 2,030)	38	-
Prothonotary Warbler	379,101 (± 451,216)	33,114 (± 19,182)	276 (± 35)	-
American Redstart	3,135,498	4,308 (± 4,746)	568 (± 623)	1,709
Yellow-breasted Chat	10,969 (± 13,633)	6,679 (± 5,804)	9,325 (± 9,763)	5,346 (± 6,648)
Indigo Bunting	133,313 (± 90,430)	22,254 (± 13,619)	1,774 (± 1,472)	71,635

Although a variety of datasets and publications provide density estimates for our nine focal species, we acknowledge certain caveats. These sources are variable in terms of sampling location, sampling year(s), cover type classification, and method of data collection. In some cases, published densities were not available, so abundance data had to be extrapolated. Lastly, publications varied in their use of standard error, standard deviation, or 90% confidence intervals for error estimates. Original sample sizes were often unavailable, so standardized estimate of error could not be calculated.

Due to the multiple caveats in these data, we feel that these population estimates are not a strong enough foundation upon which to build specific population and habitat goals in the present plan. Although we lay out a framework for these long-term population goals below, further data collection and analysis are necessary to solidify these estimates so they can be used to make conservation decisions. This need is addressed in the conservation goals outlined in Part III of this document.

B.3.c. Population Goals

Once reliable population estimates are made from field data, we must estimate the population trajectories, deficits, and goals for our focal bird species in the St. Louis District. As per the updated PIF Landbird Conservation Plan (Rosenberg et al. 2016), these goals will fit into one of three categories, depending on severity of population decline: 1) Recover, 2) Prevent Decline, and 3) Reverse Decline. Although the LHCS provides detailed population modeling for landbirds across six different BCRs, their plan does not target bottomland forest habitats along the UMRS bluff-to-bluff corridor, and population estimates are now a decade old (Potter et al. 2007). We need to update population estimates and goals from the BCR levels in the LHCS, and make them specific to the St. Louis District boundary so we can link existing deficits to habitat objectives. It would be very useful to have population models for the UMRS as a whole and for the St. Louis District in order to best prioritize management activities. This is our most immediate and central need in future iterations of this stewardship plan. Maps that use this information to identify areas of relative abundance for each focal species will be useful tools for identifying priority areas.

C. Biological Models and Research

A combination of land cover data and avian population surveying makes it possible to shift individual species goals into attainable habitat goals. The specific habitat needs for all nine focal species are discussed above, and the next step is translating that information into models that estimate how much habitat must be added or improved to meet these needs. These models can then be used to enumerate specific habitat goals for each focal species.

D. Assumptions and Research Objectives

We have chosen nine focal species to represent the four primary forest cover types found in the UMRS. Modeling population and habitat trends requires a series of assumptions and specific research objectives.

D.1. Explicit Planning Assumptions

1. Habitat is a limiting factor for breeding and migrating bird populations.
2. Migratory habitat use is implied if a species uses the forest as breeding habitat; if some individuals of a species are breeding in the St. Louis District, others are stopping through to migrate farther north.
3. Focal species act as umbrella species; benefitting them benefits non-focal species as well.
4. The estimates of bird populations [that will be] presented here are accurate enough for conservation purposes.
5. Creation and management of breeding habitat will also benefit nonbreeding habitat, which is not explicitly within the scope of this plan.
6. Local-scale habitat improvement can aid bird populations at a regional scale.

D.2. Research Objectives

Research Objective 1. Determine status and trends of forest bird populations in the St. Louis District. It is important to understand avian population trajectories to best identify threats and priority actions. Breeding and migrating bird populations should be considered during these analyses to identify key habitat sites. Baseline monitoring is needed at the local level, followed by repeated samples to assess the trends.

Research Objective 2. Determine local habitat-related causes of bird population change. In addition to tracking bird population trends, it is a priority to identify the causes behind these changes. This involves tracking habitat coverage, quality, continuity, and location regarding local bird populations. Plant species composition, forest heterogeneity, and structural features can all heavily influence avian species richness (Twedt and Portwood 1997, Twedt and Loesch 1999, Gabbe et al. 2002, Wilson and Twedt, 2005, Twedt et al. 2010), but it is not fully understood which features are key restoration priorities in management settings. Thus, during bird monitoring projects, it is ideal to collect vegetation data alongside population data to better understand these relationships.

Research Objective 3. Determine the importance of the St. Louis District for focal species populations in a regional context. Assess whether population sizes and trends in the district differ from national and BCR-levels. If a large proportion of a focal species' population relies on habitats within the St. Louis District, conservation efforts by the Corps and partner organizations become a higher priority.

E. Monitoring and Adaptive Management

Adaptive management strategies are supported by ongoing monitoring projects that provide data to determine if the goals of the management projects are being met. Often these projects require long-term monitoring commitments because the effects of habitat manipulations on vegetation and wildlife can be slow and subtle. In addition, natural ecosystems exhibit variability in response to habitat manipulations, so trends in responses may take years to determine. At the same time, natural resource management agencies are not immune to increasing funding pressures. The potential for decreasing financial support for long-term monitoring efforts requires land management agencies to employ careful prioritization and to focus management efforts on clearly defined habitat goals as well as ensuring monitoring results truly facilitate the required land management decision making process.

E.1. Current Regional Monitoring and Needs

The bottomland forest avian monitoring project was initiated in 2011 with a Cooperative Ecosystem Study Unit (CESU) agreement between Audubon and the Corps. The project provides a model of a cooperative effort to create an avian monitoring program to support bottomland forest bird populations. Survey site and point count locations were developed in cooperation with Cornell Lab of Ornithology (Appendix H). The University of Missouri-St. Louis, Maryville University and Southern Illinois University Edwardsville provide internships to students to work on the project. Surveys have been conducted on 25 sites in Pools 24, 25 and 26 covering approximately 100 river miles from 2012 to 2018. Data gathered in past survey seasons will provide density and abundance, thus establishing baseline population estimates for bottomland forests in the St. Louis District. In addition, the cooperative agreement also delineates the development of this plan. To better understand regional trends, systemic coordinated monitoring, analysis and assessment is needed throughout the UMR as well as project specific pre and post monitoring to assess impacts, changes and success of prescription implementation.

E.1.a. Data Management and Access

Avian stewardship and conservation at a landscape scale requires collaboration and continuity between Audubon and the Corps to facilitate data collection and analyses. This requires not only standardized data collection, but also common data storage and access. To accomplish this, the Midwest Avian Data Center is used to deposit and disseminate all collected data. This center is a regional hub of the Avian Knowledge Network, and is a widely accessible database for point counts and similar data (Appendix E). This database streamlines data collection, storage, and access. The St. Louis District further recommends standardized data management including data policy, ownership, quality assurance, and metadata (Appendix F).

E.1.b. Standard Methodologies

Large-scale population monitoring efforts are a key component of avian conservation. Local population data from different locations can be compiled to gain a larger picture of trends over space and time. For these data to be useful, collection methodologies must be standardized among agencies, and yet be adaptable to changes in management and conservation strategies. Collection efforts must also become more comprehensive to ascertain breeding, migrating, and overwintering bird populations, and to fully understand the role of forest habitat structure and function in stopover, breeding and foraging sites. It is important for population data to be collected reliably for as many consecutive years as possible; statistical reliability increases dramatically with length and number of sample periods.

Point Counts and Transects (Audio/Visual)

Point counts and call transects are currently the most widely employed population monitoring techniques. They are useful in that researchers and trained citizen scientists can conduct them without permits, they require minimal equipment and training, and they can be carried out by one group in multiple locations in the same day. To standardize data collection, all point counts in the St. Louis District will follow the Knutson protocol (Knutson et al. 2008). This protocol is simple and easy to implement, while allowing some tailoring to meet specific monitoring needs.

Audubon, on behalf of the Corps, previously employed an additional eight-minute playback of mobbing chickadees and screech-owl vocalizations at the end of the 10-minute passive listening period in order to elicit calls from silent birds. The Corps, NAS, and Cornell Lab of Ornithology collaboratively developed this modified, Knutson-based protocol. However, a recent assessment of the data collected using this modified protocol revealed a sampling bias (a letter detailing this information is provided in Appendix D). Given this information, Audubon will employ only the standard Knutson protocol (Knutson et al. 2008) for all future monitoring efforts, using targeted callback only for rare or cryptic species such as the Cerulean Warbler and Red-shouldered Hawk.

Mist Netting

Mist netting is a commonly used technique in ornithological research but may be underused for monitoring purposes. The drawbacks of using mist netting as a broad-scale monitoring technique include: equipment costs and requirements; the necessity of proper permitting and training; low capture rates in mature temperate forests; the time-consuming nature of collection (only one site can be monitored by a group in a day); captures are generally limited only to birds utilizing the lower and middle areas of the habitat. However, data collected from nets is very useful, as they give insight into breeding status, body condition and overall health, age class (juvenile/adult), and allow data collection from birds that are not singing or easy to see. Moreover, netting later in the season can give a general idea of the number of fledged offspring relative to adults from the most recent breeding season, which is another important aspect of population monitoring. Although labor and training intensive, mist netting is an important secondary data collection technique. Due to the expense and time-consuming nature of collection, mist netting is perhaps most useful in focal areas where more detailed population data are desired, such as remaining large forest tracts, recently reforested areas, and isolated habitat fragments.

Targeted Monitoring

Rare or cryptic species may not be accurately monitored with point counts, transects, or mist netting. Targeted monitoring consisting of territorial playback for cryptic priority species such as Cerulean Warblers and Red-shouldered Hawks could also be added to increase detection and may be necessary to accurately estimate population densities. This is especially true for hawks, which are difficult to accurately sample with the point count protocol presented in this document.

Territory Mapping

This method takes advantage of the fact that many species of bird are territorial during the breeding season. The aim of this method is to record the number of territories for each species that occur on a map of the study area by using cues from territorial males (songs, locations of disputes and displacing behaviors, etc.) to define territory boundaries. Territory mapping usually occurs from about an hour after sunrise until late morning (but before bird singing declines significantly). Standardized methods for territory mapping are provided in Bibby et al. (2000). In order to use the territory mapping method, care must be taken in selecting an area that is not too small or too large. This method is energy intensive and often not practical on large plots of land. If the area is too small, territories will overlap the edge and into adjacent habitat. An alternative to recording all species is to reduce the list to a subset of less common species. In many cases a study area should be visited at least 5 times during different times of the breeding season to ensure that early and late-breeders are recorded. Species maps can be generated by looking at maps of each visit and recording locations for each species in the study area, and density estimates can be obtained from map analyses. A benefit of territory mapping is that bird distribution maps can be created for all breeding birds recorded during the survey. This method can be used alongside other methods (nest searches or mist-netting) depending on project goals.

Nest Monitoring

Monitoring active nests, either for all species in an area or for specific target species, can be extremely difficult and labor intensive. However, data on reproductive success is perhaps the most important information that can be collected from breeding bird populations, as they give insight into habitat quality, food availability, number of breeding pairs, and predation and nest parasitism rates. Moreover, as the stability of breeding forest bird populations is currently in doubt, nest monitoring is necessary to determine the actual stability of populations, and the effects of source/sink dynamics on point count data. If nests and nestlings are being monitored only for presence and activity, no permitting is required, although nest detection and access is still difficult, especially for cavity nesting birds. This data collection technique may be most useful for a particular target species or suite of species, and would most likely require GPS work to maintain locations.

Vegetative and Habitat Monitoring

Habitat monitoring should go hand-in-hand with bird monitoring. The LHCS discusses the need for protection, maintenance, and restoration of degraded and fragmented habitats, but no specific protocol is provided (Potter et al. 2007). Because the Corps focuses more resources on forest stand improvement than on forest expansion, monitoring the quality of existing forest habitat is an important tool in avian conservation in the St. Louis District. The Corps has a defined vegetation monitoring protocol for fine-scale plots and qualitative variables (Appendix G) that covers many useful habitat variables such as overstory closure and height, dominant plant species (both woody and herbaceous), and snag and mast tree counts. The Corps vegetation protocol provides a standardized method for measuring important habitat variables, and future analyses of these data can provide insight into stand quality for prioritization of restoration efforts. Some additions to this protocol that should be considered to make the protocol more avian specific include; tree and shrub density within 10 m of plot center, subcanopy cover within 100 m, ground cover within 100 m, 4th and 5th most abundant trees and shrubs, and vine abundance and coverage.

E.1.c. Sampling Scheme

The sampling scheme used to select survey islands and point count locations in the St. Louis District is included in Appendix H, and should be used alongside the point count protocol proposed in this document. If the tracts you wish to monitor are not large enough to establish survey points as in Appendix H, then use the alternative sampling design by Knutson et al. (2016) SOP #1.

E.1.d. Filling Information Gaps

It is key that research and monitoring goals not only focus on local areas, but that they connect with and inform research in the entire St. Louis District. This requires communication and collaboration between Audubon and the Corps, and streamlined methods and analyses. Reliably monitoring avian populations requires joint projects that are implemented the same way, in the same timeframe, across a large geographical area. A regional research and monitoring focus achieved through partnership development with other state and federal agencies as well as non-governmental organizations will strengthen bird conservation efforts throughout the region.

E.2. Monitoring Responsibilities

In addition to the specific monitoring needs addressed above, it is necessary for this plan to maintain a regional focus. This can be achieved through partnership development with other state and federal agencies, as well as non-governmental organizations. As a federal management agency, the Corps and their partner agencies have a responsibility to document the resources needed to meet population goals for species of conservation concern and to provide this data on the Midwest Avian Data Center to facilitate collaborative conservation efforts. This may require adaptive planning that will allow for monitoring targets to shift as priority species change, as well as continual assessment of conservation actions over time. The development of specialized surveys for rare or cryptic species that are not well represented in BBS data (e.g. Cerulean Warbler) is part of this responsibility. This effort could include additional survey methods or targeted playback periods added to point counts to obtain more precise population estimates for priority species.

E.3. Adaptive Management

The Systemic Forest Stewardship Plan outlines the use of adaptive management and feedback loops in detail (Guyon et al. 2012, Section IV, p. 50). All monitoring and stewardship efforts must be conducted with feedback loops in place to assess the impacts and efficacy of forest management activities. This plan is a component of adaptive forest management to be used to determine if avian habitat goals are being met by St. Louis District forest projects, with goals and protocols revised as needed to better meet habitat goals for focal species.

F. Habitat Goals and Objectives

F.1. Habitat Area Goals

One of the long-term goals of this plan is to identify the amount of habitat management and restoration required to maintain or increase bird populations in the St. Louis District. Because reliable, district-specific avian population estimates are not currently available, we are unable to set specific habitat area goals at this time. This is a data need that must be addressed in future iterations of this plan when high quality avian population estimates become available. Using accurate population estimates and the high-quality land cover data possessed by the Corps, it will be possible to determine how much additional habitat area is required to stabilize focal populations, as done at a larger scale by Potter et al. (2007).

Table 4. Priority forest areas along Upper Mississippi River for the St. Louis Corps District. Areas include patches with interior or core habitats identified using the 100 ha window size. River mile starts at 0 at the Mississippi-Ohio Rivers Confluence and increases upriver to the headwaters. Asterisks indicate non agency lands with general descriptive titles as opposed to official names.

Management Area	Core/Interior Areas	Pool	River Mile
Bumgard Island	Core	Open	31
Devils Island	Core	Open	57
Shawnee National Forest-Wittenburg	Core	Open	83
Wilkinson Island	Interior	Open	94
Jones Towhead	Interior	Open	97
Lower Kaskaskia Island	Interior	Open	111
Moro Area*	Interior	Open	121
Mosenthein	Core	Open	188
Cuivre Island	Interior	26	237
Amaranth Island Area	Interior	25	269
Clarksville Island	Interior	25	272
Angle/Blackburn Island	Interior	24	285
Fritz Island	Interior	24	288
Gilbert Island	Interior	24	296

In the interim, we have identified the largest tracts of forest within the floodplain that we believe provide the greatest opportunity for maintaining suitable conditions for area sensitive species, or for increasing forest cover to increase the amount of 'interior' and 'core' forest on the landscape. We identified relatively unfragmented forests within the St. Louis District using data layers analyzed in De Jager and Rohweder (2011). We used the largest window size of 100 ha (e.g. 100 x 100-pixel windows) because we believe this best identifies patches that might be suitable for area sensitive species (e.g. Red-shouldered Hawk and Cerulean Warbler). An example map is provided from Pool 24 (Figure 5). This map includes forest pixels categorized as core (100%

forest in adjacent pixels), interior (90% or more forest cover, but less than 100% forest cover in adjacent pixels), dominant (greater than 50% forest cover but less than 90% in adjacent pixels), and other (forest cover includes area with less than 50% forest). Very few locations in the St. Louis District meet the criteria of 'core' pixels, so we used 'core' or 'interior' forest to initially identify priority forest conservation areas. Potential priority areas by District for both the Mississippi and Illinois Rivers can be found in Tables 4 and 5.

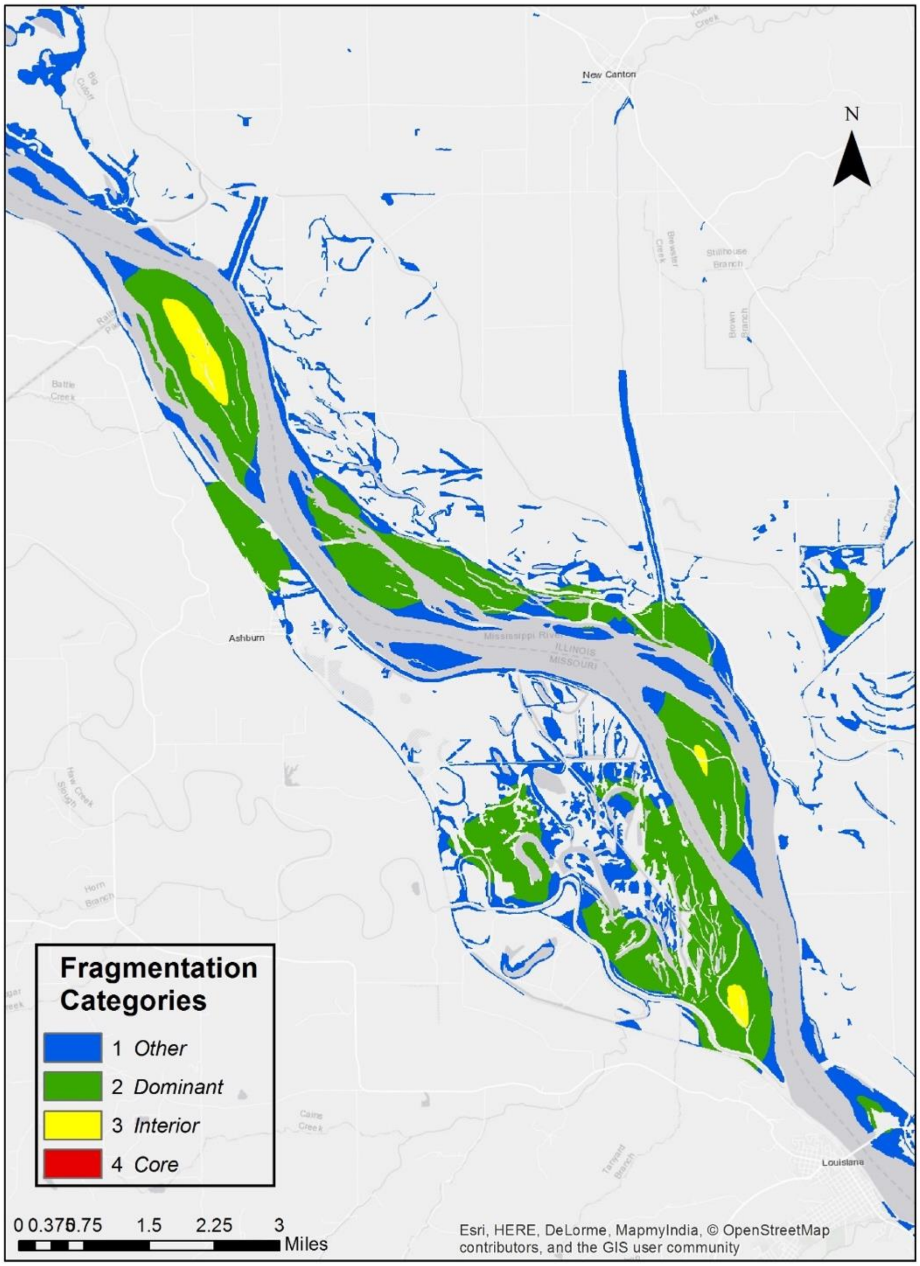

Figure 5. Priority forest areas in Pool 24 of the in the St. Louis U.S. Army Corps of Engineers District. Areas with interior habitats identified using the 100 ha window size represent priority areas to focus reforestation efforts and conserve existing forest cover conditions.

Table 5. Priority forest areas along the Illinois River in the St. Louis U.S. Corps District. Areas include patches with interior or core habitats identified using the 100 ha window size. River mile starts at 0 at the Mississippi-Illinois Rivers Confluence and increases upriver.

Management Area	Core/Interior Areas	Pool	River Mile
Glades/Helmbold Island	Interior	Lower	15
Meredosia area	Interior	Lower	78

F.2. Restoration and Enhancement

F.2.a. Timber Management and Harvesting

Timber management and selective harvesting can be used to maximize forest heterogeneity and habitat value. Using timber harvesting techniques to simulate natural disturbance regimes, such as wind storms, ice and flood damage, can provide canopy gaps that encourage the recruitment of native seedlings while reducing the effects of invasive plants (Cooper et al. 2009). This technique can be used throughout the management of a reforested area to create systems with trees of all developmental stages, as well as to increase structural heterogeneity. Occasionally, the sale of timber can be used as a tool to provide financial support for ongoing management or preferably timber sales can be used to provide “in kind” services where timber buyers perform prescribed management actions in lieu of payment.

Timber Harvest Best Management Practices at the Federal and State Level

The USFWS has specific forest management recommendations for colonial waterbirds (Vermont Fish and Wildlife Department 2002) and Bald Eagles (USFWS 2013), but not for the focal species within this plan. States have developed their own timber harvest best management practices document to assist with planning a timber harvest that helps to reduce impacts to sensitive resources. Most of these documents contain chapters or sections focused on best management practices for tending treatments and tree release treatments; protection of soil productivity and water quality; protection of visual quality; protection of cultural resources; reducing spread of invasive species; road planning, design, and maintenance; skid trail development; landing design considerations; wetland protection; protection of streamside management zones; wildlife enhancement; and recommendations for retaining forest structural components in harvest areas. Best management practices for Missouri were developed by the Missouri Department of Conservation (2014), and the practices for Illinois were developed by the Illinois Department of Natural Resources (2007).

Structural Components

Retention:

Biological legacies are components of a stand that are present prior to a harvest or other disturbance and influence the post-disturbance recovery. Biological legacies may serve as a seed source for a developing stand, provide nutrients, influence microclimatic conditions, provide habitat for organisms that recolonize a stand, and improve connectivity between undisturbed areas (Lindenmayer and Franklin, 2002). Retention of legacy structures (e.g. live trees, dead trees, species diversity, species composition, logs, snag, tipover mounds, pits, seed bank, etc.) should be an important consideration of any harvest method implemented on the landscape. This should include how the density and distribution vary within the treatment area when compared to a similar natural disturbance (e.g. windthrow, flood disturbance, insect damage, competitive exclusion, etc.). The pattern of retained structures can constrain development or help to enhance the variability in structure that is often beneficial to wildlife. For example, if legacy structures are retained at even intervals within a stand they may homogenize regeneration initially even though canopy structure may be heterogeneous vertically. As the canopy develops, additional intermediate treatments would be required to increase the overall structural diversity of the stand. Retention at even intervals is often done so that tree growth is maximized, but retention that is irregular across a stand may result in more structural and compositional diversity (variable retention). Retained trees and structural features should represent the full diversity of a stand rather than be represented by a single species or feature type wherever possible. Identifying legacy trees from a variety of species can be used to provide a range of growth rates, bark surfaces, and complexity to a managed stand. Each tree has a different phenology and provides resources for wildlife at certain times of the year (e.g. hard mast, soft mast, support different invertebrate prey, provide special nesting/roosting structures, etc.). Ewert and Hamas (1996) outline the importance of large patches of diverse plant communities, riparian areas, and habitat mosaics on the landscape for migrant bird habitat selection.

Large trees:

There are at least 29 bird species that are either primary or secondary cavity nesters and 14 species of raptor or waterbird that use large trees in bottomland forests along the UMRS for roosting or nesting, and a number of other species that may prefer large trees found in bottomland forests for foraging or nesting.

Super-emergent trees include large-diameter trees with crowns extending well above the surrounding canopy. These trees may be particularly important for raptors and colonial waterbirds as nest and roost sites. Large trees with rough, scaly, or deeply fissured bark often provide more insect biomass for insectivorous birds compared to smooth-barked trees. Tree species with rough bark may be preferred by bark-gleaning species (Brawn et al. 1982). Large, old trees are also most likely to provide other unique conditions such as tree hollows, large dead limbs, and support cryptogam communities (e.g. lichens, bryophytes, fungus, etc.). Management for these conditions over the long-term should be conservative enough to compensate for reasonable losses to developing trees that will become the next large trees (e.g. trees greater than 30 in. DBH) as a stand develops (e.g. loss to disturbance, competition mortality, disease, etc.).

Dead wood management:

Dead trees representing various stages of decay offer different opportunities for nesting, resting, and foraging for vertebrates and invertebrates. Standing snags should be retained when possible for cavity nesters. Healthy primary cavity nester populations (e.g. excavating species) are critical for secondary cavity nesters (e.g. species that use natural cavities and cavities created by primary excavators). Primary cavity nesters primarily excavate in dead wood or through live wood into decaying heartwood (Conner et al. 1976). Many cavities are excavated in snags showing decay, so these snags may be more important to conserve than hard snags. Retention of large snags (e.g. ≥ 18 in) is often more important than small snags because they allow for a range of cavity sizes including the largest cavity requirements. Smaller snags are still important because they can be more numerous on the landscape and support smaller species. It is ideal to retain as many dead snags as possible during harvests when it is safe to do so. Forest Guild (2012) recommended a goal of having 6 snags/ac with 10+ inch DBH on average for bottomland forests in the south, and a similar goal could be used for the UMRS. Alternatively, the Lower Mississippi Valley Joint Venture developed a table of desired forest conditions with average snag metrics per acre for bottomland forests that can guide management (Wilson et al. 2007). Note that both guidelines provide an average per acre rather than an absolute value per acre. Variation in distribution and density can provide added benefits for wildlife and should be incorporated when possible.

If the above conditions are not met it is recommended that live trees with the potential for developing the desired snag/cavity sizes be retained on the site. Regardless, some live trees should be retained as legacy trees to aid in stand redevelopment. Retaining a range of snag/cavity sizes helps to ensure a wider range of wildlife can be supported now and in the future.

Trees with a defect are generally more prone to have conditions that will support cavity formation and dead wood in the future (Healy et al. 1989). These trees are often removed during a harvest because they are thought of as less valuable or marketable, but they often develop into important wildlife features. It is important to keep some of these trees in a harvested area to allow the generation of snags in the future.

In areas where trees are treated to create snags a few considerations might be warranted. Girdling trees to create snags may not produce the conditions necessary for cavity formation because the trees fall over at the girdling point prior to providing cavities (Hennon and Loopstra, 1991). Other methods such as topping or herbicide killing may be more economical and produce more suitable conditions for wildlife snag tree management and maintenance in a stand. The persistence of existing snags is another consideration when attempting to manage for standing snags in the future. For instance, Flower et al. (2014) cite the rapid loss of Ash (*Fraxinus* spp.) snags within four years of a mortality event.

Hollow trees are also important to retain for wildlife such as bats and Chimney Swifts (*Chaetura pelagica*). Hollow trees are formed when the top breaks out of a tree or through another mechanism that allows heart rot to begin. These hollow trees can then create hollow logs for animals such as amphibians, reptiles, small mammals, and ground nesting birds if they fall. Similar to cavity trees, logs > 4 in in diameter will support a wider range of wildlife (e.g. amphibians, reptiles, invertebrates, mammals, etc.) and provide more stable temperature and moisture conditions for associated organisms over a longer time period.

Forest Guild (2012) recommend the retention of some down woody material of a range of sizes at the harvest site and distributed throughout the site where possible. The additional structure can be important for providing a wider range of microclimates for wildlife, germination sites, increase foraging opportunities for insectivorous birds and wildlife, and release nutrients slowly. In some instances, retention of down woody material may not be practical such as when soil prep requires bare soil for germination.

F.2.b. Large Forest Fragments

Although the loss of forest area has been slowed or reversed along much of the Mississippi River, many habitat patches are still too small and isolated to support stable bird populations. Twedt and Loesch (1999) estimate that forest patches must be upwards of 9,900 acres to support a sustainable population of 500 breeding pairs of birds, while Fahrig (2003) notes that potential local extinction thresholds may exist when habitat cover is between 20-30% of its original range. Very few forests and patch conglomerates of this extent exist on the Mississippi River floodplain, and many of these fragments are population sink areas (Grettenberger 1991, Brawn and Robinson 1996, Knutson et al. 2006). Enlarging fragmented patches within the landscape will reduce local population extinctions by moderating edge effects and reducing predation and parasitism events (Robinson et al. 1995, Twedt et al. 2010). Twedt et al. (2010) point out that the most effective way to make a positive impact is starting with existing patch augmentation within landscapes that already have a moderate amount of forest cover. This technique will make a positive impact on populations of area-sensitive species of concern, such as the Cerulean Warbler (Thompson et al. 2012).

F.2.c. Heterogeneous Habitat Matrices

Increasing forest cover is a key component of bird conservation on the Mississippi River, but it is important to remember that bottomland forest and associated habitats are not intended to be islands, but rather dynamic parts of a matrix. These areas are naturally variable and subject to change, and homogenous hardwood forest is not necessarily a desirable feature (Wigley and Roberts 1997). Nesting success of forest birds is related to proportion of forest within the landscape, but the reverse is true for grassland birds (Twedt et al. 2010), and the variety and coverage of habitat types within the landscape may influence patch size sensitivity (Wigley and Roberts 1997). Thus, while reaching habitat coverage goals is important, it is also essential to view these goals in the context of the landscape matrix. An objective thus is to create natural transitions between diverse native habitats, especially in landscapes dominated by urban and agricultural areas; maintenance of all natural habitats within the landscape is key to long-term avian population stability and increase.

In addition to considerations of habitat heterogeneity, habitat goals should focus on spatial and structural heterogeneity within patches. Both horizontal and vertical diversity in vegetation structure within a given habitat are desirable features. Structural complexity plays a central role in the biodiversity of local flora and fauna, as it is responsible for creating habitats with the microenvironments and niche space required for diverse communities (Tews et al. 2004, Gardner et al. 2009). This applies to both living and dead vegetation, such as snags. Both horizontal and vertical structure should be considered separately, as they can impact species with different levels of severity; structural diversity can mean heterogeneity to species operating at a larger scale, but fragmentation to those operating at a smaller scale (Tews et al. 2004).

Ideally, a mixture of hardwood mast species and more quickly growing species such as silver maple and cottonwood should be used to diversify canopy species. Goals should initially be focused on expanding larger forest patches, ideally building a multitude of forested areas of thousands of acres each, as stipulated by Twedt and Loesch (1999). Any reforestation or management efforts should include an implemented disturbance regime, creating small gaps or removing individual trees to ensure that the canopy is not of a single age, as this will ensure that there are multiple stages of regeneration occurring. In the initial growing periods, invasive plants need to be intensively controlled so native seedlings and understory plants have a competitive advantage.

F.2.d. Creating and Augmenting Complex Forests

Creating complex forests as quickly as possible is a necessity with for avian conservation. This can mean reforesting former agricultural land. It can also mean improving quality of existing forests (Twedt et al. 2010). Invasive plants and insects can cause significant damage to regenerating forests by outcompeting seedlings and preventing establishment. Thus either intensive groundcover management or additional plantings or natural regeneration of rapidly growing native trees and shrubs must accompany any hardwood plantings in order to quickly generate suitable forest habitat. Whenever possible, efforts should be made to generate a closed canopy forest comprising a variety of species spanning multiple developmental stages, as this will be more likely to create a robust forest that, once mature, can regenerate without continued intensive management efforts.

F.2.e. Flooding Regimes

Although perhaps the most difficult goal to achieve, returning to a natural flood regime as much as possible will have a broad-reaching impact on restoring native habitats and protecting birds and other wildlife. Completely returning to a natural hydrology is impossible due to anthropogenic changes in the river and its watershed, yet there are several smaller scale options to aid in this effort. Allowing controlled temporary floods in bottomland forests is already done to augment waterfowl habitat throughout the year in many areas **(**Heitmeyer 2006) and could be used more widely as a tool to replace natural seasonal flooding where possible.

Temporary pool drawdown is another option that will allow for soil compaction and plant growth in areas close to the river, not only supporting habitat expansion, but also providing valuable foraging habitat and reducing runoff and erosion. The multi-agency Water Level Management Task Force has already facilitated multiple pool drawdowns during the summer growing season in the St. Paul District, resulting in an increase native vegetation cover and breeding, foraging, and migrating shorebird detections (River Resources Forum 2012). Since 1994, the St. Louis District has performed annual pool drawdowns as part of an Environmental Pool Management program. Targeted and standardized forest bird monitoring in response to pool drawdown does not exist at this time. Managing all pools with more depth variability would significantly increase the resilience of riparian habitats in the St. Louis District, and is the best option for maintaining the system in a state of altered hydrology.

F.2.f. Hydrogeomorphic Analysis

Hydrogeomorphic analyses for St. Louis District has been completed (Heitmeyer 2008 and Heitmeyer 2010). These analyses help to determine which types of vegetation communities, such as hard mast or early successional species, can be sustainably managed at a given site based on the interactions between river hydrology, local topology, and other factors. This information is useful for early restoration efforts and can be used to develop scientifically based restoration and rehabilitation goals that provide for large-scale habitat needs, thus improving the restoration manager's ability to treat appropriately targeted areas rather than an opportunistic prioritization.

G. Future Direction of Avian Stewardship in the UMRS

This plan is intended for use alongside the SFSP (Guyon et al. 2012) to streamline and unite avian and forest stewardship within the St. Louis District. Although this plan has been initially developed for use in the St. Louis District, long-term avian stewardship cannot rely on a single agency and only a portion of the UMRS; coordinated, landscape-level action is needed across the UMRS. Ideally the concepts and actions proposed here will be expanded to the Rock Island and St. Paul Corps Districts over time, but cooperation with other organizations is also needed to achieve this goal. This does not need to be limited to federal organizations like the USFWS or state conservation agencies; collaboration with private and nonprofit organizations is also critical. Part III of this document provides a timeline and goals for broadening this plan.

Future Goals for the St. Louis District

1. Complete the analysis of the 2014-2017 avian point count data sets and establish standard analysis methodology for future survey seasons.
    a. Evaluate the results to identify and recommend changes in the current survey protocol that may be required to achieve the quality data necessary to generate population estimates as well as inform adaptive management techniques.
2. Integrate the current forest vegetation survey data set with the avian survey data set to allow for modeling of bird-habitat relationships.
3. Finalize the point count survey protocol recommendations.
    a. Determine necessity/functionality of targeted callback periods for rare or cryptic focal species.
    b. Determine if all survey points are required every year in order to obtain the quality of results necessary to accurately track avian density and abundance.
4. When appropriate, incorporate the information and learnings derived from point count data analysis into this plan.
5. Continue collecting avian point count data in order to create a more robust population estimate for focal species.
    a. Continue exploring alternative survey methods such as area searches.
6. Once adequate point count data are available, estimate population sizes for focal species and determine priority areas for forest restoration projects based on these populations.

7. Depending on the status of focal species populations, determine if current Corps forest management practices align with avian habitat needs in priority areas; if they do, focus management on priority areas. If they do not, identify and implement the necessary changes prior to additional implementation.
8. Determine if current forest prescription protocols and practices combined with the current survey protocol and survey point count locations will provide the desired quality of information to inform adaptive management and guide land management decisions.
9. Analyze systemic avian point count data every three years to assess and inform future conservation activities in the District.

III. U.S. Army Corps of Engineers and Audubon Partnership in the Upper Mississippi River System

Partnerships can be effective strategies for maximizing limited resources to address increasing pressure on ecosystems while developing effective solutions at scale. This section guides the collaborative efforts of the NAS and Corps to manage natural resources for the benefit of birds, other wildlife and people on the UMRS. It also outlines how we can broaden our cooperative approach to affect conservation at a landscape scale on the UMRS. More specifically, this section describes objectives, activities, recommendations and strategies for expanding avian conservation in UMRS bottomland forests.

A. Expansion of the Conservation Footprint in the Upper Mississippi River System

Geo-political borders don't define wildlife and habitat needs. The Corps and Audubon are therefore leveraging their partnership to build collaborations with other natural resource management agencies and organizations to extend conservation on the UMRS beyond the St. Louis Corps District. Collaborative monitoring and land management activities that cross these borders can present opportunities for future landscape-scale conservation.

Audubon Important Bird Areas (IBA) in the UMRS, such as the Great Rivers Confluence Global IBA, which includes the RMBS, provide additional opportunities to impact conservation at a large scale. Audubon's IBA program is a global initiative to identify and conserve the most important places for bird populations. The IBA program emphasizes science-based identification, assessment and conservation. There are 1.8 million acres of IBAs that border the Mississippi River and its tributaries across five states (WI, MO, IL, MN, IA). Missouri alone has 305,129 acres with IBA status near the Mississippi River. IBAs include state, federal and privately owned and managed lands providing an existing framework which to engage stakeholders in avian and vegetation monitoring as part of an adaptive management program to support avian populations in UMRS bottomland forests. With a goal of landscape scale forest bird conservation, Audubon and the Corps are now working to expand comparable and standardized avian and vegetation monitoring protocols and techniques to assist our respective organizations and other local, state and federal agencies in filling information gaps to improve management of UMRS bottomland forests on public lands.

One purpose of this document therefore is to introduce potential UMRS stakeholders to using avian monitoring to inform adaptive management of bottomland forests to sustain avian populations. This can be achieved by sharing scientific expertise and technical assistance detailed in this document through conferences, workshops, webinars and other formats.

Expanding bird conservation at a landscape scale on the UMRS will require both public and private land strategies. Audubon has identified working with private landowners to improve the quality of habitat as a strategic priority. Private lands are therefore another opportunity to expand avian monitoring and bird habitat conservation in the UMRS. While our current avian monitoring efforts focus on public lands, future efforts may include private lands outreach in coordination with other agencies and organizations with established private lands programs.

Over the next five years, Audubon will establish an avian monitoring network on the UMRS. This will include standardized monitoring protocols, coordinated training and monitoring and analysis to aid stakeholders with data-driven best management practices that will benefit birds and other wildlife. In order to keep up with changes in monitoring techniques, we will review the avian monitoring protocol defined in this document every three years to ensure its integrity, efficiency and effectiveness.

B. Objectives and Activities

Goal: Leverage the Avian Stewardship Plan to achieve conservation of the bottomland forests and associated avian populations throughout the UMRS. This will be achieved by expanding and improving the reach of the ASP practices and principles, as well as developing a network of data sharing and collaboration.

Objective 1: Expand the footprint of the Avian Stewardship Plan avian monitoring practices and adaptive management principles to areas outside the Corps' St. Louis District by building partnerships that result in the stabilization or growth of focal species populations as defined in the document or by the partnering agencies.

a) Identify and capitalize on opportunities to communicate the value of the ASP and monitoring.
b) Identify, contact, and meet with key public land managers (e.g. IBAs, refuges, parks, conservation areas) on the UMRS with bottomland forest habitats and their associated management agencies for targeted partnership outreach. Target agencies include USFWS, MDNR, IDNR, MDC and the Rock Island and St. Paul districts of the Corps.
c) Identify, contact and meet with potential partners building conservation planning documents (e.g. Habitat Management Plans) to advocate for incorporation of ASP recommendations and principles.
d) Assess the opportunity for expansion of the ASP conservation footprint into bottomland forests in private ownership.
e) Onboard additional staffing resources/capacity to plan, initiate and manage a private land outreach program.
f) Convene a meeting of partners for planning and implementation of ASP recommendations in new areas of the UMRS.

Objective 2: Integrate ASP practices and principles into Audubon's bird conservation strategy for the UMRS.

a) Identify, meet with and capitalize on opportunities to communicate the value of ASP practices and principles to other Audubon staff.
b) Convene a meeting focused on integration of the ASP into Audubon's UMRS strategy.
c) Utilize ASP practices into the larger conservation plans for bird communities on the Riverlands Migratory Bird Sanctuary and UMR flyway.
d) Identify effective public policy strategies and tools that communicate the importance of conservation of bottomland forests to support healthy bird populations in the UMRS.
e) Onboard additional staffing resources/capacity to plan, initiate and manage a UMRS public policy program.
f) Develop and implement a public policy strategy and tools.
g) Utilize this public policy strategy and tools to educate legislators and their staff on the importance of conservation of bottomland forests to support healthy bird populations in the UMRS.

Objective 3: Determine what datasets and information regarding bird, forest inventory, land cover, vegetation and other habitat characteristics are available from other natural resource agencies along the UMRS. Using these external datasets focused on other resources along the UMR to help contribute to habitat interaction questions for species of concern.

a) Initiate investigation of available datasets from natural resource organizations and agencies pertaining to land cover, habitat, bird and vegetation data.
b) Investigate standardized protocols used to obtain data from local natural resource organizations and agencies.
c) Determine ways to combine or use datasets to support each other, as well as areas where information is missing.
d) Investigate the feasibility of obtaining data in those areas that don't have relative data to help expand the spatial coverage of data (i.e. who would do the surveys, how much would it cost, etc.).
e) Compile a table of types of data, time periods collected, organization/individuals that collected, and potential use. If applicable, download data into corresponding databases (i.e. bird data into Avian Knowledge Network).

Objective 4: Determine population dynamics of bottomland forest birds and how their trends connect to habitat characteristics along the UMRS.

a) Identify information gaps between bird-habitat interactions within the ASP framework and partners throughout the UMRS.
b) Determine a method in which to analyze the local associations between bottomland forest characteristics from Corp's forest inventory to avian occupancy data from

surveys through Audubon. Implement the methodology to include the entire UMRS to determine wide spread population dynamics of bottomland forest birds.

c) Analyze avian population trends from the RMBS bottomland forest avian surveys through Audubon.
d) Create a tool that relates ASP and other partner focal bird species habitat needs to forest management and restoration actions.
e) Utilize tool and analysis for implementation throughout the UMRS to promote bird-forest management and restoration actions for partners and stakeholders.

Objective 5: Determine population dynamics of bottomland forest birds to forest succession (i.e. pre and post timber management) along the UMRS in forest management sites.

a) Identify information gaps between bird and forest successional stages within the ASP framework and throughout the UMRS.
b) Determine standardized monitoring protocol to determine avian responses pre and post timber harvest.
c) Survey avian population trends in timber management areas through Audubon and associated partners.
d) Analyze the associations between avian occupancy to bottomland forest successional stages at different forest management sites throughout the UMRS.
e) Create management and restoration suggestions based on bird occupancy to different forest successional stages that can be applied throughout the UMRS by partners and stakeholders.

Objective 6: Continue refinement and implementation of standardized monitoring protocols for bottomland forest bird surveys to accommodate partnerships along the UMRS. This includes reviewing focal bird species to incorporate those found throughout the UMR.

a) Determine current efficiency of avian detectability for point count, area search surveys and survey frequency (i.e. yearly, biyearly, etc.) via power analyses for the RMBS and at partner survey sites throughout the UMRS.
b) Identify maximum observer effort needed to retain high bird richness detectability along surveys sites within the UMRS.
c) Convene meetings every 3 years to update and review standardized monitoring protocol for bottomland forest bird species in the UMRS with partners and stakeholders.
d) Develop and review logistical progression of survey points for project areas along the UMRS in order to maximize number of points completed by the end of season and maximum detectability of bird species richness and abundance.

C. Key Recommendations and Strategies

C.1. Partnership Development

Developing partnerships that can leverage expertise and resources is central to implementing the recommendations and executing the strategies detailed in this document. Identifying appropriate tracts of bottomland forest and their respective land managers will guide our partnership-building efforts. We recognize IBAs, refuges, state parks and conservation areas on UMRS as potential opportunities. We will initially focus on collaborations with federal and state agencies in the UMRS with policies that require resource development plans. We recognize an existing partnership with the Corps St. Louis District, and the USFWS Landscape By Design as ideal starting points.

As noted previously in this document, we recognize private lands as a key opportunity to expand avian monitoring and landscape scale bird conservation. Rather than build our own private lands program, we will first seek to cooperate with existing private lands programs of other organizations such as D.U., USFWS, state agencies and other natural resource entities, to optimize all stakeholder resources.

Partnerships with universities, colleges and similar educational institutions can extend our capacity to sustain research and monitoring on the UMRS. Utilizing undergraduate and graduate students to assist in research, data collection, and field surveys can alleviate staffing costs, while affording students opportunities to gain essential field and career development experiences. Their efforts can further serve to increase our understanding of various restoration and management techniques. Ongoing working relationships with appropriate university departments and professors can also bring additional expertise and resources necessary to sustaining avian monitoring on the UMRS.

C.2. Data Storage and Access

Data management of large-scale avian monitoring projects requires a robust and scalable data storage and access system that can be shared across partnering organizations to facilitate data entry, access and analysis. The Avian Knowledge Network provides a platform for cooperating organizations and individuals to conserve birds and their habitats using science to inform adaptive management practices (Appendix E). The Midwest Avian Data Center, a node of the Avian Knowledge Network focusing on the Midwestern states, provides a centralized database for data access, storage and analysis that can be easily shared across collaborating organizations (Appendix E). Audubon and the Corps currently utilize this data management system for the avian point count data generated for the bottomland forest surveys. In addition, we recommend that standardized data management principles including data policy, ownership, quality assurance and metadata (Appendix F) be adopted and followed throughout the UMRS by partners participating in avian monitoring.

C.3. Meeting the Resourcing Needs of Landscape-scale Avian Monitoring

Monitoring and adaptive management programs vary widely in costs depending on the frequency and intensity of both the monitoring and management actions implemented. Partner implementation of avian monitoring recommendations will depend on the ability to identify and justify resources to support this type of program. The process of partnership development includes ascertaining barriers to implementation of ASP recommendations. It is likely that identifying funding and resources will be a challenge for some partners. Solutions to this potential barrier are likely to vary for each partner. Leveraging partnerships through shared grant applications can provide additional funding opportunities to address this issue. Knutson et al. (2016) provides a summary of estimated operational costs of ~$30,000 - $33,746 (4% increase in costs per year over 2015 dollars). This estimate corresponds to specific survey conditions (e.g. 130 points, 8 points surveyed/day, survey points accessible by driving and walking). This information can act as a guideline for partners to facilitate discussions of resourcing considerations for ASP implementation and expansion.

Programs that already exist within potential partner agencies provide additional opportunities to justify resource allotment to projects that employ adaptive management tied to monitoring to forward wildlife conservation efforts on larger scales. The Landscape Conservation Design program (USFWS 2017) of the USFWS is well-aligned to the principles described in this document including identification of priority species, development of measurable population objectives and application of monitoring and adaptive management to conserve the habitats that support priority species. This alignment can be leveraged to justify the resources required to initiate and maintain avian and vegetation monitoring programs that support adaptive management of bottomland forests on the UMRS. Another example is the Corps' Upper Mississippi River Restoration Program, an environmental restoration program focused on the Upper Mississippi River that employs restoration efforts tied to monitoring and research to ensure the conservation and sustainability of the wildlife resources dependent on the system. This program also emphasizes the importance of partnerships to the overall success of restoration and conservation efforts on the river. Both of these programs provide platforms for enlistment of partners and possible funding sources for avian stewardship efforts in the bottomland forests of the UMRS.

D. Summary

Through valued partnerships Audubon strives to be the leader in forest bird monitoring, scientific analysis and coordination of management recommendations that benefit birds on the Upper Mississippi River. Expanding upon existing successes with partners will benefit habitat and the birds that use them, especially focal species of concern that are, in many cases, indicators of overall ecological system health. Leveraging resources and exploring pathways to fully implement the recommendations of this plan will only lead to more informed management of the Upper Mississippi River.

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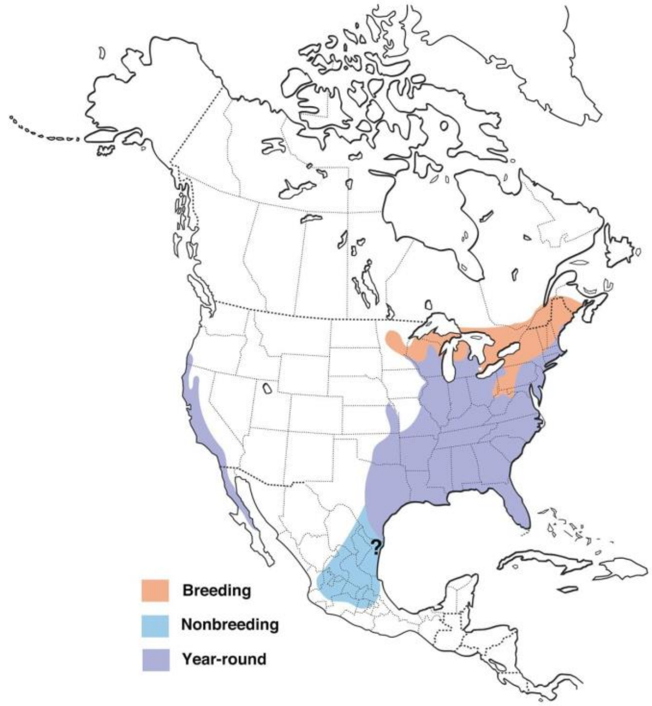
V. Appendices

Appendix A: Acronyms

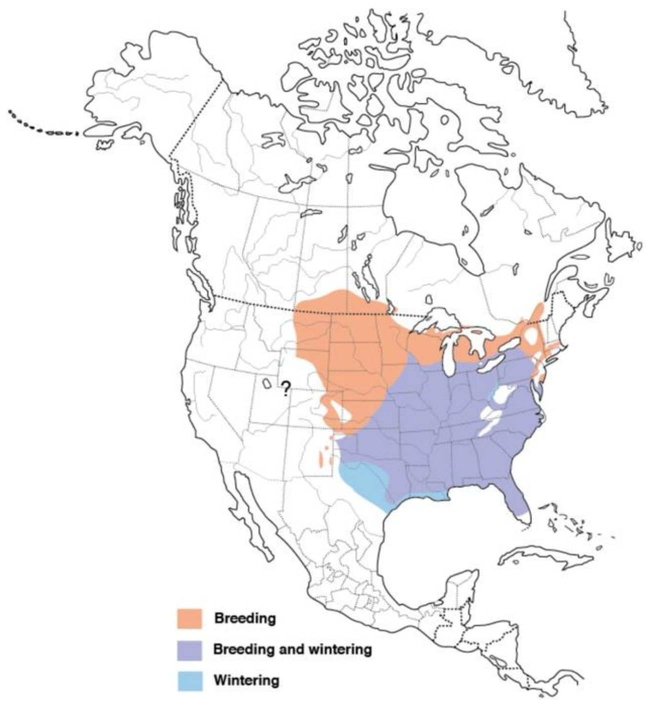
BBS	Breeding Bird Survey
BCH	Bring Conservation Home
BCR	Bird Conservation Region
BMP	Best Management Practices
CESU	Cooperative Ecosystem Study Unit
GIS	Geographic Information Systems
GWVCS	General Wetland Vegetation Classification System
IBA	Important Bird Area
IDNR	Illinois Department of Natural Resources
IUCN	International Union for Conservation of Nature
IWMM	Integrated Waterbird Management and Monitoring
LHCS	Upper Mississippi River and Great Lakes Region Joint Venture Landbird Habitat Conservation Strategy
MDC	Missouri Department of Conservation
MOBCI	Missouri Bird Conservation Initiative
NAS	National Audubon Society
RMBS	Riverlands Migratory Bird Sanctuary
SFSP	Systemic Forest Stewardship Plan
SLAS	St. Louis Audubon Society
UMESC	Upper Midwest Environmental Sciences Center
UMRS	Upper Mississippi River System
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Appendix B: Focal forest bird species range maps

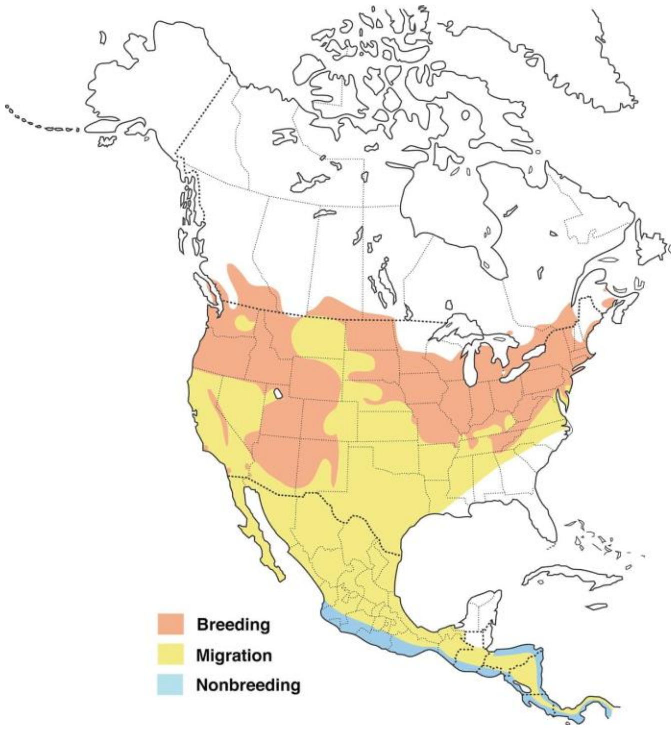
All maps provided by the Cornell Lab of Ornithology via allaboutbirds.org.



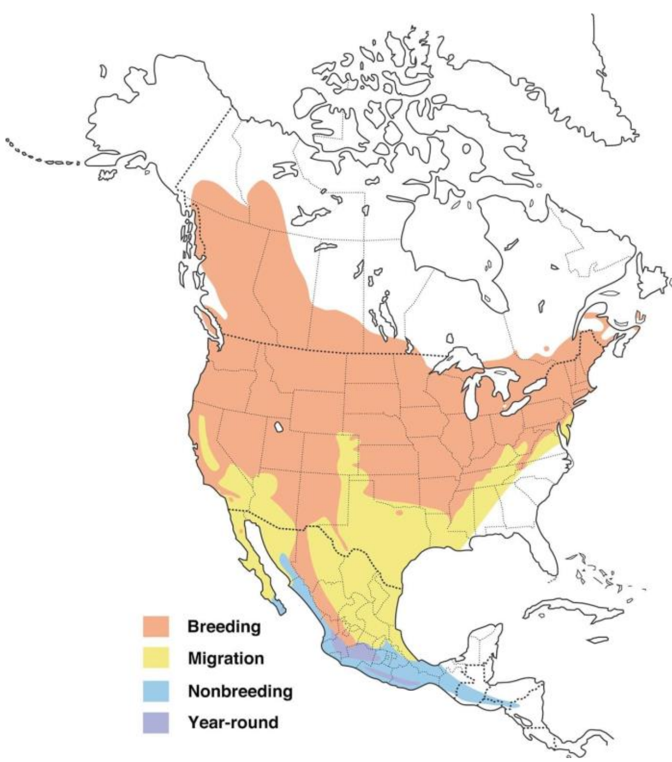
1. Range map for the Red-shouldered Hawk (*Buteo lineatus*).



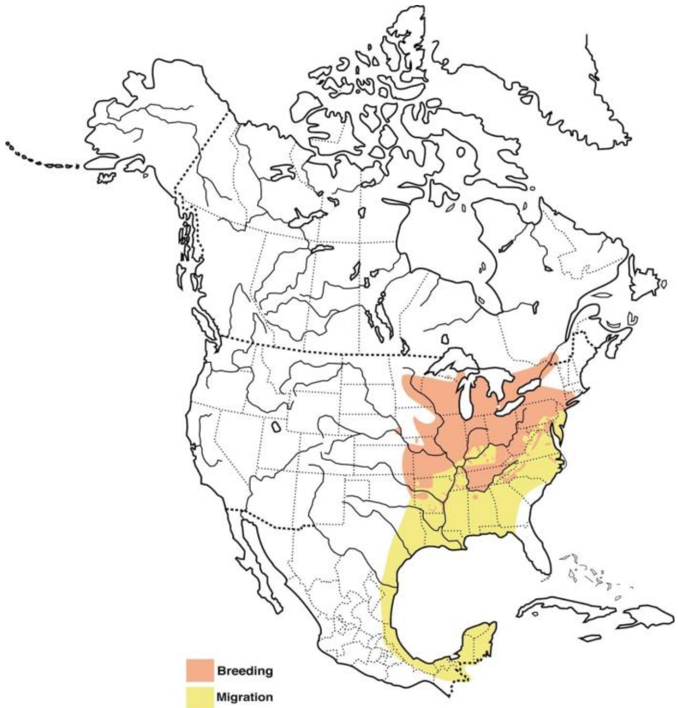
2. Range map for the Red-headed Woodpecker (*Melanerpes erythrocephalus*).



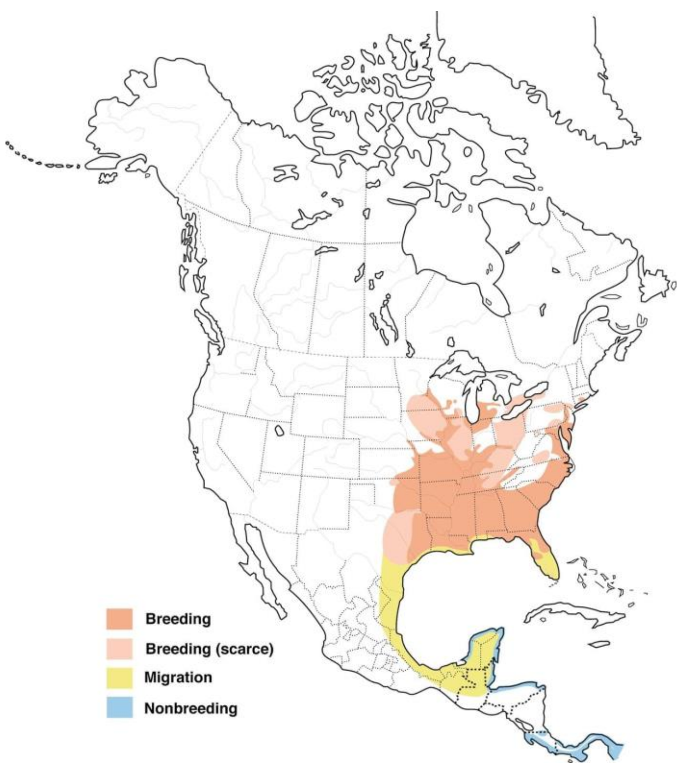
3. Range map for the Willow Flycatcher (*Empidonax traillii*).



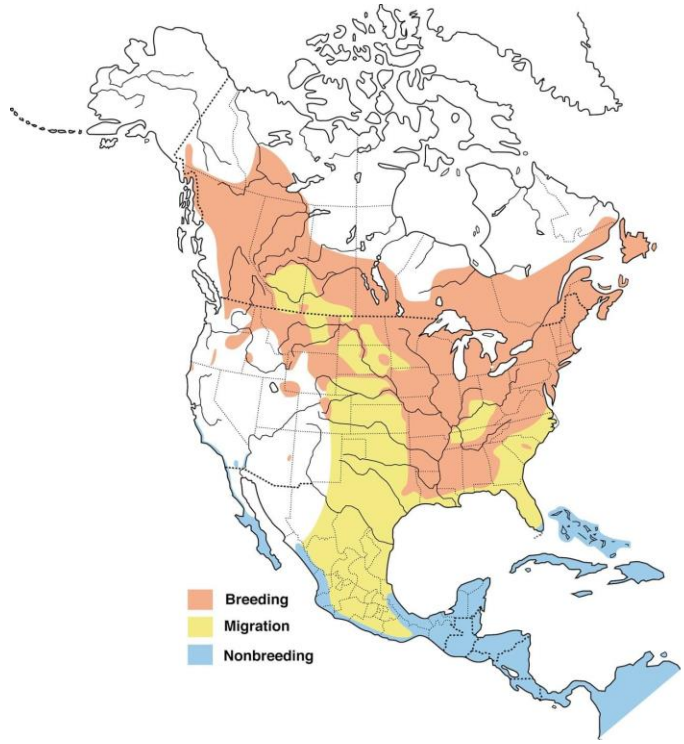
4. Range map for the Warbling Vireo (*Vireo gilvus*).



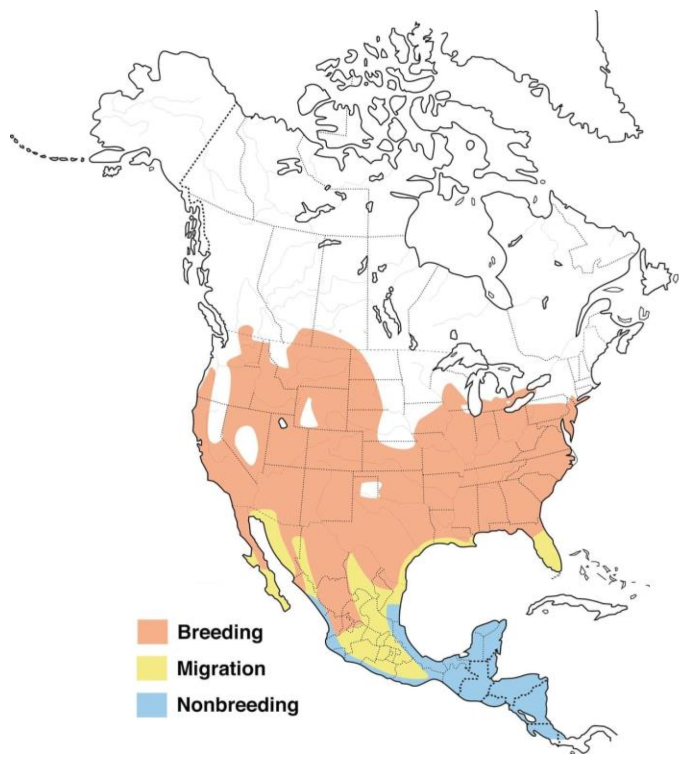
5. Range map for the Cerulean Warbler (*Setophaga cerulea*).



6. Range map for the Prothonotary Warbler (*Protonotaria citrea*).



7. Range map for the American Redstart (*Setophaga ruticilla*).



8. Range map for the Yellow-breasted Chat (*Icteria virens*).

9. Range map for the Indigo Bunting (*Passerina cyanea*).

Appendix C: Avian population estimate protocol

1. Literature survey

- Literature was surveyed extensively, using all relevant publications available.
- Publication relevancy is determined by inclusion of all of the following:
  - Density or abundance estimates for one or more of the nine focal species.
  - Estimates were made in one or more of the focal habitat types (floodplain forest, lowland forest, *Salix* community, *Populus* community).
    - Cover types under any other name were classified by a Corps forester using the tree species information provided in the publication in question. When tree data were not available, the paper was excluded from analysis.
  - Avian abundance and density estimates were accompanied by an estimate of area.
  - Study location was in riparian areas of the Midwest or within the reaches of the Mississippi Alluvial Valley.
  - Publication within the last 20 years whenever possible (old papers were only used when data was scarce for a species or cover type).
- Literature search continued until at least one published estimate was collected for each of the nine focal species in all associated habitats.

2. Calculations

- Calculation assumptions:
  - If counts were males, assumed an equal number of females (multiply by 2).
  - If counts were territories, assumed 2 birds per territory (one male and one female).
  - Removed estimates of uncertainty (confidence intervals, standard deviation, etc.), as they varied between studies and raw sample sizes were often not provided, meaning that standardized error estimates could not be calculated.
- Calculations were made independently for each published value (differing for each species, cover type, and publication), and then were averaged within species and cover types when calculations were complete.
- Noted if counts were made in terms of number of males, total birds per unit area, or number of territories. Normalized these values to number of birds per unit area using the assumptions above.
- Transformed number of birds per unit area (typically m^2, km^2, $miles^2$, or ha) to be number of birds per km^2.
- Multiplied number of birds per km^2 for a given cover type by the total number of km^2 of the relevant cover type within the UMRS.
- Averaged all population estimates for a given species in a given cover type to yield one species population estimate per cover type.

- Separately calculated standard deviation for the mean values using each published value as a data point.

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Appendix D: Evidence of sampling bias using the modified Knutson protocol

September 13th, 2018

Nicole Michel[1] Ph.D., Senior Quantitative Ecologist
Joanna Wu[1], Project Manager, Avian Biologist and Important Bird Areas

Science Division
National Audubon Society
[1]220 Montgomery St. Suite 1000
San Francisco, CA 94104

The Audubon Center at Riverlands (ACR), on behalf of the U.S. Army Corps of Engineers Rivers Project Office (USACE), currently employs an additional eight-minute playback of mobbing chickadees and screech-owl vocalizations at the end of the 10-minute passive listening period in order to elicit response from silent birds. The ACR and USACE requested an evaluation of the playback period by analyzing the first four years of point count data (2014-2017) to determine if the playback period should continue to be utilized.

NAS Science conducted two analyses to evaluate the added value of the eight-minute playback survey after the 10-minute passive period. First, we fit separate models to data including a) the 10-minute passive period only, and b) the 10-minute passive period plus the eight-minute playback period (i.e., 18-minute protocol), and we compared density estimates between the two time periods after correcting for imperfect detection. Species that showed a sharp increase in density when including the eight minute playback period may be responding to playback. Second, we estimated the probability of detection for each species during each of the 18 minutes. Species that exhibited a sharp increase in detection probability at or after the initiation of playback at the 10-minute mark were determined to be responding to playback. We evaluated this both visually, by plotting probability of detection by minute, and statistically, by determining the breakpoint (i.e., the time period at which there was a sharp change in slope in the relationship between detection probability and time) in the time series of detection probabilities by minute.

While density estimates are statistically significant higher for all species surveyed for 18 rather than 10 minutes which is expected due to the extra time alone, most species did not show a clear response to playback as indicated by a sharp increase in detection at the 10-minute mark, when playback began. Based on an evaluation of 35 species, we found two species – Black-capped Chickadee and American Goldfinch – that appeared to be responding to playback. This determination was based on a substantially larger density estimate in the 18 minute survey relative to the first 10 minutes, and a sharp increase in detection probability that was apparent both visually and through a breakpoint identified when playback began at 10 minutes. Moreover, the density estimate for Black-capped Chickadee when using the full 18 minute survey period was over three times higher than published breeding density estimates for the species (1.6 birds/ha, versus 0.1 – 0.6 birds/ha reported in the Birds of North America species account). This suggests that birds were being drawn into the point count survey area from outside in response to playback, which violates the crucial point count assumption that there is no movement of birds in or out of the survey area during the survey period (Bibby et al., 2000). We were not able to obtain accurate estimates of the American Goldfinch density using playback. However, based on overall results, we recommend that playback is not only unnecessary, but in some cases it leads to unrealistic density estimates due to violations of point count survey assumptions.

As a result of these analyses, Audubon and U.S. Army Corps of Engineers have chosen to adopt the standard Knutson et al. (2016) point count protocol which utilizes a 10-minute passive listening period starting in May 2019.

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Appendix E: Contributing data to the Midwest Avian Data Center

A primary goal of the project is to establish a coordinated database for avian data which is accessible to Corps districts and the broader research community. We suggest that project data be uploaded to the MWADC, or another regional node of the Avian Knowledge Network (AKN) if applicable. The AKN is a partnership of people, institutions, and agencies focusing on bird and habitat conservation based on data and adaptive management. The AKN has four major goals:

- Foster dialog among scientists, land managers, and stakeholders about the purpose and use of bird monitoring projects and data.
- Improve the quantity, quality, and availability of data for scientific research.
- Advance new analysis and visualization techniques to understand bird population dynamics.
- Provide interactive decision-making tools for land managers.

The AKN has become the primary location for linking observation-based bird monitoring data from all over the Western Hemisphere, and regional nodes provide a number of online tools for habitat managers, conservation practitioners, decision makers, scientists, and the public to visualize and explore project data.

Data can be contributed to the MWADC by registering for an account, and setting up a project by following the steps at http://data.pointblue.org/partners/mwadc/index.php?page=add-data. The Project Leader will describe the project protocol, define the sampling units, designate who has access to the data (for entering and proofing), set the data access level, and determine which individuals can access the entire dataset. It is of paramount importance that the Project Leader understands the data sharing policy of the Midwest Avian Data Center, the access levels, and that the proper access levels are set for project data. A resource guide providing more detailed information on the AKN, MWADC, managing data, exploring data, and other resources can be found at:
http://data.pointblue.org/partners/mwadc/uploads/images/MWADC/MWADC_UsersGuide_V2_FINAL.pdf

Data are entered into the system for the project using the Biologist application. They will have the ability to browse, enter, and proof data. The Analyst application allows the Project Leader and other approved individuals access to tools for retrieving and analyzing the data.

For other questions about the Avian Knowledge Network and Midwest Avian Data Center, please visit these webpages:

- http://www.avianknowledge.net/index.php?page=faqs
- http://www.avianknowledge.net/index.php?page=about-nodes
- https://griffingroups.com/file/view/80047/q-a-about-the-akn-data-management-applications
- https://griffingroups.com/groups/profile/39509/akn-help
- https://www.youtube.com/channel/UC3ktJM4Ddz3k-aClyxtntqg/videos

Appendix F: St. Louis Corps district data management recommendations

Data Policy

The data policy for a project defines the goals and guiding principles for data management. Whether one organization is involved or the project is a partnership involving several organizations, all elements of data management should be clearly defined so that data are up-to-date, accurate, and accessible to the appropriate people or organizations. A goal of the avian monitoring efforts implemented in the St. Louis District is to make project data available to other Corps districts, project partners, and researchers throughout the MWADC or direct contact with the Corps Rivers Project Office.

In the Corps St. Louis District, Audubon has been responsible for data collection, entering and proofing data locally, uploading cleaned data to the MWADC, updating project metadata each monitoring season, archiving and data storage, and providing project data to the Corps for incorporation into existing GIS (Geographic Information Systems) layers. Audubon also works with project partners to analyze the data and develop project reports. As the project is implemented at other locations the data policy will need to be revisited as necessary to ensure that the roles and responsibilities for proper data management actions are clearly identified.

Collection, Capture, and Data Security

A number of measures should be taken to help ensure that the quality and usability of the data remain high throughout the duration of the project, and that a record exists to track any changes that may occur in regards to components or implementation of the monitoring program. This will help to ensure that data maintains the highest value possible over the long-term. Proper training is required to ensure that high quality data is maintained throughout the duration of the project. Audubon uses a combination of pre- monitoring training materials, protocol training, field trials for data collection, bird ID by sight and sound, and distance estimation to ensure all observers are proficient prior to the field season start.

During the monitoring season, survey teams should transfer bird observations from the circle plot form to the front page of the field data form to ensure that observations are legible and accurate for input back in the office. Completed datasheets are returned to the field office within three days of conducting surveys, and project data will be entered into the project database within two days of receiving datasheets to identify any errors as soon as possible. Pictures associated with sampling locations will be submitted to the field office with completed datasheets, and filed and coded in the appropriate folders for the project.

At the end of the monitoring season data should be reviewed again for accuracy and consistency. This will help to ensure that transcription or entry errors are identified and corrected, and to verify that the data are complete. A metadata document describing information at the dataset level including quality, spatial context, data attributes, and distribution of datasets should be filed with project data. A datafile contents document should also be included with the data and contain details on parameter names, units of measure, formats, definitions of coded values, dataset title, author, today's date, date the file was last modified, and companion file names. Using clear terminology will aid data searches by future investigators. A copy of other project materials should be included in the file such as the method used to select points, the monitoring protocol (noting when the details of the protocol have been modified due to revisions or changes in accepted sampling methods), and any other pertinent information. Together these items will help to ensure that data can be clearly interpreted between partner organizations and any other group that has access to the data.

The data custodian(s) for the project should take into account potential risks to data security and how to best mitigate that risk. At a minimum, paper datasheets should be filed and labeled with project date and name, periodic digital backups of project data should be created, and copies housed at multiple locations (ex., host organization, partner organization, MWADC, and possibly a remote web-based database) to reduce risk of loss. An assessment of risks and the costs of mitigating those risks should be performed to develop an acceptable data security plan.

Appendix G: U.S. Army Corps of Engineers fine scale vegetation sampling variables

Finalized in 2008

STATEMENT OF WORK

Forest Resource Survey
Illinois River, Upper River (Pool 24 and 25) and Lower River

1.0 BACKGROUND

A comprehensive forest resource survey (forest inventory) for all of the Rivers Project Office, St. Louis District fee title lands has been identified as a long-standing backlogged need. This type of survey will provide lands managers with the site and stand specific information on diversity, forest health, structure and invasive species needed to make sound management decisions and plans.

2.0 PURPOSE

The purpose of the forest resource survey is to obtain forest resource information on approximately 4,000 acres of land on the Illinois River and approximately 15,500 acres on Upper River, primarily in the Pool 24 and 25 portion, and 3,500 acres in Lower River portion (Chain of Rocks). The information will be used to support forest management decisions, including the development of an environmental sustainability project to sustain and improve the bottomland forest resource. Forest resource data collection shall include basal area per acre, vegetation species, heights, tree diameters, canopy density, tree age and growth rates, number of snag and mast trees per acre, and general forest health classifications.

3.0 OBJECTIVES

The general objectives of this project are:

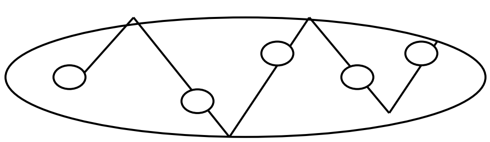
- Establish forest sample plots and obtain geographic coordinate data for each plot center.
- Obtain descriptive forest information from each sample plot (i.e. vegetation species composition, heights, stand age, forest health, site conditions, etc.).
- Obtain a characterization of mid and understory vegetation within the forest.
- Obtain copies of all forest resource survey data in digital format and in an appropriate computer software package.
- Identify and document all invasive plant species on sample plots.

4.0 REQUIREMENTS

1) General Sampling Methods

a) Use data collection GPS units for inventory. The type of GPS units used is up to the Contractor, however a Trimble data dictionary has been established for this application and will be provided to the Contractor if that method is used. Manual data sheets will be used if the Trimble unit is not used and all data will be transferred into a Microsoft Excel file (.xls format) provided to the Contractor by the Government. Prism plot data can be entered on the GPS unit without GPS position as long as a GPS point is created for the fixed plot.
b) Exact land areas to be included in the survey will be provided to the Contractor by the Government with maps, access points and acreages.

2) Plot establishment
   a) Maps provided for fieldwork shall map the boundaries of terrestrial areas as defined by the latest UMESC land cover and Corps fee title. They shall delineate large contiguous areas of non-forested land which are defined as dominated by herbaceous and/or multiple fork shrub species and greater than 15 acres in size. Establish sample grid point locations on the maps with the appropriate spacing for field crew reference. This is for a reference to sampling intensity only, not target locations. These layers should be printed for field reference and may also be downloaded to the gps units.
   b) Systematic sampling will be employed on forested and mixed sampling areas (sampling areas are heretofore referred to as "tracts") in a grid pattern in the field using compass and pacing for determining plot location. Plots will be 5 chains (330) feet) apart thus establishing one plot, on average, for every 2.5 acres. Randomly selected starting plot should be at least one chain inside edge of sampling area. A randomly selected UTM coordinate starting point may be provided to crew to assist in establishment of grid. The most statistically valid way to establish the grid orientation is randomly. Lining the grid up with the prevailing shape or topography of an area will bias the sampling. It may be easier to walk/sample the center of a ridge, but it won't be as random.
   c) Tracts less than 8 chains across in one direction should be sampled using a zigzag pattern. Reference the map to determine/double check the number of points needed to sample the area. A randomly selected starting plot should be at least one chain inside the forest edge. Continue chaining until you reach the tract edge at which point you will turn 90 degrees and continue chaining until you have walked a total of 5 chains since your last plot. See diagram for an example.



   d) Plots need to be completed at location derived from compass and pacing. For example, points falling on the forest edge should be done in place and not relocated further interior to the edge. If inventory plot falls on forest edge, it needs to be documented in miscellaneous column under fixed plot.
   e) Reduced sampling of 1 plot per 10 chains will be conducted for predetermined large and contiguous areas of non-forested land.

3) Forester Field Tools
   a) Wedge Prism/Angle Gauge- Optical device used for estimating basal area and determining "count" trees for the variable radius (or prism) plot. Ten basal area factor will be used. The only difference between the wedge prism and the angle gauge is positioning over plot center. Prism needs to be directly over plot center. With the angle gauge, the observer's eye needs to be directly over plot center.
   b) Clinometer- Hand held instrument for measuring vertical angles to determine tree height. Standing a distance of one chain (66 ft.) from the base of the tree, heights can be measured directly. If there is no line of site to the tree top from one chain, then the height can be estimated from a 33 foot standoff by dividing that resulting value by two.
   c) Loggers tape- Tape will be used to measure standoff distances for clinometer measurements and for measuring the DBH of aged trees. Has tree diameter in inches on one side, and other side measures length in tenths of a foot.
   d) Compass- Used to follow directional transect grid lines to determine where plots are established.
   e) Biltmore stick- Graduated for direct reading of tree diameters at breast height.
   f) GPS- Used to input plot data while recording locations.
   g) Increment borer- Hand operated drill with a hollow bit that extracts a wood core from the stem of a tree. Increment borer will be used to determine age and growth ring index for the age plot.

4) Definitions-
   a) Plot – Geographical area that is used as a point of reference to locate a center or starting point.
   b) Prism – Variable radius plot where area of the plot is directly proportional to the basal area of the tree it represents. Radius of the plot increases as the increase of diameter in tree being surveyed.
   c) Fixed plot – Fixed radius plot is used to sample trees that are less than the specified breakpoint diameter. Fixed plot is an area of a measured distance from plot center to a defined radius.
   d) Age – Annual rings are counted to determine the origin of the tree by extracting an increment core from the tree using and increment borer.
   e) Count tree – Wedge Prism or Angle Gauge is used to determine whether or not the tree is inside the plot radius based on the diameter at breast height of the tree and its distance from the plot center. If the tree is inside the plot radius it is marked as a count tree.

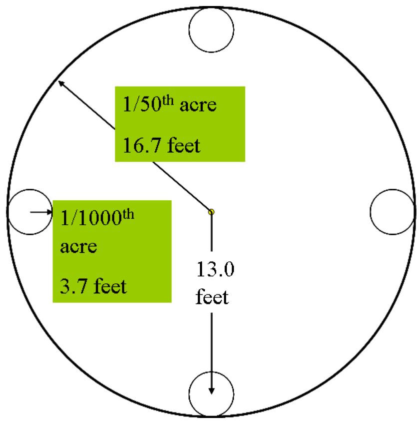
5) The GPS data collection is split into three categories: prism, fixed, and age data. These are listed as separate features in the Trimble data dictionary and labeled as: "Prism", "Fixed Plot", and "Age". Each plot location shall include the collection of prism and fixed plot data. Every 5th plot shall also include the collection of age data.

   a) Prism - The prism data is intended to capture information on the overstory canopy and includes data on count trees in the variable radius plot using a 10 factor prism or angle gauge. The data for each "count" tree will be individually recorded in a separate point or feature on the GPS unit. The GPS point does not need to be collected directly at the count tree but somewhere within the plot vicinity. The following data will be collected for every "count" tree at the plot location. Plots with no count trees shall be documented by recording a Prism feature and selecting "no tree" for the tree species.

i) PL_NUM - Plot number for each prism plot should coincide with fixed plot numbering. All "count" trees within an individual plot will have same plot numbering.
ii) TR_SP - Tree species of "count" tree selected from menu pick list of common names. If there are no count trees in the plot, select "no trees" in this field.
iii) TR_DIA - Measurement of tree diameter at breast height (DBH), 4.5 feet from ground, to nearest inch. Tools that may be used include: diameter tape, logger tape, or Biltmore stick. The US Forest Service timber cruise handbook provides protocols on the measurement of unusual situations or problem trees. If there are no count trees in the plot, select zero for this field.
iv) TR_CL – Tree canopy class menu pick list to include: dominant (top of canopy), co-dominant (top of canopy and similar height to neighbor), intermediate (top of canopy extends into lower canopy of dominant trees), suppressed (top of canopy below bottom of dominant canopy.) If there are no count trees in the plot, select "no trees" in this field.
v) TR_HLTH – Tree health menu pick list to include: healthy, stressed, significant decline, and dead. If there are no count trees in the plot, select "no trees" in this field. Healthy tree has a vigorous canopy with no dieback, epicormic branching, or significant disease. Stressed tree has one of the following factors: dieback comprising of less than 50% or more of the canopy, epicormic branching, defoliation, or significant vine competition. Significant decline has one or more of the following: dieback comprising 50% or more of the canopy, significant epicormic branching, significant defoliation, broken top or major vine competition. Dead tree is a standing stem with no live foliage.
vi) TR_MISC – Miscellaneous comments may be added as necessary allowing up to 60 characters to be entered.
vii) TR_CREW – Select crew leader from pick list. Crew leader's initials will be populated in database.
viii) TR_DATE – GSP automatically populates current date.
ix) TR-TIME – GPS automatically populates current time.

6) Fixed Plot - GPS point will be collected at plot center.
   a) PL_NUM – Plot number starts at one each day for each individual GPS unit. Fixed plot numbers will automatically populate as fixed plots are conducted throughout the day.
   b) OV_CLSR – Overstory closure will be determined through means of ocular estimation in increments of 10 percent for count trees in coverage area over understory prism plots.
   c) OV_HT – Overstory height is the measurement of co-dominant canopy layer using a clinometer within plot area. There is a tolerance level of plus or minus 5 foot in determining tree height.
   d) UND_HT – Understory height average of tree species in an area inside 16.7 feet from plot center. Heights are categorized in feet from a pick list: 5-10, 10-15, 15-20 etc…
   e) UND_COV – Understory coverage noting presence/absence of <u>trees</u> greater than or equal to 2 feet tall and less than or equal to 4 inches DBH in 1/50 acre plot (16.7 radial feet from plot center) and four 1/1000th acre plots (3.7 radial feet) in cardinal directions at 13

feet from plot center (see diagram). Possible scores consist of 0 (no trees in 1/50th acre plot) to 5 (trees in each of small plots and 1/50th acre plot). One point for any regenerating tree stem within 1/50th acre plot and one point for each cardinal direction plot with regeneration present. If regeneration is present in any one cardinal direction plot and nowhere else in the plot, it will still receive a 2 score (one for 1/50th acre and one for cardinal direction).



f) UND_SP1 – Understory species 1 referencing most dominant woody species from menu pick list of woody vegetation greater than or equal to 2 feet tall less than or equal to 4 inches in diameter within 1/50th acre plot.
g) UND_SP2 – Understory species referencing 2nd most dominant woody species from menu pick list of woody vegetation greater than or equal to 2 feet tall less than or equal to less than 4 inches in diameter within 1/50th acre plot.
h) UND_SP3 - Understory species referencing 3rd most dominant woody species from menu pick list of woody vegetation greater than or equal to 2 feet tall less than or equal to less than 4 inches in diameter within 1/50th acre plot.
i) GRD_SP1 – Dominant herbaceous species within 1/50th acre plot. Enter official U.S. Department of Agriculture (USDA) species code. If species cannot be determined, enter the code for Genus or at last resort: family.
j) GRD_SP2 – Second most dominant herbaceous species within 1/50th acre plot. Enter official USDA species code. If species cannot be determined, enter the code for Genus or at last resort: family.
k) GRD_SP3 – Third most dominant herbaceous species within 1/50th acre plot. Enter official USDA species code. If species cannot be determined, enter the code for Genus or at last resort: family.
l) NOT_SP1 – Notable species 1 includes listing species of relative importance in terms of most significance to lesser significance within 1/50th acre plot area for management implications. Species should be listed in following order as they occur in plot area: invasive woody, invasive herbaceous, previously undocumented woody species, and herbaceous species outside of typical bottomland forest vegetation. Enter official USDA species code. If species cannot be determined, enter the code for Genus or at last resort: family.
m) NOT_SP2 – Notable species 2 includes listing species of relative importance in terms of most significance to lesser significance within 1/50th acre plot area for management implications. Species should be listed in following order as they occur in plot area: invasive woody, invasive herbaceous, previously undocumented woody species, and herbaceous species outside of typical bottomland forest vegetation. Enter official USDA species code. If species cannot be determined, enter the code for Genus or at last resort: family.
n) NOT_SP3 – Notable species 3 includes listing species of relative importance in terms of most significance to lesser significance within 1/50th acre plot area for management implications. Species should be listed in following order as they occur in plot area:

invasive woody, invasive herbaceous, previously undocumented woody species, and herbaceous species outside of typical bottomland forest vegetation. Enter official USDA species code. If species cannot be determined, enter the code for Genus or at last resort: family.

o) NOT_SP4 – Notable species 4 includes listing species of relative importance in terms of most significance to lesser significance within 1/50th acre plot area for management implications. Species should be listed in following order as they occur in plot area: invasive woody, invasive herbaceous, previously undocumented woody species, and herbaceous species outside of typical bottomland forest vegetation. Enter official USDA species code. If species cannot be determined, enter the code for Genus or at last resort: family.
p) NOT_SP5 – Notable species 5 includes listing species of relative importance in terms of most significance to lesser significance within 1/50th acre plot area for management implications. Species should be listed in following order as they occur in plot area: invasive woody, invasive herbaceous, previously undocumented woody species, and herbaceous species outside of typical bottomland forest vegetation. Enter official USDA species code. If species cannot be determined, enter the code for Genus or at last resort: family.
q) FP_MISC – Fixed plot miscellaneous comments may be added as necessary. There is space to allow for 60 characters to be entered as necessary. Enter codes from list that other stakeholders would like people conducting inventory to document in the fixed plots as the occasion occurs.
r) FP_Crew – Select crew leader from pick list. Crew leader's initials will be populated in database.
s) FP_Date – GSP automatically populates current date.
t) FP-Time – GPS automatically populates current time.

7) Age – Data on aged tree should be collected every 5th plot with a GPS location taken directly next to the tree.
   a) PL_NUM – Plot number coinciding with prism plot number.
   b) AGE_SP – Species of aged tree. Tree chosen should be representative of the stand within plot area. Tree selection should not be made specifically on ease of reading rings.
   c) AGE_DIA – Diameter measured at breast height to nearest tenth of an inch using a diameter tape. The US Forest Service timber cruise handbook provides protocols on the measurement of unusual situations or problem trees.
   d) AGE_ORIG – Origin year of tree will be recorded. Current year minus ring count on tree core minus 3 years for growth to DBH.
   e) AGE_GRW – Growth rate indexes number of rings within outer 1 inch of tree excluding tree bark.
   f) AGE_MISC – Allows for up to 60 characters to be entered as necessary.
   g) AGE_CREW – Select crew leader from pick list. Crew leader's initials will be populated in database.
   h) AGE_DATE - GSP automatically populates current date.
   i) AGE_TIME - GPS automatically populates current time.

8) GPS/Data Collection Unit

a) Recommend Trimble GPS units, but other data entry GPS would be sufficient.
b) Data could be recorded on paper as long as the plot center was marked with a GPS unit. And the data could be manually entered later.

9) Data Storage
   a) GPS/Data collection units need to be backed-up daily, charged daily, and downloaded daily. Data downloads need to be completely backed up daily on a pc. Long term data storage will include redundant digital storage and hard copy printouts of data.

10) Miscellaneous code list shall be maintained and recorded by field observers. Notable species and other items shall be recorded in the GPS or on data sheets at or in route to work areas similar to the following:
   a) Recommended management 10-19
      i) 10 - harvest recommended
      ii) 11 - timber stand improvement recommended
      iii) etc
   b) Listed species found 20-29
      i) 20- Eagle nest nearby
      ii) etc
   c) Wildlife habitat 30-39
      i) 31- Den tree on plot
      ii) 32 - heron rookery nearby
      iii) etc
   d) Inventory comments 40-49
      i) 40 - plot falls on forested edge
      ii) etc

Appendix H: USACE/Audubon sampling scheme for selection of survey islands and point count survey sites

Modified from the Cornell Lab Conservation Science Program (Crawford et al. 2011).

Selecting Islands

The current project focuses on medium to large sized forested islands. Many of the islands in our study area are relatively narrow and linear in shape. To reduce the effect of edges associated with small and narrow islands, we focused our efforts on larger islands that could accommodate surveys without sampling edge-dominated habitats. This included 11 of the 39 islands in Pool 26 (Figure 1).

Based on the literature and our field survey techniques, we assumed a maximum acoustic detection distance of 150 m. This meant that point count sites must be located at least 150 m from an island's edge to avoid sampling edge habitats. In other words, an island must be at least 300 m wide along its narrowest axis to accommodate a point count site. Using GIS we measured the dimensions of each island and eliminated those that could not support a maximum point count radius of 150 m. Note: in 2013 several new islands were added to the study. Some of these islands violated the "edge rule" because they were too narrow or contained large habitat openings (edges) that could not be avoided. In these cases, the distance from the point count center to the nearest habitat edge was measured and noted as part of the data record. If desired, these points can be analyzed separately from those containing no edge habitats.

Selecting Point Count Sites

Habitat data are being collected by the Corps and its partners in the study area as part of an existing long-term vegetation monitoring program. To take advantage of these habitat data, the selection of point count sites was driven by the location of Corps vegetation sampling points on each island. Vegetation sampling points were stratified by forest type and position within river pools (e.g. upper, mid, and lower). By co-locating point count sites with existing vegetation sampling points, we were able to "layer" avian data with vegetation data to facilitate bird/habitat studies and measure the response to forest management activities. This co-location; however, created some challenges in ensuring that bird survey data among point count sites remained independent, and in making sure that we could tie bird data to silviculturally treated and untreated locations.

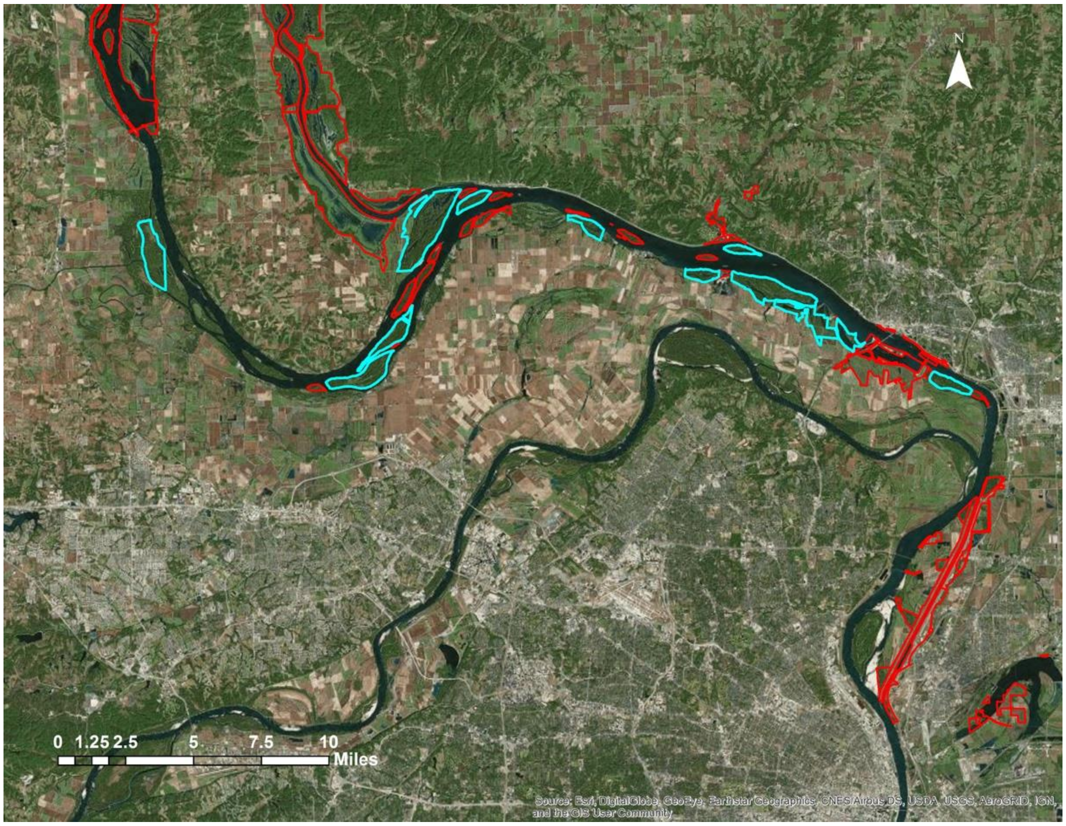


Figure 1. Pool 26 land managed by the Corps. Areas outlined in blue were large enough to fit one or more point count sites during initial site selection.

To standardize selection of point count sites we used GIS to establish a 300 m x 300 m grid over the entire study area and then clipped the grid to conform to the islands of interest (Figure 2). We used a series of rules to guide our selection of points (Table 1). On each island we selected at least one habitat sampling point (hereafter habitat centroid) that was at least 150 m from edge habitat. We then randomly selected two satellite sampling points adjacent to the habitat centroid. These were selected by randomly choosing two of the 8 cells that bordered the habitat centroid cell (Figure 3). In Figure 2 the habitat centroid is labeled “H” and the associated random satellite points are labelled “HS1” and “HS2.” This constellation of “H” points is intended to sample birds within the silivculturally treated zone around the habitat centroid.

To survey birds in untreated forest areas, we randomly selected a new point count site within a cell that was at least 300 m away from the nearest H, HS1, or HS2 cell. Associated with this new Random site, we selected two new satellite point count sites. In Figure 2 these are labelled “R, “RS1,” and “RS2.” The “R” points are meant to sample birds in untreated habitat. On large islands, the process of H and R point selection can be continued until the desired number of points is obtained. On most islands; however, the number of points was limited by the island’s size and shape.

Using the standardize field survey protocol, we conducted avian point counts at all H, HS, R, and RS sites. Because of space constraints, not all R sites were paired with two RS sites. Also, for the same reason, not all islands have “R” sites.

Table 1. Site Selection Criteria- The following rules were used to determine which sites were suitable for point count sampling.

Rule 1: Exclude habitat islands that are too small to fit at least 1 sampling centroid + 2 satellites.
Rule 2: Establishing habitat centroids and satellite sampling points A. First use habitat centroids that are >300 m from edge B. Secondarily use habitat centroids >150 m from edge C. Don’t use centroids <150 m from edge D. Habitat centroids can have 1 or 2 associated satellite points E. Satellite points selected randomly from suitable, bordering grid cells F. When random selection not possible, choose suitable cells
Rule 3: Establishing paired random point and satellite sampling points A. Select random centroid from remaining cells B. Follow rules 2d-f to choose satellites

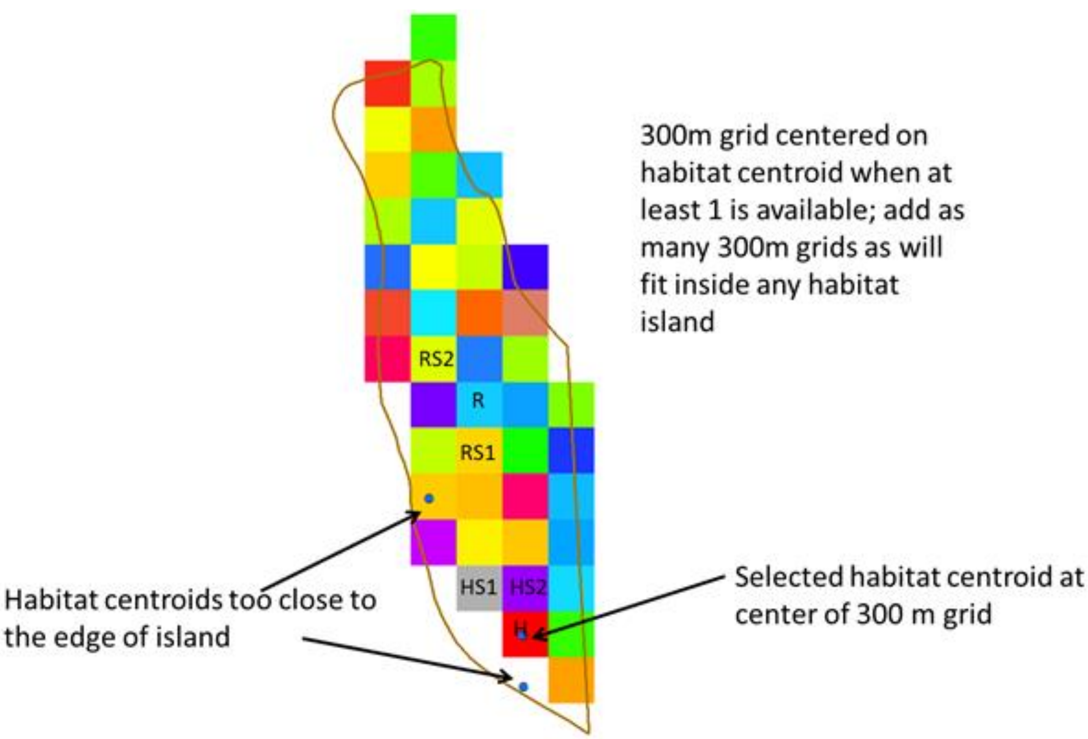


Figure 2. Overlay of 300 m grid on a habitat island. Habitat centroids are selected using the steps outlined in rule 2. (H= Habitat Centroid, HS1= Habitat Satellite 1, HS2= Habitat Satellite 2, R= Random Centroid, RS1= Random Satellite 1, RS2= Random Satellite.

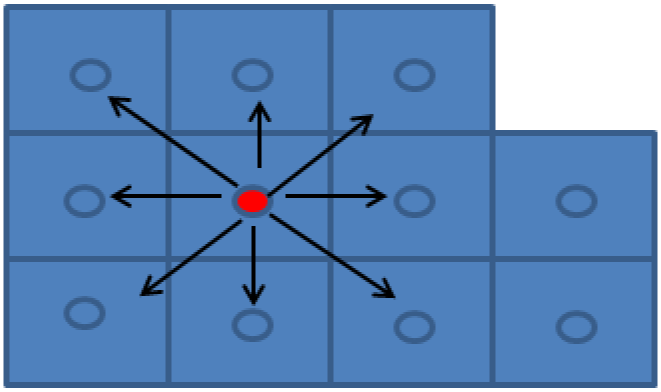


Figure 3: Selection of points: a Habitat or Random centroid (red circle) is associated with 2 random satellite points (hollow circles) that are selected from 8 possible directions (arrows). If a point selected is found to be unsuitable, it is appropriate to use a point from a neighboring grid cell (300m x 300m, see Figure 1), with the following being true:

1. Use Alternate points first if they are available,
2. Use Vacant points 2nd if they are available,
3. Use points from a lower ranked set of points if they are available.

Literature Cited

Crawford, D., R. Rohrbaugh, and J. Lowe. 2011. USACE/Audubon sampling scheme for selection of survey islands and point count survey sites. Cornell Lab of Ornithology Conservation Science Program.