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Send all manuscripts and correspondence to the Editor; information for "Seasonal Field Notes" should be sent to the Associate Editor or the appropriate Field Note Compiler. Manuscripts that deal with information on birds in the State of Wisconsin, with ornithological topics of interest to WSO members, or with activities of the WSO will be considered for publication. All manuscripts submitted for possible publication should be typewritten, double-spaced, and on only one side of page-numbered typing paper. Illustrations should be submitted as photographs or good-quality drawings. Keep in mind that illustrations must remain legible when reduced to fit on a journal page. All English and scientific names of birds mentioned in manuscripts should follow *The A.O.U. Check-List of North American Birds (7th Edition)*. Use issues after Vol. 50, No. 1, 1988, as a general guide to style.

Assessing Our Wetland Birds and Habitats

It has long concerned me that we know less about wetland birds than about any other avian group. Although they comprise nearly 70% of Wisconsin's breeding avifauna—a greater proportion than any other assemblage of birds—wetland species are poorly represented in data from the federal Breeding Bird Survey and other standardized bird counts. This is, in part, due to the inherent difficulties of performing field censuses in wetland habitats, but also to a reluctance by many observers to enter into the wetland domain to study birds. If, however, one can devote a half-day or more to wetland bird observation—let's say by way of a June canoe foray into a large marsh—and can look past the mosquitoes and flies (not always easy to do), a wonderful natural world defined by the interspersion of water and aquatic plants will reveal itself. Here may be found a grand community of animals and plants, of which birds are a significant part.

In order to take stock of our current knowledge of wetland birds in Wisconsin, WSO convened a Wetland Birds Symposium at Sentry World in Stevens Point on 26–27 February 1999. Cosponsored by the Madison Audubon Society, Wisconsin Department of Natural Resources, Wisconsin Wetland Association, U.S. Fish and Wildlife Service, and the Wisconsin Steering Committee for the North American Waterfowl Management Plan, the event drew nearly 200 people and included over 20 speakers. Presentations covered a plethora of recent and historical information on wetland birds and their habitats. For those of you who missed this important event, this special issue of *The Passenger Pigeon* will afford you the opportunity to read about much of what you missed.

Presentations on the symposium's first day focussed on a variety of species or species groups, including Common Loon, Double-crested Cormorant, Great Blue Heron, Trumpeter Swan, Mute Swan, rails, Black Tern, Osprey, Sandhill Crane, Red-shouldered Hawk, floodplain forest songbirds, and waterfowl. In the evening, participants were treated to a rousing post-banquet talk by WDNR naturalist Bill Volkert on the importance of wetlands to Wisconsin birds within the context of wetland degradation and restoration at Horicon Marsh.

The conference's second day focused on research and management programs at several of the states premier wetland complexes, including Rush Lake, Necedah National Wildlife Refuge, Upper Mississippi River National Wildlife and Fish Refuge, St. Croix National Scenic Riverway, Crex Meadows Wildlife Area, and Lake Superior's coastal wetlands. The information shared allowed participants to learn about the remarkable diversity and richness of our wetland ecosystems, and to appreciate more fully what we have within our state borders.

As you read the articles in this volume, reflect for a moment on the places near you that contain wetlands and whether you have visited them—a marsh,

sedge meadow, floodplain forest, or other type—among the myriad of wetland communities defined eloquently by WDNR ecologist Eric Epstein at the symposium's beginning.

This year and beyond, I encourage you to learn more about the wetlands and wetland birds in your area. And, if you care to do so, become active in teaching others about wetlands and in efforts to preserve them through such organizations as the Wisconsin Wetlands Association (608-250-9971), headquartered in Madison. For now, within the boundaries of this volume, sit back, explore, and absorb.

President

A Special Issue on Wisconsin's Wetland Birds and Habitats

Did you know that:

- the lakes on which Wisconsin Common Loons produce the most chicks—those between 25 and 50 acres in size—are also the lakes under the most pressure from shoreline development?
- floodplain forests like those along Wisconsin rivers—havens for imperiled songbirds and Red-shouldered Hawks—represent a globally threatened resource?
- Northern Pintails are renowned among Wisconsin's prairie-nesting ducks for their promiscuity?
- important wetland habitats at Horicon, Necedah, and Crex Meadows—once all but decimated by ditching and draining for agriculture—are a product of historical and ongoing restoration efforts?

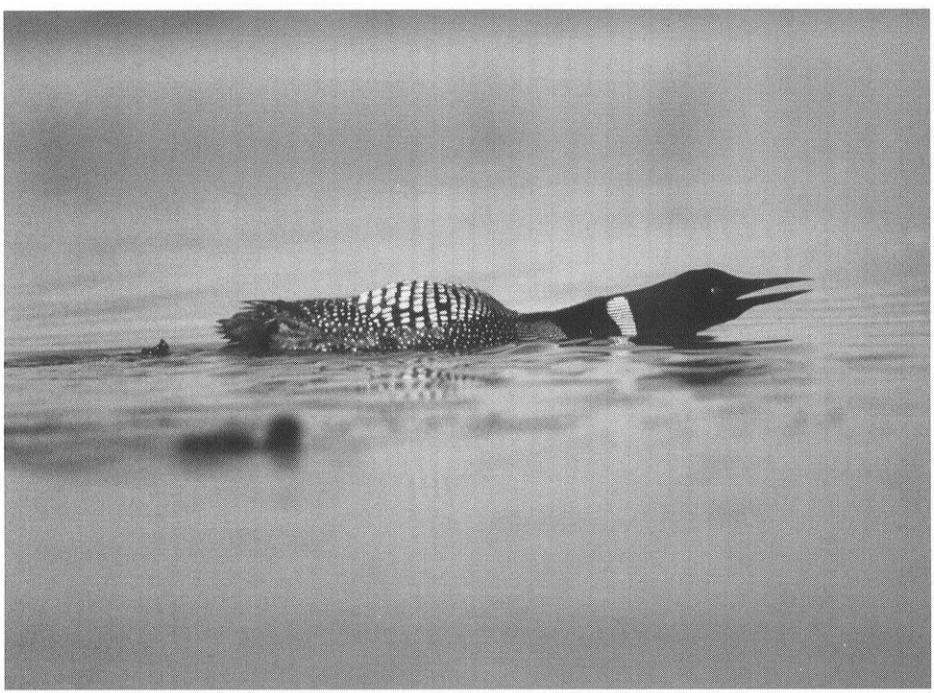
Even if you did, you will still learn much more about these and diverse other topics in this special issue of *The Passenger Pigeon*, based on presentations given at WSO's February 1999 Wetland Birds symposium in Stevens Point.

The symposium was a truly exciting gathering, providing bird and wetland experts from across the state and beyond a venue in which to bring each other and the public up to date on research and management issues involving the state's wetland birds. As I listened to speakers and scribbled notes during the two-day event, I was struck not only with the consistently high quality of the presentations, but with the vital importance of the information I was hearing. Others in attendance agreed, and their comments that the speakers' messages deserved a much larger audience were the impetus for this volume.

The articles that follow detail many different perspectives and approaches to the conservation of wetland birds and habitats in Wisconsin. Some articles are status reports or updates on particular species or conservation programs; some are technical presentations of research and monitoring efforts; yet others describe the history of land use and conservation at specific wetland sites. All of them will repay a careful reading. Together, they represent the accumulated knowledge and expertise of many people, from professional staff in state and federal wildlife agencies to workers in nonprofit conservation organizations to energetic private citizens.

I'm sure all WSO members join me in thanking the symposium speakers, as well as Bettie Harriman, Kent and Sue Hall, and the many others who helped to conceive and/or organize the event. My personal thanks go out to the many authors and artists who contributed to this issue—it was a delight working with you.

R. Tod Highsmith, Editor



Common Loon *by Gregory M. Nelson*

The Common Loon in Wisconsin

*Common Loon (*Gavia immer*) populations are doing well in Wisconsin, but environmental contaminants such as mercury and continuing shoreline development on northern lakes remain causes for concern.*

by Theodore J. Gostomski

The Common Loon (*Gavia immer*) is a well- known and much-loved bird of the northern forest region. To many, the loon represents northern lakes and is a stamp of authenticity on wilderness. The naturalist and author, Sigurd Olson, wrote that the loon is "the symbol of the lake country, the sound that more than any other typifies the rocks and waters and forests of the wilderness" (Olson 1958, p. 62). Olson's allusion to the loon's call captures the first experience many people have with the Common Loon—a haunting voice in the darkness that signifies solitude and peace.

Natural History of the Common Loon in Wisconsin

The Common Loon historically nested throughout Wisconsin and, prior to the turn of the century, was regarded as a "common breeder on the small lakes from the southern tier of counties northward" (Kumlien and Hollister 1951; pp. 2–3). Since that time, the species has exhibited a contraction of its entire North American range. Whereas loons in the Midwest formerly nested as far south as northern Iowa, Illinois, Indiana, and Ohio, they are now found only in the northern portions of Minnesota, Wisconsin, and Michigan, with the southern edge of their North American range now in southwestern lower Michigan (McIntyre 1988). However, recolonization within the former range has been reported in Pennsylvania and Massachusetts, as well as a greater frequency of winter residence on reservoirs in Alabama and Georgia (McIntyre and Barr 1997).

Loons are generally found on clear, oligotrophic lakes with a good supply of fish (McIntyre and Barr 1997). They prefer lakes surrounded by forests and having islands and bays, but will also nest on lakes with light to moderate shoreline development if nest sites, chick rearing habitat, and abundant food are available and water quality is good. Lake size is thought to be a determining factor in territory selection, with larger lakes supporting greater

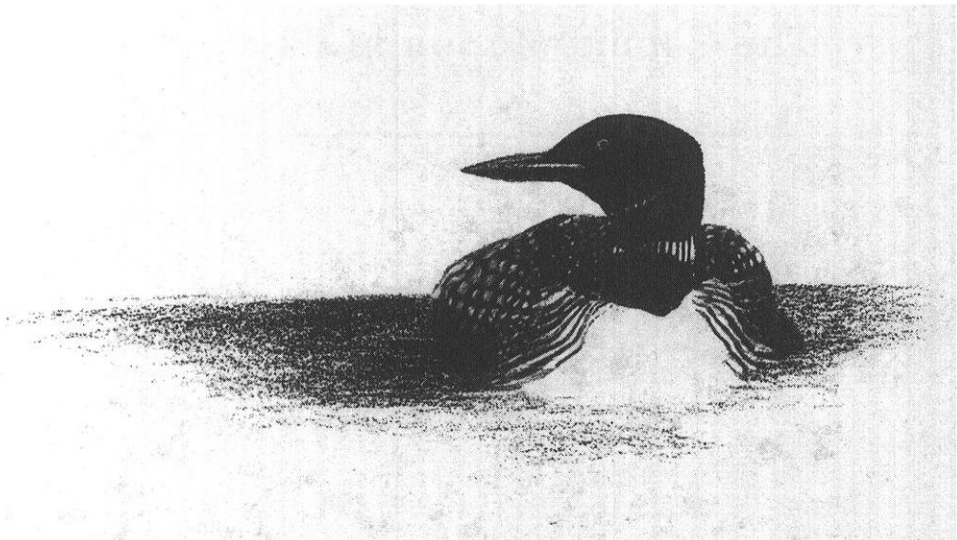


Figure 1. Naturalist and author Sigurd Olson called the Common Loon "the symbol of the lake country." Drawing by Steve Lubahn.

numbers of nesting loons (McIntyre 1988). The average loon territory is about 50 acres in size, but the birds will sometimes nest on lakes as small as 12 or 14 acres. Lake shape may be a more critical factor than size, however, and the size of a territory is often determined by the natural features of the lake. Even small to medium lakes (22 to 88 acres) can support two loon pairs if physiographic features such as bays and islands form visual barriers between the territories (McIntyre 1988). Conversely, large lakes that are round with no bays or other shoreline indentations can be successfully defended by a single pair of loons.

Loons prefer to nest on islands if they are available. Islands provide protection from terrestrial nest predators such as raccoons (*Procyon lotor*), skunks (*Mephitis mephitis*), and mink (*Mustela vison*), while also allowing separation from the busyness of human-occupied shorelines (McIntyre and Barr 1997). Nests are typically located at the water's edge to facilitate quick and inconspicuous arrivals and exits (McIntyre and Barr 1997). If loons are able to slide off their nest when danger approaches and subsequently return to it without being seen, aerial predators such as Herring Gulls (*Larus argentatus*), American Crows (*Corvus brachyrhynchos*), and Northern Ravens (*Corvus corax*) will be less likely to discover the nest and steal the eggs. Though a loon pair can habituate to human presence and activity on a lake, too much activity, or activity at the wrong time (for example, during nesting or the first four to six weeks of the chick-rearing stage), can cause loons to abandon a nest or lose their young. Continued nest failure can lead loons to abandon a lake altogether.

Loons are visual predators, meaning that they actively search out prey before diving to catch it. This searching for prey occurs when loons put their

faces below the surface of the water, a behavior called "peering" (McIntyre 1988). Because loons prefer to see their prey before submerging to catch it, water clarity is an important factor in nest site selection, as is a healthy supply of fish of all sizes.

Loons are opportunistic foragers who eat primarily fish, but they also feed on aquatic invertebrates and occasionally vegetation, the latter consumed when individuals are stressed or ill (Barr 1973, McIntyre and Barr 1997). Where fish are scarce or the water is murky (1.0 meter visibility or less), loons have been known to feed on crustaceans, such as crayfish (*Decapoda* spp.), and on leeches. Fish between 10 and 70 grams form the predominant diet of adult loons, while young loons, depending on their age, are fed fish between 1.0 and 10 grams (McIntyre and Barr 1997). The most common fish species taken by loons in the Great Lakes region is the yellow perch (*Perca flavescens*), but any fusiform (tapered), soft-scaled species may be caught, particularly those that exhibit atypical or erratic behavior within a school (McIntyre 1988, McIntyre and Barr 1997). Loons that utilize lakes with turbid water (low visibility) have been reported to take sub-optimal prey items. Evers (1993) reported that brown bullhead (*Ictalurus nebulosus*), a bottom-feeding fish, composed more than 95% of the diet of adult loons nesting in the Seney National Wildlife Refuge in the Upper Peninsula of Michigan. Though not quantified, the refuge pools are extremely turbid, creating low visibility in the water column and likely causing loons to have to spend more time foraging. Behavioral observations, though not statistically significant, support this hypothesis (Evers et al. 1996).

Loons are currently faced with a number of threats to their survival in Wisconsin and throughout their range, most of which are anthropogenic. Contaminant loading, particularly of mercury, in the blood and feathers of both young and adults is a great cause for concern, and continues to be intensely studied (Belant and Anderson 1990, Meyer et al. 1995, Evers et al. 1998). Shoreline development is another problem that has received some attention in Wisconsin (Jung 1991, Meyer et al. 1997). However, Meyer et al. (1997) could not define a direct link between shoreline development and loon productivity, primarily because loons on their study lakes exhibited elevated levels of mercury in their blood. Consequently, any change in productivity could not be directly tied to shoreline development because of the interaction of the effects of mercury. Their continued studies should provide a clearer picture of the separate effects that development and mercury are having on loon productivity.

Wisconsin Loon Monitoring

The LoonWatch program of the Sigurd Olson Environmental Institute in Ashland, Wisconsin, is responsible for maintaining records of the state's loon population and nesting success. Since 1978, LoonWatch has coordinated an annual monitoring program using citizen volunteers and natural resource agency personnel. The annual monitoring is not designed to document trends in loon productivity, but instead serves to keep a finger on the pulse of loon nesting on non-randomly selected lakes across the species' state

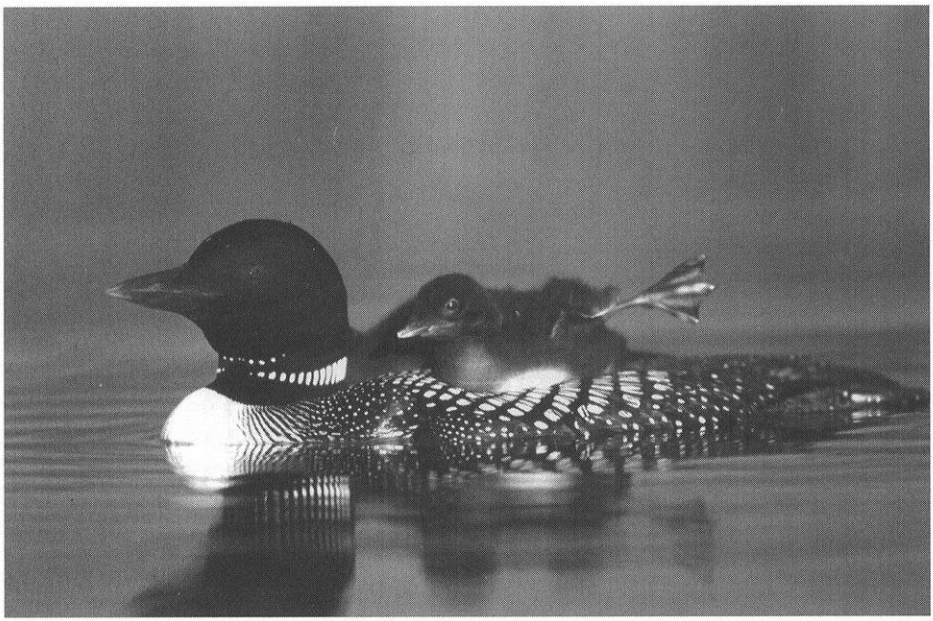


Figure 2. Among the threats facing Common Loon families in Wisconsin are mercury contamination and loss of shoreline nesting habitat. Photo by Gregory M. Nelson.

breeding range. In addition, information provided allows the documentation of encroachment on loon habitat, problems on particular lakes that may decrease productivity, and the annual use of lakes by migrating and nonbreeding loons as well as territorial pairs.

In 1985, LoonWatch and the Wisconsin Department of Natural Resources (WDNR) devised a survey to estimate the state's loon population (both adults and young of the year). This survey is conducted every five years and consists of counting the number of adults and young on randomly selected lakes during a single day in mid–July. Lakes are classified according to size into one of four categories: 25–49.9 acres, 50–149.9 acres, 150–499.9 acres, and 500+ acres. Results from the most recent survey, conducted in 1995, were reported by Daulton et al. (1997), and the following summary is taken largely from that paper.

Table 1 compares the results of the 1995 survey to those done in 1985 and 1990. Both the number of adults and young increased each time the survey was conducted, and the increase between 1985 and 1995 was statistically significant. Counties with loons present on 75–100% of surveyed lakes were Marinette, Lincoln, Iron, Sawyer, and Chippewa. The following counties had loons present on 50–74% of surveyed lakes: Vilas, Oneida, Burnett, Polk, Oconto, Price, Forest, Washburn, Langlade, and Taylor. Fifty-seven percent of the adult loons and 70% of the chicks were found on lakes less than 150 acres in size during the 1995 survey. Interestingly, the average number

Table 1. Summary of Common Loon population surveys for Wisconsin, 1985, 1990, 1995 (Daulton et al. 1997).

Year	No. of Lakes Surveyed	No. of Adults	No. of Chicks
1985	185	2,358	516
1990	207	2,420	608
1995	191	3,017	678

of adult loons per lake was highest on the 50–150 acre size class, but the greatest proportion of the chick population (43.6%) was found on the smaller lakes (25–50 acres). It is these smaller lakes that are most at risk due to the threat of development.

The Wisconsin Department of Natural Resources (1996) reported that of the approximately 12,400 lakes north of State Highway 29 in Wisconsin, approximately two-thirds are less than 10 acres in size, and almost 90% are under 50 acres. Of those lakes 10 acres and larger, approximately one-quarter remain entirely undeveloped today. Development is increasing on northern lakes, however, with the highest rates of development occurring on lakes that are 10–49 acres and 200–999 acres in size (WDNR 1996). Overall, there has been a 216% increase in the number of dwellings on northern lakes since the 1960s, and, if current rates continue, the remaining privately owned undeveloped lakes could be developed by 2015.

The results of the 1995 survey indicate that loons are doing well in Wisconsin, as illustrated by a significant increase in their population over the past 10 years. Chick production is highest on the smaller lakes (25–50 acres), but these are also the lakes under the most amount of development pressure. Monitoring and five-year population surveys will continue to be conducted by LoonWatch and the WDNR, and these data will determine the need for specialized areas of study and will underscore the importance of shoreline restoration and protection. In addition, the results of Meyer et al. (1997) have been disseminated to northern county zoning administrators and lake associations to better equip them with information needed to enhance shoreland zoning regulations and to work at the individual level to maintain the ecological, aesthetic, and economic values of our northern lakeshores.

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Changes in the Status, Distribution, and Management of Double-crested Cormorants in Wisconsin

*From only 66 nests in 1973, the state's Double-crested Cormorant (*Phalacrocorax auritus*) population now numbers over 10,000.*

by Sumner W. Matteson, Paul W. Rasmussen, Kenneth Stromborg, Thomas I. Meier, Julie Van Stappen, and Eric Nelson

We reviewed and summarized historical data, and conducted population surveys during 1973–1997, to determine the breeding status and distribution of Double-crested Cormorants (*Phalacrocorax auritus*) in Wisconsin (Figure 1). Breeding cormorants historically occupied large, isolated lakes and wetlands in northern Wisconsin, but there were no known nesting sites until 1919, when cormorants were reported nesting on Lake Wisconsin in south-central Wisconsin. During the 1920s through 1950s, cormorants occupied 17 colony sites in 16 different counties, though no more than seven sites were occupied during any particular year. From the 1950s to the early 1970s, the number of cormorant nests and colony sites plummeted due to bioaccumulation of DDT and its metabolites, human persecution at some colony sites, and habitat loss. The installation of 1,269 artificial nesting platforms at 13 locations in north central, northeastern, northwestern, east central, and southwestern Wisconsin, coupled with a decline in DDE levels in breeding birds, as well as protection as a state endangered species, led to a marked recovery. Between 1973 and 1997, the state's breeding population grew at an annual rate of nearly 25%, from 66 nests at three colony sites to 10,546 nests at 23 colony sites. We estimated population trends for six geographic regions in the state determined by distinct distribution patterns of nesting birds. Cormorant populations for five of six regions increased during 1973–1997. Trends differed significantly among regions, with a greater estimated increase in Great Lakes sites ($P < 0.01$). In 1997, 81% of the state's breeding population occurred on four islands in Green Bay, Lake Michigan. Increasing Lake Michigan Double-crested Cormorant populations have raised concerns among sport and commercial fisheries about impacts on yellow perch (*Perca flavescens*), although recent studies indicate

Figure 1. Double-crested Cormorants roosting on a rocky beach, Apostle Islands National Lakeshore, Lake Superior, Wisconsin. Photo by Sumner Matteson.

that alewives (*Alosa pseudoharengus*) predominate in cormorant diets.

[This article was abstracted from a longer article that appears in: Tobin, Mark E. (tech. coord.). 1999. Symposium on double-crested cormorants: population status and management issues in the Midwest; 7 December 1997, Milwaukee, WI. Tech. Bull. 1879. Washington, DC: U.S. Department of Agriculture, Animal and Plant Health Inspection Service.]

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Mute Swans in Wisconsin: the Rise and (Projected) Fall of an Exotic Feral Species

*The exotic Mute Swan (*Cygnus olor*) poses a threat to Wisconsin's native waterfowl, especially the state-endangered Trumpeter Swan (*Cygnus buccinator*). The author describes measures underway to control the species.*

by Patricia F. Manthey

There are four species of large, white waterfowl that one may encounter in a Wisconsin marsh: the Snow Goose (*Chen caerulescens*), Trumpeter Swan (*Cygnus buccinator*), and Tundra Swan (*Cygnus columbianus*), all of which are native to North America, and the exotic Mute Swan (*Cygnus olor*).

The Mute Swan originated in Eurasia, where it was valued for its beauty and for its value as food, and was brought to America in the early 1900s to grace estates and ponds (Long 1981) (Figure 1). Some individuals escaped to thrive in the wild, and, like many exotic species, their numbers increased exponentially. Feral Mute Swans were first observed in Wisconsin in 1958 and 1963 (Robbins 1991). By the early 1970s, they had established populations in northwestern and southeastern Wisconsin and have since spread out from there. We have two good indices to the Mute Swan population in the state—Christmas Bird Count data and Mike Mossman's Mukwonago Study Area surveys. Both of these sources show that the population has increased but now appears to be leveling off.

Why are we concerned about this species? Mute Swans can affect the availability of habitat for native waterfowl, especially the state-endangered Trumpeter Swan. They nest in some of the same wetlands where the Wisconsin Department of Natural Resources (WDNR) is trying to establish Trumpeter Swan breeding populations, and they fight with and drive the Trumpeters and other waterfowl away. They also use up nesting habitat and food resources needed by native species, and their foraging can damage beds of aquatic vegetation. Mute Swans can also be aggressive to humans and their pets.

Because of these concerns, WDNR formed a Mute Swan Committee to evaluate the problem and to make recommendations. After determining the

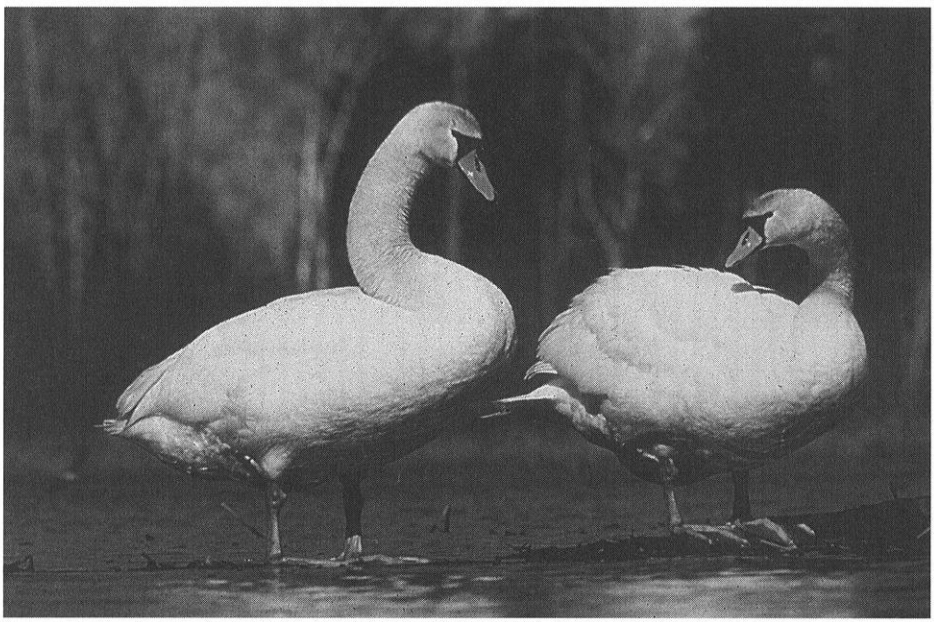

Figure 1. A pair of Mute Swans on a Wisconsin pond. Photo by Wisconsin Department of Natural Resources.

state and federal legal status of the swans and obtaining the U. S. Fish and Wildlife Service's position on controlling the species, a strategy was designed to control Mute Swans in Wisconsin. Public informational meetings were held throughout the state to inform the public about the plan and to get their input. Response from individuals and conservation organizations overwhelmingly supported control efforts. WDNR Secretary George Meyer informed the Natural Resources Board of the control plans.

WDNR proposed the following control strategies: removal of adults to captivity, egg treatments to prevent hatching, sterilization of adults, humane euthanization of adults, and prevention of further escapes from captivity. Thus far, we have concentrated primarily on treating eggs by injecting them with a diluted solution of household bleach, followed by shaking. A pilot project in 1997 tested this method and found it to be effective. WDNR wildlife management staff around the state have learned the procedure. Adult Mute Swans that directly interfere with Trumpeters have been removed from the wild to captivity. We have shelved the sterilization/vasectomy option as too expensive. We have proposed changes to the game farm laws to ensure that captive Mute Swans remain captive.

It is clear that if we are to reach our goal of eliminating the Wisconsin feral Mute Swan population by 2005, we need to increase our rate of removal of adults from the wild. If appropriate captive placement is not available, they will be humanely euthanized. We have a good start at control. We hope that

by 2005 our aerial swan surveys will show only native Trumpeter Swans.

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50 Years Ago in *The Passenger Pigeon*

The circumstances surrounding Wisconsin's second record of a Dovekie (*Alle alle*) were described in an interesting article by Dorothy M. Mead in Volume 11, No. 3, 1949 of *The Passenger Pigeon*. The dead bird was found beneath telephone lines along Highway 12 in Monroe County on March 3, 1949 by Joe Rice, an employee of the Wisconsin Conservation Department's Tomah Ranger Station. (Wisconsin's first record was shot near Port Washington, Ozaukee County, in 1908.) Fortunately Ms. Mead, who lived in Tomah and wrote a weekly nature column, recognized its significance. The bird was placed in an unused, unheated room, but as Ms. Mead relates, "One member of the family, fearing spoilage, threatened to take the bird out and burn it! But I firmly refused to allow anyone to touch it. I explained that the Dovekie was a rare find and would be properly taken care of as soon as I could see a way."

On March 6, she wrote Sam Robbins a letter about the bird and received a telegraph on March 9 from John Emlen, who, along with congratulations, asked her to "express it collect" to the Zoology Department, University of Wisconsin. A letter from Emlen on March 21 included this interesting tidbit:

"The stomach of the bird was empty except for one piece of quartz. We are going to ask the geologists if they can give us any idea as to the place of origin of the stone." A picture of the specimen is included in the article. There are no other Dovekie records from Wisconsin.

Tundra Swans at A&W Ponds, Dodge County *by Jack Bartholmai*

Wisconsin's Prairie Ducks: Traits and Trends

*Wisconsin's prairie ducks employ a variety of reproductive strategies that enable them to succeed in an unpredictable environment. Data from 26 years of Wisconsin Spring Duck Surveys show that Mallard (*Anas platyrhynchos*) numbers have increased greatly while those of Blue-winged Teal (*Anas discors*) have greatly declined.*

by Ron Gatti

Nine duck species nest in the prairie region of southern Wisconsin: Mallard (*Anas platyrhynchos*), Blue-winged Teal (*Anas discors*), Green-winged Teal (*Anas crecca*), American Wigeon (*Anas americana*), Ruddy Duck (*Oxyura jamaicensis*), Northern Shoveler (*Anas clypeata*), Northern Pintail (*Anas acuta*), Gadwall (*Anas strepera*), and Redhead (*Aythya americana*). Wisconsin's prairie duck community is strongly dominated numerically by the Mallard (60%), and sharply drops off to Blue-winged Teal (31%). The remaining seven species comprise only 8% of total prairie duck numbers, mainly because Wisconsin is at the edge of these species' ranges.

Ducks have traits that are unique in comparison with other groups of birds; these traits interact to form a reproductive strategy that is both shaped and constrained by the dynamic prairie ecosystem. Prairie wetlands are extremely productive ecosystems that give great seasonal pulses of food resources that vary drastically within and among years. As a result, ducks have become very flexible in their habitat selection, food habits, and reproductive strategy on the prairies.

Biology of Wisconsin's Prairie Ducks

Prairie ducks lay large clutches of energy-rich eggs. To meet these huge energy needs in an unpredictable environment, most ducks store body energy supplies ahead of time on the wintering grounds and import this energy to spring prairie marshes for nesting. Because they secure food resources on the wintering grounds, they select mates there as well and migrate together as a pair, unlike most birds. Because they are getting their food and mates away from breeding grounds,

most male ducks do not defend territories of food resources on the prairies. The male instead defends a "moving area" around the hen in order to protect his genetic investment in her eggs.

The energy-rich eggs are incubated only by the hen, and they hatch into highly precocial young that need little parental care. These conditions free male ducks to concentrate on their own survival or to pursue alternative reproductive opportunities (such as courting additional females). Males generally abandon their original hen at the start of incubation, after they are certain of the paternity of her eggs. Without breeding territories to defend, males do not return to the same breeding site in subsequent years. Unlike other bird groups, duck females (but not males) return every year to the same prairie wetlands where they were reared. Duck pair bonds last for only part of one breeding season, and they pick new mates each year on the wintering grounds.

There are some general differences between the reproductive strategies of dabbling and diving ducks. Diving ducks, such as Redheads (Figure 1), live longer and do not invest as intensively in reproduction. They do not breed during their first year of life, and rarely renest in the same year if their initial nest fails. They form pair bonds later in the winter or on migration, arrive later on the prairies in spring, and wait longer after arrival to nest than do dabblers. They occupy more stable and less productive habitats in the more permanent wetland basins and are somewhat more monogamous than dabblers.

Dabbling ducks (Figure 2), on the other hand, have shorter life spans and invest more heavily in reproduction. They breed during their first year, pair early in winter, and return north to nest late in spring. They initiate nesting shortly after spring arrival, and renest following nest destruction. Dabbling ducks are adapted to exploit the most temporary wetlands with extremely patchy, unpredictable food resources that vary over time. They are more flexible in moving to find and use food patches, which allows them to respond more quickly to good wetland conditions and to be more productive than diving ducks.

A diversity of reproductive strategies exists within the prairie duck community. Mallards, for example, are highly adaptable generalists, a trait that accounts for their success across our state. Northern Pintails are the most promiscuous of the group, forming weak pair bonds that break down while the female is still laying eggs; males then switch to a strategy of mating with other hens. The Northern Shoveler social system is based on that species' feeding method of straining very small invertebrates from the water with its specialized bill. This method is very time consuming and requires males to protect feeding females from other males during frequent breaks from incubation. Shovelers have strong pair bonds that last into late incubation. They also display classical territorial defense of feeding areas, with the most aggressive encounters among prairie ducks.

Blue-winged Teal also form strong pair bonds that last into late incubation; they winter the farthest south, and return north and nest late in spring. Blue-winged Teal do not home to natal marshes very consistently, but instead settle where they find good water conditions in spring.

Figure 1. Diving ducks, such as this drake Redhead, are long-lived and rarely breed during their first year. Photo by Jack Bartholmai.

Figure 2. Gadwalls, like many dabbling ducks, have relatively short life spans and commonly breed as one-year-olds. Photo by Jack Bartholmai.

Green-winged Teal are the smallest of the prairie ducks and have the highest annual mortality rate. Like Northern Pintails, they have weak pair bonds with little aggression between conspecifics. Gadwalls form pair bonds early, but nest late in the spring; their diet of submergent aquatic plants is low in nutrition, requiring three to four weeks for nutrient acquisition for eggs. Gadwalls display strong homing to past nest sites and also nest semicolonially.

Redheads commonly exhibit the unusual behavior of brood parasitism, in which females lay eggs in the nests of other females. This practice is variable in its application; some Redhead females nest normally, others only practice parasitism, and some do both in a given year. Brood parasitism allows females to increase their productivity or to salvage breeding success when stressed.

Ruddy Ducks make the greatest relative investment in egg production of the prairie ducks. Unlike other species, the Ruddy stores egg nutrients and forms pair bonds on the prairies, with the males arriving on the nesting grounds before the females.

Prairie ducks have evolved in a very dynamic ecosystem that requires flexibility in order to assure survival. They increase their reproductive efforts to take advantage of good conditions, and decrease reproductive effort when conditions are bad. Reproduction during a drought, for example, incurs higher mortality risks with a lower probability of successfully fledging young. As a result, many prairie ducks forego reproduction during drought, a strategy of waiting for better times. Mallards and Northern Pintails often overfly the prairies during drought to improve their survival in the boreal forests or Arctic. The gains of nesting are weighed against survival risks and future life expectancy. Nesting during a drought is attempted mainly by older hens; young birds, with most of their lifetime reproductive value ahead of them, avoid the risks of nesting during these periods and opt to increase their chances for survival. This is termed a temporally dynamic reproductive strategy, one that can vary in time and space relative to environmental or self constraints.

Wisconsin Prairie Duck Population Trends

The Wisconsin Department of Natural Resources has surveyed Wisconsin's duck abundance in May every year since 1973 through the Wisconsin Spring Duck Survey (WSDS). Ducks are counted within four strata of density from the air on scattered, strip transects each 30 miles long and one-quarter mile wide. Ducks are also counted from the ground on selected transect segments to determine the visibility rate from the air. Data are summarized for three species groups to calculate population estimates: Mallards, Blue-winged Teal, and all other ducks combined.

The average WSDS from 1994 to 1998 estimates annual statewide breeding populations of 225,000 Mallards and 87,900 Blue-winged Teal. The population estimate for all other ducks (202,000) is less precise, but primarily consists of non-prairie species, Wood Ducks (99,000), and Ring-necked Ducks (58,000), with 12 other species totaling 45,000. Over the 26 years of the survey, Mallard populations have shown a curvilinear increase that ac-

celerated in the late 1980s and averaged a 5% increase per year (Figure 3).

Another source of duck abundance data is the number of ducks seen during ground-truthing in the WSDS. Although this count is done on only 65 square miles statewide, an average of over 200 Mallards were seen in these ground counts each year. The ground count data show the same longterm trend of increasing Mallards, averaging a 5% increase per year. A third source is the federal Breeding Bird Survey (BBS). Because it is a roadside survey that more efficiently surveys birds by sound than sight, you would not expect it to be very sensitive to duck abundance trends. Nonetheless, Wisconsin BBS data also show an increase over time for Mallards that averages 4% per year.

All three data sources indicate that the Blue-winged Teal population has declined over time (Figure 3). The population estimates and ground counts from the WSDS and the Wisconsin BBS index all average a 2–3% decrease per year from 1973 to 1998. Wood Duck population estimates from the WSDS are highly variable, but ground counts from the WSDS and the Wisconsin BBS data both indicate an increasing Wood Duck population that has averaged a 9–10% annual increase from 1973 to 1998.

Blue-winged Teal outnumbered Mallards in the 1970s and early 1980s in Wisconsin. After 1982, this has reversed and we now have over twice the number of Mallards as Blue-winged Teal. The reason for the Blue-winged Teal decline is uncertain, but evidence points to the alfalfa agriculture that is unique to Wisconsin: Blue-winged Teal are attracted to hayfields for nesting more than Mallards, and hayfield mowing operations kill nesting females along with eggs. Several factors are coincidental to the timing of the Mallard increase: the Conservation Reserve

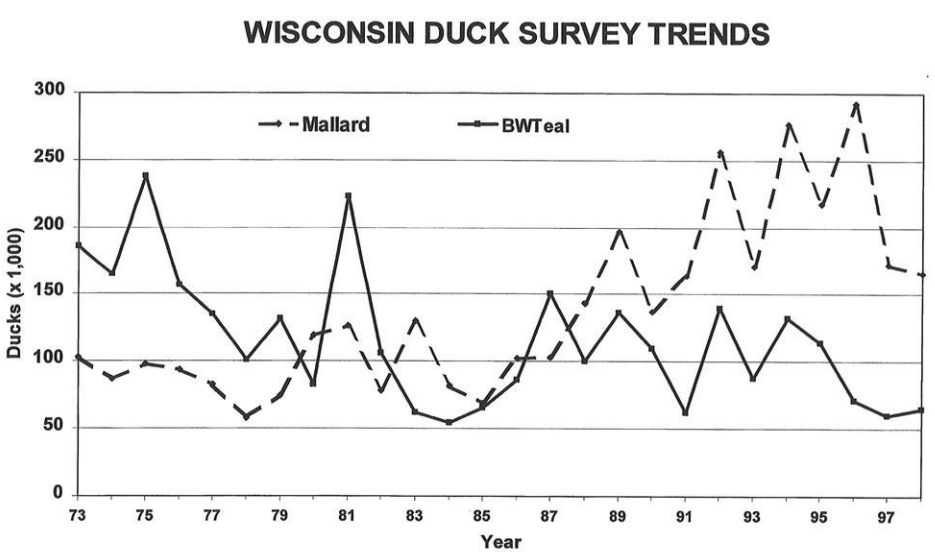

Figure 3. Population estimates of Mallard and Blue-winged Teal from the Wisconsin Spring Duck Survey, 1973–1998.

Program improved upland habitat, wet years improved wetland habitat, predator numbers declined, and hunting pressure declined. All of these factors, except for the last, would also benefit Blue-winged Teal. The most recent data hint that the Mallard population increase has stopped and that hunting pressure is again increasing on Mallards.

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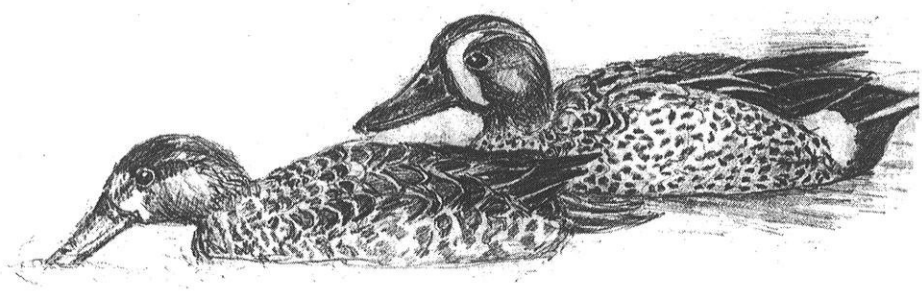

Blue-winged Teal *by Karen R. Whitford*

The Osprey in Wisconsin

*The author summarizes 26 years of data on the Osprey (*Pandion haliaetus*) in Wisconsin. Severely impacted by organochlorine pesticides in the 1950s and 1960s, the state's Osprey population has rebounded to over 400 nesting pairs in 1998.*

by Ron Eckstein

The Osprey (*Pandion haliaetus*) is a rather noisy, fish-eating raptor with distinct features. While perched, the Osprey appears unsophisticated; in flight, it is spectacular. The Osprey parallels the Peregrine Falcon in being specialized to a particular way of capturing food that enables it to occupy habitats across large areas of the world (Beebe 1974). The Osprey combines the plunging technique of the tern or pelican with the raptorial foot, and makes an honest living by plunging below the water to capture live fish. In Wisconsin, favorite prey include bullheads, perch, crappies, bluegills, and other hand-sized fish.

The large stick nests built by Osprey are always at the top of something, usually a snag near or over water or the very top of a live pine tree. Osprey are tolerant of people and may build their nests on manmade structures such as power lines or fire towers. Currently, over half of Wisconsin's breeding population nests on artificial platforms (Figure 1).

In North America, the Osprey is a neotropical migrant. It arrives from Central and South America soon after ice out and leaves Wisconsin by the first week in October. Events that impact the population are as likely to occur on the long stay in South America as they are on the short stay in Wisconsin.

The History of Osprey in Wisconsin

Before European settlement, Osprey nested throughout Wisconsin in suitable habitat. The exceptions include the muddy Mississippi River and, possibly, the Apostle Islands. Indiscriminate shooting and an expanding human population eliminated the Osprey from southern Wisconsin. The use of organochlorine pesticides after World War II caused the eggshell thinning syndrome that further reduced Osprey populations in the 1950s and 1960s. Organochlorine pesticides were banned in Wisconsin in 1969, largely through the efforts of Dr. Joseph

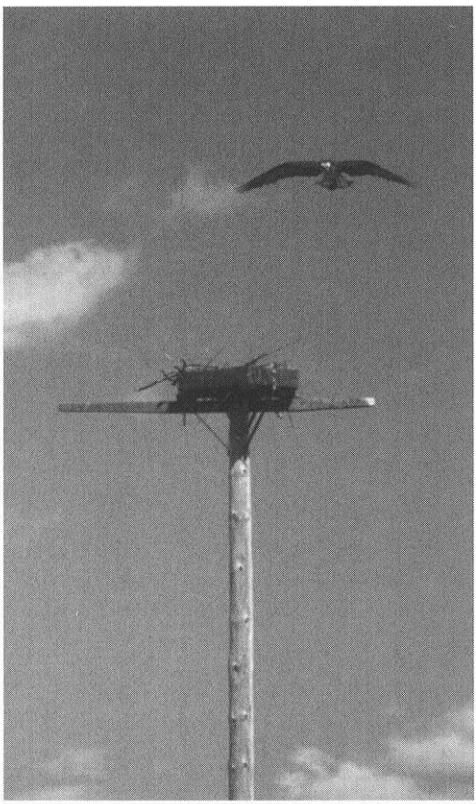

Figure 1. Over half of Wisconsin's breeding Ospreys nest on artificial platforms. Photo by Ron Eckstein.

Hickey and his colleagues at the University of Wisconsin. In 1972, the Osprey was placed on the state's list of endangered species.

Starting in the 1950s, independent researchers like Dan Berger, Charles Sindelar, and Sergej Postupalsky banded and inventoried Osprey. Statewide conservation efforts began in the late 1960s, when game managers with the Wisconsin Department of Natural Resources (WDNR) began limited aerial nest surveys and nest protection work. In 1973, more intensive aerial surveys began.

WDNR wildlife managers have conducted annual nest surveys since 1973 (Figure 2). These surveys consisted of two flights: one flight was in mid–May to determine which nests were active, and the other was in mid–July to count chicks. This 26-year history of research on Osprey distribution, abundance, and productivity has produced one of the best long term databases in Wisconsin wildlife management.

An Osprey nest platform program began in the mid-1970s and continued at a high rate of activity until 1993, when funding declined. Nest platforms replaced unstable nests and brought nest sites and nesting Osprey to places like the Rainbow, Willow, Flambeau, and Petenwell Flowages, as well as to the extensive flowages of the Mead and Crex Meadows State Wildlife Areas. Funding for WDNR work with Osprey came from the WDNR's Bureau of Endangered Species, through tax check funds and the Adopt-A-Nest Program.

Osprey Distribution and Abundance in Wisconsin

Figure 3 shows the 26-year history of Osprey in Wisconsin. Statewide, the Osprey population showed a steady, gradual increase up to 1993, when the statewide population hit a plateau. Throughout this period, there have been several plateaus, such as in 1977–1978 and again in 1982–1983. The period 1993–1998 has been the most extended period of population stability during the entire 26 years. Factors that may help explain this ceiling include competition and interference by the state's large (689 pairs) Bald Eagle (*Haliaeetus leucocephalus*) population, the decline in the Osprey platform pro-

Figure 2. Annual nest surveys of Wisconsin Ospreys began in 1973. This large chick occupies a nest in the Rainbow Flowage, Oneida County. Photo by Ron Eckstein.

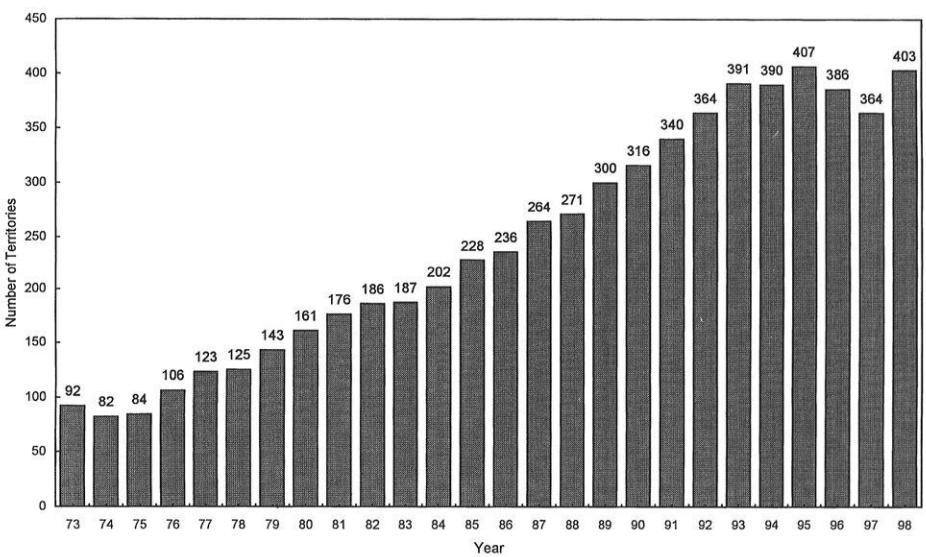

Figure 3. Number of active Osprey territories in Wisconsin, 1973 to 1998.

gram after 1993, and problems on the wintering grounds.

Figure 4 shows the statewide distribution of the 403 pairs of Osprey that nested in Wisconsin in 1998. Osprey nests are concentrated in the inland lakes region of Vilas and Oneida Counties in north central Wisconsin, and in Burnett, Washburn, and Sawyer Counties in northwest Wisconsin. Osprey love flowages and their statewide distribution is closely tied to these habitats. The population has continued to concentrate in the traditional northern inland lakes region, and has only very slowly pioneered into areas away

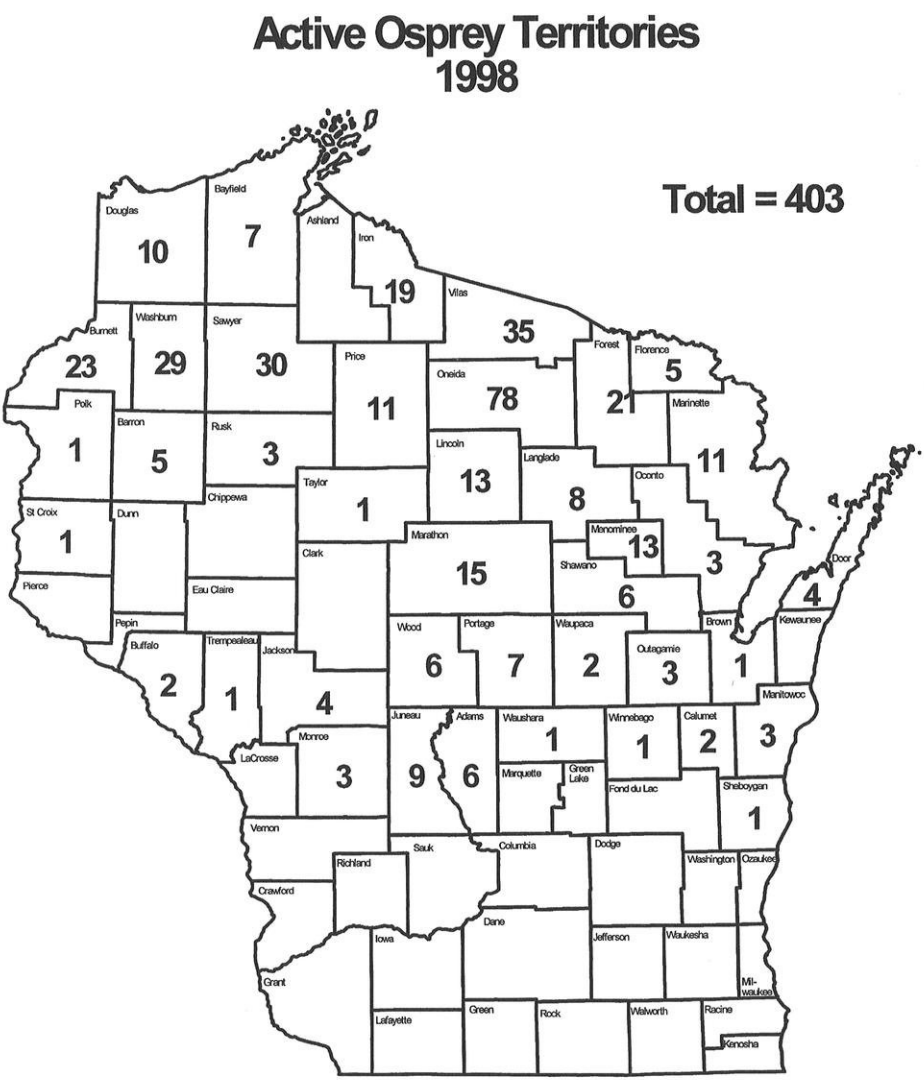

Figure 4. Distribution of active Osprey territories in Wisconsin in 1998 (total = 403). Active territories are defined as having at least one adult at or attending a nest.

Table 1. Average annual Osprey nesting success and productivity in north central and central Wisconsin, 1973 to 1998.

Location	Number of Pairs	Years of Data	Average % of Nests Successful (Range)	Average Young per Active Nest (Range)	Average Brood Size (Range)
N. Central Wisconsin	44 to 215	26	58 (43–70)	1.0 (0.6–1.3)	1.8 (1.4–2.1)
Rainbow Flowage	5 to 18	23	64 (36–77)	1.1 (0.4–2.0)	1.8 (1.0–2.7)
Mead Wildlife Area	1 to 13	23	61 (44–100)	1.4 (0.8–3.0)	2.2 (1.7–3.0)
Willow Flowage	3 to 10	16	60 (13–100)	1.1 (0.1–1.6)	1.9 (1.0–3.0)

from the Wisconsin River in central Wisconsin.

Osprey Productivity in Wisconsin

Table 1 summarizes annual Osprey nest success and productivity information. Osprey had an average annual rate of productivity of 1.0 young per active nest over 26 years in north central and central Wisconsin. This level of productivity allowed the Osprey population to slowly increase (Poole 1989). Some habitats, like the Mead Wildlife Area in Marathon County, are much more productive than places like the Rainbow and Willow Flowages in Oneida County (Table 1). Whether this is due to a greater food supply or less competition and disturbance from Bald Eagles has yet to be determined.

The Future for Osprey in Wisconsin

Osprey remain listed as a threatened species by the WDNR. Recent band recovery information needs to be analyzed to help determine if there is an increase in mortality on migration or on the wintering grounds. The role of the large population of Bald Eagles in Osprey distribution and abundance needs to be determined.

There is a great deal of suitable habitat for Osprey in east central Wisconsin on Lakes Poygon, Butte des Morts, and Winnebago. It is possible, with a little help, for Osprey to inhabit this region and other habitats in southeastern Wisconsin.

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Young Osprey in Nest *by Ron Eckstein*

Rails in Wisconsin, With a Focus on Sora and Virginia Rail

*There are five species of rails historically or currently found in Wisconsin, but little information is available on their statewide distributions, overall or by habitat. The author reviews information on Wisconsin rails and presents data from local surveys of cattail and sedge marshes on the distribution, calling phenology, and habitat preference of the two most common species, Sora (*Porzana carolina*) and Virginia Rail (*Rallus limicola*). Rails occurred most frequently and at relatively high abundances at Trempealeau, Necedah, and Horicon National Wildlife Refuges.*

by Christine A. Ribic

Rails are cryptic and secretive wetland-dependent birds about which relatively little is known. There are five species of rails historically or currently found in Wisconsin: Black Rail (*Laterallus jamaicensis*), Yellow Rail (*Coturnicops noveboracensis*), King Rail (*Rallus elegans*), Sora (*Porzana carolina*), and Virginia Rail (*Rallus limicola*). Yellow Rail is a state threatened species, and Black and King Rails are species of special concern in Wisconsin. King Rail, Sora, and Virginia Rail are huntable species, which are managed by the U.S. Fish and Wildlife Service (USFWS) (Tacha and Braun 1994).

Looking at historical information, it appears that rails (as well as other marsh birds) are one of the most understudied components of marsh systems in Wisconsin (Hoffman 1990). Basic information on their statewide status and distribution is lacking. Information on the presence of breeding rails for systematically surveyed areas throughout the state will become available in the next few years from the Wisconsin Breeding Bird Atlas (WBBA) (Wisconsin Society of Ornithology 1998). However, details on habitat use and relative abundance indices will not be available from the WBBA. The purpose of this paper is to review the distribution and abundance of rails in Wisconsin, overall and by habitat, and to present information on rail occur-

rence and habitat preference at 20 sites in southern Wisconsin. Information on the value of the call-playback survey technique and calling phenology is also presented.

Methods

Literature Review—I used information from the U.S. Geological Survey Breeding Bird Survey (BBS) (Sauer et al. 1997) and the Wisconsin Breeding Bird Atlas. Both databases have limitations. The BBS does not monitor wetland species adequately (Sauer et al. 1997, Sauer 1999), and the WBBA is still in progress so the information available is incomplete. Additional information sources were Robbins (1991) and Temple et al. (1997). *The Passenger Pigeon* from 1980 on was searched for review and research articles on specific areas in Wisconsin. Unpublished reports from the files of the Wisconsin Department of Natural Resources (WDNR) were also made available (Sumner Matteson, WDNR, pers. comm.). Data from recent local surveys (Graetz et al. 1997, Ribic 1998) were reanalyzed for presentation here.

Methodology for Local Surveys—Choice of Survey Points and Timing: All work was done on state and federal lands. We selected 20 wetlands or wetland complexes in southern Wisconsin, including some near Horicon, Necedah, and Trempealeau National Wildlife Refuges (Table 1). These areas were chosen in order to develop a large scale picture of rail distribution and abundance in Wisconsin and to verify patterns detected by Graetz et al. (1997).

The survey was designed to sample general geographic areas of wetlands or wetland complexes that included specific management units (e.g. national wildlife refuges [NWR] and state wildlife areas [SWA]). Rail survey points were randomly chosen from a group of potential survey points identified prior to the first census. To maximize coverage, all surveys took place from a road or dike. Potential survey points in an area were all points that could be "fit" around the wetlands and wetland complexes from roads or dikes using a specific survey radius and minimum distance between points (see below). For example, in areas of high wetland density, 30 points may have been chosen as potential survey points and then 15 were picked at random for the actual surveys. The survey points were later matched to specific management units for analysis here.

In May–June 1997, 63 wetland points were surveyed; in May–June 1998, 89 wetland points were surveyed. Points were a minimum of 250 meters apart (Graetz et al. 1997, Ribic et al. 1999). The first round of surveys started on 6 May in 1997 and on 14 May in 1998. All points were resurveyed starting on 28 May in 1997 and on 4 June in 1998.

Vegetation Surveys: Vegetation surveys of the rail survey points were made in June using visual estimation. Cattail (*Typha* spp.), grasses (*Poaceae*), sedge (*Carex* spp.), broad leaf emergents, *Phragmites*, and purple loosestrife (*Lythrum salicaria*) were estimated to the nearest percentage cover. A survey point was categorized as cattail if cattail made up 50% or more of the cover, or as sedge if sedge and/or grass made up 50% or more of the cover. In 1997, 21 of the points were cattail and 42 were sedge. In 1998, 35 of the points were cattail and 54 were sedge.

Table 1. Number of survey points at which Sora and Virginia Rail were detected by marsh/marsh complex and habitat type. Year of survey is in parentheses after the marsh name. Only marshes with five or more survey points are reported in the table. NWR = National Wildlife Refuge, SWA = State Wildlife Area.

	Sora		Virginia Rail		No. of survey points	
Marsh/Marsh Complex	cattail	sedge	cattail	sedge	cattail	sedge
Cherokee Marsh (1997)	0	–	0	–	5	–
Hook Lake (1998)	0	0	0	0	1	4
Schoenberg Marsh (1998)	–	3	–	1	–	5
Necedah NWR (1997)	–	7	–	5	–	10
Meadow Valley SWA (1997)	–	3	–	1	–	15
Monroe County Flowage (1998)	0	0	0	1	1	5
Wood County SWA (1998)	0	0	1	2	2	7
Sandhill SWA (1998)	0	1	0	3	1	6
Grand River Marsh SWA (1998)	1	0	1	0	6	4
Lake Puckaway (1998)	2	0	2	0	3	4
White River Marsh SWA (1998)	1	1	0	1	4	5
Germania Marsh SWA (1998)	2	0	2	1	5	6
Mud Lake SWA (1998)	2	3	0	1	2	4
Horicon NWR (1995)	8	–	8	–	10	–
Trempealeau NWR (1997)	6	1	6	1	6	4
Buffalo River Marsh (1997)	1	3	1	5	1	5
Wolf/Rat Rivers Area (1997)	2	1	4	1	4	1
Rush Lake (1998)	2	0	2	0	6	4
Outagamie, Navarino, and Wolf River Bottoms SWAs (1997)	2	5	2	2	3	6
Total	29	28	29	25	60	95

Field Surveys: We used a standardized survey methodology modified from Graetz et al. (1997) in 1997 and revised in 1998 to reflect the consensus of the Marsh Bird Monitoring Workshop (Ribic et al. 1999).

Surveys took place between the hours of 0430 and 1000. Surveys were not done when winds were greater than 15 mph, when it was warmer than 85 °F, or when there was rain or fog. At each point, before recording data, the surveyor waited for 2 minutes, then for the next 5 minutes all species heard or seen within an 80-meter radius (in 1997) or a 100-meter radius (in 1998) half-circle were recorded. The callback tape was then started at the end of 5 minutes. The tape, which was approximately 8 minutes long, had seven bird species on it. In 1997, the order of calls on the tape was Sora, Virginia Rail, King Rail, Black Rail, Yellow Rail, American Bittern (*Botaurus lentiginosus*), and Least Bittern (*Ixobrychus exilis*). In 1998, the Black Rail and Yellow Rail calls were deleted. The calls of each species were repeated three times with a 10-second pause between the calls and each species' series. After the end of the tape, the surveyor listened and recorded calls for 1–2 minutes. Each survey lasted between 17 and 19 minutes. In 1998, the surveyor indicated whether individual birds were first detected during the 5-minute passive count or during the tape playback.

Data Analysis—Data were analyzed on a survey point basis; data for Hori-

con NWR from Graetz et al. (1997) were reanalyzed at the point level for presentation here. Specifically, unlimited-distance full-circle surveys that were done in 1995 were recompiled only using rails heard at 100 meters or less.

Using call playback: The number of survey points at which rails were heard was tabulated for 1998. For the most common species, Sora and Virginia Rail, I calculated the proportion of points at which the species was heard only during the call-playback tape portion of the survey. This indicates the number of sites that would be erroneously assumed not to contain rails if only a 5-minute passive count was conducted. I tested whether the probability of hearing Sora or Virginia Rail was greater during the call-playback portion of the survey using the Sign test (Conover 1980). Significance was assessed at alpha = 0.05.

Timing of surveys: I looked at the importance of the timing of the survey for Sora or Virginia Rail by cataloguing the number of points, by major vegetation type (cattail or sedge), at which a rail occurred during a May and/or June survey. I then tested whether the probability of detecting a species was the same for May and June, by habitat, with the McNemar test (Conover 1980). Significance was assessed at alpha = 0.05.

Occurrence by habitat type and wetland/wetland complex: Using data from both years, the number of points at which Sora or Virginia Rails were detected was tabulated by habitat. I tested whether Sora or Virginia Rails were more likely to be detected in cattail or sedge habitat using a Chi-square test (Conover 1980). Significance was assessed at alpha = 0.05.

I calculated overall detectability by wetland/wetland complex (the proportion of points by wetland/wetland complex at which a species was detected) for King Rail, Sora, and Virginia Rail. For all points where Sora or Virginia Rails were heard, an index of abundance (number of rails heard per 100-meter radius half-circle) was calculated for 1998. Abundance indices in 1995 and 1997 were standardized to be the number of rails per 100-meter radius half-circle for comparability. Means and standard errors were calculated and tabulated by wetland/wetland complex and habitat type. Differences between detectability by wetland/wetland complex are described.

Results

Black Rail—Little is known about the Black Rail in the United States and this species is not found in the database of the BBS. It is the smallest rail in North America and has a sporadic distribution due to its secretive habits; its distribution over the Midwest is indicated by dotted lines on the map in Eddleman et al. (1994). For Wisconsin, there are currently no records of Black Rail in the WBBA, and the species was not detected on the local surveys. One unpublished report by Russell (1991) did not have any confirmed Black Rail sightings. Robbins (1991) considers Black Rail a hypothetical species for Wisconsin, although he thinks this species most likely occurs here.

Yellow Rail—The Yellow Rail is the second smallest rail in North America and, although its breeding distribution is not well known (Bookhout 1995), Wisconsin appears to be the southern limit of the breeding range of these

rails (Figure 1). Like the Black Rail, the Yellow Rail is not found in the BBS database, but there has been more success in detecting Yellow Rail in Wisconsin, particularly in northern Wisconsin. Crex Meadows has been noted for Yellow Rail (Faanes 1981), and more recent surveys (Hartman 1989, Mossman and Sample 1990, Grimm 1991, Zovnic and Howe 1995) detected Yellow Rail in Burnett (Reeds Lake and Fish Lake), Oconto (unnamed County Y wetland), Calumet (Killsnake River State Wildlife Area), and Door (Mink River) Counties. The WBBA, so far, has two sightings in Shawano County (one confirmed and one probable) and one probable sighting each in Marquette and Door Counties. This species was not detected on the local surveys.

From the literature reports, Yellow Rail was detected only in sedge meadows and is one of a few species dependent on sedge marsh/meadow, especially large tracts (Mossman and Sample 1990). The Yellow Rail is uncommon in northern sedge meadows and marshes. No individuals were detected in south and central Wisconsin sedge meadows/marshes by Hoffman (1990) and Mossman and Sample (1990), though Mossman and Sample (1990) noted a rare sighting of a Yellow Rail in the sedge meadows of Cherokee Marsh in southern Wisconsin. Yellow Rail has also been detected in Lake Superior bogs, but is a rare species there; only one bird was recorded at Bark Bay (Hoffman and Mossman 1993). Both Sample (1985) and Robbins (1991), af-

Figure 1. The Yellow Rail, an uncommon nester in Wisconsin, appears to be at the southern limit of its breeding range in the state. Drawing by Cary Hunkel (Wisconsin Department of Natural Resources).

ter reviewing sighting records, concluded that Yellow Rail was probably not as rare as is supposed, though it is not particularly common. Factors making it difficult to detect this species include its secretive habits and preference for large sedge meadows (D. Sample, WDNR, pers. comm.).

King Rail—King Rail is the largest of the North American rails (Reid et al. 1994) and is a game bird in 13 Gulf and Atlantic coast states (Meanley 1992). According to the BBS, King Rail is not found in Wisconsin, which is on the northern edge of the breeding range for the species (Meanley 1992). Robbins (1991) considers this species to be more common than is supposed, particularly in the southern and eastern parts of the state.

In the WBBA, there are four probable sightings of King Rail in Winnebago County. This species was detected on a few of the local survey sites. King Rail was detected on three wildlife refuges at low detection rates (0.1 at Trempealeau NWR in cattail; 0.1 at Necedah NWR in sedge, and 0.1 at Horicon NWR in cattail). King Rail was also heard at Rush Lake (0.2).

From the literature, King Rail was considered uncommon in sedge marsh and was not detected in sedge meadow by Hoffman (1990) or Mossman and Sample (1990). Faanes (1981) found that King Rails at Crex Meadows were usually associated with cattail in impoundments.

Sora—Sora is a common inhabitant of marshes in the United States (Figure 2). The BBS records their presence in Wisconsin at low levels and Wisconsin is in the center of the breeding range (Melvin and Gibbs 1994). Robbins (1991) commented that this species was common throughout the state, particularly in the southeast section due to a concentration of wetlands. There was a high reporting rate for Soras in southeast Wisconsin in Temple et al. (1997). So far, the WBBA map of Wisconsin shows confirmed and probable breeding of Sora in almost every county. Sora was commonly detected on the local surveys.

Using call-playback surveys and doing surveys in May were important for detecting Sora. In 1998, Sora was heard at 20 points, but at eight of those points birds were heard only during the call-playback portion of the survey. Therefore, using a passive survey only, eight out of 20 survey points (40%) would have been categorized as not having Sora. Sora were more likely to call during the call-playback part of the survey than during the passive 5-minute part ($T = 8$, $n = 22$ surveys, $P < 0.05$).

Regarding timing during the breeding season, more Soras were heard during May than in June in either cattail or sedge habitats (cattail: $T = 12$, $P < 0.05$; sedge: $T = 16$, $P < 0.05$). Over both cattail and sedge points, Sora was detected on 33 points in May and 18 in June. If surveys were done only in May, three points would have been erroneously categorized as not having Soras, yet if surveys were done in June, 28 points would have been erroneously categorized as not having Soras.

Considering habitat, Soras were more likely to be detected at cattail survey points than at sedge points (47% detection rate in cattail, 29.2% detection rate in sedge; $\chi^2 = 5.4$, $df = 1$, $P < 0.025$). However, when Soras were detected, a similar number were heard, on average, regardless of habitat type

Figure 2. The Sora is a common wetland inhabitant throughout Wisconsin, with confirmed or probable Wisconsin Breeding Bird Atlas records for almost every county. Photo by Jack Bartholmai.

(cattail: mean = 2.7 birds per 100-meter radius half-circle, SE = 0.4, n = 31 points; sedge: 3 birds per 100-meter radius half-circle, SE = 0.3, n = 28 points).

Focussing on cattail habitat first (Table 1), Soras were detected at high rates at Trempealeau (1.0) and Horicon NWRs (0.8). However, we did not detect as many Soras at other marshes in the southeast (0.4 at Lake Puckaway/White River SWA; 0.3 at Germania Marsh/Grand River Marsh SWAs; 0.3 at Rush Lake). We did not detect any Soras in the cattail habitat of Cherokee Marsh, though the species was considered to be present in the sedge meadow sections of the marsh (Mossman and Sample 1990). We also did not hear Soras in the cattail habitat at Wood County/Sandhill SWAs.

When we consider sedge habitat, Soras were detected at higher rates at Buffalo River Marsh (0.6) compared to Trempealeau NWR (0.25) (Table 1). Necedah NWR was also a good spot for Sora, with a detection rate of 0.7. In contrast, Soras were not commonly detected at the Meadow Valley SWA/Monroe County Flowage, and Wood County/Sandhill SWAs, all near Necedah (0.15 and 0.08, respectively). Other areas where Soras were rarely heard in sedge habitat were Germania Marsh/Grand River Marsh SWAs (0), Rush Lake (0), and Lake Puckaway/White River SWA. Hoffman (1990) found a few Soras in a single visit to Rush Lake. Sedge areas where Soras were detected at high rates were Schoenberg Marsh (0.6), Mud Lake SWA (0.75), and Navarino/Outagamie SWAs (0.8).

On the sites we surveyed, Soras were heard most consistently at Trempealeau NWR, Buffalo River Marsh, Necedah NWR, Horicon NWR, Mud Lake SWA, and Navarino/Outagamie SWAs. Not only did most of the points on these sites have Soras but, on average, we heard three to four rails at each point (i.e. within each 100-meter radius half-circle). Soras were not detected as consistently at Schoenberg Marsh and the Wolf/Rat Rivers area, but when we did hear Soras, we tended to hear, on average, two to four Soras at a point.

In the literature, Soras were considered to be fairly common (Mossman and Sample 1990) or uncommon (Hoffman 1990) in sedge marsh. The species was considered rare to uncommon in sedge meadow (Mossman and Sample 1990), but common on southern and northern Waterfowl Production Areas (Hoffman 1990). Soras were rare in Lake Superior bogs (Hoffman and Mossman 1993), and uncommon in the bulrush and cattail of the Upper Mississippi River (Tyser 1982) and along the St. Croix River (Mossman 1991). In contrast, Faanes (1981) found Soras to be common in the St. Croix River Valley, breeding at high densities in cattail and bulrush and only using sedge meadows for breeding during high water periods.

Virginia Rail—The last species to consider is Virginia Rail, which is similar to Sora in being common in marshes (Figure 3). The BBS records their presence in Wisconsin at low levels, and Wisconsin is in the center of the midwestern portion of the breeding range (Conway and Eddleman 1994, Conway 1995). Though common, Robbins (1991) does not consider Virginia Rail to be as common as Sora in Wisconsin. So far, the WBBA map of Wisconsin shows confirmed and probable breeding of Virginia Rail in almost every county in the eastern part of the state, but fewer counties in the west appear to contain Virginia Rail. Robbins (1991) found that greater numbers of Virginia Rails were found east of the Platteville-Marinette line. There was a high reporting rate for Virginia Rails in east/southeast Wisconsin in Temple et al. (1997). We frequently heard Virginia Rails on the local surveys.

Using call-playback surveys and doing surveys in May were important for detecting Virginia Rail. Of 18 points at which the species was heard in 1998, it was heard only during the call-playback portion of the survey at 11 points. Therefore, using a passive survey only, 11 out of 18 survey points (61%) would have been categorized as not having Virginia Rail. Virginia Rails were more likely to call during the call-playback part of the survey than during the passive 5-minute part ($T = 5$, $n = 20$ surveys, $P < 0.05$).

The probability of detecting a Virginia Rail on a cattail site was different in May and June ($T = 11$, $P < 0.05$), with more Virginia Rails detected in May. Specifically, Virginia Rails were detected on 19 points in May and on 10 points in June. If surveys were done only in May, two cattail points would have been erroneously categorized as not having Virginia Rails, yet if surveys were done only in June, 11 cattail points would have been erroneously categorized as not having Virginia Rails. However, the probability of detecting a Virginia Rail at a sedge point was not different in May and June ($T = 10$, $P > 0.05$), so surveying sedge

Figure 3. Wisconsin Breeding Bird Atlas records show that the Virginia Rail nests in almost every county in the eastern portion of the state. Photo by Jack Bartholmai.

habitat for these birds can be done either in May or June.

Considering habitat, Virginia Rails were more likely to be detected on cattail survey points than sedge points (47% detection rate in cattail and 26% detection rate in sedge; $\chi^2 = 7.6$, $df = 1$, $P < 0.01$). On average, when Virginia Rails were detected, 2.5 birds were heard per point (SE = 0.3, n = 31) in cattail and 2.0 birds (SE = 0.3, n = 25) in sedge habitat.

Considering cattail habitat first, Virginia Rails were detected at all points at Trempealeau NWR (Table 1). We also detected Virginia Rails in the Wolf/Rat Rivers area (1.0) and at Horicon NWR (0.8). However, we did not detect as many Virginia Rails in the other southeastern marshes (0.3 at Lake Puckaway/White River SWA, 0.3 at Germania Marsh/Grand River Marsh SWA, 0.3 at Rush Lake). Hoffman (1990) detected one Virginia Rail on a single visit to Rush Lake. Virginia Rail was not detected at Cherokee Marsh, although the rail was considered to be present in the sedge meadow habitat of the marsh (Mossman and Sample 1990). Virginia Rail was detected at a low rate (0.14) at Wood County/Sandhill SWAs.

Virginia Rails occurred less frequently in sedge habitat. We had high detection rates of Virginia Rail on only one sedge area, Buffalo River Marsh (north of Trempealeau NWR), where we detected the species at all five survey points (Table 1). In contrast, at Trempealeau NWR, we only detected Virginia Rail at one of four sedge points. Virginia Rails were detected at half of the sedge points at Necedah NWR. However, around Necedah NWR, de-

tection rates for Virginia Rail were lower (0.10 at Meadow Valley SWA/Monroe County Flowage, 0.4 at Wood County/Sandhill SWAs). We did not have high detection rates of Virginia Rails in sedge habitat at other marshes (0.20 at Schoenberg Marsh, 0.25 at Mud Lake SWA, 0.3 at Navarino/Outagamie SWAs, 0.10 at Germania Marsh/Grand River Marsh SWAs, 0 at Rush Lake, and 0.1 at Lake Puckaway/White River SWA).

On our survey sites, Virginia Rail occurred most consistently at Trempealeau NWR, Buffalo River Marsh, Horicon NWR, and the Wolf/Rat Rivers area. Not only did most of the points on these sites have Virginia Rails but, on average, we heard two to three rails at a point (i.e. within each 100-meter radius half-circle). Virginia Rails were not detected as consistently at Necedah NWR and Navarino/Outagamie SWAs, but when we did hear them, we tended to hear, on average, two rails at a point.

In the literature, Mossman and Sample (1990) considered Virginia Rail to be fairly common on their southern sedge marsh sites, but uncommon to rare on sedge meadow and northern sedge marsh. Hoffman (1990) found Virginia Rail to be uncommon on north and south sedge marsh and Waterfowl Production Areas. The rail was also rare in Lake Superior bogs (Hoffman and Mossman 1993). Along the Mississippi River, Virginia Rails made up a large proportion of rails heard on surveys at Upper Mississippi NWR (Nelson 1999). Virginia Rail was a common species in the bulrush and cattail habitat of the Upper Mississippi River (Tyser 1982), though it was considered rare along the St. Croix River (Mossman 1991). Faanes (1981) considered this species to be fairly common in the St. Croix River Valley, particularly in the prairie wetlands in St. Croix, Polk, and Washington Counties. Faanes (1981) also found that Virginia Rails bred at the highest densities in wetlands composed of cattail, river bulrush, and phragmites.

Discussion

Status and Distribution of Rails—Although we are beginning to understand the distribution of rails in Wisconsin, it is still apparent that we do not have complete information for any species nor even basic information on the smaller rails. Hoffman (1990) noted that much of the research done in marshes has been concentrated on ducks and geese. That observation is still valid, although there is some indication that this might be changing on the national level, where there has been movement toward understanding the population status and trends of rails and other marsh birds by developing a Marsh Bird Monitoring Program, including the standardization of field protocol (Ribic et al. 1999). The WBBA, when completed, will advance our knowledge on the presence of rails throughout the state, but population status and changes over time will still not be known. Current monitoring programs do not cover rails very well. The implementation of a Marsh Bird Monitoring Program in Wisconsin would help advance our understanding of the status of rail populations in the state.

There is some interest in considering rails as an indicator of marsh health (Adamus 1998). Sora has been used as one of the indicator species for assessing changes in locks and dams on

the Mississippi River (R. Fristik., U.S. Army Corps of Engineers, Rock Island District, pers. comm.). However, Soras have also been found in highly disturbed systems such as cranberry bogs (Kalinich 1991, Jorgensen and Nauman 1993), making their use as an indicator of system change questionable. In addition, there is extreme year-to-year variability in marsh bird communities (Hoffman 1990), which complicates the development of a marsh bird index.

The surveys of the 20 wetland/wetland complexes reveal the variability in the abundance of rails. Some of this variability was due to differential habitat use. Our study reinforces the importance of cattail habitat for Soras and Virginia Rails, and perhaps for King Rail. More birds occurred in cattail habitat compared to sedge. King Rail, when detected, was found primarily in cattails. Faanes (1981) noted higher breeding densities of Soras and Virginia Rails in cattail and noted that King Rails were associated with cattails. Meanley (1992) noted that cattail was the key vegetative component for King Rail, as did Conway (1995) for Virginia Rail. However, Melvin and Gibbs (1994) did not note a major habitat preference for Soras.

Importance of Using Call-playback Surveys—A number of researchers have commented on the increased detection rates of Sora and/or Virginia Rail when using call-playback surveys (Tango et al. 1997, Paine 1997, Gibbs et al. 1999, Kirsch 1999, Paine 1999, Therres et al. 1999). Our study is in agreement with these; however, in our study, call-response surveys increased the detectability of Virginia Rail more than Sora.

Timing of Surveys—The Marsh Bird Monitoring Workshop (Ribic et al. 1999) indicated that one survey during the breeding season might be adequate for regional information, but timing of the single survey was not explicitly addressed. Gibbs and Melvin (1993) indicated that surveys done throughout the breeding season (mid–May to late June) would yield comparable results. In our study, however, more sites would have been erroneously considered to be absent of Sora and Virginia Rail if a single survey had been done in June. If a single survey is to be done, it is recommended that, in Wisconsin, a May survey be conducted. This is in contrast to the conclusion of Graetz et al. (1997), who recommended that surveys be done in June in Wisconsin. However, their analysis was based on overall density estimates of all points in a refuge, whereas we considered maximum detectability at survey points.

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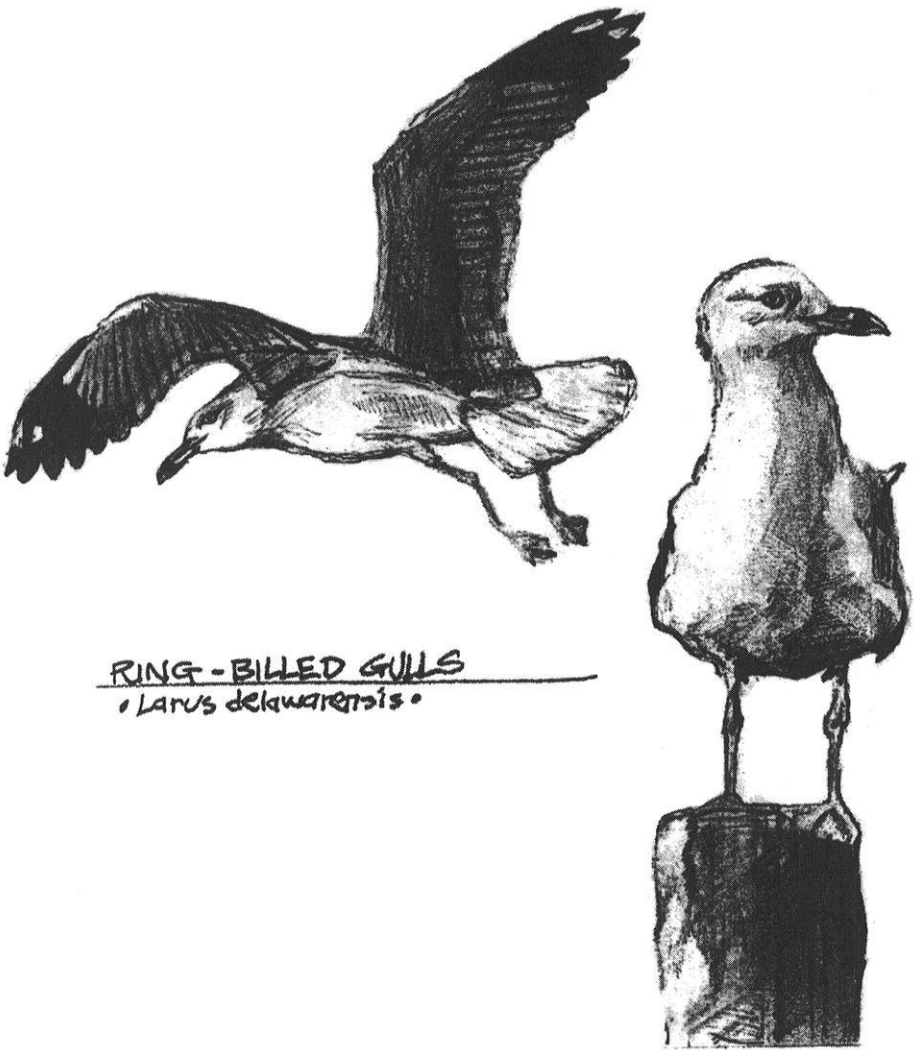

Ring-billed Gulls *by Steve Lubahn*

The Red-shouldered Hawk in Wisconsin

*The authors describe their studies of the Red-shouldered Hawk (*Buteo lineatus*), a state threatened species that is uncommon but widely distributed in Wisconsin, where it nests in extensive, mature, wet forests.*

by John P. Jacobs and Eugene A. Jacobs

The Red-shouldered Hawk (*Buteo lineatus*) was once one of the most common hawks in the eastern United States, but now is much reduced in the northern part of its range (Peterson et al. 1992). Red-shoulders inhabit large stands of mature hardwoods, or mixed hardwoods and conifers, especially bottomland hardwoods and riparian areas (Crocoll 1994). In Wisconsin, Robbins (1991) lists the Red-shoulder as an uncommon summer resident, although it can be found in greater numbers in mature stands of bottomland forests. Research on this species' status, productivity, and responses to various management practices is needed (Peterson et al. 1992). Red-shouldered Hawks are listed as endangered, threatened, rare, or of special concern in 13 states. They are listed as a threatened species in Wisconsin and there is a need for data on their population dynamics and habitat management.

In 1971, we began monitoring Red-shouldered Hawk nests, studying their basic nesting ecology and population dynamics. We started with only a few nests, but now have over 150 nest sites. We are only able to check about 120 sites each year because of time and financial constraints. Approximately 50 to 60 active nests are found each year.

Nest sites which were active in previous years, areas where Red-shoulders have been seen or heard, and suitable habitat are searched for active nests during April and May. For most sites, we search at least a 200-meter radius around the previously used nest. Young Red-shoulders are banded in the nest during June by climbing the nest trees (Figure 1). Field methods are similar to what has been described in the literature (Craighead and Craighead 1956, Pendleton et al. 1987).

During the spring of 1998, 130 Red-shoulder nest sites were checked for occupancy. Occupied territories were found at 61 sites. Fifty-one active nests were found and monitored for success. Thirty-two nests (63%) produced at least one young to the fledgling stage and were considered successful (Figure 2). Reproduction averaged 1.51 young/active nest.

Figure 1. A trio of 26-day-old Red-shouldered Hawk nestlings nervously await the ordeal of being banded and registered with the U.S. Fish and Wildlife Service. Photo by John P. Jacobs.

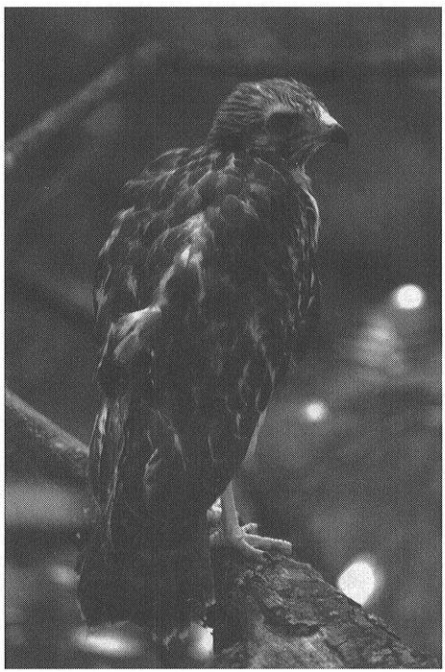

Figure 2. A recently fledged Red-shouldered Hawk quietly waits for one of its parents to return with food. Photo by John P. Jacobs.

Probably the best "bottom line" measurement of overall reproductive success is the number of young produced per active nest. Productivity for 1998 (1.51 young/active nest) was the second highest we observed in the 1990s, and was much higher than our nine-year average of 1.09 young/active nest. Reasons for the high productivity during 1998 is unclear. Some factors that have been found to affect raptor productivity are prey base (Hamerstrom 1979), weather conditions, predators, and human disturbance (Newton 1979).

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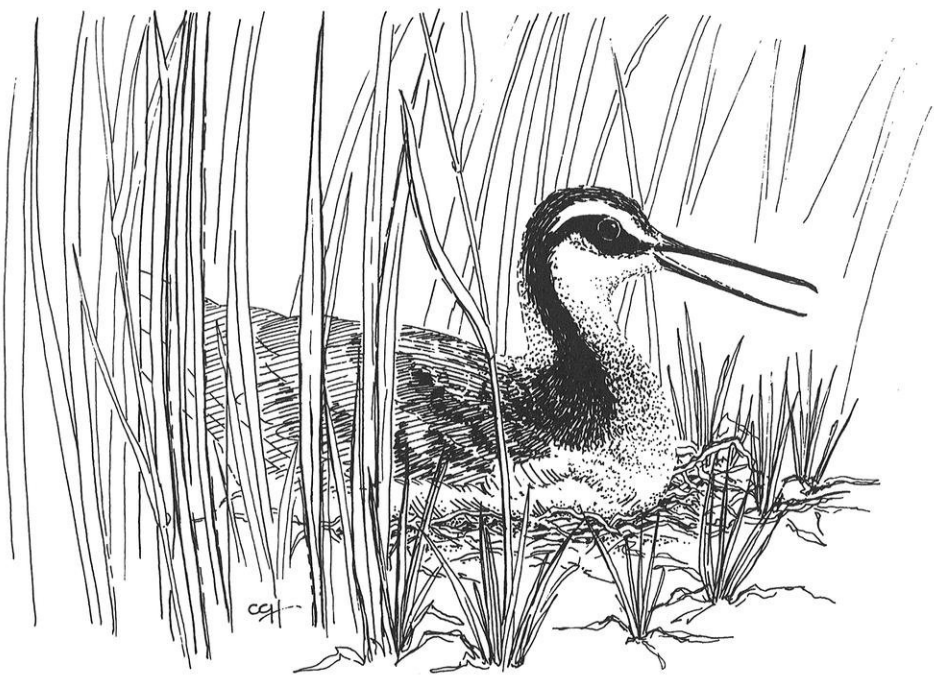

Wilson's Phalarope *by Cary Hunkel* (Wisconsin Department of Natural Resources)

The North American Waterfowl Management Plan

In 1986, Canada, the United States, and Mexico pledged to work together to restore decimated waterfowl populations. Over 200,000 acres of habitat have already been protected in the Upper Mississippi River and Great Lakes region.

by Karen Etter Hale

We have all been intrigued by historic accounts of the immense waterfowl migrations that once swept across the Great Plains, of vast flights of birds that covered the sky from horizon to horizon and would sometimes continue for days. Unfortunately, this wildlife spectacle became a thing of the past when market hunting and habitat destruction decimated populations of ducks and other waterbirds.

Market hunting was outlawed long ago, but not before one hunter could boast that he had killed more than 139,000 birds and other animals. As for habitat destruction, one half of Wisconsin's wetlands have been destroyed since colonial times, along with 98% of wetlands in Iowa. Together, Illinois, Indiana, and Ohio have lost 82% of their wetlands. The federal government helped this process along—over a 40-year period, the U.S. Department of Agriculture (USDA) helped drain nearly 57 million acres of wetlands across the nation.

The turn-around has been slow in coming, but eventually society began to recognize the value of wetlands and to acquire and restore areas such as Wisconsin's Crex Meadows and Horicon Marsh in the 1930s. Yet, duck numbers continent-wide continued to decline sharply through the 1970s and 1980s. Today, it is estimated that the U.S. is still losing 290,000 acres of wetlands each year through the building of ever more highways, homes, and shopping malls.

The North American Waterfowl Management Plan

An international plan was needed to address the many problems facing waterfowl, and in 1986 the North American Waterfowl Management Plan (known as NAWMP or the Plan) was born. Canada, the United States, and Mexico pledged to work together to restore duck populations to 1970s levels, with objectives of 62 million breeding

ducks in spring and 100 million ducks in the fall flight.

A 1998 update describes the three visions upon which the Plan is based: a strong biological foundation, a landscape approach to conservation, and the expansion of public-private partnerships that include other migratory bird interests and initiatives. The Plan encourages continental research and monitoring of bird population/habitat relationships, and adjusting habitat conservation strategies accordingly. It also embraces landscape planning that acknowledges economic stability and biodiversity as necessary components.

Conservation efforts through the Plan are focused in regional Joint Ventures. Each Joint Venture has its own waterfowl population and species goals and targets regional wetland ecosystems that are the most widespread, threatened, and valuable to wildlife. For example, the Upper Mississippi River and Great Lakes Region Joint Venture—which includes all of Wisconsin, Michigan, Illinois, Indiana, Ohio, and parts of Minnesota and Iowa—was established in 1993. To date, the partners for this Joint Venture have protected, restored, and enhanced 238,299 acres of waterfowl habitat (of which 206,100 acres are in Wisconsin). The population objective for this area of the country has been set at just over 1.5 million breeding ducks, to be achieved by conserving 9.6 million acres of wetland and associated upland habitats. Ours is one of the first Joint Ventures to add a non-game component to increase habitat for non-waterfowl species, such as shorebirds and other waterbirds, as well.

Within the Joint Ventures, conservation efforts are led by statewide steering committees, which further focus their projects where they can do the most good. The Wisconsin Steering Committee has been particularly successful, in large part because of its strong partnership base. Members of the committee include Ducks Unlimited, USDA Natural Resources Conservation Service, The Nature Conservancy, Wisconsin Department of Natural Resources, Wisconsin Farm Bureau, Wisconsin Conservation Congress, U.S. Fish and Wildlife Service, Great Lakes Indian Fish and Wildlife Commission, Madison Audubon Society, Wisconsin Waterfowl Association, and many others. We meet quarterly, including at least once each year to view some of the projects, which include the Manitowoc County wetlands, Duffy's Marsh dedication, and the Lake Superior wetlands.

Our funding comes primarily from competitive federal grants that need to be matched 2:1 by partner dollars. Wisconsin has been very successful, bringing in over $6 million in North American Wetlands Conservation Act grants. These funds have been matched by $16 million from the state stewardship fund, Ducks Unlimited, Wisconsin Waterfowl Association, The Nature Conservancy, Pheasants Forever, and others.

The North American Bird Conservation Initiative

The success of the Plan has stimulated the development of a national conservation strategy for all North American migratory birds, known as the North American Bird Conservation Initiative (NABCI), which includes all of the major bird conservation plans: the North American Waterfowl Management Plan, Partners In Flight, the

U.S. Shorebird Conservation Plan, and the North American Colonial Waterbird Conservation Plan. NABCI aims to weave together and coordinate the efforts of the various plans while retaining the uniqueness of each. Most importantly, NABCI will create a stronger and more cohesive voice for bird conservation.

NABCI will very likely be implemented through the NAWMP Joint Ventures (several of which are already taking an integrated approach to bird conservation) and will depend on expanding existing partnerships and the sharing of information and resources. The infrastructure is already in place, and the U.S. Fish and Wildlife Service and state departments of natural resources are already responsible for the conservation of all birds in all habitats. Parallel efforts are underway to secure new funding to run these programs.

We may never again experience the great aerial rivers of migrating birds that once darkened our skies. But when we thrill each season to the passage of the birds we love, we will know we have done what we could to bring them back.

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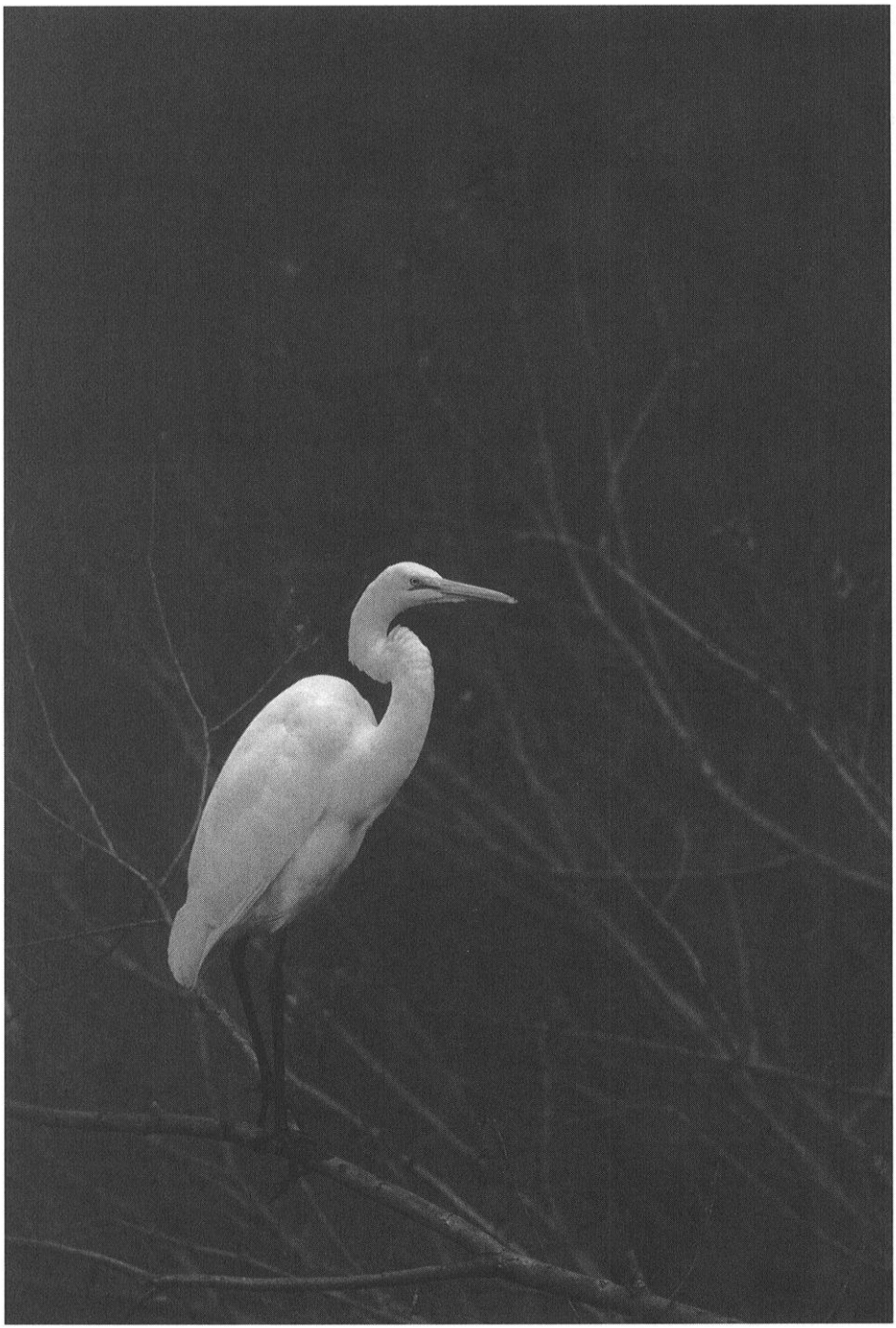

Great Egret at Horicon Marsh *by Jack Bartholmai*

Wetland Birds of the Upper Mississippi River National Wildlife and Fish Refuge

The authors describe avian population trends in the context of historic and current habitat conditions in the Upper Mississippi River National Wildlife and Fish Refuge.

by Eric C. Nelson and Laurie B. Wlosinski

The Upper Mississippi River National Wildlife and Fish Refuge (Refuge) is the longest wildlife refuge in the lower 48 states. It extends 261 miles from the confluence of the Mississippi and Chippewa Rivers in Buffalo County, Wisconsin, to almost Rock Island, Illinois. The Refuge was established in 1924 to protect floodplain habitat for migratory birds and fish (one of only a few refuges that specifically protect fish). It was expanded in the 1930s with additional land acquired by the U.S. Army Corps of Engineers for installation of a 9-foot commercial navigation channel and the construction of 26 locks and dams. The Refuge now encompasses about 200,000 acres in parts of Minnesota, Wisconsin, Iowa, and Illinois. More than half is owned by the Army Corps of Engineers but is managed by the Refuge under a cooperative agreement. Commercial navigation generally takes priority over environmental management.

Floodplain forest, backwater marshes, and large riverine lakes provide essential habitat for 290 species of birds, 57 species of mammals, 45 species of amphibians and reptiles, and 113 species of fish. The Upper Mississippi has become an oasis in America's heartland where natural lakes are scarce, bottomland forests are vanishing, many streams have been channelized, and more than half of the wetlands have been lost in the four adjoining states.

Presently, the Mississippi River annually contributes over $1 billion in recreational benefits to the region. Its attractiveness is directly related to its rich fish and wildlife populations and natural scenic beauty.

Wetland birds of the Upper Mississippi River occupy both forested and herbaceous wetland habitat. The forested wetlands, dominated by silver maple (*Acer saccharinum*), cottonwood (*Populus deltoides*), black willow (*Salix nigra*), ash (*Fraxinus* spp.), and swamp white oak (*Quercus bicolor*), are home to raptors, nesting wading birds, and songbirds. The herbaceous wetlands are dominated by river bulrush (*Scirpus*

fluviatalis), arrowhead (*Sagittaria* spp.), burreed (*Sparganium eurycarpum*), reed canary grass (*Phalaris arundinacea*), lotus (*Nelumbo lutea*), white water lily (*Nymphaea odorata*), wild celery (*Valisneria americana*), milfoil (*Myriophyllum* spp.), and pondweeds (*Potamogeton* spp). Herbaceous wetlands are used by waterfowl, secretive marsh birds, wading birds, and songbirds.

Migratory birds utilize floodplain wetlands during all seasons. This habitat has been recognized as a cornerstone in the life histories of many birds species and, in 1997, the Refuge was designated a Globally Important Bird Area by the American Bird Conservancy for the significant role the area plays in protecting bird habitat. Refuge staff monitor populations of migratory birds during the breeding and migration seasons. In addition, other federal and state agencies are monitoring some of these groups and their habitats. The purpose of this report is to describe avian population trends and their relationships to some of the historic and current habitat conditions on the Refuge.

Methods

The Refuge has utilized various Wildlife Inventory Plans over the past 75 years to monitor wildlife populations; the most recent revision was in 1993. Population trends have been determined from these plans as well as from other inventories and research work. Details of the inventory methodology may be obtained from the authors. A summary of plan methods for selected species groups is presented in Table 1.

Results

Waterfowl—Immediately after locks and dams became operational on the Mississippi River during the 1930s, inundated wet meadows and hay fields were converted to marshes that held moist-soil plants, submergent, and emergent plants. By the 1960s, many of these wetlands had been lost due to sedimentation and the constant flooding associated with reservoir aging processes. These marshes generally became less productive for puddle ducks as they converted to shallow, windswept riverine lakes. However, some of these open areas retained wild celery and pondweeds and have supported large numbers of diving ducks. During the past 30 years, Tundra Swans (*Cygnus columbianus*) have established a strong tradition of using the Refuge as a migration stopover site, feeding on the locally abundant arrowhead resource and enjoying refuge from hunting disturbance.

Mallards (*Anas platyrhynchos*), Wood Ducks (*Aix sponsa*), American Wigeon (*Anas americana*), Blue-winged Teal (*Anas discors*), Green-winged Teal (*Anas crecca*), Northern Shoveler (*Anas clypeata*), and Gadwall (*Anas strepera*) are the predominant migrating puddle duck species on the Refuge. Diving ducks are best represented by the Canvasback (*Aythya valisineria*), Lesser Scaup (*Aythya affinis*), Ring-necked Duck (*Aythya collaris*), and Redhead (*Aythya americana*). The Canada Goose (*Branta canadensis*) is by far the most abundant goose on the Refuge. Waterfowl numbers obtained from weekly fall surveys are converted to use-days to describe the daily intensity of the presence of birds on the Refuge. Use-days are calculated from the average num-

Table 1. Wildlife Inventory Plan methodologies used in the Upper Mississippi River National Wildlife and Fish Refuge, 1993 to present. Similar methods were used to monitor waterfowl, herons, and Bald Eagles during the previous 65 years of refuge operation.

Species or Group	Monitoring Objectives	Methods
Waterfowl	Determine trends; provide timely information on extent of fall migration for managers and public.	1) Weekly aerial survey, 150 ft. altitude, two observers. 2) Begin Sept 20, end Dec 1 or ice-up. 3) Repeat survey routes. 4) Numbers converted to use-days for analysis. 5) Data posted on web page; copy sent to river mgrs, biologists, and officers.
Herons, Egrets, and Cormorants.	Monitor trends in number of nests and colonies; characterize nest trees.	1) Ground checks in April (# active nests) and June (production). 2) Aerial oblique photography in late April to count nests.
Bald Eagles	Determine number of active nests and production annually.	1) Aerial surveys for nest occupancy in late March. 2) Ground surveys in May for production counts.
Red-shouldered Hawks	Determine number of occupied territories annually; production data occasionally collected.	Tape playback of Red-shouldered Hawk or Great Horned Owl vocalizations at known or suspected locations in March.
Bitterns and Rails	Determine relative abundance of breeding birds; describe habitat.	Tape playback at established points, 20 min per site, half-hour before sunrise to 1030; three counts May–June.
Songbirds	Document relative abundance of species by habitat during migration and breeding seasons.	1) Point counts, 5 and 10 min; 0–50 m, 50–100 m in open wetlands; 0–25 m, 25–50 m in forested wetlands; 0600 to 1000 hrs. 2) Spring: April to June; Summer: June; Fall: Aug-Oct.

ber of birds present between two counts and the number of days between counts. In 1998, waterfowl counts yielded about 33 million use-days, a threefold increase over the average from 1991 to 1997 (Figure 1). Peak numbers of Canvasbacks hit 320,000, which is about a third of the continental fall population.

Wading Birds—Since 1960, there have been 8 to 16 colonies of nesting Great Blue Herons (*Ardea herodias*) on the Refuge (Figure 2). Locations and sizes (number of nests) of colonies have changed often since the 1960s. The vast increase in the number of total nests since the early 1970s probably reflects the reduction in environmental contaminants, while the 1989 peak in number of nests (8,187) reflected low water conditions that may have enhanced feeding success on the floodplain. The decline during the 1990s is suspected to relate to high water in 1993 and 1997, wind storms, and possibly predation. In some areas, Great Blue Herons are traveling nearly 30 miles off river to feed during the brood rearing season.

Great Egrets (*Ardea alba*) nest in association with Great Blue Herons in

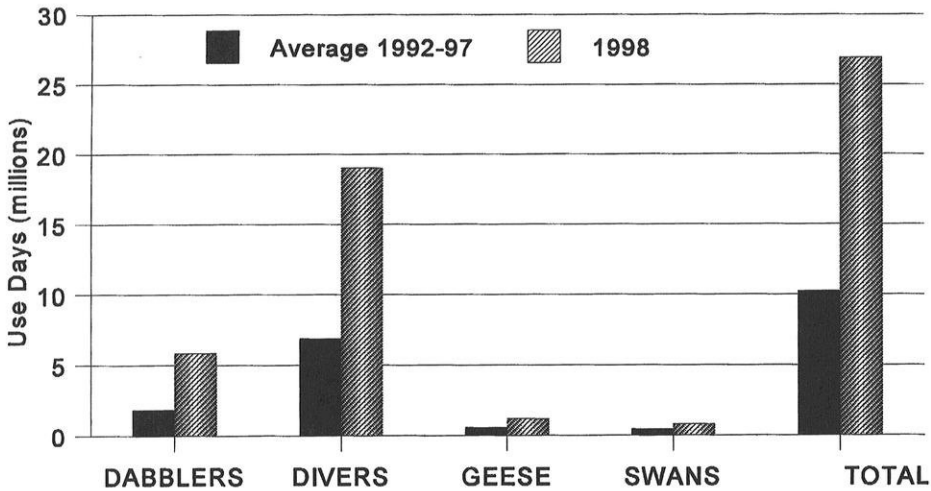

Figure 1. Comparison of waterfowl use-days between 1998 and the 1992–97 average, Upper Mississippi River National Wildlife and Fish Refuge.

four to seven colonies and have had 100 to 300 nests present between 1994 and 1998. Three of the Wisconsin colonies usually contain Great Egrets. Double-crested Cormorants (*Phalacrocorax auritis*) nest in separate colonies in Pool 13 and Trempealeau NWR, or in association with Great Blue Herons in two to five other colonies on the Refuge. Between 1994 and 1998, a total of about 650 to 1,000 cormorant nests were within these colonies.

Bald Eagles—Bald Eagles (*Haliaeetus leucocephalus*) are present year-round on the Upper Mississippi River. During the spring and fall migrations, more than 600 Bald Eagles have been counted along the river from Wabasha, Minnesota, to Prairie du Chien, Wisconsin. Over 4,000 Bald Eagles have been counted during the fall migration near Glen Haven, Wisconsin. There are currently about 90 active Bald Eagle nests on the Refuge; this compares to only nine in 1986 (Figure 3). The presence of large cottonwood, silver maple, and elm (*Ulmus* spp) trees provides abundant nest sites and the river is plentiful with fish. Human disturbance during the nesting season has been curtailed by managing access of construction contractors. Other disturbance by ice fishermen, boaters, barge traffic, and campers does not appear to have a significant adverse impact on current nesting populations. In 1997, 33 of 74 active Bald Eagle nests occurred in the Wisconsin portion of the Refuge.

Bitterns and Rails—Annual breeding bird surveys since 1994 reveal that nearly 75% of the secretive marsh birds detected on the Refuge are Virginia Rails (*Rallus limicola*), followed by about 12% Soras (*Porzana carolina*), 11% Least Bitterns (*Ixobrychus exilis*), and American Bittern (*Botaurus lentiginosus*) at 1% (Figure 4). There are no standardized migration counts of these birds.

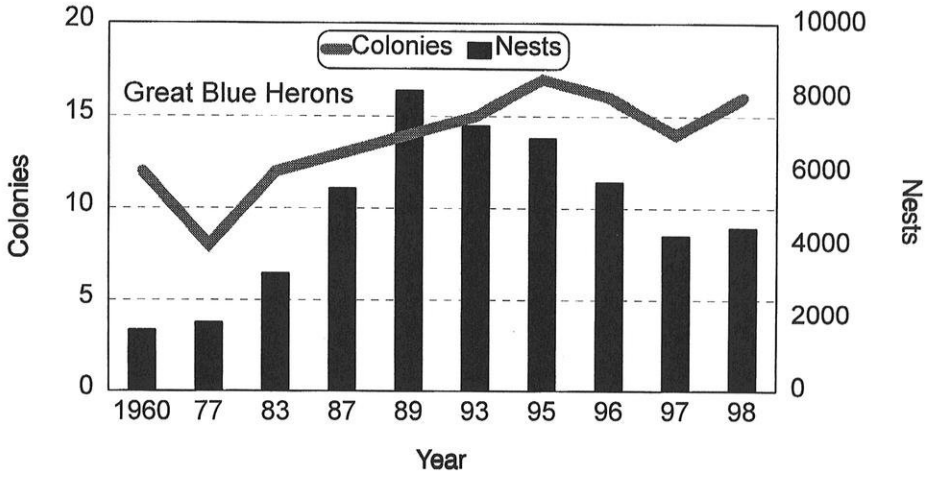

Figure 2. Great Blue Heron colonies and total number of nests, Upper Mississippi River National Wildlife and Fish Refuge, 1960–98.

Red-shouldered Hawk—Red-shouldered Hawk (*Buteo lineatus*) nests found along the Upper Mississippi River are usually located in medium age to mature forests dominated by silver maple or cottonwood. Territories are associated with flowing water, backwater pools, channels, or the confluence of two streams. A total of 36 active nests were located on the Refuge during the early 1990s, 10 of which were in Wisconsin. Between 1983 and 1994, total nest success was 72%, but declined to 36% in 1993, the year of a major flood. Nest success was low because foraging habitat was inundated near many of the nests, and fledglings often drowned if their hazardous first flights ended on the flooded ground.

Songbirds—Point count data since 1993 have revealed over 150 species migrating along the Mississippi River and approximately 90 to 100 species breeding on the Refuge (Table 2). Some of the common species breeding in the floodplain forest include the American Crow (*Corvus brachyrhynchos*), American Redstart (*Setophaga ruticilla*), American Robin (*Turdus migratorius*), Baltimore Oriole (*Icterus galbula*), Brown-headed Cowbird (*Molothrus ater*), Great Crested Flycatcher (*Myiarchus crinitus*), Red-bellied Woodpecker (*Melanerpes carolinus*), Prothonotary Warbler (*Protonotaria citrea*), Tree Swallow (*Tachycineta bicolor*), and Warbling Vireo (*Vireo gilvus*).

Other Birds—Research and special inventories are sometimes conducted for other birds in the Mississippi River floodplain. The Black Tern (*Chlidonias niger*), a species of concern within Region 3 of the U.S. Fish and Wildlife Service, has been located in nesting colonies along the Mississippi River in Trempealeau and La Crosse Counties, Wisconsin. High water can flood out nests and water level reductions can expose marsh habitat to access by mammalian predators. Black Tern nest suc-

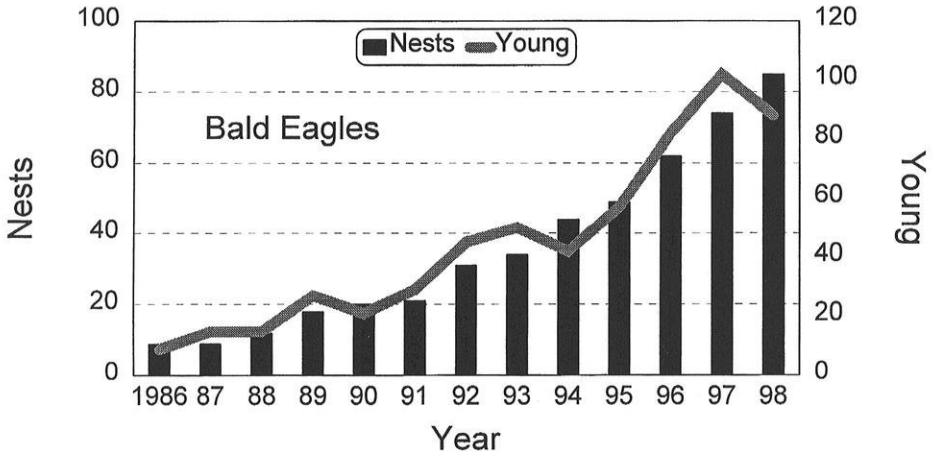

Figure 3. Annual number of active Bald Eagle nests and young produced on the Upper Mississippi River National Wildlife and Fish Refuge, 1986–98.

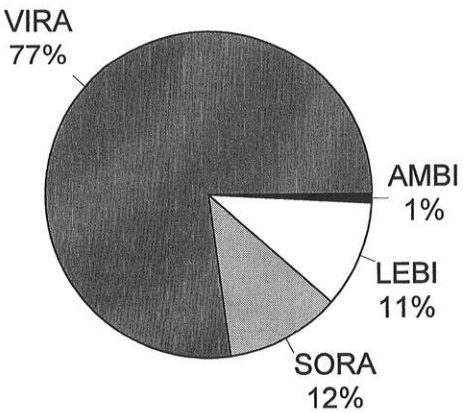

Figure 4. Proportion of breeding secretive marsh birds detected on the Upper Mississippi River National Wildlife and Fish Refuge, 1998. This is a typical annual distribution since 1994. (VIRA = Virginia Rail, AMBI = American Bittern, LEBI = Least Bittern).

cess in 1998 was near 60% for all nesting attempts.

Nesting colonies of Green Herons (*Butorides virescens*) are occasionally located in La Crosse County on the Mississippi River, with about 8 to 15 nests present. Nest success has not been determined.

Summary

Some migratory birds are well represented on the Refuge because adequate habitat and management is present. These include diving ducks, Tundra Swans, Bald Eagles, Great Blue Herons, and many songbird species.

Table 2. Number of species detected during seasonal migratory bird counts in the Upper Mississippi River National Wildlife and Fish Refuge, 1993–1997.

Year	Spring Migration		Summer Breeding		Fall Migration	
	No. of Species	No. & Type of Count	No. of Species	No. & Type of Count	No. of Species	No. & Type of Count
1997	121	137 pt counts	91	84 pt counts	69	63 pt counts
1996	154	194 pt counts	93	93 pt counts	72	58 pt counts
1995	146	222 pt counts	101	117 pt counts	107	123 pt counts
1994	134	57 area search	74	79 pt counts	none	none
1993	134	235 pt counts	no data	none	no data	none

However, habitat loss for these and other birds is a constant problem due to the mandated operation of the commercial navigation channel, the continued inundation and aging of the navigation pools, and decline of the bottomland forest with minimal regeneration and human disturbance.

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Prothonotary Warbler *by Dennis Malueg*

Floodplain Forest Songbirds of the Upper Mississippi River

Floodplain forests offer important nesting areas for many songbirds, yet these habitats may be declining in quality in Wisconsin and throughout the Midwest.

by Melinda G. Knutson, Randy K. Hines, Colin M. Sveum, Timothy J. Fox, and Carl E. Korschgen

Floodplain forests provide nesting habitat for over 130 species of songbirds in Wisconsin (Mossman 1991, Knutson et al. 1996) (Figure 1). Many of these species also nest in upland habitats, but some species, such as the Prothonotary Warbler (*Protonotaria citrea)* and the Red-shouldered Hawk (*Buteo lineatus*), are restricted to large riverine or wetland forests in Wisconsin. We have been investigating breeding habitat quality for floodplain and upland bird communities along the Upper Mississippi River since 1992 (Knutson et al. 1996, Knutson and Klaas 1997, Knutson and Klaas 1998). We find that floodplain forests have high abundances of birds compared to adjacent upland forests, demonstrating their importance as songbird breeding habitat. In addition, many bird species with affinities for rare savanna habitats, such as the Black-billed Cuckoo (*Coccyzus erythropthalmus*), Northern Flicker (*Colaptes auratus*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), Baltimore Oriole (*Icterus galbula*), and Warbling Vireo (*Vireo gilvus*) are also commonly found in floodplain forests. Populations of these species will likely benefit from restoration of either floodplain forest habitats or savanna habitats (Knutson et al. 1996).

The U.S. Fish and Wildlife Service's Upper Mississippi River National Wildlife and Fish Refuge, the focus of our current research, is a wetland ecosystem of national priority because of its biological diversity and role as a major migratory corridor for hundreds of bird species (Wiener et al. 1998). The Refuge was recently designated a Globally Important Bird Area by the American Bird Conservancy.

Nesting success of songbirds breeding in floodplain and upland forests along the Upper Mississippi River is the subject of our most recent research. Our study plots are located in the Driftless Area Ecoregion, an area of high topographic relief, where

Figure 1. Floodplain forests along the Upper Mississippi River provide nesting habitat for a wide variety of songbirds in Wisconsin. Photo by Mary Craig.

nearly half of the landscape is covered by forests. We expect to find that nesting success is higher in this ecoregion than in other ecoregions of the Midwest that experience more intensive row crop agriculture. We are also interested in whether songbirds nest more successfully in upland or floodplain forests. We used standard protocols adopted by the national Breeding Biology Research and Monitoring Database (Montana Cooperative Wildlife Research Unit) to collect our data. Data from over 1,700 nests are now being analyzed.

The bird communities in upland and floodplain forests are quite different. We found more nests of Prothonotary Warbler, American Redstart (*Setophaga ruticilla*), Warbling Vireo, American Robin (*Turdus migratorius*), and Yellow Warbler (*Dendroica petechia*) in floodplain forests. Species that nest primarily in upland forests include Acadian Flycatcher (*Empidonax virescens*), Rose-breasted Grosbeak (*Pheucticus ludovicianus*), Indigo Bunting (*Passerina cyanea*), Red-eyed Vireo (*Vireo olivaceus*), Ruby-throated Hummingbird (*Archilochus colubris*), Scarlet Tanager (*Piranga olivacea*), Ovenbird (*Seiurus aurocapillus*), and Wood Thrush (*Hylocichla mustelina*).

We need to understand how floodplain forest habitats contribute to maintaining populations of midwestern songbirds because mounting evidence indicates that floodplain forest habitat quality may be declining in Wisconsin and throughout the Midwest (Knutson and Klaas 1998). After European settlement, floodplain forests were converted to agriculture across Wisconsin, reducing the overall

amount of floodplain forest habitat and the size of habitat patches available for birds. Large floodplain forests of the Upper Mississippi River are under additional stress because locks and dams raise water levels and alter annual hydrologic cycles (Yin et al. 1997, Sparks et al. 1998). We need a better understanding of how these floodplain forests regenerate under altered hydrologic regimes in order to sustain high quality forest habitat along the Upper Mississippi River for both breeding and migrating songbirds. The large floodplain forests of the Upper Mississippi River represent a globally rare resource because the river here is unleveed, the floodplain remains connected to the river, and a natural braided channel with backwaters and forests supports high biodiversity.

Large and small river systems across Wisconsin and the Midwest will likely be the focus of intensive restoration efforts over the next decade. Concern over poor water quality in midwestern streams and rivers has led to increased interest in watershed restoration (Fennessy and Cronk 1997). In addition to local eutrophication, transfer of nutrients from agricultural land into midwestern waterways can negatively affect ecosystems as distant as the Gulf of Mexico (Rabalais et al. 1996). Restoration of riparian zones aimed at improving water quality may also benefit birds if their habitat needs are considered during the planning process (Hodges and Krementz 1996, Landers 1997). Floodplain forests, as well as grassland habitats, could be restored in quantity and size along riparian corridors with multiple societal benefits.

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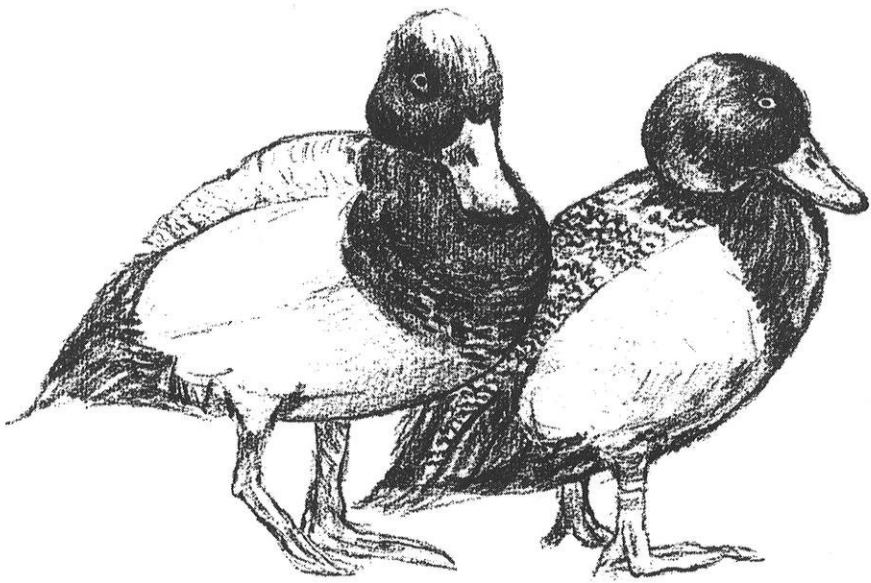

Scaup *by Karen R. Whitford*

Bird Monitoring in the St. Croix National Scenic Riverway

*The St. Croix National Scenic Riverway passes through several major landscapes and habitats that are home to many rare and sensitive plants and animals. Recent Breeding Bird Surveys have revealed substantial changes in the relative abundance of many species, including a 1,100% increase in Brown-headed Cowbirds (*Molothrus ater*).*

by Robin Maercklein

Established in 1968, the St. Croix National Scenic Riverway, located in northwest Wisconsin, is one of the original eight rivers of the nation's Wild and Scenic River system. Mostly free flowing and unpolluted, 252 miles of the Namekagon and St. Croix Rivers are preserved in the Riverway, where they flow through some of the most scenic and least developed country in the upper Midwest (Figure 1).

As a unit of the National Park Service, we strive to preserve the natural processes that produce the natural landscape. However, the Riverway is managed or influenced by a large number of public and private entities. The Riverway passes through, or includes parts of, two states, 11 counties, 18 municipalities, five state parks, three state forests, one national forest, numerous state wildlife management areas and scientific natural areas, and hundreds of private properties. The Riverway is the endpoint for a watershed of 8,570 square miles.

The Riverway is a narrow corridor that averages just one-quarter mile in width on either side of the river. Its path crosses four major plant communities and is in close proximity to the two remaining Wisconsin plant communities listed by Curtis (1959).

The Namekagon and St. Croix Rivers above St. Croix Falls begin as small, narrow, and often fast moving streams that pass through mixed hardwood and coniferous forests, numerous wetlands, and the tall sand bluffs of the pine savanna. Rocks, sandbars, or beaver dams are common obstacles during typical low summer water levels.

The river makes a dramatic change at St. Croix Falls, where resistant basalt at the Interstate state parks forced the glacial waters to carve a narrow canyon. Limestone outcroppings are evident all the way to the Mississippi River. The

Figure 1. Islands, backwaters, and the old Soo Line railroad bridge on the St. Croix River, just north of Stillwater, Minnesota. Photo by Robin Maercklein.

valley, however, broadens considerably, allowing the river to meander with multiple channels, islands, and extensive wetlands between St. Croix Falls and Stillwater, Minnesota. These channels offer many opportunities for exploration, bird watching, and isolation from the more heavily travelled main channel.

The Mississippi River creates an effective dam at the mouth of the St. Croix River. This final 25-mile stretch (called Lake St. Croix) is the most heavily visited portion of the Riverway, and is popular with users of powerboats, cruisers, sailboats, and personal watercraft.

Birds of the St. Croix Riverway

The mix of different plant communities and landforms results in a great variety of habitats for many species of birds. The Riverway's checklist is currently being revised, but lists 246 species of birds that have been identified as regular within the area. Of these, 157 species are considered to be breeding within the Riverway.

The Riverway is committed to protecting rare, threatened, and endangered species within its boundaries. To achieve these goals, populations of several bird species are being monitored. Bald Eagles (*Haliaeetus leucocephalus*) are prominent among these, with both active and inactive nests being monitored. Twenty-six active nests were located on the Riverway in 1998. Trumpeter Swans (*Cygnus buccinator*) have been seen along the Riverway since at least 1987. Nesting was confirmed in 1990 and each year since, with at least three pairs nesting in 1998. In addi-

tion, at least 24 swans overwintered on the river during 1998–99.

Because of their colonial nesting behavior, Great Blue Herons (*Ardea herodias*) are susceptible to disturbance from humans. Twenty years of notes and monitoring were gathered together in 1999 to produce the first summary of their rookeries along the Riverway. Since 1979, 11 rookeries have been identified and monitored (Figure 2). The annual counts show an increasing population. Only three or four rookeries have ever been active in the same year. Currently, three large rookeries are active.

We also collect information on several other species. Several Ospreys (*Pandion haliaetus*) and a good number of Red-shouldered Hawks (*Buteo lineatus*) nest along the river, but no concerted effort has been made to monitor their populations. Louisiana Waterthrushes (*Seiurus motacilla*), Prothonotary Warblers (*Protonotaria citrea*), and Cerulean Warblers (*Dendroica cerulea*) all reach the northern limits of their range within the Riverway. Acadian Flycatchers (*Empidonax virescens*) have nested along the Riverway and, in 1998, Hooded Warblers (*Wilsonia citrina*) were repeatedly observed carrying food to a likely nest site along the lower river. Notes and observations have been collected on all these species, but a concerted monitoring effort is needed to determine their needs and management strategies. Migrating songbirds have been also studied, with tens of thousands of songbirds mist netted and banded.

Breeding Bird Surveys in the Riverway

Resource managers need to have current information regarding population trends of many plant and animal groups to be able to make informed decisions, but few surveys have been conducted to determine the breeding status of birds along the St. Croix National Scenic Riverway. Although five U.S. Fish and Wildlife Service Breeding Bird Survey (BBS) routes are established within the St. Croix River watershed (Fannes 1981), none survey the river's immediate environment. Surveys patterned after the BBS were conducted by watercraft on the St. Croix and Namekagon rivers in 1982 and 1983, and were repeated in 1998 using the same maps and routes. Eighty-seven species were observed in each of the combined 1998 surveys and combined 1982/1983 surveys.

In 1982 (Hudick 1982) and 1983 (Webster 1983), breeding bird surveys were conducted along 24.5-mile portions of the lower St. Croix (lower river) and Namekagon Rivers, respectively. These followed the methods for the BBS (Robbins 1967) with the following exceptions: 1) These were river routes instead of road routes. 2) Instead of an automobile, a motorized boat or a canoe was used on the lower river or the Namekagon, respectively. 3) The count was conducted on two days because the slower means of travel prevented it from being performed on one day. 4) Locations of stops were determined by marks on a map depicting a half-mile separation from previous stops. 5) Each stop was not a stationary point, but was instead a point at which the count was begun. The boat or canoe was allowed to drift until the three-minute count period ended.

When these routes were resurveyed in 1998, I was assisted by District Interpreter Terry O'Halloran on the Namekagon route and by Lower District

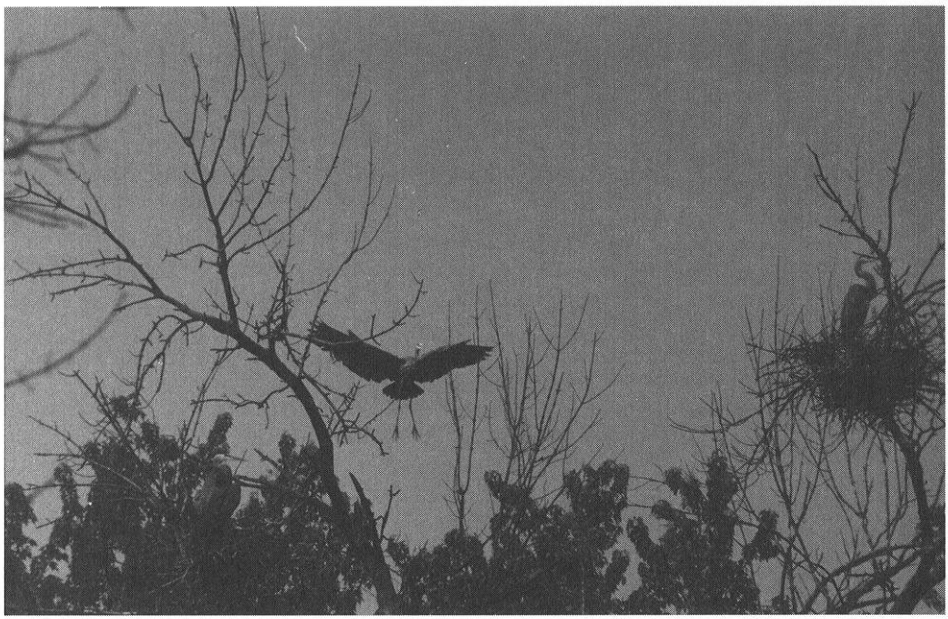

Figure 2. Activity at the Cedar Bend Great Blue Heron rookery in the St. Croix National Scenic Riverway. Photo by Robin Maercklein.

Ranger Joe Hudick on the lower river route. The Namekagon route was surveyed on 23 June 1998, and the lower river route was surveyed on 17–18 June 1998.

Drastic changes in the frequency of observation for over 30 species appear to be evident when comparing the 1982/83 surveys with those done in 1998 (Table 1). The greatest change was the 1,100% increase in Brown-headed Cowbirds (*Molothrus ater*) on the lower river survey.

Several points must be acknowledged, however, when comparing data from the different surveys. First, bear in mind that these surveys represent but two 'snapshots' of each route. Second, Joe Hudick and I both feel that our birding abilities have improved since we participated in the original surveys, and this may have affected the 1998 results. Third, care must be taken in interpreting the data on frequency of observation. For example, Wood Thrushes (*Hylocichla mustelina*) were observed at three stops in 1982 compared with only two stops in 1998 (Table 1); although this decline is probably not biologically meaningful, it does result in a large (33%) decline in frequency of observation. Also note that the frequency of observation of a species can increase by an unlimited amount, but can show at most a 100% decrease. Finally, only small percentage increases are possible for very common species that are found at a large number of stops.

Results for the following species are of particular interest:

Great Blue Heron—A substantially larger number was counted in 1998

Table 1. Species showing substantial changes in the number of stops at which they were observed during breeding bird surveys in 1982/83 and 1998. No. Obs. is the count of individuals for the entire route. Stops Obs. is the number of stops per route during which the species was observed.

	Lower River					Namekagon River				
Species	1982 No. Obs.	1982 Stops Obs.	1998 No. Obs.	1998 Stops Obs.	% Change	1983 No. Obs.	1983 Stops Obs.	1998 No. Obs.	1998 Stops Obs.	% Change
Great Blue Heron	11	10	418	11	10	3	3	11	8	167
Green Heron	10	6	1	1	−83	0	0	1	1	
Bald Eagle	5	3	9	7	133	2	2	4	4	100
Red-shouldered Hawk	4	4	0	0	−100	0	0	0	0	0
Yellow-billed Cuckoo	0	0	0	0	0	0	0	12	9	
Belted Kingfisher	12	10	5	5	−50	1	1	10	9	800
Red-bellied Woodpecker	7	6	19	17	183	0	0	0	0	0
Yellow-bellied Sapsucker	1	1	1	1	0	2	2	8	7	250
Hairy Woodpecker	5	5	13	11	120	3	2	6	6	200
Downy Woodpecker	1	1	13	12	1100	4	4	2	2	−50
Eastern Phoebe	7	7	30	21	200	7	6	6	4	−33
Least Flycatcher	0	0	5	4		19	16	20	14	−13
Alder Flycatcher	0	0	0	0	0	0	0	3	2	
Eastern Wood-Pewee	9	7	24	22	214	15	15	10	9	−40
Tree Swallow	24	6	43	22	267	27	16	8	7	−56
Blue Jay	47	26	12	11	−58	26	21	22	18	−14
American Crow	81	38	56	35	−8	8	8	33	22	175
White-breasted Nuthatch	20	15	32	26	73	10	10	28	19	90
American Robin	14	10	48	32	220	13	11	9	6	−45
Blue-gray Gnatcatcher	7	6	23	22	267	0	0	0	0	0
Cedar Waxwing	2	1	8	6	500	22	14	55	18	29
Red-eyed Vireo	7	7	22	17	143	51	34	138	49	44
Warbling Vireo	4	3	15	13	333	7	6	3	3	−50
Black-and-white Warbler	0	0	1	1		8	5	21	15	200
Prothonotary Warbler	23	14	36	24	71	0	0	0	0	0
Nashville Warbler	0	0	0	0	0	9	9	1	1	−89
Chestnut-sided Warbler	0	0	0	0	0	6	6	22	16	167
Cerulean Warbler	0	0	3	3		0	0	2	2	
Pine Warbler	0	0	0	0	0	1	1	12	9	800
Common Yellowthroat	21	14	60	35	150	20	15	55	30	100
American Redstart	0	0	9	8		10	9	35	21	133
Brown-headed Cowbird	2	2	42	24	1100	5	5	20	12	140
Northern Cardinal	1	1	12	10	900	0	0	0	0	0
Indigo Bunting	3	3	10	9	200	3	1	3	3	200
Song Sparrow	67	41	111	51	24	56	38	75	40	5

(418 compared to 11 in 1982/83) due to the inclusion of estimates of three colonies not included in the 1982 BBS on the lower river. Two of these rookeries were present in 1982, but were not counted at that time. On the Namekagon, this species was seen at eight stops compared to three stops in 1983, for a 167% increase in frequency (Figure 3).

Green Heron—A substantial reduction in Green Heron (*Butorides virescens*) numbers was observed (10 at six stops in 1982 compared with one at one stop in 1998) for an 83% decline in frequency on the lower river route. The reason for the difference is unknown.

Bald Eagle—The number of eagles observed doubled in both counts (from five in 1982 to nine in 1998 on the lower river and from two to four on the Namekagon). The number of reported active eagle nests has risen from two in 1982 to a high of 22 in 1996.

Red-shouldered Hawk—Recorded at four locations on the lower river route in 1982, they were completely absent in 1998, despite multiple observations made outside of the count period. This is probably an insignificant change.

Yellow-billed Cuckoo—Yellow-billed Cuckoos (*Coccyzus americanus*) were recorded at unprecedented numbers on the Namekagon survey. Completely lacking on the 1982/83 surveys, 12 were recorded at nine stops on the Namekagon River. This species has also been observed regularly along the

Figure 3. Park Ranger Terry O'Halloran watches a Great Blue Heron on the Namekagon River, St. Croix National Scenic Riverway. Photo by Robin Maercklein.

lower river route, but not during the count period.

Prothonotary Warbler—Present only along the lower river, the observations increased 71% from 14 to 24 stops.

Cerulean Warbler—This species was not observed on either route in 1982/83. Two individuals were heard calling in 1998 on the Namekagon route, and three were recorded at three stops on the lower river route. This may be a species for which improved call recognition on the part of observers affected the increase in observations.

Brown-headed Cowbird—An increase in observation frequency along the lower river route by 1,100% is the highest, tied with Downy Woodpecker (*Picoides pubescens*) (Table 1), for any species recorded on the two routes. Along the lower river, stops at which it was observed increased from two to 24. On the Namekagon, it increased from 5 to 12 stops, for a 140% gain. The unfortunate increase along the lower river may be attributable to increasing development along the St. Croix in close proximity to the Twin Cities area. Further studies are warranted.

Northern Cardinal—Observed only on the lower river route, Northern Cardinals (*Cardinalis cardinalis*) showed a 900% increase, going from one stop in 1982 to 10 stops in 1998. This change may also be due to increased housing development and subsequent bird feeding along the river.

Too few studies have been conducted on the St. Croix and Namekagon Rivers and their immediate environment to determine population trends on birds breeding within the Riverway. However, comparison of the 1982/83 and 1998 breeding bird surveys does point to some species whose trends may need further monitoring. Further, these surveys suggest that up to 106 species may be breeding within the Riverway. Mossman (1991) suggests that the potential breeding population may include about 155 species. Clearly, further surveys are needed to verify breeding and to establish population trends.

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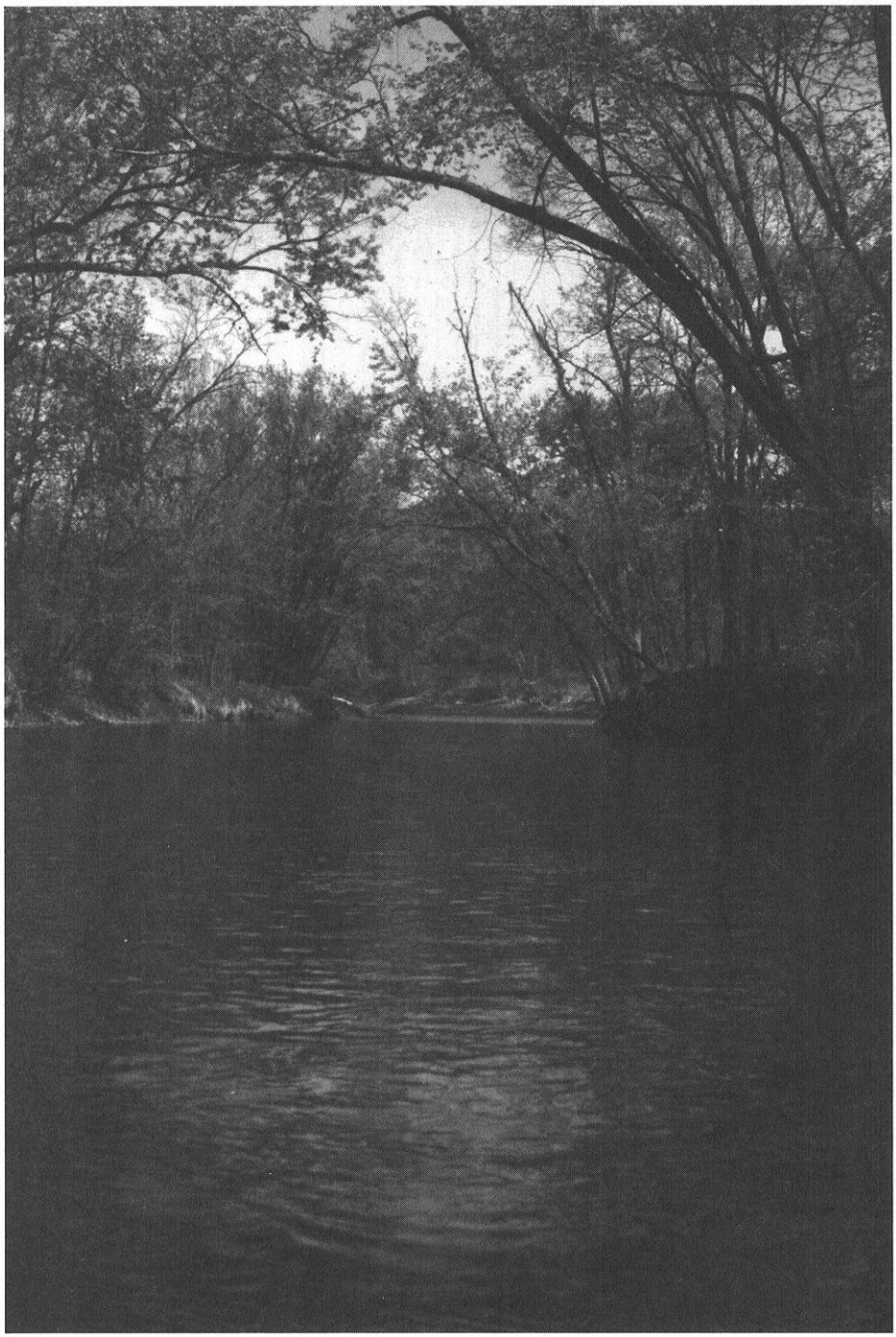

Typical backwater habitat on the lower St. Croix River. National Park Service photo.

The Crex Meadows Wildlife Area

The vast wetlands and prairies of Crex Meadows were severely degraded following human settlement, but successful restoration efforts have made the area a haven for many waterbirds.

by Jim Hoefler

The 30,000 acre Crex Meadows Wildlife Area is owned and managed by the Wisconsin Department of Natural Resources. It is located in Burnett County in northwestern Wisconsin, just north of Grantsburg along the Minnesota border.

Crex Meadows is situated in the bed of an ancient glacial lake called Glacial Lake Grantsburg. The lake drained away and filled in over the years but the deepest portions of the lake were located in the area now occupied by Crex. This portion of the lake evolved into the extensive sedge meadows now found in this area. The largest of these sedge marshes are five to seven miles long and up to a mile wide. More than half of Crex is sedge marsh.

Interspersed among the sedge marshes are sandy uplands. At the time of European settlement, the upland vegetation consisted of large jack and red pine trees widely scattered throughout an undulating expanse of prairie grasses and forbs, sweet fern, hazel, and oak brush. This mixture of trees, brush, and prairie vegetation was called a brush-prairie. It was maintained by frequently occurring wildfires.

Many changes occurred during settlement. The advent of fire control reduced the number and extent of wildfires, allowing much of the brush-prairie to grow into a pine and oak forest. Wetland drainage for farming purposes began in 1890. Over the next twenty years, most of the sedge marshes were drained.

From 1911 until 1931, the Crex Carpet Company owned most of the area. They harvested sedges, which they used to manufacture grass carpets. Local residents referred to sedge marshes as "meadows" and when the marshes were owned by the Crex Carpet Company, they were called the "Crex Meadows." The state retained this local name when they purchased the area.

The Crex Carpet Company became bankrupt in 1931, and by 1940 nearly two-thirds of the land in the county was tax delinquent. Most of this land reverted to county ownership. The state began purchasing these tax delinquent lands in 1946 to start the Crex Meadows Wildlife Area.

Soon after purchase, work was begun to restore the marshes that had been drained and the brush-prairie that had grown into oak and jack pine forests in the absence of fire. Wetland restoration began in 1947, when the first dikes were constructed to reflood the marshes. Since then, 22 miles of dikes have been constructed to create 29 flowages, which flood nearly 7,000 acres. Prescribed burning was employed, beginning in 1948, to restore forested areas to brush-prairie. Seven thousand acres of brush-prairie have since been restored.

Crex receives more than 100,000 visitors annually. Even though the area is funded almost exclusively from hunting and trapping revenues, hunting and trapping are minority uses of the property. The number one activity, accounting for 75% of visitor use, is wildlife observation.

The property is well suited for public use. It contains more than forty miles of interior roads, several observation areas, and a rest area with picnic tables, benches, restrooms, fire grates, grills, and drinking water.

Birders are drawn to Crex by the diversity and abundance of birdlife. Two hundred and sixty-five species of birds, including many endangered, threatened, and uncommon species, are found here.

Birds of the "open water" marshes include many species of waterfowl, including Trumpeter Swans (*Cygnus buccinator*) (Figure 1), which were decoy-reared here in 1989 and 1990. Several pairs of Trumpeter Swans nest here each year and as many as 40 nonbreed-

Figure 1. Several pairs of Trumpeter Swans nest at Crex Meadows Wildlife Area each year. Photo by Jack Bartholmai.

Figure 2. Large numbers of Sandhill Cranes use Crex Meadows as a stopover site during the fall migration. Photo by Jim Hoefler.

ing birds are present for most of the year. Red-necked Grebes (*Podiceps grisgena*) nest here in most years, and Western Grebes (*Aechmophorus occidentalis*) are spotted every year.

Sandhill Cranes (*Grus canadensis*) are the most notable resident of the sedge marshes (Figure 2). More than 6,000 cranes are present during the fall migration. Serious birders visit the sedge marshes in search of the elusive Yellow Rail (*Coturnicops noveboracensis*) and Nelson's Sharp-tailed Sparrow (*Ammodramus nelsoni*).

The Crex Headquarters is located on County Road D on the north side of Grantsburg. One room of the office building serves as a visitor center. Here you may obtain property maps, self-guided auto tour booklets, and other information. The visitor center is usually open on weekdays from 7:45 AM until 4:30 PM, and on spring and fall weekends from 10 AM until 4 PM. The new Crex Meadows Wildlife Education Center is scheduled for completion in the summer of 2000.

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American White Pelicans *by Jack Bartholmai*

Plant Communities and Birds of Six Lake Superior Coastal Wetlands

Of the large number of relatively pristine wetlands occurring within the Lake Superior watershed, we chose six on which to focus. We describe the vegetation community types within each wetland, discuss similarities among the wetlands, list the threats to each wetland, and conclude with a brief discussion of breeding birds of the six wetlands.

by Joan E. Elias and James E. Meeker

Many coastal wetlands are located along the southern shore of Lake Superior, with the largest concentration occurring in the western part of the basin. In Wisconsin, these wetlands are protected from long fetches across Lake Superior by the Bayfield Peninsula and the Minnesota north shore. Here we will focus on six Lake Superior coastal wetlands: Allouez Bay, Port Wing Slough, Bark Bay Slough, Lost Creek Slough, Fish Creek Slough, and the Kakagon/Bad River Sloughs complex (Figure 1). We will discuss similarities among these wetlands, describe the vegetation communities of each wetland, and list the birds observed in each wetland. Our combined experience with these wetlands includes vegetation and bird surveys for the Wisconsin Department of Natural Resources (WDNR) as part of their larger Lake Superior Coastal Wetlands Inventory Project (Epstein et al. 1997), vegetation mapping and bird surveys for the Bad River Band of the Lake Superior Chippewa Indians (Meeker 1993, Meeker 1995, Elias 1995, Elias 1996a), and vegetation work relative to lake level fluctuations for the Biological Resources Division of the U.S. Geologic Survey (Wilcox et al. 1992).

Similarities among The Six Focus Wetlands

While each of the six coastal wetlands listed above is unique, they share a number of ecological features:

1) All of our focus wetlands are located on the edge of the Lake Superior clay plain, a region of red clay soils extending approximately 8–20 miles inland along the entire Wisconsin shoreline of Lake Superior. The red clay, which is a result of glacial and lacustrine deposits, provides a rich soil environment when compared to wetlands

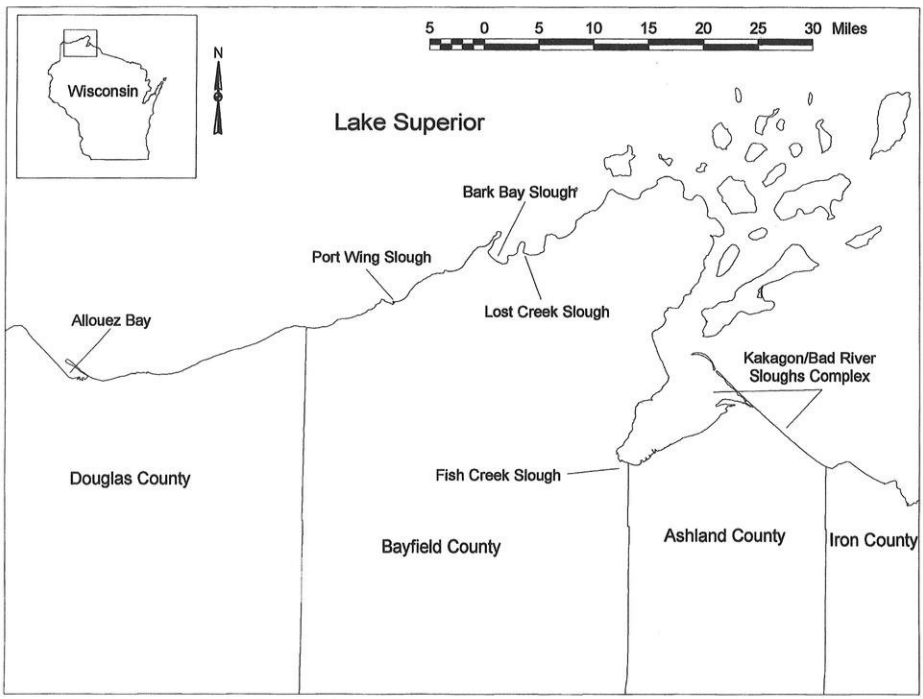

Figure 1. Locations of Allouez Bay, Port Wing Slough, Bark Bay Slough, Fish Creek Slough, and the Kakagon/Bad River Sloughs Complex on the coast of Lake Superior.

in the eastern part of the Lake Superior basin, which are underlain by bedrock and gravel deposits.

2) All six of the wetlands are fed by rivers, the mouths of which are subsiding or drowning relative to longterm water level changes. Lake Superior's outlet at Sault Ste. Marie is rebounding from the former glacier's weight at a rate faster than the western end. Due to this differential isostatic rebound, the western end of Lake Superior is slowly undergoing submergence at a rate of approximately 24 centimeters/century (Larsen 1994), while the wetlands near the eastern end of the lake are no longer connected to the lake. This differential isostatic rebound results in what is commonly known as "drowned river mouths" in all six of our focus wetlands.

3) These six wetlands are coastal freshwater estuaries (or lacustuaries), directly connected to, and freely exchanging water with, Lake Superior. As lacustuaries, these wetlands often experience daily water level changes, some much more so than others. As the water in the basin of Lake Superior is pushed back and forth due to wind action and atmospheric pressure changes, the coastal wetlands experience something like small tides, known as seiches, as lake water flows into the wetland and back out again.

4) Except for Fish Creek Slough, all of the wetlands are protected from Lake Superior's wind, wave, and ice ac-

tion by long, narrow sand spits. (Aerial photographs show what appear to be remnants of a sand spit in front of Fish Creek Slough, suggesting that this wetland, too, once had protection from Lake Superior.) Development on these sand spits is a threat common to all six wetlands.

5) All six of the wetlands are complex, encompassing several different plant communities, such as marsh, open peatlands, and forested wetlands. These different communities provide a variety of habitat types for wildlife, especially migrating and nesting birds.

Vegetation Community Types

Those who specialize in plant community descriptions often split a few broad categories into many smaller, very specific community types. For example, Harris et al. (1996), in describing Ontario wetlands, identify 13 different kinds of marsh based on a combination of substrate type and vegetation; Epstein et al. (1997) split open peatlands into coastal bogs, coastal fens, and open bogs; and on a more regional scale, Cowardin et al. (1979) divide forested wetlands into needle-leaved evergreen, broad-leaved evergreen, needle-leaved deciduous, and broad-leaved deciduous. Many of these fine divisions are valid and necessary for floristic projects. For our purposes here, we place community types in three broad categories (marshes, open peatlands, and forested wetlands), with two to four more narrowly defined communities within each, described below. (A more complete description of the plant communities in the six focus wetlands, as well as many other wetlands within the Lake Superior watershed, exists in Epstein et al. 1997.)

Marshes—We divide marshes into shallow-water and deep-water marshes. Plant nomenclature follows Voss (1972, 1985, 1996). Shallow-water marsh habitats are dominated by emergent vegetation such as cattail (*Typha latifolia*), arrowhead (*Sagittaria latifolia*), burreed (*Sparganium eurycarpum*), and soft-stem bulrush (*Scirpus validus*).

Deep-water marshes typically contain floating-leaf species, such as the water lilies (*Nuphar variegata, Nymphaea odorata*) and watershield (*Brasenia schreberi*), and submergent vegetation, such as the milfoils (e.g., *Myriophyllum heterophyllum*), coontail (*Ceratophyllum demersum*), submersed pondweeds (e.g., *Potamogeton zosteriformis, P. amplifolius*), and bladderwort (*Utricularia vulgaris*). Shallow-water marshes are generally found in depositional environs associated with riverine habitat, while deep-water marshes are characteristic of the protected embayments behind barrier beaches and also as a fringe along the outside edge of the riverine shallow-water marshes.

Open Peatlands—We have divided the open peatland community type into three categories: northern sedge meadow, wiregrass meadow (Figure 2), and *Sphagnum* bog. The dominant vegetation of a northern sedge meadow consists of sedges (*Carex lacustris, C. stricta*); blue-joint grass (*Calamagrostis canadensis*); a variety of herbs, such as marsh bell flower (*Campanula aparinoides*), water arum (*Calla palustris*), spotted Joe-pye weed (*Eupatorium maculatum*) and blue flag iris (*Iris versicolor*); and scattered shrubs, such as alder (*Alnus rugosa*), willows (e.g., *Salix petiolaris, S. pedicellaris*), and dogwood (*Cornus stolonifera*).

Figure 2. Many coastal wetlands of Lake Superior contain open peatland habitats, like this wiregrass meadow. Vegetation in this habitat type is dominated by wiregrass (*Carex lasiocarpa*). Photograph by James E. Meeker.

Typical plant species within a wiregrass meadow include the mat-forming wiregrass (*Carex lasiocarpa*), herbaceous species such as bogbean (*Menyanthes trifoliata*) and purple cinquefoil (*Potentilla palustris*), twig rush (*Cladium mariscoides*), bladderwort (*Utricularia intermedia*), scattered clumps of leatherleaf (*Chamaedaphne calyculata*) and sweet gale (*Myrica gale*), and less *Sphagnum* moss than the following community type, *Sphagnum* bog.

Sphagnum bogs are nutrient-poor communities, dominated by *Sphagnum* moss species, with hummocks of ericaceous shrubs such as leatherleaf, bog rosemary (*Andromeda glaucophylla*), bog laurel (*Kalmia polifolia*), and cranberry (*Vaccinium oxycoccos, V. macrocarpum*); carnivorous plants such as pitcher plant (*Sarracenia purpurea*) and sundew (*Drosera rotundifolia*); and sedges such as wiregrass, *Carex limosa*, and *C. chordorrhiza*.

Forested Wetlands—Forested wetland community types consist of conifer bogs, conifer swamps, deciduous swamps, and shrub swamps. Conifer bogs have a sparse to dense canopy of black spruce (*Picea mariana*) and/or tamarack (*Larix laricina*), and ground flora similar to that of the *Sphagnum* bog, described above (Figure 3).

Conifer swamps have richer substrates than conifer bogs, and contain more white cedar (*Thuja occidentalis*) and tamarack, with lesser amounts of black spruce. Alder is common in the shrub layer. Ground flora in conifer swamps include three-leafed Solomon's seal (*Smilacina trifolia*), white vi-

Figure 3. The forested wetlands surrounding Honest John Lake include vast areas of conifer bog. The dominant tree species in this bog is black spruce (*Picea mariana*). Photograph by Joan E. Elias.

olet (*Viola macloskeyi*), goldthread (*Coptis trifolia*), and sedges such as *Carex disperma* and *C. trisperma.*

Deciduous swamps typically contain black ash *(Fraxinus nigra)* and red maple *(Acer rubrum)* in the canopy; a shrub layer of alder, dogwoods, and *Viburnum* spp; and a ground layer with marsh marigold (*Caltha palustris*), sensitive fern (*Osmunda sensibilis*), manna grass (*Glyceria striata*), and water arum.

Shrub swamps are dominated by alder, dogwood, and willows, and the ground layer is similar to that of the deciduous swamps and northern sedge meadows.

Descriptions of Individual Wetlands

Allouez Bay—Allouez Bay, located in the city of Superior, is a large open-water bay, with a wetland of several hundred acres located on the eastern portion of the bay. The bay and associated wetland are protected from Lake Superior by a long, highly developed sand spit (Wisconsin Point). The City of Superior, the U.S. Coast Guard, and private individuals share ownership of this wetland area.

The Allouez wetland contains a large marsh, both shallow-water and deep-water, patches of sedge meadow, and a conifer swamp. A few small wild-rice patches are scattered in the marsh, perhaps remnants of once much larger rice beds. Allouez Bay and wetland must have been rich with plants and animals before becoming degraded and confined by the encroaching city of Superior. Even though it is disturbed and eutrophied, Allouez Bay is still of wildlife value. For example,

Mike Van Stappen reported a large concentration of migrating waterfowl in the bay (data within Epstein et al. 1997).

Port Wing Slough—Located near the town of Port Wing, the Port Wing Slough encompasses approximately 1,000 acres. Most of the wetland is privately owned, with some town ownership, and some state ownership designated as a State Natural Area. A road crosses the wetland, and a harbor is located at the mouth of the slough.

The Port Wing wetland is fed by the Flag River and several smaller creeks. The wetland includes a large open-water slough, called Bibon Lake, as well as sedge meadow, wiregrass meadow, *Sphagnum* bog, shallow-water marsh, and conifer swamp communities. Several disturbances threaten the integrity of this wetland, including eutrophication from the sewage ponds located immediately uphill from the Bibon Lake Slough; development along the sand spit; activities associated with the harbor, such as dredging and a change in the pattern of sediment deposition due to the jetty; and invasion by giant reed (*Phragmites australis*), an aggressive species that tends to form monocultures and outcompetes a more diverse, native species assemblage.

Bark Bay Slough—Bark Bay Slough, located near the town of Herbster, is largely state-owned and in State Natural Area protection (Figure 4). The Bark Bay wetlands are fed by the Bark River on the east and a couple of small, unnamed creeks on the west. Extensive wetlands occur on both sides of Bark Bay Road. The western portion of the wetland has tannin-stained water, and contains a wiregrass meadow community, *Sphagnum* bogs, and floating tamarack islands. With the addition of silt-laden water from the Bark River, the eastern portion of the wetland contains shallow-water and deep-water marsh communities.

While this wetland is currently in excellent condition, it is threatened by development along the sand spit, eutrophication due to the outhouses on the sand spit, and invasion by giant reed.

Lost Creek Slough—Lost Creek Slough is a relatively small wetland (200–300 acres) located near the town of Cornucopia. Ownership of this wetland includes private individuals, the Town of Bell, and the state, which manages its portion of the wetland as a State Natural Area. Three creeks feed this wetland—Lost Creeks #1, #2, and #3—all of which converge in the wetland to form one drowned river mouth. Community types within the wetland include sedge meadow, wiregrass meadow, a small *Sphagnum* bog area, deep-water marsh, shrub swamp, conifer swamp, and deciduous swamp.

Development along the sand spit and power boat traffic in the open water lagoon threaten the integrity of this wetland. Lost Creek Slough is one of only a few sites in the state that host the rare plant, lake cress (*Armoracia aquatica*). The power boat traffic threatens to chop up and destroy the beds of this species.

Fish Creek Slough—Located on the western outskirts of the city of Ashland, Fish Creek Slough is a largely state-owned wetland, several hundred acres in size. North Fish Creek, South Fish Creek, and several smaller creeks converge in the wetland to form one large

Figure 4. Bark Bay Slough, showing typical marsh habitat of Lake Superior coastal wetlands. The vegetation in the foreground is dominated by burreed. Photograph by Joan E. Elias.

drowned mouth, as in some of the other wetlands. Community types within this slough include shallow-water and deep-water marshes, shrub swamp, and deciduous swamp. Fish Creek Slough experiences dramatic seiche activity, on the order of 20–40 centimeters, several times a day. The large fluctuations are due to the slough's location within Chequamegon Bay, which has its own seiche in addition to the Lake Superior seiche.

Many disturbances plague this wetland, such as U.S. Highway 2 (which crosses the mouth of the slough), encroaching development, and invasion by purple loosestrife (*Lythrum salicaria*). In spite of these threats, the mud and sand flats at the mouth of the slough provide excellent feeding and resting areas for waterfowl, gulls, terns, shorebirds, and herons. Mike Van Stappen reported this wetland to be a migratory bird concentration area (Epstein et al. 1997).

Kakagon/Bad River Sloughs Complex—Encompassing approximately 12,000 acres, the Kakagon/Bad River Sloughs Complex is the largest wetland complex on Lake Superior (Figure 5). The wetland complex is located within the boundaries of the Bad River Indian Reservation, and is largely owned by the Bad River Band of Lake Superior Chippewa Indians, with some private inholdings. Two main rivers, the Kakagon and the Bad, along with their tributaries, as well as Denomie Creek and Beartrap Creek, feed this system. Even though this wetland complex technically consists of two sub-watersheds, the system is linked ecologically. Historically, the Bad River flooded into the

Figure 5. Aerial view of the Kakagon/Bad River wetland complex, showing Long Island and Chequamegon Bay in the background. Photograph by James E. Meeker.

Kakagon River, and as recently as 1992 the Bad once again flooded into the Kakagon. The entire complex consists of the Kakagon Slough, the Bad River Slough, and Honest John Lake.

Protected by the long sand spit known as Chequamegon Point, the mouth of the Kakagon River lies within Chequamegon Bay. Like Fish Creek Slough, the Kakagon Slough can experience dramatic seiche activity on the order of 20–40 cm, six times a day (Meeker 1993). The Kakagon Slough consists of vast areas of sedge meadow, wiregrass meadow, *Sphagnum* bog, shallow-water and deep-water marshes, with conifer swamps scattered throughout. This slough is unique among Lake Superior wetlands in that it contains substantial stands of wild-rice, which are harvested by Bad River members annually. Because of the tribe's spiritual connection to the rice, and the fact that the rice is more important to the tribe than development, the rice beds have been protected. Motor boat traffic is probably the largest threat to the wild-rice beds.

The Bad River Slough is located immediately to the east of, and adjacent to, the Kakagon Slough. The mouth of the Bad River is on Lake Superior, not in Chequamegon Bay, so the seiche activity of this slough is much less than that of the Kakagon. This slough is a large open-water area with shallow-water and deep-water marshes, sedge meadow, wiregrass meadow, and shrub swamp communities. A large clone of giant reed occurs within the slough; its rate of growth is monitored by the Bad River Natural Resources Department. The Bad River Slough is a transition between the lacustuarine characteris-

tics of the Kakagon slough and the bog lake character of Honest John Lake to the east.

The Bad River Slough is unique among all the wetlands discussed in this article in that it is fed, in part, by a large river bordered by floodplain forest habitats. Even some of the Bad River's tributaries, such as the White River and the Potato River, have small floodplain forests. The only other system in Wisconsin like the Bad River and associated floodplain forests is the Nemadji River (E. Epstein and E. Judziewicz, pers. comm.), which has been extensively altered and degraded. The Bad River bottomlands are flooded seasonally, sometimes dramatically so. The soils are extremely rich and support a thick growth of ferns and some very large trees. The spring ephemerals are especially diverse. (See Elias 1996b and 1997 for discussions of the birds of the Bad River Corridor.)

Honest John Lake, the most nutrient-poor area of the wetland complex, is a classic bog lake with tannin-stained waters surrounded by wiregrass meadow, *Sphagnum* bog, and conifer bog communities. However, Denomie Creek, which flows into Honest John Lake, brings high nutrient loads at certain times due to sewage treatment pond overflow. This situation is being monitored and remedied by the tribe.

The Kakagon/Bad River Sloughs Complex is the most extensive and least disturbed of all the Lake Superior coastal wetlands, due in large part to the stewardship of the Bad River Band. Threats to the system as a whole include invasion by purple loosestrife and giant reed and eutrophication.

Coastal Wetland Bird Surveys

While the main focus of this paper is to describe the habitats within six of Lake Superior's coastal wetlands, we also include a brief description of the breeding birds of these wetlands. All of the bird information comes from surveys conducted by Joan Elias between 1 June and 3 July 1996, as part of the larger WDNR Lake Superior Coastal Wetlands Inventory Project (Epstein et al. 1997). Sampling methods varied from site to site, depending on the types of habitat present. Birds were surveyed via canoe on open water and riverine sites. Point counts were conducted at sites with solid ground. Relevés were used to survey birds in habitats too small for point count sampling, and late in the season when some birds were no longer singing. At most sites, a combination of methods was used since more than one habitat type was present. Night surveys were conducted via canoe at Port Wing Slough, Bark Bay Slough, and the Kakagon/Bad River Sloughs Complex. The sampling methods are briefly described below.

Canoe Surveys—Surveys began at approximately 0430 and usually ended no later than 1030 (with the exception of the Kakagon Slough, which lasted until 1200). Night surveys began around 0200. In all canoe surveys, a route was paddled close to the shoreline throughout the open water area of the wetlands. Tapes of wetland bird songs and calls were played at intervals during the surveys in an attempt to elicit a response. All bird species heard and seen were recorded, along with relative or actual abundance data.

Point Counts—Ten-minute, unlimited-distance point counts were conducted in wetlands inaccessible via canoe. Points were located a minimum of

100 meters from a road or edge with an upland habitat type to minimize counting of individuals from other habitats, and 250 meters apart in order to minimize double-counting of individuals. All birds heard and seen during the 10-minute counts were recorded. Bird species encountered between points and not present at a point were also recorded.

Relevés—Data on bird species presence and relative abundance levels were gathered by walking around and through portions of the wetlands.

Results of Bird Surveys—In describing the birds associated with the different vegetation community types of our six focus wetlands, we return to the three broad categories described above: marshes, open peatlands, and forested wetlands.

Some species of birds—Red-winged Blackbird (*Agelaius phoeniceus*), Common Yellowthroat (*Geothlypis trichas*), Chestnut-sided Warbler (*Dendroica pensylvanica*), Song Sparrow (*Melospiza melodia*), and White-throated Sparrow (*Zonotrichia albicollis*)—were common in all habitat types, while other species seemed to show a preference for one or two habitat types. The following species were most common in forested wetland habitats: Golden-crowned Kinglet (*Regulus satrapa*), Golden-winged Warbler (*Vermivora chrysoptera*), Hermit Thrush (*Catharus guttatus*), Nashville Warbler (*Vermivora ruficapilla*), Northern Waterthrush (*Seiurus noveboracensis*), Palm Warbler (*Dendroica palmarum*), Yellow-bellied Flycatcher (*Empidonax flaviventris*), and Yellow-rumped Warbler (*Dendroica coronata*). Northern Harrier (*Circus cyaneus*), Savannah Sparrow (*Passerculus sandwichensis*), LeConte's Sparrow (*Ammodramus leconteii*), and Bobolink (*Dolichonyx orizyvorous*) were associated with open peatland habitats, though they were never encountered in high numbers. Rails, bitterns, and herons tended to occur in marsh habitats.

Our three broad vegetation community types overlap with some of the habitats discussed in a series of articles published in *The Passenger Pigeon* in recent years. For a more regional perspective on the birds and vegetation of some of these overlapping community types, we refer you to Hoffman (1989) for tall shrub communities, Mossman and Sample (1990) for sedge meadows, Hoffman (1990) for deep marshes, and Hoffman and Mossman (1993) for northern swamps and bogs.

The Kakagon/Bad River Sloughs Complex had the highest number of bird species (72), which is not surprising since it is the largest wetland surveyed and contains many habitat types (Table 1). Allouez Bay had the fewest number of bird species (32), which, again, is not surprising since it has a relatively small wetland area.

The lists of bird species observed in each of the six focus wetlands (Table 1) is not exhaustive—additional surveys would undoubtedly yield more species—yet they hopefully provide the reader with a good sense of the birds likely encountered in a single visit. These lists do not include migrating birds, since the breeding bird surveys were conducted after the main migration.

Several of the bird species found in the six focus wetlands are on the Wisconsin Natural Heritage list. Some of these species—Blue-winged Teal (*Anas discors*), Veery (*Catharus fuscescens*), Yellow-bellied Flycatcher, Golden-winged

Table 1. Species list and relative abundance of birds found in six Lake Superior coastal wetlands in Wisconsin (1 June to 3 July 1996). A = abundant, C = common, U = uncommon, R = rare.

Species	Allouez Bay	Port Wing Slough	Bark Bay Slough	Lost Creek Slough	Fish Creek Slough	Kakagon/ Bad River Sloughs
Alder Flycatcher	U	A	A	A	C	C
American Bittern		U	U		U	R
American Black Duck						U
American Crow	U	U	C	A	C	R
American Goldfinch	R	R	U	C	U	U
American Redstart		R	U	C	A	C
American Robin	U	C	U	C	C	U
Bald Eagle		R	R			U
Baltimore Oriole	R	R				R
Barn Swallow		R				
Belted Kingfisher			U	R	R	
Black-and-white Warbler		R	U	U	C	C
Black-capped Chickadee		U	C	C	C	U
Black-throated Green Warbler		U		R	R	
Blue Jay		U	C	C	C	U
Blue-winged Teal	C	U	U		A	U
Bobolink						R
Brewer's Blackbird			R			
Broad-winged Hawk			R			
Brown Creeper				R	U	R
Brown Thrasher		R				
Brown-headed Cowbird			R		C	U
Canada Goose	C	C	C	U	A	
Canada Warbler			R	R		
Cape May Warbler					U	
Cedar Waxwing	U	C	C	C	C	U
Chestnut-sided Warbler	R	R	U	U	C	C
Chipping Sparrow		R		R		R
Clay-colored Sparrow		R	R		R	R
Cliff Swallow					U	U
Common Grackle		U	R			R
Common Loon			R			R
Common Nighthawk		R	R			
Common Raven			R	U		
Common Snipe		U	U			R
Common Tern	A				C	
Common Yellowthroat	A	A	C	A	C	A
Double-crested Cormorant	C	R				R
Downy Woodpecker				U	R	
Dunlin					R	
Eastern Kingbird	R	U	C	C		C
Eastern Phoebe		R	R	U		R
Eastern Wood-Pewee			R		R	U
Evening Grosbeak				U		
Golden-crowned Kinglet				R		R
Golden-winged Warbler			U	C		R
Gray Catbird	R	U	R		R	R
Great Blue Heron	C				C	C
Great Crested Flycatcher			R		C	U
Great Horned Owl		R	R			
Hairy Woodpecker			R	R	U	R

(continued)

Table 1. *Continued*
A = abundant, C = common, U = uncommon, R = rare.

Species	Allouez Bay	Port Wing Slough	Bark Bay Slough	Lost Creek Slough	Fish Creek Slough	Kakagon/ Bad River Sloughs
Hermit Thrush		C			R	R
Herring Gull	A	C				R
Indigo Bunting					R	
Least Bittern	R					
Least Flycatcher			R			R
Le Conte's Sparrow						R
Lesser Yellowlegs						U
Lincoln's Sparrow						R
Magnolia Warbler						R
Mallard	A	U	C	U	C	U
Marsh Wren	C	C	U			U
Merlin				R		
Mourning Warbler			R	R	R	R
Mute Swan					U	
Nashville Warbler		C	C	C	U	C
Northern Flicker			U	U	C	U
Northern Harrier	R			U		R
Northern Parula		R	R	R		
Northern Waterthrush				R	C	
Olive-sided Flycatcher		R				
Ovenbird		U	U	U	U	
Pileated Woodpecker				U		
Pine Warbler		R	R	R		U
Purple Finch			R	U	R	U
Red-breasted Merganser					R	
Red-breasted Nuthatch				R	U	
Red-eyed Vireo		C	U	C	C	C
Red-winged Blackbird	A	A	A	A	A	C
Ring-billed Gull	A	C	A	A	C	C
Rose-breasted Grosbeak		R	R	R	U	
Rough-winged Swallow			R			
Ruby-crowned Kinglet				R		
Ruby-throated Hummingbird		R	U			
Ruffed Grouse				R		R
Sandhill Crane						R
Savannah Sparrow						R
Sedge Wren	A	A	A	A	C	C
Semipalmated Sandpiper					U	
Solitary Sandpiper				R	C	
Song Sparrow	C	C	C	C	C	A
Sora Rail	C	R	R		C	
Spotted Sandpiper		R	R			
Swamp Sparrow	C	A	A	A	C	C
Tree Swallow	R	R	U	U	U	C
Trumpeter Swan						U
Veery		C	U	R	C	U
Virginia Rail	R	C	U			U
Warbling Vireo					U	
Whimbrel				R		
White-throated Sparrow	R	C	A	C	U	C
Wilson's Warbler			R			

(continued)

Table 1. *Continued*
A = abundant, C = common, U = uncommon, R = rare.

Species	Allouez Bay	Port Wing Slough	Bark Bay Slough	Lost Creek Slough	Fish Creek Slough	Kakagon/ Bad River Sloughs
Winter Wren			U	R		R
Wood Duck	A	R			C	U
Wood Thrush				R		R
Yellow Rail			R			
Yellow Warbler	C	C	C	C	C	C
Yellow-bellied Flycatcher				C		
Yellow-bellied Sapsucker			U	U	R	
Yellow Palm Warbler				R		R
Yellow-rumped Warbler		R	R	C		C
Yellow-throated Vireo						R
Total No. Species	32	56	66	60	59	72

Warbler, and Nashville Warbler—are common or abundant in one or more of the wetlands, suggesting the regional importance of Lake Superior coastal wetlands to the maintenance of these species.

Summary

The six wetlands discussed above have varying degrees of ecological integrity. Many good examples of native wetland plant communities still exist in these wetlands, though development pressures, invasion by exotic and aggressive plant species, and eutrophication are the most common threats. Lake Superior coastal wetlands are unusual among Wisconsin wetlands because of their lacustuarine characteristics, drowned river mouths, and protection from Lake Superior by long, narrow sand spits. While some of these wetlands are partially protected through State Natural Area designation, a greater degree of protection for all of Lake Superior's coastal wetlands is needed in order to preserve their functional integrity and plant and animal communities.

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Avian Communities of the Necedah Wildlife Management Area and Yellow River

Songbird censuses were conducted in nine habitat types within and adjacent to the Necedah Wildlife Management Area. Analysis of the results indicate that conservation of sedge meadows, old fields, savannas, and bottomland hardwoods is vital for the preservation of avian diversity in central Wisconsin.

by Richard S. King

The lake bed of Glacial Lake Wisconsin has experienced dramatic hydrological, successional, and land use changes. Once mostly inundated by Glacial Lake Wisconsin, the landscape was left swampy and barren by the receding waters. The Great Central Wisconsin Swamp, as this area was to become known (Martin 1932), was dominated by sedge meadows, tamarack bogs, savannas, and islands of white pine. It was largely viewed as undesirable land once the limited timber was removed. However, early twentieth century farmers did attempt to raise crops on the nutrient-poor, windblown sand deposits of Glacial Lake Wisconsin (Clayton 1988). Their relative lack of agricultural success was predictable, but these early farmers did have a dramatic effect on the area's birdlife. Their land clearing activities, use of fire, and tendency to plant buckwheat (*Fagopyrum esculentum*) led to an explosion in Greater Prairie-Chicken (*Tympanuchus cupido pinnatus*) numbers. The work of Hamerstrom (1939) illustrated the abundance of prairie-chickens and the openness of the landscape in the 1930s. Another dramatic effect of the early farming efforts was the dredging of drainage ditches through the area, with an estimated 7 meters of ditch per hectare. Drainage lowered the water table and resulted in the elimination or degradation of most of the area's tamarack stands and sedge meadows.

Delinquent taxes led to 46,540 hectares in Monroe, Jackson, Wood, and Juneau Counties being acquired by the federal government in 1938. This property is now part of the National Wildlife Refuge System and is known

as the Necedah Wildlife Management Area. As this area came into public ownership, fire prevention and wetland creation efforts began immediately, bringing another large-scale change to the landscape. Savannas, which had always been part of the landscape, became closed canopy forests. Large water impoundments were created where very little open water previously occurred. Most of the wetland creation involved dike construction and resulted in the flooding of thousands of hectares of old fields.

Present Habitat Types

Fire prevention and control efforts and hydrological changes have allowed the development of closed canopy forests within Necedah. These closed canopy forests—most of them degraded savannas—are dominated by Hill's oak (*Quercus ellipsoidalis*). Jack pine (*Pinus banksiana*) is also abundant on excessively drained soils. Wetter stands have yellow birch (*Betula alleghaniensis*), red maple (*Acer rubrum*), white pine (*Pinus strobus*), and aspen (*Populus* spp.) present. Closed canopy forest (referred to as degraded savanna in all following texts, tables, and figures) is currently the most abundant habitat type, comprising approximately 65% of the landbase.

Initiated in 1960, savanna restoration efforts marked the return of fire to the landscape. Most of these savannas were clearcut before they were burned. However, one savanna was restored with a selective cut in which no large oaks (*Quercus* spp.) were removed. This unit was cut in the 1960s and has also been managed with prescribed fire. Additionally, one savanna (16 hectares) is a remnant of a 1936 wildfire. Totaling just 216 hectares, savannas are a small (0.5% of the landbase) but important habitat type on the Necedah Wildlife Management Area.

The second most abundant (approximately 25%) habitat type is sedge meadow (Figure 1), for which the Great Central Wisconsin Swamp was named. Extensive drainage at the turn of the twentieth century eliminated and degraded thousands of hectares of sedge meadow. However, existing sedge meadows are glacial relics, remaining relatively stable since the last glaciation.

Old fields are relics of the area's agricultural past. Although succession has claimed many of them, some old fields remain open as a result of impoverished soil, prescribed burning, or mowing. Prescribed burning helps to maintain many young aspen and willow (*Salix* spp.) stands on wetter soil. Aspen and willow stands also occur naturally in the transition between wetlands and uplands.

Forestry activities provide the last two major habitat types on the Necedah Wildlife Management Area. Clearcuts have been used extensively for fiber production and to reduce wildfire fuel. Clearcuts structurally resemble shrubby savannas or brush-prairies within just a few years. However, the herbaceous layer of clearcuts remains dominated by Pennsylvania sedge (*Carex pensylvanica*), which severely limits their use by ground nesting birds and rare species that are typical of savannas. Selective cuts have been used on a limited basis for wildfire fuel reduction, with all trees being removed except scattered, mature Hill's oaks. Ongoing savanna restoration efforts in the area use a similar prescription, with mature

Figure 1. Sedge meadow habitats comprise about 25% of the Necedah Wildlife Management Area, providing habitat for the increasingly rare Henslow's Sparrow. Necedah NWR file photo.

oak and pine being left regardless of species. For purposes of this study, current savanna restoration units that are still dominated by Pennsylvania sedge were grouped with the selectively cut group. Those savannas that were restored with a selective cut, but which are dominated by warm season grasses and savanna forbs, were grouped with savannas.

The Yellow River bottoms provide the last major habitat type in the area (Figure 2). The Yellow River runs in a north-south direction on the eastern boundary of the management area, and has also experienced dramatic structural changes during the twentieth century. Surveys conducted in the 1930s showed that the Yellow River had very few large trees. In fact, in those stands containing the largest trees, the average diameter-at-breast-height was only 30.5 centimeters. In contrast, the area is currently dominated by stands of large silver maple (*Acer saccharinum*), aspen, white pine, and swamp white oak (*Quercus bicolor*) (King 1997).

The primary purpose of this study was to determine the distribution and abundance of nesting birds within the Necedah Wildlife Management Area and bottomland hardwoods of the Yellow River. The secondary goal of the study was to develop a means of prioritizing the need for conservation measures on the respective habitats.

Sampling Methods

A total of 323 point counts (Ralph et al. 1995) was conducted within all habitat types between 15 May and 30 June, 1994 to 1998. Counts were conducted between 0530 and 1000 hours when rain or wind did not interfere with bird detection. Counts lasted 10 minutes

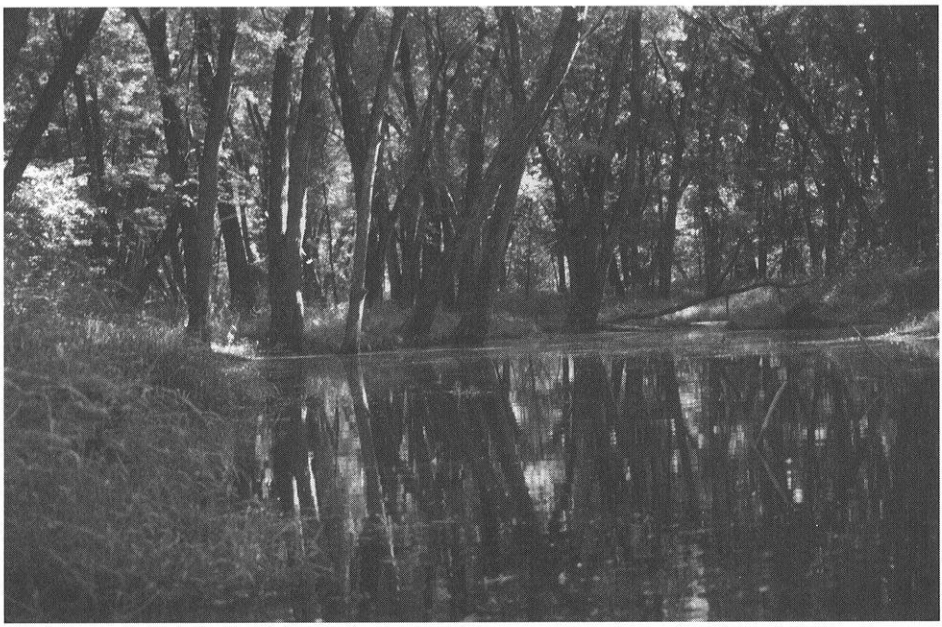

Figure 2. Large silver maples line the backwaters of the Yellow River at the Necedah Wildlife Management Area, and are home to many floodplain forest songbirds. Necedah NWR file photo.

and were subdivided into two periods of 5 minutes each. All birds detected within an unlimited distance were recorded, but birds detected within 50 meters were recorded separately from those individuals detected at a distance ≥50 meters. Point count locations were randomly assigned within habitat types with the stipulation that they be ≥75 meters from adjacent habitat types. The habitat types that occur in small stands (willow, aspen, savanna, old field, sedge meadows) did not always provide this opportunity.

Statistical Analysis

Canonical discriminant analysis was used to illustrate differences in avian communities of the habitat types. The discriminant analysis provides insight into the uniqueness of bird communities that can be used to make management decisions and prioritize conservation actions. Use of the analysis for null hypothesis testing is premature because uneven sample sizes led to inequality of the discriminant function variance-covariance matrices. Species on the edge of their range were excluded from the analysis as their abundance was sporadic and not exclusively habitat related. This group included Cerulean Warbler (*Dendroica cerulea*) and Dickcissel (*Spiza americana*). Species that could be detected from great distances were also excluded from the analysis because the habitat from which they were calling could not always be determined. This group included Sandhill Crane (*Grus canadensis*), Wild Turkey (*Meleagris gallopavo*), and Ruffed Grouse (*Bonasa umbellus*). All statistics are reported as indivi-

duals detected per 10 minutes of survey. All statistical analysis was conducted with SAS software (SAS 1998).

Results

Eighty species were detected on 323 point counts, and 55 species met testing criteria for inclusion in the discriminant analysis. Point counts conducted in savannas provided the greatest number of species (42), followed by old fields (39), degraded savannas (37), and bottomland hardwoods (36) (Figure 3). Fifteen species appeared to be habitat generalists in that they occurred in seven or more of the nine habitats (Table 1). Two habitat generalists not included in Table 1 were the Brown Thrasher (*Toxostoma rufum*) and Mourning Dove (*Zenaida macroura*). Eleven species appeared to be habitat specialists in that they occurred in two or fewer of the nine habitat types (Table 2). The bottomland hardwoods habitat type (Yellow River) accounted for 55% of the habitat specialists. Sixteen species reached their maximum abundance in the bottomland hardwoods, followed by selective cuts (8 species), clearcuts (8 species), aspen (6 species), willow (5 species), old fields (4 species), savanna (4 species), sedge meadows (3 species), and degraded savannas (1 species). Canonical discriminant analysis further illustrates separation among the habitat

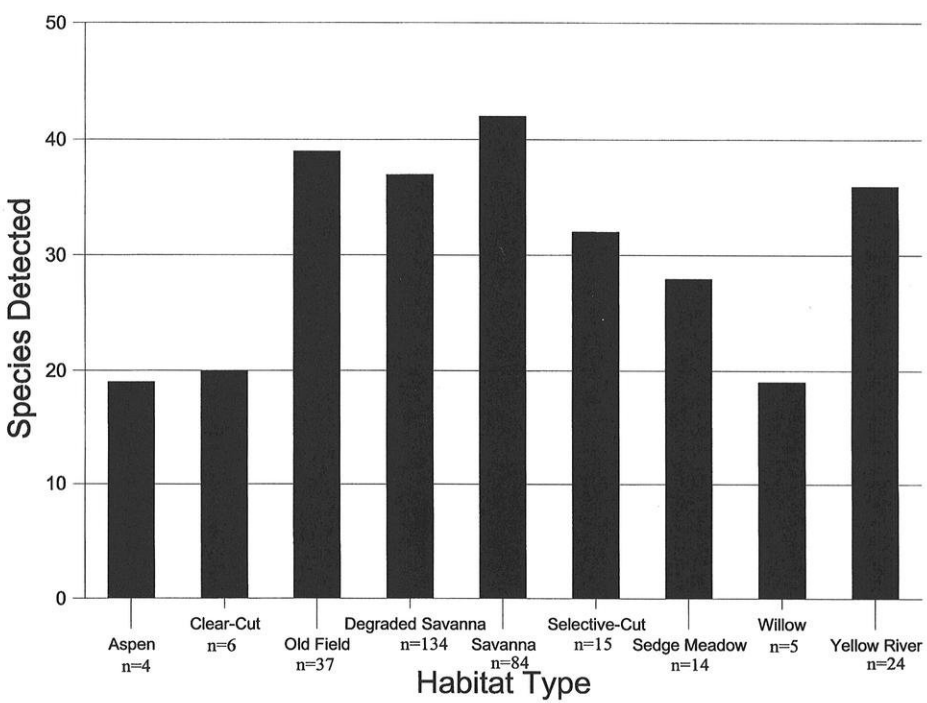

Figure 3. Avian species richness for habitat types within the Necedah Wildlife Management Area and neighboring Yellow River, Juneau County, Wisconsin (n = number of point counts in each habitat type).

Table 1. Bird detections per 10 minutes of survey (±SE) on the Necedah Wildlife Management Area and neighboring Yellow River, Juneau County, Wisconsin (n = number of point counts in each habitat type). Bold print indicates habitat type where individual species reached maximum abundance. Underlined print indicates the five most abundant species per habitat type.

	Habitat Type								
Species	Aspen (n=4)	Clear Cut (n=6)	Degraded Savanna (n=134)	Old Field (n=37)	Savanna (n=84)	Selective Cut (n=15)	Sedge Meadow (n=14)	Willow (n=5)	Yellow River (n=24)
Yellow Warbler	2.5±1.0	0.2±0.2		0.6±0.2	1.4±0.2	0.1±0.1	0.8±0.3	**2.6±0.7**	0.4±0.2
Eastern Towhee	0.3±0.3	**2.3±0.3**	0.2±0.0	0.4±0.1	0.9±0.1	0.3 ±0.2	0.3±0.2	0.4±0.2	
Scarlet Tanager			0.7±0.1				0.1±0.1		**0.8±0.3**
Song Sparrow	1.0±0.6		0.1±0.0	1.7±0.3	1.4±0.2	0.3±0.2	0.9±0.2	2.4±0.8	**3.3±0.4**
Field Sparrow		1.2±0.6	0.1±0.0	1.1±0.2	**1.8±0.2**	0.3±0.2	0.6±0.3		
Red-headed Woodpecker		0.3±0.2	0.3±0.1			**1.6±0.5**			0.1±0.1
Sedge Wren	0.3±0.3			0.2±0.1			**1.4±0.3**	1.0±0.3	
Baltimore Oriole			0.1±0.0	0.7±0.2	0.3±0.1	**1.6±0.4**	0.3±0. 2	1.0±0.3	0.3±0.1
Common Yellowthroat	0.8±0.3		0.2±0.1	1.3±0.2	0.9±0.2		1. 9±0.3	**2.6±0.5**	0.9±0.4
Red-eyed Vireo			1.1±0.1	0.1±0.0	0.1±0.0	0.2±0.1	0.2±0.2	0.2±0.2	**2.0±0.3**
Blue Jay		**1.5±0.5**	1.0±0.1	0.5±0.2	1.0±0.2	**1.5±0.4**	1. 0±0.4	0.2±0.2	1.3±0.3
Ovenbird	0.3±0.3	0.2±0.2	1.7±0.1	0.2±0.1		0.9± 0.3	0.1±0.1	0.4±0.4	**1.9±0.4**
Eastern Wood-Pewee		0.7±0.3	1.3±0.1		0.1±0.0	0.7±0.2	0.1±0.1		**1.5±0.3**
Red-winged Blackbird			0.1±0.0	0.8±0.2	2.1±0.9	0.1±0.1	**2.9±0.5**	0.6±0.6	0.1±0.1
American Robin		0.7±0.3	0.3±0.1	0.3±0.1	0.3±0.1	**2.0±0.4**			0.2±0.1
Chipping Sparrow	0.3±0.3	**1.8±0.3**	0.5±0.1	0.1±0.0	0.3±0.1	1. 1±0.2			
Tree Swallow	0.5±0.3			1.1±0.2	**1.5±0.2**	0.1±0.1	0.4±0 .2		
Bobolink				**2.1±0.4**	0.5±0.1		0.3±0.2		
Brown-headed Cowbird		**1.0±0.5**	0.5±0.1	0.2±0.1	0.6±0.1	0.5±0.3	0.6±0.3	0.6±0.4	0.3±0.1
Rose-breasted Grosebeak	**0.8±0.8**	0.2±0.2	0.2±0.1	0.3±0.1	0.2±0.1	0.2±0.1		0.6±0.4	0.2±0.1
Swamp Sparrow	**0.8±0.5**			0.1±0.1			0.7±0.2		
Gray Catbird	**1.5±0.7**			0.1±0.1	0.8±0.1		0.2±0.2	0.2 ±0.2	1.0±0.2

Table 2. Abundance (birds detected per 10 minutes of survey ±SE) of avian habitat specialists on the Necedah Wildlife Management Area and neighboring Yellow River, Juneau County, Wisconsin (n = number of point counts in each habitat type).

	Habitat					
Species	Aspen (n=4)	Clear Cut (n=6)	Degraded Savanna (n=134)	Savanna (n=84)	Sedge Meadow (n=14)	Yellow River (n=24)
Red-breasted Nuthatch			0.05±0.02			
Nashville Warbler		0.67±0.67	0.04±0.02			
Hairy Woodpecker			0.03±0.02			0.13±0.07
Common Grackle	0.25±0.25			0.15±0.06		
Barn Swallow				0.06±0.04	0.14±0.14	
Red-shouldered Hawk						0.38±0.15
Wood Thrush						0.29±0.19
Spotted Sandpiper						0.29±0.13
Northern Cardinal						0.04±0.04
Blue-winged Warbler					0.04±0.04	
American Redstart						0.08±0.06

types based on their bird communities (Figure 4). The first and second discriminant functions accounted for 36.2% and 23.5% of the variation in the data set, respectively.

Discussion

The Necedah Wildlife Management Area and neighboring Yellow River provide habitat for a number of rare and declining birds. Some of these birds were actually among the most abundant species in some habitats. Examples include the Bobolink (*Dolichonyx oryzivorus*) in old fields, Sedge Wren (*Cistothorus platensis*) in sedge meadows, and Red-headed Woodpecker (*Melanerpes erythrocephalus*) in selective cuts. The selective cuts where the Red-headed Woodpeckers occurred are actually savanna restoration units that have been cut but have not been burned enough to restore the herbaceous layer. Lumped together, selective cuts and savannas harbored the greatest number of "high ranking" species based on Partners in Flight (PIF) scores (scores from Wisconsin geographic area only) (Hunter et al. 1993). Of those species receiving a PIF rating of 20 or higher (29 was the highest rating), nine used savannas, five were found in sedge meadows, four in bottomland hardwoods, and three in old fields (Table 3). With a cumulative PIF score of 190 for these rare species, the savanna habitat's ecological importance is obvious.

Although they received a slightly lower cumulative PIF score (115), sedge meadows are equally important because Henslow's Sparrows (*Ammodramus henslowii*) are found within this habitat type (at 29, this species has the highest PIF rank in the state). The bottomland hardwoods provide habitat for the Cerulean Warbler (PIF score of 25), which elevates this habitat's ecological significance although its cumulative score was only 90. The last cover type providing habitat for species

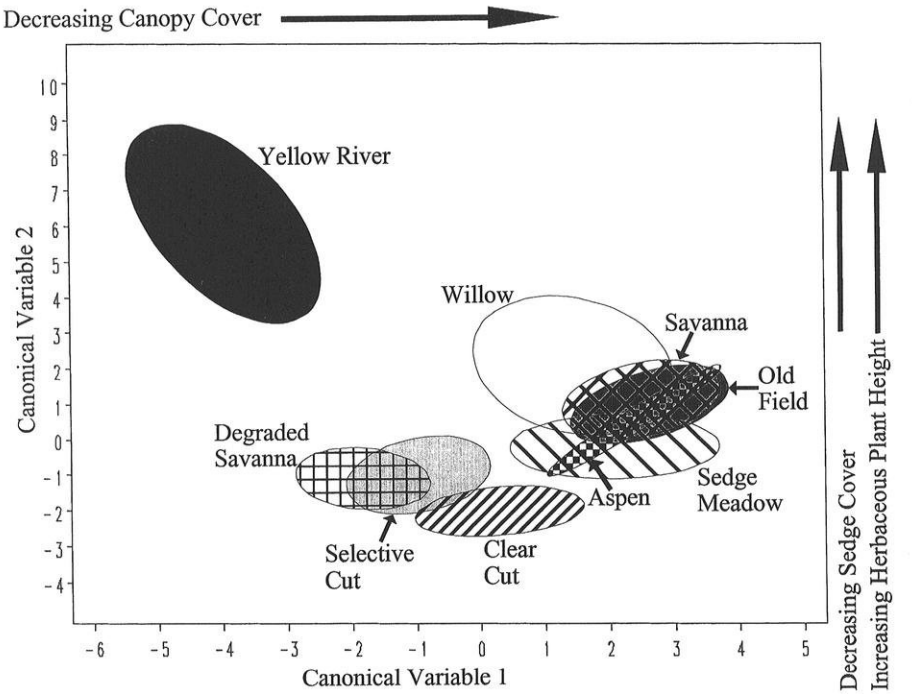

Figure 4. Songbird community discriminant function scores (75% ellipse) for nine habitat types within the Necedah Wildlife Management Area and neighboring Yellow River, Juneau County, Wisconsin.

with PIF scores of 20 or higher was old field, which had a cumulative PIF score of 65. Three rare or declining species occurred within this habitat type (Table 3); however, two of these species reached their maximum abundance in other habitat types. Only the Dickcissel (PIF score of 22) was found in old fields exclusively. None of the other habitat types harbored rare or declining bird species with PIF scores of 20 or higher. However, the data on number of species detected per habitat type and the resulting PIF scores should be viewed cautiously as some habitat types had small sample sizes (10 or fewer).

Management Implications

The occurrence of rare or declining birds within the Necedah Wildlife Management Area and neighboring Yellow River centers within four habitat types. All of these habitat types should receive management priority. Savannas, sedge meadows, and old fields all require active management. Management can come in several forms, including mowing, logging, burning, and water level maintenance. If left unchecked, succession will eliminate all of these habitat types.

The Glacial Lake Wisconsin basin has unique restoration opportunities. Restoring pre-drainage hydrology is inexpensive as ditches can easily be plugged. The sand ridges that dot the landscape offer the potential to restore the shrubby habitat and savannas that once harbored millions of Passenger

Table 3. Partner in Flight scores for bird species of concern and the habitats in which they occur within the Necedah Wildlife Management Area and neighboring Yellow River, Juneau County, Wisconsin. Species in boldface occurred in more than one habitat type.

	Habitat			
Species	Yellow River	Savanna	Sedge Meadow	Old Field
Sandhill Crane		20	20	20
Least Flycatcher		20		
Warbling Vireo		20		
Blue-winged Warbler			20	
Field Sparrow		21		
Clay-colored Sparrow		21		
Veery	21			
Brown Thrasher		21		
Prothonotary Warbler	22			
Red-headed Woodpecker		22		
Black-billed Cuckoo		22		
Wood Thrush	22			
Dickcissel				22
Sedge Wren			23	
Bobolink		23	23	23
Cerulean Warbler	25			
Henslow's Sparrow			29	
Total	90	190	115	65

Pigeons (*Ectopistes migratorius*) (Schorger 1947). Because most of the Yellow River is privately owned, its preservation presents additional challenges and opportunities. Its conservation is paramount as it not only provides habitat for rare birds, but for other rare species such as the eastern massasauga (*Sisturus catenatus catenatus*), western slender glass lizard (*Ophisaurus attenuatus attenuatus*), Blanding's turtle (*Emydoidea blandingi*), and the federally endangered Karner blue butterfly (*Lycaeides melissa samuelis*).

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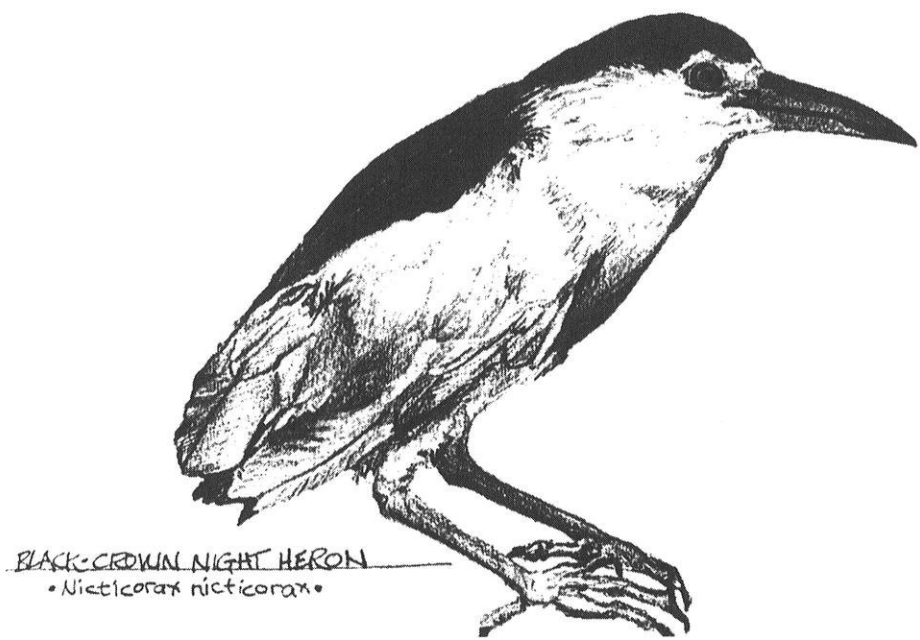

Black-crowned Night-Heron *by Steve Lubahn*

The Nesting Waterbirds of Rush Lake

Rush Lake, in east central Wisconsin, supports a diverse community of nesting waterbirds, but high water levels and loss of emergent vegetation are reducing habitat for many species.

by Thomas J. Ziebell

Rush Lake is a shallow, prairie pothole wetland located in the southwestern corner of Winnebago County and the northwestern corner of Fond du Lac County, Wisconsin. It has an area of 1,245 hectares and an average depth of only 60 centimeters. The lake was once largely covered with hardstem bulrush (*Scirpus acutus*) and scattered islands of cattail (*Typha latifolia* and *T. angustifolia*). Unfortunately, this emergent vegetation has been steadily disappearing due to high water levels maintained by a dam that was constructed at the lake's outlet in 1953 (Mossman et al. 1988, Ziebell 1990).

Rush Lake Management Issues

The loss of vegetation and degradation of habitat on Rush Lake has occurred in two phases. First, the lake has lost much of its emergent vegetation due to high water levels, a process that is still occurring. Second, since 1994, the remaining beds of bulrush have been steadily inundated by cattail. Some once pure bulrush beds are now 70% to 80% cattail.

The lake is now sparsely covered with hardstem bulrush and scattered islands of cattail. Emergent vegetation covers only about 25% of the lakes surface. By mid-summer, the lake becomes choked with dense beds of submergent plants (mostly the alga *Chara*).

For the last 30 years, citizens, university scientists, and Wisconsin Department of Natural Resources (WDNR) personnel have expressed concern about the loss of emergent vegetation on Rush Lake. Many public meetings have been held and possible solutions discussed. However, nothing has been done to solve the problem because of opposition from the Township of Nepeuskun, which owns and operates the dam that has maintained the high water levels. The township has traditionally been very resistant to cooperating, but, happily, this attitude appears to be changing.

As stated in Mossman et al. (1988), a management project is urgently needed to return Rush lake to its former condition, that of a large "prairie" wetland with an interspersion of

open water and extensive beds of emergent vegetation. Hopefully, such a management plan will be developed in the near future as the WDNR and Winnebago County have received a State Lake Planning Grant to develop a Rush Lake Management Plan. Although reluctant to participate at first, the township of Nepeuskun has verbally agreed to participate. This is a huge first step.

Even if a solution for the dam is found, there will still be many questions. What is the best way to restore the emergent vegetation? If the water level is drawn down, will the desired emergent vegetation (bulrush) return? How will a draw down affect the birds that feed or nest on the lake, such as the Red-necked Grebe (*Podiceps grisegena*)? Rush Lake has a long history of waterfowl die-offs due to lead poisoning. Will a draw down expose more waterfowl to lead poisoning?

Bird Surveys on Rush Lake

Birds are good indicators of the health of an ecosystem, and by observing the different species of birds and the changes in their populations we can get some idea of the health of Rush Lake. Since 1980, I have conducted an annual, one-day survey of birds on Rush Lake during the third week of June. A hunting skiff is used to navigate the shallow waters. The survey begins at 5:00 AM and takes seven to eight hours. The same general route is followed every year and covers most of the remaining emergent vegetation, which is mostly in the center of the lake away from the shoreline. The emergent vegetation along the shoreline, which is mostly cattail, is not included in this survey.

The survey was started in order to census Black Terns (*Chlidonias niger*), Forster's Terns (*Sterna forsteri*), and Red-necked Grebes for the WDNR's Bureau of Endangered Resources and primarily concentrates on these species, but all other species seen are recorded as well. Because of the concentration on these three species, other more abundant species are often underreported. All adult birds, young, eggs, and nests are counted.

Nesting Grebes on Rush Lake

Four species of grebes have been observed on Rush Lake during this survey. They are the Pied-billed Grebe (*Podilymbus podiceps*), Red-necked Grebe, Western Grebe (*Aechmophorus occidentalis*), and Eared Grebe (*Podiceps nigricollis*). Except for the Eared Grebe, all have been documented as nesting on the lake.

Pied-billed and Red-necked Grebes are common nesters on the lake, and the numbers observed during the surveys are presented in Figure 1. Despite the numbers in Figure 1, Pied-billed Grebes are actually more abundant on the lake than are Red-necked Grebes, but the Pied-bills are undercounted because of the greater effort during the surveys to count Red-necked Grebes.

The numbers of Red-necked and Pied-billed Grebes shown in Figure 1 closely parallel each other, with their lowest numbers recorded in very dry and/or low water level years, such as 1986 and 1988. Yet in 1994, which was neither a dry or low water year, Red-necked Grebe numbers plummeted while Pied-billed Grebes remained steady. This may have been the result

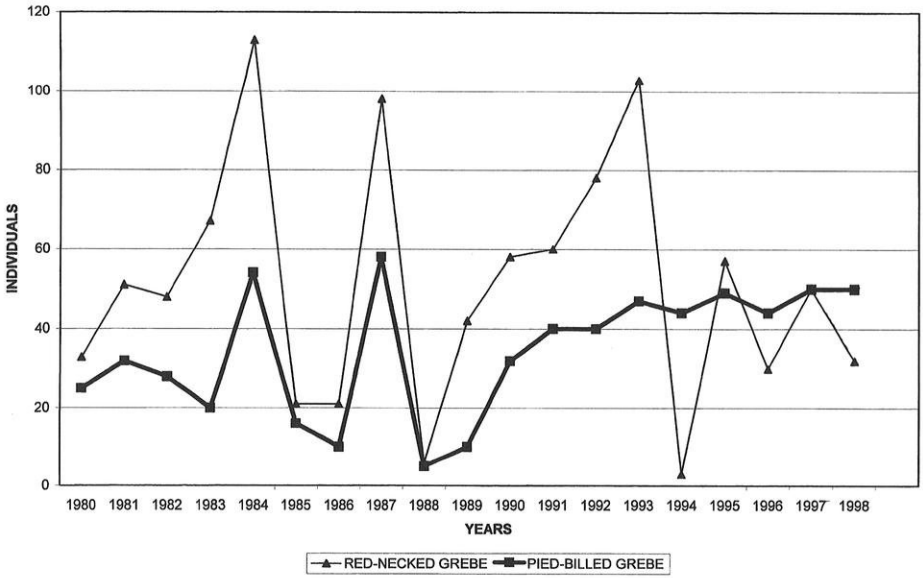

Figure 1. Red-necked and Pied-billed Grebes observed during June surveys on Rush Lake, Winnebago County, Wisconsin, 1980–1998.

of the Great Lakes freezing over during the winter of 1993–1994, which forced Red-necked Grebes to migrate from the Great Lakes to find open water. Although many grebes headed for the East Coast, many did not make it to open water and came down inland. Grebes were found dead or grounded from Ontario to the Appalachian region (Kaufman 1994). The following summer, few Red-necked Grebes returned to Rush Lake to nest.

Western and Eared Grebes observed during the surveys are presented in Figure 2. Western Grebes nested on the lake in 1990, 1991, and 1997 (Ziebell 1990), but the Eared Grebe has not yet been documented as nesting on Rush Lake. All of the grebes, but to a lesser extent the Pied-billed, prefer to nest in the remaining beds of bulrush. With the continued loss of bulrush on the lake, nesting sites for grebes will also decrease.

Nesting Terns, Herons, Gulls, and Other Waterbirds on Rush Lake

Forster's and Black Terns can be common nesters on Rush Lake. Their numbers fluctuate from year to year depending on the availability of nesting substrate. The birds prefer to nest on rhizome mats of bulrush or cattail and also on accumulations of residual vegetation. In high water years, such as 1989 and 1993, nest sites are limited and few birds are on the lake (Figure 3).

Into the late 1970s, the Black-crowned Night-Heron (*Nycticorax nycticorax*) was an abundant nester on Rush Lake. The birds nested on cattail islands and in beds of bulrush. With the loss of emergent vegetation, the number of nesting night-herons decreased. In addition to the loss of nesting sites, heavy predation by Great Horned Owls (*Bubo virginianus*)

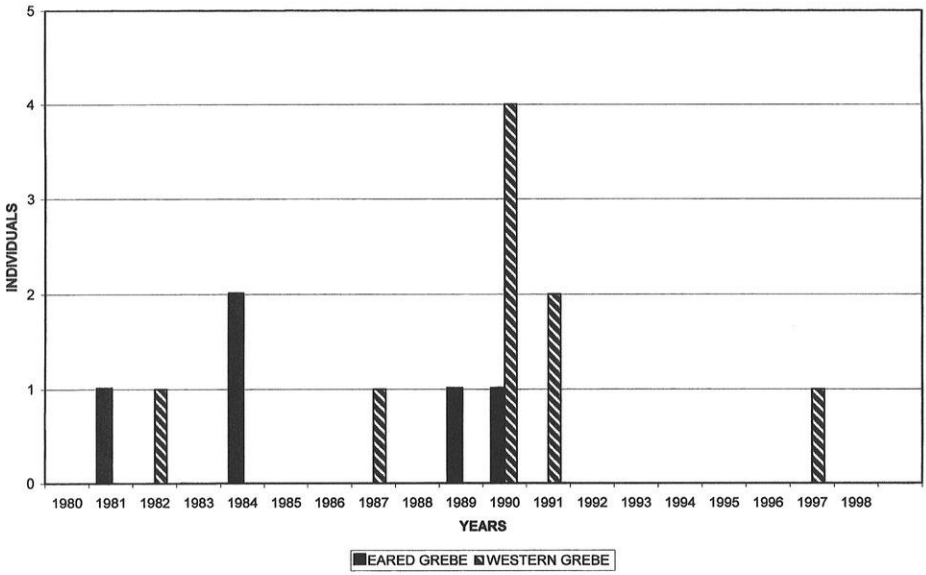

Figure 2. Eared and Western Grebes observed during June surveys on Rush Lake, Winnebago County, Wisconsin, 1980–1998.

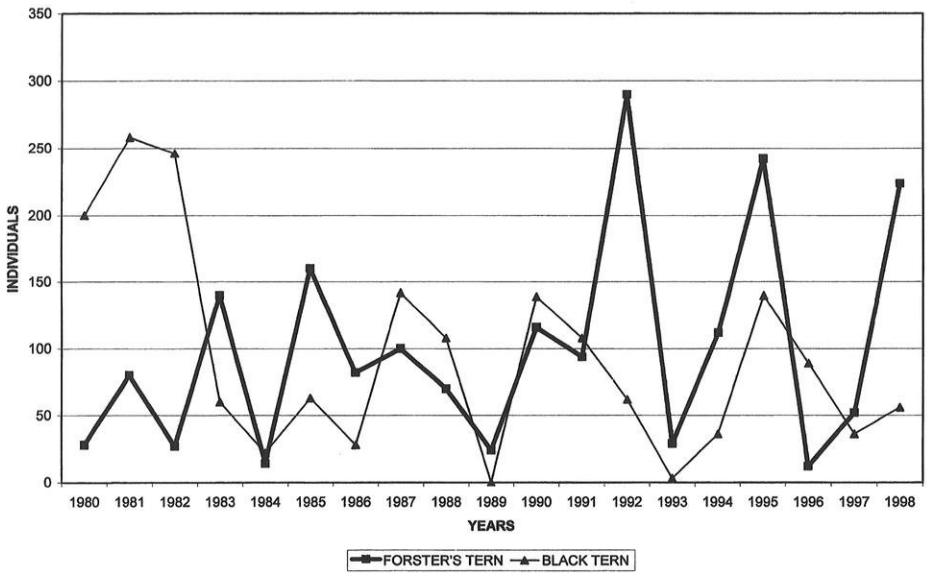

Figure 3. Forster's and Black Terns observed during June surveys on Rush Lake, Winnebago County, Wisconsin, 1980–1998.

helped to eliminate the nesting population by 1983 (Ziebell 1985). One night-heron nest was found in 1988, but none have been found since (Figure 4). Although they no longer nest here, large numbers are still commonly seen feeding on the lake. These birds fly in from nesting colonies in Oshkosh and Horicon.

The American Coot (*Fulica americana*) is a common nester on Rush Lake. Beginning in 1982, coot numbers began to drop. This was believed to be the result of heavy predation from Great Horned Owls (Bett 1983). After the owls' food supply of Black-crowned Night-Herons was depleted, they switched to eating coots. Coot numbers were very low by 1986 (Figure 4), but they then began to increase, with another drop in 1993 possibly due to high water levels and/or predation.

In the 1970s, Herring Gulls (*Larus argentatus*) were regular nesters on Rush Lake (McAsey 1979). During these surveys, they were found nesting in 1980, 1981, and 1982, but have not nested on the lake since then. Herring Gulls nested on old hunting blinds and muskrat houses. These nest sites are still available, so their disappearance from the lake in the early 1980s suggests that Great Horned Owls may be a problem.

The Least Bittern (*Ixobrychus exilis*) is a regular nester on Rush Lake that prefers to nest in cattail. The number of Least Bitterns documented on this survey fluctuates from many to only a few (Figure 5). However, since 1994, their numbers have remained fairly steady.

The Common Moorhen (*Gallinula chloropus*) is another regular nester on Rush Lake that prefers cattail for

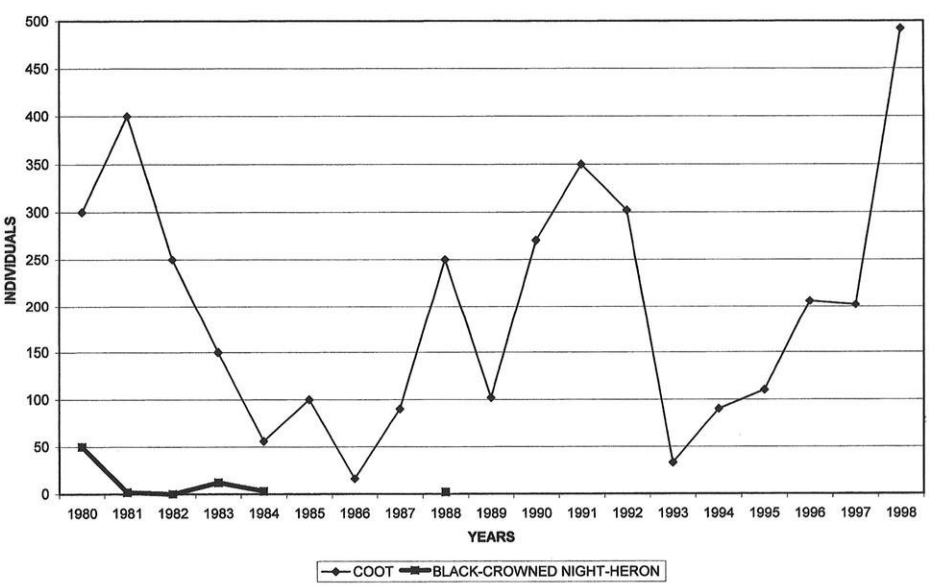

Figure 4. American Coots and Black-crowned Night-Herons observed during June surveys on Rush Lake, Winnebago County, Wisconsin, 1980–1998.

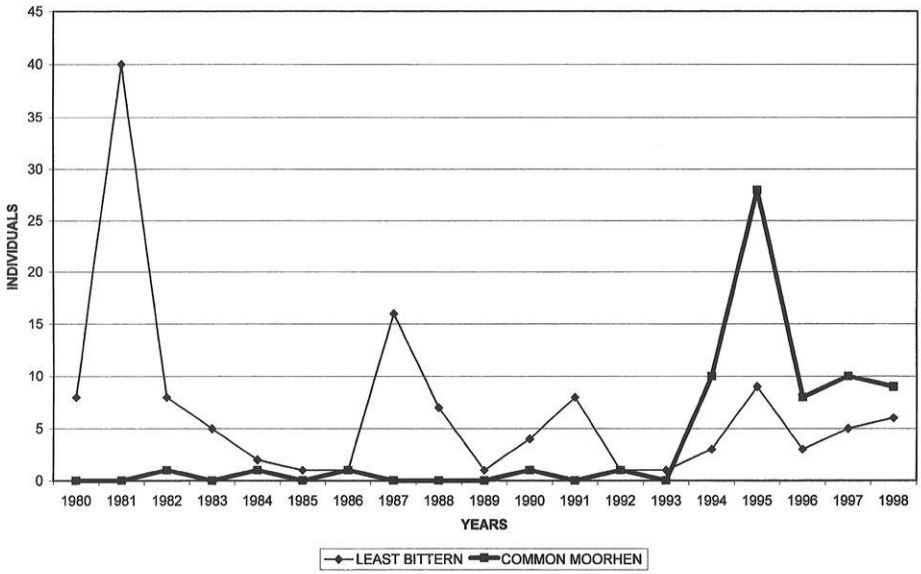

Figure 5. Common Moorhens and Least Bitterns observed during June surveys on Rush Lake, Winnebago County, Wisconsin, 1980–1998.

nesting. Prior to 1994, the number of moorhens observed on this survey was zero to just a few. After 1994, numbers increased and remained steady (Figure 5). The increase in Least Bittern and Common Moorhen observations is the result of increased cattail habitat on the survey route. Since 1994, the remaining beds of bulrush have been steadily inundated by cattail, providing nesting habitat for these birds.

Other Nesting Birds on Rush Lake

Redheads (*Aythya americana*) and Ruddy Ducks (*Oxyura jamaicensis*) are common nesters on Rush Lake that prefer to nest in cattail. The Mallard (*Anas platyrhynchos*) is also a regular nester, taking advantage of any suitable nesting site.

Rails are often observed during this survey. The adults and young of Sora (*Porzana carolina*) and Virginia Rail (*Rallus limicola*) are observed most often. One King Rail (*Rallus elegans*) nest was found in 1992.

Other common nesters found during this survey, listed in descending order of abundance, include Marsh Wren (*Cistothorus palustris*), Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*), Red-winged Blackbird (*Agelaius phoeniceus*), and Swamp Sparrow (*Melospiza georgiana*).

Species that have been observed during this survey but that do not nest in the survey area are listed in Table 1.

Even with all its problems Rush Lake is still a wonderfully special place. Hopefully, future changes will make it even better.

Table 1. Non-breeding bird species observed during June surveys on Rush Lake, Winnebago County, Wisconsin, 1980–1998.

Eared Grebe (*Podiceps nigricollis*)
American White Pelican (*Pelecanus erythrorhynchos*)
Double-crested Cormorant (*Phalacrocorax auritus*)
American Bittern (*Botaurus lentiginosus*)
Great Blue Heron (*Ardea herodias*)
Great Egret (*Ardea alba*)
Green Heron (*Butorides virescens*)
Canada Goose (*Branta canadensis*)
Wood Duck (*Aix sponsa*)
Green-winged Teal (*Anas crecca*)
American Black Duck (*Anas rubripes*)
Northern Pintail (*Anas acuta*)
Blue-winged Teal (*Anas discors*)
Northern Shoveler (*Anas clypeata*)
Gadwall (*Anas strepera*)
American Wigeon (*Anas americana*)
Canvasback (*Aythya valisineria*)
Ring-necked Duck (*Aythya collaris*)
Greater Scaup (*Aythya marila*)
Lesser Scaup (*Aythya affinis*)
Bufflehead (*Bucephala albeola*)
Osprey (*Pandion haliaetus*)
Bald Eagle (*Haliaeetus leucocephalus*)
Northern Harrier (*Circus cyaneus*)
Sandhill Crane (*Grus canadensis*)
Killdeer (*Charadrius vociferus*)
Semipalmated Sandpiper (*Calidris pusilla*)
Least Sandpiper (*Calidris minutilla*)
White-rumped Sandpiper (*Calidris fuscicollis*)
Dunlin (*Calidris alpina*)
Wilson's Phalarope (*Phalaropus tricolor*)
Bonaparte's Gull (*Larus philadelphia*)
Ring-billed Gull (*Larus delawarensis*)
Caspian Tern (*Sterna caspia*)
Mourning Dove (*Zenaida macroura*)
Great Horned Owl (*Bubo virginianus*)
Chimney Swift (*Chaetura pelagica*)
Belted Kingfisher (*Ceryle alcyon*)
Purple Martin (*Progne subis*)
Tree Swallow (*Tachycineta bicolor*)
Bank Swallow (*Riparia riparia*)
Cliff Swallow (*Petrochelidon pyrrhonota*)
Barn Swallow (*Hirundo rustica*)
Common Yellowthroat (*Geothlypis trichas*)
Common Grackle (*Quiscalus quiscula*)
Brown-headed Cowbird (*Molothrus ater*)

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Red-winged Blackbird *by Jack Bartholmai*

Wetland Habitats and Their Ecology: The Horicon Marsh Case History

Horicon Marsh is Wisconsin's largest wetland and has a history of environmental change and human impact that has been played out on a vast scale. Some aspects of Horicon's history are unique to this marsh, while others are representative of changes in many other wetlands in the state and beyond. Horicon Marsh is a restored wetland, and concerns today center on maintaining the ecological health and integrity of this altered ecosystem.

by William K. Volkert

Like most of Wisconsin's 15,000 lakes and innumerable wetlands, Horicon Marsh owes its origins to the great glaciers of the last Ice Age. When they retreated nearly 12,000 years ago, these glaciers left behind an entirely altered landscape of gently rolling hills, depressions, and an irregular drainage system.

A Brief Geological History

Horicon Marsh was formed as the glaciers moved over and scoured the underlying bedrock. The advancing ice mass split around the Door County peninsula, creating Lake Michigan to the east and carving out three major basins—Green Bay, Lake Winnebago, and Horicon Marsh—to the west. As the ice moved forward, it heaped up the land into a series of elongated hills, known as drumlins, along its axis of movement. The greatest concentration of drumlins in the world is found south and west of Horicon Marsh. Even the islands in the marsh, presently surrounded by accumulating peat, are the remnants of drumlins.

The ice began to wane as the climate warmed, but did not simply melt away in a steady progression. Instead, the glacial front retreated in stages, sometimes coming to a rest on the land and occasionally even re-advancing. Each time it came to rest, the rocks, sand, gravel, and clay that had become incorporated into the ice mass were deposited at its front, leaving behind a moraine to mark its temporary halting point. Between Madison and Fond du Lac, there exist seven major reces-

sional moraines that mark the resting points of the retreating glacier.

Two such recessional moraines were laid down across the southern and northern ends of the Horicon basin, where the Cities of Horicon and Waupun are located today. The southern moraine served as an earthen dam to impound the meltwaters, creating a vast post-glacial lake. From this ancient lake, the waters flowed out at the southern end and cascaded over the glacial moraine to give rise to the Rock River. Because it was comprised of loosely consolidated glacial debris, the moraine was easily eroded and eventually led to the draining of the glacial lake. Thus was born the Horicon Marsh.

Horicon's Archeological History

From the end of the Ice Age until modern settlement, Horicon Marsh has been home to a profusion of wildlife, which has attracted a variety of human cultures that came to take advantage of these abundant natural resources. The archeological record clearly demonstrates that people have been a part of Horicon ever since the end of the Ice Age.

Artifacts such as stone tools and implements, campsites, village sites, effigy mounds, and a vast trail network provide the evidence to tell this ancient story. Scientists have found that nearly every major prehistoric Indian culture known to Wisconsin has been represented in the archeological record at Horicon Marsh, including the Early Paleo and Late Paleo Indians, the Copper Culture, the Red Ochre Mound Builders, the Effigy Mound Builders, the Hopewellian Indians, and others. This latter group of prehistoric cultures is commonly referred to as the Woodland Indians, yet most of these people associated more with wetlands and shallow lake and river systems than with woodlands. They are responsible for some of the largest archeological sites in Wisconsin, found around Green Bay, the Lake Winnebago area, Horicon Marsh, Sheboygan Marsh, and along the Wisconsin and Mississippi rivers (Figure 1).

Horicon's tremendous biological diversity and productive wetlands offered hunting and gathering opportunities that supported relatively large human populations. By the time of early European exploration and settlement, Horicon Marsh and the Rock River formed the dividing boundary between the Potowatomi and Winnebago (Ho-Chunk) people, and also separated the wide open prairies to the west from the hardwood forest on the marsh's east side. The site of the City of Horicon was at one time a large Winnebago village of more than 2,000 people. These people were displaced when the treaties of 1829 and 1832 opened the region for land claims and settlement.

Although Horicon Marsh has a human history that spans nearly 12,000 years, the early people who harvested plant and animal life from the marsh and the surrounding prairies and woodlands did relatively little to alter the marsh itself. As is true of most of Wisconsin and North America, more changes have taken place here in the last 150 years than in the thousands of years prior. While aspects of the history of Horicon Marsh are unique, others are representative of the history of wetland changes and changing attitudes over the past century and a half.

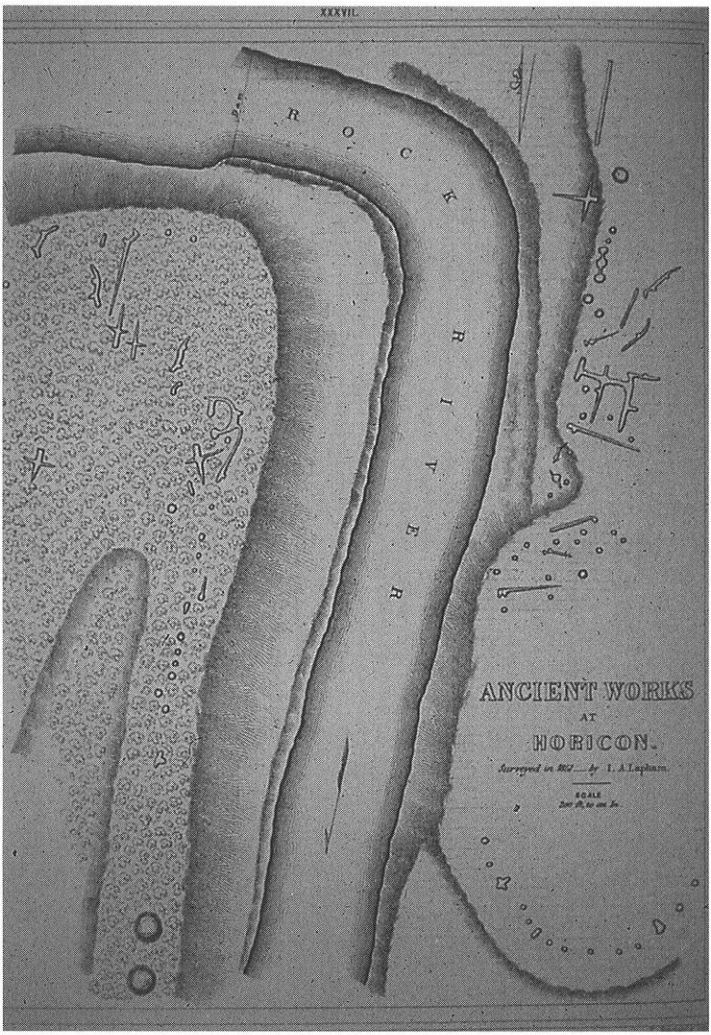

Figure 1. Indian effigy mounds once lined the banks of the Rock River where the City of Horicon is located today, as seen in this 1856 map prepared by early Wisconsin naturalist Increase A. Lapham. WDNR file photo.

Horicon's Settlement History

Lake Horicon—The City of Horicon was the first city on the marsh of the same name, founded in 1845 (Figure 2). This site was surveyed in 1838 by Solomon Juneau, the founder of Milwaukee, but the town was established by others seven years later. With the rapid influx of settlers into the area, changes came quickly. In 1846, only one year after the arrival of the settlers, a dam was built across the Rock River at the outlet of the marsh to power the first sawmill and, later, a gristmill. Composed of logs, rocks, mud, and hay, the dam measured 9 feet high and 150 feet across.

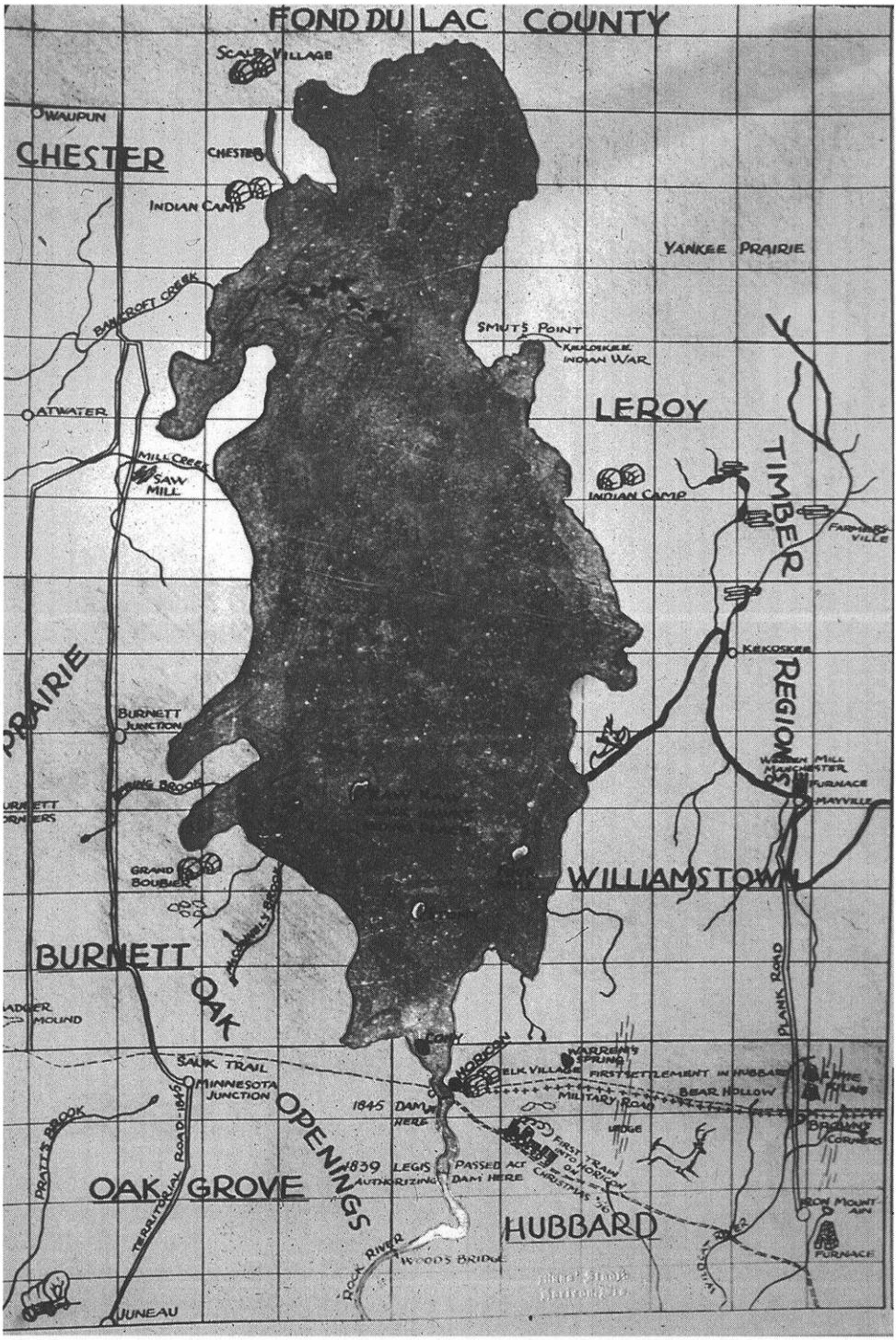

Figure 2. Map of Lake Horicon, showing surrounding communities and habitats as they were in the mid-1850s. WDNR file photo.

As a result of the dam, which essentially plugged up the outlet of the marsh, a vast lake was recreated that had not existed since the end of the Ice Age. Lake Horicon measured 51 square miles in area and was considered to be the largest manmade lake in the world at the time. But the high water flooded surrounding farmland, resulting in damage to private land and leading to demands for compensation. The case made its way to the Wisconsin State Supreme Court, which in 1869 ruled in favor of the landowners and required the dam operators to pay farmers for lost crop production. In the end, it was cheaper to simply remove the dam; 23 years after it was built, the dam was disassembled.

Private Hunting Clubs and Market Hunters—When the dam was removed, the land reverted to marsh and once again hosted an abundance of waterfowl and other wildlife. During the late 1800s, ducks—rather than the abundant Canada Geese we see today—were the primary waterfowl using the marsh.

During the period from 1870 to the early 1900s, two major forms of waterfowl hunting became established on Horicon Marsh to take advantage of this seemingly infinite resource. One of these was the development of private hunting clubs (Figure 3). These were comprised of wealthy businessmen from nearby towns—as well as from Madison, Milwaukee, Fond du Lac, and Chicago—but they also lured hunters from as far away as Ohio, Boston, and New York. The clubs included the Kaw-Kaw Club, the Greenhead Club, Strooks Club, the Fond du Lac and Horicon Shooting Clubs, and the Diana Club. The clubs leased huge tracts of land on the marsh, and in some cases hired their own wardens to keep out nonmembers.

The clubs' attempts to privatize the marsh actually provided for the first form of conservation on Horicon. At this period in our history, wildlife resources were perceived to exist in unlimited supply and, as a result, there were no hunting laws or regulations. In spite of this perception, the private clubs did not allow hunting during spring migration and established the first bag limits on the marsh—at 25 ducks per day! While these conservation efforts may seem weak by today's standards, they were at least an attempt to restrict the harvest.

Areas of the marsh not controlled by private hunting clubs were open to the exploits of market hunters, who commercially harvested wildlife for sale in the larger cities. Horicon Marsh was known as a major supplier of wild ducks for the markets of the upper Midwest. Market hunters sought to harvest the largest possible number of ducks in a short period of time. Waterfowl were baited by placing shelled corn or other grain in the shallow waters of the marsh to lure in and concentrate the flocks. These hunters commonly used four and two gauge shotguns—called "punt guns"—that were essentially small cannons with barrels 12 to 15 feet long (Figure 4). On average, a hunter could easily kill 30 to 50 ducks with a single shot. The ducks were taken to the towns of Horicon and Mayville and packed at a rate of 200 per barrel.

The market hunters harvested birds without regard for their limited populations (Figure 5), and also hunted prior to the nesting season (some hunters claimed that hunting in the spring was often more successful than

Figure 3. Members of a private hunting club pose with their day's take of ducks in downtown Horicon in the late 1800s. WDNR file photo.

in the fall). This so seriously decimated waterfowl populations that, within 25 years, a seemingly inexhaustible population of ducks had been hunted to its limit and most market hunters had abandoned the marsh. As a result, market hunting became a nearly extinct industry even before laws were passed to ban the practice.

The depletion of Horicon's waterfowl affected what was the primary value of the marsh for most people. In the public's mind, the value of a duck marsh that was nearly devoid of ducks was being called into question.

Ditching and Draining—In the early part of the twentieth century, efforts were undertaken to reap another kind of harvest from this land by ditching and draining it for agricultural use. At the time, Horicon Marsh was called "The Wasteland" and was considered useless swampland and an impediment to human progress. The hope was that if the land could be drained, it would become some of the most productive cropland in the state.

Beginning in 1910, ditches were excavated by a large piece of machinery known as "The Dredge," which consisted of a barge with a steam shovel on it (Figure 6). The main ditch was dug 8 feet deep, 60 feet wide, and 14 miles long. It required four years to dig this ditch and an additional two years to complete the lateral ditches, which connected to the main ditch to drain the backwaters.

Farmers tried to raise onions, carrots, and potatoes on the dried peat soils (Figure 7), but drainage remained a problem, particularly in the southern portion of the marsh. Hori-

Figure 4. Market hunters on Horicon Marsh used cannon-like punt guns capable of bringing down 30 to 50 ducks with a single shot. WDNR file photo.

con has a large watershed and catchment basin, and a large amount of water flows into it following rains and the spring thaw. Drainage of these waters was impeded by the Hustisford dam and the slow flow of the Rock River, which drops only about 8 vertical inches between the cities of Horicon and Hustisford.

Failure to bring the land into agricultural production and to show significant profits eventually led to abandonment of the farming effort. By the 1920s, the peat soils lay exposed to the atmosphere and began to dry and rot under the summer sun. Decomposition of the peat led to spontaneous combustion, and fires burned throughout the 1920s and into the 1930s. One fire was reported to have burned continuously for three years.

Instead of improving a "wasteland," humans had not only devastated the duck population through overhunting, but had ruined an entire wetland ecosystem through drainage and the resultant fires. By the 1920s, Horicon Marsh lay useless to both people and wildlife.

The Restoration of Horicon Marsh

What we see at Horicon Marsh today is the result of a vast restoration project—an attempt to rebuild the marsh for wildlife purposes. The campaign to restore the marsh was initiated locally (Figure 8). Under the leadership of Louis "Curly" Radke, then president of the state Isaac Walton League, a

Figure 5. One day's bag of ducks by market hunters on Horicon Marsh in the late 1800s. WDNR file photo.

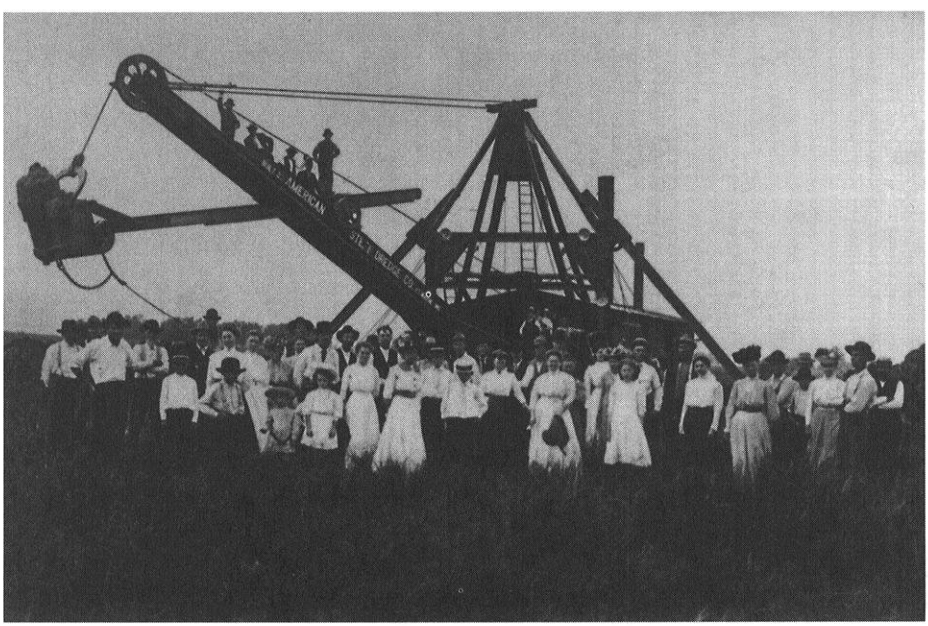

Figure 6. The arrival of "The Dredge," a barge-mounted steam shovel for ditching and draining Horicon Marsh, was a cause for celebration, as shown in this 1910 photo. WDNR file photo.

Figure 7. Once the marsh was ditched and drained, Horicon's peat soils were broken and plowed for agriculture. WDNR file photo.

campaign was organized in 1921. The purchase and restoration of the marsh was too costly and complex for local conservationists to undertake alone, so they took their efforts to Madison where they worked with the state legislators to enlist public assistance. Following a seven-year campaign, the state passed into law the Horicon Marsh Wildlife Refuge Bill in 1927.

This bill provided funds over a ten-year period to purchase land and to construct a dam at the outlet of the marsh to essentially plug up the ditches and restore the original water levels. When the dam gates were closed, the Horicon basin was again flooded, dousing the fires and encouraging the re-establishment of native wetland vegetation. This, in turn, created the habitat that began to lure wildlife back to the area. When the state funds were depleted by the late 1930s, however, only about one-third of the marsh had been acquired.

Horicon Marsh showed such a quick recovery and potential for restoration that it gained national attention as a conservation effort. In 1941, the federal government came in to complete the job begun by the state and established a national wildlife refuge. Today, the southern third of the marsh is a state wildlife area, under the control of the Wisconsin Department of Natural Resources (WDNR), and the northern two-thirds comprises the Horicon National Wildlife Refuge, under the jurisdiction of the U.S. Fish and Wildlife Service.

Horicon is finally receiving the appreciation it has long deserved. Due to its unique and outstanding glacial history, Horicon Marsh is now included as a unit of the Ice Age National Scientific Reserve, in cooperation with the National Park Service. In 1991, Horicon was recognized by the Ramsar Convention under the United Nations and received the prestigious title of Wetland of International Importance. And in 1997, the marsh was recognized by the

Figure 8. Members of the campaign to restore Horicon Marsh gather in downtown Horicon in 1927. WDNR file photo.

American Bird Conservancy as a Globally Important Bird Area.

Horicon is now recognized as one of the most important wetland ecosystems in the upper Midwest. The state portion of the marsh was originally established as a migratory stopover site and nesting grounds for waterfowl, and the national wildlife refuge was established as a nesting area for Redhead ducks (*Aythya americana*). Today, Horicon is one of the largest nesting sites for Redheads in the eastern U.S. Over the years, management efforts have also focused on restoring populations of Canada Geese (*Branta canadensis*) and, in recent decades, of a number of threatened and endangered species. Concerns during the 1970s and 1980s focused on nongame wildlife, and now increasingly emphasize the biodiversity of this entire wetland ecosystem.

The Horicon Marsh Ecosystem

Compared to what the early settlers found more than 100 years ago, Horicon Marsh today is a vastly altered wetland system. Descriptions from waterfowl hunters of the late 1800s tell us that the original marsh was shaped by a braided stream system formed as the two branches of the Rock River spread out over this vast basin. At that time, the marsh was comprised of a series of wetland communities, with river channels and open water areas interspersed with oxbow lakes, peat lands, and islands. Early naturalists described the area as supporting open water with lily pads, cranberry bogs, floating bogs, cattail marsh and sedge meadows, lowland brush, and forested areas. It was, in fact, a mosaic of various wetland types that changed and shifted over

time with drought and flood, and with the occasional fires that swept in from the prairies and oak savannas on the west side of the marsh. It was essentially diverse and ever-changing.

Today, Horicon Marsh is a very monotypic wetland composed primarily of open water and cattails. Paradoxically, this very simplified wetland still supports a diverse bird community; over the years, a total of 268 species of birds have been recorded here. The marsh's present bird diversity appears to be a function of Horicon's vast size and the variety of structural habitats available among the cattails and open water. Species that are area-dependent (restricted to large wetlands), such as Great Blue Herons (*Ardea herodias*), Great Egrets (*Ardea alba*), and American White Pelicans (*Pelecanus erythrorhynchos*), find plenty of space in Horicon's 32,000 acres. Other species exploit the structurally diverse habitats that range from shallow to deep expanses of open water, sparse to dense stands of cattails, and occasional exposed mudflats.

The bird community has favorably responded to the restoration of Horicon Marsh, but there still have been dramatic changes in bird populations over the past two to three decades. Many waterfowl hunters can verify that ducks and American Coots (*Fulica americana*) were much more abundant in the 1940s through 1960s than they are today. In the past, coots were seen in "rafts" of literally thousands of individuals.

Unfortunately, people often try to reduce the complexity of nature to simple cause and effect relationships. I have often heard people say that increasing Canada Goose populations chased the ducks out of the marsh. While it is evident that duck populations at Horicon are down and that geese have dramatically increased, no simple relationship exists between the two. Horicon has also witnessed changes in other wildlife populations, such as the dramatic increase in carp and the decline of muskrats. These changes are the result of a complex series of interacting ecological events and are more complicated than simply one species supplanting another.

Changing Land Use Practices in the Rock River Watershed—The east and west branches of the Rock River are the primary streams that feed into Horicon Marsh. Horicon is considered to be the headwaters of the Rock River, which eventually delivers its water to the Mississippi River.

The primary land use in this region of Wisconsin is agriculture. During the 1940s to 1960s, when the small-scale agricultural practices of the day were much more compatible with the needs of wildlife than they are today, the region from Madison to Horicon Marsh to Green Bay was considered among the most productive agricultural land in the state and the most productive region for nesting waterfowl and pheasants. We can assume that other grassland and wetland birds were also relatively abundant in this same area, but we only have data on game species for this period. During the 1970s, duck and pheasant populations showed their greatest decline in this part of the state.

The advent of modern agriculture brought a tremendous increase in food production, but also resulted in the loss of hedgerows, numerous small wetlands, and the practices of rotating crops and letting land lie fallow. Like so many other areas, the Rock River wa-

tershed has seen a tremendous loss of topsoil, which continues today. These events set in motion a complex series of changes that have had profound impacts—both positive and negative—on bird and plant populations in the Horicon ecosystem.

Due to the loss of small wetlands surrounding Horicon Marsh, there is less land to absorb rain and melting snow and spring runoff has greatly increased. This surge of runoff carries a tremendous load of sediment and nutrients from the surrounding farmland and expanding urban centers. Water quality monitoring in the Rock River upstream from the marsh, conducted by the WDNR in cooperation with the U.S. Geological Survey, has shown that 17,600 pounds of phosphorous and 3.9 million pounds of sediment poured into the marsh during a single four-inch rain event in April 1998.

Sedimentation has changed the bottom of the marsh from peat layers to soft, semi-suspended muck and silt. Additionally, nutrients have increased to a point where existing aquatic plants cannot absorb the abundant phosphorous, leading to increasingly common algal blooms in recent years. Dense algal mats shade out the submergent plants, allowing fewer plants to grow in the water column and leaving even more nutrients to fuel algae growth. When the algae dies and decomposes, oxygen levels in the water fall, occasionally resulting in die-offs of northern pike and panfish, such as bluegills. The survivors of these low oxygen conditions are carp and bullheads, which are now without predators or competitors.

A healthy aquatic plant community is important because it provides a number of vital functions for the marsh. Aquatic plants take up nutrients, produce oxygen for aquatic life, and slow wave action that acts to re-suspend sediments. They also provide spawning sites for fish and frogs and shelter for fish and aquatic invertebrates. These plants and invertebrates are the primary food for most of our ducks and coots, as well as for other wetland birds. Their loss has led to the decline of food in the marsh, and, in turn, the decline of ducks and coots.

Changes in Fish Populations—In recent decades, the carp population has exploded in Horicon Marsh due to a loss of predators. In the 1940s, northern pike weighing over 20 pounds were caught in the marsh (Figure 9). These large predators kept check on the carp, while bluegills fed on carp eggs and fry.

Carp now dominate Horicon's fish population, and have major impacts on the aquatic and wetland environment. Carp are bottom feeders that wallow in the mud to obtain food. This action resuspends the sediments and further clouds the waters, in many cases reducing water clarity to as little as 4 to 6 inches. When this occurs, there is insufficient light reaching the bottom to allow submerged aquatic plants to grow. When carp wallow in the soft mud bottom, they disturb existing submergent plants by uprooting them. As a result, there exist today large open water areas of Horicon Marsh that are nearly devoid of aquatic vegetation due to abundant carp.

Over the years, there have been at least three attempts to chemically eradicate carp from the marsh through the application of rotenone as a fish toxicant. Literally millions of pounds of carp were killed, but their populations

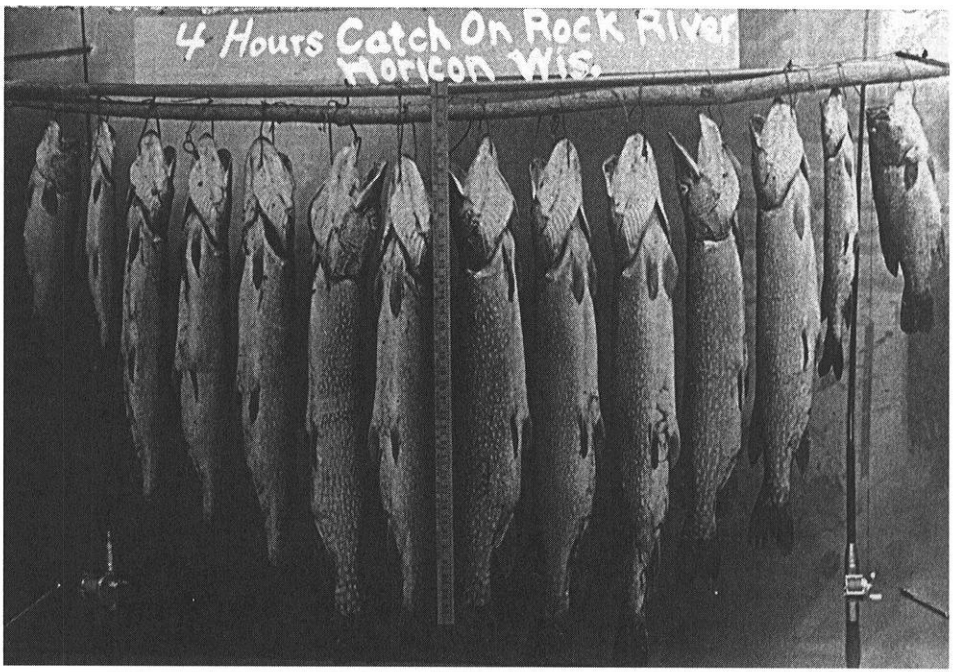

Figure 9. A "four hours catch" of northern pike from the Rock River at Horicon in the 1940s. Note the yardstick in center. WDNR file photo.

rebounded to former levels within 10 years because the ecological condition of the marsh had not changed. Essentially, it still remained as ideal carp habitat and the few remaining carp soon repopulated the marsh.

Changes in Bird Populations—Horicon Marsh and similar wetlands have seen major changes in the composition of populations of waterfowl and other birds. The decline in ducks over the past several decades is not a result of competition with Canada Geese, but rather is due to a lack of food resulting from the many complex changes to Horicon's aquatic environment. Canada Geese have increased due to controlled hunting and because, unlike ducks, they can find abundant food in the cornfields surrounding the marsh. Geese will eat aquatic vegetation, but they are primarily upland grazers. They use the marsh as a safe resting area and fly out each day during migration to feed in agricultural fields.

When assessing the ecological health of Horicon Marsh, it is important not to focus our attention only on Canada Geese. After all, if these birds can thrive in downtown Milwaukee and Chicago, what can they tell us about the health of this marsh? Instead, attention should be focused on the marsh's most sensitive species.

Among the 268 species of birds that use Horicon, we find a spectrum that runs from highly specialized birds like Forster's Terns (*Sterna forsteri*), Great Egrets, Least Bitterns (*Ixobrychus exilis*), and King Rails (*Rallus elegans*) to generalists such as Canada Geese, Red-winged Blackbirds (*Agelaius phoeniceus*), and Ring-billed (*Larus delawar-*

ensis) and Herring Gulls (*Larus argentatus*). Some of the most specialized species are already listed as threatened or endangered across their ranges. How do these birds respond to Horicon's altered ecology? While the generalists tend to maintain themselves or even increase as habitats are altered, the specialists find it increasingly difficult to maintain their populations.

Due to the fact that they are so observable, birds are some of the best indicators of ecosystem stability or change. For example, the state threatened Great Egret (Figure 10) and the state endangered Forster's Tern, both of which nest in the marsh, are good environmental indicators. So are Black-crowned Night-Herons (*Nycticorax nycticorax*), American Bitterns (*Botaurus lentiginosus*), Sora (*Porzana carolina*) and Virginia Rails (*Rallus limicola*), and Black Terns (*Chlidonias niger*), among others. As we watch for changes in populations of these species, they hint of subtle changes in the habitat or ecosystems on which they depend.

Challenges for the Future

Restoring the ecological health of Horicon Marsh depends on developing sustainable uses of the land within the watershed. This will not be achieved through further regulations alone, but will require increased public understanding of our role in the scheme of things on an ecosystem-wide scale.

Certainly there is a great need for public education. Most of Horicon's 400,000 annual visitors can identify

Figure 10. Great Egrets, a Wisconsin state threatened species, have nested at the Fourmile and Cotton Island rookery in Horicon Marsh since 1946. Photo by William K. Volkert.

only a very small fraction of all the birds present on the marsh. Many people come primarily to see the large flocks of Canada Geese during fall migration, and are unaware of the impacts ecological change has had on the marsh's other bird species. Vast numbers of birders are drawn to and are concerned about the marsh, but many come from great distances and do not affect local land use policies and practices.

While we have tried to manage Horicon Marsh as an ecosystem, we are still only treating the symptoms of poor land use and poor water quality. Horicon has been recognized as a Wetland of International Importance, yet we continue to use it as a septic system for agricultural and other nonpoint sources of runoff. We need to address on a local level the sources of these problems, which include land uses that are incompatible with wildlife habitat and the resultant nonpoint source pollution.

The challenges at Horicon should not be construed as a problem of agriculture versus the environment, however. We need to remember that farmers were compelled to rely on modern agricultural practices through programs of the U.S. Department of Agriculture and university extension services. In the final analysis, this is not so much an agricultural problem as one for society as a whole. Unless we offer assistance to farmers and local townships to change to more sustainable agricultural and other land use practices, they will be forced to sell their land off to developers, leaving us with yet another set of ecological problems for wildlife and the health of the marsh.

Wildlife is simply a product of the land. In the natural scheme of things, wildlife populations are abundant in some areas and scarce in others because the resources they require—food, water, and shelter—are either available or not. As the land changes, certain species will find increased opportunities while others will decline. Sustainable use of the land will allow Horicon and similar wetlands to support a diversity of birds and other wildlife. Our actions and activities will be judged by nature, by whether or not we can define a sustainable lifestyle—a Land Ethic—that allows us to share this land with wildlife. This dynamic relationship is well revealed through the natural and cultural history of Horicon Marsh.

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Forster's Tern at Horicon Marsh *by Jack Bartholmai*

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Gregory M. Nelson has spent countless days studying Common Loons and participating in activities that promote their success. His photographs of birds, mammals and landscapes have been featured in numerous books, calendars, and magazines across the U. S. and Canada. For more loon information and photographs, visit his website at www.gmnphotography.com.

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Karen R. Whitford graduated from UW-Stevens Point in 1974 with a degree in Art Education, and has since taken numerous other art courses at colleges in Minnesota, Wisconsin, and Ohio to maintain licensure for teaching. She is a freelance artist who con-

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Laurie B. Wlosinski is a biological technician for the U.S. Fish and Wildlife Service and has been stationed at the Upper Mississippi River National Wildlife and Fish Refuge since 1989. Her areas of expertise include wildlife censusing, GIS, prescribed burning, and law enforcement.

Thomas J. Ziebell earned his M.S. degree in Biology at UW-Oshkosh studying Black-crowned Night-Herons. He has been observing wetland birds on and around Rush Lake since 1970, and has written several articles for *The Passenger Pigeon.* He is the Hazardous Materials Editor at J. J. Keller and Associates in Neenah.

Yellow-headed Blackbird *by Jack Bartholmai*

Swamp Sparrow *by Jim McEvoy* (Wisconsin Department of Natural Resources)

THE WISCONSIN SOCIETY FOR ORNITHOLOGY

The Wisconsin Society for Ornithology is an educational and scientific non-profit organization founded in 1939 "to encourage the study of Wisconsin birds." The Society achieves this goal through programs in research, education, conservation, and publication.

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