Final Report:
Bald Eagle Nest Monitoring on the Upper Mississippi River, 1990–2012

Photo of bald eagles on nest at Seedskadee NWR by Tom Koerner/USFWS
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Abstract

Nesting activity of bald eagles was monitored in the Upper Mississippi River National Wildlife and Fish Refuge and some adjacent lands, including the Trempealeau National Wildlife Refuge, continuously from 1990 through 2012. The Upper Mississippi River National Wildlife and Fish Refuge occurs along a 261-mile (420-km) stretch of the Upper Mississippi River from approximately Wabasha, Minnesota in the north to Cordova, Illinois in the south, occupying about 244,000 acres (98,743 ha) of land and water occurring in Minnesota, Wisconsin, Iowa, and Illinois (U.S. Fish and Wildlife Service 2006b). The Trempealeau National Wildlife Refuge (Trempealeau NWR) occupies about 6,400 acres (2,589 ha) in Trempealeau and Buffalo Counties in Wisconsin.

Refuge staff and volunteers searched for bald eagle nests on foot, in vehicles, and by boat throughout the entire refuge and some adjacent lands. In at least the early years of the 1990–2012 period, bald eagle nests were also located and observed from an airplane. Every known nest was recorded and revisited each year (as feasible) during the breeding season to classify it as active or inactive. Nests that were classified as active were supposed to be visited again in the same breeding season to determine the presence and number of eaglets. Data were submitted each year to a biologist in the Headquarters Office of the Upper Mississippi River National Wildlife and Fish Refuge for compilation and summarization. A summary report of the monitoring effort, incorporating each year's newly acquired data, was distributed among refuge staff and state, federal, tribal, and private-entity partners on an annual basis.

The 23-year monitoring effort across the Upper Mississippi River generated 5,825 records of 697 bald eagle nests. The number of active bald eagle nests reported increased steadily from 14 in 1990 to 324 in 2012. The number of active nests in 2012 ranged widely by district with 30 in Savanna, 49 in La Crosse, 71 in Winona, and 174 in McGregor. Data from Trempealeau NWR were captured in results reported for the Winona District. The mean annual increase in number of active nests varied by district with a low of 14.2% in the La Crosse District and a high of 33.6% in the Savanna District. The number of inactive nests also increased across the monitoring period, with 80 being observed in 2012. The proportion of active to inactive nests in the peak nesting year of 2012 varied among districts with a high of 94% of nests being classified as active in the La Crosse District and a low of 70% in the Winona District. During the 23-year period, observers recorded at least 2,367 eaglets in or associated with nests on the refuge and adjacent lands, with 501 in the Winona District, 430 in the La Crosse District, 1,054 in the McGregor District, and 382 reported in the Savanna District. The number of eaglets per nest was relatively similar across the four refuge districts (1.35–1.55 eaglets per nest per year).

The data collected during the 23-year period of monitoring served a very important function of capturing information about relatively specific locations of bald eagle nests, which allowed refuge staff to assess the potential for human activities to threaten or disturb nesting bald eagles. However, several limitations in study design, data collection, and the entry and management of data were evident in this survey effort, leading to reservations about the utility and reliability of the resulting dataset. Conclusions that can be drawn from the data are limited

and require nuanced and cautious interpretation. Although every effort was made to check every known nest on the refuge during every year of the monitoring effort (1990–2012), the data should not be considered a total count or census of breeding pairs of bald eagles or active bald eagle nests. In addition, the data may not be suitable for generating a statistical estimate of the number of breeding pairs or active nests. The data would most appropriately be used to generate an index of bald eagle nesting activity, though there are limitations to its effectiveness for this purpose as well. Even with these caveats, trends in the data across space and time were evident and reasonable enough to warrant reporting.

This report serves as a definitive account of the 23-year monitoring effort and summarizes the information that was generated. Additionally, it describes the comprehensive, functional database that was constructed in order to house all of the collected data. This database is available for examination and analysis of its contents. Finally, this report identifies ways in which methods employed during the 23-year monitoring effort likely resulted in some data being inaccurate and unreliable, and offers suggestions for avoiding these problems in future monitoring efforts.

Introduction

In the late 1960s, populations of the bald eagle (*Haliaeetus leucocephalus*) were declining across the contiguous United States. The decline was widely attributed to use of the pesticide Dichlorodiphenyl trichloroethane (DDT), habitat destruction and degradation, and illegal shooting (Broley 1958, Fraser et al. 1985, Stalmaster 1987, U.S. Fish and Wildlife Service 2019a). Because of the decline in the number of bald eagles, the Secretary of the Interior published a Federal Register notice on March 11, 1967 (32 FR 4001) listing bald eagles south of the 40° N latitude as "endangered" under the Endangered Species Preservation Act of 1966. The species previously was partitioned into two races based on the 40° parallel, including a northern race (*H. l. leucocephalus*) that was stable to declining and a southern race (*H. l. alascarius*) that was experiencing precipitous declines. The United States Environmental Protection Agency banned the use of DDT in the United States on December 31, 1972 (U.S. Environmental Protection Agency 2016). The following year, Congress passed the Endangered Species Act of 1973 (16 U.S.C. 1531–1544). In 1978, the bald eagle was listed throughout the contiguous 48 States as "endangered" except in Michigan, Minnesota, Oregon, Washington, and Wisconsin, where it was listed as "threatened" (43 FR 6233, U.S. Fish and Wildlife Service 2019b).

Protection under the Endangered Species Act and the banning of DDT resulted in dramatic increases in the breeding population of bald eagles throughout their range. Based on these developments, on July 12, 1994, the U.S. Fish and Wildlife Service published a proposed rule to reclassify the bald eagle from "endangered" to "threatened" in 43 States where it was classified "endangered" and to retain "threatened" status for the remaining five contiguous (59 FR 35584). The final rule was published on July 12, 1995 (60 FR 36000).

The number of bald eagles continued to increase after reclassification to the point where the U.S. Fish and Wildlife Service no longer believed "threatened" status was needed to sustain populations. On July 6, 1999, the U.S. Fish and Wildlife Service proposed a rule (64 FR 36454) to delist the bald eagle in the contiguous 48 States. The final rule on delisting and the Notice of Availability for the draft monitoring plan were published simultaneously in the Federal Register (72 FR 37346) on July 9, 2007. The population of bald eagles in the Great Lakes Region at the time of delisting was estimated to be about 27,440 individuals (U.S. Fish and Wildlife Service 2016).

Bald eagles are presumed to have nested on the Upper Mississippi River at the start of the 20th century but they were not known to be nesting on the area associated with the current Upper Mississippi River National Wildlife and Fish Refuge was established in 1924 (U.S. Fish and Wildlife Service 1993). Some of the earliest reports of bald eagles nesting on the refuge were from 1964 (in Pool 4) and 1965 (in Pool 9; U.S. Fish and Wildlife Service 1993). The refuge's Comprehensive Conservation Plan (U.S. Fish and Wildlife Service 2006b) reported one active nest being present on the refuge in 1972 while in 1986, nine eaglets were produced in nine nests.

Although removed from the Federal Endangered and Threatened Species List in 2007, the bald eagle remains a high-profile bird that attracts public attention and still is protected by the Migratory Bird Treaty Act and the Golden and Bald Eagle Protection Act. The importance of bald eagles in the conservation history of the United States, their iconic status as a highly-valued "charismatic" wildlife species, the legislative mandates that provide a basis for protection and monitoring efforts, and the conspicuous nature of their nests make them an understandable candidate for monitoring efforts by the U.S. Fish and Wildlife Service, other conservation agencies, and non-governmental entities. Bald eagle nests routinely are monitored by researchers and managers to make inferences about population recruitment, abundance, and productivity, and to assist with recovery or protection of the species (Zwiefelhofer 2007, Elliott et al. 2011, Smith et al. 2016, Cruz et al. 2018). Monitoring of bald eagle nests was specifically identified as an objective in the refuge's Comprehensive Conservation Plan (U.S. Fish and Wildlife Service 2006b). Additionally, bald eagles continue to be an important biosentinel for monitoring chemical contamination of the environment (Dykstra et al 2019).

Bald eagles are an important species of the Upper Mississippi River Valley, especially because of their ecological and societal values (U.S. Fish and Wildlife Service 2006b). They are present and often abundant in the Upper Mississippi River floodplain and surrounding areas throughout the year. The refuge is considered one of the most-visited refuges in the National Wildlife Refuge System and many visitors come specifically to view and photograph bald eagles (U.S. Fish and Wildlife Service 2006b). The National Eagle Center, a non-profit interpretive center, is located near the refuge in Wabasha, Minnesota and draws tens of thousands of visitors to the region each year (https://www.nationaleaglecenter.org/about/).

Monitoring Area and Methods

Monitoring Area

The monitoring area encompassed the Upper Mississippi River National Wildlife and Fish Refuge and some adjacent lands, including Trempealeau NWR, along the Mississippi River from approximately river mile 763 in the north to approximately river mile 503 in the south (Figure 1). The Upper Mississippi River National Wildlife and Fish Refuge was established by Congress in 1924 (U.S. Fish and Wildlife Service 2006b) and currently encompasses about 244,000 acres (98,743 ha). This area corresponds with Navigation Pools 4 through 14 on the Upper Mississippi River (Figure 1). Each Navigation Pool on the River is separated from adjacent pools by a lock and dam and the pool number corresponds to the number of the lock and dam that impounds the water upstream of it. The locks, dams, navigation channel, and water levels within each Pool are managed primarily for the purposes of navigation by the United States Army Corps of Engineers (USACE). The Trempealeau National Wildlife Refuge was established by an Executive Order in 1936 (U.S. Fish and Wildlife Service 2006a) and currently occupies about 6,400 acres (2,589 ha) in Trempealeau and Buffalo Counties in Wisconsin, and is adjacent to Pool 6.

The 261-mile (420-km) stretch of the Upper Mississippi River runs from approximately Wabasha, Minnesota in the north to approximately Cordova, Illinois in the south. The area includes several counties in four states including Houston, Wabasha, and Winona Counties in Minnesota; Buffalo, Crawford, Grant, La Crosse, Pepin, Trempealeau, and Vernon Counties in Wisconsin; Allamakee, Clayton, Clinton, Dubuque, and Jackson Counties in Iowa; and Carroll, Jo Daviess, Rock Island, and Whiteside Counties in Illinois. The refuge represents a significant area of land and water managed for conservation, as well as wildlife-dependent recreation, and has been designated as both a Wetland of International Importance and a Globally Important Bird Area (Secretariat of the Convention on Wetlands 2020, National Audubon Society undated).

The Upper Mississippi River National Wildlife and Fish Refuge currently is administered by four district offices and one Headquarters Office. Each of the four districts has an area of operations corresponding to a set of Navigation Pools on the Mississippi River (Figure 1). The Winona District currently has an office in Winona, Minnesota and includes Pools 4 through 6. The La Crosse District currently has an office in Onalaska, Wisconsin and includes Pools 7 through 8. The McGregor District currently has an office in Prairie du Chien, Wisconsin and includes Pools 9 through 11. The Savanna District currently has an office in Thomson, Illinois and includes Pools 12 through 14. The Headquarters Office currently is located in Winona, Minnesota and provides support for all four district offices and district activities. The Trempealeau NWR has an office located on that refuge near the village of Trempealeau, Wisconsin. From here forward this report will often use the term “refuge” in reference to both the Upper Mississippi River National Wildlife and Fish Refuge as well as Trempealeau National Wildlife Refuge, however, the vast majority of bald eagle nest monitoring efforts described in this report occurred on the Upper Mississippi River National Wildlife and Fish Refuge.

The climate of the region is sub-humid continental with cold, dry winters and warm, moist summers. Average annual precipitation varies from 22 to 34 inches (56 to 86 cm), of which 75% falls between April and September. Average monthly temperatures range from about 11 degrees F (-12 degrees C) in January to 74 degrees F (23 degrees C) in July (U.S. Fish and Wildlife Service 2006b). Most of the surface water within the northern reaches of the refuge freezes solid each winter but some areas remain unfrozen, particularly below locks and dams. In the southern reaches of the refuge a greater proportion of the surface water remains unfrozen through most winters. Land cover within the boundaries of the refuge is characterized by developed upland (18.2%), undeveloped upland (11.8%), grass-sedge wetland (17.7%), lacustrine wetland (18.2%), palustrine wetland (16.5%), and woody wetland (17.7%; data acquired from <https://umesc.usgs.gov/data_library/gis_data/gis_data_page.html>; see Deick et al. 2015 for land cover classification methodology). The floodplain represents a heterogeneous mixture of habitats where groups of islands often are interspersed with the main channel (maintained for commercial navigation), as well as secondary and tertiary channels, backwater lakes that can be isolated or contiguous with flowing channels, and vast open areas of impounded water immediately above locks and dams. The floodplain often is typically bordered by steep, wooded bluffs that rise 100 to 600 feet above the Mississippi River. Tributary rivers and streams intersect the Mississippi River in several locations.

Vegetation communities of the Upper Mississippi River include floodplain forest [e.g., silver maple (*Acer saccharinum*), eastern cottonwood (*Populus deltoides*), elm (*Ulmus* spp.), green ash (*Fraxinus pennsylvanica*), black willow (*Salix nigra*), river birch (*Betula nigra*)]; wet meadows [e.g., extensive areas of predominantly reed canary grass (*Phalaris arundinacea*)]; and communities characterized by emergent aquatic vegetation [e.g., cattail (*Typha spp.*), bulrush (*Bolboschoenus fluviatilis* and *Schoenoplectus spp.*), bur-reed (*Sparganium americanum*), arrowhead (*Sagittaria* spp.), and wild rice (*Zizania* spp.)] (Dieck et al. 2015, U.S. Fish and Wildlife Service 2006b)

Developed areas exist along the entire length of the refuge with cities, towns, and villages located directly adjacent or in proximity to the Mississippi River and the refuge. Transportation corridors for both vehicular and rail traffic typically parallel and occasionally cross the Mississippi River. The main channel of the River serves as a shipping route and supports high levels of barge traffic. Recreational boaters, anglers, and hunters use all aspects of the Upper Mississippi River, including the main channel, side channels, backwater lakes, and open impounded areas.

Abundant fish, which serve as prey for bald eagles, are available in the Upper Mississippi River (Johnson and Hagerty 2008) during the spring, summer, and fall, as well as in the winter in ice-free areas. Abundant waterfowl and other waterbird prey are available during the spring and fall migration periods (U.S. Fish and Wildlife Service 2006b). During the winter, when most of the Upper Mississippi River is frozen, wintering bald eagles concentrate where open water is present, particularly below locks and dams where cold-stressed and injured fish are available after they pass through dam structures. Communal roosts are considered an Important Eagle Use Area (U.S. Fish and Wildlife Service 2013a, Watts and Dyer 2018) and are also present on or adjacent to the refuge (Hall 2004). In landscapes within and near the Upper Mississippi River

floodplain, a substantial amount of scavenging by bald eagles occurs on carcasses of white-tailed deer (*Odocoileus virginianus*) killed by vehicle collisions or un-retrieved by hunters during fall and winter (Warner et al. 2014).

Bald eagle breeding habitat is readily available in the Upper Mississippi River floodplain and surrounding areas. Within the floodplain of Pools 4 through 14 (the extent of the refuge), 55,887 ac (22,617 ha) of floodplain forest are intermixed with backwater lakes, side channels, and open impounded areas (data acquired from https://umesc.usgs.gov/data_library/gis_data/gis_data_page.html). Bald eagles of the Upper Mississippi River nest in a variety of settings, ranging from isolated trees surrounded by non-forested habitat in the floodplain, to trees within or on the edge of larger extensive blocks of forest in the floodplain, as well as within trees in the forested bluffs adjacent to the floodplain. Tree species used to support nests include mature deciduous trees such as eastern cottonwood, silver maple, swamp white oak (*Q. bicolor*), and red oak (*Q. rubra*) (Mundahl et al. 2013). Bald eagle nests can weigh over 2 tons (1.8 mt; Broley 1947) and are considered one of the most conspicuous avian nests in the world (Stalmaster 1987). Adult bald eagles have also been seen occasionally in nests constructed by ospreys on power poles within the Upper Mississippi River floodplain, and in 2020 two eaglets were observed in a nest on a power pole structure at Trempealeau NWR (R. Swanson, personal communication).

Data Collection

Documentation of the methods that were used for collecting data is incomplete, which impedes a full understanding of the consistency of approaches used across the monitoring area and through the duration of the monitoring period. Limited information is available from an early Wildlife Inventory Plan (U.S. Fish and Wildlife Service 1993). One of that plan's stated purposes was to "…document breeding population trends…" and it's stated objectives were to:

- "*…determine the annual number of active breeding territories and nesting success on the refuge (and corridor)*."
- "*…document the trends over time in nesting activity at specific nest sites and on a pool, District, and Refuge-wide basis*."

The 1993 Wildlife Inventory Plan indicated that aerial surveys were the primary method of obtaining information about bald eagle nest activity, and the plane in use at that time, as identified in the plan, was a twin-engine Partenavia (fixed/high-wing) owned and operated by the USFWS. Observations of bald eagle nests were to be conducted "*…if necessary… …to verify aerial data and to locate nests not found by the aerial crew.*"

Additional information is available from a later Inventory and Monitoring Plan for the refuge (U.S. Fish and Wildlife Service 2010) and the methods described in it more closely resemble the methods in use during the final years of the 1990–2012 monitoring period. However, the version of this plan available for examination does not appear to have been completed or to have received all approval signatures, and it is not known to what extent it may have been used to guide monitoring efforts. The 2010 Inventory and Monitoring Plan does not indicate aerial

surveys were to be used for monitoring bald eagle nesting activity and it is not known when between 1993 and 2010 aerial surveys may have been discontinued as a monitoring method. Stated justifications for bald eagle nest monitoring in the 2010 Inventory and Monitoring Plan included:

- Monitoring would support "*Refuge CCP Objective 3.4 Threatened and Endangered Species."*
- *"…population trend analysis that would potentially contribute to national assessments of bald eagle population status."*
- *"…to schedule federal and state construction projects in the floodplain, avoiding sensitive times of the nesting season."*
- *"…data are reported at local civic functions and the public continues to be very interested in seeing the birds and known* [sic] *about them."*

The 2010 Inventory and Monitoring Plan identified a two-phase monitoring strategy whereby in Phase 1 all known nests would be checked at the start of the breeding season (late February through April) in what was termed an "occupancy check" to determine if a nest was active (i.e., occupied) or inactive. In Phase 2, nests that were determined to be active in Phase 1 were to be rechecked later in the breeding season (May through June), when eaglets would likely be present. During the Phase 2 check, the number of eaglets present in the nest was to be recorded with the intent of using these data to determine productivity of eagles within each district and across the refuge. The 2010 Inventory and Monitoring Plan acknowledged the abundance of eagle nests in the McGregor District as justification for rechecking only one-third of the nests in that district that were determined to be active in Phase 1. Furthermore, the 2010 Inventory and Monitoring Plan acknowledged that the other districts may need to employ such a subsampling strategy in the future should eagle nests became similarly abundant. It was stated in the 2010 Inventory and Monitoring Plan that results from such a subsample of active nests in Phase 2 checks could be used to extrapolate productivity results across all nests that were classified as active in Phase 1.

The 2010 Inventory and Monitoring Plan specified that the following data would be collected when a bald eagle nest was detected, observed, or checked:

- Pool number – number of the Navigational Pool in which the record was generated.
- State – state in which the record was generated.
- County – county in which the record was generated.
- Nest number – a unique number assigned to each nest.
- Nest name – a unique name assigned to each nest.
- Year first found – the year in which the first record of a nest was generated.
- Activity – a status code that depicted the activity, inactivity, or status of a nest.
- Young produced – number of young in the nest at the time in which the record was generated.
- GPS coordinates – geospatial location of the nest (UTM Easting and Northing).

- TWP, RNG, SEC – legal description of the location of the nest including the Township, Range, Section, and parcel.

The 2010 Inventory and Monitoring Plan only refers to the status categories of active and inactive (i.e., occupied and unoccupied). No indication was made in the 2010 Inventory and Monitoring Plan whether any nest checked during Phase 1 or Phase 2 could or should be rechecked at a later time during the same breeding season, intentionally or opportunistically, and what should be done if the status (i.e., active or inactive) or information associated with that nest (i.e., the number of eaglets present) differed from what was recorded during any Phase 1 or Phase 2 check. Furthermore, the 2010 Inventory and Monitoring Plan did not specify that a measure of monitoring effort should be recorded, such as the distance driven or the hours expended in conducting the monitoring. The 2010 Inventory and Monitoring Plan also did not specify that the date a nest was checked during Phase 1, Phase 2, or any other time should be recorded, nor did it specify recording the number of times a nest was visited during a breeding season.

Additional insight on the methods used to conduct nest activity monitoring was obtained from personal communication with current and recently retired refuge staff during the period of 2012 through 2020. Insight on methods was also obtained from information available in and provided by the 2012 version of the database that was being used to record data during the final years of the monitoring effort (file name *2012RefugewideEagleNestnad83_FINAL_July2012*, on file at the HQ office of the Upper Mississippi River National Wildlife and Fish Refuge; see Appendix A). Refuge staff and volunteers monitored bald eagle nests by vehicle, foot, and boat. It is not known when the primary survey method switched from the aerial surveys described in the 1993 Wildlife Inventory Plan to the methods described in the 2010 Inventory and Monitoring Plan whereby bald eagle nests were observed by observers in vehicles, on foot, or in boats. Observations were aided by the use of binoculars and spotting scopes. Previous years' data were used to relocate nests in subsequent years. When new nests were located that were not recorded in a previous year, they were added to the dataset as soon as they were discovered at any time of the year. During the 23-year monitoring period, an effort was made to check every known eagle nest but across all years of the monitoring effort an average of 5% of known, standing nests were not checked each year. All known standing nests in the database were checked in 1990 (*n*=25) and 1993 (*n*=43). The number of unchecked nests typically was <5% from 1990 to 2005 and typically <10% from 2006 to 2012. In 2008, 16% of all known nests (*n*=325 known nests) in the database were not checked. The database didn't provide information about why individual nests were not checked but discussions with current and retired staff did. These include limitations on staff and volunteer resources as the total number of eagle nests increased dramatically during the period of monitoring, as well as hazardous conditions on the river that would have prevented the use of boats to access nesting areas in some years and locations.

Original Data Entry and Management

Data for all eagle nests on the refuge were entered and stored in a MS Excel spreadsheet database at the refuge Headquarters Office. Before the start of Phase 1 nest checks, a biologist from the refuge Headquarters Office distributed the database containing all data from the previous years' monitoring effort to the district staff. This database was used by district staff to locate all known nests and update the Phase 1 activity status of each checked nest during that year. The same database was used during Phase 2 checks to update the information about eaglets at each nest. After data were collected in Phase 1 and Phase 2, an updated database was submitted by each district, usually by July, to the biologist in the Headquarters Office for refuge-wide compilation of data. When the Headquarters Office biologist found records that were confusing, incomplete, or potentially incorrect, every effort was made to contact the district staff for clarification and, if necessary, correction. Appendix A provides a depiction of the data contained in the 2012 version of the database (file name *2012RefugewideEagleNestnad83_FINAL_July2012*; on file at the HQ office of the Upper Mississippi River National Wildlife and Fish Refuge).

The 2010 Inventory and Monitoring Plan specified the collection of data on 10 variables (listed previously), but data for the following variables were also recorded and captured in the 2012 version of the database: Brdg Area (breeding area), River Mile, Distance from River, Year (entries in this field captured status codes for each nest in each previous year that nest was present during the entire monitoring period), and Comments. While the 2010 Inventory and Monitoring Plan specified that nests were to be classified as active or inactive, the 2012 version of the database also contained a much larger set of status codes with definitions that were to be used by data collectors to assign a status to each nest when it was checked (see rows 4–6 in the spreadsheet depicted in Appendix A). The status codes and associated definitions in the 2012 version of the database were:

- A0,1,2,3 = Nest active, adult incubating, number of young fledged
- AX = Nest active, adult incubating, unknown number
- # of young fledged
- A? = Nest active , adult incubating, no data on young
- I = Nest inactive
- NF = Nest not found
- UK = Unknown nesting activity
- NC = Nest not checked
- NP = New pair using nest in old territory
- OC = 1 or more adults present but not incubating, or repaired nest
- G = Nest gone
- R = Nest remnant
- T = Nest tree gone
- OS = Opsrey in nest
- OW = Owl in nest

- HA = Red-shouldered hawk nest

Ultimately, the 2012 version of the database contained a total of 53 unique nest status codes to describe observed nesting activity. While working with the data, and after talking with refuge staff, it became evident that several of the status codes were being used in an inconsistent and ambiguous manner. Several status codes probably represented best guesses by staff to interpret ambiguous information or capture additional information that wasn't specified for capture in the 2010 Inventory and Monitoring Plan. In discussions with current and former refuge staff, it was realized that the A? status code was likely often used when the data recorder or the person entering the data had reservations or uncertainty about the true status of the nest that had been checked, regardless of whether the nest was checked in Phase 1, Phase 2, or any other period of the breeding season.

The 2012 version of the database was not structured in a manner that would enable it to effectively capture all useful information and allow the data to be assessed and analyzed effectively or efficiently. Data structuring did not allow filtering, sorting, the use of pivot tables, or the calculation of summary statistics. For example, data from each individual nest check during Phase 1 or Phase 2 in each year was collapsed into a single cell entry within a field representing status. Therefore, A0, A1, AX, and A? could all represent information collected during both Phase 1 and Phase 2, or just information collected during either Phase 1 or Phase 2, or even data collected outside of Phase 1 and Phase 2. Similarly, each entry for Distance from River included both a numerical value for distance as well as a cardinal or intercardinal direction (N, NE, E, SE, etc.).

The methodology used to collect data affects how the data can subsequently be analyzed the conclusions that can be drawn. Opportunity or convenience sampling was apparently being conducted and there is no way to know, based on information in the 2012 version of the database, to what extent this may have occurred. For example, at any time during the breeding season, the activity status of a nest could have been changed regardless of what activity status may have been first assigned during a Phase 1 or Phase 2 check. If a Phase 1 check determined that a nest was active, and a subsequent Phase 2 check could not determine if eaglets were present, the status of that nest may have been recorded as A0, AX, or A? at the conclusion of Phase 2. If a refuge staff or volunteer happened to see that nest after the conclusion of Phase 2 and was able to identify eaglets in the nest, the status code in the spreadsheet was revised accordingly (i.e., to A1, A2, or A3). Another example would be if a nest was checked during Phase 1 and determined to be inactive. If a refuge staff or volunteer subsequently saw an adult bald eagle and/or eaglets on the same nest at any time during the breeding season, the activity status for that nest could have been changed to AX, A?, A0, A1, A2, or A3.

Perhaps the most consequential factor in how these data can be used was realized upon discussion with current and former refuge staff. For an unknown period, the four districts used three different sets of criteria for classifying a nest as active:

- **Winona District -** An adult eagle was seen on a nest or an eaglet was seen in a nest.

- **La Crosse District -** An adult eagle was seen on a nest, an eaglet was seen in a nest, or an adult eagle was seen in the same tree as a nest.

- **McGregor District -** Both staff and volunteers considered a nest active when an adult eagle was seen on a nest or when eaglets were seen in a nest. Volunteers also considered a nest active when an adult eagle was seen in a tree near a nest, or when an adult eagle was in flight and behaving aggressively toward the observers.

- **Savanna District -** An adult eagle was seen on a nest or an eaglet was seen in a nest.

We do not know how long these criteria were used prior to the period when current and former refuge staff were consulted.

Database Construction and Refinement

In an initial attempt to construct a comprehensive and more functional database, an undergraduate student at Saint Mary's University in Winona, Minnesota reconfigured all data in the 2012 version of the database by cutting, copying, and pasting into a new database (file name *20150812 - bald eagle data 1990-2012*; on file at the HQ office of the Upper Mississippi River National Wildlife and Fish Refuge). This work was completed in 2015 and resulted in a database that was structured in a manner that would facilitate operations such as filtering, sorting, pivot tables, and calculation of summary statistics. A preliminary version of the 2015 version of the database was used in a Senior Thesis by the Saint Mary's University student (O'Neill 2014). The final 2015 version of the database contained a total of 5,825 records in which each record represented information from a single nest in a single year. Appendix B provides a depiction of the data contained in the 2015 version of the database.

In 2018, the 2015 version of the database was provided to staff at the University of Wisconsin - Stevens Point for a quality assurance assessment, further refinement, and summary analyses. The quality assurance assessment of the 2015 version of the database included reviewing and verifying every line and entry of data, as well as randomly selecting 5% of the 5,825 records (n = 291 records) and comparing them to data in the 2012 version of the database. No inconsistencies were observed in the comparison of the 291 records between the 2012 version of the database and the 2015 version of the database.

Database Construction and Refinement – Nest Activity and Eaglet Index Codes
Following the quality assurance assessment, a final version of the database was constructed and revised. A portion of the refinement included reclassifying nest activity codes and eaglet index codes. During the monitoring that occurred from 1990 through 2012, refuge staff and volunteers created 53 unique nest status codes to describe observed nesting activity (see Appendix C). After consultation with current and former refuge staff, a smaller number of Nest Activity Codes and Eaglet Index Codes were used to reclassify the original codes (see Appendix C):

Nest Activity Codes used in the final version of the database:

- A= active
- I = inactive
- G = gone
- No data = no data were available

Eaglet Index Codes used in the final version of the database:

- 0 = 0 eaglets observed
- 1 = 1 eaglets observed
- 2 = 2 eaglets observed
- 3 = 3 eaglets observed
- No data – no data were available

Based on the original activity status, we classified a nest as "active" (A) if the original status label clearly indicated an active nest, dependent on district methods. We classified a nest as "inactive" (I) if it had been active in a previous year, remained intact, and no longer was active. We classified a nest as "gone" (G) if a previously active nest was damaged beyond use, missing from the tree, or the nest tree itself was no longer standing. We used a conservative approach when reviewing and reclassifying the data. We reclassified ambiguously labeled nests as "no data." We also reclassified nests in all years following a classification of "gone" due to staff no longer monitoring the nests as "no data." We conservatively reclassified nests in each year to avoid including any data that had potential of being misinterpreted. We added a new field, "EagletIndexCode" to the final version of the database to represent the number of eaglets observed in a nest based on the original activity status. We entered a numeric value (e.g., 0, 1, 2, or 3) when the recorded activity status was quantified with the number of eaglets observed in a nest. We entered "no data" in cases of a missing nest, an unusable nest, or ambiguity in the recorded activity status. Examples of ambiguity include status codes such as A?, AX, and UK.

Database Construction and Refinement – Geographic Locations of Nests

Location data were recorded for each nest in the form of legal and geographic descriptions. The legal descriptions of each nest location included the state, county, township, range, section, and cardinal or intercardinal location within the parcel. Geographic locations consisted of an easting and northing, as well as the pool number in which the nest was located, breeding area, closest river mile, and an estimate of the distance in miles from the nest to the main channel of the Mississippi River. When possible, GPS coordinates were recorded for each nest. All GPS receivers and GISs used the Universal Transverse Mercator (UTM) coordinate system (Zone 15) projected with the 1983 North American Datum (NAD 83). Exact locations (with GPS coordinates) were provided for about 82% of the 697 nests observed during the duration of the monitoring effort. No GPS coordinates were recorded for 8.8% (n=59) of the nests observed.

GPS coordinates were recorded from locations nearby but not directly at the nest in 9.2% (n=62) of the instances when nest checks were recorded. An example of why this may have occurred is when an expanse of shallow water prevented a boat from reaching a nest site and GPS coordinates at the immediate nest site could not be obtained. In such an instance such as that,

GPS coordinates may have been captured at the location of the boat. Notes recorded in the "Comments" field sometimes included the recorded distance and direction of the boat from nest. In some cases, reported GPS coordinates represented implausible locations when projected in a GIS (e.g., a nest location occurring within the main channel of the Mississippi River). When possible, GPS coordinates of nests were rectified by carefully examining coordinates of nests visible in the GIS layer or other aerial images. Rectified locations often were confirmed through subsequent communications with district staff.

We added a field titled "LocReclass" to the final version of the database to characterize confidence in the reported geographic locations of nests based on comments associated with the nests (Appendix D). We reclassified coordinate data for nests that contained clarifying comments in this field as either "ambiguous data" if the geographic information seemed uncertain, or "reliable data" if comments simply confirmed that geographic information was recorded at the nest. After correcting and adding these entries, we thoroughly examined each entry in the database. For every case in which a single "NestCode" was applied to two or more different nests, we corrected the duplicate identification.

Database Construction and Refinement – Database Fields (Columns)
The following is a comprehensive list of every individual field (column), along with information about what is contained within each field, of the final version of the final version of the database. The information about what is contained within the field is identical, or nearly so, to information contained within comments inserted in the field header cells of the database.

State: the state that the nest was located in.

County: the county that the nest was located in.

District: the District of the Refuge that the nest was located in.

PoolNum: the PoolNum identifies the closest navigation pool of the Mississippi River to the nest's location. Note that Pool 5A in the Winona District has been assigned the PoolNum 5.5 to facilitate sorting in a spreadsheet.

NestCode: a unique identification code for each individual nest. Nestcode was not recorded or assigned during original data collection or data entry efforts, and was not part of the original database. NestCode was assigned during construction of the 2015 version of the database based on available information in the 2012 version of the database. NestCode consists of a two-character code for the State the nest was located in, followed by a multi-character code for the County the nest was located in, followed by a four or five character code corresponding to NestNum. NestNum is a sequential number or combination of a number and character that provides information about when a nest was originally found and whether it was believed that nest was part of a BreedArea that represented multiple nests used by the same unique pair of breeding eagles.

YearFound: the year a nest was originally discovered and entered into the original database.

RecordYear: the year that the nest was checked and the entry was made.

BreedArea: a designation assigned by refuge staff during original data collection or data entry that attempted to quantify whether a nest, or multiple adjacent nests through time, were used by what was presumed to be the same breeding pair of eagles. It was presumed that each BreedArea designation represented a single unique breeding pair of eagles. Multiple nests, each with a unique NestCode, could be part of the same BreedArea if it was presumed that the same breeding pair of eagles used the individually unique nests.

BreedAreaName: the BreedAreaName was assigned by refuge staff during original data collection and data entry efforts and contains additional descriptive information about the location of the BreedArea.

NestNum: a number or a combination of numbers and characters that was assigned by refuge staff during original data collection and data entry. Note that NestNum codes are not unique to individual nests; the same NestNum codes could have been used in multiple states, refuge districts, counties, and pools. Within BreedArea, NestNum may indicate that refuge staff thought adjacent nests were successively lost or abandoned and replaced by the use or construction of another nest by the same unique pair of breeding eagles.

Status: the status code assigned to each nest each year by Refuge staff during original data collection and data entry efforts. Status codes were used to represent a variety of information types, including but not limited to: current activity level of the nest (based on activity criteria of each District), possible information about degradation of the nest or the tree the nest was located in, occupants of the nest other than eagles, the number of eaglets present, and whether or not the nest was checked in that year.

Status codes represent information that could have been obtained during Phase 1 checks, Phase 2 checks, or a combination of information from both Phase 1 and Phase 2 checks. Status codes could also represent information from any time a nest may have been checked outside of Phase 1 or Phase 2. Information in the Status column has been reclassified to be more concisely conveyed in the NestActivityCode & NestIndexCode columns.

NestActivityCode: includes an updated classification of nest activity based on the original Status designation: Active (A) if a nest was currently in use, based on activity criteria of each District; Inactive (I) if a nest was active in a previous year, but was no longer occupied and in use by bald eagles (based on activity criteria of each District); Gone (G) if a nest was irreparably damaged, no longer present in the tree, or if the tree itself was no longer standing; "no data" was entered if the nest was not checked that year, if a nest was designated as Gone (G) in a previous year, or if the original status code was too ambiguous to confidently interpret. Information in the NestActivityCode could have been obtained during Phase 1 checks, Phase 2 checks, or a combination of information from both Phase 1 and Phase 2 checks.

EagletIndexCode: was derived from the original Status designation. A number (i.e., 0, 1, 2, or 3) indicates the number of eaglets observed in nest in that year. An entry of "no data" was entered in the absence of production data in the original status code. Information in the EagletIndexCode could not have been obtained during Phase 1 checks because eaglets would not have been present during the period those checks occurred. It could represent information that could have been obtained during Phase 2 checks or any time after a Phase 2 check was made but eaglets still may have been present.

Easting: the eastward measurement of location (the x-coordinate). All GPS receivers and GISs used the Universal Transverse Mercator (UTM) coordinate system (Zone 15) projected with the 1983 North American Datum (NAD 83).

Northing: the northward measurement of location (the y-coordinate). All GPS receivers and GISs used the Universal Transverse Mercator (UTM) coordinate system (Zone 15) projected with the 1983 North American Datum (NAD 83).

Comments: these are comments made by refuge staff during original data collection or data entry efforts. Note that when comments occur in this database they occur for every record of an individual nest. This is an artifact of transferring data from the *2012RefugewideEagleNestnad83_FINAL_July2012* database. In that database, all of the information for each individual nest was recorded in one row, with one cell containing a comment for that nest (see Appendix A). Based on that database structure and format, it was not possible in many instances to know if that comment applied to when that nest was checked during a single year, to multiple years, or all years of record. When constructing the current database, the same comment was entered in the database for every year of record for a nest.

LocReclass: this is a field used to designate entries in which the geospatial information entered in the original database is considered too ambiguous to be reliable. This was usually based on information contained within the Comments column that suggested the data may be inaccurate, questionable, or incorrect.

TWP: this is the Public Land Survey System Township designation the nest was located within. This information was recorded by refuge staff during original data collection and data entry efforts and was entered inconsistently but most often during early years of data collection when GPS technology was not readily available.

RNG: this is the Public Land Survey System Range designation the nest was located within. This information was recorded by refuge staff during original data collection and data entry efforts and was entered inconsistently but most often during early years of data collection when GPS technology was not readily available.

SEC: this is the Public Land Survey System Section designation the nest was located within. This information was recorded by refuge staff during original data collection and data entry efforts

and was entered inconsistently but most often during early years of data collection when GPS technology was not readily available.

Parcel: this is the Public Land Survey System Parcel designation the nest was located within. This information was recorded by refuge staff during original data collection and data entry efforts and was entered inconsistently but most often during early years of data collection when GPS technology was not readily available.

RiverMile: is the closest Mississippi River Mile (or sub-mile) that the nest is located near. This was recorded by refuge staff during original data collection or data entry efforts and was done using U.S. Army Corps of Engineers navigation charts or refuge pool maps.

DistRiver: this is an indicator of how many miles the nest is located from the main channel of the Mississippi River, as well as an indication of the associated cardinal, and sometimes ordinal, direction. This data was recorded during original data collection and data entry efforts by refuge staff. Note that it is not known if refuge staff were originally recording cardinal/ordinal directions from the nest to the river, or from the river to the nest, in a consistent manner. This information for individual nests has not been checked against GIS analyses of nest geospatial data (i.e., Easting and Northing) and Mississippi River land cover data.

RecordEntryDate: this the date (dd-mmm-yy) when a record was cut/copied and pasted from the 2012 version of the database into the 2015 version of the database. A preliminary draft of the 2015 version of the database was used in the following Senior Thesis:

O'Neill, J.M. 2014. Spatial analysis of nesting bald eagles (*Haliaeetus leucocephalus*) in the Upper Mississippi River National Wildlife and Fish Refuge. Senior Thesis. Saint Mary's University. Winona, Minnesota, USA.

RecordEnterer: these are the initials of the person who cut/copied and pasted the record from the 2012 version of the database into the 2015 version of the database.

RecordProofDate: the date (dd-mmm-yy) when a record was proofed after being cut/copied from the 2012 version of the database and pasted into the 2015 version of the database. Proofing was done to ensure data was correctly placed within the 2015 version of the database.

RecordProofer: these are the initials of the people who proofed the data after it was cut/copied and pasted from the 2012 version of the database into the 2015 version of the database. Proofing was done to ensure data was correctly placed within the 205 version of the database.

RecordProof2: this is the date when 5% of the records in the 2015 version of the database were proofed again by comparing them to the 2012 version of the database. This was conducted when the data was received by the Wisconsin Center for Wildlife staff.

RecordProofer2: these are the initials of the Wisconsin Center for Wildlife staff member who conducted the proof of 5% of the records in the 2015 version of the database against the 2012 version of the database. This was conducted when the data was received by the Wisconsin Center for Wildlife staff.

The final comprehensive database is available in the U.S. Fish and Wildlife Service's Service Catalog (ServCat), a secure, centralized web application that compiles, organizes, and archives biological information such as reports, databases, and geospatial data (see https://www.fws.gov/Refuges/NaturalResourcePC/IandM/serviceCatalog.html). The tabular dataset represented by the comprehensive database containing bald eagle nesting activity information has been assigned the ServCat Code 115659 and can be accessed at <https://ecos.fws.gov/ServCat/Reference/Profile/115659>.

Geodatabase Construction

We constructed a GIS geodatabase using ArcMap 10.5 to capture geospatial information about the monitoring of eagle nests from 1990 through 2012. The projected coordinate system of the geodatabase was set as NAD 83 UTM Zone 15N, with a Transverse Mercator projection. Individual nests with known geographic locations were digitized and are contained in the feature class *Nest_Loc_All*. Boundary layers of the Upper Mississippi River National Wildlife and Fish Refuge and Trempealeau National Wildlife Refuge are included as the *UMRNWFR_refuge_boundary* feature class and the *TrempealeauNWR_refuge_boundary* feature class. Both boundary layer feature classes are from approximately 2012 but the exact date of their creation is unknown because of uncertainty associated with refuge records. Finally, we created a map document that depicts the data contained within the geodatabase. The final geodatabase (.gdb file) and accompanying map (.mxd file) are available in the U.S. Fish and Wildlife Service's Service Catalog (ServCat Code 115662; https://ecos.fws.gov/ServCat/Reference/Profile/115662)

Results

The following information and summary statistics were obtained from the final version of the database. During the 1990 through 2012 monitoring period, an average of 5% of nests that were known to exist were not checked each year. All known nests in the database were checked in 1990 (n=25 known nests) and 1993 (n=43 known nests). During the 1990 through 2005 portion of the 23-year monitoring period, the number of unchecked nests was typically <5% each year; during the 2006 through 2012 portion of the monitoring period the number of unchecked nests was typically <10%. In 2008, 16% of all known nests (n=325 known nests) in the database were not checked.

During the 23-year monitoring period, the number of active nests increased in all four refuge districts (Figure 2). The Winona District had 5 active nests in 1990 and 71 active nests in 2012

(Table 1), for an overall increase of 1,420% and a mean annual increase of 16.3%. The La Crosse District had 5 active nests in 1990 and 49 active nests in 2012 (Table 1), for an overall increase of 980% and a mean annual increase of 14.2%. The McGregor District had 3 active nests in 1990 and 174 active nests in 2012 (Table 1), for an overall increase of 5,800% and a mean annual increase of 22.3%. The Savanna District had 1 active nest in 1990 and 30 active nests in 2012 (Table 1), for an overall increase of 3,000% and a mean annual increase of 33.6%. Across the entire refuge, the number of active nests increased from 14 in 1990 to 324 in 2012. Table 2 provides the annual change in the number of active nests in each refuge district, and the percent annual change in the number of active nests in each district during each year of the 23-year monitoring effort.

Several nests became inactive after years of activity. As more new nests were established, we observed more nests becoming inactive (Figure 3, Table 3). The McGregor District, which had the most active nests in 2012, also had the most inactive nests at the end of the monitoring period, followed by the Winona District. In the later years of the monitoring period, the Savanna District had more inactive nests than the La Crosse District, despite the La Crosse District having more active nests. Across the entire refuge, the number of inactive nests increased from 3 in 1990 to 80 in 2012.

The proportion of active to inactive nests varied greatly among districts. In 2012, the McGregor District had 174 active nests and 40 inactive nests (81% active), compared to Winona in 2012, which had 71 active nests and 30 inactive nests (70% active). In 2012, the proportion of inactive nests in the Savanna District was similar to that in the McGregor District, with 30 active nests and 7 inactive (81% active). The La Crosse District had the highest proportion of active nests in 2012, with 49 nests active and only 3 inactive (94% active) (Figures 4 and 5).

Refuge staff and volunteers observed 2,367 eaglets during the 23-year period, with 501 observed in the Winona District, 430 observed in the La Crosse District, 1054 observed in the McGregor District, and 382 observed in the Savanna District (Figure 6, Table 4). Across the entire refuge, the number of eaglets observed increased from 19 in 1990 to 204 in 2012. The number of eaglets observed per nest per year was relatively uniform among districts (Figure 7). The McGregor District had the highest average index of eaglet observations (1.66 eaglets per nest per year), followed by the Savanna District (1.5), the La Crosse District (1.44) and the Winona District (1.35). Over the entire monitoring period, the greatest proportion of all observed eaglets were in the McGregor District (45%), followed by the Winona District (21%), the La Crosse District (18%), and the Savanna District (16%; Figure 8).

Discussion

The data collected during the 23-year period of monitoring served a very important function of capturing information about relatively specific locations of bald eagle nests, which allowed refuge staff to assess the potential for human activities to threaten or disturb nesting bald eagles. This addresses one of the justifications for monitoring provided in the 2010 Inventory

and Monitoring Plan (U.S. Fish and Wildlife Service 2010) whereby the monitoring results could be "…used to schedule federal and state construction projects in the floodplain, avoiding sensitive times of the nesting season."

However, the data collected across the 23 years appear less reliable for addressing another justification for monitoring provided in the 2010 Inventory and Monitoring Plan: "…population trend analysis that would potentially contribute to national assessments of bald eagle population status." The data collected are probably best considered indices of bald eagle nesting activity (index of active nests; index of eaglet abundance) and not as total counts (i.e., a census) of active nests or total counts of eaglets. Nor should they be considered statistical estimates of total active nests or statistical estimates of total eaglets produced. The number of monitored nests that were classified as "active" during any year may have been less than the number of nests that truly were active. It also is likely that some nests were classified as "inactive" that were in fact active.

It should be noted that use of the term "active" in this 23-year monitoring effort differs from that term's use and definition in the Post-delisting Monitoring Plan for the Bald Eagle (*Haliaeetus leucocephalus*) in the Contiguous 48 States (U.S. Fish and Wildlife Service 2009). The post-delisting monitoring plan emphasized the following with regards to terminology: "Standard terminology for describing the status of bald eagle nests and territories is essential, especially if a meaningful comparison is to be made of the data collected by different workers over many years and throughout the nation." In the post-delisting monitoring plan, an "active" nest is defined as: "A nest where eggs have been laid. Activity patterns are diagnostic of breeding eagles (or those with an "active" nest). This category excludes non-nesting territorial pairs or eagles that may go through the early motions of nest building and mating, but without laying eggs." Furthermore, the post-delisting monitoring plan defines an "occupied" nest as: "Any nest where at least one of the following activity patterns was observed during the breeding season:

- a recently repaired nest with fresh sticks or fresh boughs on top;
- one adult sitting low in the nest, apparently incubating;
- one or two adults present on or near the nest;
- one adult and one bird in immature plumage at or near a nest, if mating behavior (display flights, nest repair, coition) was observed;
- eggs were laid (detection of eggs or eggshell fragments);
- any field sign that indicate eggs were laid or nestlings hatched; or
- young were raised"

In the post-delisting monitoring plan (U.S. Fish and Wildlife Service 2009), the term "occupied" is a relatively broad category that includes nests which can be simultaneously categorized as "active", but it also includes nests that cannot be simultaneously categorized as "active". In the 23-year monitoring effort we describe in this report, the term "active" was applied to nests that often would have been categorized as "occupied" according to the definitions of the post-delisting monitoring plan, but not simultaneously categorized as "active" according to that plan.

However, the latest revision of federal regulations regarding the take of eagle nests included revisions to the terms used to describe eagle use of nests and the activity of eagles associated with nests (50 C.F.R. 22 Revised as of December 16, 2016):

> *Nests that are not currently being used for reproductive purposes are defined as ''alternate nests,'' while nests that are being used are ''in-use nests.'' Some commenters suggested the latter be called ''occupied nests,'' but we believe that term would cause confusion because nests are in use for breeding purposes prior to being physically ''occupied'' by nestlings or an incubating adult. An ''in-use nest'' is defined as ''a bald or golden eagle nest characterized by the presence of one or more eggs, dependent young, or adult eagles on the nest in the past 10 days during the breeding season.'' This definition includes the period when adults are displaying courtship behaviors and are building or adding to the nest in preparation for egg-laying. We define ''alternate nest'' as ''one of potentially several nests within a nesting territory that is not an in-use nest at the current time.'' When there is no in-use nest, all nests in the territory are ''alternate nests.''*

We did not pool and analyze data for the entire refuge because three different sets of criteria were used by the four refuge districts to classify a nest as active or inactive with regards to the presence or absence of an adult bald eagle. The McGregor District used the most inclusive, least restrictive set of criteria compared to the other districts and the data from the McGregor District differs markedly from the data obtained from the other three districts. Whether this is because of the difference in data collection methodology that was used, or because there truly was a difference in the amount of eagle nesting activity, is unknown. The methods and criteria used to monitor nesting activity of bald eagles described in the 2010 Inventory and Monitoring Plan (U.S. Fish and Wildlife Service 2010) appear to have been used in two of the refuge districts, whereas in the other two refuge districts additional, more inclusive and less restrictive criteria were also employed. This was confirmed during conversations with current and former refuge staff. However, current and former refuge staff were either unable to recall how far back in time the multiple methods were used, or they were not present as staff members in the earlier periods of the 23-year monitoring effort.

In addition to the issue of different criteria for activity status being used by different refuge districts, several other issues were evident in the data collection and data entry methodologies that make it difficult to draw conclusions about trends in bald eagle nesting activity. One issue is the non-probabilistic nature of the data collection efforts. Many bald eagle nests were located in areas where they were easily observed by refuge staff or volunteers during travel on roads or on the Mississippi River. Regardless of whether a nest had been checked in Phase 1 or Phase 2, if that nest was subsequently observed during the breeding season and satisfied the criteria for "active," or if it was seen to contain eaglets, data were accordingly updated for that nest during that year. For example, if a nest was checked in Phase 1 and classified as "inactive," then it was not intentionally checked during Phase 2. If that nest was coincidentally or opportunistically observed at any later time during the period of the breeding season when eaglets could have been in the nest, and eaglets were in fact observed to be present, the database was updated so

that the nest was classified as “active” and the number of eaglets associated with the nest was recorded. Thus, nests that were more likely to be observed several times during the breeding season were more likely to be classified as “active” and more likely to have eaglets recorded as being present. Conversely, nests that were in more remote and inaccessible locations, and farther from well-traveled areas such roads routinely travelled by refuge staff or volunteers, were less likely to be checked subsequent to the Phase 1 and Phase 2 data collection efforts. This type of sampling methodology has been described as convenience, opportunistic, or haphazard sampling (Anderson 2001, Nusser et al. 2007, Pierce et al. 2012) and should not be utilized in monitoring efforts, in part because of the bias that can result (Pierce et al. 2012). Finally, some refuge staff reported there were years when nests weren’t checked during or according to Phase 1 and Phase 2 periods, they were just checked when staffing resources were available that permitted checking of nests.

The dataset does not quantify the amount of effort expended (e.g., km of survey route, hours of survey effort, number of times a nest was checked) during any nest monitoring activities, so the effect of monitoring effort is unknown. During the early years of the data collection period, all or most nests classified as active in Phase 1 may have been checked again in Phase 2. Relatively few bald eagle nests existed during the early years, so checking each nest that was classified as “active” in Phase 1 a second time during Phase 2 probably took less effort and was more feasible considering refuge staff and volunteer resources. During the later years of the monitoring period, the relatively high number of bald eagle nests may have made it difficult for each nest identified as “active” in Phase 1 to be checked a second time in Phase 2, because of limited staff and volunteer resources. Relative effort per year may have declined for nests located in remote, not easily-accessed locations due to the increased number of new nests that had to be checked. Conversely, relative effort per year may not have changed through time for nests that were in proximity to roads that were regularly travelled by refuge staff and volunteers.

An indication that an increase in the number of nests that needed to be checked placed an increasing burden on limited staff and volunteer resources, and how this may have influenced data collection efforts, is provided by the number of known nests that were not checked. Across the 23-year monitoring period, an average of 5% of known, standing nests were not checked each year. During the first 16 years of that period (1990–2005), the number of unchecked nests was typically <5% of the total whereas during the last seven years of that period (2006–2012) the number of unchecked nests was typically <10% of the total. In 2008, 16% of all known nests (n=325 known nests) in the database were not checked. While recognizing the reality that refuge staff and volunteers did as good a job as possible in checking nests alongside the numerous other tasks that needed to be completed during annual refuge work cycles, it is important to recognize the effect that variation in the amount of effort expended may have on results obtained from the data that is collected.

One suggestion of this potential effect is provided by the average annual increase in the number of active nests we report for each district (see Results). In the Savanna District, there were 13 active nests reported in 2000, eight active nests in 2001, and 16 active nests in 2002. The percent increase from 2001 to 2002 was 100%. Similarly, in 2007 the number of active nests

reported in the Savanna District was 17, in 2008 it was eight, and in 2009 it was 28. The percent increase from 2008 to 2009 was 250%. Whether the relatively large fluctuations in the number of active nests described in these two examples were truly because of large fluctuations in actual bald eagle nesting activity or if they were the result of large fluctuations in monitoring effort, is unknown in part because monitoring effort was never quantified.

A paper was published in 2013 using a portion of the refuge's 2009 bald eagle nest activity data (Mundahl et al. 2013) and it is possible the authors were unaware of the full extent to which there are limitations inherent to the data, particularly with regard to the non-probabilistic nature of the sampling. Although the authors acknowledge that the data were opportunistically collected, they do not discuss, and perhaps were not aware of, the fact that many nests were likely checked multiple times throughout the breeding season, thereby influencing the likelihood that a nest would be classified as active or that eaglets would be observed. A portion of their analyses and subsequent conclusions addressed how nest activity status and eaglet presence may have been influenced by proximity of a nest to features such as travel corridors including roads and river channels. How their results may have been influenced by the unknown amount of bias in the data resulting from the unequal probability of nests being checked once, twice, or more than twice through a breeding season, is unknown.

The 2012 version of the database contained 53 different status codes used to classify the activity status of bald eagle nests. Many of these status codes were combinations of information about activity of adults and presence of eaglets, codes to identify species other than bald eagles using a nest, or codes identifying degrees of nest degradation. Of the 5,825 records in the final version of the database, 35 of the 53 status codes were used less than five times and 22 were used only once. Sixteen of the 53 status codes did not contain easily understood information that could indicate whether a nest was active, inactive, or gone, which resulted in records with those status codes being reclassified as "no data". A total of 514 records had their status codes reclassified as "no data", representing 8.8% of the 5,825 records in the database.

The reliability of data on observed eaglets collected during Phase 2 checks when eaglets would potentially have been present, but also at other times subsequent to Phase 2 checks, is unknown and may be low. Observations of eaglets were made from the ground or water surface and there is no way to assess or quantify detectability which would likely have varied substantially among observed nests. Variability in detectability could have arisen because of, but not be limited to, the following: the distance between the observer and the nest; whether a nest was approached by foot, vehicle, or car; the density and structure of the tree canopy around the nest; and the developmental stage of eaglets. Ambiguity associated with status codes resulted in a total of 4,104 eaglet index codes being reclassified as "no data". This represents 70% of all records in the database. After reclassification, reliable data on eaglets observed in nests are only available from 1,721 records, or 30% of all records.

The 2012 version of the database did not contain information about the number of times an individual nest was checked in a breeding season, or the dates when a nest was checked. Instead, each year's data for a nest, regardless of the number of times the nest was checked,

was captured in a single data entry record with no specific information about date other than the year the nest was checked. Capturing the information associated with each individual check of a nest, including the date the nest was checked, would have resulted in a larger database with a greater number of records, but many of the problems associated with the non-probabilistic sampling would have been avoided. Additionally, a substantially lower number of records would have been reclassified as "no data" to resolve issues with ambiguity in the recorded data.

Of the 697 nests observed during the 23-year period, geographic coordinates were recorded for about 82% of the nests (*n*=551) while no geographic coordinates were recorded for 8.8% (*n*=59) of the nests observed. In 9.2 % of the nests observed (n=62), geographic coordinates were recorded from locations adjacent to or in proximity of the observed nests. This was done when nests were not easily accessible in which case the geographic coordinates were presumably obtained as close to the nest as possible. These instances were noted in the database accordingly and were often qualified with notes about an ocular estimate of distance between the observer and the nest, as well as an indication of a cardinal or intercardinal direction. However, it is not known if the recorded cardinal and intercardinal directions represent the direction from the observer to the nest, or the direction from the nest to the observer.

Some error attributed to GPS accuracy in the field may have been due to technological limits present during the 23 years of monitoring. During the first decade of monitoring the government intentionally degraded GPS accuracy for all civilian devices through Selective Availability (SA) practices, but SA was deactivated in May 2000. When activated, SA resulted in 95% of fixed points taken to fall within a 45-m radius in a 24-hour period with 30-second intervals. With SA deactivated, accuracy of fixed points in an identical period with 30-second intervals increased to 95% falling within a radius of 6.3 m (National Coordination Office for Space-based Positioning, Navigation, and Timing 2018). These measurements comparing accuracy before and after SA likely would be more accurate than single points that may have been taken with hand-held devices used by refuge biologists. However, it is known that at least some Precision Lightweight GPS Receivers (PLGRs) were in use by some refuge staff during the early years of this monitoring effort. When PLGRs were used, accuracy presumably would not have been affected by SA. In addition to SA, canopy cover or other signal obstructions also may have decreased the accuracy of points taken by refuge staff with any devices..

Summary and Recommendations

The data collected during the 23-year period of monitoring served a very important function of capturing information about relatively specific locations of bald eagle nests. This allowed refuge staff to assess the potential for human activities to threaten or disturb nesting bald eagles and make recommendations for appropriate buffer distances and timing of projects to avoid nest disturbance. Additionally, the data are suitable for drawing a general conclusion that the number of nesting bald eagles in the area of data collection clearly increased during the 23 years of monitoring. However, a number of issues associated with the methodology employed during

data collection efforts, as well as during data entry and data management efforts, restrict the utility and reliability of the data.

Future monitoring efforts of this type would benefit from greater adherence to accepted and commonly adopted standards for monitoring wildlife populations. Current U.S. Fish and Wildlife Service Policy provides foundational guidance for how scientifically rigorous natural resource surveys should be conducted on National Wildlife Refuges (U.S. Fish and Wildlife Service 2014) and guidance for developing protocols that meet U.S. Fish and Wildlife Service policy requirements is also available (U.S. Fish and Wildlife Service 2013b). General guidance for designing and implementing biological monitoring programs is provided by Nichols and Williams (2006), Silvy (2012), and Reynolds et al. (2016). Methodologies and guidance specific to the monitoring of bald eagle nesting activity is available from U.S. Fish and Wildlife Service (2009), Watts and Deurr (2010), Sauer et al. (2011), Wilson et al. (2014, 2017, 2018), and Cruz et al. (2018).

Using Reynolds et al. (2016) as a guide, the following recommendations, and how they relate to the monitoring of bald eagle nesting activity during 1990–2012, are provided:

- Problem(s) or question(s) to be addressed should be clearly defined and objectives that are to be achieved should be explicitly identified. The 2010 Inventory and Monitoring Plan (U.S. Fish and Wildlife Service) alludes to what could be considered two questions: 1) what is the trend in bald eagle nesting activity, and 2) where are bald eagle nests located? Much of the information that is required to answer these two questions is common to both questions. However, each of these questions requires some information that is unique to the specific question.

- Design the most appropriate monitoring approach. This includes the writing of a protocol that delineates the data collection, data analysis, and data management elements. The 2010 Inventory and Monitoring Plan specified much of the methodology that would be utilized and implemented but acknowledged that the data management methodology was still to be developed. It appears though, that a new data management methodology was never implemented, that the database used to capture and store data did not change from before 2010 to the last year (2012) that all districts attempted to check every known bald eagle nest. The way information was captured in the original database resulted in a substantial amount of data being reclassified as “no data” which greatly reduced the utility and reliability of the data. Finally, the 2010 Inventory and Monitoring Plan did not identify a need for annual refresher training on implementing the methodology. This would have been particularly helpful in preventing the adoption of different criteria in classifying nests as active or inactive, and the proliferation of 53 nest activity status codes.

- After implementation of the monitoring effort, learn and revise. Reynolds et al. (2016) note that it is particularly important when conducting status and trends monitoring to “pause and reflect”. This can entail a regularly-scheduled period when the results are

synthesized which can help in determining if the information being produced is relevant. It can also be an opportunity when others outside of the immediate implementation team (refuge staff and volunteers) are allowed to scrutinize the efforts and provide constructive criticism for revision or improvement.

Acknowledgements

We acknowledge and appreciate the great amount of effort expended by the staff and volunteers of the Upper Mississippi River National Wildlife and Fish Refuge and Trempealeau National Wildlife Refuge during 23 years of bald eagle nest monitoring. Their interest in, passion for, and commitment to bald eagle conservation was exemplary. Without their significant annual contributions in the field and the office from 1990 through 2012, the data described in this report would not be available. Particularly noteworthy were the efforts of Eric Nelson and Brian Stemper, Wildlife Biologists in the Upper Mississippi River National Wildlife and Fish Refuge's Headquarters Office. Current and former refuge staff who were consulted and provided valuable insight on the methodology used during the most recent years of monitoring included Calvin Gehri, Victoria Hirschboeck, Edward Lagace, Lisa Maas, Eric Nelson, Brian Pember, Lisa Reid, Brian Stemper, and Jeramie Strickland. We also thank John O'Neill, former student at Saint Mary's University of Minnesota, who did the initial work in constructing a comprehensive, functional database that subsequently was refined and used for conducting summary analyses in this report. The following people reviewed earlier drafts of this report and provided valuable comments and suggestions: Jennifer Froehly (UMR NWFR Winona District), Cheryl Groom (UMR NWFR La Crosse District), Scott Mehus (National Eagle Center), Lisa Reid (Trempealeau NWR and UMR NWFR Winona District, retired), Mags Rheude (USFWS Migratory Bird Program), Richie Swanson (Winona, Minnesota-area Ornithological Citizen Scientist), Tim Yager (UMR NWFR HQ Office), as well as Colleen, Dan, Jane, and Francis Koll (Winona, Minnesota-area Ornithological Citizen Scientists). This project was funded through a cooperative agreement between the U.S. Fish and Wildlife Service and the University of Wisconsin - Stevens Point (F18AC00814).

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Table 1. Active nests in each district of the Upper Mississippi River National Wildlife and Fish Refuge during each year of the 1990–2012 monitoring period. See the Methods and Discussion sections for information about how standardized criteria were not used across all four districts to classify the activity status of nests.

Year	Winona District	La Crosse District	McGregor District	Savanna District	Refuge Total
1990	5	5	3	1	14
1991	6	5	3	3	17
1992	8	8	4	5	25
1993	8	8	9	5	30
1994	6	9	12	4	31
1995	8	7	16	3	34
1996	11	7	20	8	46
1997	10	5	29	9	53
1998	12	7	36	12	67
1999	10	11	37	12	70
2000	18	12	40	13	83
2001	15	15	44	8	82
2002	26	15	63	16	120
2003	25	14	69	20	128
2004	30	18	73	20	141
2005	40	19	89	23	171
2006	28	26	96	21	171
2007	40	27	104	17	188
2008	38	21	123	8	190
2009	53	37	135	28	253
2010	61	37	148	18	264
2011	69	33	167	27	296
2012	71	49	174	30	324

Table 2. Annual change in the number of active nests in each refuge district, and the percent annual change in the number of active nests in each district of the Upper Mississippi River National Wildlife and Fish Refuge during each year of the 1990–2012 monitoring period. See the Methods and Discussion sections for information about how standardized criteria were not used across all four districts to classify the activity status of nests.

	Winona District		La Crosse District		McGregor District		Savanna District	
Year	Change in the number of active nests	Percent change in the number of active nests	Change in the number of active nests	Percent change in the number of active nests	Change in the number of active nests	Percent change in the number of active nests	Change in the number of active nests	Percent change in the number of active nests
1990	-	-	-	-	-	-	-	-
1991	1	20.00%	0	0.00%	0	0.00%	2	200.00%
1992	2	33.33%	3	60.00%	1	33.33%	2	66.67%
1993	0	0.00%	0	0.00%	5	125.00%	0	0.00%
1994	-2	-25.00%	1	12.50%	3	33.33%	-1	-20.00%
1995	2	33.33%	-2	-22.22%	4	33.33%	-1	-25.00%
1996	3	37.50%	0	0.00%	4	25.00%	5	166.67%
1997	-1	-9.09%	-2	-28.57%	9	45.00%	1	12.50%
1998	2	20.00%	2	40.00%	7	24.14%	3	33.33%
1999	-2	-16.67%	4	57.14%	1	2.78%	0	0.00%
2000	8	80.00%	1	9.09%	3	8.11%	1	8.33%
2001	-3	-16.67%	3	25.00%	4	10.00%	-5	-38.46%
2002	11	73.33%	0	0.00%	19	43.18%	8	100.00%
2003	-1	-3.85%	-1	-6.67%	6	9.52%	4	25.00%
2004	5	20.00%	4	28.57%	4	5.80%	0	0.00%
2005	10	33.33%	1	5.56%	16	21.92%	3	15.00%
2006	-12	-30.00%	7	36.84%	7	7.87%	-2	-8.70%
2007	12	42.86%	1	3.85%	8	8.33%	-4	-19.05%
2008	-2	-5.00%	-6	-22.22%	19	18.27%	-9	-52.94%
2009	15	39.47%	16	76.19%	12	9.76%	20	250.00%
2010	8	15.09%	0	0.00%	13	9.63%	-10	-35.71%
2011	8	13.11%	-4	-10.81%	19	12.84%	9	50.00%
2012	2	2.90%	16	48.48%	7	4.19%	3	11.11%

Table 3. Inactive nests in each district of the Upper Mississippi River National Wildlife and Fish Refuge during each year of the 1990–2012 monitoring period. See the Methods and Discussion sections for information about how standardized criteria were not used across all four districts to classify the activity status of nests.

Year	Winona District	La Crosse District	McGregor District	Savanna District	Refuge Total
1990	3	0	0	0	3
1991	5	0	0	0	5
1992	1	0	2	1	4
1993	1	0	0	3	4
1994	6	1	1	2	10
1995	3	3	1	6	13
1996	0	2	1	1	4
1997	1	7	2	4	14
1998	0	7	5	3	15
1999	2	6	6	0	14
2000	4	6	6	1	17
2001	4	4	13	0	21
2002	10	4	12	0	26
2003	14	13	18	0	45
2004	10	9	28	1	48
2005	10	12	31	4	57
2006	14	10	22	4	50
2007	14	9	37	1	61
2008	15	8	29	0	52
2009	9	1	33	3	46
2010	25	7	28	2	62
2011	22	4	33	8	67
2012	30	3	40	7	80

Table 4. Eaglets observed in each district of the Upper Mississippi River National Wildlife and Fish Refuge during each year of the 1990–2012 monitoring period.

Year	Winona District	La Crosse District	McGregor District	Savanna District	Refuge Total
1990	5	6	7	1	19
1991	7	7	9	4	27
1992	8	10	8	6	32
1993	7	9	11	5	32
1994	5	9	20	5	39
1995	2	9	27	6	44
1996	10	9	38	8	65
1997	22	4	36	13	75
1998	9	4	38	23	74
1999	16	16	60	16	108
2000	16	13	34	19	82
2001	17	17	27	12	73
2002	35	21	57	24	137
2003	30	17	53	31	131
2004	30	16	61	20	127
2005	37	25	80	36	178
2006	16	48	77	26	167
2007	33	22	96	21	172
2008	23	27	46	7	103
2009	47	36	46	18	147
2010	45	38	73	26	182
2011	42	26	47	34	149
2012	39	41	103	21	204
Grand Total	501	430	1054	382	2367

Figure 1. Map of the Upper Mississippi River National Wildlife and Fish Refuge, including locations of pools, dams, and refuge districts (from U. S. Fish and Wildlife Service 2006).

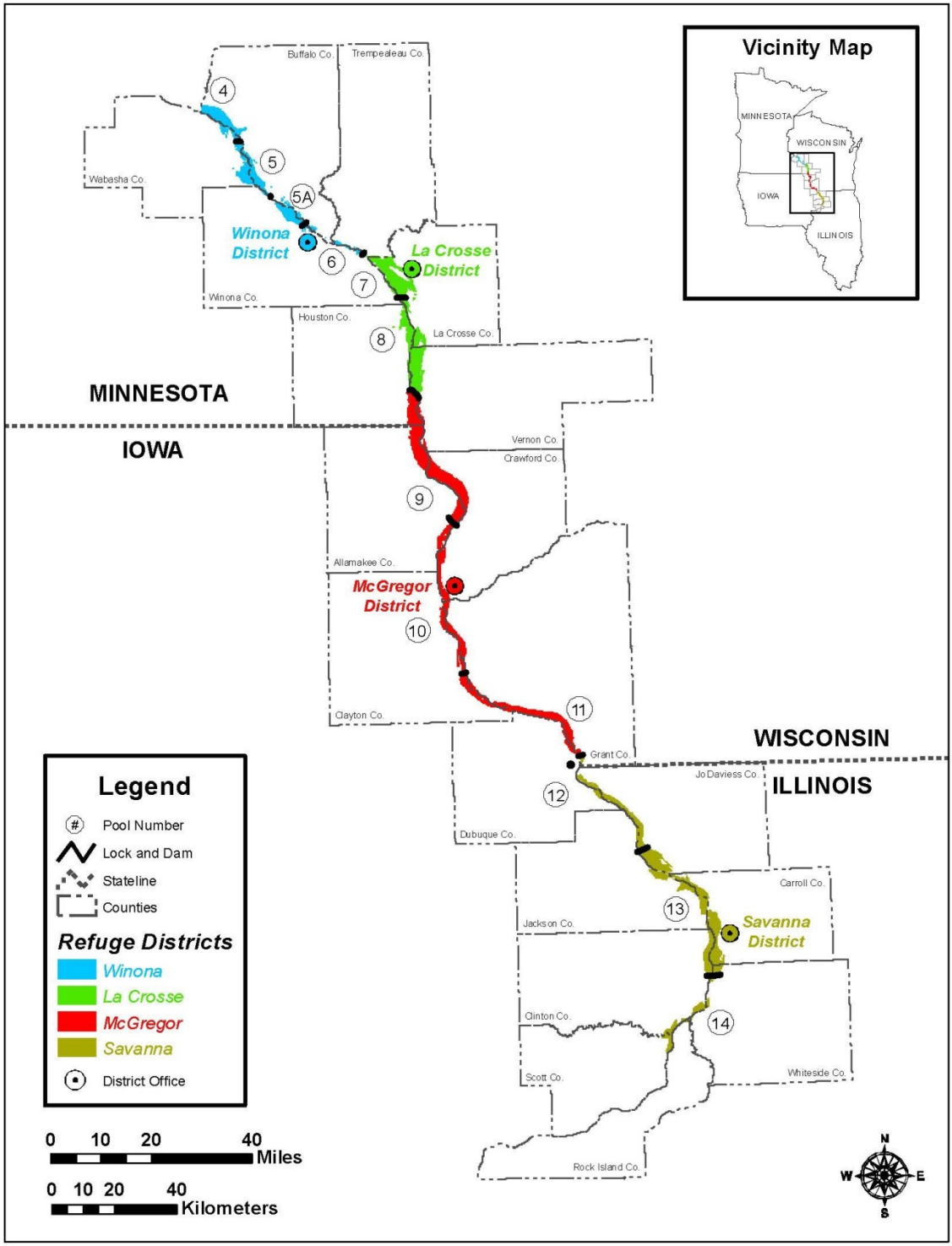


Figure 2. Active bald eagle nests observed in each district of the Upper Mississippi River National Wildlife and Fish Refuge during 1990–2012. See the Methods and Discussion sections for information about how standardized criteria were not used across all four districts to classify the activity status of nests.

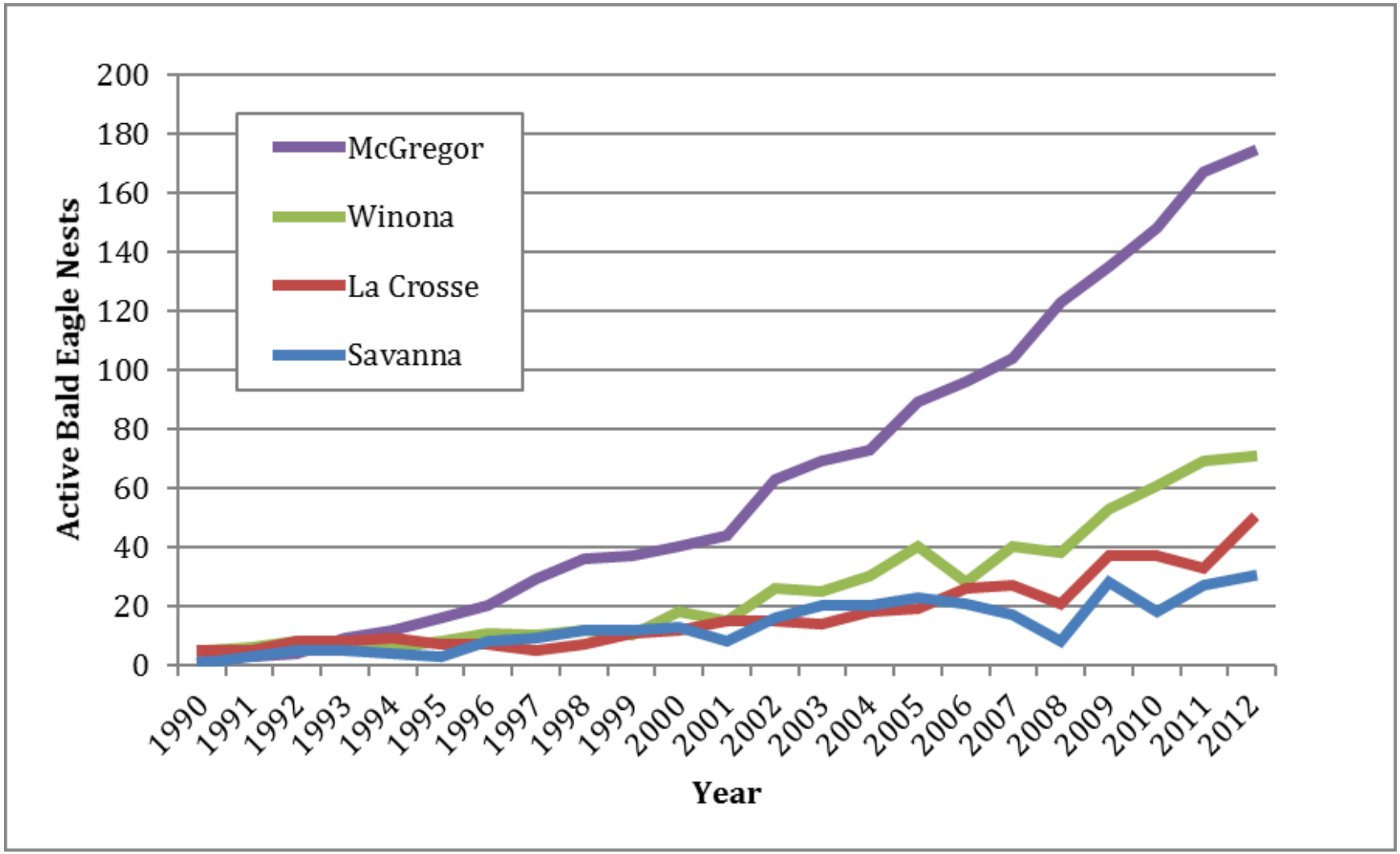


Figure 3. Inactive bald eagle nests observed in each district of the Upper Mississippi River National Wildlife and Fish Refuge during 1990–2012. See the Methods and Discussion sections for information about how standardized criteria were not used across all four districts to classify the activity status of nests.

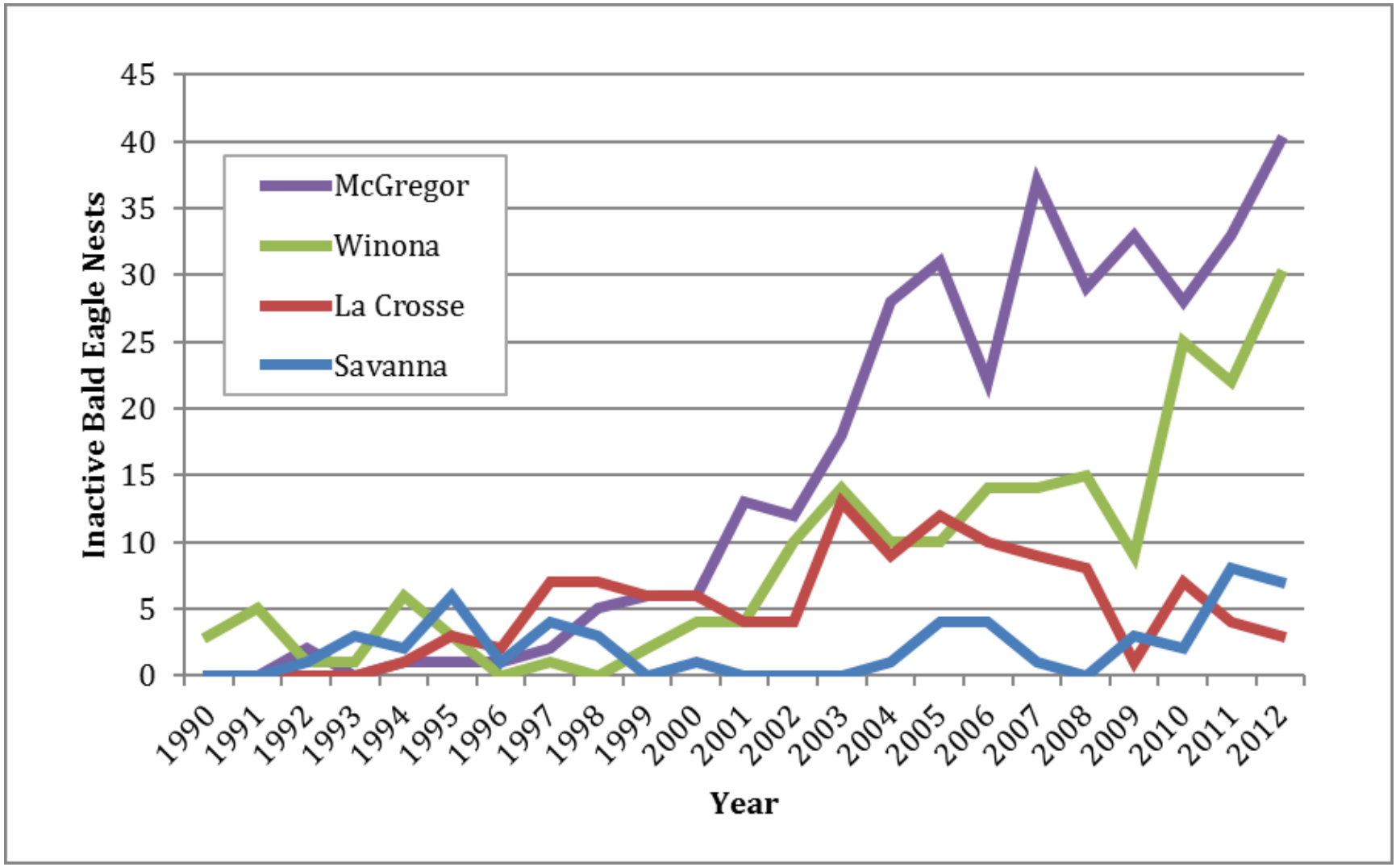


Figure 4. The proportion of active to inactive nests observed by each district of the Upper Mississippi River National Wildlife and Fish Refuge during 2012. See the Methods and Discussion sections for information about how standardized criteria were not used across all four districts to classify the activity status of nests.

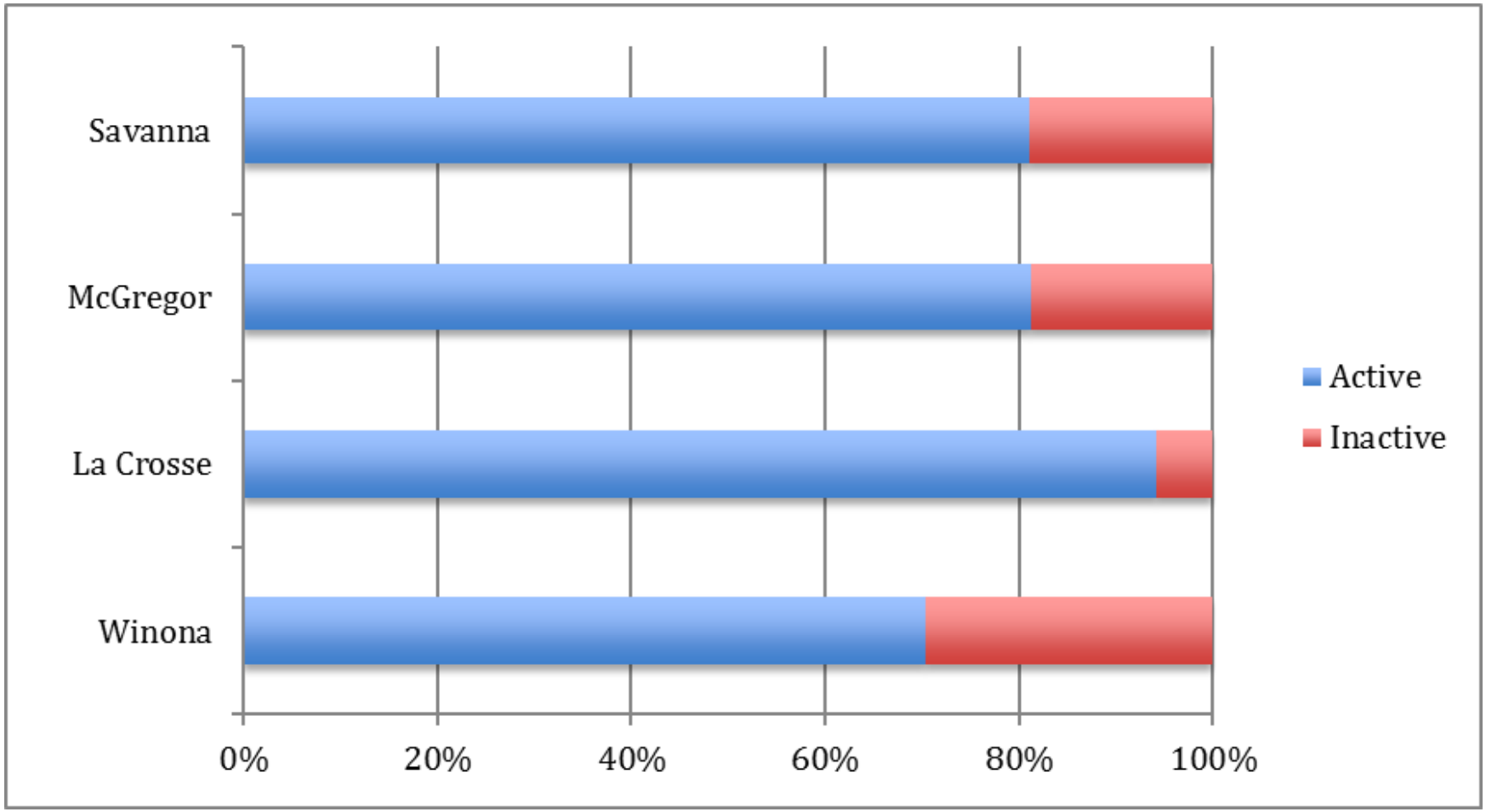


Figure 5. The number of active and inactive nests observed by each district of the Upper Mississippi River National Wildlife and Fish Refuge during 2012. See the Methods and Discussion sections for information about how standardized criteria were not used across all four districts to classify the activity status of nests.

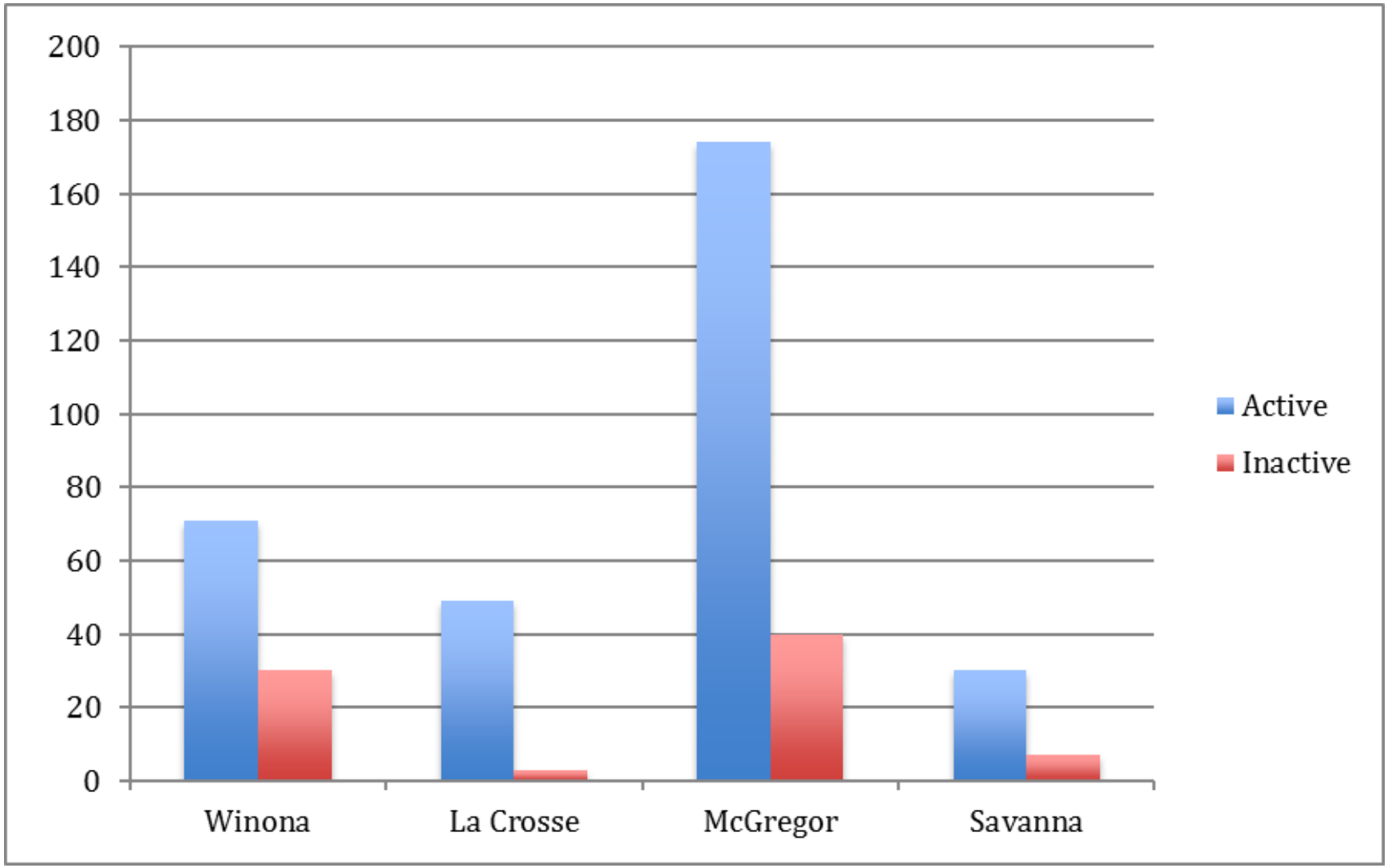


Figure 6. The number of bald eagle eaglets observed in each district of the Upper Mississippi River National Wildlife and Fish Refuge during 1990–2012.

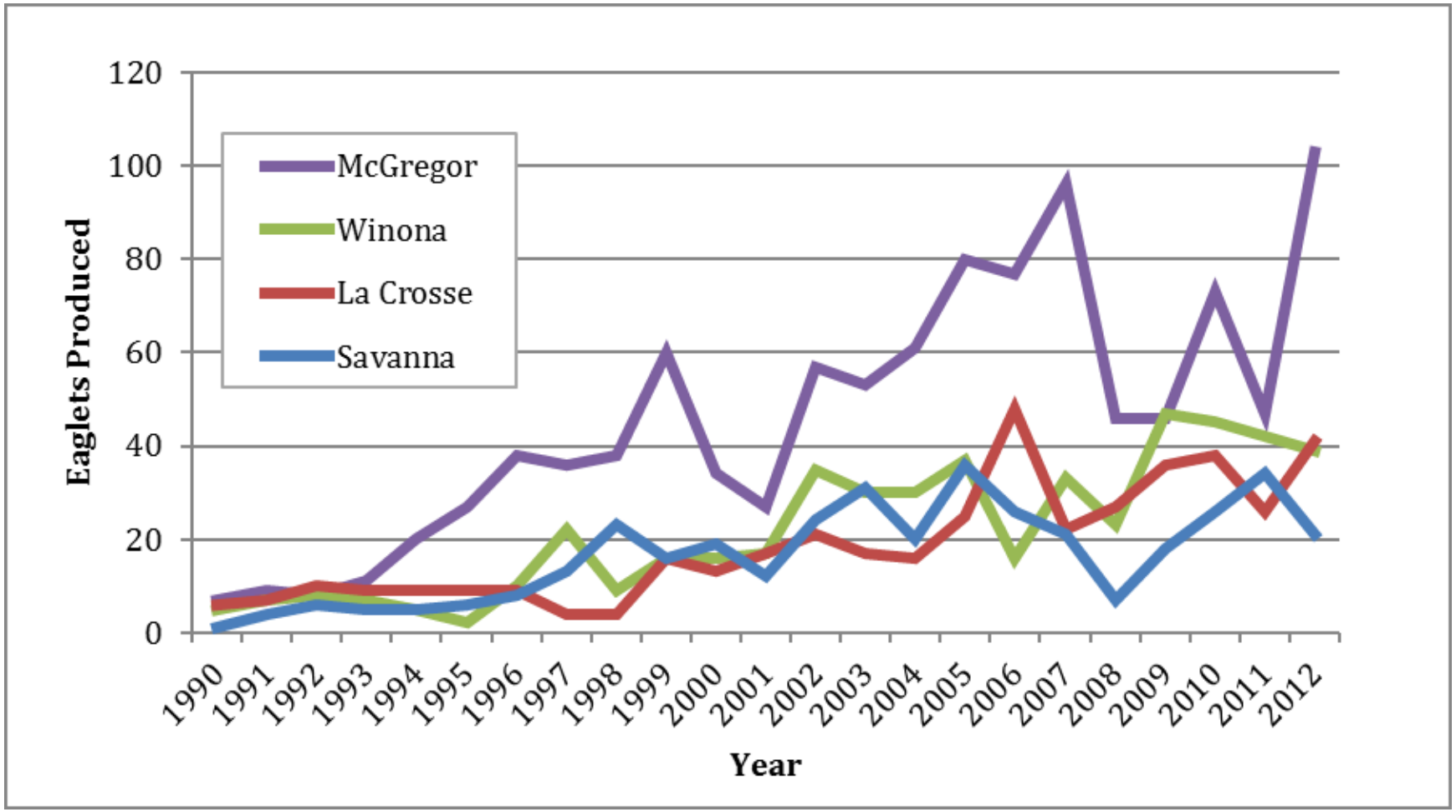


Figure 7. The average number of bald eagle eaglets per nest observed in each district of the Upper Mississippi River National Wildlife and Fish Refuge during 1990–2012.

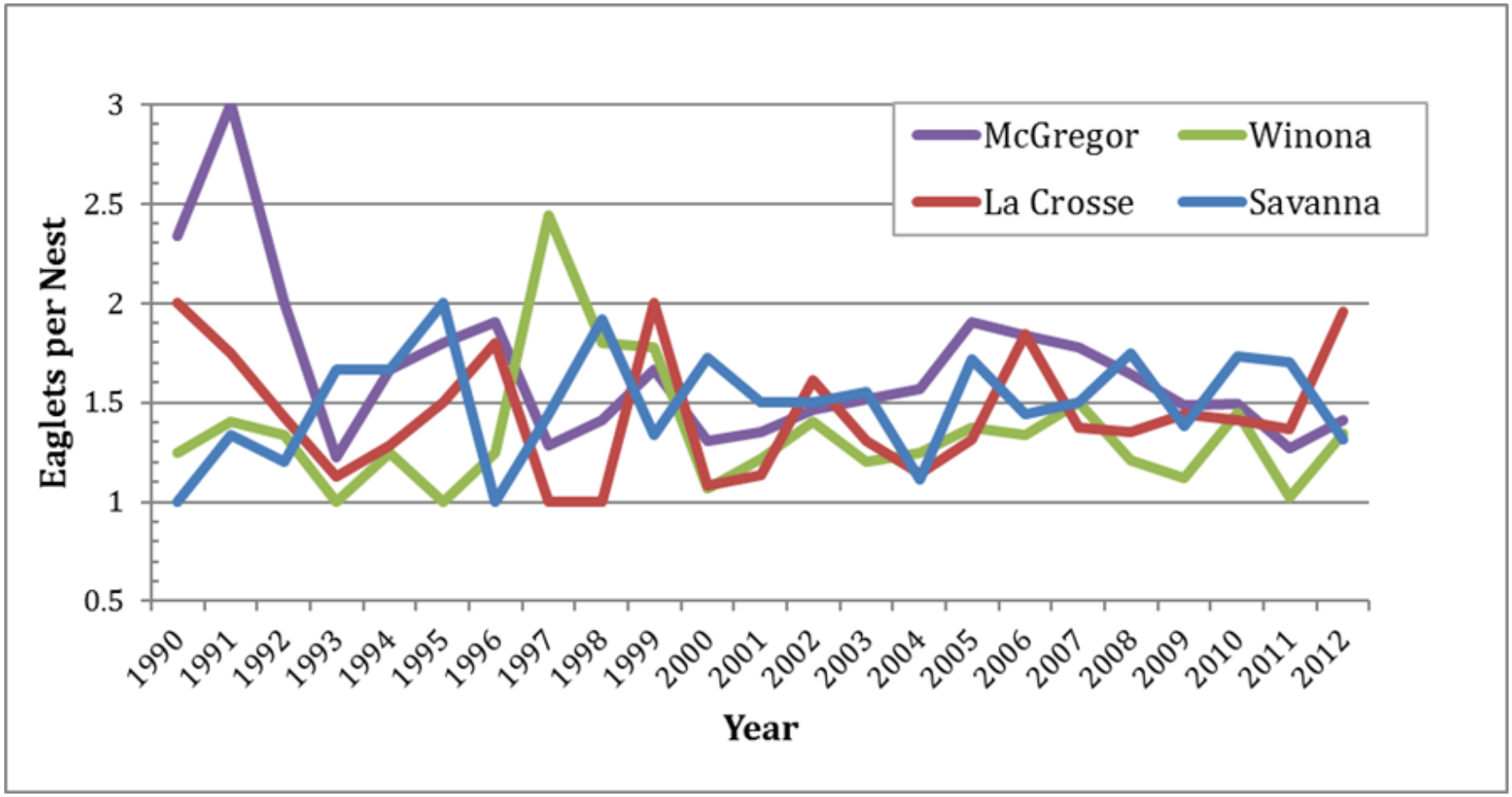
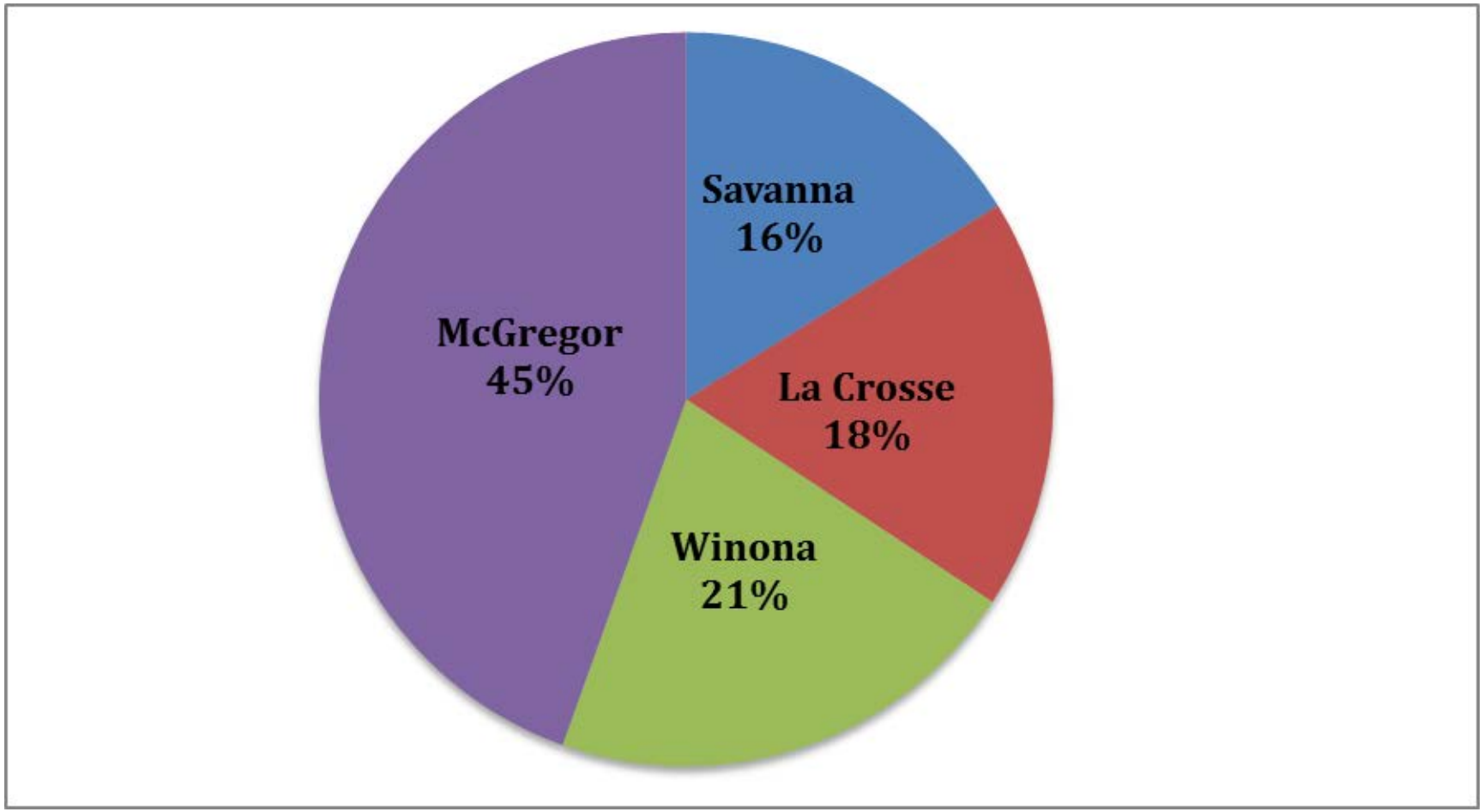


Figure 8. The proportion of all observed bald eagle eaglets that were observed in each district of the Upper Mississippi River National Wildlife and Fish Refuge during 1990–2012.



Appendix A. Depiction of the data contained in the 2012 spreadsheet used to capture all data collected during each year of the 2990–2012 nest activity monitoring efforts. (file name *2012RefugewideEagleNestnad83_FINAL_July2012*; on file at the HQ office of the Upper Mississippi River National Wildlife and Fish Refuge).

Refugewide 2012

Bald Eagle Nest Locations and Nesting History *Upper Mississippi River National Wildlife and Fish Refuge*

Organized by River Mile

A0,1,2,3 = Nest active, adult incubating, # of young fledged | I = Nest inactive | NC = Nest not checked | G = Nest gone | OS = Opsrey in nest | Database prepared by Wildlife Biologist Brian Stemper

AX = Nest active, adult incubating, unknown # of young fledged | NF = Nest not found | NP = New pair using nest in old territory | R = Nest Remnant | OW = Owl in nest | Revised August 14, 2012

A? = Nest active , adult incubating, no data on young | UK = Unknown nesting activity | OC = 1 or more adults present but no incubating, or repaired nest | T = Nest tree gone | HA = Red Shouldered Hawk nest | D:\Eagles\2012\2012RefugewideEagleNestnad83_FINAL_July2012

State	County	Brdg Area	Nest #	UTM Coordinates NAD 83 Easting	Northing	Land Survey Description TWP	RNG	SEC	Parcel	Pool #	River Mile	Distance from River	Breeding Area Name	Year Found	YEAR 2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	Comments
WI	Pepin	3	3	572031	4920529	T023N	R14W	33	SWNW	4	764.7	E 1.5	Pepin-1	2010	NC	A?	A?																					Approximate GPS coordinates from ARCMAP - Off Refuge
WI	Pepin	1	1	X	X	T022N	R14W	5	X	4	764.5	E 0.4	Steamboat Bay	1991	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	A?	A2	A2	A2	A?		
WI	Pepin	1	1A	571424	4918862	T022N	R14W	5	SWNE	4	764.5	E 0.5	Steamboat Bay - A	1996	A?	A?	A?	UK	A?	I	A1	A1	A2	A2	A1				A?	NC	A?							Approximate GPS coordinates from ARCMAP- Off Refuge
WI	Pepin	4	4	571924	4918646	T022N	R14W	5	SENE	4	764.2	E 0.3	RM 764.2	2010	NC	I	A2																					Approximate GPS coordinates from ARCMAP - Off Refuge
WI	Pepin	2	2	X	X	X	X	X	X	4	763.7	E 0.5	Green Cabin	2000	G	G	G	G	G	G	G	G	R	I	I		A2										
WI	Buffalo	28	28	573266	4918245	T022N	R14W	4	NESE	4	763.4	E 0.4	Chippewa River	2006	G	G	G	G	NC	UK	UK																
WI	Buffalo	28	28A	573266	4918245	T022N	R14W	4	NESE	4	763.4	E 0.4	Chippewa River - A	2010	A?	A?	A2																					
WI	Buffalo	47	47	573129	4920013	T023N	R14W	33	NESE	4	763.3	NE 1.4	Burlington Tracks	2011	A1	A?																						Coordinates from WI DNR
WI	Buffalo	27	27	574515	4918117	T022N	R14W	3	SESW	4	762.2	E 0.5	Gov"t. Light Slough	2000	G	G	G	G	G	G	G	G	A1	I	I	A0	A0											
MN	Wabasha	8	8	574391	4916418	T111N	R10W	19	NWSW	4	762.1	W 0.5	Reads Landing	2001	A?	A?	A?	A1	A?	I	A?	A?	A0	A2	A2	I												Off Refuge, on private land
MN	Wabasha	9	9	574936	4916214	T111N	R10W	19	SWSE	4	761.8	W 0.4	Reads Landing A	2008	I	I	I	UK	A1																			Approximate GPS coordinates from ARCMAP - Off Refuge
WI	Buffalo	9	9	X	X	T022N	R14W	2	SWNE	4	761.8	NE 1.3	Nelson-Trevino	1994	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	A0G	A?	A1				
WI	Buffalo	34	34	576971	4915777	T022N	R14W	13	NWNW	4	760.4	N 0.1	Nelson Dike A	2007	G	NC	A1	A0	A?	I																		
WI	Buffalo	34	34A	577104	4915511	T022N	R14W	13	SWNW	4	760.3	N 0.1	Nelson Dike A - #2	2011	A2	A3																						
WI	Buffalo	13	13	578048	4918232	T022N	R14W	1	NESE	4	760.2	E 2.0	Nelson Dike Road	1998	A?	A0	A1	A1	NC	A?	I	A?	A0	A1	A1	A1	A1	A?	A?									
WI	Buffalo	33	33	578957	4916295	T022N	R14W	12	SENE	4	760.0	N 1.2	Nelson Dike B	2007	A?	A2	I	I	A1	UK																		
WI	Buffalo	24	24	578994	4915563	T022N	R13W	18	NWNW	4	759.4	N 0.6	Indian Slough	2005	A2	I	A?	A1	I		I	A1																
MN	Wabasha	16	16	578723	4914152	T111N	R10W	33	SENE	4	758.8	S 0.1	Hershey Island	2010	A2	A?	A2																					Approximate GPS coordinates from ARCMAP
WI	Buffalo	16	16C	579462	4914631	T022N	R13W	18	SESE	4	758.5	E 0.3	Big Lake (Catfish C)	2004	A?	A?	I	A?	NC	A?	I	I	0															
WI	Buffalo	17	17	581748	4915643	T022N	R13W	16	NWNW	4	758.0	NE 1.6	Varanick Point	2000	A3	A1	A1	A2	A1	A1	A1	A?	A1	A0	A2	A2	A1											
WI	Buffalo	16	16B	580885	4913923	T022N	R13W	20	NWNW	4	757.9	N 0.2	Big Lake (Catfish) - B	2002	I	NC	A?	A1	A1	UK	I	A?	A1	I	A2														
WI	Buffalo	5	5	X	X	T022N	R13W	21	SWNW	4	757.5	X	Big Lake (South)	1988	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	I	I	
WI	Buffalo	5	5A	X	X	T022N	R13W	21	SWNW	4	757.5	N 0.5	Big Lake (South 2) - A	1991	G	G	G	G	G	G	G	G	G	G	G	G	G	NC	G	I		I	I	A2	A2	A1		
WI	Buffalo	16	16	581983	4913541	T022N	R13W	20	SWNE	4	757.5	N 0.6	Big Lake (Catfish) - A	2000	A?	A0	I	A1	NC	A1	I	A?	I	I	I	A1	A?											
WI	Buffalo	6	6	X	X	T022N	R13W	20	SENW	4	757.5	X	Big Lake (West)	1989	G	G	G	G	G	G	G	G	G	G	G	G	G	NC	G								I	
WI	Buffalo	6	6B	581619	4913818	T022N	R13W	20	SWNE	4	757.2	N 0.2	Big Lake -B	1996	G	G	G	G	G	G	G	G	G	G	G	I	I	A2	I	A1	A3	A3						
WI	Buffalo	6	6C	582355	4914017	T022N	R13W	21	NENW	4	757.0	N 0.6	Big Lake (South 3)	2010	A?	A?	I																					Approximate GPS coordinates from ARCMAP
WI	Buffalo	6	6A	X	X	T022N	R13W	20	SENW	4	757.0	N 0.2	Big Lake - A	1990	G	G	G	G	G	G	G	G	R	I	I							I	OW	I	ANF	A1	A1	
WI	Buffalo	19	19A	583118	4912862	T022N	R13W	21	SESE	4	756.1	N 0.3	Beef Slough B	2004	G	G	A1	NF	NC	A?	A1	A?	I															
WI	Buffalo	19	19	583640	4912270	T022N	R13W	28	NENE	4	755.9	N 0.2	Beef Slough Island	2001	I	I	I	I	I	I	I	A?	A1	A2	A1														
WI	Buffalo	4	4	X	X	T022N	R13W	28	SENE	4	755.7	X	Nest B (North)	1987	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	
WI	Buffalo	4	4A	X	X	T022N	R13W	28	SENE	4	755.7	X	Nest B (South) - A	1988	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	

Appendix B. Depiction of the data contained in the 2015 version of the database (file name *20150812 - bald eagle data 1990-2012*; on file at the HQ office of the Upper Mississippi River National Wildlife and Fish Refuge).

State	County	District	Pool #	nest code	year of record	status	easting	northing	comments	Brdg Area	nest #	TWP	RNG	SEC	Parcel	River Mile	Distance from River	Breeding Area Name	Year Found
MN	Houston	La Crosse	8	MNHouston0024	1994	A2	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	1995	I	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	1996	.	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	1997	.	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	1998	A1	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	1999	I	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	2000	A1	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	2001	A2	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	2002	A2	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	2003	A2	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	2004	I	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	2005	A1	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	2006	A2	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	2007	G	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	2008	G	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	2009	G	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	2010	G	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	2011	G	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0024	2012	G	638106	4855628		24	24	T104N	R4W	2	NE	700.5	E 0.4	MN Island	1998
MN	Houston	La Crosse	8	MNHouston0025	1998	.	638670	4854676		25	25	T16N	R8W	25	NWSE	699.5	E 0.2	Barron Island (MN Isl S tip) - A	1998
MN	Houston	La Crosse	8	MNHouston0025	1999	A2	638670	4854676		25	25	T16N	R8W	25	NWSE	699.5	E 0.2	Barron Island (MN Isl S tip) - A	1998
MN	Houston	La Crosse	8	MNHouston0025	2000	A1	638670	4854676		25	25	T16N	R8W	25	NWSE	699.5	E 0.2	Barron Island (MN Isl S tip) - A	1998
MN	Houston	La Crosse	8	MNHouston0025	2001	A2	638670	4854676		25	25	T16N	R8W	25	NWSE	699.5	E 0.2	Barron Island (MN Isl S tip) - A	1998
MN	Houston	La Crosse	8	MNHouston0025	2002	A2	638670	4854676		25	25	T16N	R8W	25	NWSE	699.5	E 0.2	Barron Island (MN Isl S tip) - A	1998
MN	Houston	La Crosse	8	MNHouston0025	2003	I	638670	4854676		25	25	T16N	R8W	25	NWSE	699.5	E 0.2	Barron Island (MN Isl S tip) - A	1998
MN	Houston	La Crosse	8	MNHouston0025	2004	G	638670	4854676		25	25	T16N	R8W	25	NWSE	699.5	E 0.2	Barron Island (MN Isl S tip) - A	1998
MN	Houston	La Crosse	8	MNHouston0025	2005	G	638670	4854676		25	25	T16N	R8W	25	NWSE	699.5	E 0.2	Barron Island (MN Isl S tip) - A	1998
MN	Houston	La Crosse	8	MNHouston0025	2006	G	638670	4854676		25	25	T16N	R8W	25	NWSE	699.5	E 0.2	Barron Island (MN Isl S tip) - A	1998
MN	Houston	La Crosse	8	MNHouston0025	2007	G	638670	4854676		25	25	T16N	R8W	25	NWSE	699.5	E 0.2	Barron Island (MN Isl S tip) - A	1998
MN	Houston	La Crosse	8	MNHouston0025	2008	G	638670	4854676		25	25	T16N	R8W	25	NWSE	699.5	E 0.2	Barron Island (MN Isl S tip) - A	1998
MN	Houston	La Crosse	8	MNHouston0025	2009	G	638670	4854676		25	25	T16N	R8W	25	NWSE	699.5	E 0.2	Barron Island (MN Isl S tip) - A	1998
MN	Houston	La Crosse	8	MNHouston0025	2010	G	638670	4854676		25	25	T16N	R8W	25	NWSE	699.5	E 0.2	Barron Island (MN Isl S tip) - A	1998
MN	Houston	La Crosse	8	MNHouston0025	2011	G	638670	4854676		25	25	T16N	R8W	25	NWSE	699.5	E 0.2	Barron Island (MN Isl S tip) - A	1998
MN	Houston	La Crosse	8	MNHouston0025	2012	G	638670	4854676		25	25	T16N	R8W	25	NWSE	699.5	E 0.2	Barron Island (MN Isl S tip) - A	1998
MN	Houston	La Crosse	8	MNHouston0026	2005	A2	638479	4852915		26	26	T104N	R4W	11	SE	698.2	W 0.8	Pipeline	2005
MN	Houston	La Crosse	8	MNHouston0026	2006	A1	638479	4852915		26	26	T104N	R4W	11	SE	698.2	W 0.8	Pipeline	2005
MN	Houston	La Crosse	8	MNHouston0026	2007	A2	638479	4852915		26	26	T104N	R4W	11	SE	698.2	W 0.8	Pipeline	2005
MN	Houston	La Crosse	8	MNHouston0026	2008	T	638479	4852915		26	26	T104N	R4W	11	SE	698.2	W 0.8	Pipeline	2005
MN	Houston	La Crosse	8	MNHouston0026	2009	T	638479	4852915		26	26	T104N	R4W	11	SE	698.2	W 0.8	Pipeline	2005
MN	Houston	La Crosse	8	MNHouston0026	2010	T	638479	4852915		26	26	T104N	R4W	11	SE	698.2	W 0.8	Pipeline	2005
MN	Houston	La Crosse	8	MNHouston0026	2011	T	638479	4852915		26	26	T104N	R4W	11	SE	698.2	W 0.8	Pipeline	2005
MN	Houston	La Crosse	8	MNHouston0026	2012	G	638479	4852915		26	26	T104N	R4W	11	SE	698.2	W 0.8	Pipeline	2005
MN	Houston	La Crosse	8	MNHouston0027	1990	A3	638933	4851827		27	27	T104N	R4W	13	SW	697.4	W 0.5	Target Lake	1988
MN	Houston	La Crosse	8	MNHouston0027	1991	A3	638933	4851827		27	27	T104N	R4W	13	SW	697.4	W 0.5	Target Lake	1988
MN	Houston	La Crosse	8	MNHouston0027	1992	A3	638933	4851827		27	27	T104N	R4W	13	SW	697.4	W 0.5	Target Lake	1988
MN	Houston	La Crosse	8	MNHouston0027	1993	A0	638933	4851827		27	27	T104N	R4W	13	SW	697.4	W 0.5	Target Lake	1988

Appendix C. The 53 unique nest activity status codes in the 2015 version of the database, the number of occurrences of each status code in the 2015 version of the database, and a description or definition of what each status code means. The descriptions and definitions are based on the unfinished 2010 wildlife monitoring plan as well as discussions during with current and former refuge staff. The 53 nest activity status codes were reclassified to a smaller number of nest activity codes and eaglet index codes in the final version of the database.

status code	number of occurances in database	description/definition	replace with the following nest activity code	replace with the following eaglet index code
0	1	winona district big lake during the first year a nest was observed, and perhaps observed outside the phase 1 and phase 2 checks	I	no data
OCT	1	probably OC in phase 1 check; tree gone in phase 2 check	no data	no data
.	203	no data	no data	no data
?	2	for one record it was the first year the nest was found and the subsequent two years it was coded as inactive; for the the other record it probably wasn't checked that year	no data	no data
A	11	active according to the criteria used by districts but no information about whether this was determined in phase 1 or phase 2 checks; perhaps phase 2 check was never conducted	A	no data
A,G	1	active in phase 1 check; gone in phase 2 check	A	0
A/?	1	active in phase 1 check; no data in phase 2 check	A	no data
A/G	2	active in phase 1 check; gone in phase 2 check	A	0
A/R	3	active in phase 1 check; unusable remnant of nest is all that was observed in phase 2 check	A	0
A/T	2	active in phase 1 check; tree gone in phase 2 check	A	0
A?	1115	active in phase 1 check; no data in phase 2 check	A	no data
A?.	1	active in phase 1 check; no data in phase 2 check	A	no data
A?/G	1	active in phase 1 check; no data in phase 2 check; later in the year after phase 2 check it was noted that the nest was gone	A	no data
A?/T	2	active in phase 1 check; no data in phase 2 check; later in the year after phase 2 check it was noted that the tree was gone	A	no data
A?G	1	active in phase 1 check; no data in phase 2 check; later in the year after phase 2 check it was noted that the nest was gone	A	no data
A0	125	active in phase 1 check; no young observed in phase 2 check	A	0
A0, G	2	active in phase 1 check; no young observed in phase 2 check; later in the year after phase 2 check it was noted that the nest was gone	A	0
A0/G	1	active in phase 1 check; no young observed in phase 2 check; later in the year after phase 2 check it was noted that the nest was gone	A	0
A0/T	1	active in phase 1 check; no young observed in phase 2 check; later in the year after phase 2 check it was noted that the tree was gone	A	0
A0?	1	savanna district; perhaps active in phase 1 check, no young observed in phase 2 check, but someone involved in data recording or data entry had a question about the data	no data	no data
A0G	2	active in phase 1 check; no young observed in phase 2 check; later in the year after phase 2 check it was noted that the nest was gone	A	0
A1	644	active in phase 1 check; a single chick observed in phase 2 check	A	1
A1 - T	1	active in phase 1 check; a single chick observed in phase 2 check; later in the year after phase 2 check it was noted that the tree was gone	A	1
A1G	1	active in phase 1 check; a single chick observed in phase 2 check; later in the year after phase 2 check it was noted that the nest was gone	A	1
A2	717	active in phase 1 check; two eaglets observed in phase 2 check	A	2
A2G	1	active in phase 1 check; two eaglets observed in phase 2 check; later in the year after phase 2 check it was noted that the nest was gone	A	2
A3	95	active in phase 1 check; three eaglets observed in phase 2 check	A	3

status code	number of occurances in database	description/definition	replace with the following nest activity code	replace with the following eaglet index code
AG	3	active in phase 1 check; nest gone in phase 2 check	A	0
ANF	4	active in phase 1 check; nest couldn't be found in phase 2 check	A	no data
AO	3	active in phase 1 check; no young observed in phase 2 check	A	0
AR	1	active in phase 1 check; unusable remnant of nest is all that was observed in phase 2 check	A	0
AT	1	active in phase 1 check; tree gone in phase 2 check	A	0
AX	56	active inphase 1 check; no data in phase 2 check	A	no data
G	1680	nest gone in phase 1 check	G	no data
G?	2	uncertainty about whether the nest was gone or the nest not found	no data	no data
G-?	1	uncertainty about whether the nest was gone or the nest not found	no data	no data
Goose	2	Canada goose using nest	I	no data
HA	10	red-shouldered hawk using nest	I	no data
I	685	inactive in phase 1 check; not checked in phase 2 OR not checked in phase 1; incative in phase 2	I	no data
IK	1	probably a typo whereby UK was supposed to have been entered	no data	no data
NC	138	not checked during both phase 1 check and phase 2 check	no data	no data
NF	40	not found in phase 1 check and not checked in phase 2 check OR not found in both phase 1 check and phase 2 check	no data	no data
NFG	1	not found in phase 1 check; nest confirmed as gone in phase 2 check	no data	no data
NN	1	perhaps was used to indicate "not known" or "no nest"	no data	no data
OC	20	probably occupied in phase 1 check and/or phase 2 check	no data	no data
OCG	1	probably occupied during phase 1 check but nest gone in phase 2 check	no data	no data
Ow	20	owl using nest	I	no data
OW ?	1	owl in nest but uncertainy about something	no data	no data
R	50	unusable remnant of nest is all that was observed in phase 1 check and/or phase 2 check	G	no data
T	63	tree gone in phase 1 check and/or phase 2 check	G	no data
T?	1	tree gone in phase 1 check and/or phase 2 check but perhaps uncertainty on the part of the observer	no data	no data
TG	2	tree gone in phase 1 check and/or phase 2 check	G	no data
UK	100	unkown	no data	no data
Grand Total	**5825**			

Appendix D. Characterization of the confidence in reported geographic locations of nests, based on comments associated with the nests in the database.

original order from pivot table	comments that include coordinate information	number of records	proposed reclassification of coordinate information
1	25 YDS. SO.	15	ambiguous data
2	GPS under tree, 2" dbh cottonwood	16	reliable data
3	3/22/12 nest rebuilt: need to verify coordinates	1	ambiguous data
4	actual coordinates	2	reliable data
5	adjacent to above nest; est coord	1	ambiguous data
6	Approx. UTM from Arcview	18	ambiguous data
7	Approximate GPS	19	ambiguous data
8	Approximate GPS coordinates from ARCMAP	32	ambiguous data
9	Approximate GPS coordinates from ARCMAP - Off Refuge	11	ambiguous data
10	Approximate GPS coordinates from ARCMAP- Off Refuge	24	ambiguous data
11	Approximate GPS coordinates from ARCMAP, close to Refuge Boundary	5	ambiguous data
12	Approximate GPS coordinates from ARCMAP/ Off Refuge	12	ambiguous data
13	check coordinates	16	ambiguous data
14	Coor taken from GIS: verify winter 2012	1	ambiguous data
15	coordinates from approx map location	1	ambiguous data
16	Coordinates from WI DNR	2	ambiguous data
17	coordinates not exact nest location ~100m to the south	1	ambiguous data
18	coordinates on water near shore	1	ambiguous data
19	coordinates taken in field	9	reliable data
20	coordinates taken in the field	3	reliable data
21	coords at nest	3	reliable data
22	estimated coordinates	1	ambiguous data
23	found 3-8-12; approx. GPS coord, Off Refuge	1	ambiguous data
24	found 5/31/12; shoreline coords	1	ambiguous data
25	GPS COORDINATES ARE OFF	5	ambiguous data
26	GPS coordinates estimated	38	ambiguous data
27	GPS coordinates from map, Off Refuge	1	ambiguous data
28	GPS coornates estimated	5	ambiguous data

original order from pivot table	comments that include coordinate information	number of records	proposed reclassification of coordinate information
29	GPS location is about 100 yds. East of nest.	8	ambiguous data
30	GPS off of GIS	3	ambiguous data
31	GPS off of GIS, Checked for on 4/6/2011	10	ambiguous data
32	GPS~100yds. W	19	ambiguous data
33	GPS~120yds SW	23	ambiguous data
34	GPS~150yds W	35	ambiguous data
35	GPS~230yds ESE	19	ambiguous data
36	GPS~30yds SW	16	ambiguous data
37	GPS~40yds SW	21	ambiguous data
38	GPS~50yds E, COTTONWOOD	36	ambiguous data
39	GPS~50yds SSW, SILVER MAPLE, 2 1/2	16	ambiguous data
40	GPS~50yds SW	18	ambiguous data
41	GPS~70yds S	16	ambiguous data
42	Moved from IA to MN; GPS~80yds SW	16	ambiguous data
43	need coordinates	2	ambiguous data
44	Need GPS coordinates	1	ambiguous data
45	Nest on Trempealeau NWR. Approximate GPS coordinates	7	ambiguous data
46	new coordinates	26	ambiguous data
47	Winter 2012 need to verify location	10	ambiguous data
	total number of records referring to coordinates or geospatial information	547	
	total number of records with comments that are ambiguous and geospatial data should not be used	501	
	total number of records with comments that indicate the geospatial information is reliable	46	