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DUCK AND COOT

ECOLOGY AND MANAGEMENT IN WISCONSIN

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DUCK AND COOT ECOLOGY AND MANAGEMENT IN WISCONSIN

By

Laurence R. Jahn and Richard A. Hunt

Technical Bulletin Number 33

WISCONSIN CONSERVATION DEPARTMENT

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FOREWORD

The nature of investigations and management of waterfowl are generally well known in North America. But as the human population and activities of people expanded after World War II, the need became increasingly obvious for additional information to help guide more intensive types of waterfowl management.

This bulletin is aimed at meeting this informational need. It emphasizes the avenues management must follow to maintain reasonable sized seasonal populations of ducks and coots in Wisconsin. Key to accomplishing this objective is maintaining aquatic habitat, both public and private, in a condition attractive to waterfowl. Where disturbance by people limits or prevents waterfowl use of suitable habitat, management must include establishment of priorities and guidelines for water-use activities. This aspect of management is at times controversial, but must be advanced in order to develop and maintain a sound waterfowl program.

As a conservation administrator, I cannot emphasize too strongly the broad perspective required to view waterfowl populations and management opportunities. To many conservationists, a state is a large geographic area with specific boundaries. But to wide-ranging migratory birds, a state is merely one locality within their range.

Although it may seem complex at first glance, management efforts for waterfowl frequently must be cooperative efforts between agencies, and between agencies and private groups. While our administrative efforts are geared to political or administrative boundaries, such as counties, states, and flyways, our management efforts must cover the entire range of the waterfowl species to be benefited. Securing the essential joint action between different groups in widely separated areas will test the ability of any resource administrator. However, the problem is no different than implementing sound management on watersheds involving the actions of two or more counties. Our perspective must be sufficiently broad to view our own area, whether it be a state or flyway, as but one part of the entire range used by the birds. Decisions must be arrived at jointly to provide appropriate actions within the biological boundaries of the birds.

The authors have attempted to incorporate findings from Wisconsin's waterfowl investigations into a broad framework and to design this bulletin for the convenience of readers. Summaries of the detailed information, for example, appear at the end of each section. The pictures and their explanatory captions are included to give a bird's-eye-view of the different types of aquatic habitat and some of the management problems and possibilities in Wisconsin.

This bulletin constitutes a summary of information regarding ducks and coots in Wisconsin, and should function as a base to orient our thinking and actions in waterfowl management. Ingenuity is still badly needed to implement waterfowl management procedures on a larger scale in our modern society.

L. P. VOIGT
Conservation Director

ABSTRACT

The over-all objective of Wisconsin's duck and coot habitat and population investigations was to develop guidelines for managing seasonal duck and coot populations.

Wisconsin has an estimated 1,170,698 acres of inland aquatic habitat of importance to ducks and coots, in addition to 9,878 sq. miles of Great Lakes' waters. Habitat quality varies regionally and locally. Considered solely on the basis of aquatic plants, southern hard-water lakes can support 17 to 2,250 times more duck use than northern soft to medium-hard water lakes. Activities of people threaten to destroy some and degrade the quality of other waterfowl habitat.

Crude estimates place the average yearly breeding duck population at 133,500 to 280,500 and duckling production at 217,100 to 456,300 (1949–50). Indicated statewide densities per sq. mile were 2.6 breeding pairs of ducks and 0.5 of coot (1949–50). The blue-winged teal, mallard, and ring-necked duck averaged 84 percent of the breeders (1948–56). Productivity of ducks on the *better quality* Wisconsin wetlands balanced or exceeded total mortality.

Chronology of fall duck use for each species using Wisconsin was similar among years, but the pattern varied among species. Statewide, the bulk of the ducks and coots were present between October 10 and November 10. Important fall concentration sites were limited in number for only the ruddy duck, canvasback, and redhead.

Main Mississippi Valley fall flight routes of American widgeon, blue-winged teal, canvasback, lesser scaup, ring-necked duck, ruddy duck, and coot cross Wisconsin. Many mallards using the state in fall very likely come from Manitoba and Ontario where water conditions are more stable than on the western prairies. Segregation of sexes and possibly an earlier migration of one sex are indicated for immatures of 5 species of ducks. Migration of adult female ducks appeared to coincide with the Wisconsin hunting season and resulted in a disproportionately heavy harvest of hens for many species. This differential loss probably helps explain the excess of males in the adult class of the duck population.

Wisconsin's wintering population consisted of an annual average of 33,700 ducks and 1,200 coots (1954–58). The mallard, black duck, common goldeneye, and lesser scaup averaged 89 percent of the population.

Waterfowl hunting pressure in Wisconsin was high, with over 100,000 duck stamps sold annually (1948–60). Peak numbers of hunters were afield on the opening 2 or 3 days of the season and on subsequent week ends. Excessive numbers of hunters on some Wisconsin hunting areas force waterfowl to leave suitable habitat and poor quality hunting results. Greater application of managed hunting is needed to improve harvesting conditions.

The daily bag limit of 4 was of greatest importance in limiting and distributing the duck kill (1) on the first 2 days of the season and (2) on areas of light hunting pressure supporting reasonably high duck populations. Reported duck crippling loss averaged 22 percent, was highest when hunting pressure was greatest and for pass shooting, and was not different for parts of the day. Coot crippling loss averaged 5 percent.

Hunters frequently misidentified bagged ducks. Most common waterfowl hunting violations involved daily shooting hours, improperly plugged guns, and closed seasons (1955–57). Waste of the resource included (1) wood ducks shot accidentally by hunters during closed seasons, and (2) coots shot for target practice in open seasons.

Refuges are needed in Wisconsin in fall to protect ducks from excessive disturbance caused by hunters, fishermen, and motor boat users. Small refuges (under 10,000 acres) are not effective in reducing hunting mortality on local breeding ducks.

The contribution of local ducks to Wisconsin's duck harvest (454,000) was estimated at 9 percent in a year of low production and 18 percent in a year of high production (1948–60).

Most important of 16 recommendations offered to guide management of seasonal populations of ducks and coots in Wisconsin are (1) maintaining and developing suitable habitat, and (2) providing the birds with protection from excessive disturbance.

ACKNOWLEDGMENTS

Many people contributed to the successful completion of the surveys and investigations reported here, and space does not permit naming each person individually. Team effort was the key to ultimate success. We sincerely acknowledge each person's assistance.

For initiation of the waterfowl research project, credit is due the Wisconsin Conservation Commission, which authorized establishment of the project, and the U.S. Fish and Wildlife Service, which encouraged and sponsored the project through the Federal Aid in Wildlife Restoration Act.

Many members of the U.S. Fish and Wildlife Service contributed to our studies, but especially: **A. S. Hawkins** for helping to develop the pioneer investigational efforts and for periodic counsel; **W. E. Green** and the late **R. C. Steele** for providing records on waterfowl populations for the Upper Mississippi River Wildlife and Fish Refuge; **L. F. Gunther, R. F. Russell,** and **L. H. Dundas** for providing records on waterfowl populations for the Horicon National Wildlife Refuge; **E. J. Smith, F. R. Martin,** and **C. E. Pospichal** for providing records on waterfowl populations for the Necedah National Wildlife Refuge; **H. K. Nelson** for helping to assemble spring migration records for National Wildlife Refuges; **E. L. Atwood** for furnishing records on duck stamp sales and waterfowl kill.

Personnel of the Wisconsin Conservation Department assisted in innumerable ways. Credit is extended to former director **E. F. Swift,** present director **L. P. Voigt,** the late **W. F. Grimmer, J. R. Smith, F. H. King,** former chief of wildlife research **I. O. Buss, C. Kabat,** and others for supervision and support of many types; **J. B. Hale** for patience and assistance while the report was being completed; **A. J. Rusch, R. E. Kyro, F. A. Hartmeister, M. J. Hansen, W. Kitz, R. Milhalek, G. H. Amelong, J. Johnson, J. Kreier, M. Skinner, E. Hartnagel, R. Wicks, J. Dreymiller, D. Q. Thompson,** members of the Horicon Marsh maintenance project, personnel of the Poynette State Game Farm, and members of the Wildlife Research Section for field assistance, many times at odd hours over and above the regular working day; **W. E. Scott, N. R. Barger,** and **O. S. Bersing** for providing records on waterfowl; **D. R. Thompson** and **C. W. Lemke** for statistical services; **W. C. Truax, H. Stroebe, R. B. Hovind, B. H. Popov, N. R. Stone, B. H. Hubbard, C. E. Germain, J. R. Berkhahn, W. Radke,** and **K. L. Beghin** for conducting aerial waterfowl censuses; **W. F. Johnson** for preparing figures of this report in final form; **G. F. Martz** for reading sections of the report; and all conservation wardens who provided information on waterfowl. Special credit is due all game managers for many hours of stimulating discussion and for untold hours of assistance in completing field surveys. Special recognition is also due **B. J. Sohre, G. K. Bahr,** and **H. F. Jahn** for completing many hours of tedious tabulations and typing.

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Welcome and helpful comments were received on an original draft of this report from **H. A. Hochbaum** and **I. N. Gabrielson** (Wildlife Management Institute); **A. S. Hawkins** and **A. E. Geis** (U.S. Bureau of Sport Fisheries and Wildlife); and **R. L. Hine** (Wisconsin Conservation Department). **L. B. Keith** (University of Wisconsin) offered valuable suggestions on productivity and mortality rates of ducks. Special credit is due **J. J. Hickey** and **R. A. McCabe** (University of Wisconsin) for examining various drafts of this report and for providing challenging and stimulating comments leading to improvement.

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The senior author is now North-Central Field Representative with the Wildlife Management Institute.

Edited by Ruth L. Hine

CONTENTS

HISTORY OF WISCONSIN WATERFOWL MANAGEMENT RESEARCH PROJECT

The waterfowl management research project was established as a Pittman-Robertson unit of the Game Division of the Wisconsin Conservation Department in 1940. From 1940 through 1943, Fred R. Zimmerman served as project leader. During this 3-year period, the primary objective of the studies was to sample the state's principal waterfowl habitats and, on those areas selected, to survey food and cover resources and study the factors—chemical, physical, biological and economic —that were affecting aquatic life. Information was also obtained on waterfowl food habits, waterfowl hunting conditions, winter concentrations of waterfowl, disease outbreaks, sex ratios, and spring and fall migrations. Several reports were published, including those on aquatic habitat and food habits studies (Zimmerman, 1953) and spring sex ratios of ducks (Zimmerman, 1961).

From January 1944 through December 1946, the waterfowl research project was inactive.

From January 1947 through April 1951 Ralph C. Hopkins served as project leader. During those years the work of the waterfowl research project was expanded, largely at the request of the U.S. Fish and Wildlife Service. Project activities included conducting spring breeding-pair inventories, summer brood surveys, spring and fall migration censuses, hunter checks, winter inventories, and many other special habitat and population surveys. A test of prehunting season stocking of hand-reared mallards was carried out from 1946 to 1953 (Hunt *et al.,* 1958).

From May 1951 through June 1959, Laurence R. Jahn served as leader of the Wisconsin waterfowl management research project. During this period, emphasis was placed on continuing many of the activities initiated earlier, developing intensive and extensive survey techniques, carrying out studies dealing with Canada geese, preparing reports on many studies undertaken by the project, and co-operating with other states of the Mississippi Flyway to advance sound waterfowl research and management. Assistance was given the Office of River Basins of the U.S. Fish and Wildlife Service to complete a report on the wetlands survey of Wisconsin (Mann, 1955). Reports covering waterfowl breeding-pair and brood surveys were issued annually (Hopkins, 1949; Hopkins *et al.,* 1950; Jahn and Rusch, 1951; Jahn, 1952, 1953, 1954, and 1956; Jahn and Hunt, 1955a and 1957; Hunt, 1958). Results from intensive studies of breeding Canada geese (Collias and Jahn, 1959) and managed goose hunting at Horicon Marsh (Hunt, Bell, and Jahn, 1962) were also published. Other reports on geese are pending.

Richard A. Hunt has been waterfowl project leader from 1959 to date.

All pertinent information collected by personnel of the waterfowl research project on duck and coot populations is presented in this report.

INTRODUCTION

This report presents findings of habitat and population surveys and investigations carried out on ducks and coots in one geographic area, namely Wisconsin. Overall objectives of the studies were to (1) determine general features of Wisconsin's aquatic habitat resources, (2) determine the characteristics of seasonal duck and coot populations, (3) determine and evaluate features of waterfowl hunting, and (4) formulate management recommendations. To satisfy these objectives, the findings from our research are presented by incorporating them with historical information and findings of other investigators. The ultimate purpose is to make the information available for future management and research planning and operations.

Experiences with drastically fluctuating waterfowl populations during the past 30 years have emphasized that additional knowledge about the creatures is needed, species by species and region by region. Until more is known about the birds and their habitat, waterfowl management will fail to function as efficiently as it can. In face of diminishing aquatic habitat resources and increasing demands for the resource by a rapidly expanding human population, the need for basic information on the birds is becoming more critical as time passes.

Principles governing waterfowl management are, in most cases, similar to those involved in the management of any other game species. Exceptions involve (1) the relationship between populations and hunting regulations, and (2) the perspective needed to visualize the principles in operation.

Accumulated evidence shows that hunting regulations have little effect on the status of resident small game. In sharp contrast, hunting regulations influence the proportions of migratory game-bird populations that are harvested (Geis, 1963). Planning and establishing hunting regulations for ducks and coots are, therefore, more crucial than for small game.

Ducks and coots cross state and international boundaries in migrating from their breeding areas to suitable wintering grounds. Numerous aquatic and upland sites located between these two terminal points provide seasonal resting and feeding areas where the aesthetic and recreational values of the birds are enjoyed by the public. This migratory behavior and resulting wide distribution of the birds complicates management efforts and dictates that research and management be a co-operative undertaking of many individuals and organized groups. Joint regional efforts are essential to cover the extensive range of the birds within the brief time available for most seasonal investigations.

Many of the surveys and investigations reported here were conducted as co-operative undertakings with the U.S. Bureau of Sport Fisheries and Wildlife. Some of the information has already been used for Flyway management purposes, especially as essential background material for developing the more refined procedures now used in waterfowl management. Much of the information was used as it became available to answer day-to-day management problems in Wisconsin.

In this report, we will discuss the general features of Wisconsin's aquatic habitat resources (Part I), characteristics of seasonal populations of ducks and the coot (Part II), and hunting aspects (Part III). A summary of management guidelines and suggestions for future research are presented in the final section (Part IV). Wherever possible, common names of plants and animals are used in the text to facilitate reading; scientific names are presented in Appendix A. Limited data on spring migration are discussed in Appendix B. Also presented in the Appendix is special detailed material on (1) aquatic habitat, (2) duck and coot fall-concentration sites, (3) waterfowl hunting regulations, (4) characteristics of the duck harvest, and (5) duck and coot weights.

The information from Wisconsin constitutes one "building block" which, when combined with similar "blocks" from other states and provinces, should, we sincerely hope, result in better management of this resource, both now and in the future.

PART I. WISCONSIN'S AQUATIC HABITAT RESOURCES

Wisconsin's aquatic habitat is here considered briefly from the standpoint of (1) its origin and general distribution in the state, (2) variations in production of aquatic plants in various types of waters, (3) man's major influences on the aquatic habitat, and (4) its current quantity. While each of these important items is treated separately, it is paramount to recognize that prevailing habitat conditions are the product of interactions of many physical, chemical, economic, social, and biological factors. Discussion of each of these factors is beyond the scope of this report. Only broad ecological relationships are considered here. Knowledge of the capabilities of aquatic habitat to yield food and cover utilized by ducks and coots is essential to help understand the general distribution and local abundance of seasonal waterfowl populations.

Origin of Aquatic Habitat

The natural aquatic habitat of any area is primarily the result of climatic and geologic forces acting over eons of time. One of these forces, namely glaciation, played a dominant role in creating much of the aquatic habitat which now provides food, cover, and water for waterfowl in Wisconsin. Man has created aquatic habitat only recently, and to a limited extent.

One part of Wisconsin, the Driftless Area, was not glaciated (Fig. 1)*. Within its boundaries is preserved a large sample of the general type of topography that existed throughout Wisconsin before the last glacial period. Comparisons between the glaciated and unglaciated areas emphasize the dramatic role the glaciers played in changing the topography of much of Wisconsin.

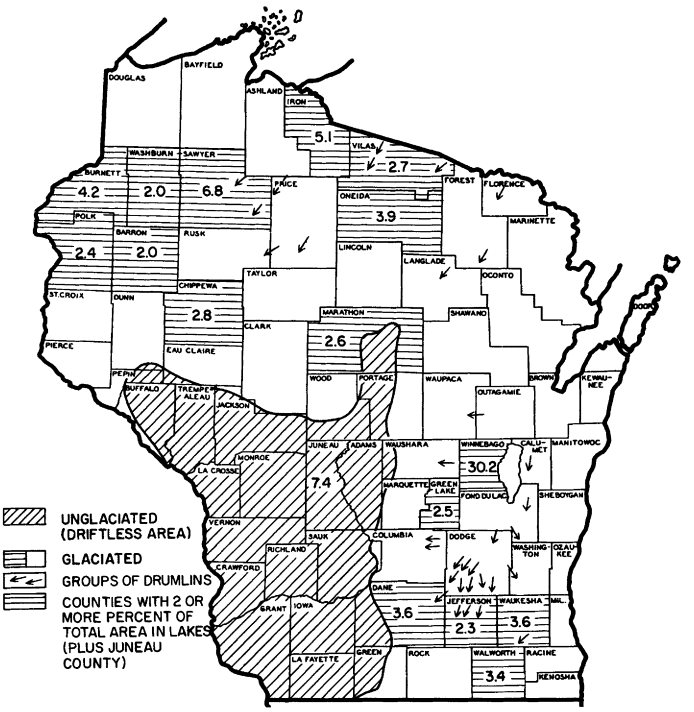
Within the Driftless Area, streams have been eroding to grade without major geological interruption for a million years or more. A rather complete drainage pattern has developed. Natural lakes and swamps are almost non-existent. Waterfowl habitat consists mainly of streams and depressions in their floodplains. These depressions are filled with water when the streams overflow. Submerged aquatic vegetation is restricted largely to suitable localities of the stream channels where the rate of flow is sufficiently slow to permit plants to grow. Floodplain depressions many times yield excellent stands of smartweeds and other moist-soil waterfowl food plants. When flooded, these stands are favored feeding sites for ducks. Conditions such as these prevailed throughout Wisconsin during the preglacial period. Water, food, and cover of the types preferred by ducks and coots were minimal, and consequently the seasonal populations of these aquatic birds had to be restricted.

During the last glacial period, which extended from more than 25,000 to about 10,000 years ago (Thwaites, 1956:131), sheets of ice periodically covered parts of northern and eastern Wisconsin (Fig. 1). Through glacial erosion and deposi-

* Since this unit was written, we learned of a new theory suggesting that at least part of the "unglaciated" area was glaciated.

◀ Photo by Wisconsin Conservation Department

Figure 1. Extent of glaciated area in Wisconsin (after Martin, 1932: 83), and location of major groups of drumlins (after Nat. Resources Com. of State Agencies, 1956:15) and lakes (calculated from Wis. Conserv. Dept., 1958).



tion the drainage pattern of the area was changed drastically, leaving basins which now contain the lakes and marshes essential to accommodate waterfowl. Inland lake basins were generally formed in four different ways (Fenneman, 1910:4; Birge and Juday, 1914:1): (1) blocks of ice embedded in the glacial debris melted and subsequently formed pits or kettles, (2) preglacial streams or erosion valleys were dammed by terminal or recessional moraines, (3) valleys between terminal moraines were blocked with glacial drift at either end, and (4) depressions remained in the ground moraine. Lakes and marshes occupy undrained depressions and pits which extend below the water table or where a basin seal (Broughton, 1941) holds the surface water. Lakes are widely distributed in the glaciated area of Wisconsin, with concentrations occurring in certain counties in the northwest, northeast, and southeast (Fig. 1).

Variations in Production of Aquatic Plants

Within a given climatic area, the nature of the geological materials and the soils of the basin and watershed, to a large degree, determine the kind and amount of primary nutrients available in aquatic environments. The relative capabilities of water areas to produce aquatic plants of value to ducks and coots are determined largely by the nature of the geological formations, and they vary with hardness of the water (Moyle, 1945, 1956; Moyle and Hotchkiss, 1945). Calcareous materials and lacustrine clays yield mineral nutrients essential for growth of aquatic plants.

For practical purposes of waterfowl management, Moyle and Hotchkiss (1945) divided the surface waters of Minnesota into three classes on the basis of the type of water involved: (1) soft, (2) hard, and (3) alkali or sulphate. Soft waters produce few species and sparse stands of aquatic plants of value to waterfowl. Both hard and alkali waters are capable of yielding dense stands of food and cover plants heavily utilized by waterfowl. Wisconsin data for soft- and hard-water lakes support this general classification (Table 1). Alkali surface waters are unknown in Wisconsin. Based on this relationship between water hardness and aquatic plant production, regions and localities of Wisconsin are delineated here on the basis of distribution of waters of different hardness.

While water hardness is used as an index to the quality of waterfowl habitat, it must be recognized that a complex of factors determines plant species composition (Moyle, 1945, 1956; Swindale and Curtis, 1957) and production. Characteristics of water (chemistry, clarity, movement), substrate (type, fertility, stability), and basin (shape, size, depth) interact to form numerous natural environmental conditions for growth of aquatic plants. Favorable water hardness indicates that the potential is good for producing duck food and cover plants. Other features of the water and characteristics of the substrate and basin determine whether or not desirable plants are present.

Hardness of underground water in Wisconsin's geological surface formations varies regionally from soft in the north central area to very hard in the southeast (Fig. 2). While

TABLE 1

Relative Abundance of Duck Food Plants in Lakes in Northern Wisconsin*

Water Hardness**	Percent of Lakes With Duck Food Plants	
	None to Scarce	Fairly Abundant to Abundant
Very soft to soft	77	1
Medium to medium hard	19	49
Hard	4	29
Total number of lakes	174	79

* Based on records summed for Douglas County (Bordner *et al.*, 1933), Langlade County (Univ. of Wis., 1934), Rusk County (Bordner *et al.*, 1935) and Sawyer County (Bordner *et al.*, 1932).

** Water from lakes was classified according to Juday's categories of bound carbon dioxide content (Bordner *et al.*, 1939:4): very soft is 0–5 ppm of bound carbon dioxide; soft, 5–10 ppm; medium, 10–20 ppm; medium hard, 20–30 ppm; hard, over 30 ppm.

these regions of water quality are helpful guides in appraising the general potential for waterfowl habitat, bodies of water in the northern soft-water area must be evaluated individually. Good quality waters and reasonable stands of duck food and cover plants are known in certain localities of the soft-water area. In much of the area, the noncalcareous drift is at least 35–200 ft. deep (Broughton, 1941). Older calcareous materials are buried by the recent glacial drift, and in places come close to the surface. Waters are harder where this occurs. Limestone-bearing glacial drift was deposited in parts of Forest, Langlade, Shawano, and Waupaca counties, and to a lesser extent in northern Polk and Burnett counties (Weidman and Schulz, 1915:185).

Influence of these limestone deposits on the quality of water is indicated by comparing the waters of landlocked lakes in a county generally lacking limestone (Vilas County) with those in a county having some limestone (Polk County). Ninety-six percent of 730 landlocked lakes in Vilas County had very soft to soft water and the balance had medium-hard water (calculated from Black, Andrews, and Threinen, 1963). In Polk County, 58 percent of 341 landlocked lakes had very soft to soft water and the balance had medium-hard to hard waters (calculated from Sather and Threinen, 1961). Many small lakes in Polk County are noted for their waterfowl. Likewise, small lakes in Vilas County are known for their scarcity of ducks.

The influence of lacustrine clays on the quality of surface waters is most noticeable in Burnett County and along Lake Superior and Lake Michigan. Much of Burnett County was formerly covered by Glacial Lake Grantsburg, in which clays were deposited (Martin, 1932:456). Lakes receiving water that contacts these clays can be expected to yield good stands of aquatic plants. Buggert Lake is one such area in Burnett County (Swindale and Jahn, 1956).

Hardness of water and production of duck food plants are also, generally, associated with the type of lake within the northern soft-water area (Fig. 2). Northern landlocked lakes usually have very soft to soft water (Table 2) and few aquatic plants (Table 3). For example, in the northeast, 90 percent of 370 landlocked lakes had very soft or soft water (Table 2). Of 334 landlocked lakes in the northwest, 76 percent had very soft or soft water. Twelve landlocked lakes in the southeast, where limestone is common throughout the area, had medium-hard to hard water. In sharp contrast, drainage lakes (having an inlet, outlet, or both) provide much better potential conditions for duck food and cover plants. Sixty-nine percent of 405 drainage lakes in the northeast, 81 percent of 305 drainage lakes in the northwest, and all drainage lakes in the southeast had medium-hard to hard water (Table 2).

Many northern drainage lakes with inlets receive a constant addition of carbonates from inflowing streams (Juday and Birge, 1933:236; Birge, Juday and Meloche, 1938:236; Broughton, 1941). The streams serve as collecting agents for calcium carbonate and other nutrients, and the lakes act as reservoirs for the accumulated nutrients. This relationship

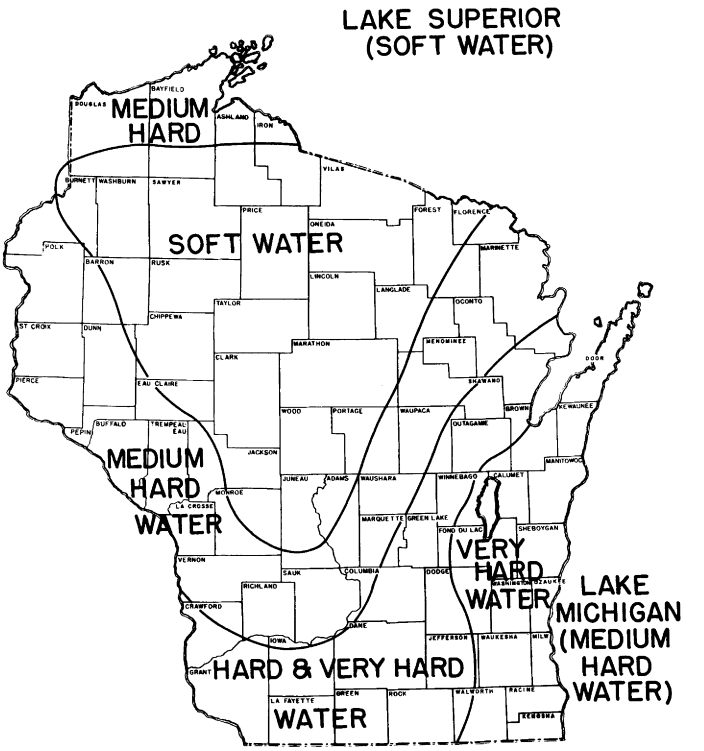


Figure 2. General regions of underground water hardness in the geological surface formations (after Weidman and Schulz, 1915:162). (Boundary lines between areas are not absolute, as there is a gradual change in mineral content in passing from one region to another. Also, some individual aquatic sites within the designated areas may possess water having a hardness quality other than that indicated for the general area, particularly in the soft-water area.)

suggests why waters in many drainage lakes in the soft-water area are much harder than in most landlocked lakes. By dividing lakes into landlocked and drainage types, much can be predicted about their potential for accommodating waterfowl.

Overall differences in yields of plant foods for waterfowl are indicated by variations in the standing crop of aquatic plants in lakes having water of different hardness (Table 4). Two hard-water lakes in Wisconsin's southeastern limestone region had from 16 to 2,573 times more plant material (weight) per unit of occupied area than 6 northern soft to medium-hard water lakes (Table 4). The great difference in plant yields between these lakes of different hardness results from variations in species and growth forms of the plants (Fassett, 1930; Moyle and Hotchkiss, 1945; Swindale and Curtis, 1957).

Soft-water lakes are primarily of two types: (1) bog lakes, and (2) sand-lined kettle lakes. Both are generally characterized by small quantities of plants and the absence of many submerged aquatics known to be of value to waterfowl. Bog lakes often contain very soft water and a mat of floating sedges, Sphagnum moss, and leatherleaf. The limited food in a bog lake is made largely unavailable to most wildfowl by this mat of plants. A sedge *(Carex lasiocarpa)* with the unique ability of extending its roots into open water, forms the floating mat, ever striving to advance toward the center of the lake. This mat eliminates shallow waters preferred by waterfowl for resting and required by dabbling ducks for feeding.

TABLE 2

Hardness of Water in Landlocked and Drainage Lakes in Northeast, Northwest and Southeast Wisconsin*

Hardness of Water**	Percent of Lakes					
	Landlocked Lakes			Drainage Lakes		
	Northeast	Northwest	Southeast	Northeast	Northwest	Southeast
Very soft	78	41	0	12	4	0
Soft	12	35	0	19	15	0
Medium	7	10	0	52	27	0
Medium hard	1	8	25	12	26	2
Hard	2	6	75	5	28	98
Total number of lakes	370	334	12	405	305	46

* Records for many northern counties are from Wis. Dept. Agr. (1945), for (assumed) Oneida and Vilas counties from Juday, Birge and Meloche (1935), and for southeast counties from Zimmerman (1953). Lakes were sampled in the northeast in Forest, Iron, Langlade, Lincoln, Oneida, and Vilas counties; in the northwest in Ashland, Barron, Bayfield, Burnett, Chippewa, Douglas, Polk, Price, Rusk, Sawyer, Taylor, and Washburn counties; and in the southeast in Columbia, Dane, Dodge, Door, Fond du Lac, Green Lake, Jefferson, Kenosha, Manitowoc, Marquette, Ozaukee, Portage, Racine, Rock, Sheboygan, Walworth, Washington, Waukesha, Waupaca, Waushara, and Winnebago counties.

** Hardness of water in all northern lakes is based on Juday's scale (Bordner *et al.*, 1939:4): very soft is 0–5 ppm of bound carbon dioxide; soft, 5–10 ppm; medium, 10–20 ppm; medium hard, 20–30 ppm; hard, over 30 ppm. In southeastern lakes, hardness is based on the methyl orange alkalinity test; lakes with a rating of very hard are included in the category hard.

Only divers, such as the ring-necked duck, can utilize the limited foods produced in the soft water.

Sand-lined kettle lakes with fluctuating water levels and broad sand beaches serve primarily as feeding sites for diving ducks and resting areas for waterfowl during migration. Submerged and floating-leaved aquatics comprise the vegetation. Absence of emergents limits overwater nesting and escape cover for waterfowl.

In summary, Wisconsin lakes and marshes capable of producing food and cover for waterfowl may be found anywhere in the state where basic nutrients are available. In northern areas, where soft water is abundant, drainage-type lakes have the best chance of yielding duck food plants. Nutrients accumulated by streams from broad watersheds many times enhance plant production in lakes having dependable inlets. Calcareous materials and lacustrine clays are distributed irregularly among the granitic drift in northern Wisconsin. Therefore, the potential for a lake or proposed impoundment to yield duck food plants must be evaluated for each individual project.

TABLE 3

Relative Abundance of Aquatic Plants in Northern Wisconsin Landlocked and Drainage Lakes According to Hardness of Water*

Hardness of Water**	Percent of Lakes With Aquatic Plants					
	In Landlocked Lakes			In Drainage Lakes		
	Scarce	Fairly Abundant	Abundant	Scarce	Fairly Abundant	Abundant
Very soft	73	16	8	28	7	1
Soft	20	46	31	16	23	4
Medium	3	22	30	23	34	27
Medium hard	3	7	14	19	14	37
Hard	1	9	17	14	22	31
Total number of lakes	204	87	77	43	58	188

* Based on records in Bordner *et al.* (1939) and tabulated for Ashland, Bayfield, Burnett, Douglas, Iron, Langlade, Polk, Rusk, Sawyer, and Washburn counties.

** Hardness of water in all northern lakes is based on Juday's scale (Bordner *et al.*, 1939:4): very soft is 0–5 ppm of bound carbon dioxide; soft, 5–10 ppm; medium, 10–20 ppm; medium hard, 20–30 ppm; hard, over 30 ppm. In southeastern lakes, hardness is based on the methyl orange alkalinity test; lakes with a rating of very hard are included in the category hard.

TABLE 4

Estimated Standing Crop of Large Aquatic Plants in Certain Wisconsin Lakes and Their Estimated Per Acre Capacity for Feeding Ducks*

Lakes		Hardness of Water	Total Acres	Percent of Bottom Occupied	Crop on Occupied Bottom (Lbs.)		Percent of Crop by Depth			Number of Ducks Per Day Per Acre of Plants**
Name	Type				Average Per Acre (Dry)	Total Dry Weight	<3.4′	3.4′–9.8′	9.9′+	
Silver	Landlocked	Medium	215	23	0.7	38	64	21	15	1
Trout	Drainage	Medium hard	3,912	27	0.7	708	61	23	16	1
Muskellunge	Drainage	Soft–medium	919	52	4	1,947	—	—	—	5
Little John	Drainage	Medium	166	31	4.8	247	—	—	—	6
Sweeney	Drainage	Medium hard	157	30	15.6	732	—	—	—	20
Weber[1]	Landlocked	Very soft	38	34	97	1,254	—	—	—	121
Nebish	Landlocked	Soft	91	—	—	4,823	—	—	—	—
Green	Drainage	Hard	7,343	29	1,590	3,369,019	9	40	51	1,988
Mendota	Drainage	Hard	9,735	26	1,801	4,630,500	30	45	25	2,251

* Except for the last column, data for each lake are from the following references: Silver, Wilson (1935); Trout, Wilson (1941); Muskellunge, Wilson (1935); Little John, Wilson (1935); Sweeney, Wilson (1937); Weber, Potzger and Van Engel (1942); Nebish, Juday (1942); Green, Rickett (1924); and Mendota, Rickett (1921).

** Based on (1) ducks averaging 2.0 pounds each and consuming 10 percent of their weight daily, (2) comsumption of 25 percent of the standing crop of vegetation (dry weight), and (3) assuming that all types of aquatic plants are palatable and are eaten. Because of the last condition, all numbers of ducks listed here are maximum values, especially those for soft to medium-hard waters which yield some species of aquatic plants of little value to ducks. Also, a small quantity of unpalatable emergent vegetation is included for some of the lakes.

[1] Dry weight of the crop was calculated for 1933 on the basis of the wet weights given by Juday (1942) and reduced by 90 percent, as shown by data presented by Potzger and Van Engel (1942).

Carrying Capacity of Lakes For Ducks

By using an established relationship between food supply and food demand by waterfowl (Sincock, 1962), it is possible to estimate how many ducks can be fed with the standing crop of submerged aquatic plants from lakes of different quality. Sincock (1962) developed the rule of thumb that the daily consumption of plant material, in pounds dry weight, is approximately 10 percent of the average body weight of a waterfowl species. Based on this rate of consumption, and assuming that 25 percent of the standing crop of vegetation is consumed, hard-water lakes can support at least 17 to 2,250 times the duck use that soft to medium-hard water lakes can (Table 4).

Capacity of a lake to feed waterfowl is considered here solely on the basis of plant resources. Small animal life associated with the plants and serving as important food for some waterfowl species is disregarded. Too few data are available to assess the relationship between the supply of small animals and food demands by waterfowl. Potentially, the food supply can be considerable. For example, in Lake Mendota along the south shore of Picnic Point between the 2- and 6-foot contours, 72 lbs. of macroscopic organisms were produced per acre of mixed aquatic plants (Andrews and Hasler, 1943). This is the standing crop of fauna at a given time, not the total annual yield. Several generations of invertebrates may be produced in a growing season.

Distribution of invertebrates is associated with the growth form of the plants. Those plants with the most dissected leaf surface, such as coontail and water milfoil, generally harbor the largest populations of animals (Andrews and Hasler, 1943). General absence of these types of submerged aquatics in soft water (Fassett, 1930; Moyle and Hotchkiss, 1945) suggests minimal animal yields, as well as low plant production.

The number of 2.0-lb. ducks that could be fed solely on plant material can be calculated for an approximate 90-day combined spring and fall migration period, using Lake Mendota (Dane County) as an example of a hard-water lake. The 90 days are made up of April, October, and November, the ice-free months when migrant ducks are normally present.

If all plant materials were consumed, it would take 257,250 ducks, averaging 2.0 lbs. apiece, feeding for 90 days to consume the entire plant crop of Lake Mendota. This is 23,152,500 duck-days of use.

Twenty-five percent of the standing crop of aquatics in Lake Mendota (Table 4) would feed 64,300 ducks. This is 5,787,000 duck-days of use. Estimates from aerial censuses for 1951–54 indicate an average yearly use of 2 million duck-days for the 90-day period. If the standing crop of plants during the early 1950's was similar to that of the early 1900's when the vegetation was studied (1912–21), and the ducks present in the early 1950's depended solely on aquatics (no feeding on animal matter or uplands), approximately 9 percent of the plant crop would have been consumed by waterfowl. Since 9 percent of the total duck use was by puddlers, the bulk of which were mallards and black ducks that fed to some degree in upland fields, the actual demand on aquatics was something less than 9 percent of the available crop. This estimate gives an indication of the percentage of the potential standing crop of

aquatic plants that might be consumed by waterfowl at Lake Mendota. Since over 75 percent of the aquatics occurred in water more than 18 inches in depth (Table 4), the bulk of the feed would be available to diving ducks only. Approximately 90 percent of the fall waterfowl use in 1951–54 was by divers and coots.

Based on this analysis, we conclude that Wisconsin's mineral-poor lakes have a capacity to accomodate only a few hundred ducks, primarily divers, for a few days each year. The carrying capacity of soft-water lakes is something less than that indicated in Table 4, for many species of plants growing in mineral-poor waters are of limited value for waterfowl (Moyle and Hotchkiss, 1945:19). Hard-water lakes have the potential capacity to accomodate thousands of ducks for thousands of days. The area producing plants varies among lakes, and water depth controls availability of the feed, especially for puddle ducks. Therefore, carrying capacity for waterfowl must be determined for individual bodies of water. Submerged foods for puddle ducks, presently the most abundant ducks in the Mississippi Flyway, must be in water 18 inches or less in depth to be available to the birds.

Man's Influence On Aquatic Habitat

People have both added and subtracted waterfowl habitat by developing lands and waters, largely for agriculture, industry, navigation, recreation, and living sites. Waterfowl have indirectly benefited or been affected adversely. Major factors resulting in the loss or degradation of habitat include (1) draining and filling depressions, (2) mechanical and chemical control of aquatic plants, (3) introduction and actions of carp, and (4) pollution and sedimentation. Benefits accrue through conversion of habitat types and by adding water areas where none previously existed. Our purpose is to show the general nature and, where possible, the extent of some of these important factors. Disturbance factors, such as hunting and motor boating, that keep waterfowl from using suitable aquatic habitat are discussed later in the section on "Fall Migration".

Draining and Filling

Since the late 1800's, some waterfowl habitat has been completely eliminated through improvement of land for agriculture. While detailed statewide figures on losses of aquatic areas important to ducks and coots are unavailable, enough data are available to indicate the magnitude of draining and filling of all types of wetlands. In appraising the drainage figures it is important to recognize that only a part of the habitat lost was of value to waterfowl.

Approximately one-half of the original 5 million acres of wetlands in Wisconsin have been drained or affected by drainage (Wis. Conserv. Dept., 1959). In recent years, the bulk of the drainage has been completed to improve existing cropland. For example, from 1937 through 1954, records of the U.S. Soil Conservation Service show that not over 2,500 acres out of 116,379 acres affected by drainage were marshland (Nat. Resources Com. of State Agencies, 1956:79). Specific figures for one county illustrate the high loss of habitat in the southeastern part of Wisconsin, where the hard-water habitat provides the potential for producing the best quality habitat for waterfowl. In the past 50 years (1904–54), 87 percent of the wetland area of Racine County was lost, largely through draining and filling (Jahn and Kabat, 1955). It is only a matter of time before many of the remaining wetlands are converted to man's direct use.

Throughout Wisconsin, increasing numbers of summer and permanent homes are located on the shores of the state's lakes. Bays, marshes, and shoreline aquatic vegetation that provide food, nesting cover, and escape cover from breeding ducks and coots and spawning grounds for northern pike are rapidly being lost through filling (Brynildson, 1958). This loss is especially critical in 24 southeastern counties. Here approximately 70 percent of Wisconsin's human population resides (Marshall, Disanto, and Davidson, 1963:49). Here the demand for lake frontage is greatest. Some owners also demand permission to place "sand blankets" in the water to kill the weeds and improve the lakes for swimming (Scott, 1959).

Control of Aquatic Plants

Mackenthun (1958) emphasized that increased recreational use of inland lakes has also accelerated the demand for chemical and mechanical control of submerged aquatic plants. Mechanical procedures include hand-pulling, hand-cutting, hand-raking, chain-dragging, underwater weed saws, and power-driven underwater weed cutters. Specific figures on the number or acreage of lakes treated with these methods are unavailable.

Under existing Wisconsin procedures, chemical weed control on large lakes (over 10 acres in size) is limited to a marginal strip 200–300 feet along a portion of the shoreline (Mackenthun, 1952). Complete destruction of aquatic vegetation in a large lake is not recommended or approved by the State Committee on Water Pollution. Since initiation of the statewide program of chemical control of submerged aquatic vegetation in 1939, interest in the program has steadily grown. In 1939 one treatment was completed. From 1950 through 1957, some 80 Wisconsin lakes were treated one or more times with sodium arsenite (Mackenthun, 1958). The total amount of chemical applied to the various lakes has shown a corresponding increase (Mackenthun 1958).

Some lakes important to ducks and coots were treated. Natural food resources for ducks and coots may have been reduced in certain localities by the destruction of submerged aquatic plants. If the control of submerged aquatic plants continues to grow in popularity, it may become necessary to investigate fully the effect on waterfowl foods in lakes serving as major waterfowl concentration sites. Part of the study should be

aimed at ascertaining whether or not chemicals used to control aquatic plants enter the fauna of lakes and are concentrated in certain "levels" of the animal pyramid. If chemicals are concentrated their effects on waterfowl ingesting them should be determined.

Introduction and Actions of Carp

Shortly after the introduction of carp into Wisconsin about 1883, measures to control it were sought (Mraz and Cooper, 1957). Since that time the destructive effects of large carp populations on aquatic plants have been well documented (Cahn, 1929; Black, 1946; Cahoon, 1953; Threinen and Helm, 1954; Tryon, 1954). Plants are either directly uprooted or eaten by these fish, or are prevented from growing when roiled waters exclude sunlight. Which of these destructive features is most important in limiting plant growth seems to vary with the locality and the type of substrate within the water area. Mraz and Cooper (1957) demonstrated that the type of substrate of the water area affects the degree of turbidiy resulting from the physical activity of carp. Two ponds were each stocked at the rate of 200 lbs. of carp per surface acre. In the pond where the bottom was composed predominantly of fibrous plant materials, the water remained clear throughout the summer period. In the other pond where the bottom was a mixture of loams and plant fibers, the water rapidly became turbid and remained so until the pond was drained in fall.

The magnitude of the carp's influence in retarding the growth of aquatic vegetation is shown by an example from Wisconsin. By fencing, Threinen and Helm (1954) excluded carp from a 75-acre bay on Lake Koshkonong, formerly a very important waterfowl concentration site. Forty-four days following fencing, no other bay of the lake had a stand of aquatic vegetation in density or species composition which approached that in the protected bay. Stands of coontail, floating-leaf pondweed, leafy pondweed, flat-stemmed pondweed, and sago pondweed provided food for waterfowl. Cover, in the form of emergent plants, remained poor. Closing off the bay dramatically demonstrated the prolific nature of the vegetation and the destructive potential of the carp in shallow water, the area potentially of most value to waterfowl.

Carp are now found in the southern two-thirds of Wisconsin (Black, 1946; Druschba, 1959), the part of the state where undisturbed water areas are naturally capable of yielding the best quality food and cover for ducks and coots. Because of its wide distribution and destructive feeding habits, the carp continues to be an important factor reducing natural aquatic food and cover for ducks and coots in certain water areas.

Sedimentation and Pollution

Soil erosion and the lack of or improper treatment of domestic and industrial wastes prior to discharge can alter aquatic areas (McAtee, 1939:83; Martin and Uhler, 1939; Hynes, 1960). In small or moderate amounts, non-toxic pollutants may serve as fertilizers and stimulate plant and animal growth. In excessive quantities, both silt and pollutants in suspension reduce the penetration of light into water and thereby limit the growth of waterfowl food plants. After silt is present, water motion resulting from winds and feeding activities of rough fishes, especially carp, keep the silt in suspension and increase turbidity. Where the water is not too turbid, sago pondweed and floating-leaf pondweed, two important waterfowl food plants, often persist (Hynes, 1960: 106). However, continued accumulations of silt reduce storage capacities of water areas and eventually eliminate waterfowl habitat.

In the past 25–30 years, after tractors became available to most farmers, excessive manipulation of the soil led to increased runoff and erosion (Lovely, Free, and Larson, 1960). The increased rate of sedimentation resulting from modern agricultural practices has affected aquatic life in many lakes in Wisconsin, Illinois (Jackson and Starrett, 1959) and elsewhere. For example, in floodplain lakes along the Illinois River, siltation and other forms of pollution were important factors involved in drastic changes in species and densities of bottom fauna of the lakes studied (Paloumpis and Starrett, 1960). Following a drastic decline in the population of small mollusca of Quiver Lake, Illinois, the number of lesser scaup ducks using the lake declined from a peak of 20,000 in 1953 to less than 1,000 birds in any year thereafter (Paloumpis and Starrett, 1960). Quiver Lake is now filled with sediments, and the water is too turbid for plant growth (Jackson and Starrett, 1959).

While the location and extent of pollution and soil erosion in Wisconsin are generally known (Nat. Resources Com. of State Agencies, 1956), the seriousness of pollutants and silt in limiting waterfowl foods in the numerous aquatic areas is known in only a few cases. In the Fox River and its associated lakes, excessive siltation and turbidity are considered the primary factors limiting development of aquatic plants (Thompson, 1959). Industrial wastes have produced serious pollution conditions in the Chippewa River and Wisconsin River basins (Public Health Serv., 1951). As of 1 May 1956, over 30 uncorrected sources of pollution of varying seriousness existed on each of the following rivers: Wisconsin, Chippewa, Pecatonica, Fox, Sheboygan, Sugar, Grant-Platte, and Rock (Nat. Resources Com. of State Agencies, 1956:133).

Thompson (1959) found that turbidity varies with the type of soil and intensity of farming. Lightly farmed sandy soils contributed little silt to the Fox River, whereas erosion of intensively cultivated loam soils in Columbia, Marquette, and Green Lake counties was the major source of silt contributing to the very turbid conditions in the Fox River.

The type of agriculture carried out in the watersheds draining into the Rox River is similar to that practiced in other regions of Wisconsin. Approximately two-thirds (65 percent) of Wisconsin's soils are in farms (Muckenhirn and Dahlstrand, 1947). The majority of the farm soils is of a loam texture. Only slightly over one-fifth (22 percent) of Wisconsin's farm land is covered by soil conservation plans, and ac-

celerated erosion is occurring in various degrees on nearly all of the intensively used crop and plowable pasture lands (Nat. Resources Com. of State Agencies, 1956). The magnitude of soil losses is considerable on some streams.

There is, therefore, widespread potential for silt to limit the growth of aquatic organisms important to waterfowl. Observations made while conducting state-wide waterfowl surveys show that suspended silt is common in many water areas in Wisconsin. Special studies are needed to define further relationships between siltation, pollution, and maintenance of habitat for waterfowl.

Improvement of aquatic food and cover for waterfowl is really but one phase of a much larger task, proper management of watersheds. Natural capabilities of different waters to produce foods utilized by various species of ducks must be recognized, if waterfowl are to receive adequate consideration. If the public demands it, food and cover production in lakes and marshes important to waterfowl could be restored and maintained, where needed, by (1) limiting the mechanical and chemical control of aquatic plants and (2) controlling water levels, rough fish populations, sedimentation, and pollution. Specific management needs should be determined for individual bodies of water and watersheds. This approach recognizes that management practices for lakes and marshes are but one part of watershed management.

Habitat Conversions and Additions

Lake Koshkonong (Jefferson County) is an example of a famous duck concentration site which was degraded and converted to other primary uses. In the late 1800's, Lake Koshkonong was one of the most widely known migrant waterfowl concentration areas in the United States, especially for canvasbacks (Hallock, 1879:177). Today, the lake, with its 10,089 acres of open water, is much less well known, but is still considered an important area for migrant ducks and coots in southern Wisconsin. Events leading to degradation of the habitat have been recorded (Hylan, 1923; Main, 1945; Threinen, 1952) and are summarized here.

In 1843, when ornithologist Thure Kumlien arrived to live on the shore of Lake Koshkonong, the lake was a widening of the Rock River. Bays and shallow parts of the lake supported wild rice and wild celery (Main, 1945). Water depth varied from 4 to 12 ft. in 1850, with wild rice so abundant that the area appeared to be a meadow (Main, 1945). Extensive low meadows adjacent to the lake provided thousands of tons of marsh hay annually. Ducks and coots were abundant (Kumlien, 1877).

In the early 1850's, a 4-ft. mill dam was constructed near the outlet of the lake at Indian Ford. Chief effects of this dam on the lake apparently were to increase the size of the area flooded and to stabilize water levels somewhat. Stands of aquatic vegetation, including wild rice, wild celery, and various pond weeds, were so dense that boats had to be poled rather than rowed. These lush growths of plants minimized wave action and provided excellent feeding and resting conditions for waterfowl.

Response of migrant ducks, particularly canvasback and redhead, was tremendous. In the early 1870's, Thure Kumlien took Wisconsin's Governor Hoard to see the spectacular migration and concentration of canvasback at Lake Koshkonong (Main, 1945). In his sportsman's gazetteer, Hallock (1879:177) reported that ". . . for canvas-back ducks this lake vies with the Delaware and Potomac Rivers, and with Chesapeake Bay." Hunters came to this nationally famous duck feeding and concentration site from Boston, New York, and other eastern cities to participate in the fine canvasback, redhead and bluebill hunting.

Two events in man's development and use of land and water drastically altered the value of Lake Koshkonong for waterfowl. Carp were introduced in the lake in 1881 (Main, 1945). After 1912, carp populations expanded to the point that feeding and up-rooting activities of the fish greatly limited growths of waterfowl food plants and adversely affected waterfowl shooting (Threinen, 1952:26). In 1917, the old mill dam at Indian Ford was raised approximately 1½–2 ft. to provide electrical power. The added water depth eliminated wild rice over most of the lake (Main, 1945), thereby ruining thousands of acres of breeding and feeding grounds for ducks (Threinen, 1952:26). High water levels combined with periodically large carp populations brought about the conversion of the marsh to an unstable open water lake. By 1923 the abundant duck food plants were gone, and the water was so turbid that visibility was restricted to a depth of 2–3 inches (Hylan, 1923).

From 1923 to 1964, annual yields of aquatic vegetation have fluctuated. Where lush stands of duck food plants formerly prevailed, three aquatic plants are now prevalent. Sago pondweed, a floating-leafed pondweed *(Potamogeton americanus),* and coontail provide the principal foods for waterfowl (Threinen, 1952:27).

A complex of interacting factors, resulting largely from man's activities over 122 years (1843–1964) degraded the waterfowl food and cover resources of Lake Koshkonong. Dominant influences include (1) high water levels, maintained primarily to produce electrical power, (2) excessive wind and wave action, resulting in high turbidity, (3) erosion of watersheds and shorelines, with accompanying deposition of silt and turbidity in the lake, (4) large carp populations, with associated roiling of sediments and up rooting of plants, and (5) pollution, contributing to turbidity. Because the intensity of these factors varies among years, stands of aquatic plants fluctuate periodically in density and abundance. However, vegetative growth in years of peak production is now not as lush as it was in the late 1800's.

Conversion of Lake Koshkonong from a marsh to a carp-infested, wind swept, turbid lake affected the continental duck population by (1) subtracting a valuable breeding area

and (2) reducing drastically the food for migrant waterfowl, thereby altering distribution of the birds in spring and fall. Species composition and volume of duck use on the lake were modified. Whereas divers were most common in the late 1800's, field-feeding puddle ducks, particularly the mallard and black duck, were predominant in recent years (1949–63). With lower duck use of the lake, local hunting opportunities declined.

Shores of Lake Koshkonong now support many residences. Local people as well as nonresidents seek recreation on this lake in addition to waterfowl hunting. The lake is used for fishing, swimming, water skiing, and boating. Activities of carp which minimize production of waterfowl foods, help maintain "weed-free" water desired by boaters. Motor boats frequently disturb resting waterfowl and discourage the birds from using the lake.

Lake Koshkonong could be converted to its former status as a marsh by lowering the water level and controlling the carp population. Whether or not the conversion will ever take place, depends upon the wishes of the people involved directly. Biologically it is possible.

Just as man's activities in utilizing land and water resources have many times affected waterfowl habitat adversely, some of his modifications have benefited waterfowl. Outstanding benefits have accrued from channel construction on the Mississippi River, farm pond construction, and other water impoundment projects.

Modification of natural drainage of the Mississippi River created some of the finest waterfowl habitat in Wisconsin. For its entire length in the state, the Mississippi River is a federal refuge known as the Upper Mississippi River Wildlife and Fish Refuge. It was established in 1924. Conclusions formulated regarding the favorable aquatic-food and cover conditions that developed following impoundment and stabilization of water levels are pertinent (Green, 1953; Steele, 1955; Green, 1963).

At the time the refuge was established (1924), the 1- to 5-mile-wide river bottom was primarily covered with wooded islands interlaced with deep sloughs. Hundreds of lakes and ponds were scattered about on the floodplain through the wooded stands. Emergent aquatic vegetation was present, but not in great abundance. Periodic flooding and drying out of basins on the floodplain in summer and fall limited growths of emergent, submerged, and floating aquatic plants. Moist-soil plants, such as smartweeds, thrived when water levels fluctuated at the proper time during the growing season.

This drastic seasonal fluctuation of water levels was eliminated between 1935 and 1939 when the Corps of Engineers constructed a series of locks and dams on the Upper Mississippi River to maintain a 9-foot navigation channel. Impoundment of waters resulted in semistabilized water levels which favored development of the excellent marsh and aquatic habitat now present. Spring floods continue, but summer dry periods are eliminated. Channel construction converted the vegetation of importance to waterfowl from predominantly moist-soil to water plants. Food, water, and cover conditions for waterfowl have been improved markedly by these activities of man.

The increase in waterfowl use of the river in spring and fall has been phenomenal following improvement in habitat conditions. Both number of species and length of time the birds frequent the area have increased. Greatest increases have been in puddle ducks. While use of the river during migration is high, opportunities for nesting ducks and coots are rather limited, and the potential is minimized as a result of fluctuating water levels in spring (Griffith, 1952).

A total of 2,857 farm ponds were constructed in Wisconsin from 1936 through 31 December 1963 (J. W. Densmore, pers. comm., 1964). Their primary purposes are to retard flood waters, reduce soil erosion damages, control gullies, furnish livestock with water, and provide recreational opportunities for landowners. Except for some ponds constructed specifically for fish and waterfowl in recent years, the bulk of the areas benefit waterfowl only secondarily. Information from 117 pond owners in southwestern and south central Wisconsin shows the degree of waterfowl use (Miller and Reber, 1962). Seventy-eight percent of the ponds were used by ducks, 28 percent for nesting. Ponds with broods averaged 2.7 ducklings per acre of water. Such duckling yields are within the range of production on good quality aquatic habitat in Wisconsin (see "Breeding Population" for data.)

Forty-nine percent of the ponds attracted enough ducks in fall to provide fair to good hunting. One owner reported harvesting 100 ducks in 1960, and another owner 75. Other harvests were smaller per pond, but provided considerable recreational opportunity.

More farm pond construction is anticipated in the future under various agricultural programs. Particularly important are the cost-sharing wildlife practices under the Agricultural Conservation Program initiated in 1962. Up to one-half the cost of eligible practices are paid by ACP. Permitted wildlife practices of value to waterfowl include: (1) restoration of wetlands of value to fish and wildlife, (2) construction of water areas, and (3) planting vegetation that provides preferred foods.

Other aquatic areas have been added to the landscape by man for various purposes. Small ponds and marshes have been constructed specifically for hunting and fishing. Large impoundments have been developed for hydropower. Such storage reservoirs used to stabilize the flow of streams to produce water power usually yield only limited quantities of submerged waterfowl food plants (Zimmerman, 1953:42). Both large and small impoundments have been developed specifically for waterfowl by local, state, and federal governments. These management areas contain some of the finest waterfowl habitat in Wisconsin.

Present-Day Aquatic Habitat Resources

For convenience of discussion, the aquatic habitat resources of the state are divided into five types: (1) wetlands, (2) lakes and flowages, (3) streams, (4) waterfowl management areas, and (5) the Great Lakes. A lake is defined as a body of water, not stream-like, that is 10 acres or larger in size. Acreage figures are presented according to physiographic regions of Wisconsin (Fig. 3) and are for "average" years. Fluctuations in these figures will occur between years, depending largely upon the amount of precipitation and runoff of surface water. Game managers of the Wisconsin Conservation Department supplied information on the portion of each type of aquatic habitat, except wetlands, that is of importance to ducks and coots. Results from periodic aerial and ground censuses, general knowledge gained from experience, and band recoveries were also used to help determine the relative importance of individual sites to ducks and coots. Sites not considered of importance here may be used infrequently by small numbers of ducks and coots or very rarely for a matter of hours by large numbers of birds on migration.

Wisconsin has an estimated total 1,170,698 acres of inland aquatic habitat of importance to waterfowl; however, the 9,878 sq. miles of outlying waters in Lake Superior, Lake Michigan, and Green Bay are of only limited value to waterfowl (Table 5). Distribution of the inland aquatic habitat of importance to ducks and coots is shown in Figure 4. A wide variety of types and qualities of inland aquatic habitat occurs in forested and agricultural watersheds.

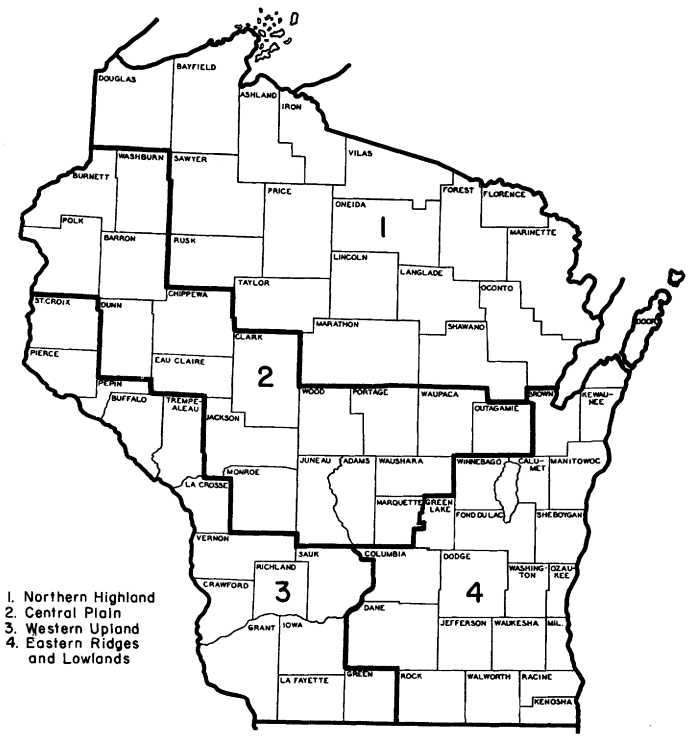


Figure 3. Four major physiographic provinces of Wisconsin; boundaries placed primarily on the basis of counties (adapted after Martin, 1932:33). (Principal underlying bedrock that influences water quality is: Northern Highland, crystalline rock; Central Plain, sandstone; Western Upland, Eastern Ridges and Lowlands, limestone.)

Wetlands

There is an estimated total of 2,790,588 acres of wetlands in Wisconsin, 15.7 percent of which is considered of moderate to high value for ducks and coots (Table 5). The portion of the total wetland acreage in each of the four geographic provinces that is of major value to ducks and coots varies from a low of 6.7 percent in the Western Upland to 33.3 percent in the Eastern Ridges and Lowlands. Differences in the portion of total wetland acreage that is of value to ducks and coots are related to the type of wetland present. Statewide, 27.7 percent of the acreage is of inland fresh areas and fresh meadows which have surface water only in spring when runoff and precipitation are adequate (Table 6). These types are largely of value to spring migrants and breeding pairs early in the breeding season.

Wetlands supporting woody vegetation make up 58.3 percent of the total acreage. Bogs, wooded swamps, and shrub swamps are the most important wetland types in the Northern Highland and Central Plain (Table 6). Woody plants commonly found growing in these wetlands include leatherleaf, sweet gale, alder, willow, dogwood, meadowsweet, bog birch, black spruce, white cedar, black ash, elm, and tamarack. Cottongrass is common in northern bogs and swamps. These wetlands, primarily supporting woody vegetation, are of limited value to ducks and coots. Lack of surface water, preferred foods, and interspersion of cover types are among the most important features limiting duck and coot use.

Inland fresh areas and fresh meadows are the dominant types of wetlands in the Western Upland and Eastern Ridges and Lowlands. Plants commonly found in these wetlands include smartweed, dock, sedge, cordgrass, reed canary grass, wool grass, and cattail. When flooded, smartweed stands are very attractive feeding areas for ducks.

Only 14.0 percent of the wetland acreage of Wisconsin is of shallow and deep fresh marshes and open fresh water, the types of most importance to ducks and coots. Food plants include a variety of submerged aquatic plants, sedges, bulrushes, and burreeds. Cattails are also common.

Lakes and Flowages

There are 8,830 inland lakes in Wisconsin totaling 915,036 acres. Of this total, 374 lakes (4.2 percent) totaling 533,041 acres (58.3 percent) are of major importance to ducks and coots (Table 5). Distribution of the important acreage of permanent waters is shown in Figure 5.

Within the four geographic provinces, the lakes and flowages of importance to ducks and coots are distributed unevenly. Forty-six percent of the total important acreage of the entire state is located in the Eastern Ridges and Lowlands, with approximately two-thirds of this being located in Winnebago

TABLE 5

Wisconsin's Aquatic Habitat Resources and Portions of Importance to Ducks and Coots*

Habitat Types and Items**	Northern Highland	Central Plain	Western Upland	Eastern Ridges and Lowlands	Entire State
Wetlands					
Est. total acreage (1954)	1,595,551	769,765	110,300	314,972	2,790,588
Acreage of importance (1954)	(12.7%)	(16.0%)	(6.7%)	(33.3%)	(15.7%)
High	202,236	117,334	6,052	63,861	389,483
Moderate	0	5,823	1,351	41,043	48,217
Low	1,393,315	646,608	102,897	210,068	2,352,888
Lakes and Flowages					
Total number (1958)	4,969	2,693	248	920	8,830
Total acreage (1958)	427,530	202,212	10,357	274,937	915,036
Number of importance (1955)	106 (2.1%)	181 (6.7%)	8 (3.2%)	79 (8.6%)	374 (4.2%)
Acreage of importance (1955)	160,147 (3.7%)	122,363 (60.5%)	4,232 (40.9%)	246,299 (89.6%)	533,041 (58.3%)
Streams					
Total mileage (1952)	14,278	8,690	5,493	6,384	34,845
Mileage of importance (1955)	71 (0.5%)	205 (2.4%)	127 (2.3%)	82 (1.3%)	485 (1.4%)
Acreage of importance (1955)	1,750	5,193	34,422	5,477	46,842
Federal Management Areas					
Total number (1958)	0	1	1	1	3
Total acreage (1958)	0	39,608	88,307	20,796	148,711
Acreage of importance (1958)	0	13,449 (34.0%)	43,452 (49.2%)	20,741 (99.7%)	77,642 (52.2%)
State Management Areas					
Total number (1962)	22	17	8	33	80
Total acreage (1962)	74,266	151,493	22,781	69,383	317,923
Acreage of importance (1962)	14,962 (20.1%)	25,796 (17.0%)	4,634 (20.3%)	22,571 (32.5%)	67,963 (21.4%)
Municipal Management Areas					
Known number (1958)	1	1	0	3	5
Total acreage (1958)	200	80	0	7,188	7,468
Acreage of importance (1958)	100	80	0	4,650	4,830 (64.7%)
Private Management Areas[1]					
Known number (1958)	0	0	1	1	2
Total acreage (1958)	0	0	5,600	870	6,470
Important acreage (1958)	0	0	2,040	640	2,680 (41.4%)
All Types					
Important acreage	379,195	290,038	96,183	405,282	1,170,698
Percentage of important total acreage by region	32.4	24.8	8.2	34.6	100.0
Great Lakes					
Total square miles					2,378
Lake Superior					
Lake Michigan and Green Bay					7,500
Area of importance	"Trace" of each lake; sections of Green Bay are the most important.				

* Data used in compiling this table were secured from: the Office of River Basin Studies, Region 3 (Minneapolis), of the U.S. Bureau of Sport Fisheries and Wildlife; R. E. Dreis (pers. comm., 1952); Jahn and Hunt (1955b); Wis. Conserv. Dept. (1958); Panzer (1957); Hawkins (1959). For detailed breakdowns of all habitat types except wetlands, see Appendix C.

** Percentage of total number of acres or of acreage of a particular type of habitat is given in the appropriate vertical column.

[1] In addition to the acreage shown for the private waterfowl management areas, 67,900 acres were established as private muskrat and mink farms in 1957 (Field, 1957). Many of these areas accommodate ducks. Since practically all of the aquatic habitat included in these fur farms is undoubtedly entered in one of the other categories in this table, the acreage is not added under "Private Management Areas."

County. By number, 44 percent of the important lakes and flowages of the Eastern Ridges and Lowlands are found in Dane, Walworth, and Waukesha counties.

In the Northern Highland, 45 percent of 106 important lakes and flowages are in Bayfield, Forest, Oneida, and Sawyer counties. Seventy percent of the important acreage is in Sawyer, Iron, Vilas, Oneida, and Marathon counties.

In the Central Plain, 65 percent of 181 important lakes and flowages are in Burnett and Polk counties. Ninety-one percent of the important acreage is located in Burnett, Polk, Barron, Washburn, Chippewa, and Juneau counties, and approximately 36 percent of this acreage is accounted for by flowages for hydroelectric power on the Wisconsin River in Juneau County.

In the Western Upland, all eight lakes of importance are in St. Croix County.

Many lakes and flowages of most importance to ducks in the Central Plain are too small to accommodate large numbers

TABLE 6

Major Types of Wetlands in Each of the Four Physiographic Provinces of Wisconsin, 1954*

Type of Wetlands	Percentage of Total Acreage				
	Northern Highland	Central Plain	Western Upland	Eastern Ridges and Lowlands	Entire State
Inland fresh areas, seasonally flooded	1.2	4.6	6.6	20.0	4.5
Fresh meadows	15.2	26.0	69.8	40.0	23.2
Shallow fresh marshes	5.0	7.1	2.9	10.2	6.1
Deep fresh marshes	0.8	2.0	0.9	8.1	1.9
Open fresh water	6.9	6.2	1.7	2.0	6.0
Shrub swamps	34.3	29.1	15.0	8.8	29.2
Wooded swamps	25.6	16.4	2.1	9.6	20.3
Bogs	11.0	8.6	1.0	1.3	8.8
Total Estimated Acreages	1,595,551	769,765	110,300	314,972	2,790,588

* Based on data made available through the Office of River Basin Studies, Region 3 (Minneapolis), of the U.S. Bureau of Sport Fisheries and Wildlife. Wetland types were sampled on 64 ¼-mile-wide transects, each totaling 28 lineal miles. Acreage figures were assembled for whole counties grouped as closely as possible within the boundaries of each physiographic province (see Fig. 3 for province boundaries). Acreages are not as accurate as decimals in percentages suggest.

of birds during the waterfowl hunting season when edges are hunted. For example, in Burnett County where some of the better quality lakes of the region are found, only 7 of 83 important lakes are over 640 acres in size (Appendix C, Table 91). Average size of the 76 lakes under 640 acres is 180 acres. Under light hunting pressure, small good quality lakes contribute to large kills. Ducks are vulnerable to shooting as they move over the large amount of edge of huntable habitat.

Streams

In the aggregate, 34,845 miles of streams, excluding the Mississippi River, are present in Wisconsin, with 485 (1.4 percent) miles being classified as having significant value to waterfowl, primarily ducks (Table 5). The Mississippi River is included as a "Federal Management Area."

Streams are used by ducks during all seasons of the year. Even though the total area is small, the open water of streams accommodates the bulk of the Wisconsin wintering waterfowl population. Sections of some streams have food and cover available to accommodate more waterfowl in fall, but lack the relatively undisturbed conditions required to permit prolonged bird use. Many units of suitable habitat are too small to be used consistently or to accommodate large numbers of birds.

Waterfowl Management Areas

Four types of waterfowl management areas are found in Wisconsin: (1) federal, (2) state, (3) municipal, and (4) private. In the first three types combined, there is a total of 474,102 acres, of which 150,435 acres (31.7 percent) are of importance to ducks and coots. An additional 2,680 acres in Private Management Areas are of importance to waterfowl (Table 5). A list of individual management areas of all types is presented in Appendix C. Not shown is the acreage of small, scattered wetlands secured by the Wisconsin Conservation Department through fee title purchase and easement between initiation of the effort in 1958 and 31 December 1963. Easements were obtained on 528 acres in Barron County. Fee title purchases totaled 7,429 acres in 12 counties (Barron, Dane, Dunn, Jackson, Jefferson, Juneau, Lafayette, Marquette, Oconto, Rock, Trempealeau, and Walworth).

These waterfowl management areas and scattered wetlands represent the combined efforts, to date, of federal, state, and local governments to maintain and restore habitat for waterfowl in Wisconsin. There are additional state and local government-controlled wildlife projects, but on these areas ducks and coots rate very low on the list of management objectives.

Development has proceeded on the different types of management areas in varying degrees. Federal Management Areas are developed to a considerable degree. An average of 52.2 percent of the total acreage is of importance to ducks and coots. On Municipal Management Areas an average of 64.7 percent of the total acreage is of importance. On State Management Areas an average of 21.4 percent of total acreage is of importance to ducks and coots. On all types of management areas, additional acreage can be developed and needs development before the full potential usefulness of the projects for waterfowl can be realized. This is especially true on State Management Areas. In many cases, acquisition must be completed before additional development can take place.

Great Lakes

The outlying waters of Lake Superior, Lake Michigan, and Green Bay comprise a total of 9,878 sq. miles. Green Bay and the shoreline bays of the two lakes are the most important portions for many game ducks. Food and cover are limited along most of the open shorelines where wind

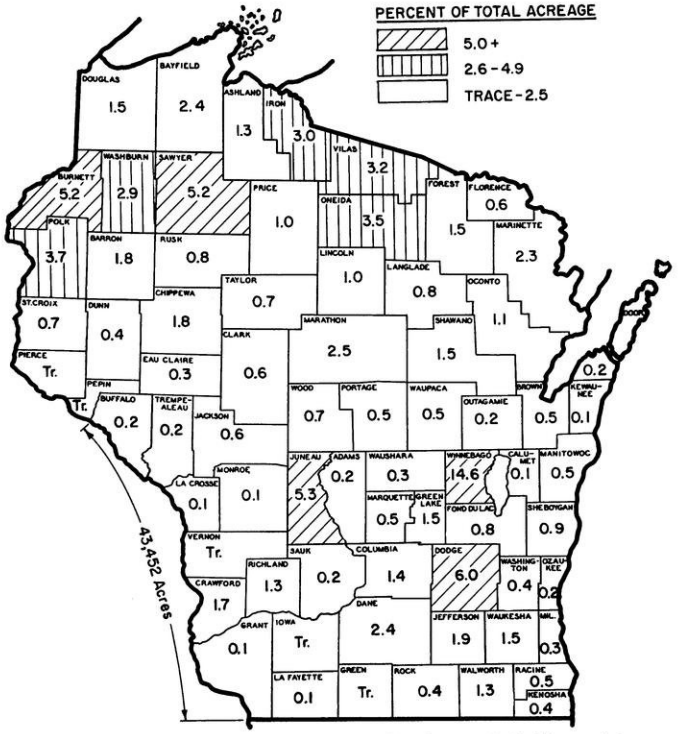


Figure 4. Distribution of acreage of inland aquatic habitat of importance to ducks and coots in Wisconsin. (Based on the sum of important acreages for wetlands, lakes and flowages, streams, and federal, state, municipal, and private management areas, or 1,127,246 acres. Not included in this figure are 43,452 important acres of the Upper Mississippi River Wildlife and Fish Refuge. For names of individual projects, see Appendix C.)

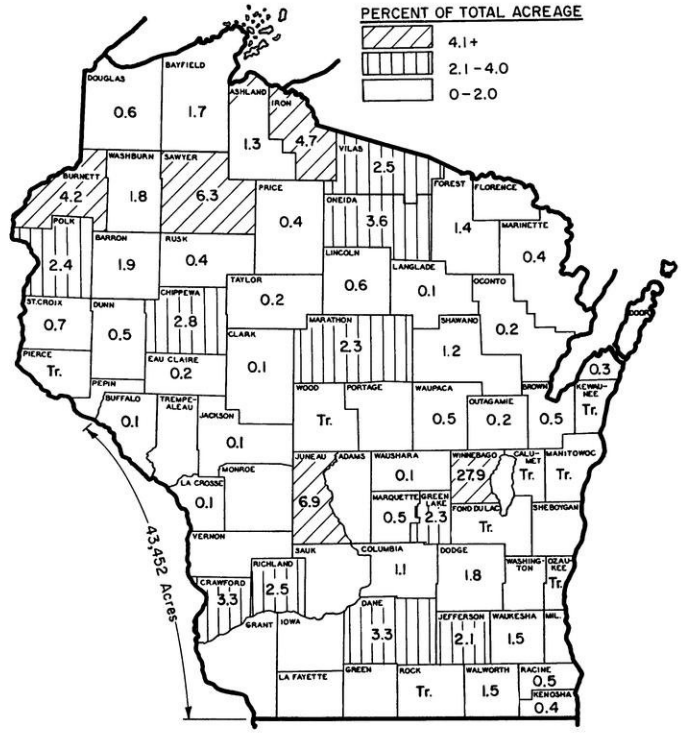


Figure 5. Distribution of acreage of inland lakes, flowages, and streams of importance to ducks and coots in Wisconsin. (Based on a total of 579,883 important acres. Not included in this total are 43,452 important acres of the Upper Mississippi River Wildlife and Fish Refuge. For names of important individual lakes, flowages, and streams, see Appendix C, Table 91).

and wave action eliminate aquatic vegetation. In the Great Lakes, water depth prevents puddle ducks from feeding and thus restricts their use of the lakes to temporary resting. Old squaws and common goldeneyes use the open expanses of water in fall, winter, and early spring. From 1,000 to 1,200 scaup winter on portions of Lake Michigan adjacent to Wisconsin.

Summary

Most of the prime waterfowl habitat in Wisconsin was created by glacial action between 10,000 and 25,000 years ago. More recently, man has developed some excellent waterfowl habitat along the Mississippi River and on private, municipal, state, and federal waterfowl management areas.

Quality of the natural aquatic habitat varies among regions and localities of Wisconsin. The poorest quality habitat is located in the Northern Highland, which is underlain by siliceous rocks, and in the Central Plain, which is underlain by sandstone. Very soft to soft waters are common and yield only small stands of aquatic plants important to ducks and coots. Many drainage lakes in these physiographic regions, however, yield fine crops of duck food plants. Nutrients accumulated by streams from broad watersheds frequently enhance plant production in lakes having dependable inlets.

The best quality aquatic habitat is located in the Eastern Ridges and Lowlands, which are underlain by limestone and support very hard to hard waters. Standing crops of aquatic plants in two southern Wisconsin hard-water lakes were 16 to 2,573 times larger per unit of occupied area than in six northern soft to medium-hard water lakes. Considered solely on the basis of aquatic plants, hard-water lakes can support 17 to 2,250 times the duck use that soft to medium-hard water lakes can. Possibly an annual average of 9 percent of Lake Mendota's available crop of aquatics was consumed by ducks (based on plant surveys of 1912–21 and duck use for 1951–54).

Man has completely removed some and degraded the quality of other aquatic habitat of importance to ducks and coots in Wisconsin. Extensive and intensive land drainage affected approximately one-half of the state's 5 million acres of wetlands, part of which was once important to waterfowl. In many regions, especially southeastern Wisconsin, bays and marshes are being filled to provide building sites for people. Chemical and mechanical control of aquatic plants is expanding and may be affecting waterfowl foods in certain lakes serving as concentration sites during migration.

Indirectly, man has reduced the growth of aquatic plants in many areas in Wisconsin by (1) introducing the carp about 1883, and facilitating its spread to many water areas in the southern two-thirds of the state, (2) permitting soil erosion on a large part of the extensive farmland, and (3) discharging domestic and industrial wastes into natural waters. Destructive feeding habits of the carp and excessive turbidity of water now limit the growth of waterfowl food plants in

some areas, such as Lake Koshkonong (Jefferson County). This former nationally famous duck concentration site was degraded and converted to other primary uses by actions of people over a period of 122 years (1843–1964). High water levels, resulting from construction of a dam, combined with large carp populations to convert the former marsh to an unstable, turbid, open water lake. Now a complex of factors within the lake and within its watershed influence annual yields of aquatic plants. The influence of all factors operating in a watershed and causing complete loss or degradation of food and cover for waterfowl must be recognized in appraising the quantity of Wisconsin's waterfowl habitat.

Wisconsin has an estimated total of 1,170,698 acres of inland aquatic habitat of importance to ducks and coots, and 9,878 sq. miles of Great Lakes' waters of limited value to the birds. The important inland aquatic habitat is made up of the following types and acreages (rounded to the nearest hundred): wetlands, 437,700 acres; lakes and flowages, 533,000 acres; streams, 46,800 acres; and waterfowl management areas, 153,100 acres.

SEASONALLY FLOODED DEPRESSION. Such shallow depressions contain water for a few days or weeks in spring or following heavy rains. Those located in plowed fields or open pastures, where seeds and invertebrates are scarce or lacking, are of very limited value to waterfowl. When food is present, as in flooded grain and corn fields, migrant ducks use the areas, and occasionally other waterfowl too.

Pairs of ducks and lone drakes use attractive flooded areas in early spring. Normally surface water disappears in May. Lack of surface water, except following heavy precipitation, makes the areas of no value to broods or adult ducks in June or July.

Of Wisconsin's 2,790,588 acres of wetlands, 4.5 percent are seasonally flooded areas (1954). In cropfields these types of wetlands are nuisances to landowners. Except where basic nutrients and ground water levels favor excavation, there is little that can be done to enhance the depressions for waterfowl. Many areas are being eliminated through improved drainage and land leveling. (Photo by H. Reeves, U.S. Fish and Wildlife Service.)

FRESH-MEADOW. These shallow basins usually lack surface water but have the ground water level just below the soil surface. Sedges are frequently the dominant vegetation. In southern Wisconsin, many of the areas are grazed. Only when surface water is present following flooding is this type of wetland of value to waterfowl, primarily for feeding by migrants.

Of Wisconsin's 2,790,588 acres of wetlands, 23.2 percent are fresh meadows (1954). Where soil and water nutrients are adequate, these meadows can be improved for waterfowl by removing the vegetation and soil to expose the ground water. Adjacent sedges provide nesting cover. (Photo by D. R. Thompson, Wisconsin Conservation Department.)

SHALLOW FRESH MARSH. These shallow basins contain up to a foot of surface water until midsummer, at which time surface water noramlly becomes lacking. Wet soil or marsh plants, such as smartweeds and burreeds, are usually present, unless the basins are farmed during years of drought.

Migrant waterfowl and breeding pairs of ducks use these areas in early spring for feeding and resting. Unless suitable surface water is available for broods within about a mile of a shallow fresh marsh, the area serves as an attractive trap for breeding pairs. In proper combination with deep marshes they are valuable duck production areas.

Of Wisconsin's 2,790,588 acres of wetlands, 6.1 percent are shallow fresh marshes (1954). A shallow marsh could be improved for breeding ducks by deepening a portion of the basin or by adding a deep marsh nearby to provide surface water for broods until they gain flight in mid and late summer. (Photo by G. E. Mann, U.S. Fish and Wildlife Service.)

DEEP FRESH MARSH. These basins are filled with 1 to 3 feet or more of water during the growing season. Cattails and bulrushes border the areas and frequently clumps occur throughout the marsh. Submerged aquatic plants serving as waterfowl foods are usually abundant. The interspersion of emergent vegetation and open water provides the best breeding habitat for ducks and coots, particularly for broods. Migrant waterfowl frequently utilize the areas for resting and feeding.

Of Wisconsin's 2,790,588 acres of wetlands, 1.9 percent are deep fresh marshes (1954). Preservation of existing deep marshes and development of more of them is essential to help maintain duck and coot populations in Wisconsin in the future. (Photo by G. E. Mann, U.S. Fish and Wildlife Service.)

OPEN FRESH WATER. These areas have open water of variable depth, but usually are under 10 feet and have a border of emergent vegetation unless utilized heavily by livestock. Submerged aquatic plants are frequently abundant in waters having sufficient nutrients. Breeding ducks and coots use the edges of the areas when shore vegetation is not too dense. Migrant waterfowl feed and rest on the areas, unless disturbed excessively.

Of Wisconsin's 2,790,588 acres of wetlands, 6.0 percent are open fresh water. As sediments accumulate, these areas will become shallower and support more emergent vegetation. (Photo by G. E. Mann, U.S. Fish and Wildlife Service.)

SHRUB SWAMP. These are shallow basins with waterlogged soils during the growing season and frequently are covered with as much as 6 inches of water. Alder, willow, and dogwood shrubs are common in Wisconsin. Moist soil plants, such as smartweeds and beggarticks, develop in exposed areas. When flooded, shrub swamps function primarily as escape cover for migrant ducks on extremely windy days and when hunting pressure is high elsewhere.

Of Wisconsin's 2,790,588 acres of wetlands, 29.2 percent are shrub swamps. Where soils and waters have sufficient nutrients, these areas can be improved for waterfowl by removing the vegetation and soil to expose the ground water. Open water will attract waterfowl, but adjacent grassy and herbaceous nesting cover will be scarce. (Photo by D. R. Thompson, Wisconsin Conservation Department.)

WOODED SWAMP. These are shallow depressions and flat floodplain areas having waterlogged soils within a few inches of the surface, at least during the growing season. In river bottoms the areas are often covered by a foot or more of water. Tamarack, black spruce, and white cedar are dominants in northern Wisconsin, while silver maple, black willow, cottonwood, American elm and river birch predominate in southern Wisconsin. Swamps with deciduous trees frequently support beds of duckweeds and smartweeds, valuable duck-food plants. When flooded, wooded swamps furnish escape cover for migrant ducks on extremely windy days and when hunting pressure is high elsewhere. Wood ducks and mallards are commonly found in this type of habitat during migration and the breeding season.

Of Wisconsin's 2,790,588 acres of wetlands, 20.3 percent are wooded swamps. Additional information is needed to manage wooded swamps more intensively for waterfowl. (Photo by W. L. French, U.S. Fish and Wildlife Service.)

BOG. These areas usually have waterlogged soils and are covered with a layer of mosses, leatherleaf, cottongrass, and sedges. Scattered black spruce and tamarack often occur in bogs in northern Wisconsin, where this type of habitat is most prevalent. Waterfowl food plants are limited in the patches of open water by the poor supply of basic nutrients, and dark stained and acid waters. Availability of the sparse foods is in many cases limited by lack of open water or by elimination of shallow water when the bog plants encroach on open water.

Of Wisconsin's 2,790,588 acres of wetlands, 8.8 percent are bogs (1954). Additional information is needed to determine how to make bogs more attractive to waterfowl. (Photo by U.S. Fish and Wildlife Service.)

COMMUNITY OF WATER AREAS. Where seasonally flooded depressions, shallow marshes, deep marshes, and fresh water areas occur as a mixture in close proximity to each other, a community of water areas exists. When the basins contain surface water, such areas are extremely attractive to breeding ducks and coots and contribute substantially to the fall flight.

Communities of water areas are now most prevalent in the agricultural regions of North Dakota, South Dakota, Minnesota, and the prairie provinces of Canada. In cropland areas these wetlands impede tillage with modern machinery and are considered a nuisance. Land-owners are converting the bothersome wet areas to cropland by draining and filling. The ducks and coots are caught in the familiar squeeze where the actions of individuals eliminate public resources or values as they develop land to maximum economic returns.

Preservation of the communities of water areas is a major local, state, national and international problem facing resource managers and conservationists. In addition to purchase and lease, a service payment to land-owners seems necessary to preserve existing key duck breeding areas located in cropland areas.

Because of their unique migratory habits, waterfowl distribute themselves over many areas of North America far beyond the breeding grounds. Recreational activities associated with the birds bring people in close contact with basic resources and stimulate the economy in many localities of North America. Preservation of key water areas is a challenge that must be met if the flight of wildfowl is to be maintained in the future on the level of the 1950's. (Photo by U.S. Fish and Wildlife Service.)

PART II. SEASONAL POPULATION CHARACTERISTICS

The Breeding Population

In the late 1940's, only fragmentary information existed on Wisconsin breeding duck and coot populations. Historical publications containing general comments on breeding waterfowl in certain localities were given in a bibliography prepared by Schorger (1950). Remarks concerning the presence or absence of breeding birds, together with an indication of the relative abundance of some species in terms of being rare or common, were available (Kumlien and Hollister, 1903). Major duck breeding concentrations were indicated by Leopold (1931). Isolated and local breeding records reported by interested amateur and professional ornithologists were presented in *The Passenger Pigeon,* a publication started in 1939 by the Wisconsin Society for Ornithology. Information from these sources and subsequent publications are combined with results from our own studies in this report.

Investigations by the Wisconsin Conservation Department between 1948 and 1958 were aimed primarily at following trends in the breeding waterfowl population. Data collected for this purpose were analyzed to establish fundamental characteristics of this population. Specific objectives included (1) arriving at an index to the density and species composition of the breeding population, (2) determining the status and distribution of individual species, (3) establishing average dates for major events of the breeding season, (4) determining the use of existing habitat by breeders, and (5) identifying, generally, the factors affecting the distribution, density, and reproductive success of Wisconsin populations. Results from these surveys were needed (1) to determine the relationship between productivity and mortality, (2) to determine the relative importance of Wisconsin as a geographic waterfowl production unit in North America, and (3) to formulate general recommendations for managing breeding populations.

◀ Photo by J. M. Thompson, U.S. Fish and Wildlife Service

Methods

Field Survey Techniques

In 1948, when state-wide breeding duck and coot surveys were initiated in Wisconsin, no standardized method for inventorying breeding waterfowl or for conducting brood counts was available. Hence, various survey systems were employed.

Three survey techniques were used in Wisconsin: (1) cross-country road counts, (2) cross-country airplane censuses, and (3) censuses of specific aquatic sites. None of these three census schemes was based on a statistical sampling design. All cross-country road and aerial transects were laid out on state maps without prior knowledge of breeding waterfowl densities. Choice of specific aquatic sites to be censused was left to the local game manager. All breeding pair surveys were conducted during the month of May, but essentially during the last 20 days, largely between 8:00 a.m. and 5:00 p.m. Ducks observed on all types of surveys were identified as to species and classified as lone males, lone females, pairs (male plus female), or flocks of males and females. Total numbers of coot were also recorded.

All Wisconsin cross-country breeding waterfowl surveys between 1948 and 1950 were conducted on a soil-region basis with results expressed for general physiographic regions (Fig. 3). From 1951 through 1956, surveys were organized according to administrative game areas and districts of the Wisconsin Conservation Department. Each of the methods used to census breeding waterfowl is described briefly below.

Cross-country automobile transects were essentially strip censuses in relation to the road. All water areas within a ¼-mile strip (⅛ mile on each side of the road) were censused with the aid of binoculars and, where necessary, by walking to or around the aquatic sites. Approximately 1,600 miles were surveyed once each year using the road-count method (Fig. 6). Roads judged to be passable in both dry and wet springs were designated as census routes.

Cross-country airplane transects, like the road-count transects, were ¼-mile census strips (⅛ mile on either side of the airplane). Section or quarter-section lines nearest to the prescribed course were flown from a given starting point to a given ending point. All flights were conducted at approximately 100- to 200-ft. altitude using high-winged, single-engine planes with side-by-side seating. Approximately 2,000 air miles of transect were covered once each year (Fig. 7). Results are expressed on the basis of birds per square mile.

Results of cross-country road and aerial surveys disclosed that Wisconsin has a relatively small breeding waterfowl population. Consequently, the Wisconsin Conservation Department wanted a survey technique that was cheaper, that would fit into the administrative organization of the Department, and that would still yield annual trends of breeding ducks and coots. We considered the best approach to be censusing breeding waterfowl on specific aquatic sites within each game district. Between 1951 and 1956 an average of approximately 300 aquatic sites well distributed throughout

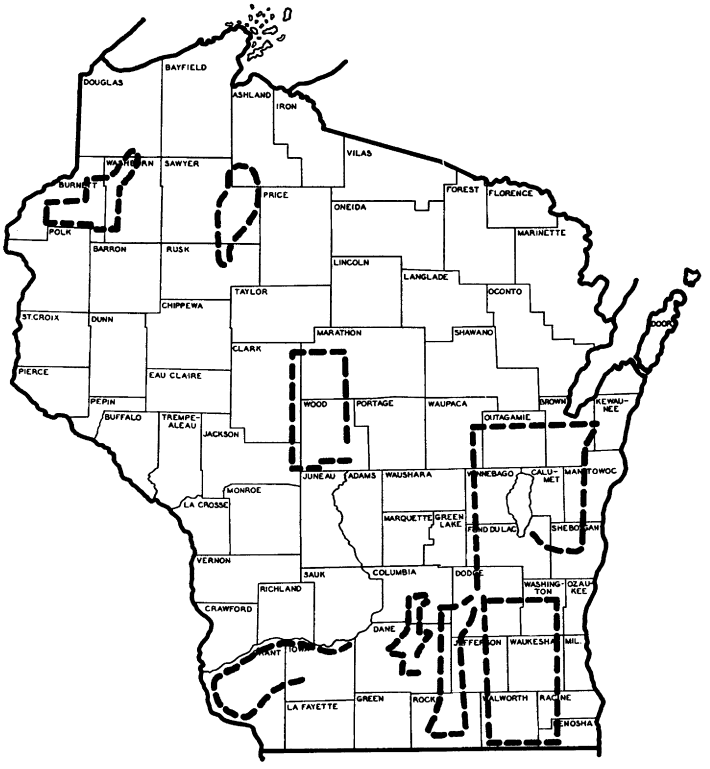


Figure 6. Location of approximately 1,600 miles of waterfowl census routes on which road counts were made in 1948 and 1949.

the state were censused each spring for breeding ducks and coots and each summer for broods (Fig. 8). Brood counts were made in late June and early July, usually between 4 a.m. and 8 a.m. Broods were classified according to species, number of ducklings, and age.

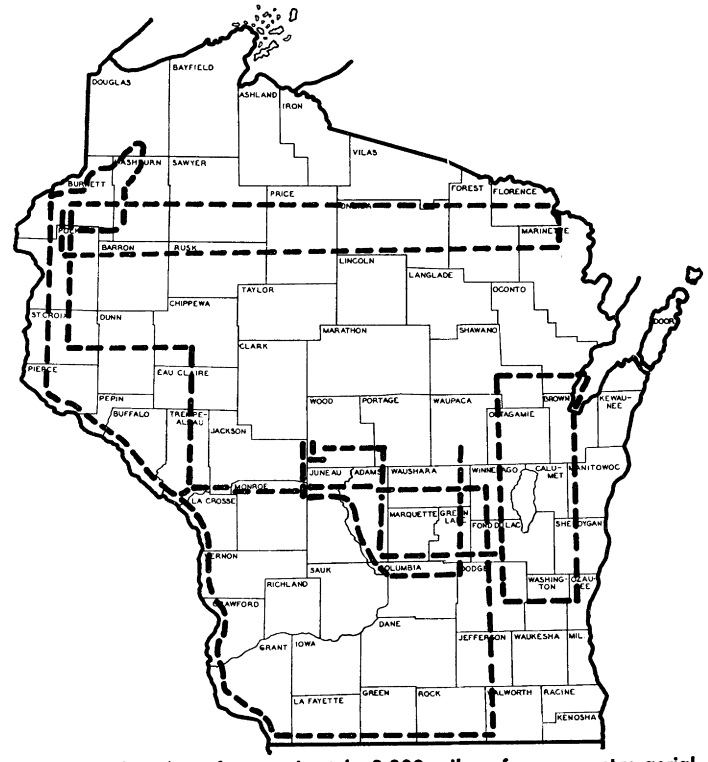


Figure 7. Location of approximately 2,000 miles of cross-country aerial waterfowl census routes flown only in 1949 and 1950.

Limitations and Corrections of Data

Results from censuses conducted on cross-country road transects (1948–50) are considered unreliable for estimating the density of the breeding population. A number of transects, because of natural topography, followed ridges and did not sample the wetland habitat properly. However, ground transects provided the best information on species composition of the breeding population and on broods.

The aerial censuses of 1949 and 1950 provide the best set of data for estimating the density of breeding ducks and coots in Wisconsin. While the transects employed were not established on a random sampling basis, they did, in our opinion, sample sufficient area within the major physiographic

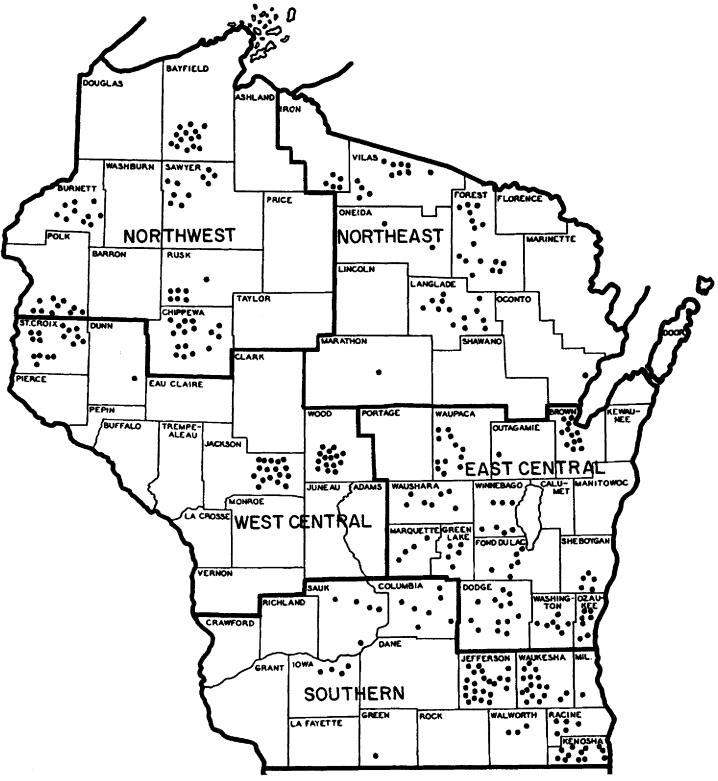


Figure 8. Distribution of specific waterfowl census sites within the administrative area organization of the Wisconsin Conservation Department, Game Management Division. (Each dot represents one water census site; an average of 300 water areas were censused annually from 1951 through 1956.)

regions (Fig. 3) to indicate the over-all density of the breeding population.

Observed numbers of ducks and coots cannot be accepted at face value. They represent only a portion of the actual numbers present. Observed numbers of birds are minimal for two reasons: (1) not all ducks and coots present were seen, and (2) timing of the surveys permitted a small percentage of early nesting mallards to progress in the reproductive cycle to the point that some pairs were not represented on the transects. Hens were incubating and drakes had deserted their home ranges for molting areas. Timing of the surveys was believed proper for the black duck which has a nesting peak in late April (Stotts and Davis, 1960) and May (Wright, 1954:36) and for late nesting species, such as the blue-winged teal and the ring-necked duck. Hatching curves, presented later, confirmed this opinion. We feel wood ducks were sampled inadequately by the procedures employed. However, by establishing a range on the density of breeding ducks, we believe the general magnitude of the over-all duck population is portrayed.

Observed numbers of ducks and coots were corrected for visibility and timing biases. Adjustments for ducks and coots not seen on aerial surveys were made on the basis of information supplied by the U. S. Bureau of Sport Fisheries and Wildlife (A. D. Geis, U. S. Bur. Sport Fisheries and Wildl. in litt., 2 March 1962). Bureau investigations show that approximately 25 percent of the blue-winged teal and 66 percent of the mallards in aspen-parkland habitat are observed from an airplane. We also arbitrarily applied the 66 percent to all other species of ducks and the coot.

The correction for mallards missed on censuses due to lateness of the surveys was based on the percent of the hatch occurring prior to the time the surveys were conducted in May. For example, in 1957 and 1958, 12 percent of the mallard hatch at Crex Meadows occurred prior to the time surveys were conducted. Less than 10 broods of mallards were reported each year in May in Wisconsin. To account for the missed pairs responsible for early broods, observed numbers of mallards were arbitrarily adjusted upward 10 percent. While this value may be larger or smaller in a particular year, due to variations in phenology and initial nesting success, we believe it is a reasonable mean estimate.

Timing of the single pair survey and the one or two brood surveys was established initially on the basis of general observations on the duck reproductive cycle in Wisconsin. Evidence collected after the Wisconsin Conservation Department surveys were established substantiated the choice of dates. At Horicon Marsh, in 1954 and 1955, from 65 to 80 percent of the mallard and blue-winged teal hatch occurred before July 5 and all except 2 to 5 percent took place prior to July 15 (Labisky, 1957).

From 1953 to 1956 only one brood survey was conducted after the May pair census and the cut-off date for field work was July 3. To account for numbers of broods of certain species hatching after the survey cut-off date, numbers of observed broods were adjusted upward proportionately on the basis of information from hatching curves (presented later). Specific adjustments varied with the species and years involved.

1. Blue-winged teal: In 1951 and 1952, an estimated 80 percent of the broods hatched prior to the terminal date of July 10. In all other years an estimated average of 65 percent of the broods hatched before the terminal survey date of July 3.
2. Mallard: In 1951 and 1952, an estimated 90 percent of the broods hatched prior to the terminal date of July 10. In all other years an estimated average of 80 percent of the broods hatched before the terminal survey date of July 3.

TABLE 7

Index to Wisconsin Breeding Duck and Coot Populations, 1949–50

(Based on ducks and coots observed on aerial transects)

Region of Transects*	Total Square Miles	Square Miles Sampled			Observed Ducks Per Square Mile Sampled**			Observed Coots Per Square Mile Sampled		
		1949	1950	Avg.	1949	1950	Avg.	1949	1950	Avg.
Northern Highland	16,267	129.1	139.1	134.1	1.4	0.8	1.1	0.0	0.0	Tr.
Central Plain	13,016	143.4	146.9	145.1	1.6	1.0	1.3	0.7	0.2	0.4
Western Upland	13,266	34.8	34.8	34.8	0.1	0.1	0.1	0.0	0.0	Tr.
Eastern Ridges and Lowlands	13,517	106.4	108.2	107.3	1.4	1.7	1.6	Tr.	1.3	0.6
Entire State	56,066	413.7	429.0	421.3	1.4	1.1	1.2	0.2	0.4	0.3

* See Figure 3 for boundaries of the four physiographic regions of Wisconsin.

** All scaup, canvasback, and bufflehead were excluded from calculations in this table, since these species rarely breed in Wisconsin. Late lingering groups of migrants, especially of scaup, were present in May when breeding surveys were conducted.

3. Ring-necked duck: In all years an estimated 65 percent of the broods hatched before the terminal date of July surveys.
4. Black duck and wood duck: In the absence of hatching curves for these species in Wisconsin, observed numbers of broods were used. A hatching curve (1953–58) for the black duck in the Kent Island area of Maryland showed approximately 8 percent of the hatch occurring after July 5 (Stotts and Davis, 1960). Both the black duck and wood duck are early nesters. Hence, we believe relatively few broods hatched in Wisconsin after terminal survey dates in July. The fact that a few probably did hatch following July surveys makes the total number of broods used in this report a known minimum.

In using data from the Wisconsin breeding ground surveys, we assumed that movements of pairs and broods onto and off from the particular census sites were equal. The scattered nature of small units of attractive duck-breeding habitat in Wisconsin, in our opinion, favors the types of analyses used here to define characteristics of Wisconsin's breeding duck populations.

Breeding Population Index

Breeding ducks occur in all parts of Wisconsin. Highest densities are found in the Eastern Ridges and Lowlands and Central Plain regions (Table 7 and 8). Ducks are least abundant in the Western Uplands, where rough topography yields a minimum of wetlands. Statewide, breeding ducks averaged 2.6 per sq. mile (1949–50). With wood ducks suspected of being under-represented in the samples used for computations, this density is considered a minimum.

The coot also breeds in all regions of Wisconsin (Table 8). It is most abundant in the Eastern Ridges and Lowlands where preferred emergent aquatic nesting cover commonly occurs. Rare occurence of the coot in the forested Northern Highlands is probably due to the sparse densities and minimal quantities of species of emergent aquatic plants that furnish nesting cover. Densities of breeding coots averaged 0.5 per sq. mile in 1949–50.

Status and Distribution of Species

Fifteen species of ducks breed in Wisconsin (Table 9). Two species, the blue-winged teal and mallard, average 76 percent of all breeders. Of the diving ducks, the ringneck is the most important. An average of 84 percent of the breeding population is represented by the blue-winged teal, mallard, and ringneck.

General distribution of breeding records of major duck species and the coot is indicated by the use of small maps (Figs. 9–15). Records for minor duck species are described below in the text, together with miscellaneous nesting records. Presence of a species as a breeding bird is based on (1) nesting records, or (2) one or more flightless broods observed within a county between 1947 and 1963. Brood records were assembled from our surveys, from unpublished field records of the Wisconsin Conservation Department, from the Sandhill Wildlife Area, and from each of the three federal waterfowl refuges located in Wisconsin.

Blue-Winged Teal

This teal is the most important waterfowl breeder in Wisconsin (Table 9) and is distributed statewide (Fig. 9). Nests are located in a variety of habitat types. Nests with eggs were found primarily on uplands and in meadows, with a few reported on muskrat houses. No records are known of nests occurring in trees or in odd places in cities, although small ponds in residential areas will support breeding teal if human disturbance is not excessive. The tolerance that at least some members of this species have for human disturbance is illustrated by the following example. A ¼-acre pond located in the city of Horicon, Wisconsin, served as the breeding site

for a pair of blue-winged teal (not necessarily the same pair) for five consecutive years. In at least 3 years, a brood hatched and walked to water about 220 yds. away. People mowed their lawns, had picnics, and children played games on the lawns adjacent to the pond. Not until children consistently invaded the pond to search for turtles and frogs did the pond become duckless.

The present breeding range of blue-winged teal is apparently similar to the area formerly occupied by this species, but the density of breeders is greatly reduced. Formerly, this species was an abundant breeding duck in southern Wisconsin (Kumlien, Hollister, and Schorger, 1951:14).

Abundance of breeding bluewings fluctuates widely between years, depending largely upon the amount of surface water available in wetlands that are normally dry. In a year of above-average precipitation, such as 1960, spring and summer water conditions provide breeding habitat which can attract larger than normal breeding populations and also insure survival of broods. Mallards, as well as blue-winged teal, reacted to the favorable habitat conditions in 1960. Whether or not this was a normal reaction to the Wisconsin habitat, or, in part, a consequence of ducks leaving the 1960 drought-stricken western-prairie breeding areas is unknown.

TABLE 8

Index to Wisconsin Breeding Duck and Coot Populations, 1959–50. (Based on numbers of ducks and coots observed on aerial transects and corrected for timing and visibility biases*)

Region of Transects	Ducks Calculated Per Square Mile Sampled			Coots Calculated Per Square Mile Sampled		
	1949	1950	Avg.	1949	1950	Avg.
Northern Highland	2.5	1.5	2.0	0.0	0.0	Tr.
Central Plain	3.0	2.6	2.8	1.1	0.3	0.7
Western Upland	0.9	0.9	0.9	0.0	0.0	Tr.
Eastern Ridges and Lowlands	3.5	4.3	3.9	Tr.	1.9	1.0
Entire State	2.7	2.5	2.6	0.4	0.6	0.5

* (a) All scaup, canvasback, and bufflehead were excluded from calculations in this table, since these species rarely breed in Wisconsin.

(b) Proportionate upward adjustments were made for ducks and coots not seen on aerial surveys: an estimated 25 percent of the blue-winged teal were observed and 66 percent of all other species. In spite of these corrections, the wood duck is believed to be underrepresented. Therefore, density figures given here are minimal.

(c) Mallard numbers were increased 10 percent to adjust for early nesters missed on the survey in May.

TABLE 9

Species Composition of Wisconsin Breeding Duck Population, 1948–56*

Species	Percent Per Year									Total	
	1948	1949	1950	1951	1952	1953	1954	1955	1956	No. Sampled	Percent
Puddlers											
Blue-winged teal	60	42	51	50	35	48	47	46	47	3,872	46.2
Mallard	20	33	24	31	36	30	29	33	22	2,479	29.6
Wood duck	5	3	2	2	9	3	4	3	3	339	4.0
Black duck	3	3	1	4	5	4	4	4	4	318	3.8
Am. Widgeon	1	6	2	1	Tr.	2	1	Tr.	8	181	2.2
Pintail	3	3	3	1	Tr.	Tr.	1	1	1	98	1.2
Shoveler	1	2	1	1	Tr.	1	Tr.	1	2	78	.9
Gadwall	0	Tr.	1	1	1	1	0	Tr.	1	48	.5
Green-winged teal	1	0	0	1	0	0	Tr.	Tr.	Tr.	24	.3
Total puddlers	95	92	85	92	87	89	86	89	88	7,437	88.7
Divers											
Ring-necked duck	3	7	7	6	12	7	12	10	7	712	8.5
Redhead	Tr.	Tr.	5	1	Tr.	2	1	Tr.	5	135	1.6
Ruddy Duck	0	0	1	Tr.	0	Tr.	Tr.	0	Tr.	24	.3
Total divers	4	7	13	7	12	9	13	10	12	871	10.4
Mergansers											
Hooded	Tr.	Tr.	Tr.	Tr.	Tr.	1	1	1	Tr.	61	.7
Common	0	0	1	Tr.	0	Tr.	0	0	0	16	.2
Red-breasted	0	0	0	0	Tr.	0	0	0	0	2	Tr.
Total mergansers	Tr.	Tr.	2	1	1	2	1	1	Tr.	79	.9
Total Number of Ducks Sampled	425	582	471	966	1,137	1,231	1,433	1,113	1,029	8,387	——

* (a) Based on road-count censuses (1948–50) and censuses of specific sites (1951–56).

(b) Numbers of ducks are based on pairs, lone males multiplied by 2, and flocked males and females observed on surveys in May. All scaup and the few canvasback, bufflehead, and common goldeneye were omitted; these species rarely breed in Wisconsin.

(c) Mallard numbers were increased 10 percent each year to adjust for early nesters missed on the May surveys.

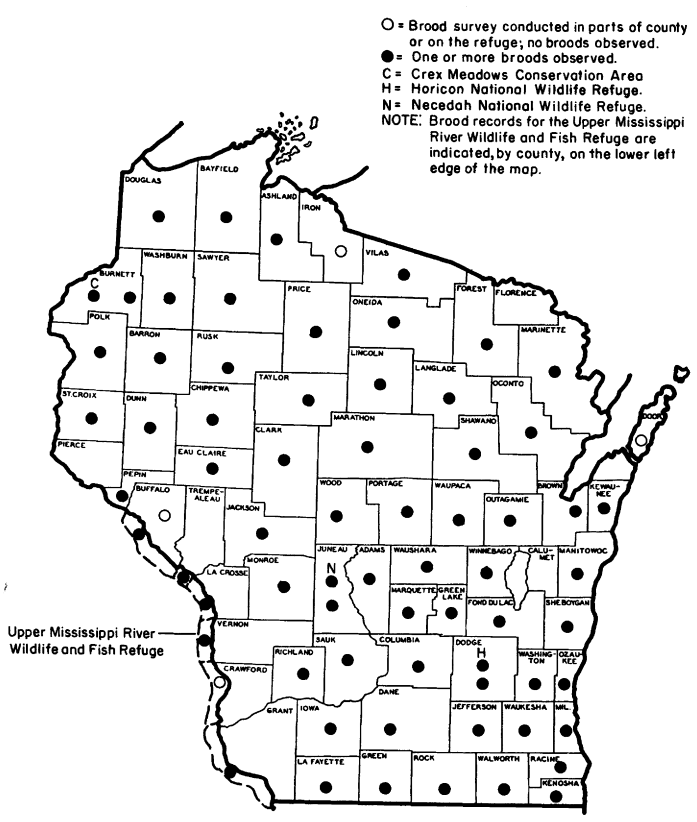


Figure 9. General distribution of the blue-winged teal breeding in Wisconsin, 1947–63.

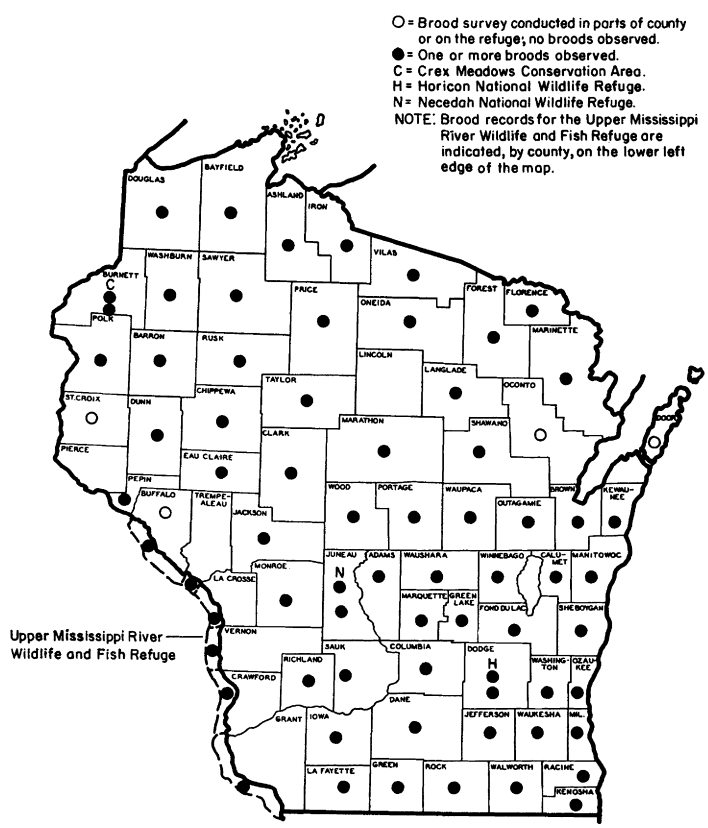


Figure 10. General distribution of the mallard breeding in Wisconsin, 1947–63.

Mallard

The mallard is the second most abundant breeding duck in Wisconsin (Table 9) and is found throughout the state (Fig. 10), as it was formerly (Kumlien, Hollister, and Schorger, 1951:12). No other species is more adaptable in its selection of a nesting site. Project personnel and game managers reported finding nests with eggs on floating mats of leatherleaf; in jack pine needles on uplands up to ¼-mile from water; in wild hay meadows and in various types of hay and crop fields; in grassy and herbaceous vegetation interspersed with brush but located near water (within 100 yds. and probably up to 220 yds.); on muskrat houses; on dock pilings; in crotches of trees 12 feet above ground; and in cities on cement walls adjacent to streams. We suspect birds of both wild and semi-domestic strains are involved in this wide range of nesting sites.

In one locality in Manitoba, 48 out of 86 mallard nests located were over water in emergent aquatic vegetation (Evans and Black, 1956:39). Although various nesting sites are utilized by the mallard, concentrations of wild breeders are known to occur in Wisconsin only where grassy and/or herbaceous upland nesting cover is abundant adjacent to suitable water sites. Like the blue-winged teal, the mallard will sometimes breed in close association with human beings, tolerating many disturbances resulting from the activities of people. Semi-domestic strains apparently tolerate much more disturbance than wild birds (Hunt *et al.*, 1958).

Wood Duck

Throughout the state this species can be found breeding (Fig. 11), primarily along streams that have timbered areas including some trees containing nesting cavities. The present Wisconsin breeding range has changed very little (Kumlien, Hollister, and Schorger, 1951:15). Density of breeders on streams initially believed to contain breeding wood ducks is indicated by figures secured in 1958 on censuses conducted primarily in west central Wisconsin (Fig. 8) by canoe or boat on 270 miles of stream. An average of 1 pair, or 2 adults, per 5 lineal miles of stream was observed. Densities were highest on the Red Cedar River in Dunn County, where an average of 12 adult wood ducks per 5 lineal miles was recorded. Many of the streams used by wood ducks are heavily fished. Some birds breed within cities. Each year a group of wood ducks nests in the community of Bath, Illinois (F. C. Bellrose, pers. comm., 1959). Human disturbance is apparently readily tolerated by this species.

Black Duck

Although distributed in certain localities throughout the state (Fig. 12) during the breeding season, the black duck is most frequently encountered in the northeastern forested section of the state, especially along streams. Historically, this bird nested throughout the interior of the state (Kumlien, Holliser, and Schorger, 1951:12). Present distribution of this species and limited observations of the reaction of breeding pairs to humans suggests that disturbance by people keeps

some suitable habitat from being occupied by breeders in Wisconsin, and also in the eastern United States (Addy and MacNamara, 1951:15).

Ring-necked Duck

The ringneck is the most important diving duck breeding in Wisconsin. Broods were recorded only in certain localities in northern Wisconsin (Fig. 13). About 1860–70, ringnecks nested in numbers throughout the state, and about 1900, a few still nested regularly as far south as Rock County (Kumlien, Hollister, and Schorger, 1951:17). Bogs and isolated beaver impoundments are now the principal breeding sites in Wisconsin, as well as in the northeastern United States (Mendall, 1958:10). Our own observations on the distribution and behavior of the ringneck and those of Mendall (1958:206) lead us to believe that human activity at the critical period of nest-site selection will cause this bird to desert otherwise suitable breeding habitat.

Hooded Merganser

Northern forested Wisconsin is the principal breeding range of this species (Fig. 14). In addition, a scattering of breeders occurs along the Mississippi River and in the Kettle Moraine State Forest in southern Wisconsin. Formerly it bred sparingly throughout the state in suitable localities (Kumlien, Hollister, and Schorger, 1951:12). The shy, retiring behavior of this species during the breeding season and its rather restricted breeding range suggest that human disturbance is a factor keeping the hooded merganser from nesting in all suitable range throughout Wisconsin.

Coot

The coot is most common as a breeder in the Eastern Ridge and Lowland region (Fig. 15). Apparently very few sites in northern Wisconsin provide suitable breeding habitat for this bird. Areas of sedges of acceptable growth form and density are used for nesting in central Wisconsin. Stands of cattail and bulrush, the preferred nesting cover of coots, are minimal and too sparse for nesting in much of northern and central Wisconsin. Distribution of brood records as well as the docile behavior of coots clearly indicate that this species will tolerate a great amount of disturbance by people during the breeding season.

American Widgeon

At present the American widgeon is a rare breeder in Wisconsin. Records of broods were reported for 4 counties: Brown (Peaks Lake), Crawford (Mississippi River), Dodge (Horicon National Wildlife Refuge), and Wood (Wood County Public Hunting Ground). Formerly this species bred sparingly as far south as Rock County (Lake Koshkonong), but by about 1900 it was found in the less settled portions of the state only (Kumlien, Hollister, and Schorger, 1951:13).

Pintail

The pintail breeds infrequently in Wisconsin. Single or a small number of broods were observed in Burnett (Crex

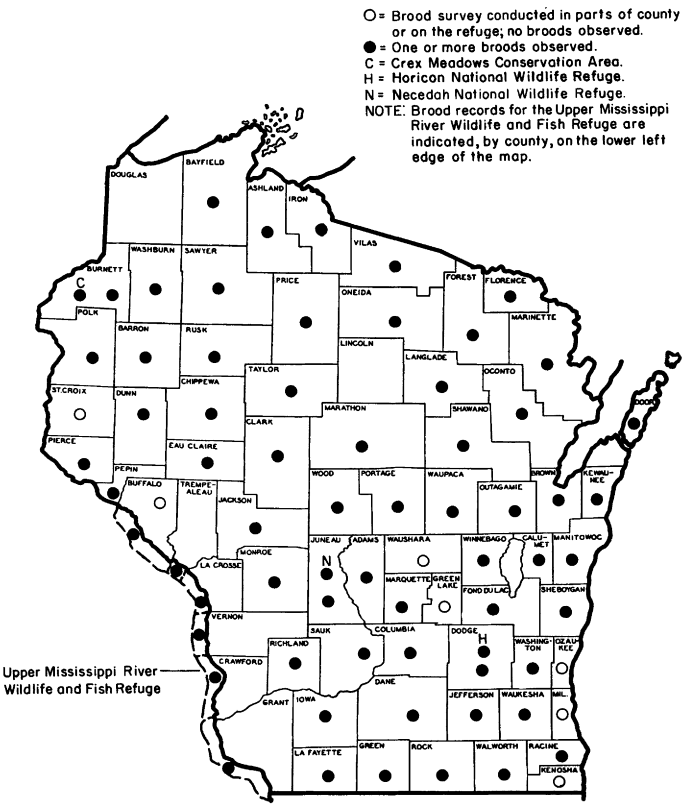


Figure 11. General distribution of the wood duck breeding in Wisconsin, 1947–63.

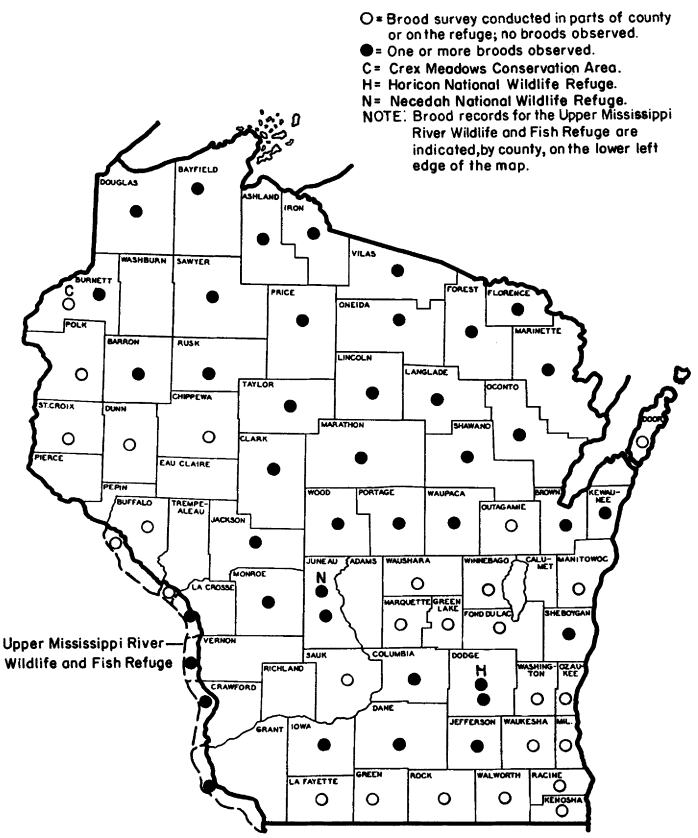


Figure 12. General distribution of the black duck breeding in Wisconsin, 1947–63.

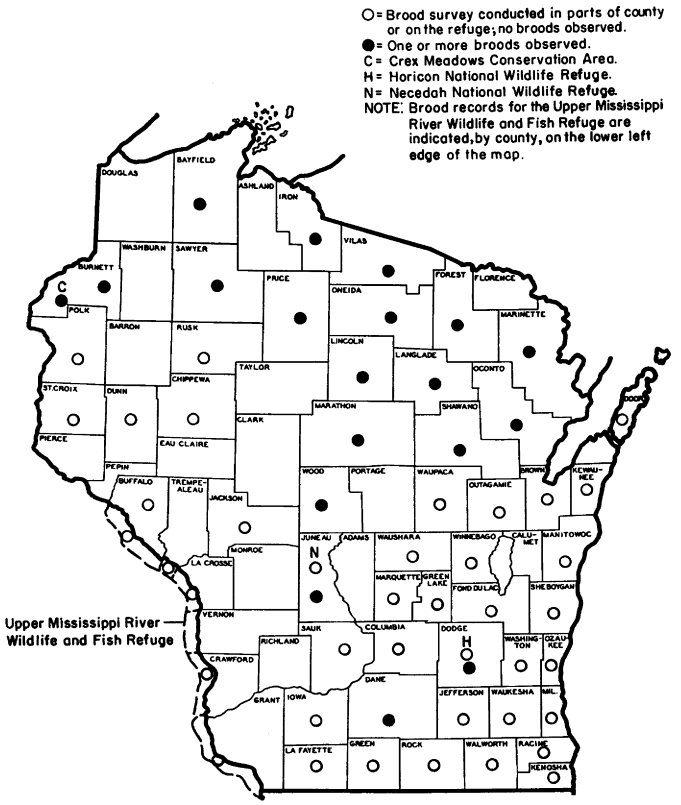


Figure 13. General distribution of the ring-necked duck breeding in Wisconsin, 1947–63.

Meadows Conservation Area), Columbia (Goose Lake), Crawford (Mississippi River), Dodge (Horicon National Wildlife Refuge), Jackson (Partridge Crop Lake), Juneau, La Crosse (Mississippi River), Marathon (Mead Wildlife Area), Marquette, Monroe, St. Croix, and Winnebago Counties. Even in 1900 only a few pintails nested in the state (Kumlien, Hollister, and Schorger, 1951:15).

Shoveler

A few broods of shovelers were reported for Dodge (Horicon National Wildlife Refuge), Columbia (Goose Lake), Dane (Goose Lake), Dunn (Buss and Mattison, 1955: 46) and Marathon (Mead Wildlife Area) Counties, the only known records in recent years. About 1900, a considerable number still nested in the state, even to the most southern counties (Kumlien, Hollister, and Schorger, 1951:14).

Gadwall

Only a few broods of gadwall have been observed in Wisconsin, all in Dodge (Horicon National Wildlife Refuge), Dunn, and Brown (Green Bay) Counties. High nesting densities, approaching semicolonial conditions, were reported on the islands in Green Bay in the 1930's by residents of Brown County. Censuses in the late 1940's revealed no breeding densities of this magnitude. Several broods were seen near the islands in the southern part of Green Bay. Historically the gadwall nested sparingly in Dodge (Horicon Marsh) and Rock (Lake Koshkonong) Counties and in the extreme

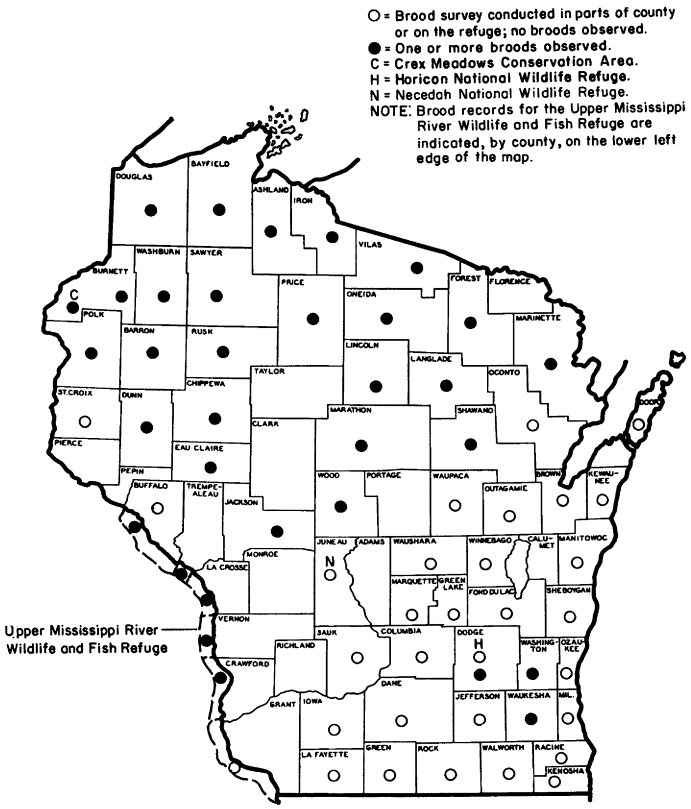


Figure 14. General distribution of the hooded merganser breeding in Wisconsin, 1947–63.

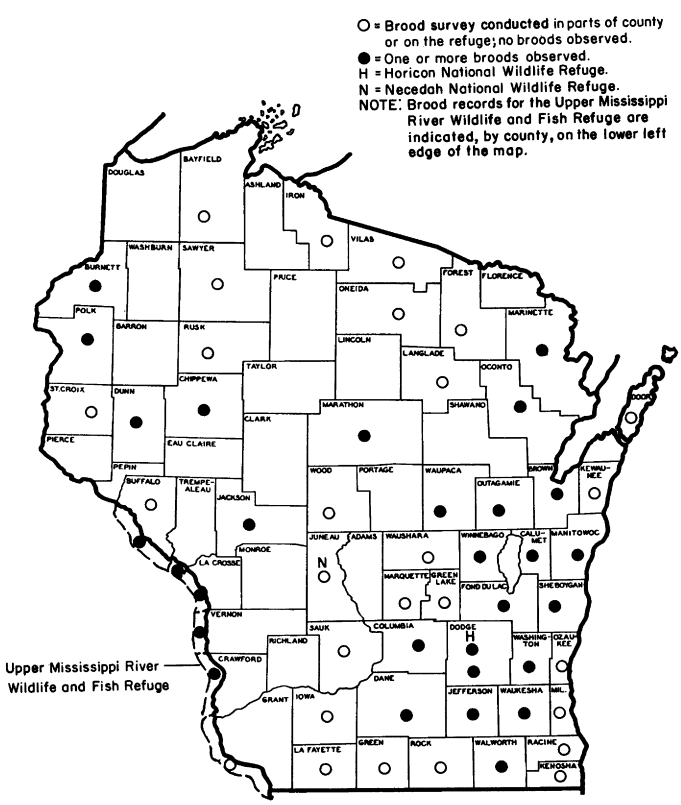


Figure 15. General distribution of the coot breeding in Wisconsin, 1947–63.

northern parts of the state (Kumlien, Hollister, and Schorger, 1951:13).

Green-winged Teal

Green-winged teal nest infrequently in Wisconsin. One or two broods per year were observed in Barron, Burnett (Crex Meadows Conservation Area), Columbia, Dodge (Horicon National Wildlife Refuge), Juneau (Necedah National Wildlife Refuge), Marathon (Mead Wildlife Area) and Wood (Sandhill Wildlife Area) Counties. Historically this species bred sparingly in southern Wisconsin and was plentiful in northern Wisconsin (Kumlien, Hollister, and Schorger, 1951:14).

Redhead

This duck is now known to breed in small numbers only in Dodge County (Horicon National Wildlife Refuge). An isolated brood occurred in Rock County in the vicinity of Lake Koshkonong in 1950. Prior to 1900, the redhead bred in Brown, Rock (Lake Koshkonong), and Waukesha (Pewaukee Lake) Counties (Kumlien, Hollister, and Schorger, 1951:16).

Canvasback

The canvasback is a rare breeder in Wisconsin. Two broods, both in Winnebago County (Rush Lake), were observed in 1952 and 1953. Historically a few birds raised ducklings in Rock County (Lake Koshkonong), but the females were believed to represent wounded birds that were unable to continue northward (Kumlien, Hollister, and Schorger, 1951:16).

Lesser Scaup

Lesser scaup rarely breed in Wisconsin. Only one brood was observed in Ozaukee County (in 1952 near Long Lake) and several broods in Dodge County (Horicon National Wildlife Refuge). Formerly, to a limited extent, this species nested anywhere from the southern counties northward (Kumlien, Hollister, and Schorger, 1951:17).

Ruddy Duck

In recent years, this species has been known to breed only in small numbers in Dane (Dushack's Marsh), Dodge and Fond du Lac (Horicon National Wildlife Refuge), Waupaca, and Winnebago Counties. Formerly a few bred in local sites (Lakes Koshkonong, Pewaukee and Horicon), principally in southern Wisconsin (Kumlien, Hollister, and Schorger, 1951:20).

Common Goldeneye

No goldeneye broods were reported in Wisconsin from 1947 through 1963. Historically there were several breeding records for northern Wisconsin (Kumlien, Hollister, and Schorger, 1951:18).

Bufflehead

No bufflehead breeding records are known for Wisconsin during 1947–63. The only historical record was for Waukesha County (Pewaukee Lake) in southern Wisconsin (Kumlien, Hollister, and Schorger, 1951:18).

Common Merganser

This bird is a rare nester in Wisconsin. Since 1947, broods were reported in only 4 counties: Door (Lake Michigan), Iron (Lake Six), Price (Riley Lake), and Vilas (Mann Lake). Historical breeding records were registered for Door and Vilas Counties (Kumlien, Hollister, and Schorger, 1951: 12).

Red-breasted Merganser

The red-breasted merganser is presently classified as an uncommon breeder in Wisconsin. Broods were reported between 1947 and 1963 for Dunn (Red Cedar River—Buss and Mattison, 1955:66), Florence (Pine River), Lincoln, Marathon (Wisconsin River) and Vilas (Big Arbor Vitae Lake) Counties. Beals (1958) saw broods at the Apostle Islands. Formerly this merganser was a regular breeder about Green Bay and Lake Superior (Kumlien, Hollister, and Schorger, 1950:12).

Chronology of Nesting, Hatching and First Flight

Duck and coot brood records were collected on a regular basis at Horicon Marsh (Dodge County) by R. L. Labisky and at Crex Meadows (Burnett County) by N. R. Stone. These records provided data for determining the dates of first eggs in successful nests, hatching dates, and dates when ducklings attained flight (Figs. 16–19). Duck brood records were handled according to the system of Gollop and Marshall (1954). Average incubation periods and clutch sizes used in computing duck nesting dates are from Kortright (1943). All required values for the coot are from Gullion (1954).

Information on the chronology of hatching was used to adjust observed numbers of broods to estimated totals. Nest initiation dates serve as guideposts for game managers to avoid nest destruction by properly timing habitat manipulation work, such as flooding, burning, plowing and mowing. Knowing dates when young ducks and coot gain flight is valuable for selecting opening dates of the hunting season.

First eggs of mallards were deposited in successful nests as early as March 27–April 2 and as late as July 3–9 (Fig. 16). Nesting started three weeks earlier at Crex Meadows (1957–58) in the northwest than at Horicon Marsh (1954–56) in the southeast. This difference in nest initiation could reflect phenological variations between periods of years or the greater abundance of small, shallow ponds at Crex Meadows. These types of ponds many times become ice-free earlier than larger and deeper marshes, such as Horicon Marsh.

Hatching of mallards extended from May 1–7 to August 7–13, with an average of 80 percent of all broods appearing before July 3. Approximately 95 percent of the young were flying by mid-September, with the other 5 percent attaining flight by October 1. Flightless broods of mallards occurred in

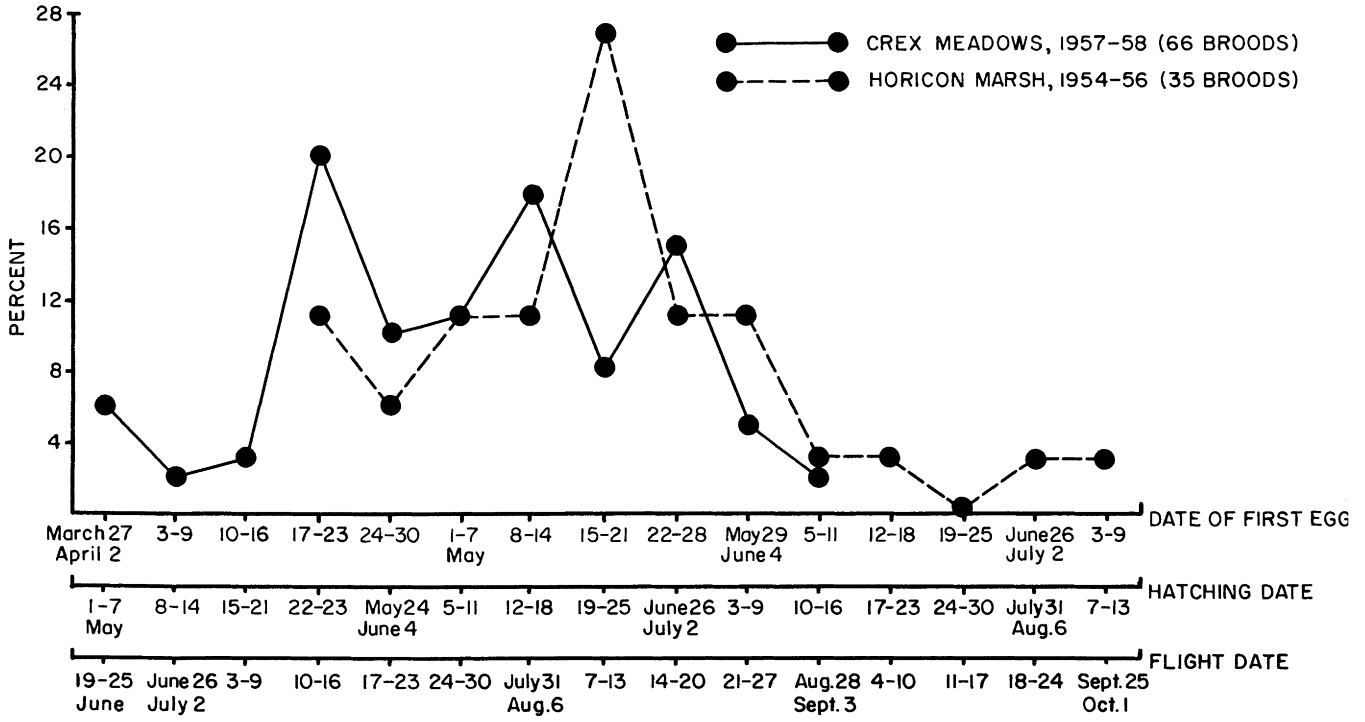


Figure 16. Average dates successful nests started, broods hatched, and flight attained by the mallard in Wisconsin. Broods observed largely by N. R. Stone at Crex Meadows and R. L. Labisky at Horicon Marsh. (Read any one of the three horizontal axes with the curves for any one graph.)

Wisconsin from May 1 to October 1. This long brood season reflects the early nesting and persistent renesting habits of this species.

Timing of reproductive and developmental events for the late-nesting blue-winged teal (Fig. 17) and ringneck (Fig. 18) falls within the broad range of dates established for the early-nesting mallard (Fig. 16). The blue-winged teal's pattern of nest initiation throughout the breeding season was similar between Crex Meadows and Horicon Marsh. Approximately 35 percent of the bluewing broods hatched after July 3. Flightless broods were present from May 29–June 4 through September 11–17.

Average breeding chronology for the ring-necked duck is similar between Maine (Mendall, 1958:78 and 127) and Wisconsin (Fig. 18). Nesting at Crex Meadows, Wisconsin started April 24–30, peaked May 22–28, and terminated June 25 (1957–58). Nesting in Maine started May 1–5, peaked May 23 (1943–55), and ended July 10 (Mendall, 1958: 78–79). Approximately 35 percent of the hatch occurred in Wisconsin after July 3–9 (1957–58). All ducklings were capable of flight by September 17.

A few coots initiated nesting one week earlier than blue-winged teal and the ring-necked duck (Fig. 19). Egg laying peaked May 15–28 and extended to July 2. Approximately 65 percent of the hatch occurred before July 3, with the last broods hatching July 31–August 6. With this extended hatching and the long period (75 days—Gullion, 1954:394) chicks require to develop, flightless broods were present from May 22 to October 15. About 5 percent of the coot broods were still flightless October 1–15.

Reproductive Success

Average reproductive success of ducks breeding in Wisconsin (1951–56) is judged by comparing, with other areas in North America, (1) the percentage of hens producing broods, and (2) the average size of broods at flight age. Corrected figures of pairs and broods per 100 acres of wetland censused are used to compute the percentage of hens successfully producing a brood. These estimates of reproductive efficiency for 5 species of ducks should be recognized as average values for the *better quality wetlands* in Wisconsin. This is an important point to recognize. We suspect, and discuss the possibility later, that pairs on poorer quality habitat, or on good quality wetlands attractive to pairs but lacking water to insure brood survival, may be less efficient in producing ducklings. Therefore, using reproductive success values secured from better quality wetlands to establish the general magnitude of duck production in Wisconsin would, we suspect, yield production figures which tend to be maximum.

The average percentages of hens producing a brood in Wisconsin were: blue-winged teal, 33 percent; ring-necked duck, 36 percent; mallard, 46 percent; black duck, 67 percent; and wood duck, 67 percent (Tables 10, 11, and 12). While average reproductive success figures are cited here, regional and annual differences exist (Tables 10 and 11). Compared to the statewide six-year (1951–56) average, a significantly higher percentage of mallard (Table 11) and blue-winged teal (Table 10) hens produced broods in 1952. A significantly lower proportion of female mallards were successful in 1954.

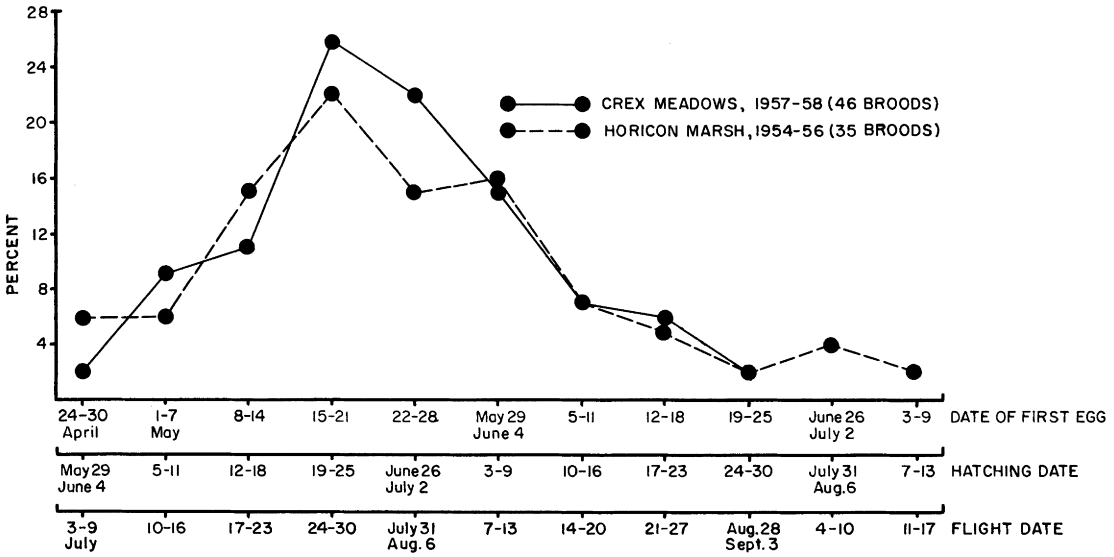


Figure 17. Average dates successful nests started, broods hatched, and flight attained by the blue-winged teal in Wisconsin. Broods observed largely by N. R. Stone at Crex Meadows and R. L. Labisky at Horicon Marsh. (Read any one of the three horizontal axes with the curves for any one graph.)

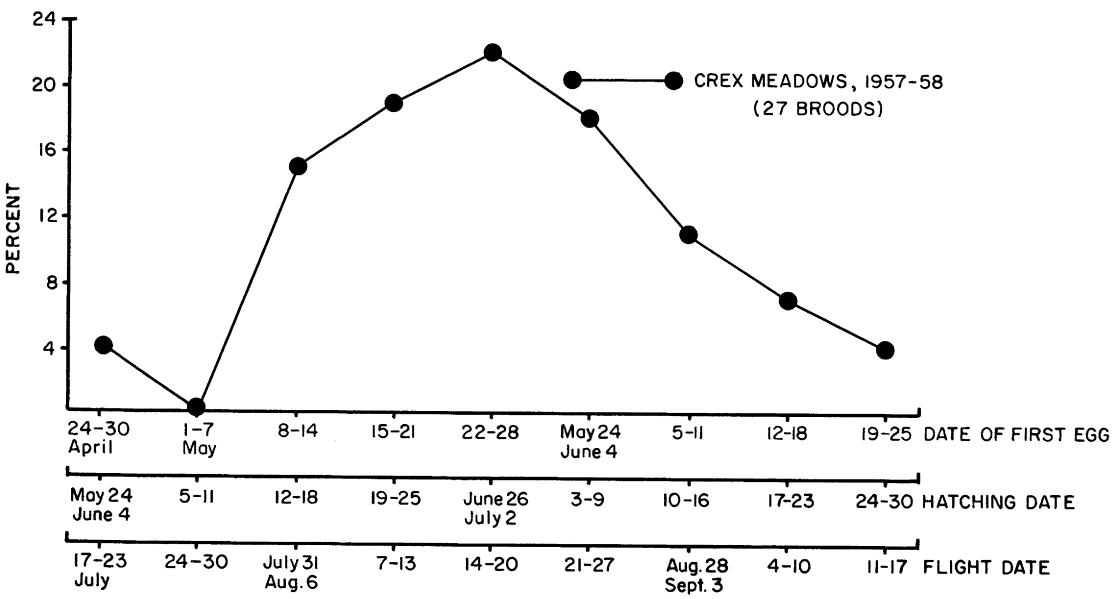


Figure 18. Average dates successful nests started, broods hatched, and flight attained by the ring-necked duck in Wisconsin. Broods observed largely by N. R. Stone. (Read any one of the three horizontal axes with the curve.)

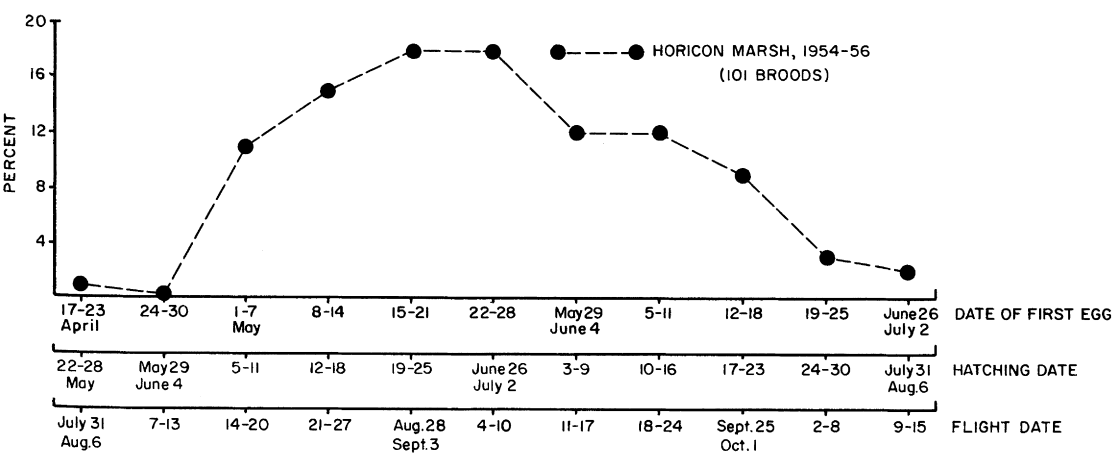


Figure 19. Average dates successful nests started, broods hatched, and flight attained by the coot in Wisconsin. Broods observed largely by R. L. Labisky. (Read any one of the three horizontal axes with the curve.)

TABLE 10

Estimated Percentage of Blue-winged Teal Hens Producing a Brood in Four Regions of Wisconsin, 1951–56

(Numbers of pairs and broods are expressed on the basis of 100 wetland acres censused, with actual numbers given in brackets. Percentage of successful hens is given when 50 or more pairs are involved. Confidence limits on the percentage of successful hens are at the 95% level)

Region and Item	1951	1952	1953	1954	1955	1956	Total and Average
Northern Highland							
No. pairs	0.5(8)	0.7(12)	0.4(5)	1.1(12)	2.2(18)	0.7(5)	0.9(60)
No. broods**	0.3(5)	0.5(8)	0.2(2)	0.2(2)	0.6(5)	0.7(5)	0.4(27)
Percentage hens successful							44 ±13
Central Plain							
No. pairs	1.5(17)	1.3(32)	5.3(55)	4.5(53)	2.6(29)	2.8(23)	2.7(209)
No. broods**	0.8(9)	0.9(23)	0.6(6)	0.7(9)	1.3(16)	1.1(9)	0.9(72)
Percentage hens successful			11 ±8*	16 ±10*			33 ±6
Western Upland							
No. pairs	10.8(10)	12.9(25)	14.9(14)	25.1(39)	15.3(24)	9.1(26)	14.0(138)
No. broods**	3.8(4)	7.7(15)	13.3(12)	10.3(16)	7.0(11)	5.0(14)	7.4(72)
Percentage hens successful							53 ±8
Eastern Ridges and Lowlands							
No. pairs	10.1(164)	8.8(126)	17.9(207)	17.7(213)	16.3(181)	18.3(169)	14.2(1,060)
No. broods**	2.6(43)	4.1(60)	6.8(81)	5.3(60)	3.7(40)	3.4(29)	4.2(313)
Percentage hens successful	26 ±8	46 ±9*	38 ±7	30 ±6	23 ±6	19 ±6*	29.6±3
Wisconsin							
No. pairs	4.6(199)	3.4(195)	8.3(281)	8.7(317)	7.8(252)	8.2(223)	6.4(1,467)
No. broods**	1.4(61)	1.9(106)	2.9(101)	2.4(87)	2.2(72)	2.2(57)	2.1(484)
Percentage hens successful	30 ±6	56 ±7*	35 ±5	28 ±5	28 ±5	27 ±6	32.8±3

* Significant difference from the average in the same row.

** Observed numbers of broods were adjusted upward proportionately, on the basis of hatching curves, for broods hatched after the terminal dates of surveys in July. In 1951 and 1952, an estimated 80 percent of the broods hatched prior to the terminal date of July 10; in all other years an estimated average of 65 percent of the broods hatched before the terminal date of July 3.

TABLE 11

Estimated Percentage of Mallard Hens Producing a Brood in Four Regions of Wisconsin, 1951–56

(Numbers of pairs and broods are expressed on the basis of 100 wetland acres censused, with actual numbers given in brackets. Percentage of successful hens is given when 50 or more pairs are involved. Confidence limits on the percentatge of successful hens are at the 95% level)

Region and Item	1951	1952	1953	1954	1955	1956	Total and Average
Northern Highland							
No. pairs[1]	0.8(12)	1.9(29)	2.2(24)	1.6(18)	1.3(11)	1.2(8)	1.5(102)
No. broods[2]	0.4(6)	1.7(26)	1.0(11)	0.5(5)	1.0(8)	0.6(4)	0.9(60)
Percentage hens successful							60 ±10
Central Plain							
No. pairs[1]	1.6(17)	1.7(43)	5.4(56)	6.9(81)	2.6(29)	1.1(9)	3.1(235)
No. broods[2]	1.9(21)	0.9(22)	3.0(31)	1.4(17)	2.0(24)	1.4(12)	21.6(127)
Percentage hens successful			56 ±13	20 ±9*			5 ±7
Western Upland							
No. pairs[1]	10.8(11)	14.4(28)	7.4(7)	9.0(14)	11.5(18)	10.2(29)	10.9(107)
No. broods[2]	2.9(3)	3.6(7)	7.8(7)	5.2(8)	3.8(6)	1.8(5)	3.7(36)
Percentage hens successful							34 ±9
Eastern Ridges and Lowlands							
No. pairs[1]	4.9(79)	4.9(70)	8.5(98)	6.3(76)	7.7(86)	3.9(36)	6.0(445)
No. broods[2]	2.2(37)	3.1(46)	3.5(42)	2.7(30)	2.1(23)	1.3(11)	2.6(189)
Percentage hens successful	45 ±11	63 ±11*	41 ±10	43 ±11	27 ±9*	33	43 ±5
Wisconsin							
No. pairs[1]	2.8(119)	3.0(170)	5.5(185)	5.2(189)	4.5(144)	3.0(82)	3.9(889)
No. broods[2]	1.5(67)	1.8(101)	2.6(91)	1.7(60)	1.9(61)	1.2(32)	1.8(412)
Percentage hens successful	54 ±9	60 ±8*	47 ±7	33 ±6*	42 ±8	40± 11	46 ±3

[1] Observed numbers of pairs were increased by 10 percent each year to adjust for early nesters missed on surveys in May.

[2] Observed numbers of broods were adjusted upward proportionately, on the basis of hatching curves, for broods hatched after the terminal date of surveys in July. In 1951 and 1952, an estimated 90 percent of the broods hatched prior to the terminal date of July 10; in all other years an estimated average 80 percent of the broods hatched before the terminal survey date of July 3.

* Significant difference from the average in the same row.

Reasonable uniformity was maintained in field census methods. Therefore, yearly and geographic variations in the percentage of successful hens could be associated with three factors. First, some late migrants may have been tallied as resident pairs, thereby enlarging the total pairs and lowering the estimate of successful hens. Second, complete loss of nests, broods, or both, could have occurred in one year or region and not been compensated by renesting to the same degree as in other years or regions. Third, a larger percentage of hens could have produced broods successfully in a particular year or region.

In appraising duckling survival from Wisconsin brood records, one must recognize that computed average brood sizes are affected by two factors: (1) both initial and renest (smaller) clutches are represented, and (2) some ducklings approaching flight age (class III) may have formed aggregations. No procedure was available to handle the brood records to minimize or remove the influence of these two factors. Variation in initial size of young broods and social behavior of older broods affect brood data from many investigations. The latter factor definitely seems to have influenced the Wisconsin figures for blue-winged teal (Table 13) and probably for other species as well.

There was no statistically significant difference between class I average brood sizes for the blue-winged teal or mallard in forested and agricultural areas of Wisconsin (Table

TABLE 12

Estimated Percentage of Black Duck, Ring-necked Duck, and Wood Duck Hens Producing a Brood in Wisconsin, 1951–56.

(Numbers of pairs and broods are expressed on the basis of 100 wetland acres censused, with actual numbers given in brackets. Confidence limits on the percentage of successful hens are at the 95% level)

Species	No. Pairs	No. Broods	Estimated Percentage Successful Hens
Wood duck*	0.6(136)	0.4(106)	67 ± 8
Black duck*	0.6(144)	0.4(82)	67 ± 8
Ring-necked duck**	1.1(163)	0.4(62)	36 ± 7

* Observed numbers of pairs and broods from the entire state were used for these species.

** Observed numbers of broods were adjusted upward proportionately, on the basis of hatching curves, for broods hatched after the terminal date of surveys in July. In all years an estimated 65 percent of the broods hatched before the terminal date of the July surveys. Only pairs and broods of ringnecks from the Northern Highland and Central Plain are included in the totals. Pairs were observed on census sites in the other two regions of Wisconsin, but no broods were seen. These pairs in the Western Upland and Eastern Ridge and Lowland regions are believed to represent late migrants. While they were present on May surveys, they were largely absent on subsequent censuses in June and July.

TABLE 13

Wisconsin Duck Brood Sizes, 1950–56

Age Class	I or Downy Young		II or ⅓–½ Grown		III or About Ready to Fly		Indicated Percentage Mortality Between Age Classes	
Species and Region	No. Broods	Average Brood Size*	No. Broods	Average Brood Size*	No. Broods	Average Brood Size*	I–II	I–III
Mallard								
Forested	21	7.6 ± 0.5	73	6.2 ± 0.3	37	5.5 ± 0.4	18	28
Agricultural	37	7.8 ± 0.5	90	7.2 ± 0.3	72	7.0 ± 0.3	8	10
Total and average	58	7.7 ± 0.3	163	6.8 ± 0.2	109	6.5 ± 0.2	12	16
Blue-winged teal								
Forested	34	7.4 ± 0.5	46	7.4 ± 0.4	12	7.7 ± 0.8	0	+
Agricultural	91	8.0 ± 0.3	126	7.1 ± 0.2	39	6.9 ± 0.4	11	14
Total and average	125	7.9 ± 0.2	172	7.2 ± 0.2	51	7.1 ± 0.4	9	10
Black duck								
Wisconsin	14	8.5 ± 0.5	23	7.2 ± 0.5	52	6.8 ± 0.4	15	20
Wood duck								
Wisconsin	20	8.7 ± 0.6	29	7.6 ± 0.5	17	5.1 ± 0.9	13	41
Hooded merganser								
Wisconsin	10	7.3 ± 0.6	41	6.1 ± 0.4	17	6.1 ± 0.6	16	16
Ring-necked duck								
Wisconsin	18	7.1 ± 0.8	21	7.3 ± 0.8	5	6.4 ± 0.8	+	10

* Standard errors accompany means.

13). A highly significant difference existed between average sizes of class II and III mallard broods in the two types of habitat. Suggested mortality between class I and II mallard broods was 2.3 times greater in the forested area. Indicated mortality was 28 percent from class I to III in mallards in the forested region. This is very close to the 24 percent mortality reported for ducklings in Alberta (Keith, 1961:71). We suspect the computed low mortality for mallard broods in the agricultural area of Wisconsin resulted, to some degree, from grouping of older ducklings, not from substantially fewer deaths than occurred in the forested area.

Suggested wood duck brood mortality between class I and III was 41 percent (Table 13). This was 2 to 3 times larger than losses (13–18 percent) suggested for Indiana in 1951 and 1952 (Mumford, 1954:53). Indicated losses between class I and II Wisconsin wood-duck broods was 13 percent, a figure comparable to losses (16–18 percent) in Indiana. Computed mortality between class II and III Wisconsin broods is 33 percent. Rather than attributing this entire figure to mortality, possibly some ducklings of class III broods were alive, dispersed, and went unrecorded. However, in the absence of specific evidence on this point, the class III average brood size for Wisconsin wood ducks is used in subsequent computations, fully recognizing that it may be biased as indicated above.

We present the Wisconsin brood data to show that, generally, brood sizes and suggested brood mortalities are comparable to those collected in other parts of the duck breeding range. From the standpoint of the average proportion of hens producing broods, as well as brood survival to flight age, mallards, black ducks, and wood ducks reproduce as efficiently in Wisconsin on the better quality wetlands as in other parts of North America (Table 14). Brood survival of the blue-winged teal and ring-necked duck in Wisconsin is comparable to that in other areas, but the percentage of successful hens is lower. Recorded percentages of successful hens in Wisconsin would be lower than actual reproductive success if any late migrant pairs had been recorded as resident pairs. There is no way of knowing to what extent this may have occurred. Indirect evidence suggests that it happened with the ringneck. For example, an annual average of 10 pairs of ring-necked ducks were observed in May on census sites in the Western Upland and Eastern Ridges and Lowlands. On subsequent censuses in June and July, pairs were rarely present in these two regions and no broods were recorded.

We believe these birds represented migrant pairs. To what extent such pairs were present in the Northern Highland and Central Plain, the regions for which reproductive success was computed, is unknown. However, this potential bias is recognized when the reproductive success figures are used later to assess the general magnitude of ring-necked duck production in Wisconsin.

Relationship Between Productivity and Mortality

The relationship between productivity and mortality for five major species of ducks breeding in Wisconsin is explored here using production data from permanent, better quality wetlands and mortality rates computed from banding data (Tables 15 and 16). This analysis should be considered exploratory because (1) productivity is indicated only for the best quality habitat, (2) mortality estimates are based on small numbers of recoveries from bandings completed over a period of years at a limited but well distributed number of stations where hunting pressure was generally high, and (3) mortality estimates for adult black ducks (Smith and Geis, 1962) and for both ages of the ring-necked duck (Smith, 1963) are average values based on bandings in states other than Wisconsin and are assumed to apply to ducks using Wisconsin.

Calculated mortality rates for Wisconsin banded ducks are within the range of values for North America (Table 15) and none are signicantly different from average annual mortality rates for four species of ducks in 7 studies summarized by Keith (1961:75). Computed average mortality rates from Keith's summary were 49 percent for adult ducks and 69 percent for immatures.

Procedures employed in constructing stochastic models (Tables 17 through 21) are patterned after those used by Keith (1961:76). To avoid complications from sex ratio changes, only females are considered in Tables 17–21. Notable limitations are involved in the data used for individual species. For exploratory purposes, the Wisconsin data are accepted at face value at this point. Essential qualifications are offered later in the text. The following facts and assumptions are involved:

1. Year A in each of Tables 17 through 21 is started with a ratio of 4.2 immatures (both males and females) per adult female on September 1.
2. Average adult mortality rates are (September 1 to September 1): blue-winged teal, 40 percent; and mallard, black duck, wood duck, and ring-necked duck, 50 percent.
3. Average immature mortality rates are (September 1 to September 1): mallard, black duck, wood duck, and ring-necked duck, 70 percent; and blue-winged teal, 75 percent.
4. Mortality is assumed to be uniform throughout the year. Although this is not likely the case, errors resulting from the assumption are probably minor.
5. The percentage of hens present on May 1 that successfully produce a brood is: blue-winged teal and ring-necked duck, 35 percent (Table 10 and Table 12); mallard, 45 percent (Table 11); and black duck and wood duck, 65 percent (Table 12).
6. The average size of each brood surviving to September 1 is wood duck, 5.0; mallard, black duck, and ring-necked duck, 6.5; and blue-winged teal, 7.0 (Table 13).

TABLE 14

Summary of Duck Reproductive Data From Production Areas in North America

Species	Area	Percent Hens Producing Broods* (Estimated)	Average Brood Size Near Flight (Class III)*	Year(s) Involved	Reference
Mallard	S.W. Saskatchewan	30		1955	Reeves, Lundy and Kreller (1956)
	S. Manitoba	31	6.6	1949	Evans, Hawkins and Marshall (1952:38)
	S.W. Saskatchewan	32		1950–55	Leitch (1956)
	S.W. Saskatchewan	37	6.1	1952–55	Stoudt and Yeager (1956)
	S. Manitoba	40		1952–55	Dzubin (1956)
	Wisconsin	46	6.5	1950–56	This study
	S.E. Alberta	49		1953–57	Keith (1961:67)
	S. Saskatchewan	54		1952–55	Sterling (1956)
	South Dakota	67	5.3	1950–51	Bue, Blankenship and Marshall (1952)
	Minnesota		6.9	1937–55	Ellerbrock (1956)
	Average	43	6.3		
Blue-winged teal	Wisconsin	33	7.1	1950–56	This study
	S. Manitoba	37	8.6	1949	Evans, Hawkins and Marshall (1952:38)
	S.W. Saskatchewan	37	8.1	1952–55	Stoudt and Yeager (1956)
	S. Saskatchewan	41		1952–55	Sterling (1956)
	S.W. Saskatchewan	49		1955	Reeves, Lundy and Kreller (1956)
	S.E. Alberta	56		1953–57	Keith (1961:67)
	S. Manitoba	61		1952–55	Dzubin (1956)
	S.W. Saskatchewan	63		1950–55	Leitch (1956)
	South Dakota	66	6.8	1950–51	Bue, Blankenship and Marshall (1952)
	Average	49	7.7		
Black duck	New Brunswick	(60)	6.3	1946–50	Wright (1954:105)
	Maryland	(64)	(8.7)	1953–58	Stotts and Davis (1960)
	Wisconsin	67	6.8	1950–56	This study
	New Brunswick		(7.4)	1954	Reid (1955)
	Maine		6.6	1955	Mendall (1956)
	Maine		5.9	1954	Mendall (1955)
	Average	64	6.9		
Wood duck	Wisconsin	67	5.1	1950–56	This study
	Missouri		4.6	1953	Helm (1956)
	Maine		7.0	1955	Mendall (1956)
	Maine		7.8	1954	Mendall (1955)
	Indiana		(6.0)	1951–52	Mumford (1954)
	New York		4.0	1953	Klein (1955)
	Average		5.8		
Hooded merganser	Maine		4.5	1954	Mendall (1955)
	Wisconsin		6.1	1950–56	This study
Ring-necked duck	Wisconsin	36	6.4	1950–56	This study
	Maine	71	5.2	1946–51	Mendall (1958:310)
	Maine		5.9	1954	Mendall (1955)
	New Brunswick		6.0	1946–50	Wright (1954, cited by Mendall, 1958:140)
	Maine		6.8	1955	Mendall (1956)
	Average	53	6.1		

* Values in brackets are calculated or inferred values.

7. The sex ratio of immatures on September 1 is: blue-winged teal, 52:48 in favor of males (Low, 1957, average sex ratio of flightless young trapped in three provinces of Canada); mallard, 52:48 in favor of males (Sowls, 1955:164, sex ratio at hatching); black duck, 52:48 in favor of males (assumed); wood duck, 50:50 (Bellrose *et al.*, 1961:403, sex ratio at hatching); and ring-necked duck, 50:50 (Mendall, 1958:223, sex ratio at hatching).

For the five species of ducks considered, blue-winged teal (Table 17) and ring-necked duck (Table 21) productivity balanced total mortality or provided slight population gains (2–6 percent). If any migrant pairs were tallied as resident pairs, the magnitude of the computed population increases is too conservative. This is a strong possibility with these two late nesters. If, instead of 35 percent of the ring-necked duck hens raising a brood, 50 percent were successful, and all other features of reproduction and mortality remained as previously stated, the population would increase approximately 30 percent yearly. In our opinion, this magnitude of population gain is entirely within reason for Wisconsin. The ring-necked duck is attracted to permanent wetlands for breeding and high nest-

TABLE 15

Mortality Rates of Wild Ducks Banded in Wisconsin Before the Hunting Season Opened Each Year and of Wild Ducks Banded in Other Areas of North America

Geographic Area and Species	Years of Bandings	Average Annual Mortality Rate (Percent)*		Reference
		Adult	Immature	
Wisconsin				
Blue-winged teal	1947–60	37**	77 ±10 (61)	Geis, Smith and Goddard (1963)
Mallard	1949–53	47 ±10 (112)	69 ±6 (247)	Table 16
Wood duck	1939–61	48 ±10 (93)	69 ±6 (265)	Smith, Goddard and Geis (1963)
Black duck	1948–51	-----	68 ±13 (69)	Smith and Geis (1962)
North America				
Blue-winged teal	Thru 1960	37–61	55–81	Geis, Smith and Goddard (1963)
Mallard	1924–55	38–49	55–68	Hickey (1952:68 & 159); Bellrose and Chase (1950); Ryder (1955)
Wood duck	1930–61	45–59	46–75	Smith, Goddard and Geis (1963)
Black duck	1945–60	45	65	Smith and Geis (1962)

* 95% confidence limits accompany Wisconsin mortality rates; number of recoveries are given in brackets.

** Based on less than 25 recoveries.

TABLE 16

Mortality Rates for Wild Mallards Banded as Immatures in Wisconsin, 1947–57 and Shot in the Years 1947–63*

Hunting Season After Banding	Number of Banded Mallards		Number Recovered Per 1,000 "Available"	Number Alive at Start of Each Age Interval (Per 1,000 "Available")	Mortality Rate**
	"Available"	Recovered			
1	1,582	247	156.1	227.1	69%
2	1,582	63	39.8	71.0	
3	1,582	19	12.0	31.2	
4	1,582	10	6.3	19.2	
5	1,582	9	5.7	12.9	
6	1,582	4	2.5	7.2	
7	1,582	0			
8	1,482	3	2.0	4.7	
9	1,482	0			
10	1,482	1	1.4	2.7	47%
11	1,482	1			
12	1,482	0	1.3	1.3	
13	1,482	2			
14	938	0	0.0	0.0	
15	668	0			
16	441	0	0.0	0.0	
17	226	0			
Totals		359	227.1	377.3	

* Mallards were banded in Burnett and Dodge Counties from June through September (prehunting season). All recoveries received by the Wisconsin Conservation Department through 6 March 1964 are included.

** The top mortality rate is for immature mallards and the lower value for adults.

ing success is anticipated. Its habits of (1) nesting very close to the water's edge, and (2) renesting (Mendall, 1958:122) help to insure high reproductive success.

Similar reasoning leads us to believe that the average yearly population increase for the blue-winged teal is greater than the 4–6 percent shown in Table 17. We consider the percentage of hens successful in raising a brood (35 percent) too low. The bluewing's habit of renesting helps to insure high reproductive success on good quality habitat. Because some late migrant pairs were recorded as breeders, we believe the average percentage of hens raising a brood could be 50 percent instead of 35 percent.

Small sample size limits the validity of the mean adult mortality rate of 37 percent for bluewings banded in Wisconsin. For 8 states and provinces the average mortality rate for adult bluewings was 46 percent (calculated from Geis, Smith, and Goddard, 1963).

If (1) 50 percent of the blue-winged teal hens in Wisconsin raised a brood, (2) the adult mortality rate were 45 percent, and (3) all other features of reproduction and mortality

TABLE 17

Indicated Change in the Wisconsin Blue-winged Teal Population Over a 2-Year Period

(Based on females only, and using productivity characteristics, mortality rates and assumptions as presented in the text)

		Number of Females											
		Cohort 1		Cohort 2		Cohort 3		Cohort 4		Cohort 5			
Year	Date	No.	Age	No.	Age	No.	Age	No.	Age	No.	Age	Total Females	Percent Population Change (Sept. 1–Sept. 1)
A	Sept. 1	100	(2 yr. adults)	100	(1 yr. adults)	403	(imm.)					603	
B	May 1	73	(2 yr. adults)	73	(1 yr. adults)	201	(imm.)						
	Sept. 1	60	(3 yr. adults)	60	(2 yr. adults)	101	(1 yr. adults)	407	(imm.)			628	4%
C	May 1	44	(3 yr. adults)	44	(2 yr. adults)	74	(1 yr. adults)	203	(imm.)				
	Sept. 1	36	(4 yr. adults)	36	(3 yr. adults)	61	(2 yr. adults)	102	(1 yr. adults)	430	(imm.)	665	6%

TABLE 18

Indicated Change in the Wisconsin Mallard Population Over a 2-Year Period

(Based on females only, and using productivity characteristics, mortality rates and assumptions as presented in the text)

		Number of Females											
		Cohort 1		Cohort 2		Cohort 3		Cohort 4		Cohort 5			
Year	Date	No.	Age	No.	Age	No.	Age	No.	Age	No.	Age	Total Females	Percent Population Change (Sept. 1–Sept. 1)
A	Sept. 1	100	(2 yr. adults)	100	(1 yr. adults)	403	(imm.)					603	
B	May 1	67	(2 yr. adults)	67	(1 yr. adults)	215	(imm.)						
	Sept. 1	50	(3 yr. adults)	50	(2 yr. adults)	121	(1 yr. adults)	490	(imm.)			711	18%
C	May 1	33	(3 yr. adults)	33	(2 yr. adults)	80	(1 yr. adults)	261	(imm.)				
	Sept. 1	25	(4 yr. adults)	25	(3 yr. adults)	60	(2 yr. adults)	147	(1 yr. adults)	571	(imm.)	828	16%

TABLE 19

Indicated Change in the Wisconsin Black Duck Population Over a 2-Year Period

(Based on females only, and using productivity characteristics, mortality rates and assumptions as presented in the text)

		Number of Females											
		Cohort 1		Cohort 2		Cohort 3		Cohort 4		Cohort 5			
Year	Date	No.	Age	No.	Age	No.	Age	No.	Age	No.	Age	Total Females	Percent Population Change (Sept. 1–Sept. 1)
A	Sept. 1	100	(2 yr. adults)	100	(1 yr. adults)	403	(imm.)					603	
B	May 1	67	(2 yr. adults)	67	(1 yr. adults)	214	(imm.)						
	Sept. 1	50	(3 yr. adults)	50	(2 yr. adults)	121	(1 yr. adults)	705	(imm.)			926	53%
C	May 1	33	(3 yr. adults)	33	(2 yr. adults)	80	(1 yr. adults)	374	(imm.)				
	Sept. 1	25	(4 yr. adults)	25	(3 yr. adults)	60	(2 yr. adults)	211	(1 yr. adults)	1,055	(imm.)	1,376	49%

TABLE 20

Indicated Change in the Wisconsin Wood Duck Population Over a 2-Year Period

(Based on females only, and using productivity characteristics, mortality rates and assumptions as presented in the text)

		Number of Females											
		Cohort 1		Cohort 2		Cohort 3		Cohort 4		Cohort 5		Total	Percent Population Change
Year	Date	No.	Age	No.	Age	No.	Age	No.	Age	No.	Age	Females	(Sept. 1–Sept. 1)
A	Sept. 1	100	(2 yr. adults)	100	(1 yr. adults)	420	(imm.)					620	
B	May 1	67	(2 yr. adults)	67	(1 yr. adults)	223	(imm.)						
	Sept. 1	50	(3 yr. adults)	50	(2 yr. adults)	126	(1 yr. adults)	580	(imm.)			806	30%
C	May 1	33	(3 yr. adults)	33	(2 yr. adults)	84	(1 yr. adults)	308	(imm.)				
	Sept. 1	25	(4 yr. adults)	25	(3 yr. adults)	63	(2 yr. adults)	174	(1 yr. adults)	745	(imm.)	1,032	28%

TABLE 21

Indicated Change in the Wisconsin Ring-necked Duck Population Over a 2-Year Period

(Based on females only, and using productivity characteristics, mortality rates and assumptions as presented in the text)

		Number of Females											
		Cohort 1		Cohort 2		Cohort 3		Cohort 4		Cohort 5		Total	Percent Population Change
Year	Date	No.	Age	No.	Age	No.	Age	No.	Age	No.	Age	Females	(Sept. 1–Sept. 1)
A	Sept. 1	100	(2 yr. adults)	100	(1 yr. adults)	420	(imm.)					620	
B	May 1	67	(2 yr. adults)	67	(1 yr. adults)	223	(imm.)						
	Sept. 1	50	(3 yr. adults)	50	(2 yr. adults)	126	(1 yr. adults)	407	(imm.)			633	2%
C	May 1	33	(3 yr. adults)	33	(2 yr. adults)	84	(1 yr. adults)	216	(imm.)				
	Sept. 1	25	(4 yr. adults)	25	(3 yr. adults)	63	(2 yr. adults)	122	(1 yr. adults)	416	(imm.)	651	3%

remained as previously outlined, the population would increase 26–30 percent annually. This magnitude of population gain is, in our opinion, entirely reasonable for the better quality teal-breeding habitat in Wisconsin.

The Wisconsin mallard population showed a moderate (16–18 percent) average annual increase (Table 18). Major gains (28–53 percent) were registered for the black duck (Table 19) and wood duck (Table 20).

Of the two criteria used to estimate productivity, average brood size is more consistent between years than the percentage of hens producing a brood. Duck populations would decline if less than the following percentages of hens produced broods, and all other conditions of reproduction and mortality remained as outlined initially: ring-necked duck and blue-winged teal, 33 percent; black duck, 34 percent; mallard, 35 percent; and wood duck, 43 percent.

In view of the productivity and mortality rates presented here, we conclude that productivity of duck populations breeding on Wisconsin's *better-quality, more permanent wetlands* exceeded total mortality during the approximate period of 1950–56. This favorable condition did not necessarily exist for breeders on poor quality habitat. Certainly it did not prevail on good quality habitat attractive to pairs but lacking surface water to insure survival of broods. Until the proportion of habitat attractive to pairs and lethal for broods is identified, the overall reproductive success of all breeding ducks in Wisconsin will remain unidentified.

Pair Densities and Duckling Yields

With productivity of duck populations in Wisconsin exceeding mortality, breeding-pair survey data can be used to estimate (1) densities of pairs, and (2) duckling and coot yields. Because individual species have different habitat preferences, tolerances, or both, only acreages occupied by one or more pairs (pair or lone male) of a species were used to compute pair densities. Presence of the birds was used to indicate

habitat meeting their breeding requirements. Where, for example, a pair of mallards and a pair of blue-winged teal occurred on a 10-acre pond, 10 acres was credited to each species.

Computed pair densities may vary slightly from the actual breeding pair densities. Blue-winged teal and ring-necked duck densities, and consequently duckling yields, may be slightly high because late migrant pairs were recorded as residents. Mallard figures are probably a little conservative because a few early nesting pairs were missed. Nevertheless, we believe recorded pair densities reveal the general magnitude of abundance for each species, as well as for all ducks and the coot, on occupied habitat.

Duck pair densities vary between the four physiographic provinces of Wisconsin (Table 22). The Northern Highland and Central Plain averaged between 2 (black duck) and 9 (blue-winged teal and ring-necked duck) pairs per 100 acres of occupied wetland. The Western Upland and Eastern Ridges and Lowlands averaged between 6 (black duck) and 22 (blue-winged teal) pairs per 100 acres. Pairs were from 2 to 11 times more abundant per unit area in southern than in northern Wisconsin. Similar differences in densities were shown by the coot. Compared to reported duck pair densities in prairie and parkland areas, Wisconsin densities are slightly more than 2 to 5 times less (Table 23).

Differences in densities and yields of ducks and coots between regions of Wisconsin reflect variations in quality of wetland habitat. The best quality duck-breeding habitat is in the hard-water, limestone areas in the Western Upland and Eastern Ridges and Lowlands. Though rough topography limits the quantity of aquatic habitat, those units in the Western Upland are of good quality and are used relatively heavily by breeding pairs (Table 22).

Northern Wisconsin, with its abundant forests and soft water, is least attractive to breeding ducks and coots. Yields of waterfowl are relatively low (Table 22), except on isolated marshes. Many beaver impoundments are quite attractive and are heavily utilized (Knudsen, 1962). Beard (1953) reported yields of 170 to 460 ducklings per 100 acres on beaver impoundments in northern Michigan. In some years the yield per unit area was about equal to that reported for the prairies and parklands (Table 22). To what degree, if any, broods from other aquatic areas moved into the impoundments along streams and ditches is unknown. Knudsen (1962:34) reported an average of at least 66 ducklings per 100 acres on 333 beaver impoundments scattered throughout Wisconsin. The total duckling yield was greater, since Knudsen's figures were based on extensive observations and do not include all broods.

Many beaver impoundments on streams, like drainage lakes with inflowing streams (Juday, Birge and Meloche, 1935), receive nutrients from a broad area. Damming a stream carrying a load of nutrients can create an impoundment having higher fertility than surrounding water areas. This is particularly true if the basins in the vicinity are landlocked and have small watersheds covered with non-calcareous materials. This relationship explains why attractive duck-breeding habitat occurs in a region, such as the Northern Highland, which normally supports few breeding ducks per unit area. With higher fertility, better quality aquatic habitat and greater duck use is expected.

Moyle (1956) showed, on the basis of water chemistry, similar differences of aquatic habitat between major regions of Minnesota. He emphasized that in areas of low water fertility in northeastern Minnesota it usually requires many acres of water to raise a duckling (Moyle, 1963).

TABLE 22

Estimated Duck and Coot Use and Yield of Young Per 100 Acres of Wetland Occupied by Individual Species or All Ducks in Wisconsin, 1951–56

(All numbers are rounded to the nearest whole number. The range gives values for individual years)

Species or Group	Number of Breeding Pairs or Birds*								Number of Young Near Flight Age*							
	Northern Highland		Central Plain		Western Upland		E. Ridges and Lowlands		Northern Highland		Central Plain		Western Upland		E. Ridges and Lowlands	
	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range
Blue-winged teal	4	1–20	9	6–15	22	12–32	22	15–27	14	3–68	23	15– 38	81	44–117	46	31– 56
Mallard	6	3–24	7	3–13	21	15–37	13	9–18	20	10–79	20	9– 37	50	36– 88	39	27– 54
Wood duck	6	2– 7	7	1–19	12	2–17	16	9–28	20	7–24	24	3– 65	41	7– 58	55	37– 95
Black duck	4	2–14	2	2–25	12	10–17	6	3–10	18	9–64	9	9–114	54	46– 78	27	14– 46
Ring-necked duck	9	2–16	6	3–16					29	6–51	19	10– 51				
All ducks	7	3–11	13	7–19	38	26–74	30	21–40	23	10–36	42	23– 62	124	85–241	98	68–130
Coot**	16	7–20	17	5–43	28	21–60	41	27–82	42	18–53	45	13–113	74	55–158	108	71–217

* Numbers of ducklings were computed by multiplying the numbers of breeding pairs in this table by the appropriate successful hen percentages (Tables 10, 11, and 12) and the average brood size near flight age (Table 13), as recorded in Wisconsin. Average brood sizes from the forested area (Table 13) were used in the Northern Highland and Central Plain and from the agricultural area in the Western Upland and Eastern Ridges and Lowlands. Because the computed percentage of successful ringneck hens for Wisconsin is believed low, 50 percent was used here for the ring-necked duck; it was also used for the category all ducks. An average of 6.5 ducklings per brood was used for all ducks.

** Ducks are given as pairs, coots as birds. A crude estimate of coot yields is presented, based on the following assumptions: (1) a 50:50 sex ratio of coots present in May, (2) 75 percent of the females successfully raising a brood, (3) all females producing one brood per year, and (4) an average of 7.0 young per brood reaching flight age.

TABLE 23

Estimated Breeding Duck and Coot Use and Yield of Young per 100 Acres of Wetland in Some Areas of North America (All numbers are rounded to the nearest whole number. Many figures were recalculated to place them on a common denominator)

Ecological Type, Area, and Species	Number Per 100 Wetland Acres: Breeding Pairs*	Young	Year(s)	Reference
Prairie and Parkland				
S.E. Alberta, all ducks	116	370	1953–57	Keith (1961:75)
N.W. Minn., all ducks	160	520**	1950–52	Farmes (1956)
South Dakota, all ducks	70	228**	1950–53	Evans and Black (1956:36)
W. Minn., all ducks		200–300		Moyle (1963)
Western Marshes				
N. Utah, all ducks		1,117[1]	1950	Wingfield and Low (1955)
N. Utah, all ducks		326	1956–57	Ryder (1961)
N. Utah, coot		1,057	1956–57	Ryder (1961)
Mixed Forest, Hard Water				
N. Mich., all ducks		170–460	1947–49	Beard (1953)
C. Minn., all ducks		100		Moyle (1963)
S. Wis., all ducks	31	101	1951–56	This study
S. Wis., coot	(40)*	105[2]	1951–56	This study
Mixed Forest, Soft Water				
N. Wis., all ducks	10	33	1951–56	This study
N. Wis., coot	(17)*	45[2]	1951–56	This study

* Figures in brackets are number of birds, not pairs, for the coot.

** Numbers of ducklings were computed by multiplying the numbers of breeding pairs in this table by 50 percent for successful hens and by 6.5, the average brood size near flight stage.

[1] Duck production was presented by Wingfield and Low (1955) for a 174-acre marsh at the rate of 1,490 ducklings at the time of hatching. This value was reduced by 25 percent to allow for mortality of young between hatching and the time of first flight.

[2] Numbers of young coots were computed based on the following assumptions: (1) a 50:50 sex ratio in the breeding birds, (2) 75 percent of the females successfully raising a brood, (3) all females producing one brood per year, and (4) an average of 7.0 young per brood near flight stage.

Densities of the ring-necked duck averaged from 6 pairs per 100 acres in the Central Plain to 9 pairs per 100 acres in the Northern Highland (Table 21). Densities in individual years reached 16 pairs per 100 acres in both regions.

In Maine, where the ringneck has invaded within the past 35 years, maximum densities averaged 4 pairs per 100 acres for 14 study areas and ranged from 1 to 20 pairs per 100 acres on individual marshes (calculated from Mendall, 1958: 208). Mendall believed maximum densities were approached on several areas. Five marshes classified as low quality by Mendall, averaged 3 pairs per 100 acres; three high quality areas averaged 14 pairs per 100 acres.

Densities of breeding ring-necked ducks in northern and central Wisconsin, in some years, approached densities of breeders on high quality marshes in Maine. These data suggest that if a pair of ringnecks per 5 to 7 acres is achieved on waterfowl management areas with high quality ringneck breeding habitat, the management effort should be considered quite good. On low quality habitat, a pair per 20 to 30 acres might be a realistic goal. At densities within these ranges in Maine, Mendall (1958:65) believed territorialism may be the factor limiting further increases in ring-necked duck breeding densities. He further speculated that at densities on the Maine marshes studied, the habitat could probably support, on the basis of available open water, food, resting areas, or nest sites, a larger population of breeding ringnecks. Our general observations and variations in breeding pair densities between years in Wisconsin support Mendall's view.

Average black duck breeding densities ranged from 2 to 12 pairs per 100 acres of occupied wetlands in Wisconsin (Table 22). Maximum densities for individual years ranged from 2 to 25 pairs. Stewart and Robbins (1958:73) reported 5.3 pairs per 100 acres on a 1,000 acres of brackish marsh in Maryland in 1956. Mendall (1949) considered 20 breeding pairs of blacks per 100 acres of marsh a very high nesting density in Maine. Small islands and offshore blinds in the vicinity of Chesapeake Bay in Maryland supported high nesting densities, with one island averaging from 5.0 to 21.4 nests per acre per year (Stotts and Davis, 1960). Mean densities of breeding black ducks in Wisconsin appear comparable to general densities of breeders in Maine and reach high levels of abundance (20–25 pairs per 100 acres) in some years. Island

concentrations of breeders may occur in Wisconsin, but are unknown to us.

Variations in breeding duck and coot densities and duckling yields associated with different quality wetlands must be recognized when waterfowl habitat management efforts are planned and appraised. For Wisconsin, breeding pairs of ducks per 100 acres of occupied wetland should average about 7 in the Northern Highland, 13 in the Central Plain, and 30 to 40 in the Western Upland and Eastern Ridges and Lowlands. Duckling yields per 100 acres of wetlands occupied by breeding pairs should average approximately 23 in the Northern Highlands; 42 in the Central Plain; and 98 to 124 in the Western Upland and Eastern Ridges and Lowlands. Expected yearly fluctuations about these mean densities and yields are indicated by the range of values presented in Table 22. Generally, a duckling per acre of occupied (by pairs) wetland can be considered good production on the better quality wetlands in southern Wisconsin (as conditions existed in 1950–56) and on fertile beaver impoundments in northern Wisconsin.

Use of Existing Habitat

Use of Wisconsin's aquatic areas by breeding ducks varies between physiographic provinces and types of water areas. On cross-country road counts, in which all types of aquatic areas were tallied, occupancy by breeders averaged 13 percent in 1948, 18 percent in 1949, and 12 percent in 1950. During the 3 years (1948–50), occupancy averaged 4 percent in the Western Upland, 7 percent in the Northern Highland, 11 percent in the Central Plain, and 18 percent in the Eastern Ridges and Lowlands.

On permanent aquatic sites (largely 10 acres or less in size) considered best for breeding ducks by local game managers, occupancy averaged 58 percent (range 55–64 percent) between 1951 and 1956. This rate of use of selected Wisconsin wetlands is similar to the rate of occupancy of water areas in the prairie breeding grounds of North and South Dakota (Table 24). Over-all low occupancy (12–18 percent) of aquatic areas by breeders, however, clearly indicates that many Wisconsin wetlands are unattractive to breeding ducks.

These occupancy figures confirm general observations on the distribution of Wisconsin's breeding duck population. There is a light density of breeders throughout the state, with major concentrations occurring only at three government-controlled waterfowl management areas: (1) the Horicon National Wildlife Refuge, (2) the Upper Mississippi River Wildlife and Fish Refuge, and (3) the Crex Meadows Conservation Area.

Factors Affecting Breeding Duck Populations

With a low density of breeders, it is difficult to obtain sufficient quantitative data to evaluate the influence of various factors on duck populations in Wisconsin. This discussion of effects of land use, plant succession, disease, human disturbance, and features of the habitat on the breeding population is largely descriptive. Bits of historical and current evidence are combined to provide a glimpse of the role these factors have had and are having in limiting the Wisconsin breeding duck population. Upland nesting mallards and blue-winged teal are given primary consideration because they are the main breeders.

Land Use and Plant Succession

When Indians occupied much of the present agricultural area of Wisconsin, most land was forested with hardwood trees or was largely grassland (Curtis, 1959). Numerous shallow water areas, especially those bordered by grasslands furnishing nesting cover, served as important duck breeding sites. Many shores of lakes, rivers, and streams were attractive to breeding ducks. Numerous marshes and sloughs located between drumlins, particularly in Dodge and Jefferson counties, provided excellent breeding habitat.

Periodic fires set by Indians to drive game and those started accidentally by lightning burned until they were stopped by natural fire breaks—surface-water areas. Vegetation in the frequently burned lowlands was drastically different than in unburned lowlands. For example, in western Jefferson County, periodic fires maintained sedge meadows on low ground between drumlins (Zicker, 1955). Depressions were created in the meadows by deep-peat burns in dry years (Grange, 1948: 215), and developed into marshes when flooded. East of the Crawfish and Rock Rivers (Jefferson County) on identical topography, unburned lowlands supported tamarack swamps.

Historically, fire maintained attractive duck breeding habitat by inhibiting normal plant succession. Grassy and herbaceous upland cover established and maintained by fires provided ex-

TABLE 24

Use of Water Areas by Breeding Ducks in Certain North Central States

State	Years	Percent Water Areas Occupied	Type of Sampling	Reference
North Dakota	1948–49	63–79	Cross-country road transects	Stout and Davis (1948); Stoudt (1949a)
South Dakota	1948–50	65–79	Cross-country road transects	Kimball, Nelson and Murdy (1949); Murdy (1950)
Wisconsin	1948–50	12–18	Cross-country road transects	This study
Wisconsin	1951–56	55–64	Selected permanent water sites	This study

cellent nesting cover for upland nesting ducks, such as the blue-winged teal and mallard. Under present-day, strict fire protection, new depressions are rarely burned in meadows, and sedges and grasses give way to shrubs and trees. Timbered swamps stand as living testimonials of what vegetation more open wetlands will support at some future date, if they remain undisturbed.

Developments in agriculture have had a tremendous impact on breeding duck habitat and populations in Wisconsin. In 1845, wheat raising became the major agricultural practice in the state. Wheat stubble must have provided nesting cover, just as it now does in major sections of the North American duck-breeding range where the highest densities of breeders occur. In the 1860's, intensive dairy farming started to replace wheat raising.

Cook (1906:11) vividly describes how the switch from grain raising to dairying severely reduced the suitability of much of the aquatic and adjacent upland habitat for breeding ducks. "In southern Wisconsin in 1864, every pond hole and every depression had its brood of young ducks. During the next 15 years (1865–1880), the farming of the region changed from grain raising to dairying, the marshes were drained, the former duck nurseries became grazing grounds (for livestock). . . ."

Draining and filling of wetlands, and overgrazing and plant succession on many of those remaining have continued for more than 70 years. Approximately one-half of the original 5 million wetland acres has been drained or affected by drainage (Wis. Conserv. Dept., 1959). Many of the remaining open wetlands are threatened by these same land-use practices and plant succession (Stroebe, 1950; Mann, 1955; Wis. Conserv. Dept., 1959).

A recent (1958–63) shift in grazing practices has temporarily made attractive nesting cover available and has enhanced plant succession. In the long run this change will be detrimental to breeding ducks. Residents on small farms are getting rid of all livestock, while those on large farms are being advised to take green feed to cattle held in restricted yards. In either case, livestock are removed from wetland pastures. In the past on many wetland areas, nesting and escape cover for ducks have been limited by overgrazing and trampling of shorelines by too many cattle. With the shift in grazing practices, another extreme is developing. Ungrazed wetland areas quickly develop borders of dense, stiff-stemmed herbaceous or woody vegetation of limited value for duck nesting cover. In southeastern Wisconsin, which has the best quality aquatic sites in the state, we have seen this transformation from an overgrazed grassy pasture to rank vegetation take place in 3 to 10 years. With dense stands of shoreline vegetation, a limited number of suitable niches are available for breeding ducks and only a scattered nucleus of breeders can be accommodated.

Land use and plant succession were also dominant factors influencing duck breeding habitat and populations in forested areas of Wisconsin. Historically, bodies of water now existing in a heavily forested matrix produced significant numbers of ducks, especially upland nesting species. Game managers and interested citizens reported instances of former breeding duck abundance. Leopold (1931:207) reported, for 1928–29, thousands of ducks produced in localities which are now heavily forested. Surveys of many of the same localities between 1949 and 1957 revealed the presence of only a few breeding ducks.

Leopold's observations in the late 1920's were made following a period of extensive timber cutting and uncontrolled fires. Hundreds-of-thousands of acres were charred. Under repeated burning, the land was covered largely with grassy and herbaceous plants, and charred stumps. Extensive areas of preferred upland nesting cover existed around water sites.

A secondary effect of these fires apparently was the enrichment of existing waters, especially those serving as settling basins. Curtis (1959:42) presents evidence which indicates that conditions of impounded water may have been improved by removal of one of the main sources of acids entering the impoundments. When the conifer-hardwood forest was present, the surface of the till was covered with a thick layer of undecomposed and partially decomposed conifer needles. This layer was low in basic nutrient salts and rich in organic acids and acidic inorganic compounds.

Lumbering and fires removed the trees yielding conifer needles and at least partly removed the humus layer. Ashes, resulting from burning the twigs and branches left by lumbering, provided a source of basic nutrients (Juncker, 1960). The ashes washed from watersheds through normal precipitation must have improved food and vegetative conditions within the waters, especially the smaller impoundments having a reasonably large watershed and subject to fluctuating water levels.

By 1930, a forest-fire-protection service, though small, was established in Wisconsin. In the next 25 years, this unit mushroomed into an excellently equipped organization. During the period from 1945 through 1955, not more than 24,000 acres of land accidentally burned over within the principal forested portions of the state (Wis. Conserv. Comm., 1957:8). After 1949, the total was under 10,000 acres per year.

With the control of fires, open lands reverted to woody vegetation. In central Wisconsin, early upland successional stages of forbs and grasses developed into dense stands of brush in 10–17 years following burning (Grange, 1949:78). Preferred nesting cover of upland nesting ducks was practically eliminated in many areas through normal plant succession. Aquatic plants probably declined in many water areas from the lack of the fertilization effect of ashes and greater stabilization of water levels.

Accumulative changes in habitat, over the 20- to 30-year period between breeding duck surveys by Leopold and ourselves, drastically changed the environment. A conifer-hardwood forest covered the area many years prior to the time of Leopold's observations (Curtis, 1959), and also blankets the area now, except for urban and agricultural areas. In the brief interval of openness, between wide-scale lumbering and re-

establishment of forests, ducks responded to favorable habitat created accidentally. Results from modern, intensive, waterfowl-habitat management confirm the interpreted historical record. Where impoundments have been constructed and adjacent grassy and herbaceous nesting cover provided through prescribed burning, upland nesting ducks have responded quickly to favorable environmental conditions.

Disease

The protozoan blood parasite *Leucocytozoon simondi* is known to infect wild ducks in Wisconsin. Incidence of this parasite is known from samples of wild ducks obtained in North America through banding and shooting (Levine and Hanson, 1953; O'Meara, 1956; and others). Fatalities from leucocytozoon disease have been reported for domestic waterfowl, hand-reared mallards (Cheatum, 1952) and one case in wild ducks in Michigan (O'Roke, 1934). Only a Wisconsin study has been directed toward learning the effects of the disease on wild duck productivity (Trainer *et al.,* 1962). Additional Wisconsin studies were aimed at learning more about the parasite's vectors and their ecology (Anderson and Dicke, 1960; Anderson and DeFoliart, 1961; Anderson, Trainer and DeFoliart, 1962). Results from these Wisconsin studies are combined with information from previous sections of this report to assess the general significance of leucocytozoon disease in Wisconsin. This discussion is limited to the mallard because it is commonly infected heavily and most of our data pertain to it.

The vector of *L. simondi* in Wisconsin is the black fly, *Simulium rugglesi* (Anderson, Trainer, and DeFoliart, 1962). This fly appears to be restricted to northern regions of Wisconsin, with its presence recorded in 7 counties in the Northern Highland and Central Plain (Anderson and Dicke, 1960). Information on duck reproduction was obtained on breeding waterfowl surveys in 5 of the 7 counties (Burnett, Polk, Wood, Juneau, and Forest), as well as in other counties in these two physiographic provinces. The 1958 pen study of wild mallard productivity was conducted in Burnett County at the Crex Meadows Conservation Area, where the vector black fly is prevalent.

Of 12 wild mallards placed in a large wire-covered breeding pen at Crex Meadows in April 1958, all but 3 of the 12 breeders showed low grade infections of *L.simondi* by May 23. In August, 75 percent of the adults and 93 percent of the immatures were infected. Biweekly observations disclosed no morbidity or mortality among adult or young mallards. Although the majority of the adults were infected during the entire breeding season, they reproduced successfully. If all adult hens produced young, the average brood size in mid-August was 5.3 per female. Brood survival in the covered pen was similar to that recorded for mallards in northern (forested) Wisconsin for 1950–56 (Table 13).

Productivity of mallards in the Northern Highland and Central Plain was comparable to the statewide average in 1951–56. The proportion of hens producing broods was average or slightly better (Table 11). Brood sizes in forested regions are not considered abnormally low (Table 13). These data further suggest that leucocytozoon disease is not an important factor limiting mallard reproduction or duckling survival in regions of Wisconsin where the vector black fly is known to occur.

While available evidence indicates that leucocytozoon disease was not important in limiting mallard productivity at Crex Meadows in 1958 or in northern Wisconsin in 1951–56, it does not follow that the disease is unimportant every year or in all localities. However, in view of the ecology of the vector and the mallard, chances for development of an epizootic appear poor. For widespread mortality to occur, it seems necessary to have (1) a population of infected mallards, (2) large adult vector populations feeding on the infected ducks, and (3) subsequent feeding by large numbers of infected vectors on susceptible ducklings. Events in the mallard breeding cycle and the vector's emergence and feeding time table must occur so feeding of large numbers of infected vectors is synchronized with the mallard hatch. The probability of simultaneous occurrence of these events seem low.

Only future studies will clarify further the effect of leucocytozoon disease on wild mallards and other waterfowl. Two aspects appear to deserve attention. First, susceptibility of wild ducklings of different ages to various levels of infection could be investigated to help appraise the potential for occurence of mortality. Second, long-term studies with penned flocks of wild mallards in areas where vector black flies are abundant would determine characteristics of duckling survival for individual years under various environmental conditions and vector population levels. Although more knowledge is needed to understand better the characteristics and effects of this disease, we conclude that it is not a major mortality factor of mallards, and probably of all ducks, in Wisconsin.

Human Disturbance

Zimmerman (1953) reported some Wisconsin lakes bordered with homes and so heavily used for recreation in the early 1940's that breeding ducks were discouraged from utilizing otherwise suitable habitat. Human activities on and near permanent water have subsequently increased tremendously. Shorelines of many lakes and some streams are now lined with homes and piers. Both habitat destruction and disturbance accompanied this urbanization. Part of the shallow-water habitat important to breeding ducks was converted to other uses through filling, adding sand to create swimming beaches, and dredging channels for boats. In other cases, the suitable shoreline habitat remains and is used very little, if at all, by breeding ducks. Apparently, activities of shore residents, fishermen, and boaters discourage breeders from using otherwise adequate habitat.

Similar conditions exist in other areas in North America (Addy and MacNamara, 1951:15; Beard, 1953; Wright, 1954; Mendall, 1958:244; Keith, 1961:79). Breeding pairs, broods, and molting adults are apparently intolerant of heavy fishing pressure, motor-boating, and other types of disturbances. Brood survival was better on an area in Maine after

TABLE 25

Prevalence of Types of Aquatic Habitat in Wisconsin and Elsewhere, in Percentage of Numbers*

Location	Temporary Areas	Shallow Marshes	Deep Marshes	Open Water	Reference
Wisconsin, 1950**	8	41	14	37	This study
Western Minnesota	63.2	24.1	8.9	3.8	Schrader (1955)
North Dakota	65.6	25.6	7.8	1.0	Schrader (1955)
Eastern South Dakota	59.7	32.9	5.9	1.5	Schrader (1955)
Waubay, South Dakota	44.3	24.6	22.7	8.4	Schrader (1955)

* General definitions of wetland types include—*Temporary areas*: Largely field puddles which go dry by June 1, except in years of heavy rainfall. *Shallow marshes*: Small depressions that hold water in spring and through July in wet years. In years of below-normal precipitation, the large portion of these areas will be completely dry in spring. *Deep marshes*: Areas that hold water throughout the growing season, except in extremely dry years. In dry years, most of the areas go dry by late summer. *Open water*: Permanent bodies of open water. Under extremely dry conditions, water levels recede and a few areas may dry up completely, especially in regions of sandy soil.

** Wisconsin figures are based on data from cross-country, road-count transects (Fig. 6).

fishing and motor-boating were prohibited than when they were permitted (Mendall, 1958:244).

Boating has become a major disturbance factor in Wisconsin. It occurs in every county and is growing in volume (Wis. Dept. Resource Development, 1962). Of the 20 counties used most by Wisconsin boaters, 12 are located in the Eastern Ridges and Lowlands. This region has the best quality aquatic habitat capable of accomodating the highest pair densities and duckling yields in the state.

Where disturbance factors are involved, breeding duck use of suitable habitat is not an all or none proposition. Reactions of ducks to human activities vary (1) with the frequency and volume of disturbance, and (2) among species. On the basis of our own observations, information from other reports cited above, and Kortright (1943), the common Wisconsin breeders can be classified according to their tolerance of human disturbance. Most tolerant are the blue-winged teal, coot, wood duck, and mallard. Least tolerant are the hooded merganser, ring-necked duck, and black duck. Blue-winged teal and coot breeders were observed on areas having a moderate volume of disturbance, such as in boat channels. Apparently they are among the last species to abandon attractive habitat as disturbence becomes excessive.

We suspect the present distribution of breeding ducks in Wisconsin is, to some degree at least, the result of intolerance of human disturbance. For example, both the wood duck and hooded merganser use cavities for nesting. Historically, both species nested throughout the state. Presently, only the wood duck occurs statewide. Possibly the shy and retiring habits of the hooded merganser forced this bird to abandon previously occupied range as human disturbance increased in frequency and volume. Shrinkage in breeding range of the ring-necked duck in Wisconsin may have involved the same factors. The ringneck is now (1950–62) found primarily in the least disturbed types of habitat. Whether this is due entirely to habitat preference, or a combination of habitat preference and intolerance of disturbance, is not known definitely. We suspect both factors are involved.

Wisconsin is one of the leading recreational states in the United States. Future predictions call for an expanding human population, more home construction near surface waters, more people with greater amounts of leisure time, and expanding water-oriented activities. Modern boats equipped with air propellers and water-jets easily invade shallow water areas of most value to waterfowl. In view of these anticipated conditions, human disturbance can only become a more important factor limiting waterfowl production on suitable habitat associated with permanent waters in Wisconsin. Mendall (1958:245) believed accelerated recreational use of water areas was among the most important factors limiting production of waterfowl in northern New England and in eastern Canada.

Limitations of Aquatic Habitat

Wisconsin has an abundance of surface-water areas, but not of the proper type and density to accomodate large numbers of breeding ducks and coots. Aquatic habitat consists primarily of (1) open water of lakes and streams that is too deep or wind-swept to provide emergent aquatic vegetation for nesting or escape cover, and (2) shallow marshes, most of which are completely choked with vegetation and lack surface water in summer, and also in spring when moisture is below normal (Table 25). Temporary areas and deep marshes, the types potentially best able to accomodate breeding ducks and coots, make up only about 20 percent of the water areas. In states supporting large breeding waterfowl populations, approximately 66 to 73 percent of the aquatic areas is of these types (Table 25). Lack of temporary shallow-water areas decreases the amount of edge available for territorial ducks.

Besides lakes and streams, Wisconsin had an estimated 2,790,600 acres of wetlands in 1952–54 (Mann, 1955). Approximately 14 percent, or 389,000 acres, has surface water in spring when runoff waters and rainfall are normal or above. These shallow and deep marshes occur throughout the state (Fig. 20) and furnish some of the best habitat for breeding waterfowl. Greatest densities of marshes are found in Dodge County and in the Burnett-Polk-Washburn County area in the northwest. Eighty-six percent of the total wetland acreage

lacks surface water, except when flooded seasonally, or contains only small isolated patches of open water.

These figures show the overall limitations of Wisconsin's wetlands for waterfowl production. However, from the standpoint of meeting the needs of breeding ducks, the distance is crucial between shallow marshes attractive to pairs, and deep marshes and other suitable permanent waters required by broods. Isolated shallow marshes do not constitute adequate habitat for duck production. Surface water is present in spring to attract breeding pairs, but is, in years of normal or below normal precipitation, lacking for broods before they are capable of flight. When shallow marshes go dry, deep marshes or other suitable permanent waters are required in the vicinity to insure brood survival.

Flightless broods in the pothole area, where the density of water areas is greater than in Wisconsin, have moved a mile or more between water areas (Evans, Hawkins and Marshall, 1952; Evans and Black, 1956:48). How far broods can move in an emergency and still survive is unknown. To gain an impression of the adequacy of Wisconsin's marshes for broods, township records from the Wisconsin wetland inventory were examined to determine the prevalence and distribution of deep marshes required for brood survival. Shallow marshes without a deep marsh within a mile radius are considered incomplete duck production units. Though present in some blocks, permanent lakes and streams are not considered here. Most lakes and sections of some streams in the counties examined are heavily developed and used by people, thereby minimizing their value for rearing broods.

Though shallow marshes are present, deep marshes are absent in 11 of 25 townships in Dodge County (Wis. Conserv. Dept., 1961a) and in 10 of 16 townships in Jefferson County (Wis. Conserv. Dept., 1961b). These two counties have some of the best quality habitat to attract pairs in Wisconsin. Townships in 12 other southeastern counties also lack deep marshes. In other townships, number and distribution of deep marshes are inadequate, if at least one deep marsh should be within a mile of each shallow marsh.

Entire townships having shallow marshes and lacking deep marshes are potential traps for breeding pairs of ducks. Pairs attracted to shallow marshes utilize their reproductive energies and have few opportunities to rear broods to flight age. Characteristics of the habitat suggest that brood mortaliy occurs in years when water is abundant in spring but absent in summer.

One of the most important investigations needed in Wisconsin is to (1) specifically locate the blocks of habitat attractive to pairs and potentially lethal for broods, (2) determine if deep marshes can be added in reasonable numbers at suitable spacing through the most appropriate habitat restoration procedures, (3) define specific construction procedures for different types of topography and qualities of soils, (4) estimate the costs for carrying out the habitat manipulation, and (5) develop new, practical, economic procedures for providing open water suitable for broods and pairs in the numerous wetlands now lacking surface water.

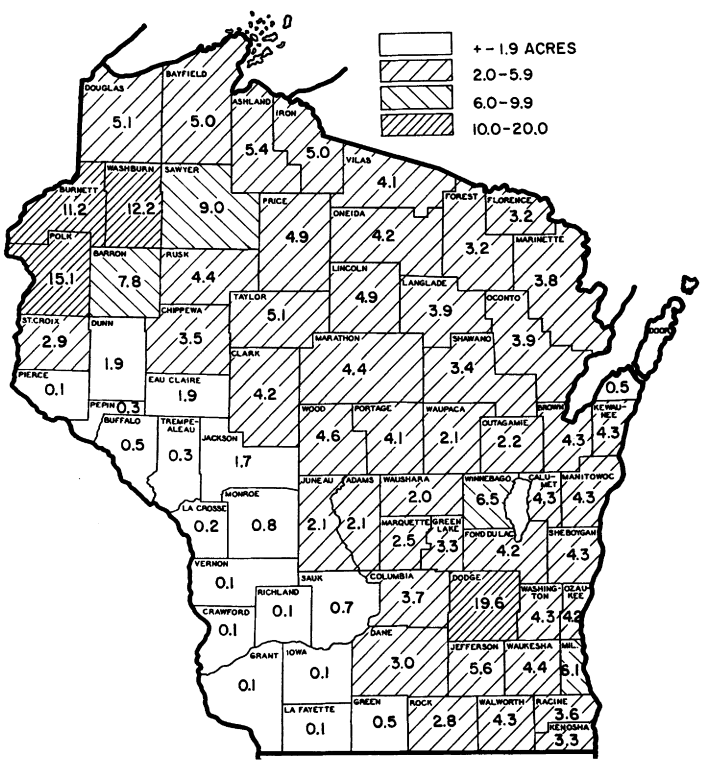


Figure 20. Distribution of Wisconsin's most important duck and coot breeding habitat, 1952–54. (Based on the number of acres of Type III and Type IV wetlands per square mile of land area. Type III wetlands are shallow marshes with up to 12 inches of water and that normally go dry by mid-summer. Type IV wetlands are deep marshes with 1 to 3 ft. of surface water during the growing season, except during drought years. County wetland acreages were made available by the Office of River Basin Studies, U. S. Bureau of Sport Fisheries and Wildlife, Minneapolis.)

Total Effect of All Factors

Natural features of topography and vegetation limit the amount of suitable habitat for breeding ducks and coots in Wisconsin. Much of the wetland habitat lacks surface water to attract pairs and accomodate broods. Small units of suitable shoreline habitat of lakes and streams support breeders, if activities of people are not excessive. In the final analysis, plant succession and activities of man, largely through fire protection, destruction of aquatic habitat or the adjacent upland nesting cover, and disturbance, are major factors limiting the density and distribution of Wisconsin's breeding duck and coot populations on available habitat.

Importance of Wisconsin as a Waterfowl Production Unit

Wisconsin had a minimum annual average of 133,500 breeding ducks in 1949–50 (Table 26). With 5.0 breeding ducks per square mile (Shaw and Crissey, 1955), the maximum was 280,500 breeders. Average yearly duckling production was 217,100 to 456,300 (Table 27). This range of values is considered the best estimate possible using available data. Establishing a range on the duck population in May and October is considered the most realistic approach. It takes into account possible variations in the amount of habitat available

TABLE 26

Estimated Average Minimum Breeding Duck Population in Wisconsin, May 1949–50

Physiographic Province	Total Sq. Miles	Ducks Calculated Per Sq. Mile*	Estimated No. Ducks**
Northern Highland	16,267	2.0	32,500
Central Plain	13,016	2.8	36,400
Western Upland	13,266	0.9	11,900
Eastern Ridges and Lowlands	13,517	3.9	52,700
Wisconsin	56,066	2.6	133,500

* Figures from Table 8.

** Figures are rounded to the nearest hundred. Wood ducks are believed to be under-represented; therefore, these are minimal values.

between years due to fluctuations of water levels. The minimum size of the breeding population is probably too large for a year of severe drought.

Compared to other duck-producing areas of North America, Wisconsin is marginal range (Fig. 21). Based on surveys conducted throughout the principal breeding areas of Canada and the United States between 1950 and 1957 (Hawkins *et al.*, 1958:231. 1–1): (1) over half of the continental duck population was produced in the prairie pothole region of Canada and the United States, (2) the United States' portion (North Dakota, South Dakota, Montana, Nebraska, and Minnesota) contributed to about 14 percent, and (3) the Canadian portion (Manitoba, Saskatchewan, and Alberta) contributed 47 percent.

While Wisconsin's contribution of all ducks to the fall flight is small, the contribution of wood ducks could be considerable. More appropriate data are required to define this relationship. The importance of the local duck population to Wisconsin's duck harvest is discussed later under "Harvest Aspects."

TABLE 27

Estimated Range in the Size of Wisconsin's Duck Population*

Item	Minimum	Maximum	Source or Condition
Size of breeding duck population, May 1949–50	133,500	280,500	Table 26; Fig. 21
Number of adult females	66,800	140,300	50:50 sex ratio
Number of females producing a brood	33,400	70,200	50 percent
Number of young at flying stage	217,100	456,300	6.5 per hen
Total local duck population on October 1	350,600	736,800	Adults plus young

* (a) All figures in this table are rounded to the nearest 100.

(b) The average maximum breeding population is set at 5.0 ducks per square mile, the figure reported by Shaw and Crissey (1955).

(c) We assumed no adult mortality occurred from approximately May 15 to October 1. Therefore, estimates of the total local duck population on October 1 are maximum values.

Summary

Characteristics of Wisconsin's breeding waterfowl population was established on the basis of information from aerial and ground censuses, primarily for 1948–58.

Breeding ducks were recorded on our surveys throughout Wisconsin, with highest densities occurring in the Eastern Ridges and Lowlands (3.9 ducks per sq. mile) and the Central Plain (2.8 ducks per sq. mile). Statewide, breeding ducks averaged 2.6 per sq. mile in 1949–50. Wood ducks are suspected of being under represented. Coots were most abundant in the Eastern Ridges and Lowlands and statewide averaged 0.5 per sq. mile.

Fifteen species of ducks breed in Wisconsin, with the blue-winged teal, mallard, and ring-necked duck making up an average of 84 percent of the breeding population (1948–56). The blue-winged teal, mallard, and wood duck are distributed statewide; the ringneck, black duck, and hooded merganser occur primarily in northern areas. Scattered breeding records were noted for the American widgeon, pintail, shoveler, gadwall, green-winged teal, redhead, canvasback, lesser scaup, ruddy duck, common merganser, and red-breasted merganser.

Based on back-dated brood records for the mallard, blue-winged teal, and ring-necked duck, egg laying in successful nests extended from March 27 to July 9. Approximately 90 percent of all nests were initiated between April 17 and June 11. Eggs were deposited in successful coot nests from April 17 through July 2 at Horicon Marsh (1954–56). Flightless duck and coot broods were present from May 1 to October 15. All ducklings were capable of flight by October 1. About 5 percent of the coot broods were still flightless October 1–15.

Reproductive efficiency of 5 species of ducks breeding in Wisconsin was judged by comparing with other areas in North America, (1) the percentage of hens producing broods, and (2) the average size of broods at flight age. The average percentage of hens producing a brood in 1951–56 in Wisconsin was: blue-winged teal, 33 percent; ring-necked duck, 36 percent; mallard, 46 percent; and black duck and wood duck, 67 percent. Figures for the blue-winged teal and ring-necked duck are believed to be low because migrant pairs were tallied as residents. The average brood size near flight age for all ducks was 6.5. Productivity of ducks on the better quality wetlands in Wisconsin is comparable with that in other breeding areas and is balancing or exceeding total mortality. This satisfactory condition probably does not prevail on good quality habitat attractive to pairs but lacking surface water to insure brood survival.

Duck pairs per 100 acres of occupied wetland averaged 7 in the Northern Highland, 13 in the Central Plain, and 30 to 38 in the Western Upland and Eastern Ridges and Lowlands. Duckling yields per 100 acres of wetland occupied by breeding pairs averaged 23 in the Northern Highland, 42 in the Central Plain, and 98 to 124 in the Western Upland and Eastern Ridges and Lowlands. Breeding coots averaged 16–17 birds per 100 acres in the Northern Highland and Central Plain,

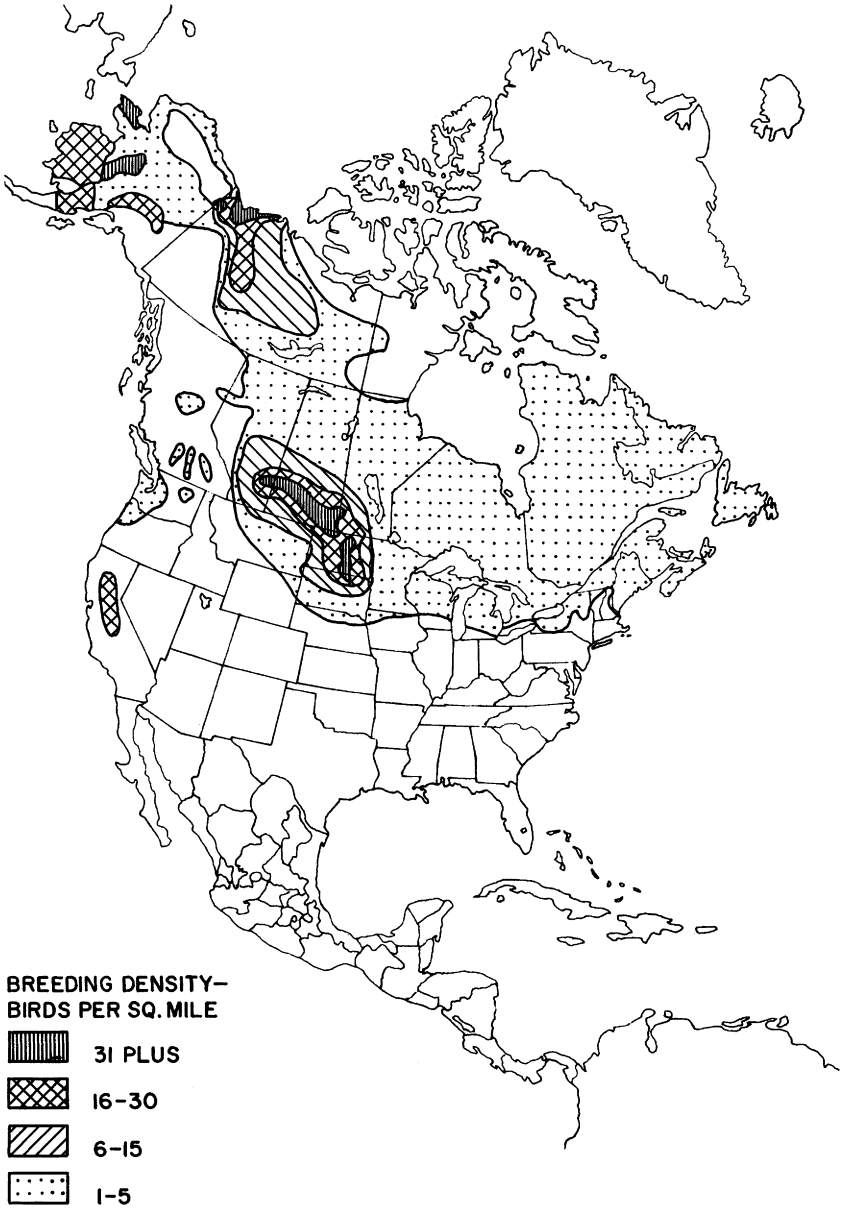


Figure 21. Distribution of North American waterfowl during the breeding season (after Shaw and Crissey, 1955).

28 in the Western Upland, and 41 in the Eastern Ridges and Lowlands. Yields of coots averaged 42–45 young per 100 acres in the Northern Highland and Central Plain, 74 in the Western Upland, and 108 in the Eastern Ridges and Lowlands. Differences in breeding bird densities and yields of young are associated with variations in fertility and attractiveness of aquatic habitat. Wisconsin duck-pair densities are approximately 2 to 5 times less than those in prairie and parkland areas. Generally, a duckling per acre of wetland occupied by pairs can be considered good production on the better quality wetlands in southern Wisconsin and on fertile beaver impoundments in northern Wisconsin.

Occupancy of all types of aquatic areas in Wisconsin by breeding ducks ranged from 12 to 18 percent, 1948–50. On selected permanent areas only, occupancy averaged 58 percent (1951–56), a rate of usage similar to that for the Dakotas. Overall low occupancy (12–18 percent) of aquatic areas by breeders indicates that many Wisconsin wetlands are unattractive to breeding ducks.

Natural features of topography and vegetation reduce the amount of suitable habitat. Historically, fires maintained attractive duck breeding habitat, especially for upland nesting species. Now, plant succession, land-use practices, and recreational activities of people limit further the amount of suitable habitat available to breeding ducks. Leucocytozoon disease is not considered a major factor limiting mallard productivity, but its effects in individual years need further study.

Wisconsin is now considered marginal duck breeding range in North America, except for the wood duck. Crude estimates place the breeding duck population at 133,500 to 280,500 (1949–50). Computed, average yearly duckling production ranged from 217,100 to 456,300.

Fall Migration

Primary objectives of our studies of fall migration were to determine:

1. The relation of Wisconsin to major fall migratory flight lanes of various waterfowl species in the Mississippi Valley;
2. The average chronology of fall duck use for the entire state, for different regions, and for each species;
3. The important Wisconsin fall concentration sites of each species;
4. The general pattern of migratory movements of ducks and coots from Wisconsin;
5. The main factors affecting the distribution of ducks in Wisconsin in fall; and
6. The factors causing mortality of ducks and coots in Wisconsin in fall.

Information on these items was used to prepare guidelines for managing fall duck and coot populations in Wisconsin (see Part IV, "Implications For Duck and Coot Management and Investigations in Wisconsin").

In discussing fall migration, statements are made on (1) the relative volume of flights passing over Wisconsin, and (2) the use of the state's waters by ducks (duck-day use). Data on the volume of flights are largely from our own observations and from reports of co-operators. Duck use was measured through periodic aerial and ground censuses. Consideration of both the volume of flight and duck use produces statements which, at first glance, seem inconsistent. For example, the volume of the fall flight of mallards crossing Wisconsin is rated as minor. Yet the mallard, because of its adaptability, uses a variety of habitat types and, of all ducks, is one of the few remaining through the fall and winter. Hence, though the volume of the flight is minor, the mallard day use is the highest for all ducks using Wisconsin.

The ruddy duck illustrates the reverse situation. Volume of the fall flight crossing Wisconsin is rated as major. However, duck use is low because only a few lakes and marshes are utilized by this species.

The effect of weather on fall flights is considered only generally. Biweekly censuses provide a measure of duck use, which we use as an index to the broad chronology of migration. To consider the effect of weather on migration in detail, information is required on waterfowl flights for specific dates. We did not have sufficient precise data to make such comparisons.

Methods

Periodic Censuses

Both ground and aerial censuses were conducted each fall in Wisconsin at periodic intervals during the period 1947–58. Aerial censuses were completed in the usual manner. Ground censuses were made from vantage points with the aid of binoculars.

Aerial counts were made at an altitude of 100–200 ft. The exact altitude used at a particular site depended primarily upon local vegetative and lighting conditions. Flights were made on weekdays to avoid disturbing large numbers of hunters. Unless flights were unexpectedly prolonged, all censuses were completed between 9:00 a.m. and 3:00 p.m. This time was picked to benefit observers and to insure the conspicuous presence of ducks on the aquatic areas. Observers have the best light conditions during these hours, and stubble ducks have returned to aquatic loafing sites after feeding in upland fields during early morning hours. Evening flights of stubble ducks do not develop to any appreciable degree before 3:00 p.m.

Actual counts were made of each species whenever time permitted, usually when 20 or fewer birds were present. When flocks or rafts of ducks and coots were encountered, estimates

◀ Photo by C. J. Henry, U.S. Fish and Wildlife Service

were made in multiples of 5, 10, 25, 50, 100, 500, and 1,000, as the flock size warranted. Large rafts of birds were circled more than once. Usually the species composition and a general impression of the numbers involved were secured on the first swing. On the second circle, an actual estimate of numbers was made. If a large raft was composed primarily of one species with a scattering of other species included, an estimate of the total flock size was secured, and counts or estimates of minor species were made. By difference, an estimate of the number of the major species was obtained.

Complete coverage was attempted on all sites censused. Shorelines and strips down the center were flown on aquatic areas too large to see across or where emergent vegetation blocked the vision of observers. When birds were spotted, they were circled and counted or estimated. We do not feel that definite established transects can be censused on large aquatic areas in our region. The distribution of birds varies with direction and velocity of the wind, motor boat disturbance, and hunting pressure. Hence, the procedure of "searching and counting" appears best.

All counts were recorded for individual aquatic sites and for each species. Ducks unidentified in the field were allocated to the identified category on the basis of the percentage identified. Censuses were made throughout Wisconsin within a few days of the scheduled date. Data presented in the text for a given date may actually have been collected plus or minus 1–3 days of the date listed. Adverse weather conditions caused this minor variation in time of census.

Identifying Important Fall Concentration Sites

Various types of information were combined to evaluate the relative importance of Wisconsin aquatic sites to each species of duck and the coot in fall. Sources of information include (1) band recoveries from birds banded outside Wisconsin but recovered within the state, (2) periodic aerial and ground censuses, (3) observations of game managers and conservation wardens, and (4) data assembled by waterfowl project personnel.

Construction of maps showing distribution and relative importance of fall concentration sites for each species involved the following procedures.

1. Figures on duck use from regular periodic censuses are classified in this report according to a 5-category numerical scale, as presented below. Duck and coot day-use figures for each year represent the sum of the birds observed on October 1 and 15, November 1 and 15, and December 1:

   High—10,000 or more
   Moderately high—5,000–9,999
   Medium—2,500–4,999
   Moderately low—500–2,499
   Low—100–499

2. Population figures obtained only for certain dates on aerial and ground censuses were used generally to rate some sites by comparing similar population figures from sites regularly censused. Figures secured during the period when the peak flight was believed present were used whenever possible.
3. Band recoveries helped identify sites used by a species. The total number of recoveries for a site was used in combination with other information to indicate the importance of the site. Variations in the numbers of each species banded, the numbers of banded birds available for recovery, hunting opportunities, and hunting pressure made it impossible to use the total number of recoveries alone to indicate the relative importance of each site.
4. General information was assembled from key people on (1) the location of wood duck roosts and concentrations, (2) local feeding flights of each species, and (3) general movements of ducks from concentration sites to nearby aquatic areas. This material was used in making up the final ratings of sites. Information on local movements was considered essential to supplement periodic estimates of the number of ducks and coots present at a particular time of day (largely between 9:00 a.m. and 3:00 p.m.).

All of those lakes, flowages, and streams that are used briefly as overnight resting sites or as infrequent local feeding sites are not necessarily indicated. Upland feeding areas of stubbling species—the mallard, black duck, and pintail—are not listed. Generally, these upland feeding sites occur within a maximum radius of 10–25 miles of the surface water concentration area. Major diving duck feeding sites, consisting of additional lakes and flowages in the vicinity of concentration areas, occur within a known maximum radius of about 20 miles and are included.

Day-use data used to construct the maps are presented in Appendix D.

Other Sources of Information

Records from ducks and coots banded in Wisconsin and from ducks and coots banded outside Wisconsin but recovered within the state were used to help identify distributional patterns. All recoveries from 1940 through 15 April 1959, were handled using international business machines. A few subsequent recoveries were added later.

Sex and age ratios of ducks are used to explore differential migration and vulnerability of each sex to hunting. Sex and age were determined by direct observation, primarily in spring, and by examining trapped and bagged birds. Banded and shot birds were classified according to sex and age using any one or any combination of (1) plumage coloration, (2) presence or absence of notched tail feathers, (3) bursa measurements, (4) presence or absence of penis, and (5) presence of ovary or testis. Ducks with notched tail feathers in fall were classified as immatures. Cloacal characteristics were used to determine the age of ducks having unnotched tail feathers. All ducks with a bursa depth of 8 mm. or more were classified as immatures.

When discussing sex ratios of individual species of ducks within age groups (immature and adult), sex ratios from

bagged birds are compared with those from ducks observed in spring. From these analyses conclusions are drawn regarding the relative vulnerability of the sexes to shooting. In using this procedure, the assumption is made that nonhunting mortality of hens following the hunting season is not sufficiently disproportionate, large, and consistent to alter the sex ratio rather drastically by spring. We consider this a rather safe assumption. We know of no evidence indicating consistent high mortality of females from approximately January 15 (posthunting season) to March 15 (pre-spring migration). Recorded losses of ducks due to fowl cholera and lead poisoning show proportionate, rather than differential, mortality of sexes (Bellrose *et al.,* 1961:422–424). Rather than disproportionately heavy losses of hens on the wintering grounds, such mortality is anticipated on the breeding grounds (Bellrose *et al.,* 1961:420–426; Keith, 1961:44).

Major Migration Routes

To plan effectively for waterfowl habitat management, it is essential for a state to recognize its position in relation to main fall migration routes of various ducks and the coot. Potentially, the supply of birds is greater along the main flight routes than it is on the fringe of them. Using extensive aerial and ground observations in combination with published and cooperators' records, we have rated the volume of the fall flight of most species crossing Wisconsin (Table 28).

Of nine puddle ducks, we consider the flight of only two —the American widgeon and the blue-winged teal—of major volume. Four diving ducks—the canvasback, lesser scaup, ring-necked duck, and ruddy duck—and the coot also have major flights.

Relative to Wisconsin, there are two main fall flight routes for ducks and coots migrating from their breeding grounds, primarily in Canada, to their wintering grounds. Flight routes of the mallard are described here as representative of those used by many puddle ducks. Routes followed by many diving ducks and the coot are also summarized below. Additional details concerning migratory movements are presented for each species in a later section entitled "Characteristics of Individual Species."

Mallard

The important flight lane of Mississippi Flyway mallards moving southeasterly from their main breeding grounds in the eastern half of Alberta, Saskatchewan, and southwestern Manitoba occurs largely west and southwest of Wisconsin (Bellrose, 1951 and 1957; Bellrose and Sieh, 1960; Cartwright and Law, 1952; Hawkins, 1949; Low, 1957). Bellrose *et al.* (1961: 446) concluded that ". . . the Great Lakes areas are frequented by only a small proportion of the mallard population of the Mississippi Flyway; these areas are to the east of the principal routes used by mallards migrating between their breeding and wintering areas."

Only the eastern fringe of this important flight passes through Wisconsin, primarily in western and southwestern areas adjacent to the Mississippi River. Band recoveries indicate that the Mississippi River and lower parts of the Wisconsin River are the sections of Wisconsin frequented most by these mallards.

In other parts of Wisconsin, fall mallard migrations have been observed along the Wolf-Fox-Rock River valleys, the Lake Michigan shore, and the upper parts of the Wisconsin River valley. Reported observations of game managers and conservation wardens indicate that these flights occur primarily in a north-south direction through Wisconsin.

Diving Ducks and Coot

Included in this discussion of diving ducks is the canvasback, scaup (both lesser and greater), ruddy duck, redhead, and ring-necked duck. Reports of fieldmen indicate that these ducks and the coot migrate into Wisconsin in fall from the west and northwest. The flight route is apparently as broad as the length of the state, with all main arteries of passage being within this area.

Migrations of divers have been carefully observed and reported by Game Manager D. L. Corbin (pers. comm., 1959) on what we believe is the main artery of the fall flight. He states that when a large flight is underway, divers are observed migrating in a 5-mile wide band in an east by southeast direction over the Big Eau Pleine Flowage in Marathon County. Ducks are seen moving as soon as it gets light. Whether or not they migrate during the night is unknown. The bulk of the birds are at altitudes of 800 to 1,000 ft. A steady stream of ducks continues moving each day for a period of 1–3 days, usually with breaks in the stream of only ½–¾ hour. Major flights take place during the last 15 days of October, usually on mild clear days, although temperatures are sometimes near or below freezing. In 1957, big flights occurred on 4 consecutive days (October 17–20). In 1958, a substantial flight occurred on October 29 and 30.

Part of this diving duck flight turns to the south at the Du-Bay Flowage on the Wisconsin River, usually does not stop in the vicinity, and within view of ground observers continues in a southerly direction. The flight continuing south may represent birds going to their Gulf Coast wintering grounds. Canvasbacks continuing east by southeast probably represent birds that winter on the Atlantic Seaboard, especially in Chesapeake Bay (Stewart, Geis, and Evans, 1958). Additional substantiating information is needed to evaluate further this suggested major directional split of ducks migrating over the Big Eau Pleine Flowage.

Because migratory movements of coots occur at night, details of their flight routes through Wisconsin remain unknown. Limited, but well-distributed records suggest that flight routes of this species are similar to those described for diving ducks going to the Atlantic Seaboard, and possibly to the Gulf Coast.

Statewide and Regional Chronology of Fall Duck Use

Statewide, the bulk of the puddle ducks are in Wisconsin between October 1 and November 15 (Fig. 22). Small numbers of diving ducks are in the state by October 1. Large

TABLE 28

Relative Volume of the Fall Flight of Certain Waterfowl Species Crossing Wisconsin

Species	Volume of Flight in Wisconsin	Location of Major Route(s)	Relation of Wisconsin	Reference
Mallard	Minor	Crosses the Dakotas and proceeds south and southeast; major flight crosses Mississippi River and enters Illinois south of Wisconsin.	Northeast of the main artery; eastern fringe of flight occurs primarily in western regions; minor flights cross other regions of Wisconsin.	Hawkins (1949); Cartwright and Law (1952:40); Low (1957); Yancey *et al.* (1958); Cartwright (1956); Bellrose and Sieh (1960); Bellrose (1951 and 1957); Bellrose *et al.* (1961).
Black duck	Minor	East and south of Wisconsin.	On the western fringe of the black duck range; flights occur primarily east and southeast of Wisconsin.	Addy (1953); Yancey *et al.* (1958).
Gadwall	Minor	West of the Mississippi River.	East and north of main flights; eastern fringe of flight crosses Wisconsin.	Jensen (1949:10); Yancey *et al.* (1958).
Pintail	Minor	West of Mississippi River.	East and north of main flights; minor flights going to the Atlantic Coast cross Wisconsin.	Low (1949a); Yancey *et al.* (1958); Cartwright (1956).
Green-winged teal	Minor	West of Mississippi River (?).	Probably east of main flights; flights going to the southeast cross Wisconsin.	Low (1949b); Yancey *et al.* (1958).
Shoveler	Minor	West of Mississippi River.	East and north of main flights; eastern fringe of flight crosses Wisconsin.	Stoudt (1949b); Yancey *et al.* (1958).
Wood duck	Minor	Originate in Wisconsin.	Wisconsin is on the northern fringe of the breeding range. Birds from parts of Minnesota and Upper Michigan pass through Wisconsin.	Pirnie (1935); Kaczynski and Geis (1961).
American widgeon	Major	Interior portion of the Central Flyway with diagonal offshoots going southeast.	Southeast flights going to Atlantic Coast cross Wisconsin.	Smith (1949a); Yancey *et al.* (1958).
Blue-winged teal	Major	Interior portion of the Central Flyway with diagonal offshoots going southeast.	Southeast flights cross Wisconsin.	Stoudt (1949c); Yancey *et al.* (1958); Cartwright (1956:42).
Redhead	Minor	Secondary trunk route east–southeast to Chesapeake Bay crosses Wisconsin.	Located on the second most important flight route of this species.	Robbins (1949); Yancey *et al.* (1958); Weller (1964:80).
Canvasback	Major	Primary trunk route east–southeast to Chesapeake Bay crosses Wisconsin.	Located on the most important flight route of this species in North America.	Stewart (1949); Stewart, Geis, and Evans (1958); Yancey *et al.* (1958).
Ring-necked duck	Major	Primary route to Atlantic Coast and Gulf Coast believed to cross Wisconsin.	Located on the most important flight routes of this species.	Duvall (1949); Yancey *et al.* (1958); Mendall (1958:307).
Greater scaup	Major(?)	Primary route to Atlantic Coast believed to cross Wisconsin.	Probably located on one of the most important flight routes of the species.	Aldrich (1949a).
Lesser scaup	Major	Primary route to Atlantic Seaboard and Gulf Coast crosses Wisconsin.	Located on the most important flight routes of the species.	Aldrich (1949b); Yancey *et al.* (1958); Cartwright (1956).
Ruddy duck	Major	Primary route to Atlantic Seaboard and Gulf Coast crosses Wisconsin.	Located on the important flight routes now recognized for this species.	Smith (1949b); Yancey *et al.* (1958).
Coot	Major	Primary route to Atlantic Seaboard, Gulf Coast and other more southern areas crosses Wisconsin.	Located on the important flight routes now recognized for this species.	Burton (1959); Yancey *et al.* (1958).

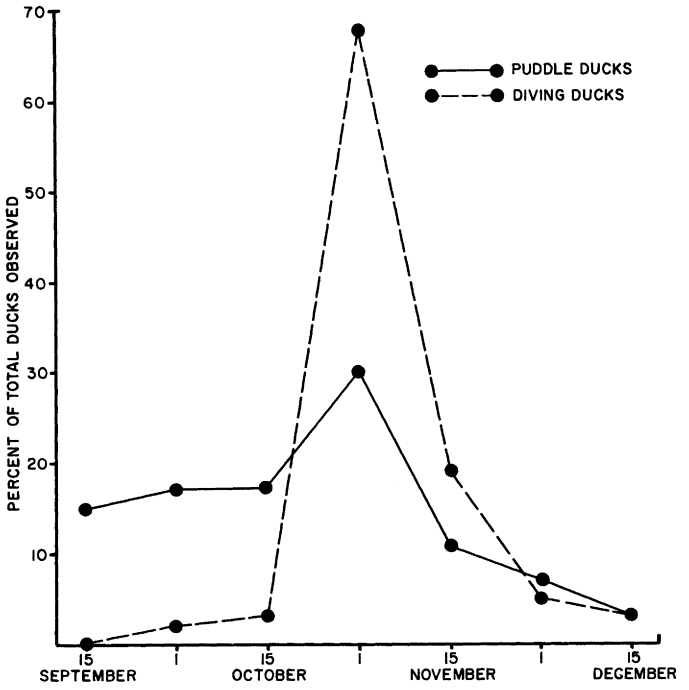


Figure 22. Average seasonal pattern of duck use for puddle ducks and diving ducks in Wisconsin, 1948–56.

numbers are present from October 15 to November 15. Major flights of many ducks arrive during the last half of October. Peak populations of a number of species are reached about November 1. Many ducks leave Wisconsin during early November.

Regionally, within the state, there is little difference from the statewide pattern of migration (Fig. 23). The only difference is the length of time ducks remain after November 15 in certain regions. Ducks leave the inland-northern area earliest. Here, ice eliminates aquatic feeding and rafting areas first. Puddle ducks and diving ducks remain the longest on Green Bay which freezes later than smaller, inland, surface-water areas. By mid-December, in most years, the bulk of the ducks have departed from Wisconsin. Remaining are those relatively few ducks that winter primarily in the southern part of the state.

Examination of the regional and statewide chronology of duck use in Wisconsin discloses no appreciable variation between years. Apparently if there is variation in the time of flight and buildup between years, it occurs during periods of less than 14 days, the interval between censuses. Hochbaum (1955:137) in southern Manitoba and Dillon (1957:11) in southern Wisconsin also reported a calendar regularity in the flight of each species that differed only occasionally among years. With regularity in time of fall flights, variations in the broad pattern of duck use can not be expected.

Composition of Fall Duck Use

Dabblers are the most important group of ducks using Wisconsin in fall. An average of slightly less than two-thirds of the duck use recorded during the 3-year period of 1954–56 was by puddlers (Table 29). Mallards, black ducks, and pintails, the upland stubble feeders, averaged 40 percent of the total duck use. American widgeon made up one-fifth of all duck use.

Diving ducks average slightly more than one-third of the duck use. Canvasback, ringneck, and scaup, in decreasing order of importance, were the three most important divers.

Ducks frequenting Wisconsin in very limited numbers (duck use) include the gadwall, green-winged teal, shoveler, bufflehead, ruddy duck, hooded merganser, common merganser, and red-breasted merganser.

Coots were, by far, more abundant than any single species of duck stopping in Wisconsin in fall (Table 29).

As one might expect, importance of duck use for the different duck species varies between calendar dates and regions of Wisconsin (Table 30). These variations very likely result from differences in time of flight, location of migratory flight lanes, and habitat preferences among species.

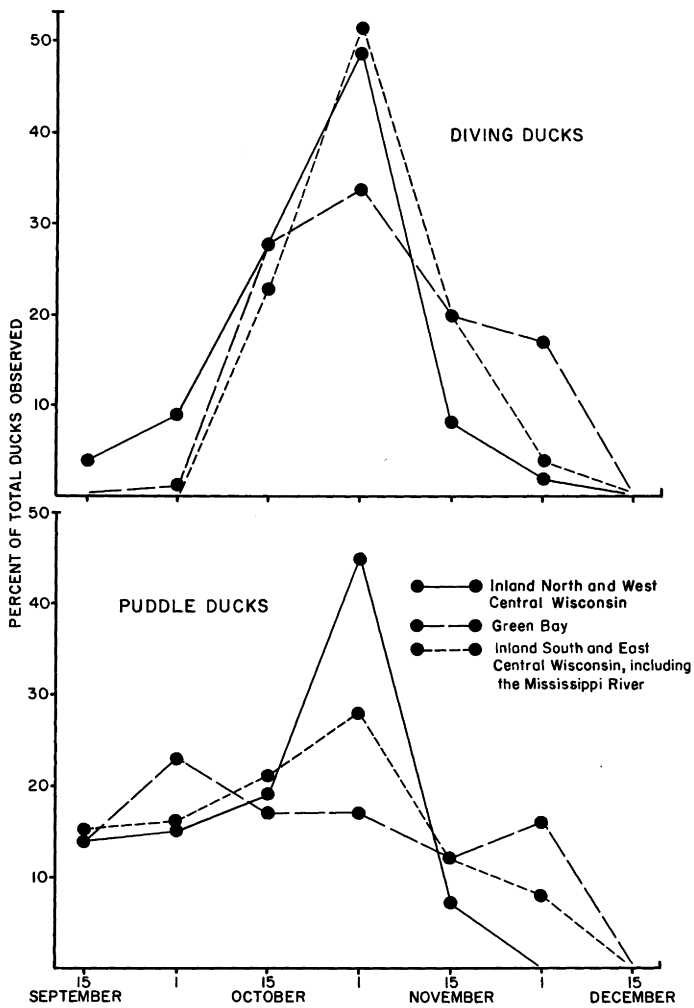


Figure 23. Average seasonal pattern of duck use for puddle ducks and diving ducks in different regions of Wisconsin, 1954–56.

TABLE 29

Relative Importance of Species Making Up the Fall Duck and Coot Day Use in Wisconsin*

Species	Percent Per Year			Total	
	1954	1955	1956	Number	Percent
Puddlers					
Mallard	33	26	34	732,000	30
American widgeon	28	15	20	483,200	20
Black duck	8	5	7	165,900	7
Blue-winged teal	3	4	3	88,900	4
Pintail	5	3	2	77,300	3
Green-winged teal	Tr.	Tr.	Tr.	8,700	Tr.
Wood duck	Tr.	Tr.	Tr.	6,200	Tr.
Shoveler	Tr.	Tr.	Tr.	600	Tr.
Total Puddlers	78	54	67	1,562,800	64
Divers					
Canvasback	13	14	14	335,100	14
Ring-necked duck	1	13	10	234,000	10
Scaup	6	11	4	185,400	8
Redhead	1	5	3	74,800	3
Com. goldeneye	1	1	1	21,400	1
Ruddy duck	Tr.	Tr.	Tr.	13,500	Tr.
Bufflehead	Tr.	Tr.	Tr.	3,500	Tr.
Total Divers	22	45	33	867,700	36
Mergansers					
Total Mergansers	Tr.	Tr.	Tr.	10,700	Tr.
Total Duck Day-use	541,600	1,056,000	843,600	2,441,200	—
Coot					
Total day-use	305,600	703,900	901,800	1,911,300	—
Percent day-use**	36	40	52	44	—

* Duck and coot day-use figures for each year are based on the sum of the birds observed on October 1 and 15, November 1 and 15, and December 1 on aerial censuses of approximately 200 inland fall concentration areas distributed throughout the state, the Mississippi River, and parts of Green Bay. Lake Michigan was not censused. Hence, old squaw ducks and other ducks on the lake are not represented in this table. All figures are rounded to the nearest 100. Figures on the wood duck are minimal because it is difficult to census this species; figures on the green-winged teal may be minimal for the same reason.

** Coot day-use is expressed as a percentage of the total day-use for both ducks and coots.

Characteristics of Individual Species

Blue-winged Teal

Chronology of Duck Use: The blue-winged teal is the earliest fall migrant. Between August 15 and 30, small flocks (20–100) at favorite feeding and loafing sites increase in size as migrants and locally produced teal join the widespread congregations. Peak populations are reached by mid-September (Fig. 24), after which there is a decline in numbers. This decline, as far as we now know, is not triggered by weather conditions, inadequate food supplies, or man's activities. Rather, departure of some birds at this time is normal behavior. By mid-October, relatively few teal remain in Wisconsin, even though open water and food are abundant and available. Teal depart even from refuge areas where trespassing is prohibited. Waterfowl hunting, which starts in early October, may hasten departure from nonrefuge areas, but only by a few days. In Iowa, Bennett (1938:17) also found that the shooting season had little effect upon the length of time teal remained. Practically all teal have left Wisconsin by November 1. Time of departure throughout the fall is apparently controlled by an internal, physiological rhythm and not importantly by food or weather, until freeze-up occurs.

We rated the blue-winged teal volume of flight through Wisconsin as "major" (Table 28). Yet the mallard, with a "minor" flight rating, made up more than seven times as much of the average duck use as the bluewing in 1954–56 (Table 29). There is no contradiction of facts. Duck-use figures in Table 29 refer to populations censused within the specific dates of October 1 and December 1. Many bluewings enter and leave Wisconsin prior to October 1. Therefore, the

TABLE 30

Three Most Important Species of Ducks on Different Calendar Dates in General Regions of Wisconsin*

Date	Northwest	Northeast	Miss. River	West Central	East Central	Green Bay	Southern
Sept. 15	Wood duck	Black duck	B-w. teal	Mallard	B-w. teal	Mallard	Am. widgeon
	Mallard	Mallard	Mallard	B-w. teal	Am. widgeon	B-w. teal	Mallard
	Ringneck	B-w. teal	Am. widgeon	Black duck	Mallard	Black duck	B-w. teal
Oct. 1	Ringneck	Ringneck	B-w. teal	Mallard	B-w. teal	Mallard	Mallard
	Mallard	Black duck	Am. widgeon	Black duck	Mallard	Am. widgeon	Black
	Wood duck	Mallard	Mallard	Am. widgeon	Am. widgeon	B-w. teal	B-w. teal
Oct. 15	Scaup	Scaup	Ringneck	Mallard	Am. widgeon	Mallard	Mallard
	Ringneck	Black duck	Mallard	Am. widgeon	Canvasback	Scaup	Black duck
	Mallard	Mallard	Am. widgeon	Black duck	Mallard	Ruddy duck	Pintail
Nov. 1	Scaup	Scaup	Scaup	Mallard	Scaup	Scaup	Mallard
	Ringneck	Ringneck	Ringneck	Black duck	Mallard	Canvasback	Canvasback
	Mallard	Goldeneye	Mallard	Ringneck	Black duck	Mallard	Pintail
Nov. 15	Scaup	Scaup	Scaup	Mallard	Canvasback	Mallard	Canvasback
	Mallard	Goldeneye	Ringneck	Black duck	Scaup	Scaup	Mallard
	Goldeneye	Ringneck	Mallard	Scaup	Mallard	Black duck	Black duck
Dec. 1	Goldeneye	Goldeneye	Mallard	Mallard	Mallard	Black duck	Mallard
	Scaup	Bufflehead	Scaup	Black duck	Black duck	Mallard	Canvasback
	Bufflehead	Scaup	Ringneck	Scaup	Goldeneye	Scaup	Black duck

* Based on combined aerial and ground census data from approximately 200 aquatic sites for 1954, 1955, and 1956. Goldeneye refers to common goldeneye; scaup includes both greater and lesser, with the latter making up the bulk of the birds.

recorded duck use of the blue-winged teal is much less than for the mallard which has a later peak of migration and remains until freeze-up.

Important Fall Concentration Sites: While in Wisconsin, the blue-winged teal is widely distributed (Fig. 25). Concentrations of 20 to 1,000 birds are common throughout the state, but primarily in the southern one-half. Those aquatic sites with shallow water and good growths of moist soil (smartweeds and millets) and submerged aquatic plants are used most frequently. Shorelines exposed by receding water levels are also very attractive and are heavily used when relatively free of disturbance.

Differential Migration of Sexes: A large part of the blue-winged teal migration (Fig. 24) takes place before the Wisconsin waterfowl hunting season opens in early to mid-October. Whether or not differential migration is involved in these prehunting season movements is revealed by examining the sex and age ratios of the birds bagged.

Sex ratios of bluewings shot in Wisconsin show a consistent preponderance of females of both adults and immatures (Table 31). With the sex ratio of bluewing ducklings (largely 1–2 months old) approximately 50:50 (Bennett, 1938:4; Bellrose *et al.*, 1961:403), the highly significant preponderance of immature hens in the bag is quite unexpected. Lack of males in Wisconsin shot samples indicates that the late summer or early fall migration involves males of both ages, and possibly a disproportionate stop-over of migrant females of both ages. Since adult drakes exceed adult hens in spring (Bennett, 1938:4; Bellrose *et al.*, 1961:414; Table 31), old males must exceed females in the fall population as well.

Late summer or early fall departure of adult bluewings occurs in other northern areas. Hochbaum (1944:130) reported a preponderance of adult females and a balanced immature sex ratio in blue-winged teal bagged by hunters at Delta, Manitoba. August and September banding records from Delta for 3 years (1946 and 1948–49) showed a scarcity of both adult drakes and hens (Sowls, 1955:165). If trapped bluewings properly represent the portion of adults in the population, here is evidence for late summer and early fall departure of both adult hens and drakes from Manitoba. In

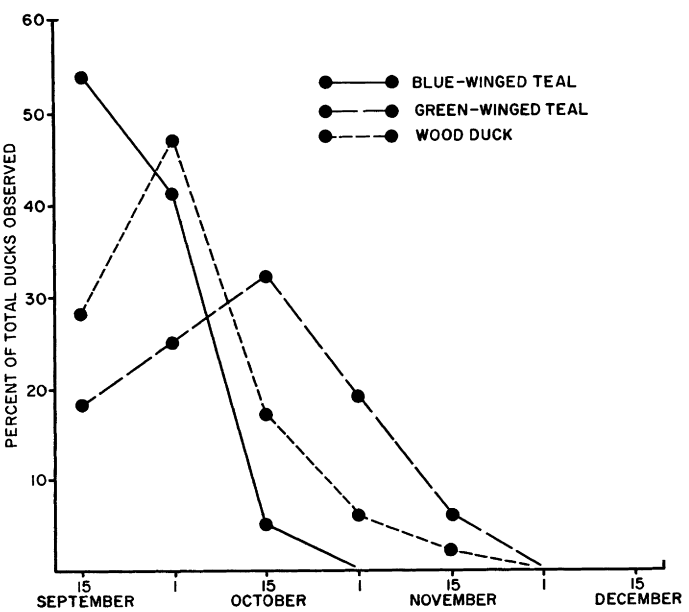


Figure 24. Average seasonal pattern of duck use for the blue-winged teal, green-winged teal, and wood duck in Wisconsin, 1948–56.

TABLE 31

Sex Ratios of Blue-winged Teal Shot and Observed in Wisconsin, 1941–51

Source	Year	Adult			Immature		
		Number Male	Number Female	Percent Male	Number Male	Number Female	Percent Male
A. Fall shot samples, Horicon Marsh[1]	1949	7	63		78	122	39**
	1950	1	15		15	25	
	1951	23	87	21**	93	193	33**
Subtotal and Mean		31	165	16**	186	340	35**
Other sites (about 25)	1947	20	70		99	186	35**
	1948	7	11		44	60	42
	1949	45	190	19**	308	551	36**
	1950	25	75	25**	138	206	40**
Subtotal and Mean		97	346	22**	589	1,003	37.0**
Wisconsin	1947–51	128	511	20**	775	1,343	36.6**
B. Observed in spring[2]	1941	88	79	53			
	1942	41	31				
	1943	7	5				
	1947	820	638	56.2**			
	1950	52	35				
Wisconsin		1,008	788	56.1**			

[1] At Horicon Marsh, hunters were checked at an established station throughout the waterfowl hunting season from approximately 7:00 a.m. to shortly after the daily closing hour of shooting; at all other stations hunters were checked on the first few days of the waterfowl hunting season and in a few cases a few days thereafter. Fewer sites were checked in 1947 and 1948 than in 1949 and 1950.

[2] Observations were made on more than 25 different aquatic sites in some years. Except for 1950, figures are from Zimmerman (1961).

** Highly significant difference from a 50:50 ratio.

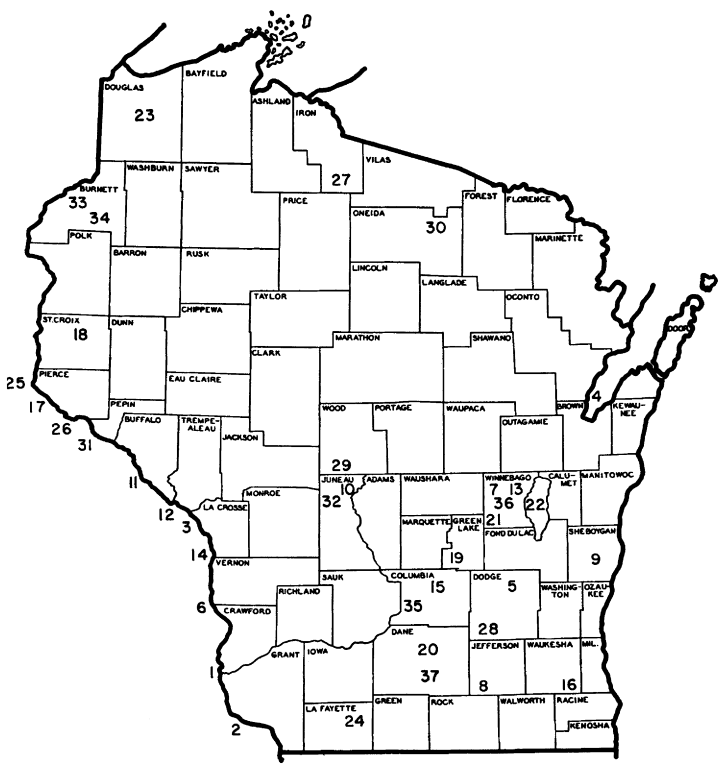


Figure 25. Distribution and relative importance of some fall blue-winged teal concentration sites in Wisconsin. (Band recoveries from blue-winged teal banded outside Wisconsin indicate more concentration sites scattered throughout the state, but primarily south of a line from Brown County to Buffalo County; the bulk of these sites would undoubtedly fall in the moderately low to low duck-use categories. Blue-winged teal also occur as small groups in the bays and sloughs of Lake Superior.) Average fall blue-winged teal day-use:

Moderately low

1. Mississippi River—Pool 10
2. Mississippi River—Pool 11
3. Mississippi River—Pool 7
4. Green Bay
5. Horicon Marsh
6. Mississippi River—Pool 9
7. Lake Poygan
8. Lake Koshkonong
9. Sheboygan Marsh
10. Necedah National Wildlife Refuge
11. Mississippi River—Pool 5
12. Mississippi River—Pool 6
13. Big Lake Butte des Morts

Low

14. Mississippi River—Pool 8
15. Mud Lake
16. Big Muskego Lake
17. Mississippi River—Red Wing to Maiden Rock
18. Oakridge Refuge
19. Lake Puckaway
20. Waunakee Marsh
21. Rush Lake
22. Lake Winnebago
23. Gordon Flowage
24. Yellowstone Conservation Area
25. Mississippi River—Hastings to Red Wing
26. Mississippi River—Pool 4
27. Flambeau Flowage
28. Crawfish River, segment
29. Wood County Public Hunting Grounds
30. Thunder Lake
31. Mississippi River—Maiden Rock to Wabasha
32. Meadow Valley Conservation Area
33. Crex Meadows Conservation Area
34. Clam Lake
35. Pine Island Conservation Area
36. Lake Winneconne
37. Lake Mendota

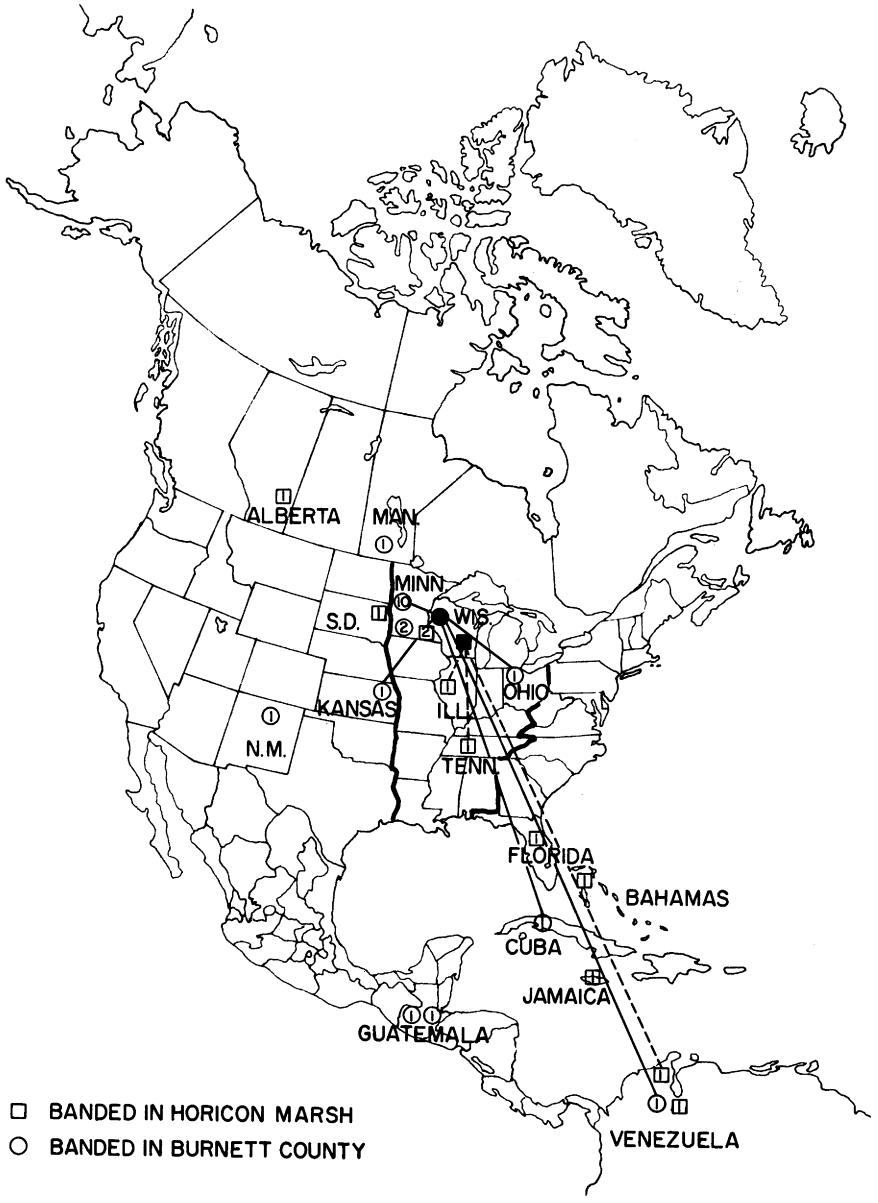


Figure 26. First-year and subsequent-year recoveries of blue-winged teal banded in fall in Burnett County and Horicon Marsh, Wisconsin. All Wisconsin recoveries are omitted. Based on 31 recoveries. First-year recoveries are arbitrarily connected to the banding stations by lines.

addition to late summer migration of old males, possibly some adult females from northern areas stop and linger more frequently during migration than do drakes. Such differential behavior would help explain the unbalanced adult sex ratio in fall in Wisconsin. Other than earlier migration of males, more frequent stop-over of females, or both, we know of no other plausible explanations for the unbalanced sex ratio of immature and adult blue-winged teal registered in Wisconsin shot samples.

Migratory Movements from Wisconsin: First-year recoveries of Wisconsin-banded blue-winged teal occur primarily in a south by southeast direction from the state, except for an appreciable westward movement into Minnesota (Fig. 26 and Hickey, 1956). One direct recovery occurred to the southwest. Many of the birds leave the United States and go to localities in South America, Central America, and the West Indies.

American Widgeon

Chronology of Duck Use: The widgeon, like the blue-winged teal, is an early fall migrant. We observed a few flocks of adult males at Horicon Marsh in late July. Since the widgeon rarely breeds in Wisconsin, these have to be migrants. By mid-August numerous flocks are present in suitable localities, largely in southern Wisconsin. On 15 August 1949, more than 10,000 widgeon were on Horicon Marsh alone. During September additional birds arrive. Peak populations occur in late October (Fig. 27), after the hunting season is open. Widgeon react to hunting pressure by concentrating on aquatic sites providing (1) preferred submerged aquatic foods, and (2) protection from disturbance. At such sites, some of the birds remain until ice eliminates their favorite shallow water foods. After November 15, the widgeon is rarely encountered in Wisconsin.

Important Fall Concentration Sites: Refuges and large open-water lakes, part of which support extensive beds of submerged aquatic plants, are the main concentration sites. Such areas are located primarily in the southern one-half of Wisconsin (Fig. 28). The Horicon National Wildlife Refuge is the most important fall gathering point. On 8 November

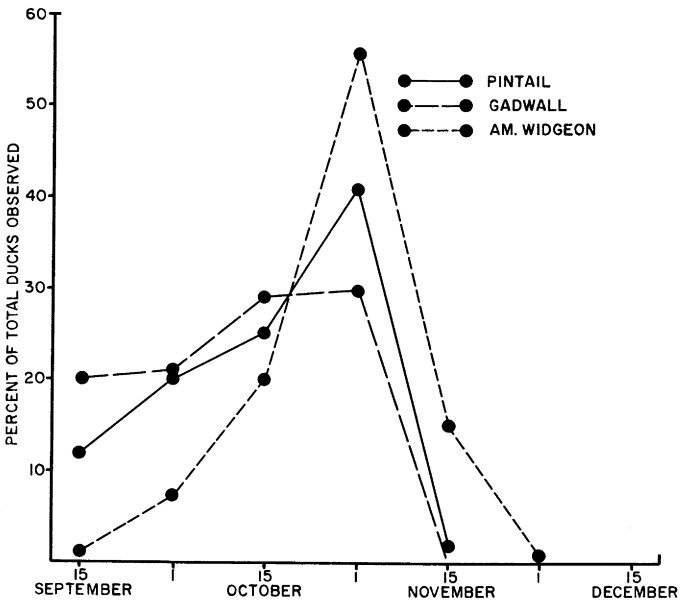


Figure 27. Average seasonal pattern of duck use for the pintail, gadwall, and American widgeon in Wisconsin, 1948–56.

1954, an estimated peak population of 67,000 widgeon were observed there by us.

Differential Migration of Sexes: Field observations made while we were tending duck traps on Horicon Marsh show that in some years flocks of American widgeon arriving on migration in August and September are largely adult males. In Manitoba, adult males are known to depart from Delta Marsh in late August and early September (Hochbaum, 1955:107).

Mid-October shot samples show a highly significant excess of adult males at Horicon Marsh and a significant excess for Wisconsin (Table 32). A similar preponderance of adult drakes was reported in bag samples from Manitoba, Illinois, and Utah (Bellrose *et al.*, 1961:404–07). An excess of drakes in the Manitoba sample is noteworthy in view of the early departure of adult male widgeon reported for Delta (Hochbaum, 1955:107). While old drakes depart in late August and early September from some localities in Manitoba, apparently they remain at other sites until at least mid- to late September (when shot samples are obtained).

Drakes also exceed hens among adults in spring (Bellrose *et al.*, 1961:414; Table 32). This fact indicates that despite differential migration of adult sexes in fall, shooting may roughly remove adult drake and hen widgeon in proportion to their existence in the population.

Immature American widgeon shot in Wisconsin show a significant excess of males at Horicon Marsh and a balanced sex ratio for all sites sampled (Table 32). In other areas of the Mississippi Flyway, a balanced sex ratio of immatures was reported (Bellrose *et al.*, 1961:403–06). In Utah, a preponderance of immature drakes was found (Bellrose *et al.*, 1961: 407). Apparently differential migration and concentration of immature drake and hen widgeon occur in certain localities.

Migratory Movements from Wisconsin: Only six recoveries of American widgeon banded at Horicon Marsh in April are available. These occurred in subsequent years in Ohio (1), the Dominican Republic of the West Indies (2), Cuba (1), Virginia (1), and Maryland (1). Although meager in number, these recoveries support previous statements concerning the flight routes of this species. Smith (1949a:11) concluded that there was a major flight route through the interior portion of the Central Flyway, with some movements occurring as diagonal offshoots from this route and proceeding across the Mississippi River to the Atlantic Coast and beyond into the West Indies and the Bahamas.

Pintail

Chronology of Duck Use: With the pintail breeding infrequently in Wisconsin, sight records usually indicate the presence of migrants. Flocks of drake pintails have been observed in late July and early August. Flocks of mallards and

Figure 28. Distribution and relative importance of most fall American widgeon concentration sites in Wisconsin. Average fall American widgeon day-use:

High
1. Horicon Marsh

Moderately High
2. Mississippi River—Pool 7

Medium
3. Mississippi River—Pool 5
4. Big Lake Butte des Morts
5. Lake Poygan
6. Mississippi River—Pool 9

Moderately Low
7. Necedah National Wildlife Refuge
8. Mississippi River—Pool 11
9. Mississippi River—Pool 4
10. Partridge Crop Lake
11. Rush Lake
12. Lake Winneconne
13. Mississippi River—Pool 8
14. Mississippi River—Hastings to Red Wing
15. Green Bay
16. Lake Puckaway

Low
17. Mississippi River—Pool 6
18. Mississippi River—Maiden Rock to Wabasha
19. Fox Lake
20. Oakridge Refuge
21. Lake Koshkonong
22. Lake Mendota
23. Cincoe Lake
24. Lake Winnebago
25. Sheboygan Marsh

TABLE 32

Sex Ratios of American Widgeon Shot and Observed in Wisconsin, 1941–51

Source	Year	Adult			Immature		
		Number Male	Number Female	Percent Male	Number Male	Number Female	Percent Male
A. Fall-shot samples, Horicon Marsh[1]	1949	18	19		121	91	57
	1950	37	32		124	119	51
	1951	81	26	76**	117	88	57
Subtotal and Mean		136	77	64**	362	298	55*
Other sites (about 25)	1946	0	3		15	8	
	1947	3	8		39	82	32**
	1948	22	26		185	186	50
	1949	22	22		71	73	49
	1950	5	3		18	25	
Subtotal and Mean		52	62	46	328	374	47
Wisconsin	1946–50	188	139	57*	690	672	50.7
B. Observed in spring[2]	1941	154	141	52			
	1942	154	147	51			
	1943	102	79	56			
	1947	1,099	765	58.9**			
	1950	58	39				
Wisconsin		1,567	1,171	57.2**			

[1] At Horicon Marsh, hunters were checked at an established station throughout the waterfowl hunting season from approximately 7:00 a.m. to shortly after the daily closing hour of shooting each day; at all other sites hunters were checked on the first few days of the waterfowl hunting season and in a few cases a few days thereafter. Fewer sites were checked in 1946, 1947 and 1950 than in 1948 and 1949.

[2] Observations were made at more than 25 different aquatic sites in some years. Except for 1950, figures are from Zimmerman (1961).

* Significant difference from a 50:50 ratio.

** Highly significant difference from a 50:50 ratio.

black ducks feeding in harvested grain fields contain pintails in mid-August. By mid-September the species is common. Populations continue to grow in size in October and reach peak levels in November (Fig. 27). After mid-November pintails are scarce, even though corn is available in harvested fields. Apparently the pintail uses waste grain for food, but not corn to any appreciable degree. After ice covers the shallow aquatic feeding and loafing sites, usually about mid-November, pintails depart even though deeper open water remains for rafting and waste corn is available for food.

Important Fall Concentration Sites: Practically all concentration sites are located in the southern one-half of Wisconsin (Fig. 29). Only small numbers of pintails occur briefly in northern areas, largely at the time major flights occur in October. During the early part of the hunting season (October), pintails occur primarily in refuge areas or as rafts on lakes having large expanses of open water. On such lakes, they feed in shallow water zones either at night or after legal shooting hours.

Differential Migration of Sexes: With the exception of a significant excess of immature hens in 1 year (1951), sex ratios of pintails bagged by Wisconsin hunters showed a 50:50 ratio in both age classes (Table 33). In areas outside of Wisconsin the sex ratio of immature pintails varies. A balanced ratio was reported for pintails hatched in incubators at Delta, Manitoba (Sowls, 1955:164). Trapped ducklings, 1–2 months old, had a predominance of drakes in Alberta, a balanced sex ratio in Saskatchewan, and a significant lack of drakes in Manitoba (Bellrose *et al.*, 1961:403). A limited sample (92) of immatures bagged at Delta, Manitoba showed a balanced sex ratio (Hochbaum 1944:130). Shot samples of immatures in Manitoba had a balanced sex ratio, in Illinois a highly significant excess of drakes, and in Utah a highly significant portion of hens (Bellrose *et al.*, 1961: 404–07). Such variability in the sex ratio of immature pintails between localities suggests differential migration of sexes.

Adult sex ratios, with but few exceptions, show an excess of drakes in fall and spring. In spring, a highly significant excess of drakes was found at Delta, Manitoba (calculated from Sowls, 1955:164), in Wisconsin (Table 33), and for a sum of nine regions of North America (Bellrose *et al.*, 1961: 414).

Fall-shot samples disclosed a highly significant excess of females in Manitoba, a highly significant preponderance of drakes in Illinois and Utah (Bellrose *et al.*, 1961:404–07), and a balanced adult sex ratio in Wisconsin (Table 33). These data suggest either that (1) adult drakes use Wisconsin in fall to a lesser degree than other states, or (2) hens are more vul-

TABLE 33

Sex Ratios of Pintails Shot and Observed in Wisconsin, 1941–51

Source	Year	Adult			Immature		
		Number Male	Number Female	Percent Male	Number Male	Number Female	Percent Male
A. Fall-shot samples, Horicon Marsh[1]	1949	40	50		119	127	48
	1950	130	4	48	90	81	53
	1951	43	41		38	66	37*
Subtotal and Mean		213	232	48	247	274	47
Other sites (about 25)	1946	4	2		5	1	
	1947	19	19		59	44	57
	1948	31	17		105	101	51
	1949	27	27		100	129	44
	1950	10	9		36	28	
Subtotal and Mean		91	74	55	305	303	50
Wisconsin		304	306	50	552	577	48.9
B. Observed in spring[2]	1941	131	105	56			
	1942	90	80	53			
	1943	73	55	57			
	1947	315	254	55*			
	1950	78	54	59*			
Wisconsin		687	548	55.6**			

[1] At Horicon Marsh, hunters were checked at an established station throughout the waterfowl hunting season from approximately 7:00 a.m. to shortly after the daily closing hour of shooting each day; at all other stations hunters were checked on the first few days of the waterfowl hunting season and in a few cases a few days thereafter. Fewer sites were checked in 1946, 1947 and 1950 than in 1948 and 1949.

[2] Except for 1950, figures are from Zimmerman (1961).

* Significant difference from a 50:50 ratio.

** Highly significant difference from a 50:50 ratio.

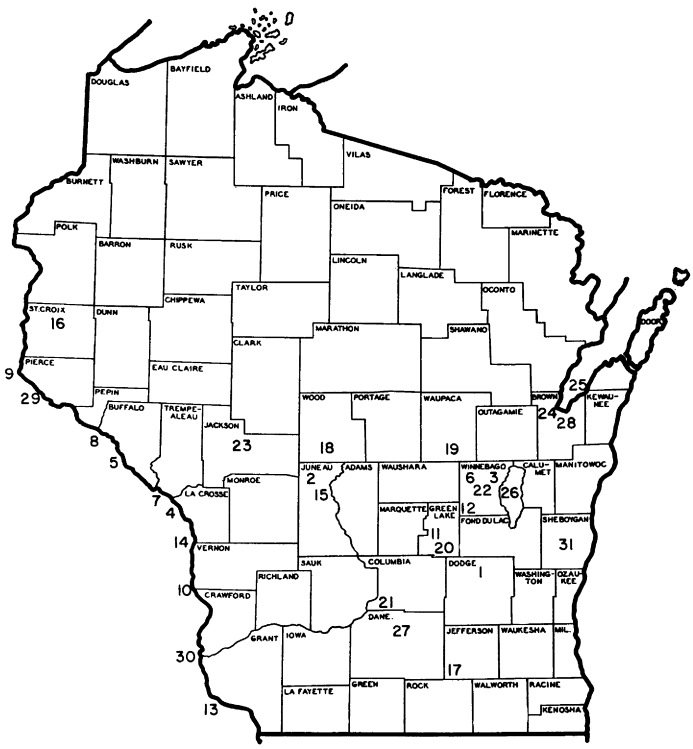


Figure 29. Distribution and relative importance of most fall pintail concentration sites in Wisconsin. Average fall pintail day-use:

Moderately High

1. Horicon Marsh

Medium

2. Necedah National Wildlife Refuge
3. Big Lake Butte des Morts

Moderately Low

4. Mississippi River—Pool 7
5. Mississippi River—Pool 5
6. Lake Poygan
7. Mississippi River—Pool 6
8. Mississippi River—Pool 4
9. Mississippi River—Hastings to Red Wing
10. Mississippi River—Pool 9
11. Lake Puckaway
12. Rush Lake
13. Mississippi River—Pool 11

Low

14. Mississippi River—Pool 8
15. Petenwell Flowage
16. Oakridge Refuge
17. Lake Koshkonong
18. Sandhill Wildlife Area
19. Partridge Crop Lake
20. Lake Maria
21. Lake Wisconsin
22. Lake Winneconne
23. Black River State Forest
24. Brown County Game Sanctuary
25. Green Bay
26. Lake Winnebago
27. Waunakee Marsh
28. Bay Beach Game Sanctuary
29. Mississippi River—Red Wing to Maiden Rock
30. Mississippi River—Pool 10
31. Sheboygan Marsh

nerable to shooting in Wisconsin than elsewhere. We believe differential migration of adult drake pintails minimizes the number available to hunters in Wisconsin.

Migratory Movements from Wisconsin: Six recoveries from pintails banded in fall in Wisconsin are available. Two first-year recoveries occurred in Kentucky and Louisiana. Four subsequent year recoveries occurred in Manitoba, Ontario, Michigan, and Delaware. At least some pintails leaving Wisconsin in fall go south to the Gulf Coast.

Gadwall

Chronology of Duck Use: Like the pintail, the gadwall breeds only in small numbers in certain localities in Wisconsin. Migrants begin arriving during the last 15 days of September, and the population increases until a peak is reached about November 1 (Fig. 27.) As ice eliminates favored, shallow-water feeding areas between November 1 and 15, gadwall populations rapidly decline. A few birds remain until late November, primarily along the Mississippi River. After December 1, gadwalls are rarely seen in Wisconsin.

Important Fall Concentration Sites: Small flocks of gadwall are found in southern Wisconsin, especially in the southwest along the Mississippi River. Very few gadwall have been observed in northern Wisconsin. After the waterfowl hunting season opens, the birds are concentrated in refuge areas where submerged aquatic foods are abundant and available in shallow water (Fig. 30). In Wisconsin, this species usually does not raft in open water of large lakes. The largest single concentration of gadwall is found on the Horicon National Wildlife Refuge.

Migratory Movements from Wisconsin: No recoveries of the limited number of gadwalls banded in Wisconsin have occurred outside the state (Jensen, 1949).

Wood Duck

Chronology of Duck Use: Another early fall migrant is the wood duck. Flocks are common in August and September. The population increase in late September (Fig. 24) undoubtedly represents (1) birds from Wisconsin streams enlarging concentrations at the sites censused, and (2) an influx of small numbers of birds, primarily from Minnesota and northern Michigan. Peak populations occur about October 1 (Fig. 24). Populations in most refuge and nonrefuge areas decline considerably by mid-October. Some birds remain, primarily in refuge areas in west central Wisconsin, until late November. Freeze-up then eliminates the shallow water required for roosting, and the last wood ducks depart.

Important Fall Concentration Sites: Small flocks of wood ducks are scattered throughout the state, with concentrations occurring largely in bays and sloughs of streams and rivers. Concentrations are located primarily along streams in west central Wisconsin. The Mississippi River is the most important area. General distribution of the 13 main (high and moderately high), fall concentration sites for wood ducks (Fig 31) corresponds, generally, to the distribution of oak trees in Wisconsin as set forth by Curtis (1959:522). Acorns form

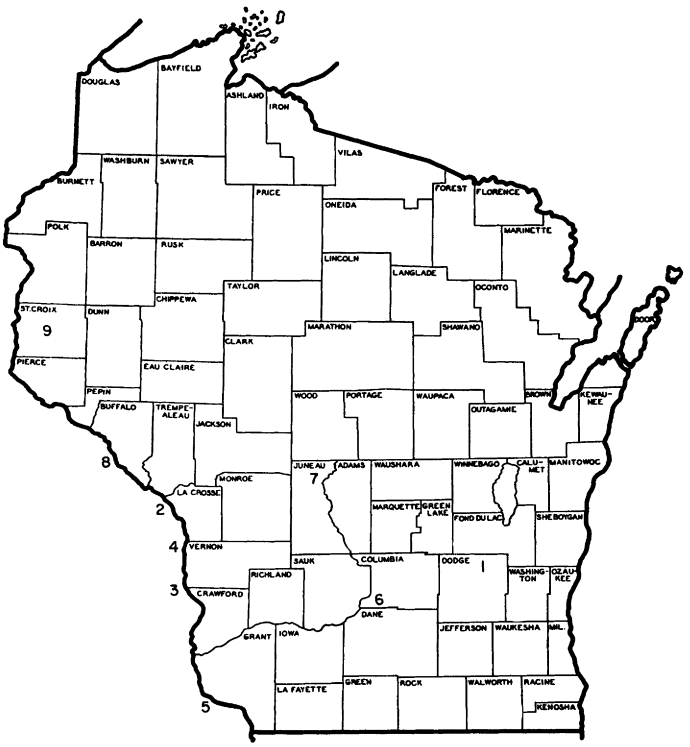


Figure 30. Distribution and relative importance of most fall gadwall concentration sites in Wisconsin. Average fall gadwall day-use:

Moderately High
1. Horicon Marsh

Moderately Low
2. Mississippi River—Pool 7
3. Mississippi River—Pool 9

Low
4. Mississippi River—Pool 8
5. Mississippi River—Pool 9
6. Lake Wisconsin
7. Necedah National Wildlife Refuge
8. Mississippi River—Pool 5
9. Oakridge Refuge

the most important food for wood ducks radiating out from roosts to feed on upland areas.

Differential Migration of Sexes: A large part of the fall migration of the wood duck occurs prior to the opening of the Wisconsin waterfowl hunting season in early to mid-October (Fig. 24). Sex ratios of woodies present in early October show a highly significant excess of both adult and immature males (Table 34). Since the sex ratio at fertilization and hatching is 50:50 (Bellrose *et al.*, 1961:402–03), the predominance of young drakes in hunters' bags suggests that immature females migrate from Wisconsin preceding the opening of the state's waterfowl hunting season. Some adult females may also leave the state during the prehunting season period. We know of no evidence to indicate that flocks of females remain in the state as separate concentrations. With heavy early season hunting pressure on ducks, early departure of females from Wisconsin may be of survival value to the species, if hens are not harvested heavily at southern concentration sites. Mortality rates of sexes and ages are needed for separate geographic areas to evaluate this premise.

Migratory Movements from Wisconsin: Patterns of recoveries were similar for wood ducks banded in Wisconsin in different years and at different banding stations. Therefore, all band recoveries are combined in Figure 32 to give a com-

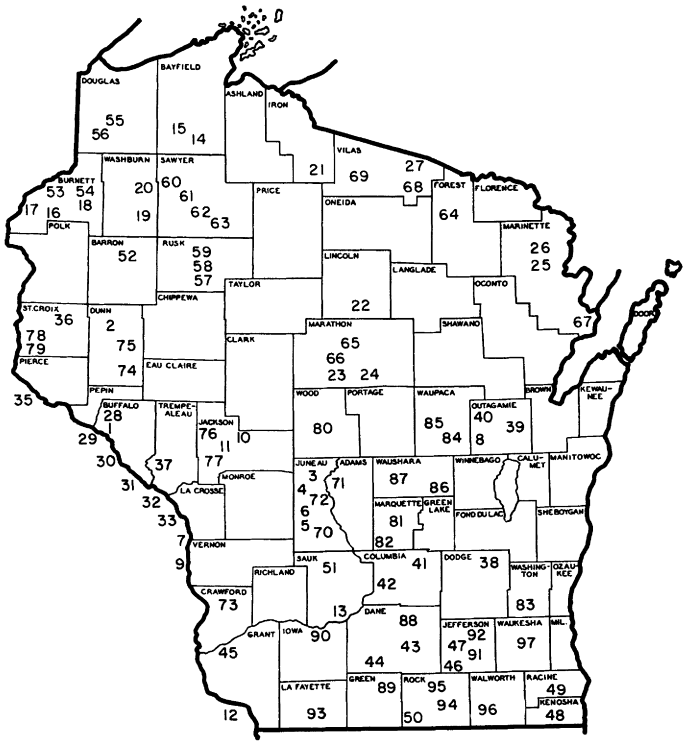


Figure 31. Distribution and relative importance of most fall wood duck concentration sites in Wisconsin. (Based on completed questionnaires from game and law enforcement personnel, 1956) and on periodic censuses, 1948–57.) Average peak number of wood ducks in September:

High (500 or more)

1. Tiffany Public Hunting Grounds (Chippewa River)
2. Hay River
3. Big Yellow River
4. Lemonweir River
5. Little Yellow River
6. Necedah National Wildlife Refuge
7. Mississippi River—Pool 8
8. Embarrass River

Moderately High (301–499)

9. Mississippi River—Pool 9
10. Black River State Forest
11. Black River
12. Mississippi River—Pool 11
13. Wisconsin River

Medium (101–300)

14. Namekagon River
15. Totogatic Lake
16. Clam River
17. St. Croix River
18. Yellow River
19. Town of Birchwood
20. Tranus Lake
21. Flambeau Flowage
22. Wisconsin River
23. Little Eau Plaine Flowage
24. Lac Du Bay
25. Menominee River
26. Pike River
27. Ellersons Lake
28. Chippewa River
29. Mississippi River—Pool 4
30. Mississippi River—Pool 5
31. Mississippi River—Pool 5a
32. Mississippi River—Pool 6
33. Mississippi River—Pool 7
34. Mississippi River—Pool 10
35. Mississippi River—Hastings to Maiden Rock
36. Apple River
37. Trempealeau River
38. Horicon Marsh
39. Black Creek
40. Wolf River
41. Mud Lake
42. Wisconsin River
43. Door Creek
44. Hook Lake
45. Wisconsin River
46. Lake Koshkonong
47. Mud Lake
48. Des Plaines River
49. Tichigan Marsh
50. Sugar River
51. Baraboo River

Moderately Low (50–100)

52. Red Cedar River
53. Loon Creek
54. Point Lake
55. St. Croix Flowage
56. St. Croix River
57. Holcombe Flowage
58. Lea Lake
59. Lake McGee
60. Billy Bog Flowage
61. Brunet River
62. Chippewa River
63. Flambeau River
64. Rat Lake
65. Lake Wausau
66. Big Eau Pleine Reservoir
67. Peshtigo River
68. Deerskin Flowage
69. Restows Flowage
70. Castle Rock Flowage
71. Roche-a-Cri Creek
72. Petenwell Flowage
73. Rush Creek
74. Chippewa River
76. Lake Tainter
76. Beaver Creek
77. Rickey Creek
78. St. Croix River
79. Willow River
80. Yellow River
81. Montello River
82. Neenah Creek
83. Jackson Marsh
84. Partridge Lake
85. Wolf River
86. Lake Poygan
87. Lower Pine River
88. Badfish Creek
89. Albany Public Hunting Grounds
90. Wisconsin River
91. Bark River
92. Rock River
93. Yellowstone Conservation Area
94. Shear's Marsh
95. Yahara River
96. Turtle Creek
97. Jericho Creek

posite picture of the recovery pattern of wood ducks migrating from Wisconsin.

Wood ducks move south from Wisconsin and remain within the United States (Fig. 32; Hickey, 1956). Of the total 405 band recoveries examined by Hickey (1956), Kaczynski and Geis (1961), and ourselves, 91 percent occurred in the Mississippi Flyway. Outside the Mississippi Flyway, recoveries were reported from Nebraska (1), Kansas (3), Oklahoma (3), Texas (23), Georgia (2), Florida (4), and South Carolina (1). Only two recoveries occurred north of Wisconsin; those were in southern Ontario. Both birds were immatures taken the same season as banded. Such post-breeding season movements are common in many species of ducks and represent exploratory, undirected, wandering by young birds (Hochbaum, 1955:144). Apparently a large part of the wood ducks using Wisconsin in fall proceed south along the Mississippi Valley to wintering areas in Arkansas, Louisiana, Texas, Mississippi, and other southern states.

Green-winged Teal

Chronology of Duck Use: Small flocks of migrant green-winged teal are common by mid-September, especially in localities in southern Wisconsin. Populations continue to build up in early October and peak in mid-October (Fig. 24). In spite of abundant and available food in refuge areas, populations rapidly decline during late October. Freeze-up in November eliminates shallow-water feeding and loafing sites. By December 1, green-winged teal are rarely observed.

Important Fall Concentration Sites: The exact status of the green-winged teal in the fall flight in Wisconsin is difficult to establish because this species is hard to census from the airplane. Based on the best available census data, the flight is rated as relatively unimportant (Table 28). Yet, in the 1959 bag reported by hunters, the greenwing ranked third and made up 11.6 percent of the state kill (Atwood and Wells, 1960n).

In an independent sample of the 1959 kill, based on wings examined by waterfowl technicians, green-winged teal ranked fourth and made up 8.9 percent of the total sample (Geis and Carney, 1961a:63). Behavioral characteristics of the species appear to be responsible for the relatively high kill that occurred in Wisconsin in spite of a minor flight. Greenwings are avail-

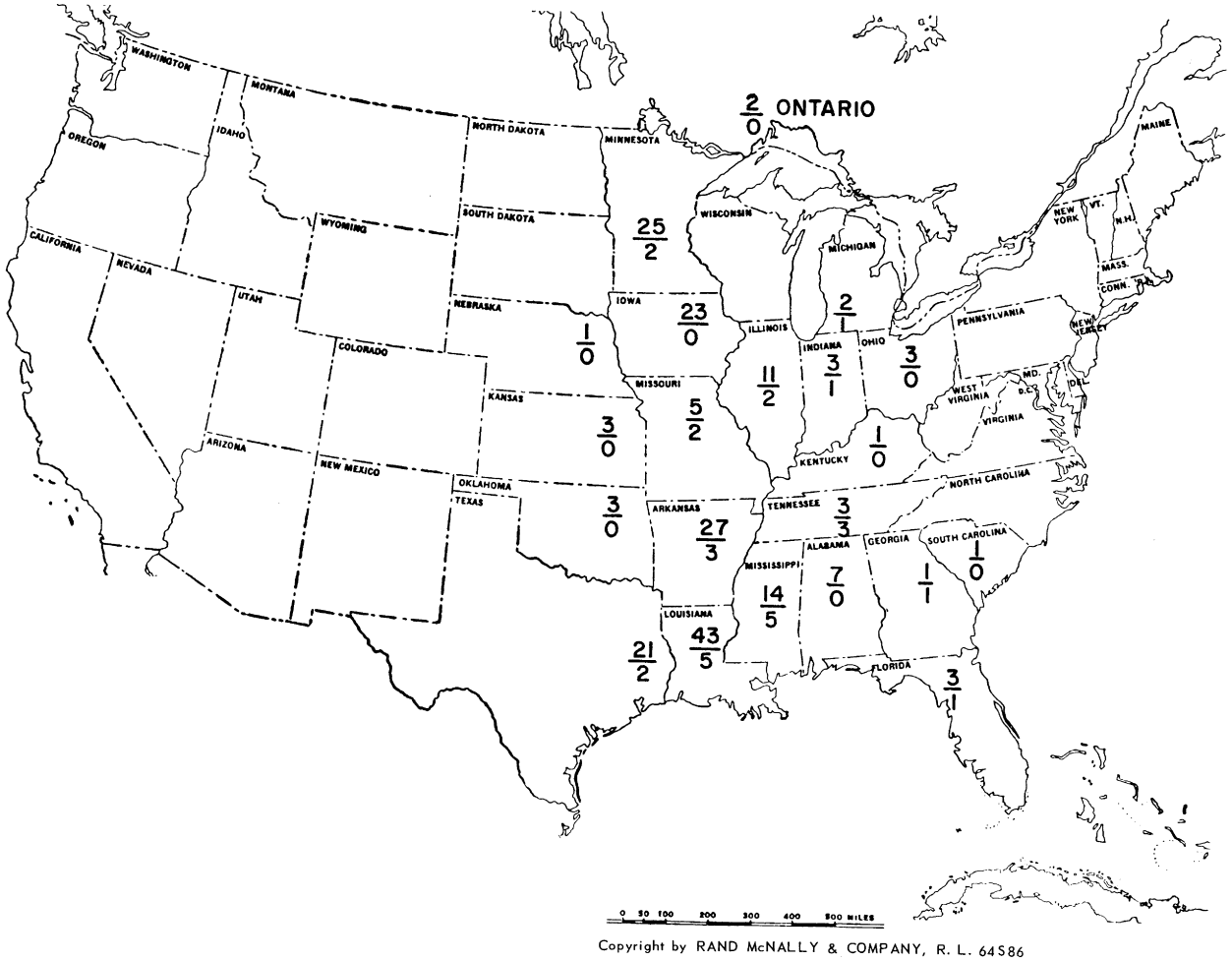


Figure 32. Pattern of recoveries of wood ducks banded in fall in Wisconsin. All Wisconsin recoveries are omitted. Based on 202 first-year and 28 subsequent recoveries. Within each state and province, first-year recoveries are the top figure listed and subsequent recoveries are the bottom figure. Data preceding 1940 are from Hickey (1956); data for 1959 and 1960 are from Kaczynski and Geis (1961). Banding stations include the Brown County Game Sanctuary near Suamico, Moon Lake Wildlife Refuge near Campbellsport, Horicon Marsh Wildlife Area and Horicon National Wildlife Refuge near Horicon, Necedah National Wildlife Refuge near Necedah, Upper Mississippi River Wildlife and Fish Refuge along the river itself and lakes and marshes in Burnett County near Grantsburg.

TABLE 34

Sex Ratios of Wood Ducks Shot in Wisconsin, 1946–51

Year[1]	Adult			Immature		
	Number Male	Number Female	Percent Male	Number Male	Number Female	Percent Male
1946	5	0		3	0	
1947	57	29		52	32	
1948	42	20		41	26	
1949	72	23		30	26	
1950	50	25		56	43	57
1951	15	4		4	4	
Total	241	101		186	131	
Mean			70**			59**

[1] At the bulk of the check stations (about 25), bags of hunters were examined on the first few days of the waterfowl hunting season and in a few cases throughout the season. Fewer stations were checked in 1946 and 1951 than in other years.

** Highly significant difference from a 50:50 ratio.

able to hunters because they usually do not concentrate in refuges, but occur as a scattering of small flocks in suitable localities throughout the state, especially in the southern part. Small concentrations are found in refuge areas, primarily along the Mississippi River (Fig. 33).

Differential Migration of Sexes: Green-winged teal shot by Wisconsin hunters show a balanced sex ratio for adults and a significant excess of immature drakes (Table 35). Immatures (4–9 months old) shot in Manitoba, Illinois, and Utah showed an excess of drakes (Bellrose *et al.*, 1961:405–07). Less than 100 greenwings checked in hunters' bags at Delta, Manitoba, also tended to have an excess of drakes (Hochbaum, 1944:130). Ducklings (1–2 months old) trapped in Saskatchewan and Alberta had a balanced sex ratio (Bellrose *et al.* 1961:403). With a balanced immature sex ratio in ducklings on the breeding grounds, the consistent preponderance of young drakes in the hunting bag suggests any one or combination of the following factors being involved: (1) at between approximately 1–2 and 4–9 months

Figure 33. Distribution and relative importance of most fall green-winged teal concentration sites in Wisconsin. Average fall green-winged teal day-use:

Moderately Low

1. **Necedah National Wildlife Refuge**
2. **Mississippi River—Pool 9**

Low

3. **Mississippi River—Pool 11**
4. **Mississippi River—Pool 6**
5. **Mississippi River—Pool 7**
6. **Clam Lake**
7. **Green Bay**
8. **Mississippi River—Pool 10**
9. **Horicon Marsh**
10. **Mississippi River—Pool 4**
11. **Brown County Game Sanctuary**

of age, females suffer a disproportionate mortality, (2) drakes are more vulnerable to shooting, (3) hens have a differential migration carrying them farther south. Of these possibilities, we believe differential migration of sexes may be involved.

In adult green-winged teal shot in fall, the sex ratio varies among sites sampled. In Manitoba and Utah, a highly significant excess of hens occurred (Bellrose *et al.*, 1961:404 and 407). In Illinois and other areas of the Mississippi Flyway (Bellrose *et al.*, 1961:406–07), as in Wisconsin (Table 35), a balanced sex ratio was reported. Differential concentration of adult hens, or early migration of adult drakes, or both, is indicated for Manitoba and Utah, both of which are breeding-ground areas. At sites serving predominantly as migration areas, including Wisconsin, possibly differential migration or vulnerability of adult females occurs, if drakes exceed hens in the total population, as in many of the important game ducks (Bellrose *et al.*, 1961:427).

Migratory Movements from Wisconsin: Limited recoveries of Wisconsin-banded birds indicate that green-winged teal go south and southeast from the state. Recoveries have occurred in Texas on the Gulf Coast and in Georgia and Florida on the Atlantic Seaboard (Hickey, 1956). Low (1949b) concluded that there was very little drift of birds to the Atlantic Coast from interior breeding grounds in parts of Saskatchewan, Manitoba, Montana, and North Dakota. Apparently, these birds remain primarily in the Central Flyway and usually do not reach Wisconsin.

Shoveler

Chronology of Duck Use: Too few shovelers were observed to construct a curve showing the chronology of fall

TABLE 35

Sex Ratios of Green-winged Teal Shot in Wisconsin, 1946–51

Source[1]	Year	Adult			Immature		
		Number Male	Number Female	Percent Male	Number Male	Number Female	Percent Male
Horicon Marsh	1949	26	36		128	86	60*
	1950	79	60	57	60	55	52
	1951	27	20		48	27	
Subtotal and Mean		132	116	53	236	168	58*
Other sites (about 25)	1946	0	0		10	3	
	1947	15	18		88	52	63*
	1948	33	36		115	100	53
	1949	47	44		163	165	50
	1950	35	30		55	66	45
Subtotal and Mean		130	128	50	431	386	53
Wisconsin	1946–51	262	244	52	667	554	54.6*

[1] At Horicon Marsh, hunters were checked at an established station throughout the waterfowl hunting season from approximately 7:00 a.m. to shortly after the daily closing hour each day; at all other sites hunters were checked on the first few days of the waterfowl hunting season and in a few cases a few days thereafter. Fewer sites were checked in 1946, 1947 and 1950 than in 1948 and 1949.

* Significant difference from a 50:50 ratio.

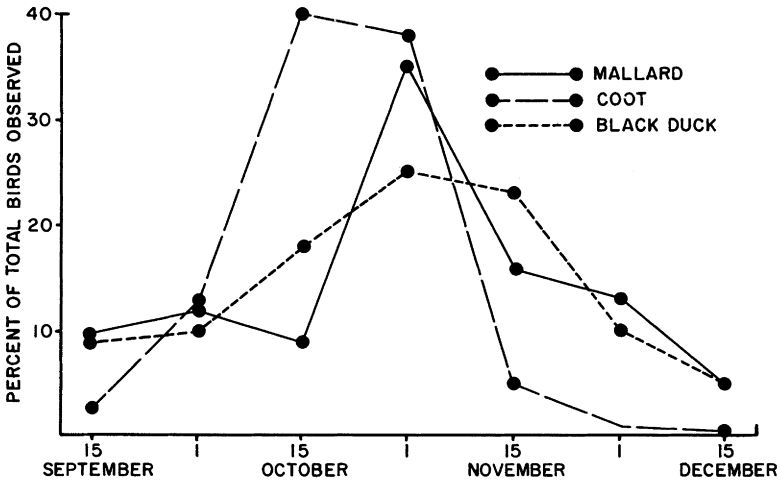


Figure 34. Average seasonal pattern of duck use for the coot, mallard, and black duck in Wisconsin, 1948–56.

flight in Wisconsin. Small flocks arrive during late August and are most abundant in late September. Departure is almost completed during the last 15 days of October, although occasionally small flocks of shovelers may be seen until their favorite, shallow-water, feeding and resting sites are closed by ice in November.

Important Fall Concentration Sites: There is no single aquatic site known where shovelers concentrate in any numbers in Wisconsin. The general rule is small flocks of 3–20 birds. Groups of this size are most frequently encountered in the southern one-half of Wisconsin, especially along the Mississippi River. The shoveler is an uncommon bird in northern Wisconsin and is numerically weak in southern Wisconsin.

Migratory Movements from Wisconsin: Only one recovery of a Wisconsin-banded shoveler is known. It occurred in Illinois (Stoudt, 1949b).

Mallard

Chronology of Duck Use: Because the mallard is present throughout the summer and is an important breeding bird in Wisconsin, sight observations do not indicate when the first mallards arrive in fall. However, based on the relative numbers of mallards involved and upon early fall movements of Wisconsin-banded mallards, we believe migrants are in Wisconsin by late August and early September. Buss and Mattison (1955:32) recorded a buildup in the mallard population during September in the lower Chippewa River area. Mallard populations decline slightly after the first few days of the hunting season in early October (Fig. 34). This decline is attributed to removal of birds by hunting and to departure of birds from Wisconsin. Annually, the peak population of mallards occurs in Wisconsin between October 25 and November 10. Populations decline in November and early December as freeze-up eliminates open water at many aquatic sites. By late December, in all except the mildest years, the mallard population is reduced to wintering levels.

Important Fall Concentration Sites: The mallard is the most abundant (Table 29) and widely distributed waterfowl species using Wisconsin (Fig. 35). Great adaptability in food habits and use of various types of aquatic habitat to escape disturbance accounts for this widespread distributional pattern. Concentrations occur where protection from disturbances is available and where preferred foods are abundant in the vicinity. In forested areas, sites offering wild rice and moist-soil plants, encouraged by natural or purposeful manipulation of water levels, are used most often by mallards. In agricultural areas, daily flights near dawn and near dusk are made to flooded or harvested upland fields to feed on waste grain. In August and early September, wheat, barley, buckwheat, oats, and rye fields are utilized. After corn picking starts in October, harvested corn fields within a 15- to 25-mile radius of aquatic concentration sites are readily used. Corn is a common item in the diet, even though aquatic foods are abundant and available. After shallow waters are covered with ice, usually by late November, mallards concentrate in open water of deep lakes, on spring ponds, and on certain spring-fed streams and continue to feed in harvested corn fields. This adaptability of feeding and rafting habits explains why the mallard can remain in agricultural areas of Wisconsin under winter conditions.

Differential Migration of Sexes: Sex ratio studies of mallards using the Mississippi Flyway show that among immatures (4–9 months old) the sex ratio is close to 50:50 (Bellrose *et al.*, 1961:405). Among adults, drakes consistently, but not in every sample, outnumber hens (Bellrose *et al.*, 1961: 408). In Wisconsin, deviations from these expected sex ratios are associated with localities, years, and periods within particular years (Tables 36–38).

Adult female mallards predominated in late-summer-trapped samples in Burnett County (Table 36), in hunters' bags at Horicon Marsh and other aquatic sites in eastern Wisconsin (Table 37), and for most periods during the hunting season in certain years at Horicon Marsh (Table 38). On the Mississippi River, adult mallards in hunters' bags showed no significant difference from a 50:50 ratio (Table 37). At Horicon Marsh (Table 37), hens tended to exceed drakes in the adult class in 10 of 11 years (1946–56). For 3 of 5 years having adequate-sized samples, and for the 11-year period, hens exceeded drakes by a highly significant margin (Table 37). Through the entire hunting season adult hens were con-

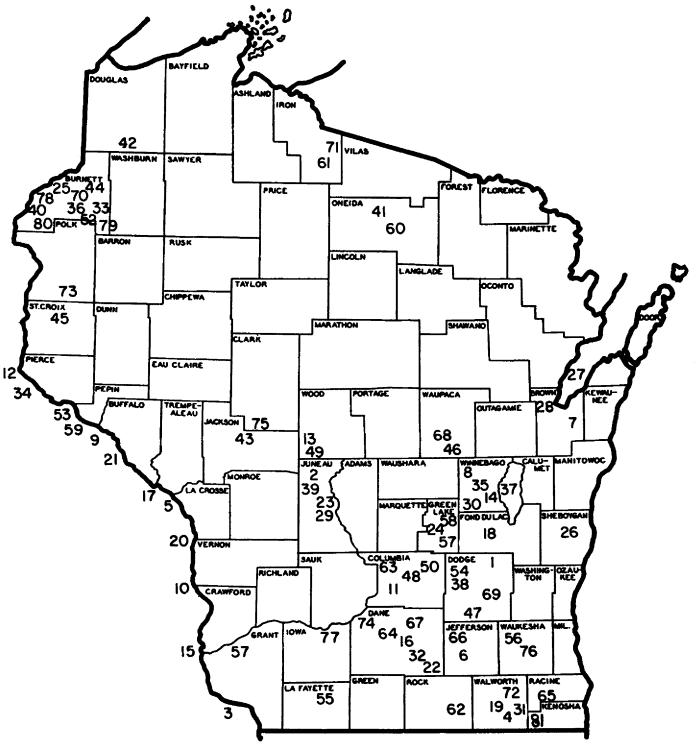


Figure 35. Distribution and relative importance of some mallard concentration sites in Wisconsin. (Band recoveries from mallards banded outside Wisconsin indicate more concentration sites throughout the state; the bulk of these sites would undoubtedly fall in the moderately low to low duck-use categories. Mallards also occur in small groups scattered along the shorelines of Lake Superior and Lake Michigan.) Average fall mallard day-use:

High

1. Horicon Marsh
2. Necedah National Wildlife Refuge
3. Mississippi River—Pool 11
4. Lake Geneva

Moderately High

5. Mississippi River—Pool 7
6. Lake Koshkonong
7. Bay Beach Sanctuary
8. Lake Poygan
9. Mississippi River—Pool 4
10. Mississippi River—Pool 9
11. Lake Wisconsin
12. Mississippi River—Hastings to Red Wing
13. Sandhill Wildlife Area
14. Big Lake Butte des Morts
15. Mississippi River—Pool 10
16. Lake Mendota

Medium

17. Mississippi River—Pool 6
18. Thornton Closed Area
19. Lake Delavan
20. Mississippi River—Pool 8
21. Mississippi River—Pool 5
22. Lake Kegonsa
23. Petenwell Flowage
24. Lake Puckaway
25. Crex Meadows Conservation Area

Moderately Low

26. Sheboygan Marsh
27. Green Bay
28. Brown County Game Sanctuary
29. Castle Rock Flowage
30. Rush Lake
31. Lake Como
32. Lake Waubesa
33. Lower Twin Lake
34. Mississippi River—Red Wing to Maiden Rock
35. Lake Winneconne
36. Yellow River, segment
37. Lake Winnebago
38. Beaver Dam Lake
39. Meadow Valley Conservation Area
40. Fish Lake
41. Rainbow Flowage
42. Gordon Flowage
43. Black River State Forest
44. Big Sand Lake
45. Oakridge Refuge
46. Partridge Lake
47. Crawfish River, segment
48. Grassy Lake
49. Wood County Public Hunting Grounds

Low

50. Mud Lake
51. Wisconsin River
52. Clam Lake
53. Mississippi River—Maiden Rock to Wabasha
54. Fox Lake
55. Yellowstone Conservation Area
56. Oconomowoc Lake
57. Lake Maria
58. Big Green Lake
59. Mississippi River—Pool 5a
60. Thunder Lake
61. Flambeau Flowage
62. Rock Prairie Goose Refuge
63. Pine Island Conservation Area
64. Wingra Lake
65. Eagle Lake
66. Rock Lake
67. Waunakee Marsh
68. Partridge Crop Lake
69. Lake Sinissippi
70. Yellow Lake
71. Powell Marsh
72. Lake Beulah
73. Apple River
74. Crystal Lake
75. Lake Arbutus
76. Pewaukee Lake
77. Wisconsin River
78. St. Croix River, segment
79. Yellow River, segment
80. Rice Lake
81. Powers Lake

sistently more abundant than adult drakes (Table 38). However, during the last week of October and the first 2 weeks of November (second and third 10-day periods of Table 38) drakes were more abundant than in other similar periods of certain seasons. Nevertheless, for 444 adult mallards trapped (Table 36) and 2,813 examined during the hunting season (Table 37), hens exceeded drakes by a significant margin.

In immatures, the sex ratio of mallards handled in traps and hunters' bags differ from the expected 50:50 ratio for certain years, stations, and periods within specific years (Tables 36–38). An important difference existed in the immature sex ratio between two stations (Table 37). At Horicon Marsh, in eastern Wisconsin, hens tended to exceed drakes in 7 of 11 years. The 11-year average showed a significant predominance of hens. In sharp contrast, on the Mississippi River, in western Wisconsin, drakes tended to exceed hens in 5 of 6 years. The 6-year average disclosed a highly significant predominance of drakes. However, for 2,548 trapped (Table 36) and 7,178 shot mallards (Table 37) in Wisconsin, the immature sex ratio did not vary significantly from the expected 50:50 ratio. Specifically why immature female or male mallards predominate at one station or another is unknown to us. Both differential migration and differential local flights could be involved.

The fact that females made up the bulk of the adult mallard kill throughout most hunting seasons (1949–52) at Horicon Marsh suggests differential migration and use of the site by hens, or if the sexes occur in equal numbers on the area, then females are more vulnerable to hunters' guns than are drakes. The preponderance of adult females in most years (Table 37) and throughout periods of certain years (Table 38) indicates that differential migration of sexes is involved. Vulnerability of the sexes to shooting would be expected to vary among years in relation to local weather and shooting conditions (Hochbaum, 1944:138).

Hochbaum (1955:109) stated that "The adult female, which molts later than the adult male and in smaller companies, does not make up aggregations of her own. When she recovers flight after the molt of the wing feathers, she joins the young-of-the-year and, according to the evidence of banding trap and hunter's bag, she migrates with these juveniles, along with a lesser number of adult males." Both Lincoln (1935) and Hochbaum (1955:111) concluded, on the basis of banding data, that many individual adult birds mi-

TABLE 36

Sex Ratios of Mallards Banded in Wisconsin from August through Early October, 1946–51

Site	Year	Adult			Immature		
		Number Male	Number Female	Percent Male	Number Male	Number Female	Percent Male
Horicon Marsh (Dodge County)	1946	26	20		93	97	49
	1947	37	29		158	195	45*
	1948	12	16		157	219	42**
	1949	13	42		91	98	48
	1950	20	61		166	157	51
	1951	49	20		269	279	49
Totals		157	188	46	934	1,045	47*
Burnett County (largely Crex Meadows)	1947	0	4		60	87	41*
	1948	0	18		82	82	50
	1949	38	39		157	101	61**
Totals		38	61	38**	299	270	53
Wisconsin	1946–51	195	249	44*	1,233	1,315	48.4

* Significant difference from a 50:50 ratio.

** Highly significant difference from a 50:50 ratio.

grate in fall over the same route, utilizing year after year the same familiar stop-over areas. Apparently, Horicon Marsh is one Wisconsin area used consistently by flocks of adult hen mallards with their accompanying bands of immature birds. Petrides (1944) and Bellrose *et al.,* (1961) concluded that differential migration of sexes, both in time and geographic area, is required to explain the large variations in adult sex ratios they studied.

The only suggestion we have that adult females are more vulnerable to hunters' guns than are drakes is from evidence secured during our foot travels on drier parts of Horicon Marsh. More hens than drakes are jumped from small depressions. If adult hens remain as singles, doubles, trios, and small flocks, while adult drakes tend to form large flocks, it is understandable why more hens are bagged than drakes. Flocking habits influence the vulnerability of ducks. Bellrose (1944a: 336) pointed out that ". . . generally, singles are more readily decoyed than a flock of 10, which in turn is more readily decoyed than a flock numbering 100 . . . The greater the concentration of ducks, under ordinary conditions, the smaller is the percentage of ducks likely to be killed. A flock of 1,000 mallards or bluebills passing over a blind is unlikey to have many more individuals killed from it than a flock numbering only 10 or 100, for after the first shot the individuals left are warned and have an opportunity to swing or climb out of range." This type of adaptive behavior in relation to shooting is characteristic of the mallard.

While both differential migration and greater vulnerability to hunters' guns are undoubtedly acting to cause more adult female mallards to appear in hunters' bags at Horicon Marsh, differential migration is believed to be the principal factor involved.

Trends in Mallard Production: On the basis of mallard age ratios secured in the Mississippi Flyway. Bellrose *et al.* (1961:447) concluded "With infrequent exceptions, such as those in 1950 and 1953, it appears that age ratios taken along the main stem of the Mississippi Flyway from Delta, Manitoba to Stuttgart, Arkansas, provide an index to the yearly productivity of the mallard in the flyway." Age ratios obtained from mallards examined in Wisconsin are presented in Table 39, and in Figure 36 are compared with those primarily from Illinois.

For certain years (1946–48 and 1954–56) Wisconsin age ratios are based on mallards handled only during the first few days of the hunting season. Since there is a tendency for the recorded age ratio early in some hunting seasons to be higher than the yearly average (Table 38; Geis and Carney, 1961a: 83), some of the early season ratios (1946–48 and 1954–56) could be exaggerated. We attempted to correct early season age ratios to learn if the indicated production trend between years would be altered. Four years (1949–52) of Horicon Marsh data provided an average age ratio for the first 2 days and the balance of the season. A 9 percent higher ratio was found for the first 2 days. Reduction of the age ratios for 1946–48 and 1954–56 by the 9 percent correction factor did not change the direction of the production trend between years. Hence, completely uncorrected age ratios are presented here (Tables 38 and 39; Fig. 36).

Production indices, based on mallards shot in Wisconsin, fluctuate in a widely different pattern than do production in-

TABLE 37

Sex Ratios of Mallards Examined in Hunters' Bags in Wisconsin, 1946–56

Site	Year	Adult			Immature		
		Number Male	Number Female	Percent Male	Number Male	Number Female	Percent Male
Horicon Marsh (Eastern Wisconsin)	1946	5	7		18	14	
	1947	24	34		98	131	43*
	1948	85	90	49	290	355	45*
	1949[1]	111	302	27**	308	354	47
	1950[1]	92	198	32**	418	393	52
	1951[1]	114	143	44	212	170	55*
	1952[1]	146	324	31**	740	835	47*
	1953	15	8		137	115	54
	1954	9	46		60	68	47
	1955	27	40		107	119	47
	1956	21	24		151	158	49
Totals		649	1,216	34.8**	2,539	2,712	48.3*
Mississippi River (Western Wisconsin)	1949	36	49		65	80	45
	1950[1]	59	57	51	215	176	55*
	1951[1]	42	36		78	58	57
	1952	54	30		95	81	54
	1953	22	32		77	55	58
	1954	15	13		42	35	
Totals		228	217	51	572	485	54.1**
Other areas (largely east half of Wisconsin)	1949	42	56		79	78	50
	1950	83	77	52	151	145	51
	1951	98	143	41**	148	157	49
	1954	3	1		3	9	
Totals		226	277	45*	381	389	49
Wisconsin	1946–56	1,103	1,710	39.2**	3,492	3,586	49.3

[1] Hunters were checked in the field at established stations every day of the waterfowl hunting season from approximately 7:00 a.m. to shortly after the daily closing hour of shooting; in all other years hunters were checked on the first 2 days of the waterfowl hunting season and in a few cases a few days thereafter.

* Significant difference from a 50:50 ratio.

** Highly significant difference from a 50:50 ratio.

dices based on mallards examined in Illinois (Fig. 36). In only 4 of 13 years (1946–56 and 1959–60) was the direction of the Wisconsin production trend similar with that from Illinois. In the 4 years when production trends were similar, 1 year (1949) involved a decline and 3 years (1947, 1955, and 1960) involved increases (Fig. 36).

Information on weather and water conditions and on status of the breeding population is too incomplete to appraise the effect these factors had on production in 1947. The decline in 1949 appears to have involved primarily adverse weather and water conditions. Based on winter inventory data, mallard breeding populations were higher in 1949 than in the three preceding years (U.S. Fish and Wildl. Serv., 1950). Drought was widespread in 1949, extending from Saskatchewan (Lynch, 1949) to Ontario (Stirrett, 1949). In many parts of the breeding grounds, including Wisconsin (Hopkins, 1949), water conditions were poorer than in 1948. Adverse water conditions over such a broad area could reduce production of a number of segments of the mallard breeding population. Under these conditions, production indices could be similar for different segments of the widespread mallard population.

In 1955 and 1960, when both the Wisconsin and Illinois indices showed increases in mallard production over the previous year, weather, water, and breeding population status were

TABLE 38

Seasonal Sex and Age Composition of Mallards Examined in Hunters' Bags at Horicon Marsh, Wisconsin, 1949–52[1]

Year	Total Number Examined	Information Secured	First 2 days[2]	First 10 days	Second 10 days	Third 10 days	Fourth 10 days	Fifth 10 days	Entire Season
1949	1,075	Percent immature	59	64	54*	(68)			61.6
		Of immatures, percent male	51	48	46	(36)			47
		Of adults, percent male	28	23	36*	(21)			27
1950	1,101	Percent immature	70	72	70	80*			73.7
		Of immatures, percent male	55	53	48	53			52
		Of adults, percent male	(22)*	25	(36)	(46)*			32
1951	639	Percent immature	71**	69**	31**				60
		Of immatures, percent male	60	58	(39)*				55
		Of adults, percent male	(35)	32*	62*				44
1952	2,045	Percent immature	89**	86**	71**	68**	66**	72	77.0
		Of immatures, percent male	49	47	51	43	45	(40)	47.0
		Of adults, percent male	(25)	30	28	(34)	(31)	(40)	31
Total	4,860	Percent immature	74.6**	74.1**	61.3**	73	66	72	70.6
		Of immatures, percent male	52.3*	50.2	48	47	45	(40)	48.9
		Of adults, percent male	28*	27**	40**	35	(31)	(40)	32.4

[1] Percentages based on less than 100 but more than 30 birds are given within parentheses; all other percentages are based on 100 or more birds.

[2] The Wisconsin waterfowl hunting season opened on October 14 in 1949 and 1950, on October 13 in 1951, and on October 4 in 1952. Hunters were checked daily until freeze-up, which usually preceded the terminal date of the hunting season.

* Significant difference from the seasonal average in the same row.

** Highly significant difference from the seasonal average in the same row.

again more favorable in Canadian grassland, parkland, and forest breeding grounds, as well as in Wisconsin (Crissey, 1955 and 1960).

Bellrose *et al.* (1961:463–64) showed that the Illinois mallard production index, with but few annual exceptions, is correlated with water and weather conditions on the Canadian prairies and parklands (Saskatchewan and Manitoba). Since the Wisconsin mallard index is not correlated with the Illinois index, except in 4 of 13 years, it logically follows that Wisconsin is deriving a relatively small volume of mallards from prairie and parkland habitat in Saskatchewan and Manitoba.

One factor influencing the Wisconsin index to a much greater extent than that of Illinois, is the mallard production occurring within the state. Illinois produces very few mallards. The Wisconsin production index is based on a combination of mallards raised within the state and migrant mallards produced in areas outside the state.

The probable source of mallards outside Wisconsin is the forest region in northern Manitoba, northern Saskatchewan, and Ontario. Limited recoveries from mallards banded in Wisconsin in fall occurred in Canada in March, April, and May (Hickey, 1956), months when mallards should be near or at their breeding grounds. Recoveries were most common in Manitoba and Ontario. Whether or not opportunities to secure banded mallards in spring were equal between the provinces is unknown to us. If they were, the greater number of recoveries in Manitoba and Ontario indicate that these provinces are the more important sources of mallards frequenting Wisconsin in fall.

With an approximate 30-inch average annual rainfall in Wisconsin, mallards breeding in the state are not subject to as frequent or necessarily to the same drought conditions experienced by mallards breeding in the prairies of the United States and Canada. Drought is also expected less frequently in other forested regions suspected of supplying mallards to Wisconsin. Age ratios of mallards bagged in Wisconsin can be relatively high in years when drought is severe on the western and northern prairies. For example, in 1959 drought severely reduced mallard and other duck production on the United States and Canadian prairies and parklands. Mallard age ratios in 9 of 14 Mississippi Flyway states were less than one immature per adult (Geis and Carney, 1961a: 81). In Wisconsin, an average of 2.1 immature mallards per adult was recorded (Fig. 36). These age ratios are uncorrected for greater vulnerability of immature mallards to hunting. Therefore, they must be used as a general index to show production trends of segments of the mallard population, not as precise measurements of production.

Migratory Movements from Wisconsin: First-year recoveries show that the bulk of the mallards banded in Wisconsin proceed south in the Mississippi Flyway (Fig. 37). Small

TABLE 39

Age Ratios Among Mallards Examined in Bags of Wisconsin Hunters*

Year	Number of Mallards Examined		Percent Immature	Immatures Per Adult
	Immature	Adult		
1946	32	12	73	2.7
1947	229	58	80**	3.9
1948	645	175	79**	3.7
1949	964	596	61.8**	1.6
1950	1,498	566	72.6	2.6
1951	823	576	58.8**	1.4
1952	1,751	554	76.0**	3.2
1953	384	77	83**	5.0
1954	257	87	75	3.0
1955	226	67	77	3.4
1956	309	45	87**	6.9
1959	234	110	68	2.1
1960	783	238	76.7**	3.3
Total	8,135	3,161		
Mean			72.0	2.6

* Data for 1946 through 1956 are from Table 37, for 1959 from Geis and Carney (1961a:81), and for 1960 from Geis and Carney (1961b).

** Chi-square tests indicate a highly significant difference of yearly figure from the average in the same column.

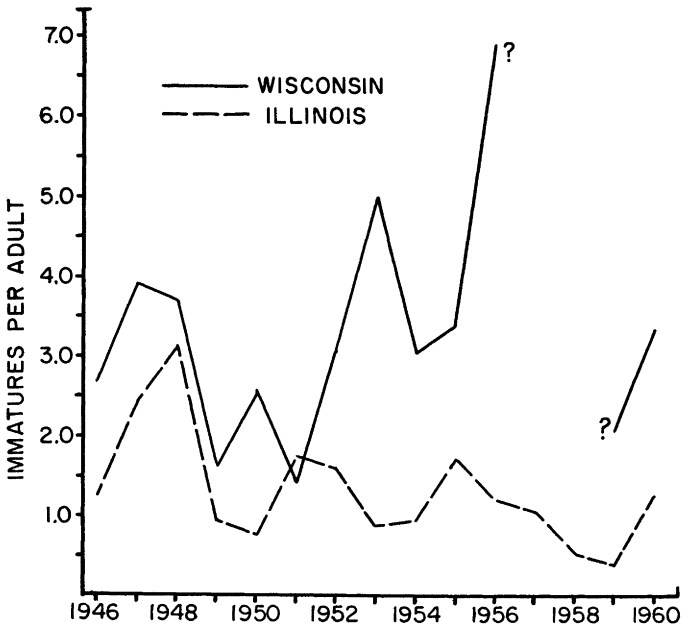


Figure 36. Trends in the annual ratio of immature mallards per adult in bags of Wisconsin and primarily Illinois hunters, 1946–60. Wisconsin data are from Table 39. Illinois data are from Bellrose *et al.* (1961:450, 454) and for 1960 from Geis and Carney (1961b). All figures are uncorrected for greater vulnerability of immature mallards to shooting.

numbers of birds occur in Texas and along the Atlantic Seaboard from Maryland to Florida (Fig. 37; Hickey, 1951 and 1956). Apparently many mallards using Wisconsin in fall spend the winter in Missisippi Flyway states from Illinois southward to the Gulf Coast, with a sprinkling of birds occurring on the south Atlantic Coast.

Black Duck

Chronology of Duck Use: The pattern of duck use for the black duck is very similar to that for the mallard (Fig. 34). Peak populations of both species occur during the last few days of October or the first few days of November. By mid-December, black ducks usually have declined to wintering levels.

Important Fall Concentration Sites: Like the mallard, the black duck is distributed state-wide (Fig. 38). After the hunting season opens, black ducks quickly react to heavy hunting pressure by concentrating in established refuge sites or on large lakes offering protection from disturbance. Most of the major concentration sites occur in the eastern one-half of the state, largely in the agricultural region. Here black ducks are found intermixed with mallards on aquatic sites, as well as in flocks feeding in harvested grain fields.

Differential Migration of Sexes: Black ducks shot in Wisconsin show a balanced sex ratio in adults and a highly significant excess of immature drakes (Table 40). In Illinois and other areas within the Mississippi Flyway, an excess of adult drakes and a balanced immature sex ratio was reported (Bellrose *et al.*, 1961:405–07). Martin (1960) found a higher proportion of adult female black ducks bagged north of wintering areas. If an excess of adult drakes exists in the population, then the balanced adult sex ratio in Wisconsin suggests, as Martin (1960) found in eastern North America, that adult hens are shot at a greater rate than drakes. Whether this is due to larger numbers of females being available, or to hens being more vulnerable to shooting than drakes is unknown. If adult drakes are numerically less abundant than hens in Wisconsin, differential migration of males is indicated. An excess of immature drakes in the bag suggests differential migration or concentration of immature hens, or greater vulnerability of young drakes to shooting.

Migratory Movements from Wisconsin: The black duck reaches the western limit of its range in Wisconsin, with records of only small numbers of birds occurring farther west in Minnesota, the Dakotas, and parts of Manitoba (Addy, 1953:1; Stewart, 1958:2). The strongest flights enter the northeastern part of Wisconsin. Flights of lesser importance enter the northwest corner of the state (Wright, 1954:66). Some blacks from the eastern end of the Upper Peninsula of Michigan enter Wisconsin (Pirnie, 1935:51). Departure from Wisconsin in fall is primarily south in the Mississippi Flyway, with a much smaller flight going east by southeast to the Atlantic Coast (Fig. 39; Addy, 1953:39; Hickey, 1956:71). Apparently the bulk of the birds winter in the lower portion of the Mississippi Flyway.

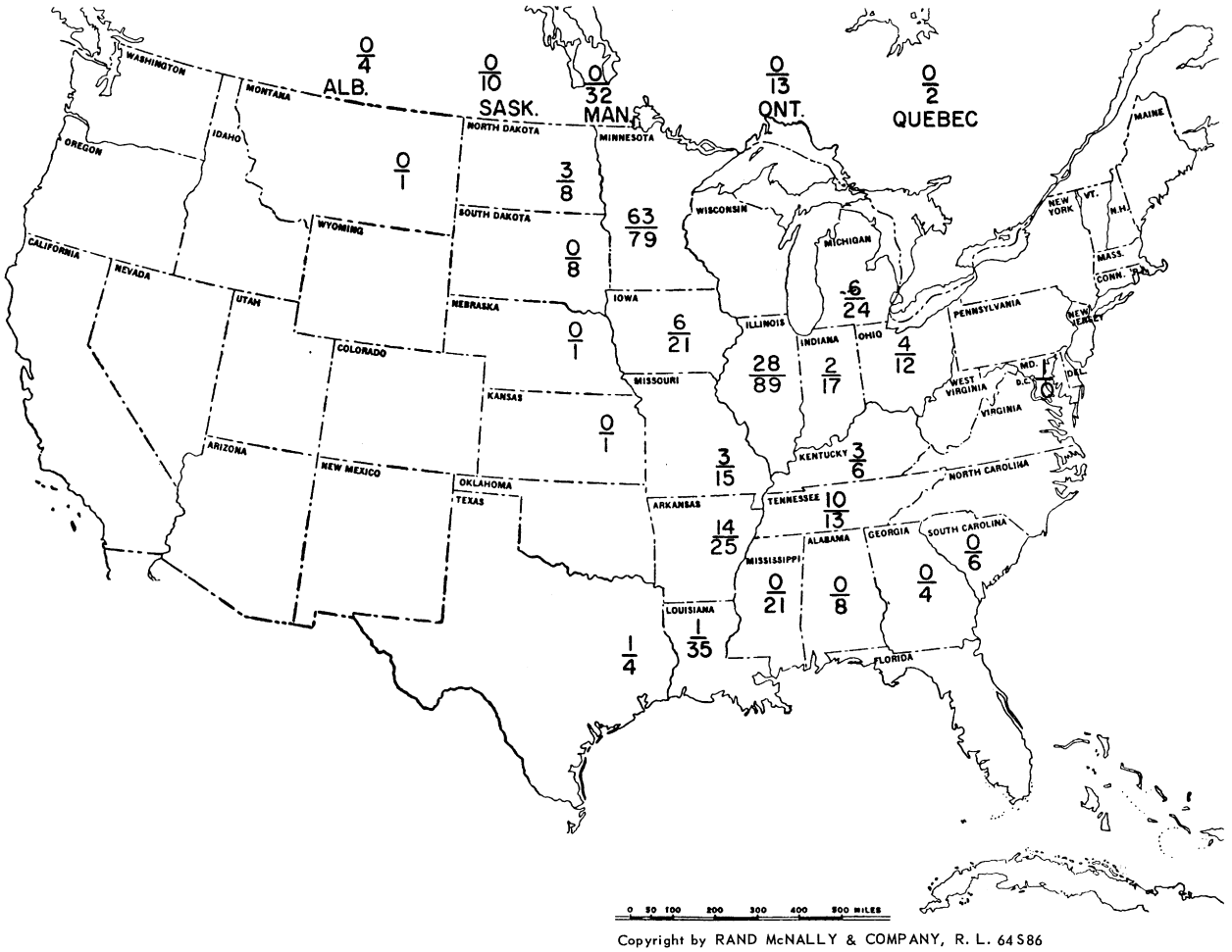


Figure 37. Pattern of recoveries of mallards banded in fall, primarily in eastern Wisconsin. All Wisconsin recoveries are omitted. Presented here are 145 first-year and 459 subsequent recoveries. Within each state and province, first-year recoveries are the top figure listed and subsequent recoveries are the bottom figure. Included are 288 subsequent recoveries from bandings preceding 1940 and reported by Hickey (1956). One first-year recovery from California and a subsequent recovery from Idaho are not shown on the map. These two records were not verified in the national banding office and may involve reporting errors. Banding stations include the Brown County Game Sanctuary near Suamico, Moon Lake Wildlife Refuge near Campbellsport, Horicon Marsh Wildlife Area near Horicon, and lakes and marshes in Burnett County near Grantsburg.

Mergansers

Chronology of Duck Use: All three mergansers—the hooded, common, and red-breasted—occur in Wisconsin in fall. Because the total number of any one species is so small, the figures for all three are grouped (Fig. 40) in this discussion. Hooded mergansers apparently arrive in Wisconsin during September, reach peak numbers in October, and are largely gone by mid-November. Common and red-breasted mergansers start appearing in mid-October, reach peak numbers in mid-November, greatly decline in abundance by December 1 as ice covers many water areas, and remain in small numbers throughout the winter in certain localities.

Important Fall Concentration Sites: No sites are known where hooded mergansers congregate in large numbers. Small numbers are scattered throughout inland waters, especially along streams. One or more hooded mergansers were encountered on 36 out of 200 census sites, with the bulk of the occurrences in the northern one-half of the state. Common and redbreasted mergansers congregate on Green Bay, the Mississippi River, Lake Superior, and Lake Michigan, but especially at the latter site. On the 200 inland, aquatic areas censused, common mergansers occurred on 35 sites and red-breasted mergansers on 17. Except on Lakes Michigan and Superior, the three mergansers generally occur in small flocks of 3–20 birds.

Migratory Movements from Wisconsin: To our knowledge, there are no recoveries from mergansers banded in Wisconsin.

Bufflehead

Buffleheads arrive in Wisconsin in early October, gradually build up in numbers, and reach peak populations in mid-November (Fig. 40). This is after some species have left Wisconsin and after most species have reached peak population levels. Between November 15 and December 15 the population declines. By mid-January, when the annual winter inventory is completed, buffleheads are rarely present.

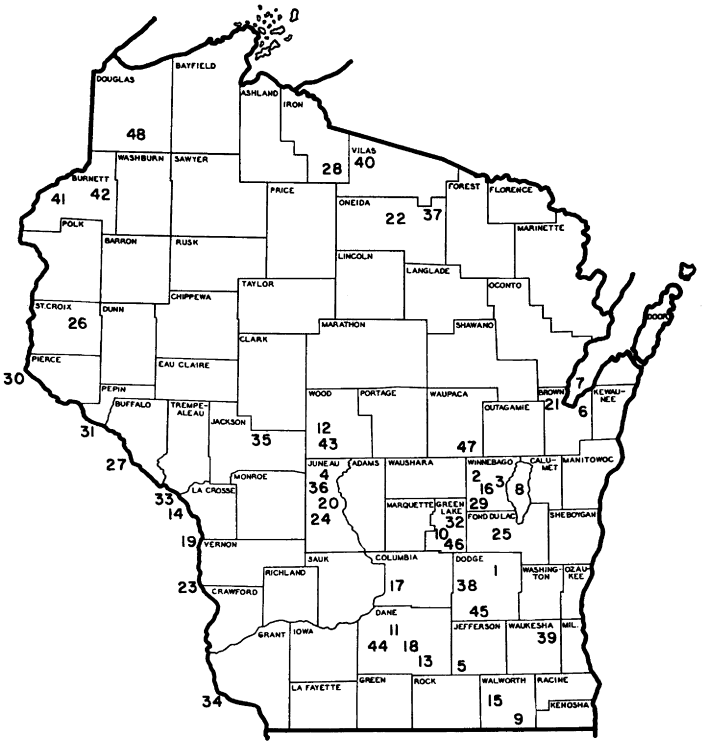


Figure 38. Distribution and relative importance of some fall black duck concentration sites in Wisconsin. (Band recoveries from black ducks banded outside Wisconsin indicate more concentration sites, primarily in the eastern one-half of the state; the bulk of these sites would undoubtedly fall in the moderately low to low duck-use categories. Black ducks also occur as small groups scattered along the shorelines of Lake Superior and Lake Michigan, and on streams and beaver flowages in northern forested areas.) Average fall black duck day-use:

Moderately High

1. Horicon Marsh
2. Lake Poygan
3. Big Lake Butte des Morts

Medium

4. Necedah National Wildlife Refuge
5. Lake Koshkonong
6. Bay Beach Sanctuary

Moderately Low

7. Green Bay
8. Lake Winnebago
9. Lake Geneva
10. Lake Puckaway
11. Lake Mendota
12. Sandhill Wildlife Area
13. Lake Kegonsa
14. Mississippi River—Pool 7
15. Lake Delavan
16. Lake Winneconne
17. Lake Wisconsin
18. Lake Waubesa
19. Mississippi River—Pool 8
20. Petenwell Flowage
21. Brown County Game Sanctuary
22. Rainbow Flowage
23. Mississippi River—Pool 9
24. Castle Rock Flowage
25. Thornton Closed Area
26. Oakridge Refuge

Low

27. Mississippi River—Pool 5
28. Flambeau Flowage
29. Rush Lake
30. Mississippi River—Hastings to Red Wing
31. Mississippi River—Pool 4
32. Big Green Lake
33. Mississippi River—Pool 6
34. Mississippi River—Pool 11
35. Black River State Forest
36. Meadow Valley Conservation Area
37. Thunder Lake
38. Beaver Dam Lake
39. Pewaukee Lake
40. Powell Marsh
41. Fish Lake
42. Lower Twin Lake
43. Wood County Public Hunting Grounds
44. Lake Wingra
45. Crawfish River, segment
46. Lake Maria
47. Partridge Lake
48. Gordon Flowage

TABLE 40

Sex Ratios of Black Ducks Shot in Wisconsin, 1946–51

Source[1]	Year	Adult			Immature		
		Number Male	Number Female	Percent Male	Number Male	Number Female	Percent Male
Horicon Marsh	1949	66	82	45	156	134	54
	1950	60	66	48	153	117	57*
	1951	71	64	53	170	95	64**
Total and Mean		197	212	48	479	346	58**
Other sites (about 25)	1946	1	1		15	6	
	1947	19	18		57	50	
	1948	30	27		83	71	54
	1949	35	27		123	109	53
	1950	21	15		48	42	
Total and Mean		106	88	55	326	278	54
Grand Total and Mean		303	300	50	805	624	56.3**

[1] At Horicon Marsh, hunters were checked at an established station throughout the waterfowl hunting season from approximately 7:00 a.m. to shortly after the daily closing hour of shooting each day; at all other stations hunters were checked on the first few days of the waterfowl hunting season and in a few cases a few days thereafter. Fewer sites were checked in 1946, 1947, and 1950 than in 1948 and 1949.

* Significant difference from a 50:50 ratio.

** Highly significant difference from a 50:50 ratio.

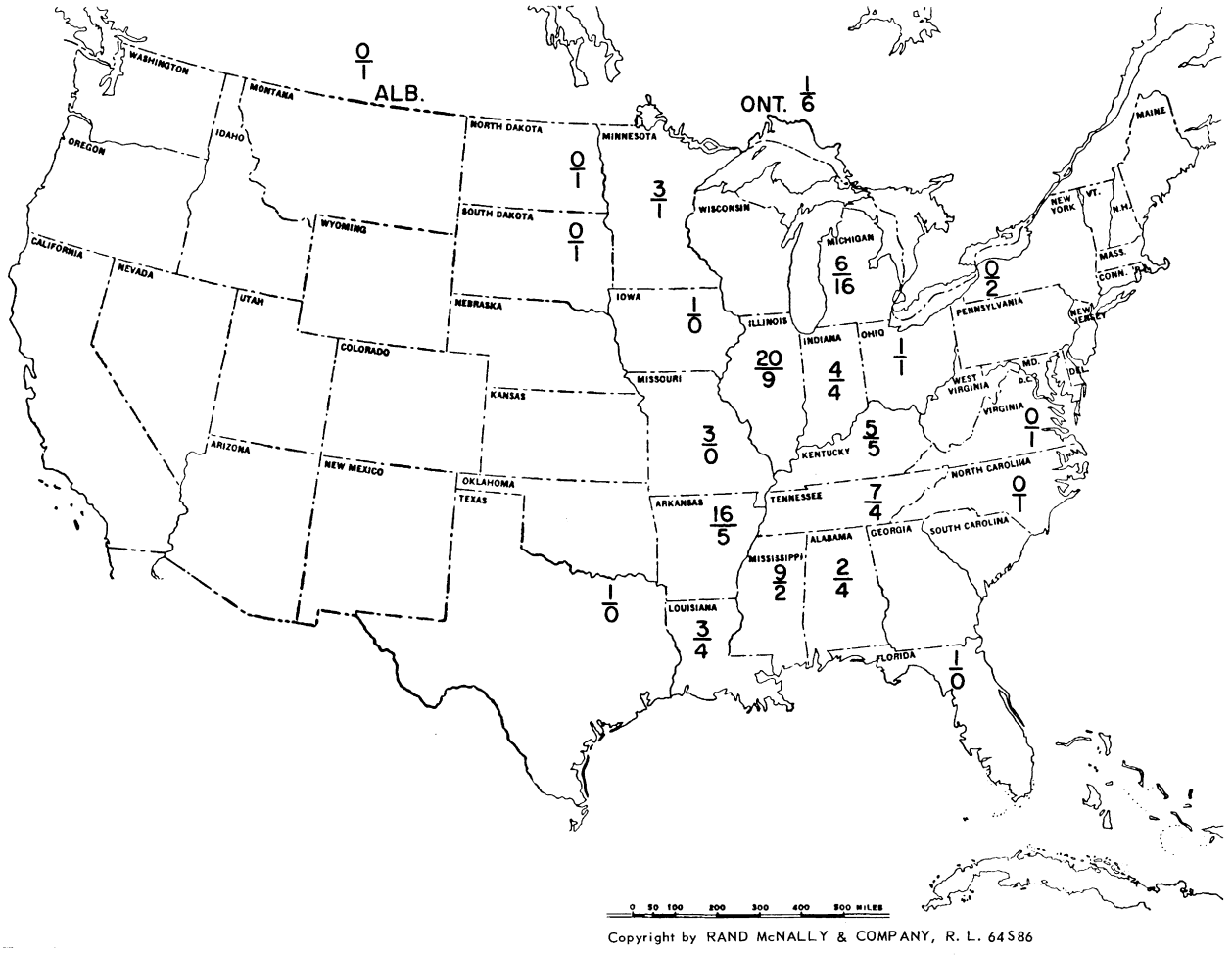


Figure 39. Pattern of recoveries of black ducks banded in fall in Wisconsin. All Wisconsin recoveries are omitted. Based on 83 first-year and 68 subsequent recoveries. Within each state, first-year recoveries are the top figure listed and subsequent recoveries are the bottom figure. Data preceding 1940 are from Hickey (1956). Banding stations include the Brown County Game Sanctuary near Suamico, Moon Lake Wildlife Refuge near Campbellsport, Horicon Marsh Wildlife Area near Horicon, and lakes and marshes in Burnett County near Grantsburg.

Buffleheads do not raft in large numbers. Small flocks of 3–25 birds are the general rule. Such groups may be encountered on lakes or streams throughout the state, but especially in northern Wisconsin and alone shorelines of Lake Superior and Lake Michigan. Concentrations are known to occur on only four areas.

1. Green Bay (Brown County): Moderately low
2. Mississippi River—Pool 8 (La Crosse County): Low
3. Mississippi River—Red Wing to Maiden Rock (Pierce County): Low
4. Lake Geneva (Walworth County): Low

To our knowledge, there are no recoveries from buffleheads banded in Wisconsin.

Common Goldeneye

Like the bufflehead, the common goldeneye is a late fall migrant. Before mid-October, very few goldeneyes are seen. Peak populations occur about December 1 (Fig. 40). Although numbers decline, some goldeneyes spend the winter in Wisconsin.

Before freeze-up, small groups of common goldeneyes are scattered about on lakes and streams throughout the state. Only relatively small concentrations occur at a few specific aquatic sites (Fig. 41). In mid-January, the birds occur primarily on the shores of Lake Michigan and at certain localities along specific streams.

To our knowledge, there are no recoveries from common goldeneyes banded in Wisconsin.

Ruddy Duck

Chronology of Duck Use: The ruddy duck is the earliest migrating diving duck to arrive in fall. Flocks of ruddies start arriving in late September, with the peak flight taking place in early October. Peak populations are reached in mid-October (Fig. 40). By November 1 or before freeze-up, populations decline greatly in spite of the fact that expanses of open water where these birds raft are never legally hunted. By late November, very few if any ruddies remain in the state.

Important Fall Concentration Sites: The ruddy duck has the most restricted distribution of any duck frequenting Wisconsin. Small groups of 5–20 ruddies are seen on only a few

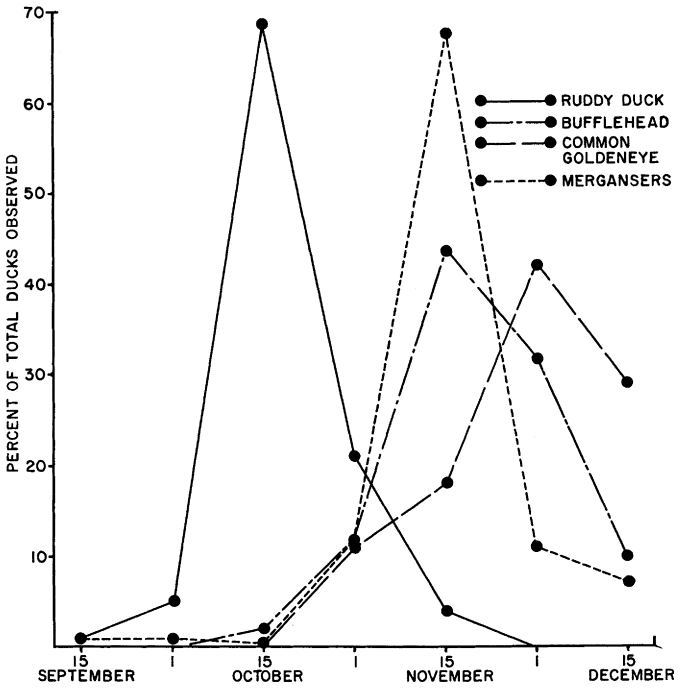


Figure 40. Average seasonal pattern of duck use for the bufflehead, ruddy duck, common goldeneye, and mergansers in Wisconsin, 1948–56.

aquatic areas other than the recognized concentration sites. Only two sites accommodate any significant numbers of ruddies.

1. Lake Winnebago (Winnebago County) :Moderately high
2. Green Bay (Brown County): Moderately high
3. Crystal Lake (Columbia County): Low
4. Big Green Lake (Green Lake County): Low
5. Big Lake Butte des Morts (Winnebago County): Low

Differential Migration of Sexes: Except for 1949, when an excess of immature hens was recorded, balanced sex ratios in both adult and immature ruddy ducks are indicated for Wisconsin bagged birds (Table 41). Spring sex ratios for five regions of North America show an excess of drakes (Bellrose *et al.,* 1961:415). With males exceeding females in spring, balanced adult sex ratios in fall suggest a disproportionately heavy harvest of females in Wisconsin. Possibly adult drakes migrate earlier or later, or migrate greater distances than hens, or both. Or as hunters have reported, hens may be more vulnerable to shooting because they respond more readily to hunters' decoys than drakes.

Migratory Movements from Wisconsin: Four first-year recoveries from Wisconsin-banded ruddy ducks occurred in New York (1), Maryland (1), Ohio (1), and Tennessee (1) —(Smith, 1949b:45). This suggests that some ruddies leave Wisconsin and proceed east and southeast as far as the Atlantic Coast.

Canvasback

Chronology of Duck Use: Canvasback arrive in Wisconsin during the first few days of October. Additional birds continue to enter the state during October, with peak populations being reached about November 1 (Fig. 42). The main flight in October occurs almost every year between October 18 and 25. Experienced canvasback hunters in Wisconsin know this well. Hochbaum (1944:128) states that canvasback leave Delta, Manitoba each year by mid-October, even though food is available and waters are ice free. Wisconsin canvasback populations, in both refuge and nonrefuge areas, decline in early November, even in years when ice is absent. Apparently the bulk of the birds migrate on a fixed-calendar schedule. A few canvasback remain until final freeze-up forces them to leave the state in late December or early January.

Important Fall Concentration Sites: No other species as numerically important has as restricted a fall distribution as the canvasback (Fig. 43). Large lakes and flowages in the Wolf and Fox River valleys, the southern part of Green Bay, Lake Mendota, and refuge areas on the Mississippi River are favorite concentration sites. Except for the Mississippi

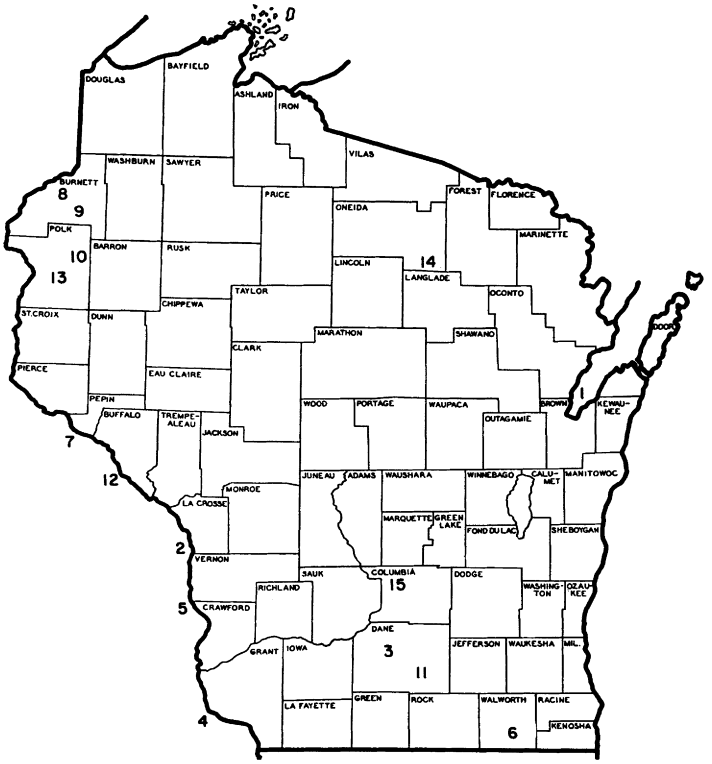


Figure 41. Distribution and relative importance of some fall common goldeneye concentration sites in Wisconsin. (Additional census data would indicate more concentration sites north of a line extending from Brown County to Buffalo County; the bulk of these sites would undoubtedly fall in the moderately low to low duck-use categories. Common goldeneyes also occur as small groups scattered along the shorelines of Lake Superior and Lake Michigan.) Average fall goldeneye day-use:

Moderately Low

1. Green Bay
2. Mississippi River—Pool 8
3. Lake Mendota
4. Mississippi River—Pool 11
5. Mississippi River—Pool 9

Low

6. Lake Geneva
7. Mississippi River—Maiden Rock to Wabasha
8. Yellow Lake
9. Devils Lake
10. Big Round Lake
11. Lake Kegonsa
12. Mississippi River—Pool 5
13. Wapogasset Lake
14. Pelican Lake
15. Pine Island Conservation Area

River pools, which did not exist until recently, canvasback concentrated at the same sites in the 1800's (Hallock, 1879: 172). All important concentration sites occur in the southern one-half of Wisconsin. From the large lakes in Winnebago County and from Lake Mendota, canvasback radiate out approximately 10–15 miles to feed at some of the smaller lakes supporting lush stands of submerged aquatic plants. Only small numbers of canvasback occur on relatively few of the abundant lakes in the northern half of the state. Lake Superior and Lake Michigan are used infrequently and by only a small number of birds. After December 1, the bulk of the canvasback are located on two deep lakes, Lake Mendota and Lake Geneva, which do not freeze completely until late in December, or until early to mid-January in some years.

Differential Migration of Sexes: With very few canvasback breeding in Wisconsin and the fall migration (Fig. 42) occurring during the Wisconsin waterfowl hunting season, sex ratios of bagged birds should reflect the composition of the fall flight unless a sex or age group is differentially vulnerable or accessible to shooting. Immature canvasbacks shot in Wisconsin show a balanced sex ratio (Table 42). Since the sex ratios of ducklings at hatching (Hochbaum, 1944:57) and when 1–2 months old (Bellrose *et al.,* 1961:403) are balanced it appears that immature drake and hen canvasbacks are shot at some localities in Wisconsin in proportion to their occurrence in the population. This is in sharp contrast to the situation in other areas. In Manitoba, immature hens predominated

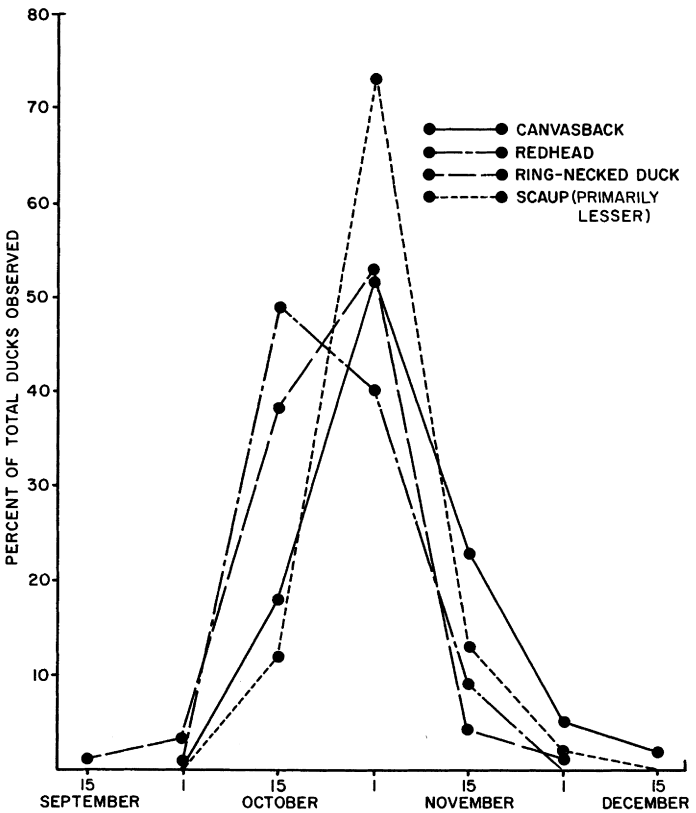


Figure 42. Average seasonal pattern of duck use for the canvasback, redhead, ring-necked duck, and scaup (primarily lesser) in Wisconsin, 1948–56.

TABLE 41

Sex Ratios of Ruddy Ducks Shot in Wisconsin, 1947–51

Year[1]	Adult Number Male	Adult Number Female	Adult Percent Male	Immature Number Male	Immature Number Female	Immature Percent Male
1947	2	1		4	6	
1948	8	17		51	73	41
1949	7	10		56	84	40*
1950	7	2		7	2	
1951	5	3		30	10	
Total	29	33		148	175	
Mean			47			46

[1] At the bulk of the check stations (about 25), bags of hunters were examined on the first few days of the waterfowl hunting season and in a few cases throughout the season.

* Significant difference from a 50:50 ratio.

in hunters' bags and in Illinois young drakes predominated (Bellrose *et al.,* 1961:404–05).

Small Wisconsin samples prohibit examining adult canvasback sex ratios in detail. A balanced sex ratio in bagged birds is suggested (Table 42). An excess of adult hens was reported at Delta, Manitoba (Hochbaum, 1944:131). A balanced sex ratio occurred in other areas of Manitoba and in the Mississippi Flyway in 1946 and 1948 (Bellrose *et al.,* 1961:404–07). In Illinois and in the Mississippi Flyway in 1947, a highly significant excess of adult drakes was bagged (Bellrose *et al.,* 1961:405–06). These variations in the adult sex ratio indicate that the pattern of migration, the vulnerability of drakes and hens, or both, varies between years and sites. With a highly significant excess of drakes in spring (Bellrose *et al.,* 1961:414; Table 42), a balanced sex ratio in fall shot birds suggests differential availability or vulnerability of hens to shooting. Stewart, Geis, and Evans (1958) reported that "Females sustained a relatively higher kill on breeding areas and early in migration, while males had a relatively heavier kill on wintering grounds." A balanced adult sex ratio in shot samples, suggests a disproportionately heavy harvest of female canvasback in Wisconsin. Our impression from aerial censuses, which did not include sex counts, of canvasback is that drakes outnumber hens. If this is actually fact rather than a visibility bias, behavior of hens locally must make them more available to hunters. Possibly, as has been reported by hunters for both the ruddy duck and canvasback, adult females react more readily to man-made decoys than do adult males.

Migratory Movements from Wisconsin: No canvasbacks were banded in Wisconsin. Birds using Wisconsin in fall either go south to the Gulf Coast or east to the Atlantic Coast, especially the Chesapeake Bay area (Stewart, 1949: 34–35). The primary trunk route is the eastern one, while part of the secondary flight leaves this main trunk route in the vicinity of southern Wisconsin and continues down the Mississippi Valley to the Gulf Coast (Stewart, Geis, and Evans, 1958:353).

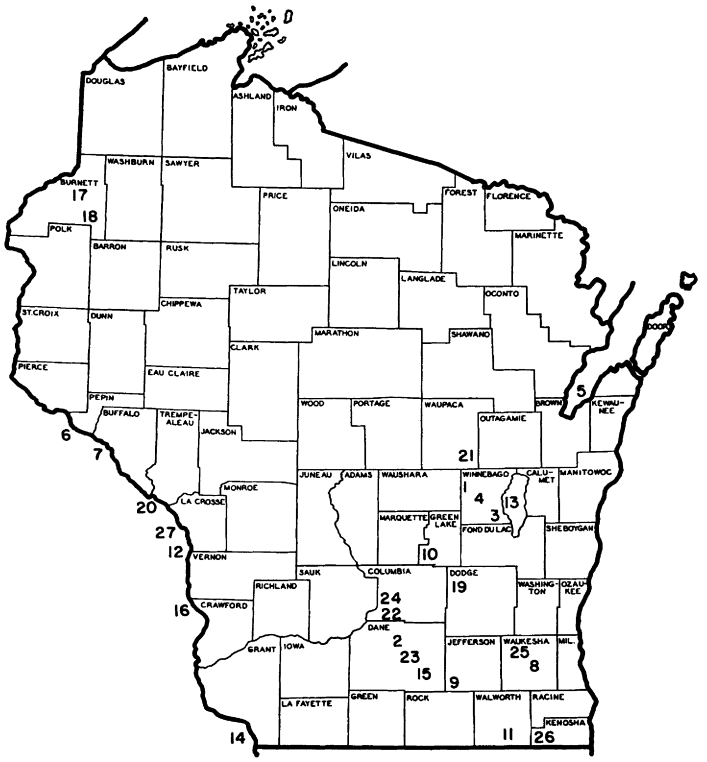


Figure 43. Distribution and relative importance of most of the fall canvasback concentration sites in Wisconsin. Average fall canvasback day-use:

High

1. Lake Poygan
2. Lake Mendota

Moderately High

3. Lake Butte des Morts
4. Lake Winneconne

Medium

5. Green Bay
6. Lake Pepin
7. Mississippi River—Pool 5

Moderately Low

8. Lake Pewaukee
9. Lake Koshkonong
10. Lake Puckaway
11. Lake Geneva
12. Mississippi River—Pool 8
13. Lake Winnebago

Low

14. Mississippi River—Pool 11
15. Lake Kegonsa
16. Mississippi River—Pool 9
17. Yellow Lake
18. Clam Lake
19. Fox Lake
20. Mississippi River—Pool 6
21. Partridge Crop Lake
22. Crystal Lake
23. Lake Waubesa
24. Lake Wisconsin
25. Lake Okauchee
26. Lake Elizabeth
27. Mississippi River—Pool 7

TABLE 42

Sex Ratios of Canvasback Shot and Observed in Wisconsin, 1941–51

Source	Year	Adult			Immature		
		Number Male	Number Female	Percent Male	Number Male	Number Female	Percent Male
A. Fall shot samples[1]	1947	5	1		6	13	
	1948	6	8		63	73	46
	1949	11	8		34	27	
	1950	2	4		12	8	
	1951	3	0		5	5	
Total and Mean		27	21		120	126	49
B. Observed in spring[2]	1941	19	12				
	1942	210	155	58**			
	1943	10	5				
	1947	319	149	68**			
	1950	31	21				
Total and Mean		589	342	63**			

[1] At approximately 25 check stations, bags of hunters were examined on the first few days of the waterfowl hunting season and in a few cases later in the season. Fewer stations were checked in 1947, 1950, and 1951 than in other years.

[2] Observations were made at about 25 different aquatic sites in some years. Except for 1950, figures are from Zimmerman (1961).

** Highly significant difference from a 50:50 ratio.

Scaup (Greater and Lesser)

Pattern of Migration: Scaup present in Wisconsin in fall are known to originate in Alberta, Saskatchewan, and Manitoba (Aldrich, 1949a and b). Other northern breeding grounds probably contribute too. Both greater and lesser scaup enter Wisconsin during the first days of October, and in late October, large flights occur. Peak populations are reached about November 1 and quickly decline when ice eliminates their aquatic feeding sites (Fig. 42). Relatively few scaup remain on a few of the deeper lakes until early December. After mid-December bluebills are rarely observed on inland areas in Wisconsin, although 1,000 to 1,200 winter along Lake Michigan adjacent to Wisconsin.

Some of the lesser scaup move southeastward to Wisconsin before turning southward toward the Gulf Coast (Aldrich, 1949b:41). Others continue east and southeast to the Atlantic Seaboard (Aldrich, 1949b:41; Hickey, 1956).

Distribution of the scaup is statewide (Fig. 44). Unlike the ring-necked duck, the scaup uses Lake Superior and Lake Michigan, but rarely uses small flowages such as beaver impoundments. Lakes of various sizes are the important concentration sites. In forested areas, many lakes lightly used by other species are frequently occupied by scaup and ringnecks.

Differential Migration of Sexes: Balanced adult and immature sex ratios of lesser scaup occur in the bags of Wisconsin hunters (Table 43). Sex ratios of ducklings (1–2 months old) trapped in Saskatchewan and Alberta were also balanced (Bellrose *et al.*, 1961:403). In shot samples of immature scaup (4–9 months old), sex ratios were balanced at Delta, Manitoba (Hochbaum, 1944:131), and in other parts of Manitoba and sections of the Mississippi Flyway (Bellrose *et al.*, 1961:404–07). In Illinois, a significant preponderance of young drakes was reported (Bellrose *et al.*, 1961:405). Agreement of the sex ratio between ducklings (4–8 weeks old) and young scaup (4–9 months old) in hunters' bags in most areas indicates that there is very little differential migration or concentration locally of immature scaup.

In adult lesser scaup, shot samples show a balanced sex ratio at Delta, Manitoba (Hochbaum, 1944:131) and in Wisconsin (Table 43). In other areas of Manitoba and Illinois, and in two (1947 and 1948) out of three (1946–48) years in parts of the Mississippi Flyway, drakes outnumbered hens in hunters' bags by a significant margin (Bellrose *et al.*, 1961:404–07). These variations in adult ratios in fall between areas and years indicate differential migration, concentration, vulnerability to shooting, or a combination of these factors. In spring, males outnumber females by a significant margin in all studies reported (Sowls, 1955:164; Bellrose *et al.*, 1961:414, Table 43). Hence, a balanced sex ratio in fall shot samples, such as in Wisconsin, suggests a disproportionately heavy kill of adult hens. Possible causes for the high harvest of females are given in the discussion of the ring-necked duck.

TABLE 43

Sex Ratios of Lesser Scaup Shot and Observed in Wisconsin, 1941–51[1]

Source	Year	Adult			Immature		
		Number Male	Number Female	Percent Male	Number Male	Number Female	Percent Male
A. Fall shot samples[2]	1947	1	3		7	34	
	1948	53	33		74	85	47
	1949	40	56		68	79	46
	1950	15	11		21	13	
	1951	9	7		27	17	
Total and Mean		118	110	52	197	228	46
B. Observed in spring[3]	1941	405	328	55*			
	1942	386	231	63**			
	1943	916	546	62.6**			
	1947	2,592	1,287	66.8**			
	1950	350	169	67**			
	1951	107	39	73**			
Total and Mean		4,756	2,600	64.6**			

[1] A few greater scaup are suspected of being included here. Scaup were checked at about 25 hunter check stations in certain years and were observed in spring on even more aquatic sites.

[2] At the bulk of the check stations, bags of hunters were examined on the first few days of the waterfowl hunting season and in a few cases throughout the season. Fewer stations were checked in 1947 and 1951 than in other years.

[3] Observations were made at about 25 different sites in some years. Except for 1950 and 1951, figures are from Zimmerman (1961).

* Significant difference from a 50:50 ratio.

** Highly significant difference from a 50:50 ratio.

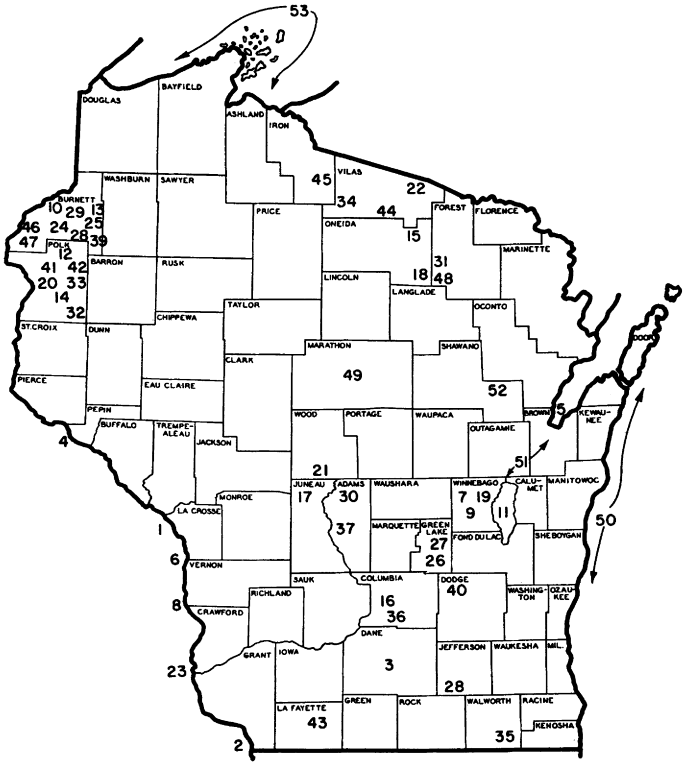


Figure 44. Distribution and relative importance of some fall scaup (primarily lesser) concentration sites in Wisconsin. (Additional census data would indicate more concentration sites north of a line extending from Brown County to Buffalo County; the bulk of these sites would undoubtedly fall in the moderately low to low duck-use categories.) Average fall scaup day-use:

High
1. Mississippi River—Pool 7
2. Mississippi River—Pool 11

Moderately High
3. Lake Mendota

Medium
4. Lake Pepin
5. Green Bay
6. Mississippi River—Pool 8
7. Lake Poygan
8. Mississippi River—Pool 9
9. Big Lake Butte des Morts
10. Yellow Lake

Moderately Low
11. Lake Winnebago
12. Big Round Lake
13. Green Lake (Burnett County)
14. Wapogasset Lake
15. Thunder Lake
16. Lake Wisconsin
17. Necedah National Wildlife Refuge
18. Pelican Lake
19. Lake Winneconne
20. Balsam Lake
21. Sandhill Wildlife Area
22. Lac Vieux Desert
23. Mississippi River—Pool 10
24. Clam Lake
25. Lower Twin Lake
26. Lake Puckaway
27. Green Lake
28. Lake Koshkonong
29. Big Sand Lake

Low
30. Petenwell Flowage
31. Pine Lake
32. Pike Lake
33. East Lake
34. Powell Marsh
35. Lake Geneva
36. Crystal Lake
37. Castle Rock
38. North Sand Lake
39. Buckhead Lake
40. Fox Lake
41. Big Butternut Lake
42. White Ash Lake
43. Yellowstone Conservation Area
44. Lost Lake
45. Flambeau Flowage
46. Mudhen Lake
47. Fish Lake
48. Bishop Lake
49. Lake Wausau
50. Lake Michigan
51. Fox River, segment
52. Shawano Lake
53. Lake Superior

TABLE 44

Sex Ratios of Redheads Shot and Observed in Wisconsin, 1941–51

Source	Year	Adult			Immature		
		Number Male	Number Female	Percent Male	Number Male	Number Female	Percent Male
A. Fall shot samples[1]	1947	10	4		8	3	
	1948	16	12		67	88	43
	1949	11	12		38	42	
	1950	6	3		7	6	
	1951	12	5		18	2	
Total and Mean		55	36	60	138	141	49
B. Observed in spring[2]	1941	63	48	57			
	1942	105	97	52			
	1943	228	82	74**			
	1947	790	441	64.2**			
Total and Mean		1,186	668	63.9**			

[1] At the bulk of the check stations, bags of hunters were examined on the first few days of the waterfowl hunting season and in a few cases throughout the season.

[2] Observations were made on more than 25 sites in some years. Figures are from Zimmerman (1961).

** Highly significant difference from a 50:50 ratio.

Redhead

Chronology of Duck Use: Only the ruddy duck is an earlier migrating diving duck than the redhead. Before October 1, very few redheads are in Wisconsin. Yet by October 15, peak populations are present (Fig. 42). Populations decline in both refuge and nonrefuge areas after this. By December 1, practically all redheads have departed from the state.

Important Fall Concentration Sites: With but few exceptions, the redhead uses the same concentration sites frequented by the canvasback (Fig. 45). All important sites are located in the southern half of the state. Only limited use is made of Lake Superior and Lake Michigan and the numerous lakes in the northern portion of the state.

Differential Migration of Sexes: Balanced sex ratios occurred in both adult and immature redheads shot in Wisconsin (Table 44). A balanced ratio was also reported at hatching (Sowls, 1955:164), for ducklings 1–2 months old (Bellrose *et al.,* 1961:403), and for immatures shot during the hunting season in Manitoba and other parts of the Mississippi Flyway (Bellrose *et al.,* 1961: 404–407). Only in Utah was a highly significant excess of young drakes reported during the hunting season (Bellrose *et al.,* 1961:407). Balanced sex ratios for different ages and most localities indicate that differential migration of sexes in immature redheads is not involved very often.

In adults, with but one exception in 1947 when an excess of hens was reported in the Mississippi Flyway, a balanced sex ratio occurred in shot samples in Manitoba, parts of the Mississippi Flyway, and Utah (Bellrose *et al.,* 1961:404–07). In spring, drakes exceed hens by a significant margin (Bellrose *et al.,* 1961:414; Table 44.) With drakes predominating in the population in spring, balanced sex ratios in the bag in fall indicate that adult hens must be rather consistently more vulnerable to shooting than males, or adult drakes are less available to hunters at the sites sex ratios were collected. Differential availability or vulnerability of adult females to hunting could be involved.

Migratory Movements from Wisconsin: Redheads banded at Horicon Marsh in spring were shot in subsequent years in Manitoba (1), Minnesota (1), Texas (1), Maryland (1), and Virginia (1). Recoveries from fall bandings occurred in Minnesota (1), Quebec (1), Indiana (1), and South Carolina (1). These recoveries indicate that redheads using Horicon Marsh proceed south to the Gulf Coast and east to the Atlantic Coast. The flight to the Texas coast is the major redhead fall flight route (Weller, 1964). However, we believe the Atlantic Coast flight is the numerically stronger of the two passing through Wisconsin.

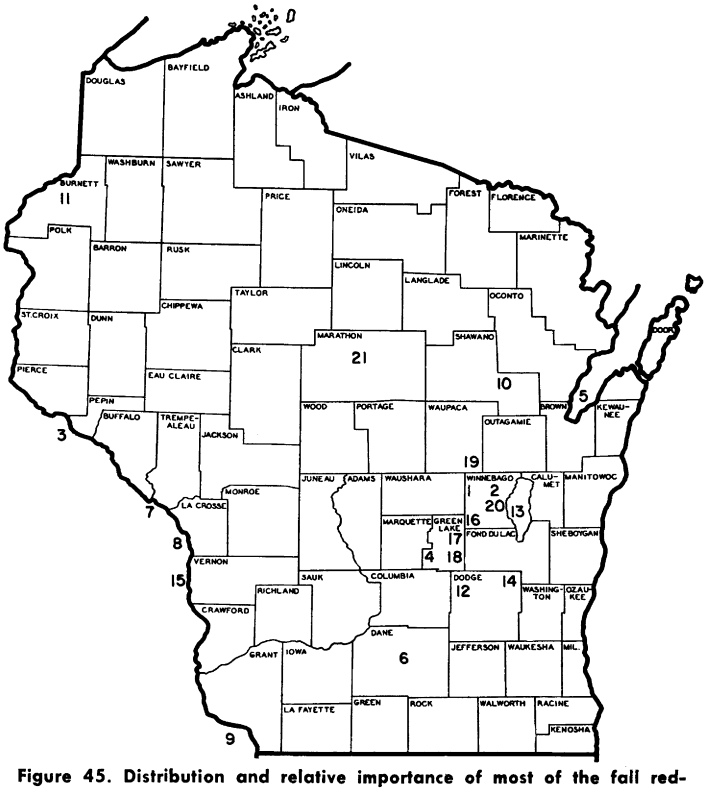


Figure 45. Distribution and relative importance of most of the fall redhead concentration sites in Wisconsin. Average fall redhead day-use:

Moderately High
1. Lake Poygan

Medium
2. Lake Winneconne
3. Lake Pepin

Moderately Low
4. Lake Puckaway
5. Green Bay
6. Lake Mendota
7. Mississippi River—Pool 7
8. Mississippi River—Pool 8
9. Mississippi River—Pool 11
10. Shawano Lake

Low
11. Yellow Lake
12. Fox Lake
13. Lake Winnebago
14. Horicon Marsh
15. Mississippi River—Pool 9
16. Rush Lake
17. Big Green Lake
18. Lake Maria
19. Partridge Lake
20. Big Lake Butte des Morts
21. Lake Wausau

Ring-necked Duck

Pattern of Migration: Ringnecks start moving into Wisconsin in late September. Small flocks of 20 to a few hundred appear on certain lakes and flowages throughout the state. The first big flight occurs in early October and additional birds continue to arrive and pass over Wisconsin in late October. Peak populations are reached about November 1 (Fig. 42). This population peak quickly declines in early November as ice eliminates many favorite feeding grounds. After December 1 very few ringnecks are seen. The birds proceed south and southeast through Wisconsin to the Atlantic Seaboard and the Gulf Coast (Duvall, 1949).

The ring-necked duck is one of the most widely distributed ducks frequenting Wisconsin (Fig. 46). Major concentrations occur on the Mississippi River and in the Wolf and Fox River valleys (Winnebago County) in eastern Wisconsin. Small concentrations occur in suitable habitat throughout the state. Beaver flowages are often used by small flocks.

Differential Migration of Sexes: Sex ratios of ring-necked ducks shot in Wisconsin indicate a balanced ratio in adults and a significant excess of immature hens (Table 45). In Illinois, a significant excess of young drakes occurred in bagged birds for 1939–49 (Bellrose *et al.,* 1961:405). Incubator-hatched ducklings in Maine (Mendall, 1958:223) and 1- to 2-month-old ducklings trapped on the breeding grounds

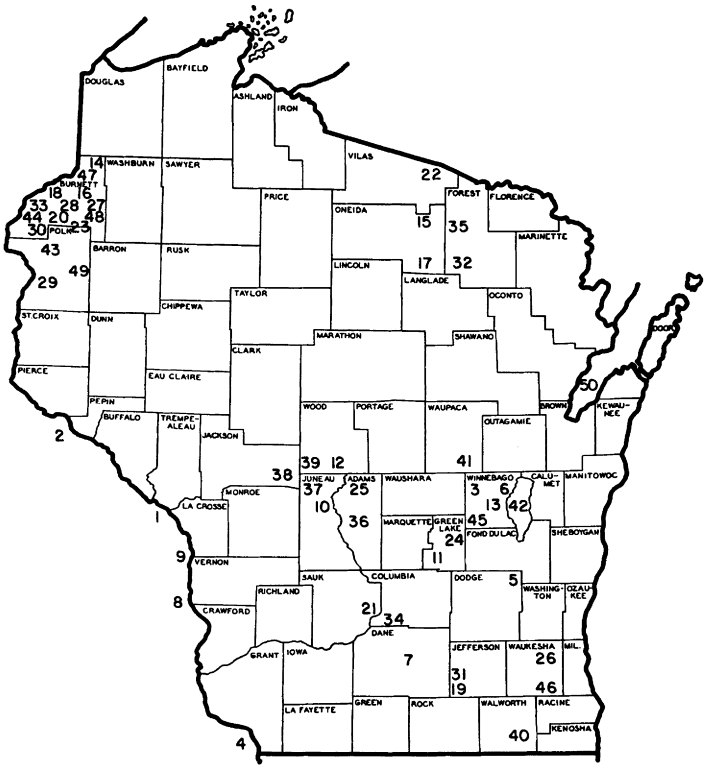


Figure 46. Distribution and relative importance of some fall ring-necked duck concentration sites in Wisconsin. (Additional census data would indicate more concentration sites north of a line extending from Brown County to Buffalo County; the bulk of these sites would undoubtedly fall in the moderately low to low duck-use categories.) Average fall ring-necked duck day-use:

High
1. Mississippi River—Pool 7
2. Lake Pepin

Moderately High
3. Lake Poygan

Medium
4. Mississippi River—Pool 11
5. Horicon Marsh
6. Big Lake Butte des Morts
7. Lake Mendota
8. Mississippi River—Pool 9

Moderately Low
9. Mississippi River—Pool 8
10. Necedah National Wildlife Refuge
11. Lake Puckaway
12. Sandhill Wildlife Area
13. Lake Winneconne
14. Yellow Lake
15. Thunder Lake
16. Lower Twin Lake
17. Pelican Lake
18. Green Lake
19. Lake Koshkonong
20. Clam Lake
21. Lake Wisconsin
22. Lac Vieux Desert
23. Fish Lake
24. Green Lake
25. Petenwell Flowage
26. Pewaukee Lake

Low
27. Big Sand Lake
28. Amsterdam Slough
29. Wapogasset Lake
30. Buckhead Lake
31. Lake Ripley
32. Bishop Lake
33. Crex Meadows Conservation Area
34. Crystal Lake
35. Pine Lake
36. Castle Rock
37. Meadow Valley Conservation Area
38. Black River State Forest
39. Wood County Public Hunting Grounds
40. Lake Geneva
41. Partridge Lake
42. Lake Winnebago
43. Big Round Lake
44. Mudhen Lake
45. Rush Lake
46. Lower Phantom Lake
47. Keizer Lake Chain
48. North Sand Lake
49. East Lake
50. Green Bay

TABLE 45

Sex Ratios of Ring-necked Ducks Shot and Observed in Wisconsin, 1941–51

Source	Year	Adult			Immature		
		Number Male	Number Female	Percent Male	Number Male	Number Female	Percent Male
A. Fall shot samples[1]	1947	7	5		30	32	
	1948	14	13		49	80	38*
	1949	10	35		102	118	46
	1950	10	9		31	32	
	1951	4	1		10	6	
Total and Mean		45	63	42	222	268	45*
B. Observed in spring[2]	1941	174	130	57*			
	1942	418	309	57**			
	1943	163	47	78**			
	1947	1,013	566	64.1**			
	1950	60	48	56			
Total and Mean		1,828	1,100	62.4**			

[1] At approximately 25 check stations, bags of hunters were examined on the first few days of the waterfowl hunting season, and in a few cases throughout the season. Fewer sites were checked in 1947 and 1951 than in other years.

[2] Except for 1950, figures are from Zimmerman (1961).

* Significant difference from a 50:50 ratio.

** Highly significant difference from a 50:50 ratio.

(Mendall, 1958:222) show a balanced sex ratio. With shot samples showing a preponderance of young females in Wisconsin and an excess of young drakes in Illinois, differential migration or concentration of sexes is suggested. In Maine, Mendall (1958:165) reported an excess of males in flocks for certain localities and speculated that sex segregation of immature ringnecks was a possibility.

Shot samples of adult ringnecks show a balanced sex ratio in Wisconsin (Table 45), Illinois, and other parts of the Mississippi Flyway (Bellrose *et al.,* 1961:405–07), and in New Brunswick (calculated from Mendall, 1958:179). In Vermont, 31 of 47 adults were drakes (Mendall, 1958:179). In Maine, a significant excess of adult hens was reported for 1946–56 (calculated from Mendall, 1958:179). The excess of females is believed to result from (1) the majority of the breeding males leaving Maine for the summer molt, and (2) early-season shooting being chiefly of resident birds (Mendall, 1958:179–180).

Adult sex ratios of ring-necked ducks on the wintering grounds and during spring migration are summarized by Mendall (1958:221–222). Spring sex ratios for Wisconsin are given in Table 45. A highly significant excess of drakes occurred in all samples of over 150 birds from different states, years, and seasons. An excess of drakes at the posthunting period (winter and spring) provides a base for interpreting the largely balanced adult sex ratios in shot samples in the Mississippi Flyway. Limited data indicate that adult hens are subject to greater natural mortality on the breeding grounds than are drakes (Mendall, 1958:214). Hens of most ducks also molt later than drakes. Recognition of these biological facts is important to help evaluate sex ratios of adult ringnecks in shot samples.

Adult drakes outnumber adult hens when the birds return to the breeding grounds. On the breeding grounds hens are more susceptible to mortality factors than are drakes (Mendall, 1958:224–225). Therefore, in fall, adult drakes should outnumber old hens in the population by an even wider margin than they do in spring. With this situation, balanced adult sex ratios in shot samples in the Mississippi Flyway can only mean that a disproportionately large segment of hens is harvested.

Reasons for this harvest pattern remain speculative. Because the female molts later than the drake, she may migrate later and be less physically fit to undergo long flights than the male. Subnormal physical condition could result in adult hens stopping more frequently during migration. Likewise, if a large proportion of females migrate during the hunting season, they may be attracted or "decoyed" by concentrations of other species of ducks or by hunters' decoys. Either influence could make females more available to hunters than drakes. Specific causes of the balanced adult sex ratio in the bag in Wisconsin and other parts of the Mississippi Flyway must be identified more precisely.

We conclude that in both breeding (Wisconsin) and nonbreeding (Illinois) areas in the northern part of the Mississippi Flyway, adult females are harvested disproportionately heavily in relation to their occurrence in the population. If a preponderance of females is harvested in many states having high hunting pressure, such as Wisconsin and Illinois, the unusual excess of drakes in the ring-necked duck, as reported by Mendall (1958:220), may be the result of greater female mortality from a combination of hunting and natural losses.

Coot

Chronology of Flight: Migrant coots start arriving in Wisconsin in early September. Populations on favorite, aquatic feeding areas continue to increase in numbers and reach peak levels in mid-October (Fig. 34). Near peak populations remain until freeze-up forces many of the birds out of the state in early November. A few hundred to a few thousand coots remain to mid-December. Only in mild winters are any mud hens present in mid-January. Freeze-up of open water on favored lakes and marshes forces the birds out of the state. Some perish as holes of open water become frozen.

Important Fall Concentration Sites: Concentrations of coots occur throughout Wisconsin on surface water areas having submerged aquatic plants (Fig. 47). Lakes in the northeastern region appear to be used least. No single species of duck is as widely distributed nor as abundant as the coot. Docile behavior of the birds and reluctance of many hunters to shoot them help to explain their distribution. Rafts of coots are not alarmed greatly by motor boats nor the sound of shooting. Many hunters let coots swim among their decoys, well within killing range of their shotguns. Although coots may have traditions established to use certain water areas more than others, it is probably because ideal food conditions exist there. They are quick to take advantage of new habitat created for them, such as at the Horicon National Wildlife Refuge.

Migratory Movements: Three coots shot in Wisconsin were banded as flightless young ("locals") in Minnesota, North Dakota, and Manitoba. Two Wisconsin-banded coots were taken in Florida and southern Ontario. Coots banded in Louisiana, Virginia, North Carolina, South Carolina, and Florida have been recovered subsequently in Wisconsin (Burton, 1959). These recoveries show that some coots enter Wisconsin in fall from the northwest and proceed south and southeast to their wintering grounds.

Factors Affecting Fall Distribution

The fall distribution of ducks and coots depends upon traditions established to use specific aquatic sites, presence of water of proper depths, abundance of foods of preferred types, and protection from disturbance. Absence of the proper combination of these items can result in limited, if any, waterfowl use.

Before the waterfowl hunting season opens, the distribution of ducks and coots is largely determined by the presence of preferred foods, the availability and abundance of foods in favored feeding conditions, and the traditions established to use certain sites. Some aquatic sites having suitable habitat

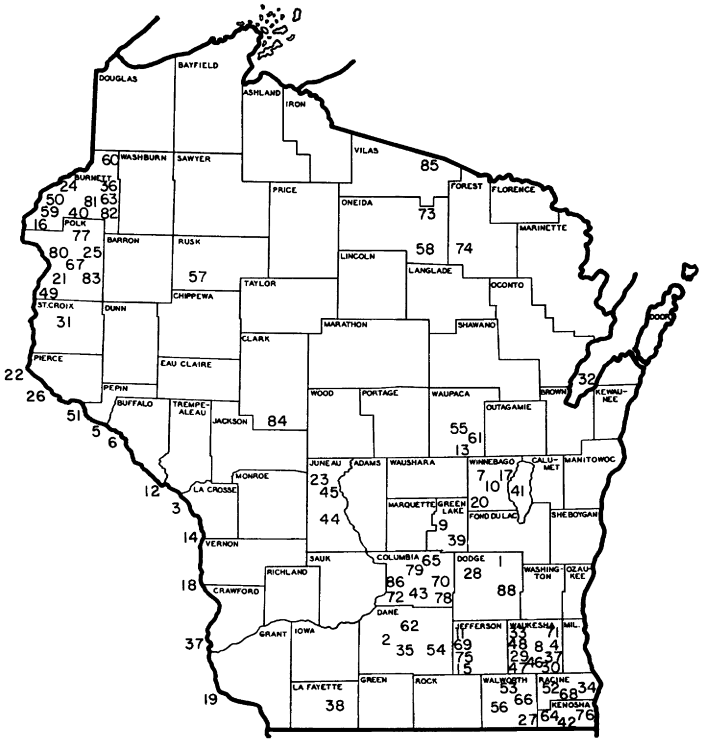


Figure 47. Distribution and relative importance of some fall coot concentration sites in Wisconsin. (Band recoveries from coots banded outside Wisconsin indicate more concentrations, especially in southeastern Wisconsin. Very few of these sites would fall in the high or moderately high coot-use categories.) Average fall coot day-use:

High

1. Horicon Marsh
2. Lake Mendota
3. Mississippi River—Pool 7
4. Okauchee Lake
5. Mississippi River—Pool 4
6. Mississippi River—Pool 5
7. Lake Poygan
8. Pewaukee Lake
9. Lake Puckaway
10. Lake Winneconne
11. Rock Lake
12. Mississippi River—Pool 6
13. Partridge Lake
14. Mississippi River—Pool 8
15. Lake Koshkonong
16. Clam Lake
17. Big Lake Butte des Morts
18. Mississippi River—Pool 9
19. Mississippi River—Pool 11
20. Rush Lake

Moderately High

21. Wapogasset Lake
22. Mississippi River—Hastings to Red Wing
23. Necedah National Wildlife Refuge
24. Yellow Lake
25. Big Round Lake
26. Mississippi River—Red Wing to Maiden Rock
27. Lake Geneva
28. Fox Lake
29. Lake Nagawicka
30. Big Muskego Lake

Medium

31. Oakridge Refuge
32. Green Bay
33. Oconomowoc Lake
34. Wind Lake
35. Lake Waubesa
36. Big Sand Lake

Moderately Low

37. Mississippi River—Pool 10
38. Yellowstone Conservation Area
39. Lake Maria
40. Mudhen Lake
41. Lake Winnebago
42. Lake Elizabeth
43. Lake Wisconsin
44. Castle Rock Flowage
45. Petenwell Flowage
46. Lower Phantom Lake
47. Silver Lake
48. Lake LaBelle
49. East Lake
50. Rice Lake
51. Mississippi River—Maiden Rock to Wabasha
52. Tichigan Lake
53. Lake Beulah
54. Lake Kegonsa
55. Partridge Crop Lake
56. Lake Delavan
57. Fireside Lake
58. Pelican Lake
59. Mud Lake
60. Yellow River, segment
61. Cincoe Lake
62. Dushacks Marsh
63. Gaslyn Lake

Low

64. Powers Lake
65. Dates Mill Pond
66. Potter Lake
67. White Ash Lake
68. Brown's Lake
69. Red Cedar Lake
70. Mud Lake
71. Pine Lake
72. Fish Lake
73. Thunder Lake
74. Bishop Lake
75. Lake Ripley
76. Camp Lake
77. Straight River
78. Goose Lake
79. North Mud Lake
80. Horse Lake
81. Crex Meadows Conservation Area
82. Fish Lake
83. Bear Trap Lake
84. Lake Arbutus
85. Lac Vieux Desert
86. Grassy Lake
87. Little Muskego Lake
88. Lake Sinissippi

conditions are used little by ducks. The frequency and volume of hunting pressure and motor-boat traffic curtails duck use.

After waterfowl hunting starts, the distribution pattern of many species, especially the puddle ducks, changes drastically where hunting pressure is severe. Aquatic sites providing preferred foods and used by ducks on a sustained basis are those offering protection from disturbance. Many suitable aquatic areas support minimal duck populations or go duckless because disturbance from boating or hunting, or both, is excessive. Human disturbance is responsible for driving concentrations of ducks from relatively small units of habitat to larger areas offering seclusion. Outstanding examples are available to illustrate the influence these factors have on duck distribution.

On the opening day (October 1) of the 1956 waterfowl hunting season, ducks were exposed to legal shooting for the first time in Wisconsin at 12:00 (noon). Intensive observations at the Horicon National Wildlife Refuge showed that at 10:30 a.m. large (100's) flocks of ducks started arriving at the refuge from a northerly direction. This flight of ducks continued and increased in intensity afer shooting started at 12:00 (noon). As far as one could see with the aid of 7 x 50 binoculars, there were flocks of ducks streaming toward the refuge. Flock after flock, some so high that they could not be seen at a distance with the naked eye, moved into the refuge, drawn to the area as though by a magnet. An approximate total of 26,000 ducks was observed entering the refuge during the day.

The arrival of ducks at the Horicon National Wildlife Refuge 1½ hours prior to the time shooting started illustrates the effect which field activities (excluding shooting) of thousands of hunters going to their shooting sites have upon ducks. After 12:00 (noon), the total effect of hunting was realized. With unlimited numbers of hunters per unit area and no refuge locally, ducks leave heavily disturbed areas and either move into refuges or out of the state. Exodus from Wisconsin was seen in Burnett and Rock counties in a number of years. The spectacular reaction of ducks to hunters described for Horicon Marsh has been seen on a lesser scale in many areas throughout Wisconsin.

Boating likewise limits, and on many smaller suitable lakes (probably 1,000 acres or less) eliminates, duck use. On numerous occasions we have seen flocks of ducks flushed by high-speed motor boats. On lakes where fall boating is popular, duck use has remained extremely low even though pre-

ferred foods are available and shooting is prohibited in open water.

On aerial waterfowl censuses, we have seen many duckless lakes with excellent stands of submerged aquatic plants. This is especially true on smaller (under 1,000 acres) lakes with numerous piers and boats. With fall vacations being encouraged more and more, motor boating is becoming increasingly prevalent. The temptation to stir up flocks of ducks and coots is apparently great. In some cases the mere passage of boats in and out of an aquatic area used by ducks creates sufficient disturbance to reduce duck use even though the birds are not purposefully disturbed. Dillon (1956:37) reported that, on the 180-acre University Bay waterfowl refuge, fall fishing influenced the use of the area by waterfowl. Passage of boats through the bay often caused considerable disturbance to the birds.

The total influence that boating has in limiting fall duck use certainly appears to be related to the frequency of boating and the size of the lake on which it is done. On lakes of less than 1,000 acres, and very probably up to 2,000 acres, a small but frequent volume of boating will greatly curtail duck use. On larger lakes, especially those of approximately 3,000 acres or more, limited boating not directed at disturbing ducks can apparently be permitted without curtailing duck use. Populations of ducks continued to build up on large lakes after the hunting season opened, in spite of rather heavy traffic by boats of hunters going to and from hunting stands in the emergent shoreline vegetation.

With shooting prohibited in open water in Wisconsin, many lakes of sufficient size serve as natural refuges. Stubble-feeding mallards and black ducks secure water and roost on such lakes. Some of the other puddle ducks raft in the expansive open water and apparently feed in the zone of shallow water at night. Diving ducks feed and roost on the open water.

In summary, the fall distribution of ducks in Wisconsin is influenced to a considerable degree by areas offering protection to the birds. Lakes larger than 3,000 acres and not having excessive boating provide natural refuges under the law prohibiting hunting from open water. Aquatic areas, such as marshes, and flooded or nonflooded upland fields providing preferred waterfowl feeds, quickly become duckless when used by unlimited numbers of hunters. In such cases, establishment of square or circular refuges of at least approximately 640 acres is necessary to provide the birds with a safe resting site. The refuge size can be slightly smaller if there is good uniform distribution of emergent aquatic plants and open water, such as at Rush Lake (Winnebago County). Lacking such undisturbed areas, ducks are pushed onto the larger natural lakes or leave the state. Where natural or purposefully established aquatic refuges exist in agricultural regions, stubble-feeding species radiate out from such areas of protection to feed in harveted grain fields. We strongly suspect that more stubble-feeding birds could be accommodated on the existing suitable habitat in Wisconsin. However, the numbers of birds potentially to be attracted are limited because Wisconsin is located off the major fall flight lanes of the mallard, black duck, and pintail.

Factors Causing Mortality

Other than losses associated with hunting, which are taken up in Part III of this report, no important mortality factors are known to affect ducks and coots in fall in Wisconsin. Botulism in the Green Bay area (Brown County) has claimed the highest number of ducks and coots in a particular locality. Three outbreaks of botulism have been reported for this area between 1936 and 1958. Known deaths of ducks and coots totaled 100 in 1936, 156 in 1941 (Zimmerman, 1946), and 369 in 1956 (H. A. Shine, Wis. Conserv. Dept., in litt., 26 Oct. 1956). Total deaths in 1956 may have been more than 600–700 birds. Species involved in the losses, in order of importance, included the mallard, blue-winged teal, black duck, green-winged teal, coot, American widgeon, pintail, gadwall, mergansers, and lesser scaup. D. O. Trainer, Jr. (Wis. Conserv. Dept., in litt., 17 Aug. 1956) found that although botulism is frequently associated with drought, excessive rainfall in the summer of 1956 created wet pockets or semi-stagnant pools on the marsh fringe. Thus, an optimum environment was available for cell germination and production of toxin by *Clostridium botulinum*. The only other known outbreak of waterfowl botulism in Wisconsin occurred on Horicon Marsh in 1938 (Zimmerman, 1946).

A fluke was recently associated with mortality of coots in Wisconsin. Losses were attributed to a species of trematode of the genus *Sphaeridiotrema,* presumably *S. globulus* (Trainer and Fischer, 1963). Observed fatalities in 1961–62 on Lake Butte des Morts exceeded 700 coots, of which approximately 100 occurred during October 1962. Losses in spring exceeded 600 in the 2 years. This fluke had not been reported previously from ducks or coots examined in Wisconsin (Table 46).

A summary of the occurrence of all diseases, parasites, and poisons encountered in fall in wild ducks and the coot in Wisconsin is presented in Table 46. Incidence of blood parasites for ducks secured at Horicon Marsh is given in Table 47. The exact relationship of each of these factors to the welfare of ducks and the coot is unknown.

One parasitic condition of the skeletal muscles is frequently noticed by duck hunters. A sporozoan *(Sarcocystis rileyi)* produces spores which are enclosed in a cystic membrane surrounded by tissues of the muscle. Upon removal of the skin, heavily infected ducks display numerous creamy-white elongated streaks on the surface of the breast muscles. Hunters frequently ask if such birds are edible. Riley (1931) suggests that it may be dangerous to consume excessively infected birds. Toxic substances have been obtained from sarcosporidia. Until more is known about the relationships between these toxic materials and human health, a cautious attitude seems appropriate for handling heavily infected ducks.

While these records of nonhunting mortality are valuable, improved knowledge of the nature and extent of such losses

TABLE 46

Summary of Presence of Diseases, Parasites, and Poisons in Wild Ducks and Coots Collected and Examined in Wisconsin, 1938–58*

Pathological Factor Involved	Species Afflicted								
	Mallard	Black Duck	Pintail	Wood Duck	Blue-winged Teal	Green-winged Teal	American Widgeon	Lesser Scaup	Coot
Bacterial infection	X								
Botulism	X	X	X		X	X	X	X	X
Flukes	X								
Pneumonia	X								
Sarcocystis spp.	X	X	X						
Tapeworms	X								
Pasteurella spp.	X								
Trematoda									
Echinostomum spp.	X	X	X	X					
Notocotylid		X	X	X					
Strigeid				X		X			
Zygocotyle lunata	X	X	X						
Cestoda									
Diorchis spp.	X	X							
Fimbriaria spp.	X		X						
Hymenolepius spp.	X					X			
Hymenolepius megalops		X		X	X				
Nematoda									
Capillaria spp.			X						
Acanthocephala	X	X		X	X	X			

* Data from Hine (1956) and files of the Wisconsin Conservation Department. All ducks were autopsied in July-November by pathologists of the Wisconsin Conservation Department or by veterinarians at the Wisconsin Department of Agriculture, Animal Disease Diagnostic Laboratory. Dr. Robert A. Rausch identified the internal parasites which came from ducks taken on the Horicon Marsh Wildlife Area in the autumn of 1946. Except for losses due to botulism, the number of ducks examined was from 1 to 10 birds. In most cases a single bird was involved.

TABLE 47

Types and Incidence of Blood Parasites in Ducks and the Coot Secured at Horicon Marsh*

Species	Number Examined	Number Positive				
		All Blood Parasites	*Leucocytozoon*	*Hemaproteus*	*Filaria*	*Plasmodium*
Mallard	97	15 (15%)	6	11	5	1
Wood duck	51	9 (18%)	5	5	0	0
Blue-winged teal	40	2 (5%)	0	2	0	0
Black duck	30	18 (60%)	13	1	15	0
American widgeon	18	5 (28%)	1	0	5	0
Coot	14	0	0	0	0	0
Pintail	10	2 (20%)	0	0	2	0
Redhead	5	0	0	0	0	0
Ruddy duck	3	0	0	0	0	0
Canvasback	2	0	0	0	0	0
Gadwall	2	0	0	0	0	0

* Based on data from birds live-trapped in August and September or shot during the waterfowl hunting season in October (from Hine, 1956: 177).

are needed to understand fully their impact on waterfowl populations in all seasons of the year. H. A. Hochbaum (Delta Waterfowl Research Station) and G. W. Cornwell (Va. Polytechnic Inst.) are presently (1964) conducting a survey to secure better information for appraising nonhunting mortality of North American waterfowl.

Summary

By mid-August, most ducks and coots occur in flocks on large Wisconsin marshes and lakes providing preferred foods and resting areas. Not all ducks observed between August 15 and October 1 are raised in Wisconsin.

Some ducks enter and leave Wisconsin prior to October 1, the earliest date the waterfowl hunting season opened (1947–58). Blue-winged teal build up in numbers until September 15–25, after which their population declines. By late October few bluewings remain in Wisconsin.

Of nine species of puddle ducks, main flight routes of only two—the American widgeon and blue-winged teal—cross Wisconsin. The most important flight route of other puddle ducks is located west and southwest of the state. Major flight routes of the canvasback, lesser scaup, ring-necked duck, ruddy duck, and coot cross Wisconsin. Some of these flights of diving ducks proceed east by southeast and south over the Big Eau Plaine Flowage in Marathon County sometime during the last 15 days of October.

Statewide, the bulk of the ducks and coots are in Wisconsin between October 10 and November 10. Regionally there is little difference in the pattern of duck use. The chief variation is the length of time ducks remain after November 15 in certain regions. Ducks remain longest in Green Bay and in the southeastern part of the state. After freeze-up eliminates open water, except in some localities, all ducks except the small wintering population are forced out of Wisconsin to wintering grounds located to the south and southeast.

At least 18 species of ducks are present in Wisconsin during fall migration. Slightly less than two-thirds of the duck use registered during the 3-year period of 1954–56 was by puddlers. Upland stubble feeders, the mallard, black duck, and pintail, averaged 40 percent of the total duck use. American widgeon made up 20 percent. Canvasback, ring-necked ducks, and lesser scaup were the three most important divers. Coots were more abundant than any single species of duck.

Chronology of duck use for each species is similar among years, but differences in the pattern of duck use varies between species. Blue-winged teal reach peak populations by mid-September and are rare by late October, before some other species become most abundant. Wood ducks attain peak populations by October 1. During the first 15 days of October, peak populations are registered for the shoveler, green-winged teal, ruddy duck, redhead, and coot. Peak populations are reached in late October and early November by the American widgeon, pintail, gadwall, mallard, black duck, canvasback, lesser scaup, and ring-necked duck. In mid-November, the common merganser, red-breasted merganser, and bufflehead are most numerous. The common goldeneye does not reach peak abundance until December 1.

Sex ratios of immature ducks bagged in Wisconsin are, with but few exceptions, balanced. Since sex ratios at fertilization and hatching are equal in most species, shooting in Wisconsin removes the sexes in proportion to their existence in the population, except for five species. In the blue-winged teal and ring-necked duck, a significant lack of immature males was recorded. In the wood duck, green-winged teal, and black duck, there was a significant lack of immature females. Segregation of sexes and possibility of an earlier migration of one sex are indicated for these five species.

Sex ratios of adult ducks shot in Wisconsin, except for the American widgeon and wood duck, show an excess of females or an equal proportion of hens and drakes. With males exceeding females in the population, a disproportionately heavy harvest of adult females of most species of ducks is indicated. A high loss of adult hens to hunting, combined with high losses on the breeding grounds due to natural mortality factors, may help to explain the excess of male ducks in the adult class of the population.

In 9 of 13 years (1946–56 and 1959–60), mallard production indices (age ratios) obtained from birds shot in Wisconsin differed in trend from indices obtained in Illinois. Generally, mallard age ratios in Wisconsin were at a higher average level than age ratios secured in Illinois. Since many mallards shot in Illinois are hatched in prairie and parkland habitat of Saskatchewan, mallards using Wisconsin in fall must be derived from breeding areas having more stable water conditions. In addition to mallard production within the state, circumstantial evidence and limited band recoveries indicate that Alberta, Saskatchewan, Manitoba, and Ontario, but especially the latter two provinces, contribute mallards to Wisconsin's fall populations.

Important Wisconsin fall concentration sites are presented for each of 19 species. Sites are limited in number for the ruddy duck, canvasback, and redhead. For the American widgeon, pintail, gadwall, and shoveler, concentration sites occur only in southern Wisconsin. Eleven other species congregate in suitable habitat throughout the state.

Distribution of ducks and coots in Wisconsin in fall depends upon traditions established to use specific aquatic sites, on the presence of water of proper depths, on abundance of preferred food, and on protection from disturbance.

Hunting pressure and motor-boat traffic, when frequent or of large volume, alter the distributional pattern of many species, especially the puddle ducks. Human disturbance is responsible for driving concentrations of ducks from relatively small units of habitat to larger areas offering seclusion. Under the law which prohibits hunting from open water, lakes larger than approximately 3,000 acres, and not having excessive motor-boat traffic, provide natural refuges.

Other than losses associated with hunting, no major mortality factors are known to affect fall duck and coot populations in Wisconsin.

The Wintering Population

Each year in early January an inventory of waterfowl is completed throughout most of the winter range of the birds in North America. The Wisconsin Conservation Department cooperates in this widespread census to secure as near a complete picture as is practical of the number and distribution of ducks and coots wintering in Wisconsin. In some years, an additional effort was made to determine the factors affecting the distribution and density of the population, and whether or not management problems are involved with the birds that spend the winter period in our state.

Methods

District game managers, with assistance from county conservation wardens, censused all waterfowl in each county from the ground on one date each year between January 7 and 15. Aerial censuses were conducted on some inland streams and lakes, largely in southeastern Wisconsin, which were difficult or impossible to cover from the ground. Harbors and bays of Lake Michigan were censused from the ground with the aid of binoculars. Aerial strip censuses were completed on outlying areas of Lake Michigan from the Illinois–Wisconsin border north to the Michigan–Wisconsin border.

Size and Distribution of Population

During the 5-year period of 1954 through 1958, an annual average of 33,700 ducks and 1,200 coots were present in early January. Eighteen species of ducks were present, with four species, the mallard, black duck, common goldeneye, and lesser scaup averaging 89 percent of the population (Table 48).

Population fluctuations among years were great. The coot population varied from a high of 4,600 in 1955 to 1 bird in 1958. Duck populations ranged from 37,200 in 1954 to 26,900 in 1955. Proportions of species represented in the total numbers varied greatly among years. Numbers of mallards, common goldeneyes, and lesser scaups fluctuated most.

Inland areas of Wisconsin, including the parks and lagoons in the city of Milwaukee, accommodated over 99 percent of all puddle ducks. Harbors and bays of Lake Michigan are used by diving ducks and mergansers, with less than 300 puddle ducks present in any one year. The bulk of the ducks are found in the southern one-half of the state. Counties bordering the St. Croix and Mississippi rivers and Lake Michigan accommodate most of the birds (Fig. 48). Specific inland aquatic sites used by the birds are largely (1) stretches of spring-fed streams, and (2) pools below dams along certain streams.

Open water of outlying areas of Lake Michigan is practically unused by the more important game ducks. Common goldeneyes, old squaws, and mergansers averaged 98 percent of all ducks observed approximately one-half mile off the shore line or the shelf ice between 1956 and 1958 (Table 49). In 1957, a strip 3½ miles off and parallel to the shore was censused to determine the use ducks make of the more distant portions of the lake. Only 69 ducks, made up of 43 old squaws and 26 common goldeneyes, were seen. To wintering ducks, the harbors, bays, and open water, up to approximately ½-mile from shore or shelf ice, are the more important portions of Lake Michigan.

Factors Affecting Distribution, Density and Species Composition

Open water and availability of preferred food influence the number of many species of ducks wintering in Wisconsin. Examples involving Turtle Creek (Walworth County) and Lake Geneva (Walworth County) are used here to show how the availability of water and food at inland sites affect the numbers of certain species present in Wisconsin in early January. Major factors affecting the distribution of old squaws on Lake Michigan are described by Ellarson (1956).

Presence of canvasback, coot, and, to a large extent, the ring-necked duck in early January depends upon whether or not parts of Lake Geneva are ice-free. In 1955, daily tem-

◀ Photo by W. L. French, U.S. Fish and Wildlife Service

TABLE 48

Species Composition and Size of Wisconsin Wintering Duck and Coot Population, 1954–58*

Species	Percent Per Year					Total	
	1954	1955	1956	1957	1958	Mean Number	Percent
Puddlers							
Mallard	44	29	43	50	21	12,800	38
Black duck	24	14	11	14	7	4,700	14
Pintail	Tr.	Tr.	Tr.	Tr.	Tr.	<50	Tr.
Gadwall	0	0	0	0	Tr.	Tr.	Tr.
American widgeon	0	Tr.	0	0	0	Tr.	Tr.
Wood duck	0	Tr.	0	0	0	Tr.	Tr.
Green-winged teal	0	Tr.	0	0	0	Tr.	Tr.
Total Puddlers	68	43	54	64	28	17,500	52
Divers							
Common goldeneye	14	17	12	18	35	6,300	19
Lesser scaup**	8	24	29	9	23	6,100	18
Old squaw	3	4	1	3	12	1,500	4
Canvasback	0	4	1	1	Tr.	300	1
Bufflehead	0	0	1	0	0	100	Tr.
Ring-necked duck	0	Tr.	0	Tr.	Tr.	<50	Tr.
Ruddy duck	Tr.	Tr.	Tr.	Tr.	Tr.	<25	Tr.
Redhead	Tr.	0	Tr.	Tr.	Tr.	<25	Tr.
Common scoter	0	0	0	0	Tr.	Tr.	Tr.
Total Divers	25	49	44	31	70	14,400	43
Mergansers	7	8	2	5	2	1,800	5
Total Number of Ducks	37,200	26,900	35,400	34,700	33,800	33,700	—
Total Number of Coot	100	4,600	100	1,000	Tr.	1,200	—

* Based on all birds observed on aerial and ground surveys in early January of each year, except for the off-shore Lake Michigan ducks listed in Table 49. All numbers are rounded to the nearest hundred where possible.

** A few greater scaup may be included.

peratures had been rather mild up to January 11, the date of the census. Open-water areas of Lake Geneva supported approximately 1,000 canvasbacks, 125 ring-necked ducks, and 4,550 coots. Practically all of these three species present in Wisconsin were on this single lake. In direct, contrast, in 1954 and 1956, temperatures were below freezing for quite a period prior to the census. Lake Geneva was almost completely frozen over, and only about 250 birds of the three species were present.

Numbers of mallards and black ducks using Turtle Creek, where open water is available every year, fluctuate in response to the availability of corn. Thus, the proportion these two species make up of the total ducks observed varies among years (Table 48). Corn is present in the form of waste grain in mechanically picked fields and as ears on stalks in standing-corn fields. Accumulation and condition of snow govern the availability of this food. With the absence of snow or with only an inch or two of this cover, the birds consume the waste grain in harvested fields. As the snow depth increases or becomes crusted, waste grain becomes unavailable, and the birds are hard pressed to secure food. Under such conditions we suspect they migrate beyond the snow line. Such situations occur infrequently, both in numbers of years and within periods of time within a year. With sufficient depth of snow, the ears of standing corn become available and are used. Kernels of corn are removed from under the husk of the ear by the birds as they stand on the accumulated snow.

In addition to natural feeds, hand feeding provides some ducks with food in certain localities. Hand feeding effectively encourages mallards and small numbers of black ducks to remain in a given locality where open water is present throughout the winter and where preferred food is naturally limited. In January 1954, Bay Beach Sanctuary in the city of Green Bay (Brown County), Spring Brook Farms (Dodge County), and the lagoons in the city of Milwaukee (Milwaukee County) accommodated large numbers of ducks. Here, corn and minor quantities of other foods were provided especially for the birds. The sites held one-third (5,350) of all the mallards and 3 percent (300) of all the black ducks recorded on the statewide inventory. Recognizing the limited

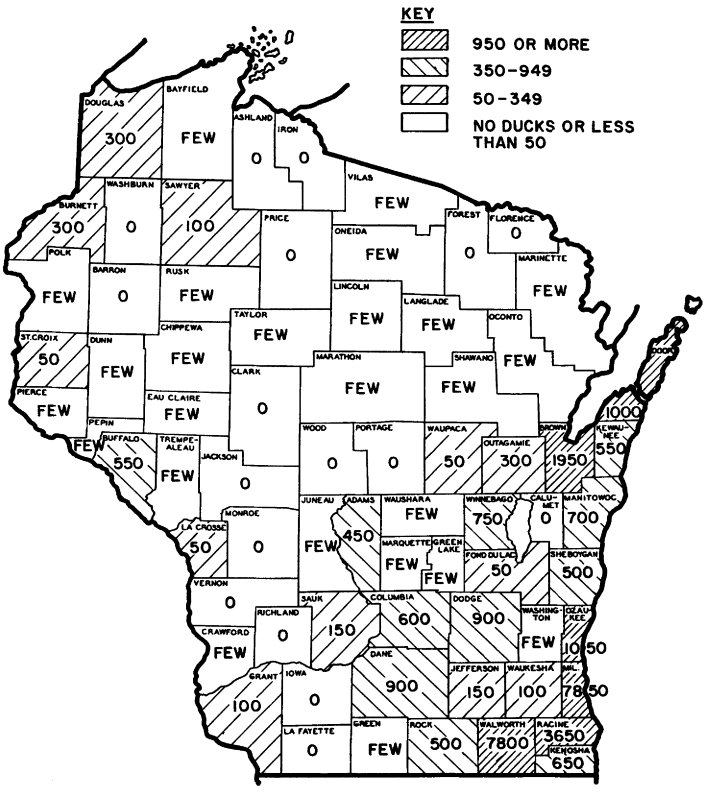


Figure 48. Average distribution of Wisconsin's wintering duck population, 1954–58. (Ducks on all inland sites and the harbors and bays of Lake Michigan are included. All ducks on the outlying waters of Lake Michigan are excluded and are shown in Table 49. All figures for individual counties are rounded to the nearest 50.)

availability of natural preferred food in the vicinity of these three sites, we judged that very few, if any, of the birds would be present if hand feeding ceased. In the absence of feeding, the birds would have to migrate or die when food resources became limited. In 1936, Gromme (1936:324) recorded the death ". . . of hundreds and probably thousands of winter ducks on Lake Michigan . . ." near Milwaukee, Wisconsin, when freezing of the surface water caused a food shortage.

The quick response of mallards to a hand-feeding program is illustrated by a project initiated by the Lake Wausau Sportsmen's Club in the fall of 1956 below a power dam on the Wisconsin River in the city of Wausau. In January 1956, preceding the start of the feeding program, only 7 common goldeneyes and 1 bufflehead were present. In succeeding Januarys, the mallard population increased steadily from 60 or 70 in 1957, to 125 in 1958 and to 650 in 1959. In 1959, 60 black ducks were also present. The feeding program increased from a minor to a major undertaking as the mallard population expanded. There is little question that hand feeding is an important factor affecting the number and distribution of mallards wintering in Wisconsin. Trautman, Bills, and Wickliff (1939:87) believed that feeding caused unusually large numbers of waterfowl to remain in certain localities of Ohio in the winter of 1931–32.

On Lake Michigan, as previously stated, the harbors, bays, and open water, up to about ½-mile from shore or from shelf ice, are used most heavily by wintering ducks. Commercial fishermen reported to Ellarson (1956:51) that in certain years ice causes old squaw ducks to concentrate in specific areas or localities on Lake Michigan. Changes in distribution of old squaws are reported by Ellarson (1956:51–52) as follows: "The concentration of birds may be quite local, as for example when the ducks are crowded into narrow leads of water between ice floes, or the concentration may take place on a much larger scale, as occurs when heavy ice formation in the northern one-half of the lake forces the greater part of the total wintering population into the southern half of the lake. . . . Old squaw ducks probably show an affinity for floe ice simply because they are forced out to deeper water by the build-up of shore ice. They remain close to the edge of the ice, as the water here would be the most shallow available to them for feeding." Ellarson did not consider the ice floes essential as resting areas to the well-being of a bird with the pelagic habits of the old squaw. Movements of old squaws on Lake Michigan, in relation to different ice conditions between years, undoubtedly explains the large variation in the percentage of old squaws observed on the midwinter census conducted in Wisconsin (Table 48).

TABLE 49

Species Composition of Off-shore Lake Michigan Wintering Duck Population, 1956–58*

Species	Percent Per Year			Total	
	1956	1957	1958	Number	Percent
Com. goldeneye	59	59	71	24,500	61
Old squaw	40	13	21	14,200	35
Mergansers	1	7	6	900	2
Lesser scaup**	0	21	1	700	2
Black duck	0	Tr.	1	Tr.	Tr.
Mallard	0	0	Tr.	Tr.	Tr.
White-winged scoter	0	0	Tr.	Tr.	Tr.
Total Number of Ducks	30,600	3,300	6,400	40,300	—

* Based on aerial census of a strip approximately ½-mile off the shoreline or shelf ice and extending from the Illinois-Wisconsin border north to the Michigan-Wisconsin border.

** A few greater scaup may be included.

Importance of Wisconsin as a Wintering Area

To the ducks and coots of North America, Wisconsin serves as a very minor wintering ground (Fig. 49). Less than 1 percent of the birds in the Mississippi Flyway are located in the state in early January. On a sustained basis, Lake Michigan is of greatest value to the old squaw and common goldeneye, and inland open-water areas are used most by the mallard and black duck.

Management Problems

There are no major management problems concerning the inland wintering ducks and coots in Wisconsin. Mortality has been minor, involving the coot more than any other species. Probably up to a few hundred coots perish as ice closes the

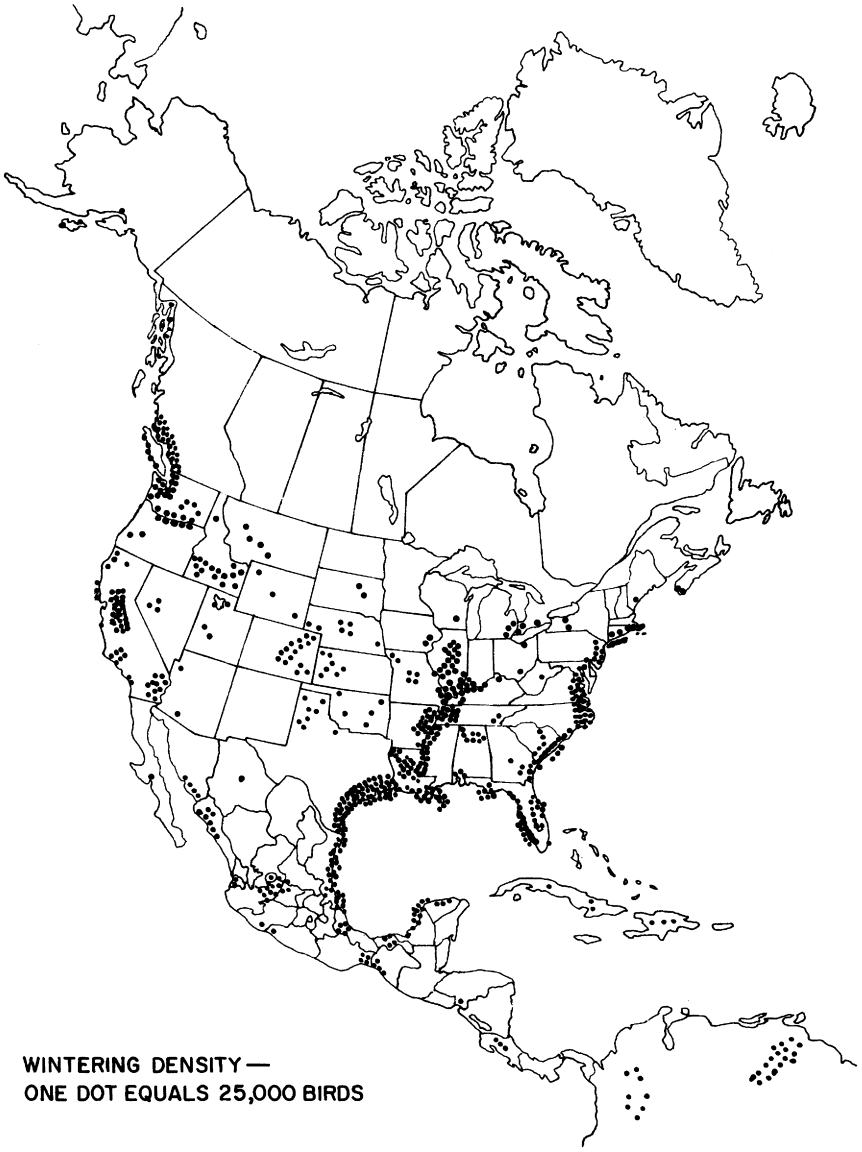


Figure 49. Distribution of North American waterfowl during the winter season (after Shaw and Crissey, 1955).

last few open-water areas of certain lakes. No other species have been lost in any numbers at inland sites due to cold weather. Climatological records for Wisconsin (U. S. Dept. Commerce) show —40° to —50° F. in various localities (1949–51), but especially in northern and central Wisconsin where relatively few waterfowl spend the winter (Fig. 48). Southern Wisconsin registered a —37° F. on 30 January 1951 (at Madison, Dane County).

Crop depredations by stubble-feeding mallards and black ducks occur infrequently. As previously described, when snows are of sufficient depth to eliminate waste corn as food and of adequate depth to permit the birds to reach ears on standing corn, crop losses take place. Such losses are estimated at only a few thousand dollars in a year of most severe damage. In most years, the bulk of the cornfields are harvested before December. However, due to the social habits of the birds to feed in only a few localities and to return to the same field to feed when unmolested, an individual farmer or a few farmers may suffer the entire loss of standing corn. To these people, making a living from the crops, the financial loss is significant. The best way known to prevent crop depredations is to scare the ducks from the crop fields when they first try to use them (Davis, 1952). Or, in the case of winter depredations, to harvest the corn during the fall.

On Lake Michigan, ducks caught in fishermen's gill nets involve economic and legal aspects. Ellarson (1956:84) summarized the situation as follows: "The catching of diving ducks in gill nets results in economic losses to the commercial fishermen. There are three sources of loss: the cost of net repair (approximately twenty-eight cents per bird in 1954), the loss of time in removing birds, and the losses caused by the reduced efficiency of nets when birds become entangled. The disposal of birds taken in nets presents a difficult legal problem since birds so taken should not be brought into possession, yet they cannot be immediately discarded because of antipollution laws. Birds caught in nets are disposed of by

fishermen in the following ways: discarding in the lake, discarding the birds on shore ice or in farmers' fields, burying them, using them as fertilizer, or sending them to a rendering plant. A few birds are used for food. The realization of an economic return to the fishermen from the sale of these birds is contingent upon securing federal and state sanctions, and on the finding and developing of markets. Two more desirable forms of utilization for netted old-squaw ducks than those currently in favor would be as food for humans, and as a source of feathers and down."

Large variations in the annual accidental take of old squaws and other diving birds on Lake Michigan complicate the potential development of markets. Ellarson (1956:105) estimated that 15,539 birds were taken in 1951–52, and 19,562 birds in 1952–53. Both estimates were for years of low gill-net mortality. In 1949–50 and 1950–51, years when large numbers of birds were taken, the total catch may have approached 100,000 birds per year (Ellarson, 1956:105).

Deliberate attempts to encourage more ducks and coots to winter in Wisconsin should be avoided. Adopted Mississippi Flyway Council policy states that a normal flow of birds should be maintained from north to south and that birds should not be deliberately encouraged to winter where mean daily temperatures are permanently below 32° F. (Hawkins *et al.,* 1958:235.2). Winter temperatures in Wisconsin average lower than 32° F.

Most of the ducks and coots providing Wisconsin citizens with recreational opportunities winter south and southeast of the state. To safeguard the supply of birds, Wisconsin must be concerned with the preservation and management of wintering grounds where the climate is suitable.

Summary

Between 1954 and 1958, an average of 33,700 ducks and 1,200 coots were present in Wisconsin in early January. Eighteen species of ducks were observed, with the mallard, black duck, common goldeneye, and lesser scaup averaging 89 percent of the total duck population. Populations fluctuated greatly among years.

The bulk of the ducks and coots are located in the southern one-half of the state. Counties bordering the St. Croix and Mississippi rivers and Lake Michigan accommodate most of the birds. Outlying areas of Lake Michigan are used almost exclusively by common goldeneyes and old squaws. Turtle Creek, in Rock and Walworth counties, is the most important single wintering area for game ducks, primarily mallards and black ducks.

Restricted availability of open water and preferred food limit the number of many species of ducks wintering in Wisconsin. Freezing temperatures and snowfall limit food and water resources.

Hand feeding effectively encourages mallards and black ducks to remain in a locality where open water is present throughout the winter and preferred food is naturally limited or absent. Adopted policy of the Mississippi Flyway Council is to discourage attempts to hold ducks and coots deliberately in areas where the mean daily temperature in winter is below 32° F., as in Wisconsin.

Winter mortality of ducks and coots on inland areas has been minor in Wisconsin, and crop depredations occur infrequently. On Lake Michigan, ducks (1) starve when ice limits aquatic food supplies, and (2) drown after becoming entangled in fishermen's nets. Losses of old squaws and other diving birds in fishermen's gill nets reached a known maximum of approximately 100,000 in 1949–50.

Wisconsin is a minor duck and coot wintering ground in North America. The birds Wisconsin citizens depend upon for recreational opportunities primarily winter south and southeast of Wisconsin.

PART III. HARVEST ASPECTS

Photo by Wisconsin Conservation Department

Each fall the ducks and coots of North America are met with a barrage of lead from millions of hunters. To insure the survival of a nucleus of breeders, hunting regulations are established. Wisconsin conducted studies with the excellent cooperation of thousands of waterfowl hunters to determine (1) some of the characteristics of the harvest, and (2) the general effects of certain hunting regulations on the waterfowl populations.

Information is needed to understand better the characteristics of the waterfowl harvest in order to establish hunting regulations that are in the best interests of the birds and the hunters. With a knowledge of harvest characteristics, refined judgment can be used in applying current regulations.

Methods

Two methods were employed to secure the main body of data reported here.

1. During each of 5 years, personnel of the Wisconsin Conservation Department checked hunters at designated entrances and exists at 8 waterfowl hunting sites open to unlimited public hunting. The sites checked were:

Site	County	Years of Check
Horicon Marsh, Main Ditch	Dodge	1947, 1949–52
Lake Puckaway, Wick's Landing	Green Lake	1949–52
Mississippi River Goose Island	La Crosse	1949–52
Mississippi River, Hartnagel's Landing	Buffalo	1949–51
Lake Poygan, Richter's Landing	Winnebago	1949
Fish Lake	Burnett	1949
Clam Lake	Burnett	1949
Powell Marsh	Iron	1950

Hunters were checked at each site from shortly after the opening hour in the morning until practically all hunters had departed at the end of the day. Checks were conducted on all week ends, holidays, and on all except one week day per week for the entire season or until water at the site froze over. Hunting statistics for the few week days not checked were estimated by computing averages from week days within the particular week involved. Standard information secured from parties of hunters included numbers of hunters, numbers of ducks and coots bagged and lost, and sex and age of some species of ducks. Additional information was secured at certain times for specific purposes.

2. Approximately 500 waterfowl hunter diaries were distributed in each of three years (1953, 1954 and 1955) to those hunters who reported bagging 20 or more ducks during the preceding season. Names and addresses were secured from hunting license report cards returned voluntarily to the Wisconsin Conservation Department. Diaries were distributed to cooperators about 25 days prior to the opening of each waterfowl hunting season. The sample of hunters obtained was not representative of the total Wisconsin duck hunting fraternity. Records from more successful hunters were desired to provide information primarily on (1) the seasonal distribution of the kill, and (2) the crippling loss of the more successful Wisconsin hunters. Information on other items was also obtained.

The diary employed was 3⅝″ by 8½″ in size, had a cardboard backing, a heavy paper cover, a single sheet of instructions, one completed form sheet, and 25 blank form sheets. About 5 weeks after the close of each waterfowl hunting season a reminder to return the completed diary was forwarded to those persons still retaining their diaries. From 70 to 74 percent of the diaries distributed preseason were returned with usable data.

Characteristics of the Harvest

Hunting Pressure

Statewide

The best information to show trends in waterfowl hunting pressure is the number of federal duck stamps sold annually. A stamp is required of each person 16 years or older. In Wisconsin, young people between 12 and 15 years of age can hunt waterfowl without a duck stamp. Some stamps are purchased by nonhunters. Total stamp sales are used here to reflect general trends in Wisconsin waterfowl hunting pressure from 1934 through 1960 (Table 50).

Total duck stamp sales have varied from a low of 35,154 in 1935 to a high of 134,351 in 1952. Statewide, waterfowl hunting pressure has increased at a greater rate than the human population or than the small game hunters. Between 1940 and 1955, duck stamp sales increased 47 percent, the human population increased 18 percent, and small game hunters increased 32 percent. Returning war veterans, a shorter work week, increased numbers of boat and motor owners, development of more public waterfowl hunting grounds, and improved travel facilities have all contributed to the rise in waterfowl hunting pressure.

Wisconsin is an important waterfowl hunting state. Compared to duck stamp sales in the other 47 states (Alaska and Hawaii excluded), Wisconsin has ranked as high as second and never lower than sixth (Table 50). In the 14 Mississippi Flyway states, Wisconsin has ranked third in 20 of 27 years, as high as second, and never lower than fourth.

Waterfowl hunting is important to a certain segment of Wisconsin's citizens. Approximately 3 percent of the state's civilian population 12 years of age or older, and estimated to total about 2,778,000 as of 1 April 1956, hunted waterfowl in 1955 (Wis. Conserv. Dept., 1956:2). Other types of hunting were more popular. Of the total population in the state, about 13.5 percent hunted small game and 10 percent hunted big game. Recognizing that in 1955 less than 1 percent of the hunters were women (Wis. Conserv. Dept., 1956:2), about 6 percent of the men 12 years of age or older hunted waterfowl.

TABLE 50

Wisconsin Duck Stamp Sales, by Fiscal Year*

Year	Number of Stamps	Rank of Wisconsin in United States	Rank of Wisconsin in Mississippi Flyway
1934–35	40,769	4	3
1935–36	35,154	3	3
1936–37	48,999	3	3
1937–38	61,783	2	2
1938–39	79,688	3	3
1939–40	84,075	3	3
1940–41	89,317	3	3
1941–42	89,195	4	3
1942–43	83,527	4	3
1943–44	66,328	6	4
1944–45	75,208	6	3
1945–46	83,681	5	3
1946–47	102,971	5	3
1947–48	91,326	5	3
1948–49	101,842	5	3
1949–50	103,826	5	3
1950–51	103,981	4	2
1951–52	108,429	6	4
1952–53	134,351	5	3
1953–54	131,029	5	3
1954–55	127,358	5	3
1955–56	131,101	5	3
1956–57	130,306	4	3
1957–58	115,248	6	4
1958–59	109,856	5	3
1959–60	100,658	4	2
1960–61	109,875	3	2

* Duck-stamp cost was $1.00 from 1934 through 1948, $2.00 from 1949 through 1958, and $3.00 in 1959 and 1960.

Within the state, waterfowl hunters are distributed unevenly (Fig. 50). Approximately 72 percent of the 1957 duck stamps were sold in southeastern Wisconsin. Of the total statewide sales, 17.6 percent occurred in Milwaukee County, which is closed to all waterfowl hunting. Generally, there is a close relationship between the distribution of the best-quality duck and coot hunting areas, the human population, and duck stamp sales. All three are centered in southern Wisconsin, particularly the southeast quarter.

Horicon Marsh

Increases in hunting pressure do not occur equally on all types of duck and coot hunting grounds. On private areas, the numbers of hunters are limited to provide sufficient space to maintain a reasonable quality to the sport. Where low populations of ducks occur, hunting pressure is light. Where high duck populations occur and lands are open to the public, hunting pressure quickly becomes excessive. Under such conditions, the quality of the sport degrades to the extent that hunting ethics are low and hunter safety is threatened. The history of Horicon Marsh (Dodge and Fond du Lac counties) is summarized here to illustrate fluctuations in hunting pressure and quality of sport on a famous waterfowl hunting site, part of which is still (1964) open to unlimited numbers of hunters.

Prior to 1940, duck hunting was largely of the blind and decoy type, with a small amount of jump and pass shooting done from the marsh itself. Pass shooting from roads and boundary lines was practically unheard of. Local people did most of the hunting. Hunter densities were estimated by Donald E. Snyder (pers. comm., 1958), a former hunter guide and son of the man who, historically, ran the only public boat landing in Horicon. The maximum number of hunters present on the entire marsh (present federal and state portions combined) in a single day was 100 to 150. Based on estimates of the portion of the marsh covered with surface water, this would mean each hunter had between 37 and 55 acres if they all hunted as singles (no parties) and were uniformly distributed. Many hunters took to the marsh in parties. Therefore, under "heavy" hunting pressure of pre-World War II years a party of hunters must have had at least 75 to 100 acres in which to hunt ducks.

In direct contrast to this type of hunting is the situation which prevailed between 1947 and 1958 on the Horicon Marsh public hunting ground, where numbers of hunters were unlimited. Figures from the first day of each waterfowl hunting season from 1947 through 1958 are used to illustrate changes in hunting pressure (Table 51).

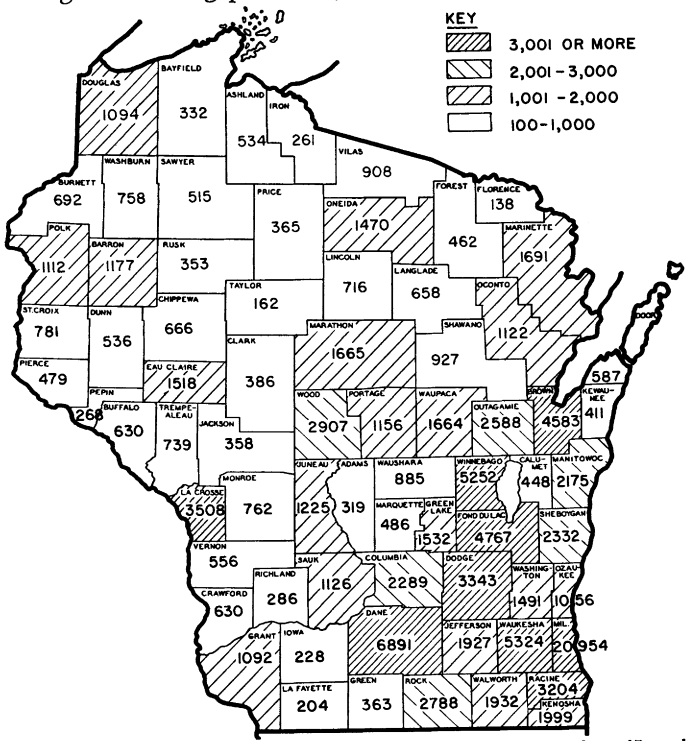


Figure 50. Distribution of 1957 Wisconsin duck stamp sales. (Based on stamp sales from 29 June 1957, through 4 April 1958. Figures provided by the U. S. Post Office Department through the courtesy of the Statistical Laboratory of the U. S. Bureau of Sport Fisheries and Wildlife located near Laurel, Maryland.)

TABLE 51

Opening-Day Waterfowl Hunting Statistics for the Horicon Marsh State Public Hunting Ground, 1947–58

Year	Hunting Pressure		Number Ducks Bagged	Number Ducks Per Hunter	Number Coots Bagged	Percent Ducks Lost**
	Number Cars	Number Hunters*				
1947	210	462	269	0.58	(1)	35
1948	220	483	520	1.08	267	22
1949	342	752	1,244	1.65	714	30
1950	485	1,067	1,085	1.02	1,374	32
1951	649	1,428	1,859	1.30	1,489	38
1952	975	2,147	2,576	1.20	4,026	35
1953	1,041	2,290	3,995	1.74	732	31
1954	2,408	5,298	4,541	0.86	1,832	41
1955	1,285	2,827	3,223	1.14	(1)	(1)
1956	1,180	2,596	1,376	0.53	(1)	37
1957	660	1,452	363	0.25	(1)	37
1958	787	1,731	1,990	1.15	(1)	24

* Obtained by multiplying number of cars by 2.2 hunters, the average party size.

** Percent ducks lost calculated by dividing total ducks lost by the sum of ducks lost and bagged.

(1) No data secured.

By 1947, or shortly after World War II, numbers of hunters were rapidly increasing. Each hunter on the state public hunting ground at Horicon had an approximate average of 11 acres from which to hunt. Between 1947 and 1954, numbers of hunters increased 1,047 percent (Table 51). Conversely, the hunting space per hunter shrank proportionately. The situation on opening day in 1954 is difficult to describe with words. Hunters were everywhere—in the marsh, on the boundary lines, and on the roads. There was an approximate average of 1 hunter per wet acre of open hunting ground. Concentrations of 9 hunters per acre were observed. Nine hunters had lead pellets imbedded in their bodies on Horicon Marsh on the opening day of the 1954 waterfowl hunting season. Under those crowded conditions the quality of wildfowling reached minimal levels, hunter safety became a real problem, and many hunters were disgusted and discouraged. The law of diminishing returns had set in.

In 1955, opening-day hunting pressure on Horicon Marsh was 47 percent less than the same day in 1954. In both years the season opened on a Saturday. Many hunters who had experienced or heard of the highly congested conditions in 1954 avoided the marsh on opening day. Others reported giving up hunting on the area. One of the most disheartening aspects was to see duck hunters of many years experience give up the sport completely. In an evolutionary sense, we saw the beginning of a degrading of standards in waterfowl hunting as some experienced hunters abandoned the sport.

To maintain the quality of wildfowling and to safeguard hunters on areas where waterfowl concentrate, one must limit the maximum numbers of hunters on the area at any one time, thereby providing sufficient space to insure an enjoyable experience for each party of hunters.

Distribution on Days of the Week

Hunter check data from all sources indicate that a definite pattern of hunting effort is correlated with certain days of the hunting season. Peak numbers of waterfowl hunters are afield on the opening 2 or 3 days of each season (Appendix F). Succeeding peaks of lesser magnitude occur on subsequent week-end days. This pattern of hunting effort apparently is the result of hunter behavior, since it held for every year and every station we checked. Hunters evidently have the urge to be afield on the opening days of the waterfowl hunting season.

Effect of Day of Week Opening is Held

The day of the week on which waterfowl hunting seasons have opened varied between 1947 and 1958 (see Appendix E, Table 110 for detailed information). In 1947 it opened on a Tuesday, in 1948 and 1949 on a Friday, from 1950 through 1955 on a Saturday, in 1956 on a Monday, in 1957 on a Tuesday, and in 1958 on a Wednesday. The magnitude of hunting pressure exerted on the opening few days is related to the day of the week on which the opening occurs. Greatest numbers of hunters are afield when the season opens on a Saturday. We believe the same would be true if the season opened on a Sunday. A third day of peak hunting pressure occurred when a Friday opening was held in 1948 and 1949. On a Monday, Tuesday, and Wednesday opening, peak hunting pressure occurs for the season, but the peak more nearly approaches that of succeeding week ends in magnitude. We suspect the same situation would hold for a Thursday opening.

Detailed information from state-wide car counts indicates the relative size of reduction in hunting pressure when a week-day, other than Friday, opening is held. In comparison to previous years, pressure with a week-day opening in 1957 (Tuesday) decreased 40 percent from a week-day opening in 1956 (Monday) and 47 percent from a Saturday opening in 1955. For areas checked on both the opening day (October 1) and the first Saturday (October 5) in 1957, car counts were 40 percent less on Saturday. In 1956, car counts were 33 percent less on the first Saturday following a Monday opening. Completed questionnaires from Wisconsin Conservation Department field personnel showed that factory workers, school teachers, and students are the occupational groups most affected by the week-day opening.

By opening the waterfowl hunting season on any of the first four week days, the extreme hunting pressure experienced on a Saturday or Sunday is avoided. Since the quality of the sport of wildfowling degrades as the number of hunters afield increases, the value of opening the season on a week day, other than Friday, is of great importance to the public and to game managers. The basic issue to be resolved is whether the reduced pressure of a week day opening is more desirable than providing greater opportunity for the average hunter to be afield on the opening on a week end. With many fall duck concentration areas in Wisconsin open to unlimited numbers of hunters, the weekday (Monday–Thursday) opening appears to be an effective method for helping to maintain a desirable quality in duck hunting on the opening few days of the season.

Effect of Concurrent Opening on Hunting Effort

With hunting pressure increasing in total volume at some areas and with large numbers of hunters afield on opening day, sportsmen have advanced the idea of opening hunting seasons simultaneously for many species to reduce pressure on any one species or group of species. Available evidence from the early 1950's indicates that the joint opening is of value in distributing hunting pressure on some game species, but not on others (Thompson, 1953:82; Hamerstrom, Mattson, and Hamerstrom, 1957:73).

In southern Wisconsin, the waterfowl hunting season opened concurrently with pheasants on 13 October 1951, and 2 weeks earlier than pheasants in 1952, on October 4. Thompson (1953:83) evaluated the concurrent and separate openings and concluded that the importance of a joint opening in shifting hunting pressure from ducks to pheasants appeared minimal.

Hopkins (1951:127) evaluated, generally, the effects of the 1950 joint opening of upland game birds and waterfowl in southern Wisconsin, as compared to 1949 when separate openings were held. He concluded that preferred waterfowl hunting areas drew fully as many duck hunters in 1950 as in 1949. With duck stamp sales almost identical in the two years (Table 50), the value of this joint opening also appears minimal.

In 1951, the ruffed grouse season opened on September 22 in approximately the northern one-half of Wisconsin. The waterfowl season opened statewide on October 13. In 1952, the ruffed grouse and pheasant season in northern Wisconsin opened on October 4, jointly with the statewide waterfowl season. Thompson (1953:82) found that the proportion of duck hunters out on the opening day in the north was almost identical between years. Duck hunters apparently went duck hunting regardless of the other hunting seasons opening on the same day.

These limited data do not provide iron-clad conclusions on the value of opening hunting seasons concurrently on many species of game to reduce hunting pressure on any one species. Available material suggests that duck hunters hunt ducks on the opening day, regardless of whether or not hunting seasons on other species open at the same time. This is somewhat surprising in view of the fact that only 8.6 percent of Wisconsin's hunters hunt waterfowl exclusively (Thompson, 1951: 96). Opening hunting seasons concurrently reduces hunting pressure on upland game birds, but not on waterfowl.

Distribution Within Parts of the Day

Throughout the years of our field studies (1946–58), more waterfowl hunters were afield in the morning than in the afternoon, regardless of the exact daily closing hour. Actual figures for a 5-year period show that an average of 57 percent of the hunter trips registered occurred before 12:00 o'clock noon, (Table 52). An additional 17 percent of the hunter trips took place in afternoons only, and another 26 percent included some morning and some afternoon hours. With daily shooting hours opening at ½-hour before sunrise, some hunters apparently have time to hunt waterfowl in the morning before going to work or school. The early morning, near dawn, is when the common species of ducks frequenting Wisconsin are very active in moving from aquatic roosting sites to other aquatic or upland feeding sites. These normal local flights of birds provide the best shooting opportunities.

Frequently the question is asked, will many hunters be affected by curtailing daily shooting hours? Reducing the opening hour to less than ½-hour before sunrise would affect at least 50 percent of the hunter trips (Table 53). Curtailing afternoon daily shooting hours would affect at least the 13 percent of the hunter trips registered during the last legal hour of shooting. If reduction of the opening or closing hour was by more than 1 hour, the portion of the hunter trips affected would be greater than the percentages given above. Theoretically, curtailment of shooting hours to reduce hunting pressure on a waterfowl species or group of species would be most effective if early morning hours were eliminated.

TABLE 52

Hunter Activity Within Full Days

	Percent of Total Season's Hunter Trips					
	1951	1952	1953	1954	1955	Average
Before 12:00 (noon)	52.6	58.1	57.8	57.3	59.3	57.2
After 12:00 (noon)	12.6	17.4	18.6	19.2	18.4	17.2
All Day	34.8	24.5	23.6	23.5	22.3	25.6
Number of hunter trips*	5,712	10,859	4,723	5,893	6,161	33,348
Daily shooting hours	Half hour before sunrise to 1 hour before sunset.		Half hour before sunrise to sunset.		Half hour before sunrise to half hour before sunset.	

* Figures are from full-season, hunter-check stations located at Horicon Marsh (1951 and 1952), Goose Island on the Mississippi River (1951 and 1952), and Lake Puckaway (1952), and from diaries of waterfowl hunters bagging 20 or more ducks per season (1953, 1954, and 1955).

TABLE 53

Portion of Hunter Trips Involving the Legal Opening Hour and the Last Legal Hour

	Percent of Season's Hunter Trips		
	1954	1955	Average
Legal opening hour	50.4	57.1	53.8
Last legal hour	13.2	12.8	13.0
Number of hunter trips*	5,893	6,161	12,054
Daily shooting hour	Half hour before sunrise to sunset.	Half hour before sunrise to half hour before sunset.	

* All figures are from diaries of waterfowl hunters bagging 20 or more ducks per season.

Influence of Hunter Density on Hunting Success

General field observations clearly show that hunter density influences daily hunter success. As hunter density increases, there is a greater tendency for hunters to shoot at high flying ducks. Chances of letting the birds work into proper range are greatly reduced.

Data from one eastern and one western Wisconsin public hunting ground are used to illustrate the daily pattern of hunter success (Appendix G). These sites were selected because hunter densities (or hunting effort) fluctuate greatly between days of the season (Appendix F). The average number of hours required to bag a duck in a day is used as an index to hunter success.

Highest hunter success is registered in most years on the first few days of the waterfowl hunting season (Appendix G), despite the fact that on these days the greatest number of hunters are afield for the entire season. Ducks are distributed within hunting areas and have not learned to react to hunters or shooting. Daily flight patterns established by ducks prior to the season frequently cross hunting grounds. Young ducks are abundant. Many ducks, especially blue-winged teal and wood ducks, which are abundant on the opening day, fly about well within killing range. All of these factors, but especially distribution and behavior patterns of the ducks, contribute to the high vulnerability of the birds to shooting on these first few days of the hunting season.

After the opening few days, hunter success varies greatly (Appendix G), but a pattern of the variation is evident. Lowest hunter success occurs on week ends when the greatest numbers of hunters are afield, except on those week ends when major flights of new migrant ducks arrive. Flights of migrants occurred on 22 and 23 October 1949, 3 and 4 November 1951, and 18 and 19 October 1952. Apparently new migrant ducks unfamiliar with the local areas offering protection furnish added hunting opportunities while passing

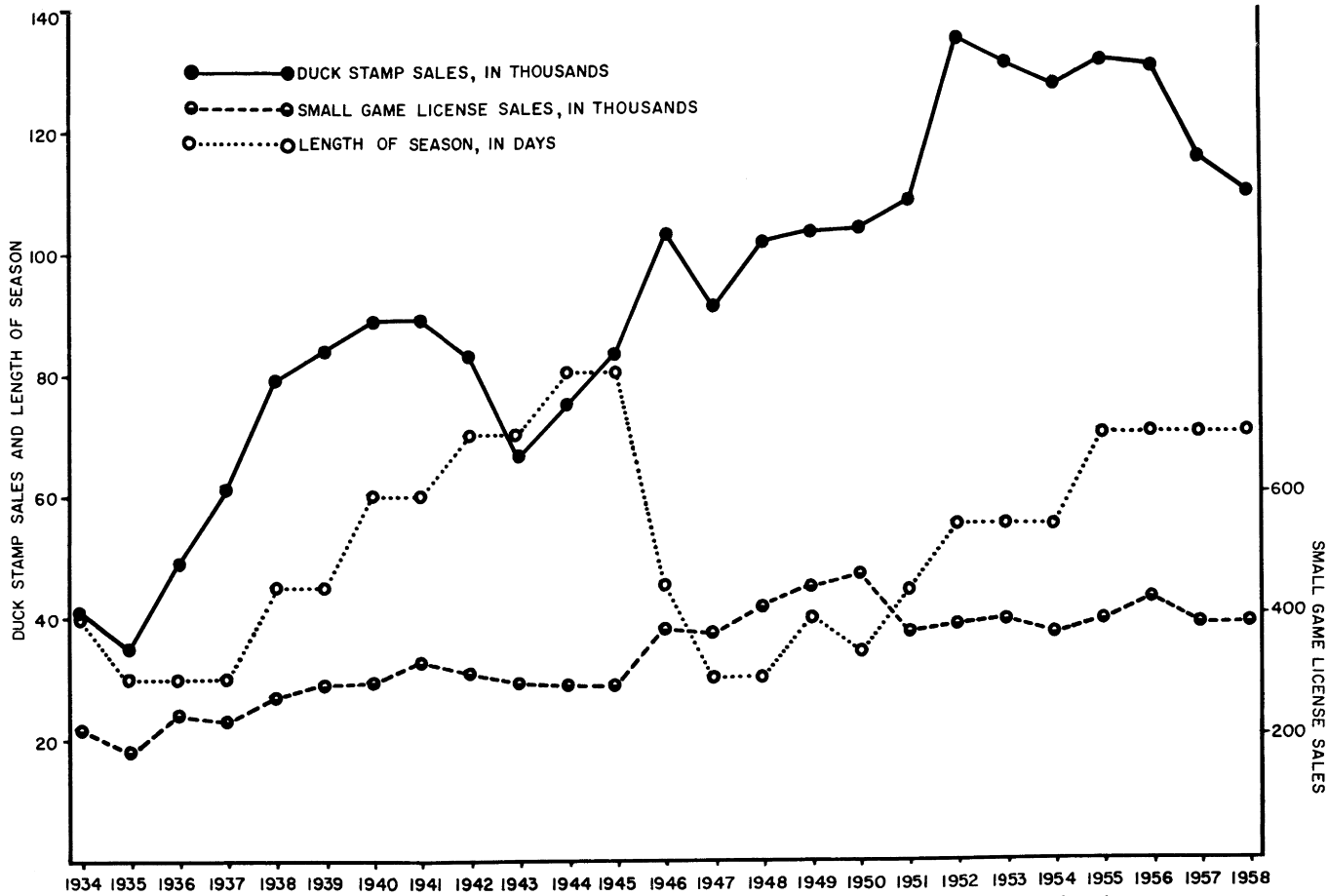


Figure 51. Relationship between trends in duck stamp sales, small game license sales, and length of waterfowl hunting seasons in Wisconsin, 1934–58.

TABLE 54

Seasonal Distribution of Waterfowl Hunting Effort in Wisconsin*

Source and Season	Percent of Total Hunter Trips by Periods of Days										Total Number of Hunter Trips
	1–7	8–14	15–21	22–28	29–35	36–42	43–49	50–56	57–63	64–70	
A. Check stations											
1947: Oct. 7–Nov. 5 (30 days)	48.4	12.8	15.5	18.9	4.4	—	—	—	—	—	1,038
1949: Oct. 14–Nov. 22 (40 days)	36.8	15.2	17.1	13.6	13.4	3.9	—	—	—	—	7,779
1950: Oct. 14–Nov. 16 (34 days)	29.6	21.5	20.9	19.2	8.8	—	—	—	—	—	8,564
1951: Oct. 13–Nov. 25 (44 days)	38.4	23.7	23.6	6.6	5.8	1.3	0.6	—	—	—	6,502
1952: Oct. 4–Nov. 27 (55 days)	30.1	18.4	12.5	11.8	10.9	8.8	6.3	1.2	—	—	11,757
B. Hunter diaries											
1953: Oct. 3–Nov. 26 (55 days)	22.9	12.4	11.9	12.9	11.7	10.4	8.3	9.5	—	—	4,724
1954: Oct. 2–Nov. 25 (55 days)	21.4	14.6	12.4	13.5	14.6	10.7	8.1	4.7	—	—	5,893
1955: Oct. 1– Dec. 9 (70 days)	20.6	14.3	12.9	13.3	14.1	11.7	7.3	2.6	1.9	1.3	6,161
C. Questionnaires											
1954: Oct. 2–Nov. 25 (55 days)	32.4	34.2		18.5			14.9		—	—	8,355
1955: Oct. 1–Dec. 9 (70 days)	13.7	26.6		28.2		20.4		9.1		2.0	4,104
1956: Oct. 1–Dec. 9 (70 days)	16.7	24.4		29.6		17.4		9.0		2.9	6,602

* Based on figures secured from hunters in the years indicated: *A.* Full-season check stations at Horicon Marsh (Dodge County) 1947, 1949–52; Lake Puckaway (Green Lake County) 1949–52; Mississippi River (Buffalo County, 1949–51, and Vernon County, 1949–52); Powell Marsh (Iron County) 1950; Lake Poygan (Winnebago County) 1949; Fish and Clam lakes (Burnett County) 1949. *B.* Hunting diaries distributed to waterfowl hunters voluntarily reporting killing 20 or more ducks in the previous year, 1953–55. *C.* Standard posthunting-season questionnaires, 1954–56. These data were made available through the courtesy of the Statistical Laboratory of the U.S. Bureau of Sport Fisheries and Wildlife, located near Laurel, Maryland.

through or while maneuvering to join "resident" concentrations of ducks.

Variations in hunter success occur mainly where numbers or densities of hunters vary widely. Where hunter densities are limited, such as at private shooting clubs, variation in hunting success is small (Bellrose, 1944a:351). The implication is clear. To avoid drastic fluctuations in daily hunter success, the maximum number of hunters afield at any one time must be limited. This is the feature of duck hunting now supplied on most private grounds and some public areas, but lacking on many public hunting grounds in Wisconsin.

Relation Between Hunting Pressure and Length of Season

No consistent relationship exists between the length of the Wisconsin waterfowl hunting season and the number of people purchasing duck stamps (index to statewide hunting pressure) (Fig. 51). For example, the season was 30 days in each of the 3 years from 1935–37 while duck stamp sales increased 76 percent during the same years. Between 1945 and 1946, season length was reduced from 80 to 45 days, while duck stamp sales increased. The return of World War II veterans is undoubtedly reflected in this increase. Again with 30-day seasons in 1947 and 1948, stamp sales increased. With three consecutive seasons of 55 days in 1952–54, stamp sales declined. Again with four consecutive 70-day seasons in 1955–58, stamp sales declined. The marked decline in stamp sales in 1957 and 1958 probably reflects (1) abandonment of the sport by some hunters, and (2) the fact that the World Series baseball games were held in Milwaukee near the opening of the waterfowl season in each of these 2 years.

The number of duck stamps sold annually in Wisconsin is not directly affected by the length of the waterfowl hunting season because seasons have not been less than 30 days. Thirty days with the option given the state to select the calendar dates of the season is of sufficient length to cover the period of time when the peak of the fall flight of most species of ducks and the coot occurs (October 10–November 10).

Distribution of hunting effort within the waterfowl hunting season, as indicated by data from various sources, suggests that with season lengths of 30–55 days, between one-fifth and one-half of the hunting effort occurs during the first 7 days (Table 54). In all years, peak numbers of hunters were afield on the first few days of the season (Appendix F). With 70-day seasons in 1955 (with a Saturday opening) and 1956 (with a Monday opening), hunting effort in the first week declined considerably, except for the more successful (diary) hunters. Hunting effort of diary hunters was nearly the same during the first 7 days of 55- and 70-day seasons (Table 54).

The implication of these data seems clear. With long sea-

sons (70 days), hunting pressure during the first 7 days is minimized and the problem of excessive hunting pressure early in the hunting season is less acute than during short seasons of 30–45 days. Reduction of hunting effort during the first week, especially the first few days, of the season is important in helping to maintain a reasonable degree of quality to waterfowl hunting at many public hunting areas open to unlimited numbers of hunters.

Because data from a variety of sources are used in drawing these deductions (Table 54), additional information secured through a standardized approach should be used to test further the relationship between season length and volume of hunting effort on the first 7 days.

In 70-day seasons, a relatively small part of the total hunting effort occurs during the latter part of the season. From 11 to 12 percent of the entire season's hunting effort was expended during the last 21 days, or between November 19 and December 9 (Table 54). Only 2–3 percent of the total hunting effort occurred during the last 7 days, or between December 3 and 9. Extension of seasons beyond approximately 60 days evidently benefits few duck hunters in Wisconsin. Persons who hunt geese, as well as duck hunters, supplied information on the questionnaires. Goose hunters in certain localities benefit from seasons longer than 60 days. However, the total number of hunters, considering the statewide situation, is small.

Effect of Hunting Pressure on Distribution and Vulnerability of Certain Ducks

Both numbers of hunters and shooting by hunters alter the distribution of ducks. Reaction of ducks to hunting pressure varies with different species. Variations exist among kinds of ducks in feeding, loafing, and flying habits, and in inherent wariness. The degree to which birds react to hunting depends largely upon the density of hunters involved.

In areas of heavy hunting pressure, disturbance resulting from sheer numbers of hunters going to their shooting sites is sufficient to cause ducks to abandon choice, but unprotected, feeding and loafing sites. One of the most striking examples of the escape and/or fear reaction of ducks to hunters was previously described in this report (see the unit on "Factors Affecting Fall Distribution" in the section on "Fall Migration").

On hunting grounds where each hunter had, on the average, from 1 to 17 acres to hunt from, mallards and black ducks temporarily abandoned the areas. For example, on the opening day in 1955 there was a general movement of ducks from the Crex Meadows Conservation Area westward into Minnesota where the waterfowl hunting season remained closed for another week. There was an average of 1 hunter per 17 wet acres on Crex Meadows on this day. In the late 1940's and early 1950's, ducks were seen entering Wisconsin from Minnesota, where the season opened from 10 to 14 days earlier than in Wisconsin (N. R. Stone, pers. comm., 1956). Many other situations of ducks moving from open hunting areas to undisturbed areas have been observed.

Reaction of ducks to hunting pressure also varies with the species involved. Mallards and black ducks react quickly and concentrate in undisturbed areas or where disturbance is minimal. After learning to react to hunters and shooting, local flights are made at high altitudes. Blue-winged teal concentrate in undisturbed areas, but seem to learn to do so at a much slower rate than do mallards and black ducks. The bluewings' habit of flying at low altitudes in face of heavy hunting pressure makes them extremely vulnerable to shooting. Wood ducks are also very vulnerable. Both in Wisconsin and elsewhere, wood ducks usually do not take advantage of protection offered by refuges (Jahn, Shanks, and Yancey, 1959:-23). This habit, plus their low-altitude local flights, even when hunting pressure is heavy, results in the wood duck being one of the most vulnerable species to shooting.

Bellrose (1944a:339) studied the vulnerability of ducks to hunting in Illinois. Our findings agree with his. Mallards and black ducks are least vulnerable because flocking, night feeding, and high flying habits favor survival of these species. Blue-winged teal and wood ducks are among the most vulnerable species. Bellrose (1944a:339) found the shoveler, blue-winged and green-winged teal, American widgeon, and gadwall were, in decreasing order of importance, most vulnerable of the puddle ducks. Most species highly vulnerable to shooting are least adaptable in modifying their daily feeding, loafing, and flying habits after being exposed to hunting pressure. Conversely, highly adaptable species react quickly to hunting pressure to benefit their own survival.

Hunter Success

Relation of Kill to Duck and Coot Population Level

Despite the fact that peak numbers of most puddle ducks, diving ducks, and coots are in Wisconsin between October 10 and November 10, approximately one-fifth to one-half of the seasonal kill of ducks and from about two-thirds to three-fourths of the coot kill takes place at many areas during the first 7 days of the hunting season (Tables 55 and 56). At permanent check stations (listed earlier) an average of 32 percent of the entire season's duck kill occurred on the first 2 days. With coots, an average of 62 percent of the entire season's kill occurred on the first 2 days. Large kills on these 2 days result from high vulnerability of the birds and peak numbers of hunters being afield.

Hunter success does not rise in proportion to increases in duck and coot populations. In fact, it may decrease drastically when large numbers of birds are present. This is especially true when large numbers of hunters are afield. Bellrose (1944a:351) studied the influence of duck population density on hunter success. He concluded that even though the duck population in Illinois was many times greater from October 15 through December 5, the daily success of the hunter was affected very little. This relationship is confirmed by Wisconsin data. As previously discussed, prehunting season behavioral and distributional patterns of some ducks, especially the mallard, are modified to benefit their own survival.

TABLE 55

Seasonal Distribution of Ducks Bagged in Wisconsin*

Source and Season	Percent of Total Ducks Bagged by Period of Days										Total Number of Hunter Trips
	1–7	8–14	15–21	22–28	29–35	36–42	43–49	50–56	57–63	64–70	
A. Check stations											
1947: Oct. 7–Nov. 5 (30 days)	58.4	13.0	17.0	10.8	0.8	——	——	——	——	——	616
1949: Oct. 14–Nov. 22 (40 days)	45.6	19.2	16.6	6.7	9.2	2.7	——	——	——	——	8,792
1950: Oct. 14–Nov. 16 (34 days)	37.0	18.7	15.5	18.4	10.4	——	——	——	——	——	6,563
1951: Oct. 13–Nov. 25 (44 days)	47.3	16.7	18.6	10.9	4.7	1.3	0.5	——	——	——	7,059
1952: Oct. 4–Nov. 27 (55 days)	43.6	13.4	12.6	10.1	7.6	5.1	4.9	2.7	——	——	9,894
B. Hunter diaries											
1953: Oct. 3–Nov. 26 (55 days)	30.5	11.1	10.7	12.4	11.0	7.9	7.6	8.8	——	——	8,831
1954: Oct. 2–Nov. 25 (55 days)	22.9	11.4	11.4	13.7	17.3	11.4	7.7	4.2	——	——	11,869
1955: Oct. 1–Dec. 9 (70 days)	21.5	13.4	12.8	12.9	14.9	12.4	6.9	2.6	1.6	1.0	13,019

* Based on figures secured from hunters in the years indicated: *A.* Full-season check stations at Horicon Marsh (Dodge County) 1947, 1949–52; Lake Puckaway (Green Lake County) 1949–52; Mississippi River (Buffalo County, 1949–51 and Vernon County, 1949–52); Powell Marsh (Iron County) 1950; Lake Poygan (Winnebago County) 1949; Fish and Clam lakes (Burnett County) 1949. *B.* Hunting diaries distributed to waterfowl hunters voluntarily reporting killing 20 or more ducks in the previous year, 1953–55.

TABLE 56

Seasonal Distribution of Coots Bagged in Wisconsin*

Source and Season	Percent of Total Coots Bagged by Periods of Days										Total Number of Hunter Trips
	1–7	8–14	15–21	22–28	29–35	36–42	43–49	50–56	57–63	64–70	
A. Check stations											
1949: Oct. 14–Nov. 22 (40 days)	78.1	8.5	7.1	4.1	2.1	0.1	——	——	——	——	3,671
1950: Oct. 14–Nov. 16 (34 days)	65.1	17.5	10.8	6.6	Tr.	——	——	——	——	——	4,636
1951: Oct. 13–Nov. 25 (44 days)	73.9	16.7	9.0	0.4	0.0	0.0	0.0	——	——	——	3,874
1952: Oct. 4–Nov. 27 (55 days)	71.2	13.2	6.6	4.5	3.6	0.8	0.1	Tr.	——	——	4,686
B. Hunter diaries											
1953: Oct. 3–Nov. 26 (55 days)	43.1	18.7	13.0	11.5	9.3	2.7	0.5	1.2	——	——	1,444
1954: Oct. 2–Nov. 25 (55 days)	25.4	29.9	17.4	13.9	5.4	4.6	2.6	0.8	——	——	2,388
1955: Oct. 1–Dec. 9 (70 days)	26.8	23.9	15.2	10.3	11.3	8.5	3.3	0.3	0.4	0.0	1,995

* Based on figures secured from hunters in the years indicated: *A.* Full-season check stations at Horicon Marsh (Dodge County) 1949–52; Lake Puckaway (Green Lake County) 1949–52; Mississippi River (Buffalo County, 1949–51 and Vernon County, 1949–52); Powell Marsh (Iron County) 1950; Lake Poygan (Winnebago County) 1949; Fish and Clam lakes (Burnett County) 1949. *B.* Hunting diaries distributed to waterfowl hunters voluntarily reporting killing 20 or more ducks in the previous year, 1953–55.

Birds Per Hunter Trip

Two measures are available for indicating the relative success hunters have in bagging ducks and coots in Wisconsin. They are (1) the average number of birds bagged per hunter trip, and (2) the proportion of unsuccessful hunter trips. From 1947 through 1958, when the daily bag limit on most ducks was 4, hunters, on the first few days of the season when ducks are vulnerable to shooting, averaged 1 duck per hunter trip at most of the check stations. In some years, approximately 75 check stations were in operation. Infrequently, on a few days and at a few local areas, the success was as high as 2.8 ducks per hunter trip. At full-season check stations, hunter success varied between stations but averaged 0.9 duck and 0.5 coot per hunter trip (Table 57). Variations are believed to be the result of (1) species and number of birds present, (2) weather conditions, (3) local flights of birds, (4) skill of hunters, and (5) different levels of hunting pressure.

TABLE 57

Average Hunter Success Statistics for Certain Shooting Sites in Wisconsin*

Place	Years	Number of Ducks Bagged: Per Hunter Trip	Number of Ducks Bagged: Total	Percent of Hunter Trips with No Ducks**	Number of Coots Bagged: Per Hunter Trip	Number of Coots Bagged: Total
Mississippi River, Buffalo County	1949–51	1.68	2,886	27	Tr.	1
Clam Lake	1949	1.45	321	33	0.37	82
Lake Poygan	1949	0.97	801	52	0.71	597
Mississippi River, Vernon County	1949–52	0.90	13,243	50	0.15	2,174
Horicon Marsh	1949–52	0.89	13,862	50	0.69	10,777
Lake Puckaway	1949–52	0.70	1,090	62	2.07	3,234
Fish Lake	1949	0.60	54	67	——	0
Powell Marsh	1950	0.14	35	90	Tr.	2
Total and Average	1949–52	0.92	32,292	50	0.48	16,867

* Figures are from full-season check stations.
** Figures on successful and unsuccessful hunter trips were available only for 1949 and 1950.

The proportion of hunter trips on which no ducks were bagged ranged from 27–90 percent and averaged 50 percent (Table 57). When the success averaged approximately 1 duck per hunter and the majority of the hunters had 1 or more ducks, hunters seemed satisfied with the hunting. When the success dropped considerably below this level, comments of hunters indicated that they were discouraged and disappointed with the hunting.

We believe these experiences provide a general set of standards that can be used to help judge the quality of shooting on an area in Wisconsin. To be of reasonable quality, solely from the standpoint of success, an area should yield approximately 1 duck per hunter trip with the majority of the hunters getting at least one bird. Many areas in Wisconsin now provide reasonably good shooting on the first few days of the hunting seaon when the birds are vulnerable to shooting. Other areas, offering good to excellent quality habitat for ducks, do not. Excessive hunting pressure results in substandard sport, especially during short seasons (30–45 days).

Distribution of Kill Within Parts of the Day

During our hunter-checking activities we found that hunters make more than half (57 percent) of their hunting trips before 12:00 (noon) and that an even larger portion of the duck and coot kill occurs then. In 4 years, an average of approximately three-fourths of the duck (74 percent) and coot (74 percent) kill occurred before 12:00 noon (Table 58). With the duck kill generally paralleling hunting effort after the first few days of the season, we believe the larger

TABLE 58

Duck and Coot Kill Within Periods of Full Days*

	Percent of Total Season's Bag: 1951	1952	1954	1955	Average
A. Ducks bagged					
Before 12:00 (noon)	82.4	71.3	70.8	75.0	73.6
After 12:00 (noon)	17.6	28.7	29.2	25.0	26.4
Total number	4,154	7,668	11,869	9,614	33,305
B. Coots bagged					
Before 12:00 (noon)	———	———	75.7	71.7	73.9
After 12:00 (noon)	———	———	24.3	28.3	26.1
Total number	———	———	2,388	1,995	4,383
Daily shooting hours	Half hour before sunrise to 1 hour before sunset.		Half hour before sunrise to sunset.	Half hour before sunrise to half-hour before sunset.	——

* Figures are from full-season hunter check stations located at Horicon Marsh (1951 and 1952), Goose Island on the Mississippi River (1951 and 1952), and Lake Puckaway (1952); and from diaries of waterfowl hunters bagging 20 or more ducks per season (1954 and 1955).

TABLE 59

Seasonal Distribution of Duck Bag Limits in Wisconsin*

Source and Season**	Potential Bag Limits: Number Possible	Potential Bag Limits: Percent Secured	Percent of Total Bag Limits by Periods of Days: 1–7	8–14	15–21	22–28	29–35	36–42	43–49	50–56	57–63	64–70	Total Number of Bag Limits
A. Check stations													
1947: Oct. 7–Nov. 5 (30 days)	1,038	2.6	59	7	30	4	0	——	——	——	——	——	27
1949: Oct. 14–Nov. 22 (40 days)	7,705	9.0–15.2	55–55	21–18	13–15	2–4	6–6	3–2	——	——	——	——	692–1,170
1950: Oct. 14–Nov. 16 (34 days)	8,564	4.1–8.7	38–41	17–18	15–13	14–16	16–12	——	——	——	——	——	354–742
1951: Oct. 13–Nov. 25 (44 days)	6,502	9.0–15.5	49–53	11–13	19–16	17–14	3–3	1–1	Trace	——	——	——	583–1,010
1952: Oct. 4–Nov. 27 (55 days)	12,236	5.4–8.7	55–52	10–12	15–14	9–10	5–5	3–3	2–2	1–2	——	——	662–1,064
B. Hunter diaries													
1953: Oct. 3–Nov. 26 (55 days)	4,724	25.6	37.3	9.4	8.9	12.2	9.9	5.7	7.0	9.6	——	——	1,208
1954: Oct. 2–Nov. 25 (55 days)	5,893	27.6	25.0	9.3	11.0	14.1	19.2	10.5	6.3	4.6	——	——	1,627
1955: Oct. 1–Dec. 9 (70 days)	6,161	30.0	22.5	12.2	12.2	12.1	15.8	13.2	7.3	2.3	1.6	0.8	1,847

* Percentages for bag limits are shown here in 2 ways for different years. Where records for individual hunter trips were available, one percentage appears. Where records for parties of hunters were available, the minimum and maximum percentage of bag limits appears.

** Based on figures secured from hunters in the years indicated: *A.* Full-season check stations at Horicon Marsh (Dodge County) 1947, 1949–52; Lake Puckaway (Green Lake County) 1949–52; Mississippi River (Buffalo County, 1949–51, and Vernon County, 1949–52); Powell Marsh (Iron County) 1950; Lake Poygan (Winnebago County) 1949; Fish and Clam lakes (Burnett County) 1949. *B.* Hunting diaries distributed to waterfowl hunters voluntarily reporting killing 20 or more ducks in the previous year, 1953–55.

portion of the kill occurring before 12:00 (noon) is due to the slightly greater vulnerability of the birds in the morning. After shooting hours end each day, the birds have an opportunity to work into shallow water areas during the night. Some ducks apparently remain there until the following morning. These birds are readily available to be shot. Also, about sunrise many species make local feeding and exercise flights and provide shooting opportunities. Hence, both local distribution and behavior of ducks and coots probably account for the large portion of the bag occurring during the morning hours.

Duck Bag Limits

Daily bag limits are established to (1) help govern the total kill, and (2) aid in distributing the kill among hunters. A range of the percentage of bag limits of 4 ducks secured on hunter trips was established by our data from permanent check stations. The number of bag limits was computed on the basis of the actual number of known bag limits checked for single hunters, plus the minimum and maximum number possible for each party of hunters. For example, a party of 3 hunters with 10 ducks had at least 1 bag limit and at most 2 bag limits of 4 ducks.

The relative importance of the daily limit of 4 ducks is shown in Table 59 for certain waterfowl-hunting sites in Wisconsin and for the more successful Wisconsin duck hunters. Bag limits were secured on an average of 3–30 percent of the hunter trips. The more successful (diary) hunters registered more daily bag limits than the average hunter, as he is depicted by data from full-season check stations on public hunting areas. Studies in Illinois (Bellrose, 1944a:361) and Utah (Van Den Akker and Wilson, 1951) have also shown that bag limits affect mainly the better hunters shooting in areas where ducks are abundant. Both studies also showed that bag limits had little effect upon the kill when set above a certain point.

Within the Wisconsin hunting season, more duck bag limits are registered during the first 7 days than any other period (Table 59). From 16 to 56 percent of the total bag limits occur within the first 7 days of the season. Variation in the portion of limits registered during this period is related to different aquatic sites, years, and types of hunters. Vulnerability of the birds to shooting is also involved and is reflected in the figures for the first 2 days of the season. Of 1,142 to 1,999 bag limits registered at permanent check stations during the first 7 days of the season, from 78 to 79 percent occurred on the first 2 days. This is when (1) peak numbers of hunters are afield, (2) ducks are most vulnerable to shooting, and (3) species of ducks (blue-winged teal and wood duck) very vulnerable to shooting are present in greatest numbers. The effect of the bag limit of 4 in limiting the kill and distributing it is greatest on these days. Any reduction in daily bag limit below 4 would have its greatest influence upon the kill during the first few days of the hunting season.

On week ends after the opening 2 days, peak numbers of hunters are again out. On Horicon Marsh, where hunting pressure fluctuates drastically between week ends and week days (Appendix F), there is a significantly greater portion of hunters getting bag limits on week days when hunting pressure is lower than on week ends when peak numbers of hunters are afield (Table 60). No such difference was found

TABLE 60

Relative Importance of Duck Bag Limit with Different Levels of Hunting Pressure, 1949–52

Station	County	Relative Hunting Pressure*	Bag Limits: Potential Number	Bag Limits: Percent Secured
Mississippi River	Vernon	High	4,803	2.5–6.2
		Low	7,185	5.4–8.1
Horicon Marsh	Dodge	High	5,386	1.9–4.6
		Low	6,459	7.4–12.6

* Figures from different days of the season were grouped into two categories on the basis of selections from Appendix F. All figures from the first 2 days of the season are excluded. High includes those Saturdays and Sundays when peak numbers of hunters were afield; low includes the balance of the days.

for the Mississippi River (Goose Island area), where total hunting pressure is less than on Horicon Marsh. This relationship suggests that when large numbers of hunters concentrate on areas used relatively heavily by ducks, hunter density is more important in limiting hunting success than is the bag limit. In general, with two hunting areas of approximately equal environmental conditions and equal duck populations, the area with the lighter density of hunters will provide the highest number of bag limits. Under these conditions the daily bag limit both limits and distributes the kill among hunters.

For individual species of ducks, the daily bag limit of 4 is of less importance than it is to the group of ducks covered by the limit. Statistics obtained from hunters checked at hundreds of stations throughout Wisconsin and from hunter diaries show that the bulk of the ducks occur in hunters' bags as combinations of individual species. At permanent check stations a maximum average of 4.3 percent of the bag limits were made up of single species (Table 61).

Attention was focused on the possibility of increasing the harvest of blue-winged teal, a species presently recognized as lightly shot (Bellrose and Chase, 1950; Hickey, 1955). Enlargement of the daily bag limit beyond 4 was considered for the first 2 days of the season, when (1) greatest numbers of bluewings are present, and (2) the birds are most vulnerable to shooting. At permanent check stations bag limits of blue-winged teal were registered on less than 1 percent of the hunter trips on the first 2 days of the season (Table 62). Hence, enlarging the bag limit on bluewings for the first few days of Wisconsin waterfowl hunting seasons opening between October 4 and 13 would not increase the harvest of this species to any appreciable degree.

With so few hunters bagging limits of individual species, any consideration of enlarging the bag limit beyond 4 for individual species, when the population status warrants, would affect the kill in Wisconsin in a minor way. Four factors are involved: (1) few hunters now get bag limits of 4, (2) hunter success does not increase in direct proportion to increases in the population level of ducks, (3) most aquatic sites support a mixture of species of ducks, and (4) most Wisconsin hunters are nonselective when shooting ducks. Field observations and numerical data indicate that most hunters shoot at the ducks near them, regardless of species. These statements on the effect of increasing the bag limit of 4 are made with the assumption that, in the year of the increase, hunting pressure, weather conditions, and numbers and distribution of ducks will remain comparable to years when the bag limit of 4 was evaluated. Variations in any one or combination of these factors could influence the percentage of hunters bagging limits.

TABLE 61

Relative Importance of Daily Bag Limit of Four During the Entire Season and on the First 2 Days*

Station	Years	Bag Limits During Entire Season: Potential Number Possible	Bag Limits During Entire Season: Minimum and Maximum Percent Secured**: All Species	Bag Limits During Entire Season: Minimum and Maximum Percent Secured**: Single Species	Bag Limits on First Two Days: Potential Number Possible	Bag Limits on First Two Days: Minimum and Maximum Percent Secured**: All Species
Lake Puckaway	1949–52	1,566	5.0–6.4	0.6–1.0	476	3–6
Lake Poygan	1949	835	8–14	1–3	212	25–34
Fish Lake	1949	90	3–6	0–1	29	3–7
Clam Lake	1949	222	16–17	1–4	72	32–40
Powell Marsh	1950	245	Trace	Trace	44	0–0
Mississippi River Buffalo County	1949–51	1,716	16.7–28.6	2.6–13.5	264	27.7–47.7
Mississippi River Vernon County	1949–52	14,687	5.4–9.1	1.1–4.4	2,606	11.4–19.1
Horicon Marsh	1949–52	15,646	6.6–12.0	0.5–3.8	3,801	11.6–21.3
Total and Average		35,007	6.6–11.3	0.8–4.3	7,504	12.0–20.9

* Based on figures secured from hunters at full-season check stations.
** Percentages for bag limits are shown as a range, since all records were assembled from parties of hunters.

Coot Bag Limits

Bag limits on coots are of most importance at aquatic sites heavily used by the birds. Lake Puckaway and Horicon Marsh are two of the most important coot concentration sites for which bag limit data are available. At these sites only 1–7 percent of the potential number of bag limits were registered (Table 63). As with ducks, the largest portion of bag limits occurs on the first 2 days of the season when peak numbers of hunters are afield. Of 293 coot limits registered at 8 permanent check stations, 81 percent occurred on the first 2 days of shooting. Potentially the bag limit on coot could be much more important after the first 2 days of the season. Some hunters let coots swim around their blinds and among their duck decoys well within killing range, but do not shoot them. We have observed this on many occasions on aerial surveys. Because of its general docile behavior and trusting attitude toward man, the coot could be much more heavily shot if hunters decided to do so. If and when this attitude becomes general, the daily bag limit will assume greater importance.

Effect of Reduced Bag Limits

In the past, bag limits have been reduced on certain species of ducks to give added protection when their population levels were low (see Appendix E, Table 111, for species and years involved). General attempts have been made to evaluate only two curtailments in the daily bag limit: (1) the reduction from 4 to 2 on redhead and canvasback in 1958, and (2) the closed season on wood ducks (1954–58).

Two types of data are available to help evaluate the reduction in daily bag limit on redhead and canvasback. Figures from full-season hunter checks at Lake Poygan (Richter's Landing) in 1949 furnish quantitative data. Lake Poygan is the most important Wisconsin fall concentration site for these two species (Appendix D, Tables 102 and 103) and it is also a famous hunting area. Our field observations, observations of game managers and conservation wardens, and personal opinions of hunters provide qualitative substantiating data.

TABLE 62

Blue-winged Teal Bag Limits Registered on the First 2 Days of Wisconsin Waterfowl Hunting Seasons

Years	Opening Days	Bag Limits: Potential Number*	Bag Limits: Percent Secured
1949–51	Oct. 13–15	22,771	0.05–0.6
1952	Oct. 4–5	12,236	0.04–0.4

* Figures are from 8 full-season hunter-check stations.

Potentially there could have been 835 (the number of hunter trips registered) bag limits of 4 in 1949. Only 5 bag limits of 4 occurred (Table 64). A total of 59, or 42 percent, of 140 canvasbacks and redheads were bagged as single birds. If the bag limit had been 2 canvasback or redhead, singly or in the aggregate, an estimated minimum total of 36 limits would have been taken. Decreasing the bag limit from 4 to 2 could have decreased the kill on redheads and canvasbacks at this site by no more than 14 percent. For this decrease to occur, duck populations, hunting pressure, and weather conditions would have to be the same in the 2 years when the different bag limits would be in force. Also, it is assumed that ducks saved at Lake Poygan would not be shot elsewhere.

In 1958, when the limit on canvasbacks and redheads was reduced to 2, fieldmen working on Lake Poygan and neighboring lakes accommodating canvasbacks and redheads believed that hunting pressure declined. Whether this reduction was due to hunters' reactions to the reduced bag limit, the low populations of these species, or both, is unknown. Many

TABLE 63

Relative Importance of Daily Bag Limit on Coot During the Entire Season and on the First 2 Days*

Station	Years	Entire Season: Potential Number of Bag Limits Possible	Entire Season: Percent of Bag Limits Secured	First 2 Days: Potential Number of Bag Limits Possible	First 2 Days: Percent of Bag Limits Secured
Lake Puckaway	1949–52	1,566	7.0	476	17
Lake Poygan	1949	835	1	212	3
Fish Lake	1949	90	0	29	0
Clam Lake	1949	222	0	72	0
Powell Marsh	1950	245	0	44	0
Mississippi River Buffalo County	1949–51	1,716	0.0	264	0.0
Mississippi River Vernon County	1949–52	14,687	0.1	2,606	0.7
Horicon Marsh	1949–52	15,646	1.0	3,801	3.4
Total and Average		35,007	0.8	7,504	3.1

* Based on figures secured from hunters at full-season check stations.

TABLE 64

Occurrence of Canvasback and Redhead in Hunters' Bags at Lake Poygan, 1949

Species	Number in Daily Bags					Total Number of Ducks Bagged
	1	2	3	4	Total	
Canvasback	35	8	3	2	48	86
Redhead	24	2	2	1	29	54
Both	—	7	4	2	13	—
Total Number	59	17	9	5	90	140
Percent of total daily bags	66	19	10	5	—	—

hunters wait for "the big flights" to arrive and then go hunting. In 1958, large flights of canvasback and redhead did not occur. Very probably hunters did not go afield because the flights failed to develop. In such a case, the decrease in hunting pressure would not be caused by the reduction in bag limit but would be the result of low duck use locally.

Where species receiving special protection through reduced bag limits are taken incidentally while hunting other waterfowl, hunting pressure may not decrease due to the restricted bag. We believe this is the case with the wood duck in many areas in Wisconsin. In Illinois in 1938–40, restricting the daily bag of canvasback, redheads, ruddy ducks, and bufflehead to 3, individually or in the aggregate, was not very effective in reducing the shooting pressure on, or the total kill of, these species (Bellrose, 1944a:361). In Illinois, these species made up a small part of the duck population and no special effort was made to bag them (Bellrose, 1944a).

Restrictions on the take of wood ducks have the longest history, dating back to 1860 in Wisconsin (Appendix E, Table 110). From 1942 through 1953 there was a daily bag limit of 1 wood duck in Wisconsin and from 1954 through 1958, there was a closed season (Appendix E, Table 111). During the closed seasons, many people argued that 1 wood duck should be permitted in the daily bag to permit hunters to salvage the birds shot accidentally. Logic favors such an appeal. However, responsibility still exists for protecting a species when its population reaches low levels. The main problem is that many hunters do not recognize the wood duck in flight before they squeeze the trigger (Bellrose, 1944a). In fact, many hunters fail to recognize the species in the hand. At a hunter check station on Horicon Marsh in 1956 and 1957, 122 hunters were asked to identify a dead female wood duck handed to them. Only 48 percent of the hunters identified the bird correctly.

In 1956, 137 replies from a questionnaire sent to Wisconsin game managers and conservation wardens indicated the factors which help to reduce the kill of wood ducks during a closed season in the state. These are: (1) hunters exert greater effort to identify ducks before shooting (34 percent), (2) instances of hunters calling "wood duck—don't shoot" are known (26 percent), (3) certain habitat types, such as streams, are not hunted (25 percent), and (4) official complaints of people shooting wood ducks were received by conservation wardens (15 percent).

Potentially the greatest, illegal, accidental kill of wood ducks during closed season takes place on the Mississippi River. Here the greatest numbers of wood ducks were bagged during the period of 1949–52, when the daily limit was 1 (Table 65).

Except for some stream populations, wood ducks occur on the same aquatic sites occupied by other species. Giving better protection to the wood duck during a closed season resolves itself largely to educating hunters to identify the species before they shoot.

Effect of Extension of Season

In 1954, Wisconsin had a 55-day waterfowl hunting season. Each year from 1955 through 1958, a 70-day season was established. Hunters did not average any more hunting trips per season in 70 days than in 55 days (Table 66). An approximate average of only 1 percent of the coot and 4 percent of the duck kill occurred during the added 15 days (Tables 55, 56, 67). Much of this kill took place on the additional days in November. After December 1, ducks involved in the kill were primarily mallards, canvasbacks, and black ducks (Table 67). These birds, as stated earlier, were located largely in southern Wisconsin along the lower portions of the Mississippi and Wisconsin Rivers, Turtle Creek, Lake Mendota, Lake Geneva, and a few other open-water sites.

While the 15-day extension of the season resulted in little additional kill and hunting effort, some hunters in a few localities in extreme southern Wisconsin were provided hunting opportunities not previously available. However, in most areas of Wisconsin, winter weather conditions in late November and early December limit the duck and coot supply and hunter activity.

TABLE 65

Index to Relative Abundance of Wood Ducks at Certain Localities in Wisconsin*

Station	Years	No. of Hunter Trips	No. of Wood Ducks Bagged	Wood Ducks Bagged Per 500 Hunter Trips
Mississippi River Vernon Co.	1949–52	14,687	798	27.2
Mississippi River Buffalo Co.	1949–51	1,716	70	20.4
Clam Lake Burnett Co.	1949	222	7	15.8
Horicon Marsh Dodge Co.	1947, 1949–52	16,684	186	5.6
Lake Puckaway Green Lake Co.	1949–52	1,566	12	3.8
Lake Poygan Winnebago Co.	1949	835	3	1.8
Powell Marsh Iron Co.	1950	245	0	——
Fish Lake Burnett Co.	1949	90	0	——
Total and Avg.		36,045	1,076	14.9

* Based on figures secured from hunters at full-season check stations.

TABLE 66

Relationship of Season Length and Average Number of Duck Hunting Trips Per Hunter Per Season in Wisconsin

	1950	1951	1952	1954	1955	1956
Average number of trips per hunter*	7.1	8.1	11.3	7.1	6.7	7.0
Length of season, in days	34	44	55	55	70	70

* Figures on trips per hunter were from postseason questionnaires. Data were furnished by A. S. Hawkins (U.S. Bur. of Sport Fisheries and Wildl., in litt., 1953) for 1950–52 and by the Statistical laboratory of the U.S. Bureau of Sport Fisheries and Wildlife, located near Laurel, Maryland, for 1954–56.

Crippling Loss

One of the most disheartening features of the duck harvest is the loss of birds through crippling. Various authors have emphasized that the degree of loss is influenced by a number of factors including (1) species of duck involved, (2) type of habitat, (3) type of shooting, (4) use of retrieving dog, (5) competition between hunters, and (6) skill of the individual hunter (Bennett, 1938; Bellrose, 1953). Our studies in Wisconsin were aimed at determining (1) the degree to which competition between hunters, time of day, type of shooting, weather, and the use of dogs influence the rate of crippling, and (2) if anything practical can be done to minimize the loss.

All figures in our studies were secured through hunter diaries or by interviewing hunters at check stations. The standard question asked was "How many ducks (or coots) did you knock down that you couldn't find?" Crippling losses reported here are minimum figures. Some birds hit with pellets undoubtedly dropped beyond the vision of hunters. All percentages of loss were calculated as the number of birds bagged plus the number lost, divided into the number lost.

Reported duck crippling losses averaged 21 percent for Wisconsin public hunting areas (Table 68). No difference in the rate of loss existed between public shooting areas and the average loss reported for all types of hunters in Wisconsin and the Mississippi Flyway (Table 69). Although the data are not presented here, there was no significant difference in average losses between years at permanent check stations in Wisconsin. Crippling losses varied among individual hunting areas, probably due largely to changes in hunting pressure, species of ducks involved, and habitat types present.

Changes in hunting pressure would influence crippling by altering the type of shooting, the percentage of experienced hunters present, and the proportion of hunters using dogs effectively.

Effect of Hunter Density on Crippling Loss

The influence of hunter density and skill of hunters on the rate of duck crippling loss is striking. Losses for more successful Wisconsin hunters, as indicated by diary records, averaged 13 percent, which is significantly lower than the 21 percent loss on public hunting areas or for all types of hunters. This lower rate of crippling by the more successful hunters is also reflected in significantly lower losses in certain states where hunter density is regulated. For example, in the Illinois River

TABLE 67

Average Distribution of Reported Shooting Mortality in Wisconsin for Certain Species of Ducks and the Coot, 1955–57*

	Percent Per Period							
	October			November			December	Number Band Reports
Species	1–10	11–20	21–31	1–10	11–20	21–30	1–9	
Blue-winged teal	86	7	4	2	1	0	0	185
Pintail	26	31	17	9	6	11	0	35
Black duck	30	20	16	13	11	9	1	70
Mallard	19	13	23	20	13	10	2	283
Redhead	22	19	24	19	14	2	0	100
Canvasback	10	14	33	20	16	5	2	80
Scaup	15	23	26	15	15	6	0	34
All Ducks	35.7	14.4	19.0	14.4	9.8	5.7	1.0	827**
Coot	66	17	14	0	0	3	0	29

* Based on hunters' reports of birds banded outside Wisconsin and bagged within the state. In each year the Wisconsin waterfowl hunting season extended from October 1 through December 9.

** This total is larger than the sum of the numbers for the individual species listed. Included are recoveries for the American widgeon (19), ring-necked duck (12), gadwall (5), and green-winged teal (4).

TABLE 68

Magnitude of Duck and Coot Crippling Loss in Wisconsin

Source	Years	Ducks			Coot*		
		Percent Lost	Number		Percent Lost	Number	
			Bagged	Lost		Bagged	Lost
A. Check Stations							
Lake Puckaway	1949–52	18.3	1,090	244	3.4	1,369	48
Lake Poygan	1949	19	801	188	2	597	12
Mississippi River Buffalo County	1949–51	16.9	2,886	588	—	—	—
Clam Lake	1949	26	321	115	—	—	—
Mississippi River Vernon County	1949–52	12.1	13,243	1,822	—	—	—
Horicon Marsh	1949–52	28.0	14,485	5,628	5.9	2,940	183
Total and Average	1949–52	20.7	32,826	8,585	4.7	4,906	243
B. Hunter diaries	1953	15.4	8,761	1,593	3.9	1,444	59
	1954	13.0	11,845	1,766	5.1	2,388	129
	1955	12.2	12,879	1,789	4.9	1,995	103
Total and Average	1953–55	13.3	33,485	5,148	4.8	5,827	291

* Figures on coot crippling losses from full-season check stations were available from Lake Puckaway (1949), Lake Poygan (1949), and Horicon Marsh (1951).

TABLE 69

Magnitude of Duck and Coot Crippling Loss in Mississippi Flyway States and in the Four Waterfowl Flyways, 1959–60 Hunting Season*

State or Flyway	Ducks			Coots		
	Percent Lost	Estimated Number		Percent Lost	Estimated Number	
		Bagged	Lost		Bagged	Lost
Alabama	26.4**	28,765	10,300	35.6	3,033	1,682
Michigan	23.8**	253,695	79,355	35.3	8,062	4,403
Kentucky	23.6**	19,136	5,904	—	—	—
Ohio	22.3**	103,220	29,620	20**	1,957	498
Wisconsin	22.2**	353,116	100,931	35.7	28,019	15,573
Iowa	21.7**	183,990	51,115	42.3**	2,817	2,068
Tennessee	21.7	76,240	21,140	44.1**	1,460	1,150
Louisiana	20.5	385,933	99,607	29.7**	9,105	3,840
Mississippi	19.6	41,020	10,015	18**	1,114	242
Arkansas	19.5	235,000	56,745	37	872	518
Minnesota	19.4	688,772	166,334	47.5**	13,284	12,043
Indiana	18.5**	37,958	8,603	45.6**	934	783
Illinois	17.5**	232,195	49,260	27.6**	10,940	4,167
Missouri	15.5**	148,547	27,242	48**	1,069	982
Mississippi	20.4	2,788,180	716,160	36.7	82,663	47,943
Atlantic	19.0	681,729	160,147	34.8	10,525	5,608
Central	12.6	1,434,692	206,647	41.6	16,240	11,528
Pacific	12.1	2,147,548	294,764	34.6	57,651	30,506
Four Flyways (U. S.)	16.3	7,052,149	1,377,718	36.4	167,079	95,585

* Based on figures from Atwood and Wells (1960a-o).

** Highly significant difference from the value for the Mississippi Flyway.

Valley, duck clubs own about 90 percent of the hunting land (Bellrose, 1944a:333). At these clubs, where hunters are above average in experience, where guides are employed to aid the shooters in decoying and retrieving ducks, and where competition for targets is practically nil, unretrieved ducks amounted to 15 percent (Bellrose, 1953). For the entire state, Illinois had a duck crippling loss of 18 percent, one of the lowest in the Mississippi Flyway (Table 69).

On the first 2 days of the Wisconsin hunting season, when peak numbers of hunters are afield, crippling losses averaged significantly higher than on weekdays following the opening (Table 70). During weekdays, when hunter densities are lightest, reported duck crippling losses were lowest at 2 full-season check stations (Table 70). With lower hunter density, ducks are able to fly about locally and work in closer to hunters. Apparently a greater proportion of clean kills results. Whether or not a greater portion of experienced hunters are afield on weekdays is unknown.

In certain crowded situations the actual rate of crippling is probably less than that reported. For example, on Horicon Marsh on the opening day of the 1954 season, when there was an average of 1 hunter per wet acre of marsh, reported duck crippling losses were the highest (41 percent) reported for any area in the state in over 10 years. Apparently hunters reported knocking down the same duck which, under such heavy hunting pressure, may have been shot at any number of times before it was finally bagged or escaped as a cripple. When hunters are crowded and success is low, competition for shots is keen. We believe that under these conditions, psychologically, the hunter wants credit for at least hitting a duck, whether or not he bags it. Sowls (1955:166) found that novice hunters were proud of the fact that they hit birds in addition to those they bagged. On the other hand, Bednarik (1961) found that hunters minimized the number of cripples reported on a managed-hunting area in Ohio. Could hunter response to questions on crippling loss be influenced by density of hunters? We suspect it could be. Or maybe replies to questions on duck crippling loss vary with the background of the people contacted. On hunting areas open to unlimited numbers of hunters, we believe reported crippling losses are exaggerated.

Relation to Time of Day

Within the legal daily shooting hours in some years, light conditions vary a great deal. When shooting hours extend from one-half hour before sunrise to near or at sunset, duck crippling losses could be greater during the "grey" half-hour preceding sunrise and the period of dusk preceding sunset. Data from the more successful Wisconsin hunters do not support this theory (Table 71). The portion of ducks lost during these periods was approximately the same as during daylight hours. Green (1963:44) found the rate of duck crippling losses on the Mississippi River less during the presunrise period than during daylight periods. Hawkins *et al.* (1958:222.1–1) reported that crippling losses in heavy cover increased as light waned with approaching dusk. Less inclination of hunters to search for downed birds was reported as a factor contributing to increased losses at a time of the day when ducks are flying about locally. Differences between the Wisconsin findings and those of Hawkins *et al.* (1958) may be related to the type of areas, experience and number of hunters, or species and numbers of ducks involved.

TABLE 70

Relation of Duck Crippling Loss to Different Levels of Hunting Pressure, 1949–52

Stations	Relative Hunting Pressure*	Percent of Ducks Lost	Number Bagged	Number Lost
Mississippi River Vernon County	High	19.0	3,768	881
	Medium	8.6	2,961	280
	Low	9.2	6,497	661
Horicon Marsh Dodge County	High	30.4	4,981	2,174
	Medium	29.7	2,706	1,143
	Low	25.4	6,175	2,108

* Figures from different days of the season were grouped into three categories on the basis of selections from Appendix F. High includes the first 2 days of each season; medium includes those weekends following the opening when peak numbers of hunters were out; low includes the balance of the days.

Relation to Type of Shooting

Variations in crippling loss are associated with the type of shooting practiced. Pass shooting, when ducks are probably shot at the greatest heights, resulted in the largest crippling loss of the three main types of duck hunting (Table 72). Crippling losses were the lowest when jump shooting was done. Such shooting is often at close range at single or small numbers of ducks, and many times at slower moving targets. These factors contribute toward clean kills and more easily retrieved ducks. Bennett (1938:119) found similar differences in duck-crippling loss associated with different types of shooting in Iowa.

Relation to Weather

Weather conditions can influence duck crippling loss. One set of data to illustrate the point was obtained in 1954 at the Horicon National Wildlife Refuge managed hunting area. Here practically all ducks bagged are upland stubble feeders, principally the mallard, taken through pass shooting (Jahn, Bell and Gunther, 1955:8). There are no shooting opportunities over water. Crippling loss on rainy and sunny or clear days was 17 percent, the highest loss recorded. This is undoubtedly because the birds fly at the highest altitudes on clear days, unless there are strong winds. On rainy days, visibility of hunters may be poorer and contribute to the crippling loss. Duck crippling losses were only 4 percent on days when it was snowing. Birds are known to fly relatively low when snow is falling. Under this condition, the birds cannot see the hunters except at short distances, hunters cannot see the birds until they are in gun range, the glide angle of hit birds is reduced,

TABLE 71

Relation of Duck Crippling Loss to Periods of the Day, 1954–55*

Year	Morning Hours				Afternoon Hours			
	Half-hour Before Sunrise		Balance		Last Hour**		Balance	
	Bagged	Lost	Bagged	Lost	Bagged	Lost	Bagged	Lost
1954								
Number	2,855	465	5,523	755	1,147	163	2,310	383
Percent lost	-----	14.0	------	12.0	-----	12.4	-----	14.2
1955								
Number	3,285	476	6,059	800	1,090	158	2,585	381
Percent lost	-----	12.7	------	11.7	-----	12.7	-----	12.8
Total and average								
Number	6,140	941	11,582	1,555	2,237	321	4,895	764
Percent lost	-----	13.3	------	11.8	-----	12.5	-----	13.5

* Based on figures from diaries returned voluntarily by waterfowl hunters reporting killing 20 or more ducks in the previous year.

** Daily shooting hours opened ½-hour before sunrise in each year and closed at sunset in 1954 and ½-hour before sunset in 1955.

and downed birds are easily seen and can be tracked on the snow-covered ground. Accumulated snow minimizes the concealing effect of vegetative cover.

Effect of Using Dogs

Dogs are particularly effective in assisting hunters engaged in pass shooting (Table 72). Under this type of shooting ducks are shot at long ranges, fall at considerable distances from the hunter, and are often concealed in heavy vegetation. Unfortunately, dogs are used least in this type of shooting. Crippling losses of hunters using dogs, compared with losses of hunters not using dogs, ranged from 29 percent less in blind and decoy hunting to 43 percent less in pass shooting (Table 72).

Dogs are also important in picking up cripples previously lost by other hunters. In 1954, on 2,402 hunter trips where at least one dog was used, 363 ducks and 30 coot were found by dogs and were picked up and examined by hunters. When these figures are related to the reported crippling loss, we find that for every 5 ducks knocked down and lost by the hunters, 3 ducks were picked up as birds having been crippled at an earlier date. For every 5 coots reported lost, 7 coots that had been shot by other hunters were picked up. This suggests that coots are purposefully shot and left in the field.

TABLE 72

Indicated Value of Dogs in Reducing Duck Crippling Loss Under Different Types of Shooting*

Year	Type of Shooting							
	Pass		Blind and Decoy		Jump		All Types	
	With Dog	Without Dog	With Dog	Without Dog	With Dog	Without Dog	With Dog	Without Dog
1953								
Number bagged	1,206	1,048	1,347	3,877	692	591	3,245	5,516
Number lost	197	368	147	705	71	105	415	1,178
Percent lost	14.0	26.0	9.8	15.4	9	15	11.3	17.6
1954								
Number bagged	1,631	1,107	2,456	5,255	1,032	364	5,119	6,726
Number lost	223	253	287	835	88	80	598	1,168
Percent lost	12.0	18.6	10.5	13.7	7.9	18	10.5	14.8
1955								
Number bagged	1,292	1,045	2,899	6,025	943	675	5,134	7,745
Number lost	162	277	309	928	62	51	533	1,256
Percent lost	11.1	21.0	9.6	13.3	6	7	9.4	14.0
Total and average								
Number bagged	4,129	3,200	6,702	15,157	2,667	1,630	13,498	19,987
Number lost	582	898	743	2,468	221	236	1,546	3,602
Percent lost	12.4	21.9	10.0	14.0	7.7	12.6	10.3	15.3

* Based on figures from diaries returned voluntarily by waterfowl hunters killing 20 or more ducks in the previous year, 1953–55.

Many of the retrieved birds previously shot by other hunters are not fit for human consumption. In 1954, about 95 percent of the crippled ducks and coots found in the field were not edible. In 1955, of 203 cripples found during the first week of the season, 83 percent were considered edible. Of 397 cripples found throughout the balance of the season, 52 percent were edible. The condition of the cripples varies between years and periods of time within the hunting season. Whether or not the cripples are edible depends upon the number of hours or days elapsing between the time the birds are lost and the time they are found, and upon the air temperature which affects the rate of decomposition of the flesh.

Coot Crippling Losses

Crippling loss of coots varies drastically between sets of data collected using similar methods. Losses on Wisconsin public hunting areas and losses of more successful hunters averaged 5 percent (Table 68). For all types of Wisconsin hunters, losses averaged 36 percent and for the Missisisppi Flyway 37 percent (Table 69).

At first glance the combined coot crippling loss obtained from Wisconsin public hunting areas and from the more successful hunters (5 percent), and losses reported by all types of Wisconsin hunters (36 percent) suggests a rather baffling difference. We believe this difference is related to the type of question used to secure information from hunters. In Wisconsin studies, the 5 percent loss was secured in response to the question "How many coots did you knock down that you couldn't find?" In answering this question objectively, the hunter would give the number of coots he could not locate after searching for them. Those birds that were shot and no attempt made to look for them, would not be reported. In contrast, the U.S. Bureau of Sport Fisheries and Wildlife (E. L. Atwood, U.S. Bur. Sport Fisheries and Wildl., in litt., 24 April 1961) used the question "Total coots knocked down by you within your sight but not retrieved (not picked up)?" Responding hunters reported both coots not found after searching and those shot and left in the field. Coots are purposely shot and unretrieved in Manitoba (Ward, 1953), Wisconsin, and probably elsewhere. Magnitude of this loss is estimated on the basis of the above figures. If approximately 5 percent represents the average crippling loss under conditions where the coot is used, then the difference between 5 percent and 36 percent (total unretrieved kill), or 31 percent, represents the percentage of coots purposefully unretrieved. Hunters are apparently willing to report these unretrieved birds because they want credit for having shot them. Such psychological reactions were previously mentioned in relation to duck crippling losses.

Coot crippling losses for Wisconsin public hunting areas and the more successful hunters (5 percent) were assembled from the same hunters who experienced an average 13–21 percent duck crippling loss. Differences between the average coot and duck crippling loss apparently is due to the behavior of the birds involved. Coots characteristically are not easily disturbed by shooting, and during the day fly about locally at low levels. Bellrose (1944b:9) also found the coot many times more vulnerable than ducks.

Most ducks (the blue-winged teal and wood duck are exceptions) are more wary of man, react to shooting, and fly about locally at higher altitudes. These differences in behavior between coots and most ducks unquestionably account for the difference in their crippling loss. Buss and Mattison (1955: 279) also believed that certain ducks (like the mallard and scaup) are more vulnerable to crippling than others (such as the shoveler and wood duck). We suspect that crippling losses of the blue-winged teal and wood duck are low because these species tend to be habitually low altitude flyers when moving about locally. This habit would increase the chances of the birds being within effective killing range of hunters. Bellrose (1953:359) concluded that the range at which ducks are shot affects the rate of crippling. For example, ". . . mallards fully centered in a shot pattern cannot be consistently bagged at ranges exceeding 50 yards for Number 4 shot and 40 yards for Number 6 shot. Beyond these ranges, crippling becomes an ever increasing probability for the respective shot sizes" (Bellrose, 1953:359).

In summary, two management approaches would help minimize duck crippling losses.

1. Hunting areas should be managed to provide sufficient space to allow ducks to work in close to the hunter. Available figures suggest that crippling loss could be reduced about 25 percent on some areas. On a public hunting ground with an annual kill of 5,000 ducks, a reduction of this magnitude would make an additional 1,250 ducks available to hunters without increasing the proportion of birds presently being removed from the population.

2. Encourage hunters to use good retrieving dogs and to shoot only birds well within killing range. Jump, and blind and decoy shooting should be encouraged through educational efforts and regulations. Pass shooting should be discouraged.

These procedures will aid to minimize crippling loss of the more wary, high-flying ducks. However, there definitely appears to be a minimal crippling loss of 15 percent or slightly less which cannot be avoided through practical means. Shooting and not retrieving coots is a wasteful practice that should be discouraged through educational programs and wanton waste regulations.

Species Composition of Hunters' Bags

In the bag, some species of ducks are more important than others. A total of 18 species of ducks and the coot occurred in bags of Wisconsin hunters between 1948 and 1957 (Table 73). Variations in abundance, availability, and vulnerability to shooting account for the relative importance of each species in the bag.

Some sportsmen have claimed that in years when the Wisconsin waterfowl hunting season opens in mid-October, blue-winged teal shooting is almost completely lost. Actually this

TABLE 73

Average Species Composition of Wisconsin's Early Season Waterfowl Kill*

Species	Average Percent of Total Ducks: Early October (1954–57)	Mid-October (1948–50)
Puddlers		
Blue-winged teal	49.9	21.9
Mallard	29.1	28.7
Green-winged teal	6.6	11.4
American widgeon	4.0	8.2
Black duck	3.6	7.2
Pintail	2.5	6.5
Gadwall	0.1	0.5
Shoveler	0.2	1.0
Wood duck	Closed	5.2
Total Puddlers	96.0	90.6
Divers		
Ring-necked duck	1.9	3.7
Redhead	0.9	1.3
Scaup	0.7	1.7
Ruddy duck	0.3	2.0
Canvasback	Tr.	0.4
Bufflehead	Tr.	0.1
Common goldeneye	0.0	Tr.
White-winged scoter	0.0	Tr.
Total Divers	3.9	9.3
Total Mergansers	0.1	0.1
Total Number of Ducks	19,003	9,855
Coot		
Number	7,974	11,598
Percent**	30.0	54.1

* Based on figures from approximately 20 hunter check stations distributed statewide. The waterfowl hunting season opened on October 14 or 15 in 1948–50 and on October 1 in 1954–57. Figures from the first 2 days of each season were used here, except in 1957 when figures from the first and fifth days were used.

** This is the percentage of the sum of ducks and coots.

is not the case, as data from past hunting seasons show (Table 73). In years when the season opened during the first days of October, blue-winged teal averaged 50 percent of the bag. When the season opened on October 14 or 15, blue-winged teal averaged 22 percent of the bag for the same days. Far fewer blue-winged teal are present in Wisconsin on October 15 than on October 1. Small populations of blue-winged teal apparently contribute heavily to the hunters' bags because the birds are very vulnerable to shooting.

Regardless of the opening date, puddle ducks made up more than 90 percent of the bag on the first few days. Two species, the blue-winged teal and mallard, made up between 51 and 79 percent of the total kill. Of the diving ducks, the ring-necked duck, redhead, and scaup made up 4 to 7 percent of the total kill. The coot is of major importance to Wisconsin hunters. In years of early October openings, an average of 30 percent of the combined total kill of ducks and coots was made up of coots. In years of mid-October openings, coots averaged 54 percent of the combined kill. The large kill of coots in mid-October results from the peak population being present, from peak numbers of hunters being afield, and from the greater bag limit permitting a large daily bag per hunter.

Waste

Two types of waste have been observed in the field. These are (1) shooting wood ducks unintentionally during closed seasons, and (2) shooting coot for target practice.

The potential, maximum, illegal kill of wood ducks at certain hunting areas is indicated by the kill of wood ducks per 100 hunter trips in years when the species could be shot legally. The actual illegal kill is somewhat less than the indicated potential kill because (1) locally the birds are not as abundant in closed seasons as during open seasons (theoretically), and (2) some hunters try to avoid shooting wood ducks during closed seasons. An average of 1 to 7 wood ducks were killed per 100 hunter trips for the entire season (Table 74). In addition, some crippled birds escape and die. This waste occurs during closed seasons. Minimizing the loss depends upon the hunter's ability to recognize the wood duck in flight before pulling the trigger. Greater efforts are needed to help hunters develop their ability to recognize individual species under various environmental conditions.

In migratory bird hunting seasons, coots have been shot for target practice in Wisconsin, Manitoba (Ward, 1953) and probably elsewhere. The dead birds are left in the field to rot. In some years in Wisconsin, this wasteful practice made up an estimated 31 of 36 percent reported crippling loss. Shooting and not retrieving coots has been observed in widely scattered localities in the southern half of the state, the region where the birds are most abundant. This is a form of wanton waste that hunters should be encouraged to eliminate.

Characteristics of Hunters

Certain characteristics of hunters must be recognized before suggested changes in some regulations and certain programs can be properly considered. These are (1) the distance most hunters go to hunt ducks and coots, (2) the ability of hunters to identify individual species of ducks, and (3) the types of violations encountered.

Hunting Radius

Most duck hunters do not travel long distances for their hunting in Wisconsin (Table 75). Approximately three-quarters (77 percent) of the banded ducks and coots reported bagged were taken in the county where the hunters live or an

TABLE 74

Index to Legal Kill of the Wood Duck with Different Opening Dates of the Wisconsin Hunting Season*

Stations	Period of Hunting Season	Wood Ducks Bagged Per 100 Hunter Trips				
		1949	1950	1951	Average for Mid-October Openings (1949-51)	Early October Opening (1952)
Mississippi River Vernon County	First 2 days	12.8	16.4	13.3	14.4	19.6
	Entire season	3.3	5.7	4.4	4.6	7.0
Mississippi River Buffalo County	First 2 days	4.7	18.3	5.8	9.9	——
	Entire season	3.1	6.4	2.3	4.0	——
Horicon Marsh Dodge County	First 2 days	4.4	1.9	3.6	3.2	1.9
	Entire season	1.6	0.7	5.8	1.6	0.8
Lake Puckaway Green Lake County	First 2 days	0.7	0.0	0.0	0.3	6.3
	Entire season	0.9	0.3	0.0	0.8	1.7
Clam Lake Burnett County	First 2 days	8.3	——	——	——	——
	Entire season	3.1	——	——	——	——
Lake Poygan Winnebago County	First 2 days	0.9	——	——	——	——
	Entire season	0.4	——	——	——	——

* Based on data from full-season check stations only. The Wisconsin waterfowl hunting season opened on October 13 or 14 each year from 1949–51 and on October 4 in 1952.

adjacent county. Roughly one-half (53 percent) of the hunters bagged the birds within their county of residence, while an additional one-fourth (24 percent) were taken in an adjacent county. Using the size of most Wisconsin counties as a base, these data indicate that the hunting radius of many hunters is between 10 and 30 miles.

Approximately one-fifth (21 percent) of the ducks and coots were bagged in counties some distance from the hunter's home county. The two major movements involve (1) hunters from Milwaukee and Waukesha counties going to Dodge and Winnebago counties, and (2) hunters from southern Wisconsin, especially in the west central region, going to the Mississippi River. All of these extended hunting trips occur within an estimated maximum 90-mile radius. Field checks of hunters indicate that a few duck hunters travel 300 or more miles to hunt within Wisconsin. Apparently few nonresidents hunt ducks in Wisconsin, as only 1.7 percent of the ducks and coots were reported bagged by this group (Table 75).

Identification of Species Bagged

While carrying out field checks of hunters, we concluded that some hunters could not properly identify all ducks they shot. As already cited, only 48 percent of 122 hunters properly identified a dead female wood duck handed to them. Band recovery reports, which carried the species as identified by both the bander and the hunter, were analyzed to provide additional information on the subject (Appendix H). A summary of these data are presented in Table 76. Whether or not the figures are representative for all Wisconsin hunters, or only those cooperating in reporting band recoveries, is unknown.

Species most frequently misidentified by hunters include the black duck, blue-winged teal, scaup and ring-necked duck. Many black ducks are called "black mallards." The same term is used on small numbers of mallards. Hence, a hunter's report of a black mallard could involve either a mallard or a black duck. Many blue-winged teal are merely called "teal." The greatest question involves the term bluebill, which is used for both the scaup and ring-necked duck. Mallards, both male and female, and coots are among the species identified best by hunters. Canvasback and redhead were properly identified by hunters in 90 percent of the cases.

Since hunters identified various species of waterfowl with varying degrees of accuracy, species composition secured from hunters would not properly reflect the actual bag. Species

TABLE 75

Indicated Radius Wisconsin Hunters Travel to Hunt Ducks and Coots*

Species	Percent Shot by Wisconsin Residents		Percent Shot by Residents From Other States	Total Number of Band Recoveries
	In County of Residence or Adjacent County	In Distant County		
Pintail	80	19	1	94
Scaup	80	19	1	120
Redhead	78	21	1	248
Blue-winged teal	77	21	2	378
Black duck	77	23	0	314
Mallard	76.6	20.7	2.6	1,030
Canvasback	76	21	3	124
Ring-necked duck	—	—	—	47
Bufflehead	—	—	—	4
White-winged scoter	—	—	—	1
Black duck X Mallard	—	—	—	3
Gadwall	—	—	—	7
American widgeon	—	—	—	37
Green-winged teal	—	—	—	14
Shoveler	—	—	—	3
Wood duck	—	—	—	29
Coot	—	—	—	56
All species	77.2	21.1	1.7	2,509

* Information on the residence of each hunter and the county where each duck was bagged was taken from U.S. Bureau of Sport Fisheries and Wildlife band-recovery slips.

TABLE 76

Summary of Reported Identification of Ducks and Coots Bagged by Wisconsin Hunters*

Species	Percent Questionable	Number Identified by Hunters		
		Total	Correct	Questionable
Black duck	69	90	28	62
Blue-winged teal	31	176	122	54
Redhead	11	105	94	11
Mallard	3	325	316	9
Ring-necked duck	—	20	5	15
Scaup	—	48	7	41
Canvasback	—	80	74	6
Bufflehead	—	1	1	0
Pintail	—	26	21	5
American widgeon	—	13	11	2
Green-winged teal	—	7	6	1
Gadwall	—	1	0	1
Wood duck	—	5	4	1
Coot	—	29	28	1
All species	23	926	717	209

* This is a summary of the data presented in Appendix H. It is based on information taken from U.S. Bureau of Sport Fisheries and Wildlife band recovery slips.

identified correctly, such as the canvasback and redhead, would be exaggerated in the reports.

Violations

A 3-year record of waterfowl hunting violations encountered in Wisconsin was examined to determine the most prevalent types of violations and to ascertain what effort is needed to reduce the occurrence of the violations.

Shooting before and after legal daily shooting hours was the most prevalent violation (Table 77). Even though the 3-shell restriction has been in force since 1935, it ranked third, behind infractions involving refuges and public hunting grounds. Eighty-eight percent of all registered cases involved (1) shooting before and after legal hours, (2) unplugged or improperly plugged shotguns, (3) closed seasons, (4) refuges or public hunting grounds, and (5) carrying loaded guns in motor boats. All types of violations identified had one thing in common—they occurred in spite of well-posted regulations. Apparently some hunters fail to recognize fully the need for their co-operation in abiding by established restrictions. Hunters must learn more about their sport and cooperate to a greater degree by hunting at the proper time and place with authorized equipment. This is the only practical avenue we can visualize to reduce infractions, especially of regulations such as the 3-shell law, which have been on the books for a quarter century or more.

TABLE 77

Types of Waterfowl Hunting Violations Encountered in Wisconsin, 1955–57*

Violations	Number of Violations			Three-year Total	
	1955	1956	1957	Number	Percent
Daily shooting hour violations					25.2
Before opening hour	51	38	27	116	——
After opening hour	98	74	68	240	——
Unplugged or improperly plugged gun	80	82	78	240	17.0
Violations involving closed season**	86	56	90	232	16.5
Violations involving a refuge or public hunting ground	38	121	113	272	19.3
Carrying loaded gun in a motor boat	37	70	40	147	10.4
Violations involving a boat with motor attached	16	21	14	51	3.6
Shooting in open water	14	28	15	57	4.0
Exceeding daily bag limit	9	13	14	36	2.6
Hunting with live decoys	4	3	0	7	0.5
Commercialization of waterfowl	0	3	0	3	0.2
Violations involving a motor vehicle	2	0	2	4	0.3
Shooting waterfowl with a rifle	1	0	1	2	0.1
Improper importation or interstate transportation	1	0	1	2	0.1
Illegal blind	0	0	1	1	0.1
Total number	437	509	464	1,410	——

* Based on a yearly summary of data made available through the Game Management Office of Region 3 (Minneapolis) of the U.S. Bureau of Sport Fisheries and Wildlife. Only identified cases are listed. Violations handled by both state and federal authorities are included.

** Includes violations involving a closed season on wood ducks, which numbered 33 in 1956 and 62 in 1957.

Evaluation of Certain Waterfowl Hunting Regulations

After a hunting regulation has been in force for a number of years, it is essential to know the general effectiveness of the regulation under certain conditions. With such knowledge, refined judgement can be used in applying the same regulation under similar conditions in the future. A summary of results from evaluating certain waterfowl hunting regulations employed in Wisconsin is offered here.

Effect of Early Season Shooting on Local Breeders

Various writers have indicated that the size of breeding duck populations can be influenced by the time at which the waterfowl hunting season opens (Stoudt, 1948:159); Hochbaum, 1947:55 and 1955:256; Lee and Tester, 1955). Very early openings could result in a disproportionately heavy harvest of local breeders. Opening dates of Wisconsin waterfowl hunting seasons varied in past years, providing the framework needed to test the suggested relationship between breeding population levels and opening dates of the hunting season.

Each year from 1948 through 1951, the Wisconsin waterfowl hunting season opened in mid-October (13–15) and from 1952 through 1954, between October 2 and 4. Breeding populations were measured on nonrefuge areas each spring from 1951 through 1956. All waterfowl census areas contained water each spring. The number of water areas decreased during the 6-year period due to drainage. This loss in number of sites, if anything, should have resulted in fewer breeders being present (Evans and Black, 1956:52).

No correlation was found between the level of the Wisconsin breeding duck population and the time the hunting season opened the previous fall (Table 78). Breeding indices for 1951 reflect population levels following three (1948–50) mid-October openings of the hunting season. Following early October openings, breeding indices were almost all above or equal to the 1951 index. If early October hunting in Wisconsin were detrimental to local breeding ducks, decreases in the breeding populations should have been registered following early October openings. Decreases were not registered. Opening the season in early October was no more limiting to most species of the local breeding population than having a mid-October opening. The wood duck may have been an exception.

The time at which the Wisconsin waterfowl hunting season opens in October affects the kill of wood ducks. Because Wisconsin is located on the northern edge of the wood duck's breeding range, we believe that many of the wood ducks present in early October represent Wisconsin breeders and their progeny. When the season opened on the first few days of October, more wood ducks were killed than when it opened in mid-October. In 1952, when the season opened on October 4, at 2 of 3 check stations, the wood duck kill was higher per 100 hunter trips than it was when mid-October openings were

TABLE 78

Wisconsin Breeding Duck Population Trends and Water Area Occupancy in Relation to Opening Dates of Wisconsin Waterfowl Hunting Seasons, 1951–56

Species	Pairs Per 100 Acres of Aquatic Habitat Censused						
	1951	1952	1953	1954	1955	1956	Average
Blue-winged teal	4.6 (199)	3.4 (195)	8.3 (281)	8.7 (317)	7.8 (252)	8.2 (223)	6.4 (1,467)
Mallard*	2.8 (119)	3.0 (170)	5.5 (185)	5.2 (189)	4.5 (144)	3.0 (82)	3.9 (889)
Ring-necked duck**	0.5 (12)	1.0 (44)	0.9 (19)	1.3 (31)	1.7 (34)	1.5 (23)	1.1 (163)
Black duck	0.4 (17)	0.4 (26)	1.2 (41)	0.8 (31)	0.5 (15)	0.5 (14)	0.6 (144)
Wood duck	0.3 (15)	0.7 (39)	0.6 (19)	0.8 (32)	0.6 (19)	0.4 (12)	0.6 (136)
Percent of water areas occupied	55	57	55	64	55	56	57
Opening date of previous year's waterfowl-hunting season	Oct. 14, 1950	Oct. 13, 1951	Oct. 4, 1952	Oct. 3, 1953	Oct. 2, 1954	Oct. 1, 1955	

( ) Number of pairs of each species.

* Observed numbers of pairs were increased by 10 percent each year to adjust for early nesters missed on surveys in May.

** Only pairs of ringnecks from the Northern Highland and Central Plain are included in the totals.

held (Table 74). The decline in the wood duck kill at Horicon Marsh from 1949–51 to 1952 is due to the presence of fewer wood ducks. Apparently the greater kill in early October at the other 2 stations reflects the presence of large numbers of local wood ducks.

Variations in the number of states of the Mississippi Flyway having closed seasons on the wood duck also appear to affect the level of the local Wisconsin population of breeding wood ducks. Each year between 1954 and 1957, the hunting season on wood ducks was closed in Wisconsin, while the number of other states of the Mississippi Flyway having a closed season varied from none to all. Could closing the season on wood ducks, in only Wisconsin or a group of northern states including Wisconsin, benefit the Wisconsin breeders? Data presented in Table 79 indicate that closing the 1955 hunting season on wood ducks in only Wisconsin, while the balance of the states of the Mississippi Flyway had an open season, did not prevent a decline in the Wisconsin breeding population. The total mortality apparently suffered by this group of breeders in other states reduced the population. Although not statistically significant, the indicated trend of the Wisconsin population of breeding wood ducks was again upward under closure of hunting in the entire Mississippi Flyway in 1956 and in eight northern states in 1957.

This discussion of trends of Wisconsin's breeding wood duck population, in relation to area of the Mississippi Flyway open to hunting, should be considered exploratory. A critical evaluation is needed to determine whether or not occupancy of artificial nest boxes can be used as a reliable breeding population index. The best approach to test the relationship would be to use banding data from wood ducks breeding and produced in Wisconsin. Effect of fluctuations in area of the Mississippi Flyway open to hunting would be indicated by calculated recovery and hunting mortality rates.

In summary, opening the waterfowl hunting season on the first few days of October is not limiting the Wisconsin breeding duck population, except possibly for the wood duck. A nucleus of breeders has sustained itself under increasing hunting pressure during hunting seasons which have not opened before October 1 since 1946. During the same period of years, increases in breeding populations have taken place in response to newly created favorable habitat conditions.

Value of Refuges to Protect Local Breeders

At numerous times in the past, the idea of establishing a refuge on suitable breeding habitat has been advocated to protect local breeding populations from peak hunting pressure early in the hunting season. The underlying assumption is that the refuge would reduce shooting mortality and permit more breeders to return to nest in following years. That local breed-

TABLE 79

Wisconsin Breeding Wood Duck Population Trends in Relation to Open and Closed Seasons, 1955–58

Year	1955	1956	1957	1958	Average
Number of nest boxes examined	386	345	404	404	—
Percent of nesting boxes occupied by wood ducks	13 ± 3	6 ± 3	7 ± 3	10 ± 3	9 ± 3
Previous year's hunting season	Closed in entire Mississippi Flyway	Closed in Wisconsin, but open in balance of Mississippi Flyway	Closed in entire Mississippi Flyway	Closed in Wisconsin, Michigan, Minnesota, Illinois, Indiana, Iowa Missouri and Kentucky	—

ing females, especially adults, do return to the same area to nest in successive years has been demonstrated by Sowls (1955:44). Theoretically, to accomplish the objective, the refuge must (1) be located where post-breeding season flocks congregate, and (2) be large enough to encompass the daily, local movements of the birds, and the birds must be within the refuge to receive the protection.

Some blue-winged teal and mallards, in both refuge and nonrefuge areas, leave Wisconsin prior to October 1, the date when waterfowl hunting seasons opened in the 1950's. Even where a refuge of approximately 20,000 acres (the Horicon National Wildlife Refuge) is available, mallards congregate following the reproductive season and radiate out for approximately 15 miles to secure preferred agricultural foods in surrounding crop fields open to hunting. Hunt *et al.* (1958:52) calculated a 75 percent first-year mortality rate for immature wild mallards banded at Horicon Marsh. Of the first-year recoveries, 79 percent were bagged in Wisconsin, with 49 percent taken within a 0- to 20-mile radius of the banding site. The bulk of these birds were banded in an approximate 2,500-acre refuge located less than 3 air miles from the 20,000-acre refuge. Local feeding flights and wandering flights of these young mallards made them available to hunters in spite of the presence of large refuges. Elsewhere in Wisconsin where refuges have been established, local flights of ducks have also extended beyond refuge boundaries. Pirnie (1935:57) concluded that ". . . a brood of ducklings may scatter widely, going hundreds of miles apart regardless of protection or attractive food supplies which are to be had in the home marshes." Hochbaum (1955:144) referred to these postbreeding season movements of immatures of many species as primary wanderings of a random nature. From all evidence, we conclude that establishing refuges for the specific purpose of reducing hunting mortality on local breeding populations of blue-winged teal and mallards does not seem warranted. The extent of prehunting season migrations and during-the-season local movements of the birds defeats successful accomplishment of the refuge objective.

Value of Refuges to Hold, Distribute, and Protect Ducks in Fall

During the years the waterfowl project has been active, approximately 45 different areas were established to offer protection to ducks and coots in fall. All waterfowl shooting was prohibited, and boat traffic was minimal if permitted at all. A general appraisal of these refuges was made to determine which species could be held locally and, therefore, be better distributed by being provided protection in fall.

For stubble feeders—the mallard, black duck, and pintail—refuges containing shallow water and shorelines partially exposed to serve as open loafing sites are best. When the protected site was located in a matrix of surrounding agricultural lands where preferred food in the form of waste grain was available, the major limitation on numbers of birds using the refuge appeared to be the supply of them passing nearby. Those refuges located on major flight routes were most successful. In forested areas, where preferred grain consists primarily of limited supplies of wild rice, the chances of holding stubble feeders is greatly reduced. Pintails are not involved to any large extent because the supply of birds crossing forested areas is very limited and wild rice may not be a preferred food of this species. Where refuges of suitable size have been established on major flight lanes and a supply of preferred food has been available, stubble-feeding ducks, especially the mallard and black duck, have been held longer in fall, been better distributed in the state, and furnished hunting opportunities within their daily feeding radius.

Of the remaining puddle ducks, the wood duck is least likely to take advantage of protection afforded by refuges. Fall concentrations or roosts of wood ducks occur where food, especially acorns or the nut-like fruit of American lotus, is available. In some cases where acorns are available some distance from the aquatic roosting site, daily flights to the feeding site are made near sunrise and a return flight to the roost is made near sunset. Concentration sites of wood ducks are well distributed throughout Wisconsin (Fig. 31).

If refuges were to be used to reduce shooting mortality on wood ducks, as has been suggested, the plan would have to

be somewhat different than is usually thought of. The usual situation, when sanctuaries are considered to protect a species, is to close shooting on the aquatic sites where the birds roost or loaf. For wood ducks, some aquatic roosting sites do not need protection over and above that offered by daily shooting hours extending from ½-hour after sunrise to 1 hour before sunset during the month of October, the period when most wood ducks are present in Wisconsin. The feeding sites, whether they be aquatic or upland areas of oak, should be set up as refuges on a temporary or short-term basis. Flexibility in locating refuges is needed to protect available feeding areas used by wood ducks. The shooting hours would permit the birds to leave their aquatic roosts and gain altitude on the flight to feeding sites. The same reasoning would apply on the return trip to the aquatic roost. If aquatic areas, other than the roost, are used for loafing during the day, they would also have to be designated as refuges. If daily shooting hours extended from ½-hour before sunrise to sunset, then the sanctuary for wood ducks should be large enough to include the aquatic roosting site, the upland and aquatic feeding sites, additional aquatic loafing sites, and the area covered by the flight pattern connecting the feeding and loafing or roosting sites. This does not appear practical in Wisconsin, where wood duck concentration sites are numerous, widely scattered, and many times support a mixture of duck species.

Reaction of other puddle ducks—the American widgeon, gadwall, green-winged teal, shoveler, and blue-winged teal—to a refuge appears to depend primarily upon (1) its location in relation to major flight lanes, and (2) the presence, abundance, and availability of preferred aquatic foods. Open shorelines, which provide favored loafing habitat, help make the area more attractive to all puddle ducks, but especially shovelers and blue-winged teal. Sowls (1955:159) also reported the need for resting places for waterfowl and stated that "Deep water with densely vegetated shores will not attract and hold high populations of surface-feeding ducks during late summer and fall."

Of the five species involved, it appears that refuges will encourage American widgeon and gadwall to remain longer than in nonrefuge areas. Shovelers are numerically too scarce in Wisconsin for us to judge completely their reaction to refuges, although they appear to react similarly to blue-winged teal. Blue-winged teal and green-winged teal, but especially the former, stay only a few additional days in refuge areas. Sites for refuges must be selected carefully for these species. Chances of success are increased by selecting sites (1) now used sparingly by American widgeon and gadwall, and (2) where preferred aquatic foods are available in sufficient quantity to support duck populations for prolonged periods.

Our experiences with refuges for diving ducks are more limited than for puddle ducks. On 355-acre Green Lake in Burnett County, ring-necked ducks and scaup naturally concentrate, if disturbance is not excessive. This lake was closed to hunting in 1952 and 1953. The average number of ducks observed per aerial census in fall was 3,900 in 1952 and 1,000 in 1953. Prior to establishment of the refuge and following its removal, the average number of ducks per flight ranged from 10 to 469. While the lake was a refuge, local feeding flights of ducks to surrounding lakes helped provide abundant hunting opportunities.

In Winnebago County, open-water refuges delineated by buoys were established experimentally to determine (1) whether or not canvasbacks and redheads could be encouraged to remain in greater numbers, and (2) if the distribution of the ducks on the lakes would be affected by the refuges. The major objective of these closed areas was to provide ducks and coots with a resting site undisturbed by motor boats. First-year results were striking (Jahn, Hopkins, and Jordahl, 1958:15). Within the 800-acre open-water closed area on Lake Butte des Morts, a 4,505-acre lake, dabbling and diving duck use was much greater within the closed area than in the open area. The dabbling duck use per 100 acres on the open area was 196 in contrast to 1,968 on the closed area, or approximately 10 times greater. For diving ducks the comparison was 39 in contrast to 4,125—or more than 100 times greater duck use in the closed area. Prior to the opening of the waterfowl hunting season, practically no waterfowl used the closed area. After 2 weeks of hunting, the closed area held 1,187 ducks per 100 acres while the open area held less than 1 duck per 100 acres. As hunting and boating pressure declined later in the season, the open area was utilized by ducks to a greater extent than during the first 2 weeks of the season. However, the closed area continued to receive far more duck use per acre of habitat than the open area. There is no question that the distribution and duck use of the lake was affected by the open-water refuge.

Open-water refuges were in effect on Lakes Butte des Morts and Winneconne (3,264 acres) in 1957 and 1958 and on Lake Poygan (10,992 acres) in 1958. Both canvasbacks and redheads used these lakes prior to establishment of refuges on them (Appendix D). Trends in duck use of these species, on all three lakes combined, have followed the declining trend in the wintering population of canvasback and redhead, as reported by A. S. Hawkins (pers. comm., 1959) on the basis of combined information from Central, Mississippi, and Atlantic Flyways. These data suggest that the open-water refuges for canvasbacks and redheads functioned primarily by affecting the distribution of these species on the lakes. Additional years of data are needed to determine further whether or not the refuges will hold increasing numbers of these species in Wisconsin until freeze-up.

In summary, the distribution of many species of ducks can be affected by establishing refuges or closed areas to provide the birds protection from disturbance, primarily excessive hunting pressure or motor boating. Success will be enhanced by locating the refuge (1) on major, migratory flight lanes, (2) at sites traditionally used by the birds to congregate, and (3) at sites having adequate food supplies.

Effect of Restricting Daily, Afternoon Shooting Hours

From 1956 through 1958, the daily closing hour on waterfowl hunting in Wisconsin was 4:00 p.m. In 1956 and 1957, attempts were made to evaluate the effectiveness of the regulation in encouraging migrant ducks to make greater use of aquatic and upland food resources. Aerial census data, reports from fieldmen, and intensive observations were employed.

Biweekly, aerial, waterfowl censuses in 1955 and 1956 showed less (39 percent) duck day use in 1956 with the daily closing hour at 4:00 p.m. than in 1955 when shooting extended to ½-hour before sunset. No increase in duck use was indicated in 1957 either.

Game managers and conservation wardens reported that in certain localities in northeast, west central, and east central Wisconsin the 4:00 p.m. closing hour permitted ducks to make greater use of natural feeds and waste grains in harvested fields. Statewide, 64 percent of 83 reports by fieldmen indicated that the waterfowl kill decreased because hunters could not shoot waterfowl 1 hour or less preceding sunset in October and early November. This hour preceding sunset is a period when many ducks are naturally active in making local flights, thereby providing hunters with hunting opportunities.

Intensive observations of local flights of stubble-feeding mallards and black ducks were made by two or more observers from 1 hour preceding sunrise to ½-hour following sunset at the Horicon National Wildlife Refuge in 1956 and 1957. Reaction of the birds to the closing hour of shooting was determined by comparing the time of preseason, daily, feeding flights (without hunting pressure) with the time of the flights occurring at certain periods during the hunting season (with hunting pressure). Before the hunting season mallards and black ducks moved out from aquatic roosting sites to feed shortly before sunrise. The bulk of those birds, which came back in the morning, returned to aquatic loafing areas within 1½ hours. A few birds continued to return for a total 4-hour period following sunrise. From 2/3 to 4/5 of the ducks remained out of the refuge all day, returning in late afternoon. In the afternoon, the bulk of the prehunting season local flights were made 1½ hours preceding sunset to 1½ hours following sunset, with the peak of outgoing and incoming flights occurring ½ hour following sunset.

With the 4:00 p.m. closing hour, the time of normal, afternoon, local-feeding flights was modified only slightly during the first few days of the season. The greatest adjustment by mallards and black ducks to heavy shooting pressure was a reduction in their local feeding radius. Prior to the hunting season the birds radiated out from aquatic roosting sites up to 15 miles to feed. Within the first 7 days of the season, the radius of feeding flights was reduced primarily to the refuge boundaries. Approximately 2,000 acres of cropland were available in the refuge. The behavioral changes of the ducks was striking. For example, on 17 October 1956, a total of 96 ducks was observed leaving the refuge during the full-day observation period. Thousands of ducks were seen feeding in the refuge crop fields; they had not eluded the observers. An estimated 9,400 mallards and 1,100 black ducks were present on the refuge.

Shooting pressure exerted on the birds each morning was of sufficient magnitude to force the birds to reduce their local, feeding radius to the boundaries of the refuge. Even though the birds had the opportunity to carry out their normal (preseason) afternoon feeding flights, they did not. This indicates that the birds adjusted their local, feeding flights to avoid shooting. After suitable, upland-feeding areas were located within the refuge, favorable behavior patterns established for morning feeding were repeated in the afternoon, even though the birds could have gone outside of the refuge to feed and would have experienced only mild disturbance (illegal shooting after 4:00 p.m. and agricultural harvesting operations). Apparently each morning some ducks attempt to go outside the refuge, thereby furnishing shooting opportunities. Evidently the "lesson" learned in reacting to shooting on one morning must be relearned by some ducks on successive mornings.

The adaptive local feeding behavior of mallards and black ducks in relation to daily shooting hours has also been reported for Illinois (Bellrose, 1944a:356) and Ohio (Winner, 1959:201). Bellrose found that the birds fed earlier in the afternoon with a 4:00 p.m. closing hour than when shooting ended at sunset. In 1942, after the first few days during which the hunting season was open, mallards would not alight or attempt to alight in cornfields until sunset or shortly thereafter. Many of these fields were undoubtedly hunted. Winner (1959), in Ohio, concluded that there was extreme variability of feeding flight time when considered in relation to the time at which daily shooting hours end. The variation in the findings of these studies indicates that mallards and black ducks are very adaptive in reacting to hunting pressure exerted during regular, daily shooting hours. Wisconsin data indicate that under heavy hunting pressure, such as occurs around the Horicon National Wildlife Refuge, the birds shorten their normal, daily, feeding radius and use preferred agricultural foods within the refuge. After these feeding patterns are established within the refuge, some birds apparently continue to feed in the fields in both morning and evening, unless disturbed or until the preferred food supply becomes exhausted. The first response to limitations of preferred food appears to be an extension of the local feeding radius beyond refuge boundaries. If shooting pressure is too heavy, apparently the birds give up trying to feed outside the refuge and migrate south. If shooting pressure is light, small flocks of birds continually try to feed in harvested agricultural fields outside of the refuge. This situation can be seen around the Horicon National Wildlife Refuge in November.

From all evidence, we conclude that the 4:00 p.m. closing hour was not of major consequence in encouraging more ducks to utilize the aquatic and upland foods in Wisconsin. To encourage greater use of the existing Wisconsin food resources by ducks, refuge areas of adequate size are needed

(1) on aquatic sites having suitable carrying capacity, and (2) on suitable, aquatic roosting sites lacking natural foods but located in agricultural regions where waste grain can serve as food. The need for protection from heavy hunting pressure is obvious. Establishing the daily shooting hours permitted by federal law, except for specific areas, would provide wildfowlers with maximum hunting opportunities each day.

Importance of Open-Water Shooting

With exceptions for Lake Michigan, Lake Superior, and certain counties bordering the Mississippi River, waterfowl hunting is prohibited in open water in Wisconsin. "Open water" is defined as any water outside or beyond a natural growth of vegetation extending over the water surface and of such height as to offer partial or whole concealment for the hunter. In Lakes Michigan and Superior, aquatic fowl can be hunted from open water under the jurisdiction of the state of Wisconsin, excepting Green Bay and the open water area within 500 feet of any shoreline. In any of the waters of the Mississippi River, the St. Croix River, Lake St. Croix, and Lake Pepin and their bays, bayous, and sloughs bordering on the counties of Buffalo, Crawford, Grant, La Crosse, Pepin, Pierce, St. Croix, Trempealeau, and Vernon, and in any inland lake of these counties, anchored blinds located not more than 100 feet from any shoreline are permitted. Observations of conservation wardens and game managers, assembled by area game biologists R. C. Hopkins and G. F. Hartman (Wis. Conserv. Dept., in litt., 1954), indicate the relative importance of open-water shooting in Wisconsin.

Very few hunters take advantage of the available open-water hunting opportunities. On Lake Michigan the limited use is concentrated off Manitowoc and Sheboygan Counties. Interference with shoreline hunting has been negligible. In fall, few ducks utilize the lake within the 500-foot limitation. Most hunters hunt quite some distance beyond 500 feet. The relatively few hunters who take advantage of this type of hunting have consistently good success in bagging ducks. Apparently the success is superior to many inland hunting areas. Law enforcement problems have been minor. Some hunters have illegally attempted to rally rafts of ducks and to shoot from a boat when the motor is running. Open-water shooting on Lakes Michigan and Superior provides hunting opportunities for limited numbers of waterfowl hunters who have the experience and specialized equipment required to safely hunt on these big lakes.

In the western counties, few hunters take advantage of the 100-foot regulation permitting anchored blinds. Because of the maze of islands and numerous beds of emergent vegetation offering shooting sites, open-water blinds are not considered to be significant in furnishing additional space for hunters.

Effect of December Hunting on the Turtle Creek Wintering Duck Population

Wisconsin waterfowl hunting seasons ended in November from 1946 through 1954. This was before a number of deep lakes in southern Wisconsin froze over completely. Starting in 1955, the hunting seasons extended into early December. Some concern was expressed over the effect the extended shooting would have on the wintering population of mallards and black ducks using Turtle Creek (in Rock and Walworth counties). This creek is the largest, natural wintering site used by these species and was completely open to hunting until 1958. Shooting in early December (1–9) from 1955 through 1957 prohibited the ducks from using the creek. However, they apparently remained in the state on some of the late-freezing, deep lakes. By early January, when the regular winter census was conducted, mallards and black ducks were present in expected numbers on Turtle Creek each year when waterfowl hunting seasons extended through December 9.

Contribution of Local Production To Wisconsin's Duck Harvest

The portion of Wisconsin's duck kill contributed by birds produced locally is estimated by relating information on the breeding population to information on the total annual kill. Reliability of the calculated estimates of the contribution will vary with (1) representativeness of the samples used, (2) accuracy of the estimate of breeding population density, (3) the portion of hens successful in producing broods, (4) the magnitude of mortality of adult ducks between May 15 and October 1, (5) the portion of local ducks shot in Wisconsin, (6) annual variations in shooting rates, and (7) the accuracy of duck kill statistics. To allow for variation between years in the number of ducks produced and harvested, the percentage of local ducks in the Wisconsin duck harvest is presented here as a series of values, each relating to a particular level of production and harvest. This seems to be the most realistic way to recognize periodic fluctuations in the size of the breeding population and the harvest.

Anual shooting rates (Table 80) and first-year recoveries of banded ducks (Tables 81 and 82) are used to estimate the portion of locally produced ducks shot in Wisconsin. Ducks banded largely as free-flying birds from May through August are presumed to represent local breeders and their young. Of the total first-year recoveries from these birds, an average of 55 percent occurred in Wisconsin (Table 81). From ducks banded as flightless immatures in other states and provinces, an average of 35.4 percent of the first-year recoveries were taken within the state or province of banding (Table 82). Variations in the percentage of recoveries occurring within the state or province of banding are associated with (1) differences in hunting pressure, (2) species differences in time of migration, (3) variations in the size of states and provinces, (4) amount of attractive habitat available in the postnesting period, and (5) nearness of the banding station to the political boundary. The influence of the latter factor on the distribution of recoveries was reported for a Montana banding operation by Hickey (1951) and was evident at the Burnett

TABLE 80

Some Calculated Average Annual Shooting Rates For Wild Ducks

Species	Area	Years	Age	Number		In Percent		Reference
				Banded	First-Year Recoveries	First-Year Recovery Rate	Annual Shooting Rate*	
Mallard	Wisconsin**	1947–57	Adult	217	19	9	28	This study
Mallard	Wisconsin**	1947–57	Immature	1,582	247	15.6	49	This study
Subtotal	Wisconsin**	1947–57	Both	1,799	266	14.8	47	This study
Mallard	L. Chaut., Ill.[1]	1939–44	Adult	14,265	1,277	9.0	28	Bellrose and Chase, 1950
Mallard	L. Chaut., Ill.[1]	1939–44	Immature	8,019	1,361	17.0	54	Bellrose and Chase, 1950
Mallard	L. Chaut., Ill.[1]	1939–44	Both	30,912	3,413	11.0	35	Bellrose and Chase, 1950
Mallard	McGin. Slough, Ill.[1]	1940–45	Both	9,751	1,127	11.5	36	Bellrose and Chase, 1950
Subtotal	Illinois[1]	1939–45	Both	40,663	4,540	11.2	35	Bellrose and Chase, 1950
Mallard	Canada	1939–46	Adult	2,947	292	9.9	31	Hickey, 1952:127
Mallard	Canada	1939–46	Immature	3,728	337	9.0	28	Hickey, 1952:127
Subtotal	Canada	1939–46	Both	6,675	629	9.4	30	Hickey, 1952:127
Mallard	Lower Souris Ref., N.D.	1939–41	Both	4,103	505	12.3	39	Hickey, 1952:127
Mallard	Des Lacs Ref., N.D.	1939	Both	4,000	——	10.1	32	Hickey, 1952:126
Mallard	Yakima, Wash.	1947–54	Both	1,104	145	13.1	27	Lauckhart, 1956
Mallard	Skagit, Wash.	1947–54	Both	1,962	502	25.6	67	Lauckhart, 1956
Mallard	Mississippi Flyway	1959–60	Both	——	——	——	app. 40	Smith and Geis, 1961
Black duck	Wisconsin**	1946–51	Adult	76	16	21	57	This study
Black duck	Wisconsin**	1946–51	Immature	420	70	17	46	This study
Subtotal	Wisconsin**	1946–51	Both	496	86	17	46	This study
Black duck	Illinois	1940–45	Both	4,382	470	10.7	34	Bellrose and Chase, 1950
Blue-winged teal	Wisconsin	1946–51	Adult	98	2	2	6	This study
Blue-winged teal	Wisconsin	1946–51	Immature	829	32	4	12	This study
Subtotal	Wisconsin	1946–51	Both	927	34	3.7	11	This study
Blue-winged teal	Illinois	1940–45	Both	6,252	160	2.6	9	Bellrose and Chase, 1950
Wood duck	Wisconsin**	1946–51	Adult	316	16	5	14	This study
Wood duck	Wisconsin**	1946–51	Immature	200	12	6	16	This study
Wood duck	Wisconsin**	1959–60	Adult	812	51	6	16	Calculated from Kaczynski and Geis, 1961
Wood duck	Wisconsin**	1959–60	Immature	2,317	219	9.5	26	Calculated from Kaczynski and Geis, 1961
Subtotal	Wisconsin**	1946–60	Both	3,645	298	8.2	22	——
Wood duck	Eastern U. S.	1958–60	Adult	3,592	207	5.5	15	Kaczynski and Geis, 1961
Wood duck	Eastern U. S.	1958–60	Immature	8,506	698	7.7	20	Kaczynski and Geis, 1961
Subtotal	Eastern U. S.	1958–60	Both	12,098	905	7.5	20	Calculated from Kaczynski and Geis, 1961

* Annual shooting rates for Wisconsin, Illinois (only the mallard), Canada, and North Dakota were calculated by adjusting the first-year recovery rate for unreported bands and crippling loss. Estimates used for reported bands were 42.1 percent for the mallard, 44.2 percent for the blue-winged teal, and 49.0 percent for the black duck and wood duck (Geis and Atwood, 1961). The knocked-down cripple loss was figured at 25 percent of the number of ducks bagged (Table 69, figure for Mississippi Flyway).

** Between 1946 and 1960, all ducks were banded in Wisconsin before the waterfowl hunting season opened.

[1] Number of first-year recoveries and first-year recovery rate are based on data corrected by Bellrose and Chase (1950) to compensate for time and place of banding: during the hunting season and halfway down the flyway.

County, Wisconsin banding station. Mallards banded less than 50 miles from the Montana boundary were shot more often in Idaho than in Montana (Hickey, 1951). Of 74 first-year recoveries from immature mallards banded in Burnett County, Wisconsin, which is adjacent to Minnesota, 59 percent occurred in Minnesota and the balance in Wisconsin. Of 20 first-year and subsequent-year recoveries from adult mallards, 65 percent occurred in Minnesota and the balance in Wisconsin. Possibly hunting pressure was greater in Minnesota than Wisconsin. In calculating the number of local ducks shot in Wisconsin, we used 50 percent of the annual shooting loss.

Species composition of Wisconsin's duck kill shows that 32–40 percent of the birds bagged consist of species breeding largely outside Wisconsin and 60–68 percent are species commonly breeding in Wisconsin (Table 83). Exactly what portion of the kill is made up of local breeders and their young depends upon the relative volume of annual duck production and harvest in Wisconsin (Table 84). The estimated contribution ranges from a little over 3 percent, in a year of low production and large kill, to about 18 percent, in a year of high production and small kill (Table 85). Since 32–40 percent of the kill is contributed by species breeding largely outside Wisconsin, 42–65 percent of the harvest must be produced outside Wisconsin by species recognized as major breeders in the state (mallard, blue-winged teal, wood duck, black duck, and ring-necked duck).

Both the production and the kill figures used here are biased to an unknown degree. Surveys of breeding ducks were conducted using nonrandomized sampling procedures. Annual harvest figures for most years were derived by expanding vol-

TABLE 81

First-Year Recoveries of Ducks Banded in Wisconsin From May Through August, 1947–59*

Source and Species	Age	Number of Recoveries	Percent of Recoveries: Within 20-Mile Radius of Banding Site	Percent of Recoveries: Balance of Wisconsin	Percent of Recoveries: Outside Wisconsin
Horicon Marsh					
Mallard	Adult	16	31	19	50
Mallard	Immature	116	37	30	33
Black duck	Adult	7	57	29	14
Black duck	Immature	43	33	40	27
Blue-winged teal	Adult	7	29	14	57
Crex Meadows					
Mallard	Immature	74	20	12	68
All Sites					
Mallard	Adult	16	31	19	50
Mallard	Immature	196	31	24	45
Black duck	Adult	8	50	25	25
Black duck	Immature	44	32	39	29
Blue-winged teal	Adult	7	29	14	57
Blue-winged teal	Immature	5	0	40	60
Wood duck	Adult	6	17	0	83
Wood duck	Immature	18	28	0	72
Grand Total and Mean		300	31	24	45

* The hunting season opened between October 1 and 15 during the years of recovery (1947–60).

untary hunter reports to 100 percent estimates. The values presented should be recognized only as the best now available to establish the general magnitude of the importance of local ducks in the Wisconsin duck kill.

A range in breeding duck density was used throughout the calculations. Based on the consistently small number of ducks observed on aerial and ground surveys and on general observations of the breeding duck population in all parts of the state, we believe Wisconsin's breeding duck density averages less than 5 ducks per square mile under "normal" water conditions. Since the Wisconsin breeding duck population density is generally low, as compared to densities recorded in the prime, prairie breeding grounds (Fig. 21), visibility biases associated with high duck density (Anderson, 1953) are believed minimal.

Accuracy of the breeding duck population estimate would be improved by employing a sampling design stratified on the basis of quality of aquatic habitat and surrounding land use. Such a plan could be used to refine values for both duck density and breeding success. Breeding success may vary between areas as the result of differential effects of farming practices, predation, and other mortality factors. For example, in agricultural areas, where hayfields are heavily used for nesting, the percentage of hens successful in rearing a brood may be reduced, especially when the mortality of females due to mowing is relatively high. Where raccoons, skunks, opossums, and crows are abundant in duck breeding habitat, nesting success is expected to be reduced. Survival of broods may be low in large areas (as townships) lacking deep marshes. Only with more refined production studies can the breeding density and breeding success figures become more precise. Whether more precision is needed must be determined jointly by administrative, management, and research personnel.

In evaluating the need for more precise production figures, it must be recognized that even if the size of the Wisconsin breeding duck population was 10 ducks per square mile, the contribution of locals to the state kill would, at most, be only slightly over one-third (36 percent) in a year when a small (454,000) kill was registered. With similar production, the contribution of local ducks would be 22 percent with an average kill (750,000) and 15 percent with a large kill (1,080,500). A breeding population of slightly more than 14 ducks per square mile would be required to have local ducks make up one-half of the Wisconsin duck harvest in a year when the kill is small (454,000). Approximately 33 ducks per square mile would be needed to have locals make up 50 percent of the kill in a year of large harvest (1,080,500), and 23 ducks per square mile would be needed in a year of average kill (750,000).

Existing average (750,000) and high (1,080,500) yearly duck kill estimates are excessive. These figures are based on voluntary hunter reports expanded to 100 percent. Such reports are known to be exaggerated by response biases (Atwood, 1956). The low (454,000) kill estimate resulted after

TABLE 82

First-Year Recoveries of Ducks Banded on the Breeding Grounds*

Species	State or Province Where Banded	Years Banded	Recoveries		Reference
			Total Number	Percent in State or Province	
Mallard	Alberta and Sask.	?	272	25	Hickey, 1951
Mallard	Saskatchewan	1954–55	320	35	Low, 1957
Mallard	South Dakota	1954–55	165	45	Murdy and Anderson, 1956; Anderson and Robbins, 1957
Mallard	North Dakota	1954–58	158	54	Schroeder, 1961
Blue-winged teal	North Dakota	1954–58	244	16	Schroeder, 1961
Blue-winged teal	South Dakota	1954–55	251	34	Murdy and Anderson, 1956; Anderson and Robbins, 1957
Blue-winged teal	Minnesota	1954	58	86	Lee *et al.*, 1954
Wood duck	Eastern U. S.	1959–60	96	47	Kaczynski and Geis, 1961
Pintail	South Dakota	1954–55	83	29	Murdy and Anderson, 1956; Anderson and Robbins, 1957
Pintail	North Dakota	1954–58	83	41	Schroeder, 1961
Gadwall	North Dakota	1954–58	96	39	Schroeder, 1961
Gadwall	South Dakota	1954–55	72	40	Murdy and Anderson, 1956; Anderson and Robbins, 1957
Redhead	North Dakota	1954–58	82	35	Schroeder, 1961
Redhead	South Dakota	1954–55	32	38	Murdy and Anderson, 1956; Anderson and Robbins, 1957
Redhead	Minnesota		61	66	Lee *et al.*, 1954
Canvasback	North Dakota	1954–58	57	18	Schroeder, 1961
Canvasback	South Dakota	1954–55	20	20	Murdy and Anderson, 1956; Anderson and Robbins, 1957
Shoveler	South Dakota	1954–55	22	41	Murdy and Anderson, 1956; Anderson and Robbins, 1957
Shoveler	North Dakota	1954–58	45	42	Schroeder, 1961
Am. widgeon	North Dakota	1954–58	22	32	Schroeder, 1961
Am. widgeon	South Dakota	1954–55	5	(4)	Murdy and Anderson, 1956; Anderson and Robbins, 1957
Ring-necked duck	Minnesota	1954	23	52	Lee *et al.*, 1954
Lesser scaup	North Dakota	1954–58	18	(11)	Schroeder, 1961
Green-winged teal	North Dakota	1954–58	3	(0)	Schroeder, 1961
Green-winged teal	South Dakota	1954–55	1	(0)	Murdy and Anderson, 1956; Anderson and Robbins, 1957
Ruddy duck	North Dakota	1954–58	2	(1)	Schroeder, 1961
Ruddy duck	South Dakota	1954–55	1	(0)	Murdy and Anderson, 1956; Anderson and Robbins, 1957
Mainly mallard, blue-winged teal, ringneck, redhead, and pintail	Minnesota	1954	123	67	Lee *et al.*, 1954
All Species		—	2,415	35.4	

* Practically all ducks considered here were banded as flightless immatures.
( ) Number of recoveries are given where total recoveries are less than 20.

making corrections in hunter reports for response biases (Atwood and Wells, 1960n).

Despite the biases involved in some of the production and harvest figures, we believe the general magnitude of the contribution of local ducks to the Wisconsin duck kill is indicated by this analysis. The maximum contribution is estimated by combining a large breeding density (5 ducks per square mile) and a low kill (454,000). When the breeding population is at this level, the contribution in a given year would be less as the kill increased. Since the kill of 454,000 was corrected for response biases and was registered in a year (1959) when a closed season was maintained for canvasback and redhead, the general magnitude of the maximum contribution of local ducks to the annual, Wisconsin duck harvest seems fairly well established.

From the evidence discussed here, we conclude that yearly duck production in Wisconsin from 1948 to 1960 apparently made up less than 10 percent of the annual, state duck kill in a year of low production, and less than 20 percent in a year of high production.

TABLE 83

Species Composition of Wisconsin Duck Breeding Population and Hunting Kill*

Species	Breeding Population (Average 1948–56)	Kill Reported By Hunters (1959)	Kill From Wing Collection (1959)	Kill Reported By Hunters (1960)
Major Wisconsin Breeders				
Mallard	29.6	36.5	28.9	46.0
Blue-winged teal	46.2	12.7	12.0	10.9
Wood duck	4.0	5.9	6.3	6.8
Black duck	3.8	4.5	6.4	1.1
Ring-necked duck	8.5	1.4	6.6	3.0
Subtotal	92.1	61.0	60.2	67.8
Largely Non-Wisconsin Breeders				
Green-winged teal	0.3	11.6	9.0	9.8
Lesser scaup	Tr.	11.2	14.1	8.6
American widgeon	2.2	3.6	5.1	4.5
Pintail	1.2	3.4	3.0	3.5
Common goldeneye	—	1.8	1.0	1.5
Canvasback	Tr.	1.4	1.0	Tr.
Bufflehead	—	1.2	2.3	0.6
Mergansers	0.9	1.1	1.0	0.8
Shoveler	0.9	1.1	0.3	1.2
Redhead	1.6	1.0	0.9	Tr.
Gadwall	0.5	0.8	0.2	0.5
Ruddy duck	0.3	0.6	0.8	1.0
Scoters	—	0.2	0.0	—
Others	—	Tr.	1.1	0.2
Subtotal	7.9	39.0	39.8	32.2

* All columns are based on over 1,000 total ducks. Breeding population figures are from Table 9 of this report; 1959 kill figures are from Geis and Carney (1961a:77); 1960 kill figures are from Atwood and Wells (1961:47).

Harvest Principles

While it is dangerous to generalize, the relationships between duck population level, behavior of the birds, hunter density, hunter success, and seasonal distribution of the kill appear so clear to us that an attempt is made here to state the principles involved. The principles presented here apply largely to areas open to unlimited numbers of hunters.

When the hunting season opens in early October in Wisconsin, (1) duck populations are at relatively low levels except for the blue-winged teal and wood duck which are either approaching or are at peak levels, (2) ducks are distributed in hunting as well as nonhunting areas and have, prior to the hunting season, established habits of using the areas, (3) on the opening 2 or 3 days the greatest number of hunters are afield for the season, (4) hunter success on the opening day is usually highest for the entire season, and (5) approximately 25 to 50 percent of the total season's duck kill occurs on the first 2 days. Later during the season, after ducks have been exposed to shooting for a period of time, (1) ducks are largely found in areas offering protection and have established habits of using these areas, (2) hunting pressure is greatly reduced on many days, compared to the opening few days, (3) peak numbers of ducks are present in the state, and (4) daily hunting success does not exceed the high success registered on the opening day. These facts can only be explained by the behavior of the ducks themselves.

Early in the season ducks are very vulnerable to shooting, largely because they are found in hunting areas and have not learned to react to shooting. Low-flying habits of the blue-winged teal and wood duck help contribute to the hunters' high success on the first few days of the season. After exposure to hunting for 1–3 days, the ducks redistribute themselves and are located in areas providing protection, whether they be lakes of adequate size, established refuges, or areas where there is very light or no hunting pressure. This is a learned behavior pattern. New migrants join the concentrations of ducks located in areas offering protection and furnish hunting opportunities on the dates of their arrival as they maneuver to join other flocks. This is a decoying behavior pattern of new arrivals. Daily, learned habits of the "resident" birds are assumed by the new migrants. This is a contagious behavior pattern. Because of it, hunter success does not increase proportionately with an increase in duck numbers. Daily feeding flights of ducks provide some shooting opportunities. However, the lesson of where not to go is relearned by the ducks

each day as they radiate out to feed. Survivors apparently pass the information on to new migrant birds through their actions on succeeding days. Adverse weather conditions, such as snow storms or strong winds, can make the "educated" ducks more vulnerable because they (1) are confused, (2) fly at lower altitudes, or (3) are blown off their regularly used local course.

Elimination of hunting for a few days again permits ducks to land, feed, and rest in open-hunting areas. This was seen in 1948 in Wisconsin when the waterfowl hunting season was closed from October 30 to November 4 in forest protection districts to meet an extreme forest fire hazard. Ducks exert an effort to redistribute themselves daily when making local feeding flights. Removal of hunting pressure permits the birds to accomplish redistribution. After becoming redistributed they are again vulnerable to shooting on subsequent days that hunting takes place. This behavior, we believe, explains the high kill of ducks that occurred during seasons when "rest days" were held (Hickey, 1952:153).

Hunter density also affects hunting success. With light concentrations of hunters, ducks can make repeated swings over the decoys and are permitted to come well within killing range or are even allowed to alight in the decoys before firing. Thus, average hunter success is generally higher where numbers of hunters are purposefully limited or on those days when few hunters are afield. With high concentrations of hunters on days after the opening, birds radiating out to feed are reluctant to swing the decoys and are discouraged from flying at low altitudes. Competition for shots at ducks becomes keen as the concentration of hunters increases. Individual hunter success is lower and crippling loss of ducks increases. Hunter safety beomes an increasingly important problem. High shooting further educates the surviving ducks. With reduction of hunting pressure on succeeding days, hunter success again increases. Adequate space is the key factor required to maintain quality duck shooting. There is no substitute.

TABLE 84

Estimated Size of Wisconsin's Yearly Breeding Duck Population and Duck Harvest

Item	Minimum	Maximum	Source or Condition
Size of breeding duck population, May 1949–50	133,500	280,500	Table 27
Total local duck population on October 1	350,600	736,800	Table 27; adults plus young
Size of duck kill, 1948–60*	454,000	1,080,500	——

* Kill figures in this table are rounded to the nearest 500 and include ducks bagged and those knocked down and lost. Kill figures from 1948 through 1958 are based on voluntary hunter reports and are from unpublished records of the Wisconsin Conservation Department; figures for 1959 and 1960 are from Atwood and Wells (1961: 47). The estimated annual duck bag for 1948–58 was enlarged by 25 percent to allow for crippling loss.

TABLE 85

Calculated Contribution of Local Ducks To Wisconsin's Annual Duck Harvest*

Species	Percent of Breeding Population (Table 9)	State Shooting Rate**	With Low Production		With High Production	
			No. Local Ducks	No. Killed in State	No. Local Ducks	No. Killed in State
Blue-winged teal	46.2	5%	162,000	8,100	340,400	17,000
Mallard	29.6	20%	103,800	20,800	218,100	43,600
Ring-necked duck	8.5	10%	29,800	3,000	62,600	6,300
Wood duck	4.0	10%	14,000	1,400	29,500	3,000
Black duck	3.8	20%	13,300	2,600	28,000	5,600
Other species	7.9	10%	27,700	2,800	58,200	5,900
Total	100.0	——	350,600	38,700	736,800	81,400

Local ducks killed, as percent of total kill:	With Low Production	With High Production
In year of small kill (454,000)	8.5%	17.9%
In year of average kill (750,000)	5.2%	10.9%
In year of large kill (1,080,500)	3.6%	7.5%

* All nonpercentage figures are rounded to the nearest 100.

** The state shooting rate represents one-half of the following average annual shooting rates: blue-winged teal, 10 percent; mallard and black duck, 40 percent; all other species, 20 percent.

Summary

Characteristics of the waterfowl harvest were studied in Wisconsin from 1947 through 1958. Data were secured by contacting hunters at check stations and through diaries submitted by a sample of the more successful duck hunters.

Wisconsin is an important waterfowl hunting state. From 1948–60, over 100,000 duck stamps were sold annually. Between 1934 and 1960, Wisconsin ranked as high as second and never lower than sixth in the sale of duck stamps in the United States, and third in 20 of 27 years in the Mississippi Flyway states. Duck stamp sales are centered in southeastern Wisconsin, where the best quality, waterfowl migrational habitat and the human population are concentrated.

Approximately 6 percent of Wisconsin's male population 12 years of age or older hunted waterfowl in 1955. Between 1940 and 1955, waterfowl-hunting pressure increased at a greater rate than the human population. During the late 1950's, duck stamp sales declined. Future trends in numbers of waterfowl hunters are not expected to parallel the anticipated increase in the human population. Lack of suitable space for hunting will limit opportunities for good quality hunting.

On some Wisconsin public hunting areas open to unlimited numbers of hunters, hunting pressure is excessive. Disturbance, resulting from sheer numbers of hunters going to their shooting sites, causes ducks to abandon choice, but unprotected, feeding and loafing areas. Under crowded conditions the quality of wildfowling reaches minimal levels, hunter safety becomes a real problem, and many hunters are discouraged. Congested conditions cause experienced duck hunters to abandon the sport.

A definite pattern of hunting effort was correlated with certain days of the hunting season. Peak numbers of hunters were afield on the opening 2 or 3 days of the season and on subsequent week ends. This pattern held for seasons ranging in length from 30–70 days. By opening the waterfowl hunting season on any of the first 4 weekdays, the extreme hunting pressure experienced with a Saturday or Sunday opening could be avoided. Wisconsin duck hunters hunted ducks on the opening day, regardless of whether or not hunting seasons on other species opened on the same date. Within full days, more waterfowl hunters were afield in the morning than in the afternoon.

No consistent relationship exists between the length of the Wisconsin waterfowl hunting season and hunting effort. With season lengths of 30 to 55 days, between 1/5 and ½ of the total season's hunting effort occurred during the first 7 days. Limited data suggest that hunting effort during the first week is greatly reduced during seasons of 70 days. Extension of waterfowl hunting seasons beyond 60 days (October 1–November 29) benefits relatively few hunters in Wisconsin. Normal winter weather conditions after December 1 limit the duck and coot supply, as well as hunter activity.

The kill and population level of ducks and coots are not correlated. Between 1/5 and ½ of the total season's kill of ducks, and approximately 2/3—¾ of the coot kill, takes place at many areas during the first 7 days of the season.

In Wisconsin, the daily bag limit had its greatest effect in limiting and distributing the duck kill (1) on the first 2 days of the season and (2) on areas supporting reasonably high duck populations and having light hunting pressure. Daily bag limits of 4 were secured on an average of 13–17 percent of 52,823 hunter trips. At full-season check stations, a maximum average of 4 percent of the bag limits consisted of single species. The bulk of the ducks were bagged as combinations of species.

At two major coot concentration areas, only 1–7 percent of the potential number of daily bag limits of coots was registered. Daily bag limits on coots could assume more importance in the future if (1) hunters took home all coots they shot, and (2) hunters shot the birds which they now allow to swim around their blinds well within killing range.

During a closed season, the kill of wood ducks was reduced by hunters (1) exerting greater effort to identify ducks before shooting, (2) calling "wood duck—don't shoot", (3) avoiding hunting certain habitat types, such as streams, and (4) reporting fellow hunters shooting wood ducks to conservation wardens.

Reported duck crippling losses averaged 21 percent for public hunting areas, 22 percent for all types of hunters, and 13 percent for a select group of more successful hunters, When hunting pressure was greatest, reported duck crippling losses were highest. Under crowded conditions, crippling reports were believed to be exaggerated to an unknown degree. For a select group of hunters, the duck crippling loss during the "gray" half-hour preceding sunrise and the period of dusk preceding sunset was the same as during daylight hours.

Pass shooting, when ducks are probably shot at the highest altitudes, resulted in a crippling loss of 22 percent, the highest loss for three main types of duck hunting (pass, jump, blind and decoy). Dogs effectively reduced duck crippling losses.

Crippling loss of the coot averaged 5 percent for the same hunters reporting an average 13–21 percent duck crippling loss. Differences in behavior between coots and most ducks unquestionably explain the difference in crippling loss.

To reduce crippling loss, hunters should (1) use a dog while hunting, (2) shoot only when the birds are within effective killing range, and (3) maintain sufficient space between hunting parties to allow birds to work in close.

Puddle ducks made up more than 90 percent of the bag on the first few days of Wisconsin waterfowl hunting seasons, 1948–57. Blue-winged teal, mallard, green-winged teal, American widgeon, black duck, pintail, and ring-necked duck represented 88–98 percent of the bag. Blue-winged teal and mallards made up ½–¾ of the kill. Blue-winged teal made up a significant part of the Wisconsin duck bag on the first few days of seasons which opened in early and mid-October. Coots made up an average of about one-third (30 percent)

of the combined kill of ducks and coots on the first few days in years when the season opened in early October, and one-half (54 percent) of the kill in years of mid-October openings.

Aquatic fowl are wasted in Wisconsin during open and closed seasons. In open seasons, coots are shot for target practice and are left in the field. In 1959, this loss was estimated to be 31 percent of the 36 percent unretrieved coot kill reported statewide. In closed seasons, wood ducks are shot accidentally by hunters unable or unwilling to identify ducks before shooting.

The hunting radius of many Wisconsin duck hunters is between 10 and 30 miles. Some hunters travel within an approximate 90-mile radius, and a few hunters travel 300 or more miles to hunt ducks. Few nonresident hunters hunt ducks and coots in Wisconsin.

Bagged ducks most frequently misidentified by Wisconsin hunters include the black duck, blue-winged teal, scaup, ring-necked duck, and wood duck. Only 48 percent of 122 hunters properly identified a dead, female wood duck handed to them. Mallards, coots, canvasbacks, and redheads are among the species identified best by hunters.

Fourteen different types of waterfowl hunting violations were handled in Wisconsin between 1955–57. Shooting before and after daily shooting hours, unplugged or improperly plugged guns, and violations involving a closed season made up over one-half (58 percent) of all infractions.

Opening the waterfowl hunting season on the first few days of October is not limiting the local, Wisconsin, breeding duck population, with the possible exception of the wood duck. Establishing refuges in Wisconsin for the specific purpose of reducing hunting mortality on local breeding populations of blue-winged teal and mallards does not seem warranted. Local and long-distance flights of the birds defeat successful accomplishment of the objective.

Refuges are needed in fall in Wisconsin to protect ducks from excessive disturbance caused by shooting pressure and motor boats. Refuges can be used to encourage some species to remain in the state longer than on nonrefuge areas, and to improve the distribution of the birds. Success of a refuge is enhanced by locating it on a major, migratory flight lane, and where an abundance of preferred food is readily available. Stubble-feeding species, especially the mallard and black duck, furnish hunting opportunities as they radiate out from protected areas to feed.

Restricting the daily closing hour on waterfowl hunting in Wisconsin to 4:00 p.m. in 1956 and 1957 was not of major consequence in permitting more ducks to utilize aquatic and upland foods. However, in certain localities, the early closing hour (1) permitted ducks to make greater use of natural foods and waste grains in harvested agricultural fields, and (2) reduced the waterfowl kill slightly because hunters could not shoot immediately preceding sunset, a time when many ducks are very active locally.

At the Horicon National Wildlife Refuge, the greatest adjustment by mallards and black ducks to initial, heavy, shooting pressure was the reduction of their local feeding radius to the refuge where agricultural food was available.

Open-water shooting in Lake Superior, Lake Michigan, and certain counties along the Mississippi River provide hunting opportunities for small numbers of hunters.

Shooting waterfowl in Wisconsin during the first 9 days of December did not adversely affect the number of mallards and black ducks using Turtle Creek the following January.

From 1948–60, the contribution of local ducks to Wisconsin's duck harvest was estimated at 9 percent of the annual, state duck kill (454,000) in a year of low production and 18 percent in a year of high production.

Based on relationships established between duck population levels, behavior of the birds, hunter density, hunter success, and seasonal distribution of the kill, duck harvest principles are presented for areas open to unlimited numbers of hunters.

PART IV. IMPLICATIONS FOR DUCK AND COOT MANAGEMENT AND INVESTIGATIONS IN WISCONSIN

There are two fundamental divisions of a waterfowl management program: (1) establishing hunting regulations in relation to the status of species and effectively enforcing the regulations, and (2) managing habitat to meet preferences and requirements of seasonal waterfowl populations. In this section we combined information presented in previous parts of this report with material from the literature to formulate management recommendations. These recommendations are aimed at providing game managers and conservation wardens with a set of guidelines that will aid them in developing hunting regulations and in managing habitat for ducks and coots. This summary should also provide background information of value to conservation administrators and the interested public. Some facts are lacking. They can, however, be secured through research. Items for future investigations are outlined.

Throughout the following discussion, we stress the importance of applying specific management procedures to meet established objectives aimed at satisfying needs of seasonal waterfowl populations (breeding, migrating, and wintering). We call this management principle *multiple use by priority*. With conflicting activities exerting increasing demands on important waterfowl areas, a system of priorities is definitely needed to maintain habitat attractive to waterfowl.

A general multiple-use policy is inadequate many times for guiding activities on waterfowl areas. Fieldmen become frustrated in trying to implement such a policy on the land and water. They attempt to meet numerous program goals and end up not satisfying any of them completely. Too frequently primary objectives under a general multiple-use policy are established without considering the capabilities of the land and water to supply seasonal needs of waterfowl. Mendall (1958:245) stated that general multiple-use policies often "... appear erroneous, and might well be discontinued on such areas in the northeast where the establishment of maximum breeding populations of waterfowl is desired." The situation in Wisconsin is similar to that in the northeastern United States.

We firmly believe that multiple use by priority is the answer to fitting certain phases of waterfowl management into a total land- and water-use program. We also believe that as long as management is geared to the status and welfare of waterfowl populations and is aimed at benefitting all people alike, instead of select groups, a variety of management practices and procedures can be applied when needed. A basically sound management program will gain public support through benefits provided from its operation.

Essentially there are three major problems facing the waterfowl management program in Wisconsin and most other similar geographic areas:

1. Preserving and developing suitable breeding habitat to maintain and, if possible, increase the production of ducks and coots.
2. Maintaining and creating high quality aquatic food and cover conditions and, where necessary, providing protection needed to attract, distribute, and accommodate optimum numbers of ducks and coots during fall migration. Since many of the aquatic sites used by the birds in fall are also used in spring, especially in the southern one-half of Wisconsin, we assume that the habitat maintained for fall migrants will meet the needs of spring migrants.
3. Establishing hunting regulations that safeguard the survival of each species and that provide sufficient space needed for hunters to enjoy wildflowing under conditions that offer quality recreation.

General guidelines for helping to solve these problems in Wisconsin are outlined below. No suggestions concerning wintering duck and coot populations are offered because Wisconsin lies north of the 32°F. winter temperature line, above which additional waterfowl should not be encouraged to winter.

◀ Photo by J. M. Thompson, U.S. Fish and Wildlife Service

Management Guidelines

Guidelines for Breeding Populations

The challenge facing Wisconsin game managers is to maintain and expand the nucleus of breeding ducks and coots in face of increasingly intensive land- and water-use activities. Expanding forestry, agricultural and recreational programs and development of natural plant succession beyond the early herbaceous and grassy stages are eliminating breeding ducks and coots from more acreage annually. Habitat restoration efforts are not balancing the ledger. To fit into the land and water uses, management for breeding ducks and coots can most profitably be carried out according to the following general guidelines.

1. Statewide, to protect the existing nucleus of breeding ducks and coots, continue to open the general waterfowl hunting season not earlier than October 1. A special 5- to 10-day early September season on blue-winged teal has been suggested in the past and is being considered for the Mississippi and Central Flyways for 1965–66. Since many blue-winged teal leave Wisconsin between September 15 and 25, to be most successful the season would have to be held during the first 15 days of September. Such a season would be questionable management in Wisconsin because (1) approximately 10–20 percent of the local duck and 65 percent of the local coot broods would be flightless and would not develop flight powers until after September 1, (2) accidental shooting of other species could be high, since blue-winged teal occur in the same aquatic areas used by other species, and (3) the accidental kill of wood ducks, a species very vulnerable to shooting, could be high because large numbers of wood ducks are present.

   A special season in late September (20–30) for blue-winged and green-winged teal could be tried on an experimental basis in designated areas. Sites where only teal concentrate would provide the best potential places for trying the special season when the status of the species warrants it. Or, if hunters would identify species before they shot, a statewide teal season would be possible. Only an experimental season evaluated objectively will reveal all management problems and possibilities under existing conditions.
2. In forested areas, maintain the beaver population at as high a level as possible without causing undue economic damage to roads, railroads, and other public and private property. Impoundments created by these "biological engineers" provide some species of ducks, particularly the mallard, black duck, blue-winged teal, and wood duck, with suitable breeding sites. Brood production per unit of this aquatic habitat is, at times, comparable to duckling yields from other good quality duck-breeding habitat.
3. Statewide, for upland-nesting puddle ducks, use fire to maintain herbaceous and grassy nesting cover adjacent to shallow water areas having suitable aquatic escape cover and plant and animal foods. Where sites for territorial ducks are abundant, such as where clusters of small (1–10 acres) shallow water areas occur, the margin of grassy vegetation should radiate out at least 100 and up to 220 yds. from the shorelines.
4. In agricultural areas, primarily for upland nesting puddle ducks, encourage grazing to a degree that suitable upland nesting and aquatic escape cover is maintained. Overgrazing that results in a denuded "golf green" appearance of uplands, heavily trampled shorelines, and grazed aquatic nesting and escape cover should be avoided (Bennett, 1938:97). Under completely undisturbed conditions, dense stands of vegetation on shorelines and uplands decrease the suitability of water sites for breeding ducks (Sowls, 1955:70; Bue, Blankenship and Marshall, 1952; Keith, 1961:49).
5. Statewide, for cavity nesters, especially the wood duck, encourage the maintenance of suitable hollow trees within a 440-yd. strip on either side of streams and other water areas, especially where a nucleus of breeding wood ducks exists. This feature should be worked into timber management plans to provide a continuing supply of nesting cavities.
6. Statewide, on waterfowl management areas where the primary objective is to accommodate a maximum breeding duck population, human activities should be regulated from March 15 through September 30 to hold disturbance to a minimum. Motor boating should be prohibited, fishing permitted only in designated sites, and sight-seeing restricted to certain routes. Even the best habitat will be utilized lightly, if at all, by breeding ducks and coots where human disturbance is excessive.
7. In forested areas, for the ring-necked duck, the only important diving duck nesting in Wisconsin, two items should be considered by management to maintain and possibly further encourage breeding: (1) Hold human disturbance on ring-necked duck breeding areas to an absolute minimum. Ringnecks are believed to be intolerant of human disturbance during the period of nest site selection (Mendall, 1958:206). (2) Encourage continued existence of islands of floating vegetation in open water. This is one type of nesting cover frequently used by ringnecks.
8. When planning small shallow impoundments for duck production, encourage development of clusters of water areas, rather than isolated single units, whenever possible. A variety of types of water areas located in close proximity to each other form a community of water types and provide a maximum amount of shoreline—two features needed to realize top production of territorial ducks.

Based on 12 years of experience, New York formulated suggestions on the size and shape for constructing small marshes for waterfowl (Bradley, 1960). Larger sized (5– to 10-acre average) areas with irregular shapes and having desired cover patterns are generally preferred to smaller units (under 5 acres) with regular round or oval shapes and with little or no emergent cover. Approximately 80 percent of New York's marshes built between 1949 and 1955 attracted breeding ducks at the rate of 40 pairs per 100 acres (Benson and Foley, 1956). Four species—the mallard, black duck, wood duck and blue-winged teal—used the water areas. Similar use of man-made marshes can be anticipated on newly flooded, small marshes in limestone and lacustrine clay areas in Wisconsin. Duck-use of older impoundments will decline (Benson and Foley, 1956), especially if water levels remain rather constant. Whenever possible, construction plans should include features to permit purposeful manipulation of water levels.

9. Encourage farm pond construction under various agricultural programs. Ponds installed primarily for retarding flood waters, reducing soil erosion damages, and providing livestock with water secondarily accommodate ducks in the breeding season, as well as during migration. Such ponds are desired by many landowners and fit into an overall land-use program. Upland nesting cover should be maintained or established, where possible, adjacent to or near each pond to help insure duck-nesting success. Construction design of ponds should provide for some surface water in summer to insure brood survival.
10. Encourage excavation of filled lake and marsh basins having the water table close to the soil surface and adequate nutrients for growth of waterfowl food and cover plants. A variety of techniques are available to create open water. Bulldozers, draglines, and blasting agents, such as ammonium nitrate (Mathisen, Byelich and Radtke, 1963), are effective. Adding openings to sedge meadows with water tables near the soil surface offer some of the best possibilities for creating waterfowl habitat in Wisconsin. Wet soils perpetuate stands of sedges, which provide nesting cover for ducks. Where moisture conditions are optimal, costs should be minimal to maintain herbaceous and grassy nesting cover adjacent to or near open water.

Game managers may eventually apply these guidelines to all suitable lands under government control. But use of lands and waters on the much larger uncontrolled acreage in Wisconsin will continue to adversely affect breeding duck and coot populations. Presently, hunting and other recreational opportunities for Wisconsin citizens are provided largely by waterfowl produced outside the state. We anticipate that this situation will continue in the future. The best way to assist in insuring a continued supply of ducks and coots is to help maintain and develop breeding habitat in as many areas as possible in North America, especially in grassland and parkland areas.

In many pothole areas in north central United States and in Canada, preferred grassy nesting cover is produced naturally. Maximum edge is provided to meet territorial requirements of ducks. Escape cover is available. Disturbance by man is minimal, and grain farming is carried out intensively around some surface water areas without eliminating breeding ducks. The ultimate solution to preserve optimum numbers of North American ducks and coots is to maintain the most productive breeding habitat requiring the least amount of maintenance. Potholes located in grassland areas meet this requirement. High duck production occurs when surface water conditions are adequate. All states must support efforts to maintain these main duck production centers. Investments in such areas help insure adequate dividends (duck-day use) from existing migration and wintering habitat (Schrader, 1955; Hawkins *et al.*, 1958).

The problem of preserving pothole-type duck and coot breeding habitat is complex (Shaw and Fredine, 1956; and many other authors). The potholes exist in a matrix of privately owned agricultural lands. At this time no way, except outright purchase or lease by government, is available to encourage an individual landowner to maintain small shallow-water areas on his farm. If he is personally interested in hunting or in the aesthetic values of the water areas, he may not drain or fill potholes. Basically, preservation of these small water areas located on private lands in the northern plains states and prairie provinces of Canada is an economic problem, not a biological one. The individual landowner is interested in a reasonable standard of living, just as is everyone else. Potholes having soils of good agricultural capabilities are drained to provide land to develop an efficient economic farming unit that will yield a cash income. Many potholes have soils of good cropping capabilities. Unless an economic incentive is developed to encourage farmers to raise ducks and coots, many potholes will disappear in the future. Preservation of potholes is a challenge that must be met if the sport of wildfowling is to be maintained in the future on the level of the 1950's.

A service payment to landowners definitely seems necessary to preserve existing key duck breeding areas located in cropland areas. Such a payment is not a subsidy. Rather, it is made to recognize the service rendered by individual landowners in producing a public owned crop of waterfowl. Because of their unique migratory habits, waterfowl distribute themselves over many areas of North America far beyond the breeding grounds. Therefore, dividends from investments in breeding habitat often are larger than anticipated. Waterfowl and the habitat they utilize help bring people in close contact with basic resources. Recreational activities associated with the birds stimulate the economy in many areas of North America. These noteworthy values are of considerable importance to society.

Guidelines for Fall Migrants

Management of fall duck and coot populations in Wisconsin largely consists of (1) maintaining and developing suitable habitat for the birds, and (2) providing protection from disturbance. Most of the important aquatic sites now used by each species is known. The next step is for game managers, fish managers, conservation wardens, and other conservationists to encourage the use of practical methods to maintain and develop environmental conditions suitable to the birds.

Maintaining and Developing Suitable Habitat: Throughout Wisconsin, maintenance of particular plant communities providing the most suitable environmental conditions for ducks and coots is a continuing operation. Grazing, mowing, burning, and fluctuating water levels are techniques that have been used to discourage establishment of woody plant communities through natural plant succession. Intensive management of the habitat in waterfowl management areas is essential, if optimum conditions for waterfowl are to exist on a sustained rather than a temporary basis. Practical procedures for maintaining habitat for different groups of ducks are outlined below.

1. For diving ducks and nonstubble-feeding puddle ducks, practical techniques for maintaining aquatic foods include (1) preventing pollution, (2) controlling carp, (3) minimizing siltation, (4) minimizing chemical and mechanical control of aquatic plants in designated sites, (5) preventing drastic fluctuations of water levels at critical times during the growing season when the habitat is being managed to produce submerged aquatic plants, and (6) employing drastic seasonal manipulation of water levels to encourage maximum production of moist-soil plants (such as smartweeds, millets, and beggarticks). Co-operative approaches with public agencies, private industries, and individuals are desirable in carrying out such activities. Pollution control and watershed development projects aimed at minimizing wind and especially water erosion of soils are efforts requiring greater attention to maintain optimum food conditions in many aquatic sites. Such soil and water management is extremely important in the agricultural region of Wisconsin, where the greatest number of the state's duck and coot concentration sites are located.
2. For stubble-feeding ducks, namely the mallard, black duck, and pintail, an effective technique is to make preferred grains, such as buckwheat, corn and other small grains, available within a maximum 15-mile radius of aquatic roosting sites and along daily feeding-flight routes. Flooding the food with shallow water (between 3 and 15 inches) will make it even more attractive. This type of management will encourage more birds to remain for a longer period of time.

With the constant shrinkage in quantity of aquatic habitat suitable for ducks and coots, there is an increasing need to develop intensively some of the remaining habitat to yield maximum quantities of preferred foods. Since the quality of the substrate and water varies from very poor to very good in Wisconsin, efforts aimed at creating or improving aquatic habitat to provide an abundance of preferred foods for ducks and coots should follow one of two avenues. For either approach, an adequate supply of water must be available.

1. Where substrate and water fertility are favorable, water levels can be managed to encourage stands of submerged and emergent aquatic plants that provide preferred foods for ducks and coots.
2. Where the substrate and/or water fertility are unfavorable, water levels should be manipulated seasonally. A summer drawdown encourages establishment of volunteer or seeded crops of preferred moist-soil food plants. Flooding in late summer or early fall places the mature crop in a favored shallow-water-feeding condition. Under such management, quantity, not quality, of water is the key to success. Whether or not the water is clear, dark stained, or silted is of little concern.

For details concerning the relationships between environmental factors and growth of aquatic plants in certain parts of North America, see McAtee (1939), Martin and Uhler (1939), Bellrose (1941), Moyle (1945), Moyle and Hotchkiss (1945), Grainger (1947), Griffith (1948), Sharp (1951), Addy and MacNamara (1951), Uhler (1956), Martin, Erickson, and Steenis (1957), and Kadlec (1962). General information on Wisconsin aquatic plant communities is given by Curtis (1959). Management recommendations for certain flowages in northern and central Wisconsin are presented by Swindale and Jahn (1956).

Providing Protection from Disturbance: Protection should be provided to ducks on aquatic areas offering daily food and water requirements for the birds, but where disturbance prohibits the birds from using these resources. Simply stated, it means reducing or eliminating those activities that greatly disturb waterfowl. Motor boating and hunting are the two main activities involved. Our experiences with over 45 important waterfowl closed areas in Wisconsin have emphasized one important point—each site where a closed area is contemplated must be evaluated on its own merits. Food conditions, land-use practices employed in the vicinity of the project, anticipated hunting problems, and local habits of the birds must be considered. Based on experiences in Wisconsin, guidelines for establishing closed areas for waterfowl have been presented (Jahn, Hopkins, and Jordahl, 1958) and are outlined here in slightly modified form.

1. Location: The most effective closed area is usually one that encompasses part of an aquatic site which waterfowl try to use regularly. In many cases the birds may have established a tradition of use for these sites. New sites of top quality that provide abundant preferred food, water, and cover will attract waterfowl in time, and new traditions of bird use may become established. New sites

located on major flight lanes will yield dividends quicker than those not located on such flight paths.

2. Size and shape: The specific size of a closed area will depend upon the type of cover included within the area. When patches of emergent vegetation are present, the closed area can be smaller than if the area is completely open water. Minimum size on many large water areas should approach 640 acres in a square or circle, if hunting is permitted on the perimeter. Smaller lakes which include some uplands around the shorelines and are entirely closed are also successful. The noise resulting from shooting and backfiring outboard motors causes some ducks to leave their resting place when the noise is as close as 1/4–1/3 mile. Prior to being shot at, ducks react to shooting more quickly than after being conditioned by prolonged shooting. Thus, the size and shape of the closed area is dictated by vegetative conditions and behaviorial characteristics of the birds.
3. Cover types: Open water interspersed with some marsh vegetation should make up a large part of a closed area for ducks and coots. Feeds preferred by the species to be attracted should be present within or near (up to a 15-mile radius) the closed area. Stubble feeders, including the mallard, black duck, and pintail, can secure preferred feed in nearby uplands.
4. Period covered: Where ducks concentrate in September, activities such as motor boating should be restricted starting September 1 or 15. Ducks permitted to remain in such areas usually help to attract more ducks when the migration is in full swing. Where hunting is the major factor limiting waterfowl use locally, the closed area should be functional at least from the opening day of the hunting season to the end of the season, or until complete freeze-up occurs and forces the birds to leave.
5. Edge hunting: People will hunt on the edge of many closed areas. If waterfowl concentrate within the area, competition for choice shooting spots will develop. Commercialization and loss of quality hunting should be avoided; the public's interest must be protected at all times. Providing managed public hunting adjacent to closed areas prevents commercialization and insures quality hunting.
6. Number of closed areas: In Wisconsin, the radius of influence of a closed area is chiefly within a few miles of the site. In general, the birds do not radiate out more than 15 miles, usually much less. Having a closed area on each major waterfowl site appears to be the soundest approach to distribute the birds, to encourage them to remain in Wisconsin longer, to permit the birds to utilize existing food resources better, to improve hunting, and to provide the general public with increased opportunities to enjoy the birds.

Closed areas are now and will be even more so in the future an integral part of a total waterfowl management program. The basic principle in establishing closed areas is to restrict human disturbance for a brief 2- to 2½-month period in fall (mid-September through November) on specified sites. During this time the birds are to receive primary consideration while other activities are restricted. This should be one of the most effective management tools for maintaining duck use in areas where disturbance is excessive.

Guidelines for Hunting Regulations

Hunting regulations are established to provide an opportunity for hunters to harvest an available crop of waterfowl. This procedure operates to insure the survival of each species. Regulations are enacted in late summer, with the assumption that average food, water, and weather conditions will prevail during the hunting season. If the harvest exceeds expectations, as can happen under extreme weather conditions (Hickey, 1955), regulations the following year can be adjusted to give added protection to waterfowl populations if reproductive gains do not compensate for the previous year's large harvest.

Length of season and daily bag limits on waterfowl are established by the federal government on the basis of results from annual surveys showing relative size of breeding populations and reproductive success of the breeders. Type of season and dates of the season are established by individual states within a general framework set by the federal government. Each state has the option of being more restrictive, but not more liberal, than the federal regulations. Some regulatory aspects are discussed here to help guide development of future regulations for hunting ducks and coots in Wisconsin.

1. **Type of hunting season:** Two types of waterfowl hunting seasons are currently offered to Wisconsin by the U. S. Bureau of Sport Fisheries and Wildlife—a continuous season and a split season. A continuous season consists of a given number of consecutive days of hunting. A split season has two periods of hunting of equal or unequal length, with a period of rest days between. A penalty of 10 percent of the days allowed under a continuous season is imposed if a split season is selected. Two opening days are provided by a split season. With waterfowl so vulnerable to shooting on opening day because of behavioral and distributional characteristics, such a penalty seems to us to be justified.

If we recognize that there is a moderately marked variation in the time of fall flight between species, that general waterfowl seasons cannot open earlier than October 1, and that heavy flights of most important species enter Wisconsin within the 45-day period of October 1 to November 15, there is no apparent reason for considering a split season for Wisconsin at this time. A continuous season provides wildfowlers with the greatest opportunity to take advantage of the flights of all species and to select hunting trips from a greater number of days. Chances of the season being closed when major flights of some species occur are eliminated.

2. **Opening date:** The opening date for the Wisconsin waterfowl hunting season received considerable attention in past years by hunters and game managers. Major considerations

in selecting the date involved (1) opening in mid-October to protect local breeding populations, (2) opening on a Saturday to give everyone an opportunity to be afield, (3) opening on a weekday to reduce hunting pressure, and (4) opening concurrently with upland gamebird seasons to distribute hunting pressure. With the earliest date for opening the general waterfowl hunting season being October 1, the only proposal that was actually found to be affected by the opening date was hunting pressure. When the season opens any day from Monday through Thursday, hunting pressure on the first day is less than when the season opens on a Friday, Saturday, or Sunday. Based on hunter densities and hunting success, we believe hunting pressure on the first days of the season is excessive on many areas in Wisconsin. In the early 1950's, hunter densities frequently were more than one party per 8 acres and hunter success often averaged one or less than one duck per hunter trip. Crowded conditions result in poor quality sport and threatened hunter safety. Therefore, the weekday (Monday-Thursday) opening appears to be a useful technique for minimizing hunting pressure on some areas. However, even with a weekday opening, some aquatic areas are still too crowded to provide hunting of reasonable quality.

Opening the season on October 1 is not detrimental to Wisconsin breeding populations of coots and ducks, except possibly the wood duck. Practically all duck broods and all except a small portion of coot broods develop powers of flight before October 1. Closing the season on wood ducks in the entire Mississippi Flyway or a large group of states in the Flyway appears to be the best way to protect the Wisconsin breeding wood duck population when the hunting season on other ducks opens on October 1. Under such a season some waste of wood ducks, shot accidentally and illegally by hunters failing to identify the birds, will occur. The large number of fall concentration sites, the intermixing with other species, and the daily feeding habits of wood ducks make a refuge system solely for wood ducks an impractical approach to protect the species.

3. Range of hunting season dates: An individual state has the choice of selecting the calendar dates for a waterfowl hunting season of a specified length within the maximum general framework of October 1 and January 15, or some shorter specified period. In 1959–60, the framework was October 8 to January 8, while in 1960–61, it was October 7–January 8. The choice of calendar dates for the Wisconsin hunting season depends to a large degree upon the length of season offered to the state by the federal government. When the season is 45 days or longer and October 1 is the earliest opening date, there is no concern in selecting the opening date. A starting date anytime during the first 10 days of October would provide the best season from the hunters' point of view. As previously stated, such an opening date should not be detrimental to ducks, with the possible exception of the wood duck.

With seasons of less than 45 days, the period of October 15 to November 10 should be included to provide maximum hunting opportunities statewide. This is the period when ducks

TABLE 86

Suggested Opening Date of the General Wisconsin Waterfowl Hunting Season, Under Different Season Lengths

Length of Season In Days	Suggested Approximate Opening Date	Comments
11–20	October 20	Some blue-winged teal and wood duck shooting would be sacrificed.
21–30	October 15	———
31–40	October 10	———
41–50	October 5	———
51–60	October 1	———
61+	October 1	Beyond a 60-day season, consider further liberalization in terms of a larger bag limit (more than 4) rather than additional days.

are most abundant in any region of the state. With freeze-up of certain surface waters in southern Wisconsin occurring later than in northern inland areas, more weight must be given to considering the potential effect of extending the season for this region of the state. Suggested opening dates are presented in Table 86 for different season lengths. We assume that October 1 is the earliest opening date and January 15 is the latest closing date permitted by federal law.

The main reason for suggesting that the bag limit be enlarged rather than the season lengthened beyond 60 days is to distribute the potential opportunity of the liberalization among more hunters. Very few places furnish hunting after December 1 in Wisconsin. Hence, few hunters would benefit by additional days of the season beyond 60. Liberalizing the bag limit gives everyone hunting throughout the 60-day season the opportunity to realize the benefits of the liberalization. Greatest benefit of the larger bag limit will be realized on the opening few days when peak numbers of hunters are afield and bag limits are secured most often.

4. Daily shooting hours: Except in years when it was necessary to help protect certain species, the daily shooting hours established by federal law have extended from ½-hour before sunrise to sunset. These hours should provide an adequate amount of time for hunting. In some past years, Wisconsin has established more restrictive daily shooting hours, either on an experimental basis or in response to public demand. In most cases the closing hour was involved in the curtailments. A variety of daily shooting hours has been experienced in Wisconsin (Appendix E, Table 112).

The controversial aspects of the closing time have been summarized as follows (Hawkins *et al.*, 1958:222.1–1). Factors favoring a presunset closing include: (a) crippling losses as related to time of day show that in heavy cover these losses increase as light wanes with approaching dusk;

(b) wood ducks become more active as the sun is setting and from sunset until dark, hence more are shot if the season is open (to sunset); (c) enforcement problems, concerned largely with after-hours shooting, increase if hunters are allowed to remain in the marsh until sunset; (d) the birds are afforded an opportunity to utilize feeding areas which might otherwise be denied them; (e) hunters are less inclined to search for downed birds late in the day when waterfowl activity usually is on the increase. To be busy searching for one downed bird may mean missing shots at several others. Factors favoring a sunset closure include: (a) thousands of acres of grain fields which stubbling ducks seldom visit until the light starts fading furnish many additional hunting opportunities; and (b) people who work and live near marshes have a chance for some additional hours for recreation which is denied them when the closing time is before sunset.

If regulations emphasize that hunters must recognize individual species, as in years when the bag limit is only one or two on certain species, we believe the best daily shooting hours would be from sunrise to ½-hour before sunset. Chances of hunters identifying the birds in flight are improved during daylight hours.

If the kill is to be reduced through curtailment of shooting hours, we believe it could be accomplished by restricting hunting to the period 8:00 a.m. to 3:30 p.m. Hunting pressure would be reduced with such hours. Certain hunters would be unable to hunt before or after work or school. Since, after the opening few days of the season, hunting pressure and duck kill generally parallel each other, curtailment of pressure should, up to a point, also curtail the bag. Shooting success on stubble-feeding ducks in agricultural fields would unquestionably be reduced. The birds normally feed in grain fields near dawn and dusk, spending the intervening time on aquatic resting areas. Such feeding could be accomplished normally before and after legal shooting hours.

We now believe that for Wisconsin the general statewide daily shooting hours should provide maximum (½-hour before sunrise to sunset) or near maximum (sunrise to ½-hour before sunset) time for hunting. Which of the two regulations to be used in any given year would depend upon whether or not the regulations emphasized recognition of individual species. Exceptions to the general statewide shooting hours could be made for localities (sites, counties, etc.) to take advantage of the daily habits of the birds under specific local environmental conditions. This general arrangement for daily shooting hours should result in the best regulation for both the birds and the hunters. Until evidence shows the need for manipulating daily shooting hours, we feel reduction of harvest for an individual or group of species should be accomplished through restrictions of the bag limit.

5. Species regulations: The size of the harvestable crop of waterfowl depends largely upon the reproductive success of the breeders that year. Young birds of many species hatched in a given year make up well over 50 percent of the hunters' bags when breeding success is average or above (Bellrose and Chase, 1950; Hickey, 1952; Crissey, 1957; Burton, 1959; Geis, 1959). When reproduction is greatly reduced, as in times of drought, few young are produced, the harvestable surplus is limited, and very restrictive hunting regulations are required to protect a nucleus of breeders. Major fluctuations in mallard production are recorded (Hawkins, Bellrose, and Smith, 1946; Bellrose *et al.*, 1961).

Many times all species are not affected adversely to the same degree in the same year. For example, the wood duck had a low population status and the season was closed from 1954 through 1957, while the population status of other species was much better and hunting seasons were allowed. In drought years, reproduction of prairie-nesting ducks, particularly divers, is seriously reduced by low water levels.

Because the size of the harvestable crop of each species varies, hunting regulations have been established from time to time for individual species to safeguard their welfare. Season length and daily bag limit have been curtailed. Such regulations constitute the first efforts toward species management. For the canvasback, changes in season length and daily bag limit have definitely influenced the hunting kill (Geis, 1959).

Attempts at species management are not new. In Wisconsin, the wood duck was protected in 1860 (Appendix E, Table 110). Since then, closed seasons on additional species, reduced bag limits, and bonus ducks permitted in the daily bag have been further attempts at regulating hunting for separate species. In Manitoba, the regular duck hunting season opened earlier than usual on only cultivated lands in September of 1957 and 1958. Objectives of this season were to (1) harvest stubble-feeding ducks, especially mallards, (2) reduce duck depredations on grain fields, and (3) avoid waste of incompletely developed, full-winged ducks and late-developing canvasback and redhead broods present in aquatic areas.

Results of attempts at species management in Wisconsin can be appraised only generally. Two points seem clear. When closed seasons or daily bag limits of one or two are imposed, (1) a certain illegal accidental kill occurs (on the wood duck largely), and (2) hunting pressure is reduced on canvasbacks and redheads, both of which require hunters to use large spreads of decoys and make trips by boat to hunt them. In areas such as the Mississippi River, where hunters bag wood ducks incidentally while hunting other species, total hunting pressure is not reduced by a closed season on the wood duck. In other situations hunting pressure declines. Certain stream-type habitat is not hunted when there is no open season on the wood duck. The value of a closed season for wood ducks has been debated where these birds occur intermixed with other species of waterfowl. Some sportsmen state that a bag limit of one is needed to prevent waste by permitting hunters to salvage the birds shot accidentally. Accidental shooting of wood ducks occurs whether the season is closed, or open with a bag limit of one. The hunter's inability to recognize the species in flight is not affected by the size of bag limit. Some field personnel of the Wisconsin Conservation Department believe

that the illegal accidental kill of wood ducks in a closed season is less than when the bag limit is one because some hunters attempt to avoid shooting the birds. If a salvage effect takes place when a bag limit of one is in force, it probably involves distributing the accidentally shot birds among members of the hunting party.

In addition to modifying season length and daily bag limit to protect certain species, conservation workers have considered establishing regulations for specific places and times to minimize the accidental illegal kill. Canada's duck hunting season on only uplands is an attempt to harvest stubble-feeding ducks while giving protection to diving ducks. Various possibilities are explored here to determine whether or not such regulations would benefit certain species or groups of species in Wisconsin. The main approach considered here is restricting hunting of specific species on designated sites for a prescribed period of time. The sites could be specified fall concentration sites, certain types of habitat, some counties, or areas enclosed by road boundaries. Hunting of the species could be limited to certain dates. This type of regulation is commonly used for upland gamebirds and for big game animals.

(1) The coot and all ducks except stubble-feeding mallards, black ducks, and pintails could be provided excellent protection during an open season by permitting hunting only on agricultural fields. Waste grains are preferred food of many mallards, black ducks, and pintails and would attract the birds out from aquatic resting areas. Response of hunters to such a season is difficult to anticipate in Wisconsin, since shooting opportunities would depend upon the interaction of an unknown level of hunting pressure and the local feeding flights of the birds. Crop depredations occur infrequently in Wisconsin; hence, there is no need to consider a separate season on stubble-feeding ducks to help solve an economic problem.

(2) Wood ducks probably cannot be protected in Wisconsin by additional restrictions of date and place. Theoretically, if the waterfowl hunting season did not open until November 1, at which time most wood ducks have departed from Wisconsin, wood ducks could be protected in Wisconsin but could be shot on the wintering grounds anytime between November 1 and January 15 (or some other terminal date). Delaying the opening of the waterfowl hunting season after October 1 will help minimize the kill of wood ducks in Wisconsin because fewer birds are available to be shot.

(3) Certain diving ducks have the behavioral and distributional characteristics that are required to make additional restrictions of time and place of hunting appear feasible. Although impractical, closing the Wisconsin waterfowl hunting season after October 10 or 12 would effectively protect the bulk of the canvasback and scaup using Wisconsin. Redheads, ring-necked ducks, and ruddy ducks would also benefit, but to a lesser degree. Blue-winged teal, wood duck, American widgeon, mallard, and black duck would provide the bulk of the shooting from October 1 to 12.

A more practical approach to provide added protection and to avoid illegal accidental shooting of diving ducks would be to prohibit shooting of all ducks on major fall diving duck concentration sites during the time the species to be protected are present. With only two major fall concentration sites, the ruddy duck would be ideally suited for such a regulation. Approximately 20 sites would have to be closed to protect the bulk of the canvasbacks and redheads. In Winnebago County, Lakes Poygan, Butte des Morts, Winneconne, and Winnebago would have to be closed to give maximum protection to canvasback and redhead. For all other species, the large number of fall concentration sites involved precludes considering closing the areas to provide added protection.

If the specific congregating sites for ruddy ducks, canvasbacks, and redheads are closed to all waterfowl hunting, shooting opportunities on other species will be sacrificed. Whether or not such restrictions are employed in Wisconsin will depend upon (a) the need to protect these three species, (b) other states concerned with the same subpopulations of birds incorporating more restrictive regulations, and (c) public acceptance of the proposed regulations.

If a method could be developed to educate hunters to identify individual species in flight, closure of major concentration areas for certain species would be unnecessary. Shooting opportunities on some species would not be sacrificed. According to Jens von Sivers (pers. comm., 1958), in certain parts of Germany a man must pass a waterfowl identification test before he can secure a hunting license. Training to develop abilities to identify the birds can be undertaken at home. In high school, all boys, regardless of background and interest, are required to take instruction in waterfowl identification in their biology class. Generally, and specifically for northwest Germany, men cannot secure a hunting license before they are 18 years of age. While these procedures may appear unduly restrictive, they have considerable merit. One American who hunted in Germany commented, "Certainly the prelicense training given to all new German hunters should make us think twice" (Kilgore, 1957:20). Serious consideration should be given to incorporating waterfowl identification training into the existing firearms-training course in the United States. Certainly many hunters must improve their abilities to recognize individual species in flight, if management by species is to be achieved without employing more restrictive regulations in the future.

6. **Needed regulations:** Wisconsin is faced with a situation that is difficult to solve. The quality of the sport of waterfowling at certain aquatic sites accommodating large waterfowl populations and located near human population centers has deteriorated to the point that some experienced hunters are abandoning the sport. Crowded conditions on areas open to unlimited hunting cause deterioration of the sport of wildfowling. Shooting competition is keen, and often the safety of hunters is threatened. Crippling loss of ducks is high because only pass shooting at high flyers is possible in many instances. Ducks cannot utilize fully the aquatic resting sites and food resources because excessive hunting pressure many times restricts them to undisturbed areas. With an expanding human population, with people having more time for recreation, and with the accelerated loss of aquatic habitat, hunting pressure has become excessive in some areas of Wisconsin. We consider hunter densities excessive when they exceed one party per 8 acres.

To maintain a reasonable degree of quality in waterfowl hunting and to correct overcrowded situations in certain localities, the Wisconsin Conservation Commission must be able to manage waterfowl hunters on specific areas at certain times. The esssential feature of such management is establishing minimum distances between shooting sites on waterfowl hunting areas. Such regulations are not new. They are widely used in some other states, both on government and private lands. In many cases, shooting sites are a minimum of 200 yds. apart.

Some sportsmen have criticized managed hunting as being too "artificial". Essentially, managed waterfowl hunting involves four features of the hunt: (1) a place or opportunity to hunt, (2) available waterfowl, (3) hunting skill, and (4) conveniences for hunting. Of these items, opportunities and conveniences are altered by managed hunting. Opportunities to hunt are limited in order to preserve enough space to provide reasonable quality hunting. Conveniences may include transportation to blinds, guide service, and other items. Left to chance are the local movements of waterfowl which furnish shooting. Whether or not hunters bag birds that react favorably to the provided space is determined by the skill of each person involved. Lacking the essential item of adequate space, waterfowl movements and hunting skill cannot operate freely. Where sufficient space is assured, the type and quantity of conveniences provided influence the quality of the hunt.

To date (1964), the Wisconsin Conservation Commission has regulated hunting pressure only on federal lands, one public hunting ground, and private lands in the vicinity of the Horicon National Wildlife Refuge. Numbers of hunters are managed on federal lands through trespass control. Terms of the deed provide for managed hunting on the Sandhill Wildlife Area near Babcock, Wisconsin. Blind spacing around the Horicon Refuge controls hunting pressure and is achieved through the Conservation Commission's authority to regulate methods of hunting when needed to manage wildlife in intensively used areas. Similar management of hunting pressure is needed on other state lands and natural waters. The Conservation Commission's legal authority to accomplish this management needs clarification. Only through appropriate regulations will it be possible to insure hunters of sufficient space to (1) assure safe hunting, (2) permit the birds to work into effective killing range, (3) minimize crippling loss associated with Wisconsin pass shooting, and (4) enjoy a pleasurable experience when afield. These features are deemed a necessary part of a successful modern waterfowl management program and are required to maintain the sport of wildfowling as an enjoyable sport in the future. Just as the duck supply does not come from a bottomless barrel, neither does quality hunting come from unrestricted hunting pressure in a limited available space.

On many public waterfowl management areas, hunter management must parallel management for the birds. Without hunter management, waterfowl hunting will, in many cases, be a frustrating experience. With many hunters not radiating out great distances on their waterfowl hunting trips, and with the human population expanding in practically all localities, hunters cannot simply go elsewhere to get better quality hunting. Providing space for hunters is a problem which must first be solved where it exists. Managed hunting, featuring minimum distances between shooting sites, is now needed in more areas of Wisconsin and will be needed even more so in the future.

Future Role of Research

Just as this report resulted from combined efforts, many future investigations must be co-operative undertakings between states, agencies, and individuals within the total range occupied by waterfowl. Leadership for broad waterfowl studies rest with the federal government (Hawkins *et al.*, 1958:210.2). Investigations to be undertaken in any given year or period of years should be determined through a representative committee. Selection of current studies will be based largely on project priorities and available manpower and funds.

In recent years, some states of the Mississippi Flyway Council and other Flyway Councils, the U. S. Bureau of Sport Fisheries and Wildlife, provincial and dominion governments of Canada, Ducks Unlimited, universities and colleges, and private groups have combined efforts to complete certain investigations. Successful projects include banding waterfowl throughout the breeding grounds and appraising production trends indicated by age ratios derived from wings of ducks furnished by hunters. While considerable co-operative effort has been expended, more is needed in the future. Only when

this approach is used will the effort yield the best information. Data collected in an individual state, such as Wisconsin, will have increased value when it can be used in conjunction with similar material collected simultaneously in other states and provinces.

Recommendations for future research effort by Wisconsin are divided into two aspects: (1) population studies, and (2) habitat investigations.

Population Studies

Because ducks and coots occupy far-flung and widely separated ranges during various seasons of the year, population studies require a pooling of manpower, funds, and equipment to provide sufficient resources to tackle high-priority research tasks. To date, in many cases, population studies of lesser importance have been undertaken to provide essential background information, and, in other cases, because it was impossible to initiate the higher-priority investigations. Lack of manpower and funds curtailed the scope of undertakings.

Some specific population studies recommended for support by Wisconsin include the following:

1. Continue to participate in co-operative international, national, flyway, and regional investigations. Many questions vital to Wisconsin regarding waterfowl populations can be answered properly only through studies extending beyond the state's boundaries.
2. Band adequate numbers of ducks on the breeding grounds in northern Manitoba and all of Ontario. Resulting data will help define the degree to which ducks from this region contribute to recreational opportunities in Wisconsin. Information is especially needed on the mallard and black duck.
3. Band adequate numbers of wood ducks in Wisconsin before the waterfowl hunting season opens to (1) establish recovery and mortality rates and (2) evaluate the effect of changes in hunting regulations. Available evidence indicates that wood ducks are heavily shot in early October during Wisconsin hunting seasons. Studies are needed to learn whether or not mortality is excessive in years of early October openings.
4. Determine the distribution and density of breeding wood ducks on Wisconsin streams and the characteristics of attractive stream habitat and natural nesting cavities. Information on these items is needed to establish more adequate guidelines for managing forests adjacent to streams used by breeding wood ducks.

   Characteristics of streams attractive to breeding wood ducks and densities of breeders must be understood better. Information on these items could be obtained by expanding the stratified sampling initiated in 1957–58 in Wisconsin. The state's 34,845 miles of streams have been classified into groups according to anticipated degree of use by wood ducks and whether or not the stream can be floated by boat or canoe. Anticipated use of streams by breeding wood ducks was based on species and age of timber within ¼-mile on either side of each suitable stream, and general knowledge of the breeding wood duck population gained from working on streams and reported by Wisconsin Conservation Department field personnel. The basic sampling unit was an approximate 20-mile segment of stream. This could be censused in a day. Nonfloatable streams could be walked. All wood ducks present in May were classified according to lone birds, pairs, and flocks. Since Wisconsin is located on the northern fringe of the wood duck's breeding range, practically all birds should represent breeders.

   Sections of streams having high densities of breeding wood ducks should be examined in detail to establish the features of natural nest cavities. Such information is required to develop more adequate guidelines for maintaining trees that have and will develop cavities used by wood ducks. Presently, maintenance of "den" trees is a part of good forest management plans. Maintaining types of trees that will eventually develop cavities and replace existing den trees should also be a part of a sound timber management plan.
5. Determine the relative susceptibility of different species of ducks and the coot to leucocytozoon disease. Of the waterfowl diseases encountered in Wisconsin, we feel this disease is potentially one of the most important. Evaluate leucocytozoon disease as a potential factor limiting the distribution and density of the breeding population of each species, including the mallard. Two aspects appear to deserve attention. First, susceptibility of wild ducklings of different ages to various levels of infection could be investigated to help appraise the potential for occurrence of mortality. Second, long-term studies with penned flocks of wild mallards or other ducks in areas where vector black flies are abundant would determine characteristics of duckling survival for individual years under various environmental conditions and vector population levels. Such information on leucocytozoon disease would be helpful in making decisions on acquiring and developing habitat for waterfowl in areas where vector black flies are periodically abundant.

Habitat Investigations

To provide essential information required by management to maintain and develop habitat for breeding and migrant ducks and coots in Wisconsin, investigations should include the following aspects.

1. Evaluate the adequacy of Wisconsin's wetland habitat to accommodate breeding ducks by (1) locating specifically the blocks of habitat attractive to pairs and potentially lethal for broods, (2) determining if deep marshes (=brood waters) can be added in reasonable numbers at suitable spacing through the most appropriate habitat restoration procedures, (3) defining specific construction procedures for different types of topography, ground water levels, and qualities of soils and

waters, (4) estimating the costs for carrying out the habitat manipulation, and (5) developing new, practical, economic procedures for providing open water suitable for broods and pairs in the numerous wetlands now lacking surface water.

2. Determine if the construction design of ponds established under the Agricultural Conservation Program can be modified to enhance the possibilities of making a larger proportion of the water areas more attractive to breeding ducks without detracting from their primary agricultural purposes. Potential importance of this study can be visualized by realizing that 2,857 farm ponds were constructed in Wisconsin from 1936 through 31 December 1963. More ponds will be built in the future for erosion control, flood control, gully improvement, and other purposes.
3. Determine the extent to which carp, silt, pollutants, and mechanical and chemical control measures are limiting the natural stands of preferred food plants and invertebrate animals in some of the major waterfowl concentration sites. Decide if sufficient preferred foods are present to satisfy the requirements of reasonable-sized migrant duck populations. Decide if anything needs to or can be done to maintain or improve the stands of plants and animals furnishing preferred waterfowl foods. Ascertain whether or not chemicals used for controlling aquatic plants are concentrated in certain "levels" of the animal pyramid. If they are concentrated, evaluate the effects of the chemicals on waterfowl ingesting them.

Ecological studies of submerged aquatic plant and invertebrate animal communities are especially needed at major diving duck concentration sites. Basic information is required to (1) document existing ecological conditions, (2) enhance future evaluations to determine reasons for vegetational changes resulting from modifications in land- and water-use activities, and (3) help determine future management possibilities.

4. Determine the best procedures for manipulating water levels, grazing, burning, mowing, and spraying with chemicals, either singly or in combinations, to control species and densities of plants in order to establish and maintain attractive food and cover for breeding and migrating waterfowl. In 1962 there were 83 federal (3) and state (80) waterfowl management areas in Wisconsin (see Appendix C, Table 92). Most of the state areas are in the land acquisition phase. More specific information on the manipulation of soil, water, and vegetation to benefit waterfowl will be required in the next 10–15 years, after acquisition is completed and major development is initiated on each project. Some projects in naturally poor quality sites offer a real challenge. New combinations of management techniques need to be developed to improve the carrying capacity of these areas.

Information gathered in past and current studies have focused attention on what to do and where to act to benefit waterfowl. Essentially the entire range of the birds must be covered through a team approach. Conservation organizations of each state and province, like players on a football team, must carry out certain phases of the management and investigational program required to manage waterfowl in North America. If individuals or separate organizations attempt to do the same job, or if most states and provinces remain relatively inactive, the resource will be lost as we now know it. The challenge is to find ways to work features benefiting waterfowl into the complex and ever expanding land- and water-use activities. Key to success in achieving this goal appears to lie in general acceptance of the philosophy that maintaining fish and wildlife populations is the responsibility of all people and agencies working cooperatively.

Some aquatic habitat capable of accommodating waterfowl is now used intensively by people for activities that discourage or prevent waterfowl use. Activities of shore residents, fishermen, and boaters are major disturbance factors.

On aquatic areas where the primary objective is to accommodate a maximum breeding or fall migrant duck population, human activities should be regulated for specific periods to hold disturbance to a minimum. Even the best habitat will be utilized lightly, if at all, by breeding and migrant ducks and coots where human disturbance is excessive. (Photo by U.S. Fish and Wildlife Service.)

Beaver benefit waterfowl by impounding small woodland streams. Their removal of trees from adjacent slopes encourages growth of temporary stands of grassy and herbaceous duck nesting cover. Open loafing sites for breeding pairs of ducks and lone drakes are provided by the dam and by the worn trails maintained by beaver moving from water to upland.

Response of breeding mallards, black ducks, blue-winged teal, and wood ducks to the impounded habitat is good. Brood production per unit of aquatic habitat is at times comparable to duckling yields on other good quality duck breeding areas.

Beaver populations should be maintained within designated watersheds and on specific streams at as high a level as possible without causing undue economic damage to roads, railroads, and other public and private property. Key to success of managing beaver is removing enough animals to prevent them from exhausting their natural food supplies. With inadequate harvests, beaver are forced to move to new locations as they cut preferred food trees faster than they are replaced by growth. Movements occur when the distance to desired trees becomes too great.

Following abandonment of the site, the old dam begins to disintegrate and the water level soon falls. A new dam is constructed at another fertile basin. This is nature's primary way of providing a natural successional cycle favorable to waterfowl in forested regions. (Photo by Wisconsin Conservation Department.)

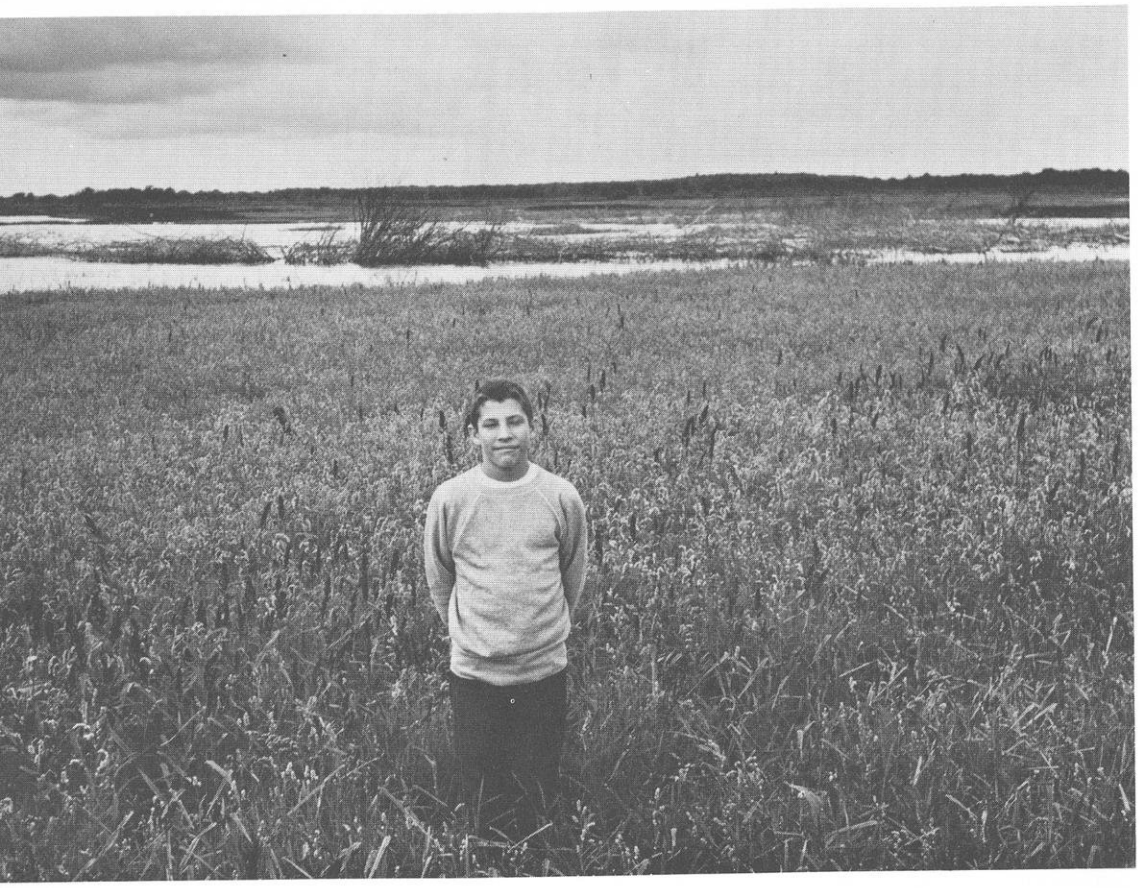
Shoreline vegetation of aquatic areas influences waterfowl use during the breeding season. Patterns of emergent aquatics largely determine the degree to which waterfowl will use fertile breeding ponds and marshes. In the absence of disturbance, nature's drive is to encourage development of compact stands of emergents. Presence of these dense stands signifies that waterfowl habitat has reached old age and that breeding ducks are scarce or lacking. Dense stands of emergents commonly develop in Wisconsin in the absence of disturbance, such as grazing and trampling by livestock.

Heavy activity by cattle can eliminate shoreline vegetation important as over-water nesting and escape cover. Light or moderate grazing and trampling helps maintain an interspersion of open water and patches of emergents, a condition attractive to waterfowl. Achieving the desirable level of shoreline disturbance is a major management objective on many waterfowl breeding areas. (Photo by L. R. Jahn.)

Prescribed burning is an effective inexpensive method for helping to maintain habitat in early successional stages that are attractive to waterfowl. Grassy and herbaceous nesting cover can be maintained for mallards and blue-winged teal on uplands adjacent to shallow water areas having suitable escape cover and plant and animal foods.

Burning of dense, solid stands of seed-producing, emergent aquatic plants in winter or very early spring prior to flooding can influence the distribution of waterfowl in spring and benefit the habitat. Such fires not only remove the mass of top growth that serves as a physical barrier prohibiting ducks from using the accumulated seeds on the marsh floor, but also discourage invasion of woody vegetation.

Charred areas, covered purposefully or naturally with a few inches of early spring flood water, serve as excellent puddle duck feeding areas. Where plant succession progresses to woody vegetation, as in Wisconsin, intensive habitat management is essential to maintain optimum conditions for waterfowl on a sustained basis. (Photo by D. Q. Thompson.)



Purposeful manipulation of water levels is one of the most effective ways of making aquatic habitat more attractive to waterfowl. On good quality aquatic areas water levels can be manipulated to improve interspersion of emergent plants and open water.

Where substrate and/or water fertility are unfavorable for growth of desirable submerged aquatic plants, a summer drawdown encourages establishment of volunteer or seeded crops of preferred moist-soil food plants. Dense stands of smartweeds and millets, as shown here, can be established by aerial sowing of moist mud flats shortly after water levels are lowered.

Flooding in late summer or early fall places the mature crop in a favored shallow-water feeding condition. Timing of a drawdown and an adequate water supply are crucial to successful use of this management technique. (Photo by L. R. Jahn.)

Over geological time natural depressions and basins become filled with sediments and organic matter, as shown in the background of this picture. Filled basins having the water table close to the soil surface and adequate nutrients for growth of waterfowl food and cover plants offer excellent development possibilities. Best results are usually secured in fresh meadows and shallow fresh marshes.

Mechanical methods or blasting can be used to expose the ground water and make attractive habitat for waterfowl. Inexpensive ammonium nitrate was used to blast the opening shown here. Concussion limits the use of blasting agents near buildings. Here bulldozer or dragline can be employed effectively. (Photo by A. S. Hawkins, U.S. Fish and Wildlife Service.)

Farm ponds constructed primarily to retard flood waters, reduce soil erosion damages, and provide livestock with water, secondarily accommodate ducks in the breeding season, as well as during migration. Such ponds are desired by many landowners, fit into an over-all land use program, and benefit waterfowl, hunters, and other interested people. Pond construction should be encouraged whenever possible, especially through various agricultural and forestry programs. (Photo by U.S. Soil Conservation Service.)

Proper management of soils, waters, and pollutants within watersheds is essential to keep ponds, lakes, and streams free from silt and contaminants, and attractive to waterfowl. Tilling sloping lands in strips on the contour minimizes soil erosion, thereby prolonging the life of natural and man-made water areas. Watershed protection, upstream flood prevention, and pollution abatement enhance aquatic habitat and benefit waterfowl. (Photo by U.S. Soil Conservation Service.)

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APPENDIX A

Scientific Names of Plants and Animals Used in Text*

(Listed in alphabetical order of common name)

Names of two ducks are used in the text in a special manner. When only the term scaup is used, both greater and lesser scaup are referred to, although the latter make up the larger proportion of the ducks involved. Where the name common goldeneye appears, it must be recognized that a few Barrow's goldeneye may be included. This is especially true when considering migrant and wintering populations. However, since the Barrow's goldeneye is encounterd infrequently in Wisconsin, the numbers included would be extremely small.

PLANTS

Alder	*Alnus* spp.
Alfalfa	*Medicago* spp.
Ash, black	*Fraxinus nigra*
Barley	*Hordeum* spp.
Beggar-ticks	*Bidens* spp.
Birch	*Betula* spp.
Buckwheat	*Polygonum* spp.
Bulrush	*Scirpus* spp.
Burreed	*Sparganium* spp.
Cattail	*Typha* spp.
Cedar, White	*Thuja occidentalis*
Coontail	*Ceratophyllum* spp.
Cordgrass	*Spartina pectinata*
Corn	*Zea Mays*
Cottongrass	*Eriophorum* spp.
Dock	*Rumex* spp.
Dogwood	*Cornus* spp.
Duckweed	*Lemna* spp.
Elm	*Ulmus* spp.
Grass, reed canary	*Phalaris arundinacea*
Grass, wool	*Scirpus* spp.
Leatherleaf	*Chamaedaphne calyculata*
Maple, Silver	*Acer saccharinum*
Meadowsweet	*Spiraea* spp.
Millet	*Echinochloa* spp.
Oak	*Quercus* spp.
Oats	*Avena* spp.
Pine, jack	*Pinus banksiana*
Pondweed, flat-stemmed	*Potamogeton zosteriformis*
Pondweed, floating-leaf	*Potamogeton natans*
Pondweed, leafy	*Potamogeton foliosus*
Pondweed, sago	*Potamogeton pectinatus*
Rice, wild	*Zizania aquatica*
Rye	*Secale* spp.
Sedge	Family Cyperaceae
Smartweed	*Polygonum* spp.
Spruce, black	*Picea mariana*
Sweetgale	*Myrica* spp.
Tamarack	*Larix laricina*
Water milfoil	*Myriophyllum* spp.
Wheat	*Triticum* spp.
Wild celery	*Vallisneria americana*
Willow	*Salix* spp.

ANIMALS

Beaver	*Castor canadensis*
Blood parasites	*Leucocytozoon* spp., *Hemaproteus* spp. *Filaria* spp., *Plasmodium* spp.
Bufflehead	*Bucephala albeola*
Canvasback	*Aythya valisineria*
Carp	*Cyprinus carpio*
Coot, American	*Fulica americana*
Crow, common	*Corvus brachyrhynchos*
Duck, black	*Anas rubripes*
Duck, ring-necked	*Aythya collaris*
Duck, ruddy	*Oxyura jamaicensis rubida*
Duck, wood	*Aix sponsa*
Gadwall	*Anas strepera*
Gizzard worms	*Amidostomum* spp.
Goldeneye, common (American)	*Bucephala clangula americana*
Goldeneye, Barrow's	*Bucephala islandica*
Grouse, ruffed	*Bonasa umbellus*
Mallard	*Anas p. platyrynchos*
Merganser, common (American)	*Mergus merganser americanus*
Merganser, hooded	*Lophodytes cucullatus*
Merganser, red-breasted	*Mergus serrator*
Mink	*Mustela vison*
Muskrat	*Ondatra zibethica*
Old-squaw	*Clangula hyemalis*
Opossum	*Didelphis virginiana*
Pheasant, ring-necked	*Phasianus colchicus*
Pike, northern	*Esox lucius*
Pintail	*Anas acuta*
Raccoon	*Procyon lotor*
Redhead	*Aythya americana*
Scaup, greater	*Aythya marila*
Scaup, lesser	*Aythya affinis*
Scoter, common (American)	*Oidemia nigra americana*
Scoter, white-winged	*Melanitta deglandi*
Shoveler	*Spatula clypeata*
Skunk	*Mephitis mephitis*
Teal, blue-winged	*Anas discors*
Teal, green-winged	*Anas carolinensis*
Widgeon, American (baldpate)	*Mareca americana*

* Scientific names of plants and animals are from the following references: plants—Fassett (1940) and Fernald (1950); mammals—Burt and Grossenheider (1952); fishes—Hubbs and Lagler (1947); birds—American Ornithologists' Union (1957).

APPENDIX B

Spring Migration

Waterfowl migration has been defined as the annually repeated cycle of travel that carries the birds away from their birthplace or breeding grounds to temperate wintering waters, and returns them to their place of birth with the advent of spring (Hochbaum, 1955:91). Ducks and coots observed in Wisconsin during spring migration are primarily waterfowl moving northwest and north to their breeding places located beyond Wisconsin, and secondarily involve small numbers of some species returning to their breeding areas in Wisconsin.

Primary objectives of our limited investigations of spring migration were to determine the (1) chronology of migration for major species, (2) general distribution of the migratory birds in Wisconsin, (3) factors causing mortality in spring, and (4) Wisconsin's management problems as they concern the welfare of the birds. Information on these items is needed to understand better the total annual seasonal activities of ducks and coots in Wisconsin.

Methods

In 1952 and 1953, approximately 130 selected co-operators in the state's 71 counties submitted weekly observations on ducks, rating the spring flight as none, light, medium, or heavy. Numerical values of zero, one, two, and three were assigned to these words respectively. The total number of points accumulated for a species from all observers was plotted on the last day of each week to construct migration curves. Observations were made weekly from late February to approximately May 1 in each of the two years. Because different phenological conditions exist between northern and southern Wisconsin, all reports on migration were separated for northern and southern Wisconsin with a line drawn approximately from Green Bay (Brown County) west to Diamond Bluff (Pierce County). Unpublished records on the spring migration of coots at University Bay (Dane County) were made available through R. A. McCabe. Co-operators' reports were supplemented by general aerial and ground observations made by waterfowl project personnel while carrying out statewide investigations.

Chronology of Flight

The first migrant ducks usually arrive in Wisconsin between early and late February. Common goldeneyes and common mergansers are the earliest, appearing along rivers and streams in both northern and southern parts of the state on about the same dates. Mallards and black ducks are also among the first arrivals in southern Wisconsin. In the lower Chippewa River area, the common goldeneye is one of the first migrants to arrive each spring (Buss and Mattison, 1955:58). At the Crawfish River near Milford (Jefferson County), common goldeneyes have arrived as early as February 10. Because of the wide distribution and relatively large numbers of goldeneyes found inland in Wisconsin in February and early March, we believe most of these birds represent migrants, rather than birds dispersing from wintering areas within the state.

Spring arrival dates vary between localities in Wisconsin (Tables 87, 88, and 89). At the Upper Mssissippi River Wildlife and Fish Refuge bordering Wisconsin (Table 87), 96 percent of 179 arrival dates during a 13-year period (1946–58) occurred before April 1. At the Necedah National Wildlife Refuge in Juneau County (Table 88), 38 percent of 190 arrival dates occurred before April 1. At the Horicon National Wildlife Refuge (Table 89), 84 percent of 217 arrivals were registered before April 1. This large variation in distribution of arrival dates between refuges reflects differences in size, topography, soil type, and vegetative cover of watersheds. These factors interact to influence the time that open water becomes available in spring.

The Necedah Refuge is located in the bed of extinct Glacial Lake Wisconsin. The watershed supplying surface-runoff water to refuge impoundments is relatively flat, small, and is largely covered with woody vegetation. Shade resulting from the woody vegetation delays the melting of snow in spring. The humus layer on the land surface and the primarily sandy soils minimize surface-water runoff. Disappearance of ice in spring depends largely upon energy received from the sun.

Watersheds supplying surface-runoff waters to the Horicon and Upper Mississippi River Refuges contrast sharply with the Necedah watershed. Both watersheds are larger in size and contain a high proportion of agricultural land, some steep slopes, and nonsandy soils. The Horicon Refuge is located on the Rock River near the head of the stream, while the Mississippi Refuge is located a considerable distance from the head of the river. Consequently, the size of the watershed supplying

TABLE 87

Distribution of Spring Arrival Dates at the Upper Mississippi River Wildlife and Fish Refuge Bordering Wisconsin, 1946–58*

Species	Arrival Dates: Earliest and Latest	Arrival Dates: No. of Days in Range	Number of Years: February 8–14	February 15–21	February 22–29	March 1–7	March 8–14	March 15–21	March 22–29	March 30–April 5	April 6–12	April 13–19	Total Number of Years Recorded 1946–58**
Pintail	Feb. 13–March 14	30	1			7	4						12
Mallard	Winter many years	—				2	1						3
Am. widgeon	Feb. 20–March 27	36		1		1	5	2	3				12
Scaup	Feb. 15–March 23	37		2		4	2	2	2				12
Bufflehead	Feb. 20–April 9	49		1	1	1	3	1	2	1	1		11
Canvasback	Feb. 8–March 29	50	1	2		3		2	5				13
Redhead	Feb. 20–March 27	36		1		3	3	2	3				12
Ring-necked duck	Feb. 20–March 23	32		1			4	3	4				12
Black duck	Feb. 26–March 23	26			1		3		3				7
Wood duck	Feb. 27–March 29	31			1	1	3	3	5				13
G-w. teal	Feb. 27–March 29	31			1	1	4	1	5				12
Gadwall	March 8–March 27	20					4	5	4				13
Coot	March 8–March 29	22					3	5	3				11
B-w. teal	March 7–April 1	26				1	2	3	6	1			13
Shoveler	March 2–April 5	35				2	2	1	3	2			10
Ruddy duck	March 7–April 10	35				1	2	2	5		2	1	13
ALL SPECIES	Feb. 8–April 10	62	2	8	4	27	45	32	53	4	3	1	—

* Data were furnished by D. V. Gray and H. K. Nelson of the Branch of Refuges, U.S. Bureau of Sport Fisheries and Wildlife, Minneapolis.

** The total number of years is reduced for some species because small numbers of the mallard, black duck, American widgeon, gadwall, green-winged teal, redhead, ring-necked duck, scaup, bufflehead, and coot wintered in certain localities in some years. Small numbers of common goldeneyes and common mergansers were present each winter from 1946–58.

TABLE 88

Distribution of Spring Arrival Dates at the Necedah National Wildlife Refuge, 1946–58*

Species	Arrival Dates: Earliest and Latest	Arrival Dates: No. of Days in Range	Number of Years: Feb. 15–21	March 8–14	March 15–21	March 22–29	March 30–April 5	April 6–12	April 13–19	April 20–26	April 27–May 3	May 4–10	Total Number of Years Recorded 1946–58
Mallard	Feb. 19–April 1	42	1	1	5	5	1						13
Com. goldeneye	March 10–April 8	30		1	3	3	3	3					13
Com. merganser	March 18–March 31	14			3	5	2						10
Black duck	March 9–April 11	34		2	1	5	4	1					13
Bufflehead	March 10–April 16	38		1		1	5	3	1				11
Wood duck	March 10–April 17	39		1		2	4	1	1				9
Ring-necked duck	March 22–April 6	26				4	3	4	1				12
Pintail	March 15–April 15	32			1	2	4	5	1				13
G-w. teal	March 21–April 20	31			1		3	3	2	1			10
B-w. teal	March 19–April 28	41			1		4	4	2	1	1		13
Canvasback	March 24–April 12	20				1	1	4					6
Scaup	March 24–April 10	18				2	6	5					13
Hooded merganser	March 30–April 20	22					7	1	1				9
Am. widgeon	March 31–April 20	21					5	1	4	1			11
Shoveler	March 30–April 30	32					2	1		3	3		9
Gadwall	March 31–April 30	31					2	1			1		4
Redhead	March 31–April 30	31					3		2	1	1		7
R-b. merganser	April 2–April 10	9					1	1					2
Ruddy duck	March 30–April 26	28					2			2			4
Coot	April 2–May 4	33					1	1	3	1	1	1	8
ALL SPECIES	Feb. 19–April 30	80	1	6	15	30	63	39	18	10	7	1	—

* Data were furnished by C. E. Pospichal and H. K. Nelson of the Branch of Refuges, U.S. Bureau of Sport Fisheries and Wildlife, Minneapolis. No waterfowl wintered on the area between 1946 and 1958.

TABLE 89

Distribution of Spring Arrival Dates at the Horicon National Wildlife Refuge, 1946–58*

Species	Arrival Dates: Earliest and Latest	Arrival Dates: No. of Days in Range	Number of Years: February 15–21	February 22–29	March 1–7	March 8–14	March 15–21	March 22–29	March 30–April 5	April 6–12	April 13–19	Total Number of Years Recorded, 1946–58**
Mallard	Feb. 21–March 23	31	1	2	4	3	2	1				13
Black duck	March 3–March 23	21		1	4	4	2	2				13
Pintail	March 3–March 27	25			4	3	3	2	1			13
Com. merganser	March 2–April 7	37			1	1	4	1	1	1		9
H. merganser	March 6–April 1	27			1		5	1	2			9
Bufflehead	Feb. 15–April 1	46	1			2		2	4			9
Redhead	March 9–April 3	26			1	4	1	4	2			12
Scaup	March 5–April 2	29			1	4	2	4	1			12
Coot	March 4–April 7	35			1	3	2	4	1	1		12
G-w. teal	March 7–March 30	24			1	2		7	1			11
Am. widgeon	March 10–April 5	27				3	1	4	4			12
Ring-necked duck	March 10–April 4	26				2	2	4	4			12
Canvasback	March 10–April 16	38				2		5	3		1	11
Com. goldenege	March 10–April 7	29				1	2	4		2		9
Ruddy duck	March 1–April 16	47			1	1	3	1	3	1	1	11
Shoveler	March 7–April 11	36			1	1	3	2	4	1		12
B-w. teal	March 10–April 7	29				2		4	5	2		13
Gadwall	March 10–April 13	35				1		2	4	2	1	10
R-b. merganser	March 22–April 17	17						1	1	1		3
Wood duck	March 27–April 20	25						1	6	1	3	11
ALL SPECIES	Feb. 21–April 20	60	2	3	20	39	32	56	47	12	6	—

* Data were furnished by L. H. Dundas and H. K. Nelson of the Branch of Refuges, U.S. Bureau of Sport Fisheries and Wildlife, Minneapolis.

** The total number of years is reduced for common goldeneye, and hooded and common mergansers because small numbers of these species wintered on the area in a few years.

water to the two refuges is greatly different. The larger quantity of water accumulated over a greater distance from the watershed feeding the Mississippi Refuge helps break up the ice earlier in spring. Thus, a larger proportion of the arrival dates of many ducks and coots occur earlier at the Mississippi Refuge than at the Horicon or Necedah Refuge.

The range in arrival dates varies from a low of 14 days for the common merganser at the Necedah Refuge (Table 88) to a high of 50 days for the canvasback at the Upper Mississippi Refuge (Table 87). For most species, the range in arrival dates was approximately 4 to 5 weeks. Early migrant species tended to be just as consistent in arrival date as late migrant species.

All common species of ducks and the coot are present in Wisconsin in March. By late March, hundreds of thousands of migrant ducks and coots are present, even though winter is not completely passed.

Peak populations of all species of ducks are reached sometime in April (Figs. 52, 53 and 54), with many species arriving earlier and remaining longer in southern Wisconsin than in northern Wisconsin. Of 14 main duck species using the state, the blue-winged teal reached peak abundance later than any other species. The shoveler, blue-winged teal, and wood duck are considered late migrants in Wisconsin and elsewhere (Bennett, 1938; Sowls, 1955). The coot is present in peak numbers during the last few days of April and first few days of May (Fig. 54). At Delta, Manitoba, Ward (1953) found that the bulk of the coot migration occurs during the first week of May.

Except for the scaup and possibly some blue-winged teal and ring-necked ducks, migrant ducks and coots leave Wisconsin between April 20 and May 10. Scaup, in flocks numbering from 3 to 70 birds often linger until mid- or late June. These are not breeding birds, since the scaup rarely breeds in Wisconsin.

General Distribution and Behavior of Ducks and Coots

Characteristics of the distribution of ducks and coots in Wisconsin were established on the basis of (1) our own general statewide field observations, and (2) the absence of species and the general remarks noted on weekly migrational reports offered by co-operators.

Ice-free waters provide resting and feeding sites for ducks and govern the distribution of the birds in late winter and early spring. Early migrants find holes and strips of open water along rivers and streams, especially in southern Wisconsin. Above-freezing temperatures and rains initiate the melting of accumulated snow by mid-March in southern Wisconsin. Flooded crop fields are common, except in dry years, although subject to alternate freezing and thawing. Reservoirs of rivers open as runoff waters from the watersheds accumulate in common channels. Lakes lacking an inlet or outlet or those having small watersheds become ice free later. Many lakes and

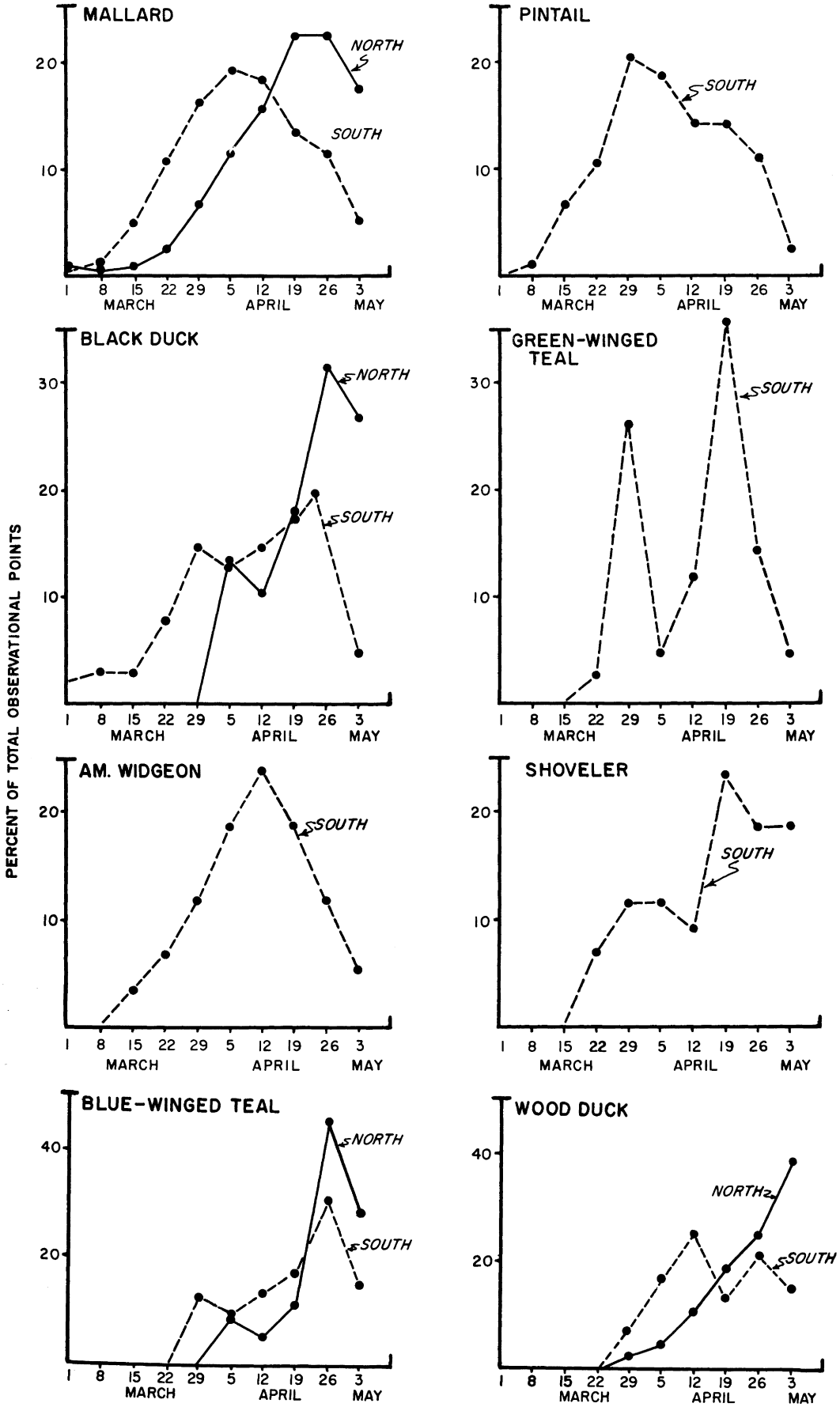

Figure 52. Average chronology of spring migration for eight species of puddle ducks in northern and southern Wisconsin, 1952–53.

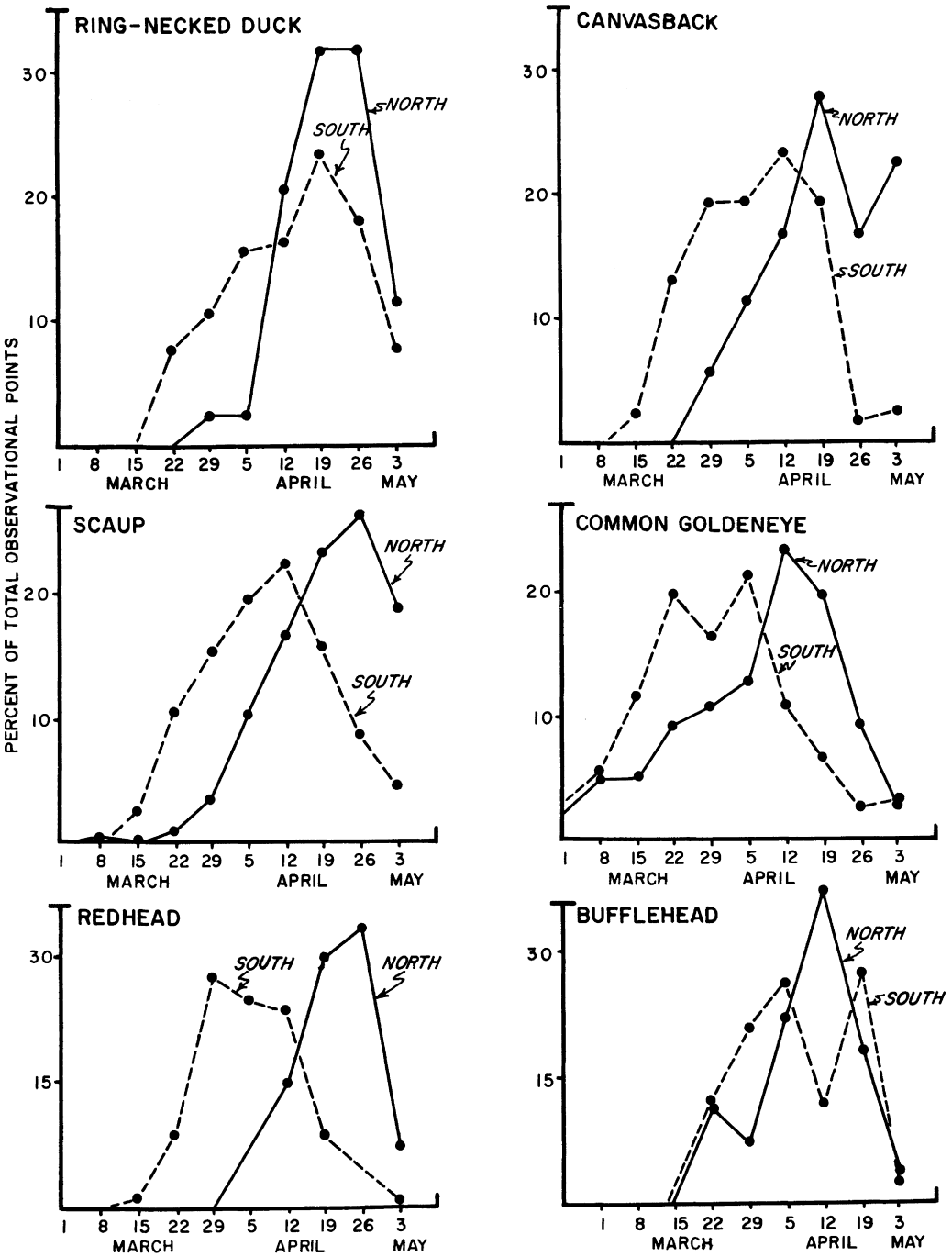

Figure 53. Average chronology of spring migration for six species of diving ducks in northern and southern Wisconsin, 1952–53.

marshes usually open completely by early April in southern Wisconsin and from mid- to late April in northern Wisconsin. This complete breakup of ice in lakes and marshes is important to the vast numbers of waterfowl migrating through the state. But most important to early migrants are the small openings in river channels, the temporary waters of flooded agricultural fields and stream bottomlands, small ponds, and shallow-water edges of large permanent waters. These types of waters are least abundant in forested areas. In spring seasons when runoff waters are minimal, areas temporarily covered with surface water do not exist. In such years, the total quantity of feed available to ducks and coots is reduced substantially, and the distribution of the birds is greatly restricted.

All species of ducks utilizing Wisconsin in spring do not occur in northern and southern parts of the state in equal abundance. American widgeon, pintail, green-winged teal, and shoveler, although generally abundant in southern Wisconsin, are scarce in northern Wisconsin. Redhead and canvasback, although present in northern Wisconsin, are never abundant. Gadwall and ruddy duck are present in very few places in southern Wisconsin and are practically absent from northern areas.

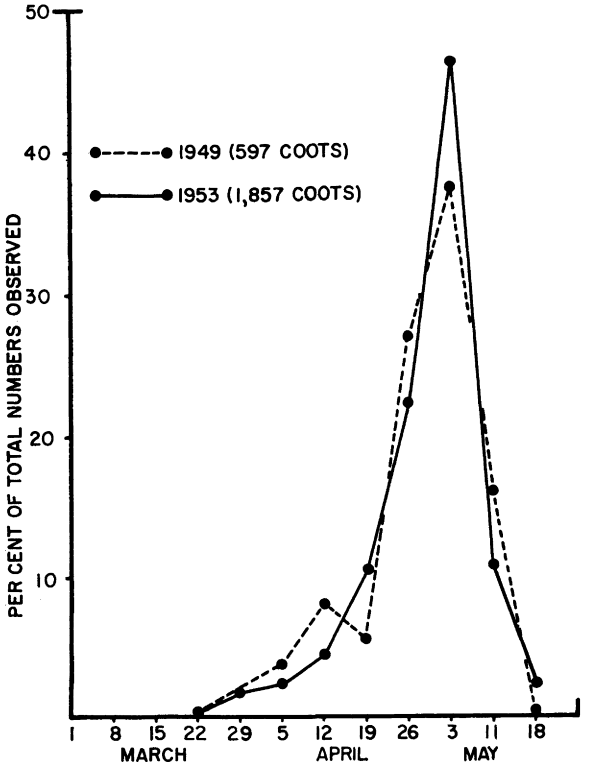

Figure 54. Chronology of spring migration of the coot at University Bay, located near Madison, Wisconsin. (Based on figures from Germain, 1949, and Doell, 1953.)

The scarcity of certain species of ducks in northern Wisconsin is unquestionably explained by any one or any combination of the following factors: (1) major migratory flight lanes do not cross the area, (2) the birds have not developed the habit of using aquatic sites in this area, (3) the lack of particular types of aquatic habitat preferred by the birds, and (4) the lack and/or limited abundance and availability of food.

Major species occurring statewide in suitable habitat include the mallard, black duck, blue-winged teal, wood duck, ringnecked duck, scaup, bufflehead, common goldeneye, and coot.

Certain sites are preferred by migrant ducks and coots. Canvasback and redhead concentrate at the same aquatic sites heavily used in fall. For example, an aerial census of Lakes Beaver Dam, Fox, Emily, Maria, Puckaway, Green, Rush, Poygan, Butte des Morts, and Winnebago on 29 March 1953, disclosed an estimated 130,000 ducks present. Approximately one-third of each lake had open water. Two of the lakes, Poygan and Butte des Morts, held 120,000 of the ducks, of which 65,000 were canvasback. In Minnesota, Smith (1946) found that Lake Christina, a famous fall concentration site for canvasbacks, also supported the heaviest numbers in spring.

Temporary and permanent water areas, other than main concentration sites, are also used by canvasback and redhead, but to limited extent. Usually these areas are within a 1- to 20-mile radius of concentration sites. The ducks radiate out from these large congregations to feed in other suitable habitat. In the absence of hunting and with other human disturbance minimized because of wet fields, cold temperatures, or both, ducks consistently utilize many sites in spring which are used intermittently in fall, if at all.

In southwestern Wisconsin, in years when the soil is saturated and runoff waters are abundant, mallards quickly take advantage of new feeding and resting areas made available by temporary flooding. Certain stretches of the flood plain of the Wisconsin and Pecatonica Rivers are two areas where the magnitude of mallard use is related to the presence or absence of flood waters. Agricultural fields and bottomlands yielding acorns are heavily used when flooded.

The distribution of ducks in spring is also benefited by the accidental and purposeful burning of dense, solid stands of seed-producing, emergent, aquatic plants in winter or very early spring prior to the time of flooding. Winter burning on Horicon Marsh was started by J. R. Smith in 1946 (Grange, 1948:203) and has been done periodically ever since. These fires not only remove the mass of top growth that serves as a physical barrier prohibiting ducks from using the accumulated seeds on the marsh floor but also discourage invasion of woody vegetation. Charred areas, covered purposefully or naturally with a few inches of early spring flood water, serve as excellent puddle duck feeding areas.

In summary, use of specific aquatic sites by migratory ducks in spring appears to be governed primarily by (1) available open water, (2) the presence, abundance, and availability of preferred food, and (3) traditions established by the birds to use some sites more than others. Bennett (1938:37) and Lincoln (1939) emphasized that most species of waterfowl move northward in spring through the same flyways used in fall migration. Hochbaum (1955:226) stated that waterfowl build up traditions to use specific aquatic areas and stressed that these habits are passed from generation to generation through experience. Our observations emphasize that migratory puddle ducks are "opportunists" in reacting to favorable habitat conditions, and are much less bound by tradition than diving ducks, particularly the canvasback and redhead. Preferred foods are used by many species when it becomes available in acceptable environmental conditions along regular flight routes or within a 15- to 20-mile radius of regularly occupied concentration sites.

Factors Causing Mortality

Autopsy reports are used in combination with field observations to identify the presence of diseases, parasites, and poisons in wild ducks present in Wisconsin in spring. Field observations established the general magnitude of some local losses to ducks, including illegal killing and deaths resulting from spring muskrat trapping operations on Horicon Marsh.

Illegal killing of ducks and coots outside of the regular hunting season is not considered a major factor in Wisconsin. Game managers and conservation wardens hear shooting in spring and believe some of it is at ducks. However, over the past 20 years increased enforcement effort and improved cooperation from the public keeps illegal killing of ducks and coots at a minimum.

TABLE 90

Summary of Presence of Diseases, Parasites, and Poisons in Wild Ducks Collected and Examined in Wisconsin, 1938–58*

Pathological Factor Involved	Species Afflicted								
	Mallard	Black Duck	Pintail	Redhead	Canvas-back	Scaup	Common Goldeneye	Old Squaw	Common Merganser
Aspergillosis					X	X	X		
Gizzard worms	X						X		
Coccidiosis				X	X	X			
Flukes	X		X			X	X	X	
Lead poisoning	X			X	X	X	X		
Pneumonia						X	X	X	
Roundworms					X		X		
Sarcocystis		X				X			
Tapeworms						X			X

* Data from Hine (1956) and files of the Wisconsin Conservation Department. All ducks were autopsied in February, March, April, and May by pathologists of the Wisconsin Conservation Department or by veterinarians at the Wisconsin Department of Agriculture, Animal Disease Diagnostic Laboratory. Except for losses due to coccidiosis and lead poisoning, the number of ducks examined was from one to seven, with single birds being involved in the greatest number of cases.

Steel traps set in spring for muskrats catch and kill ducks and coots. In 1952, a special muskrat, mink, and raccoon trapping season was held on the state end of Horicon Marsh from April 1 through 15. On 24,447 trap-nights during these 15 days, 24 ducks and 29 coots were caught accidentally and killed in steel traps. This is approximately one death per 500 trap-nights of effort. Sixteen of the 24 ducks were mallards and blue-winged teal, species that commonly breed on the marsh. While numerically these losses may seem small, the fact that species breeding locally were largely involved is important. Sowls (1955:24) found that resident ducks arrived at the Delta marsh in Manitoba before the migrants passed through. Spring muskrat trapping seasons could remove some local breeders which use muskrat houses as loafing sites. Unless muskrat populations must be controlled to benefit the aquatic vegetation, conventional steel trapping on major, waterfowl breeding or concentration sites should be avoided in spring. If trapping must be carried out, techniques should be modified to eliminate the chances of catching waterfowl.

Nine pathological factors involved in the death of ducks and coots in Wisconsin have been identified (Table 90; Trainer and Fisher, 1963). Three factors, lead poisoning, coccidiosis and trematode infestations, are the most important in spring. Lead poisoning claims some ducks every year. Lakes receiving heavy gunning pressure and having rather hard bottoms are frequently involved, especially in springs when water levels are low. When temporary water areas with abundant feed supplies are limited or absent, and when levels of permanent water bodies have receded, more ducks die than in spring seasons of abundant flood water. Reduction of surface water concentrates spring migrant waterfowl and restricts their feeding area. Lakes where both diving and puddle ducks have died most frequently include Puckaway (Green Lake County), and Poygan and Butte des Morts (Winnebago County).

On Lake Puckaway, where bottom sampling in the winter of 1949 averaged 2.7 lead pellets per square foot for 100 square feet sampled (Hartmeister and Hansen, 1949), the relative importance of lead poisoning appears to be correlated with water levels in spring. The lower the water level in spring the greater potential there is for more ducks to die of lead poisoning. In the absence of hunting pressure, lead pellets scattered about blind sites apparently become available to the concentrated birds as water depth is reduced. When an area is completely dry, lead pellets again become unavailable to ducks and coots because the area is unattractive.

Bellrose (1959:254) concluded: "The extent to which the various species of waterfowl are exposed to shot pellets on the bottoms of marshes and lakes is influenced by the feeding habits of the birds and by the kinds of foods available, as well as by the numbers of shot pellets available." While some ducks die from lead poisoning each spring in Wisconsin, a major die-off (involving hundreds of ducks) has not yet occurred in any locality. Coots have infrequently died of lead poisoning. Apparently their habit of usually feeding along the water surface, including robbing submerged foods brought to the surface by other waterfowl, helps minimize opportunities for picking up lead pellets. Whether grit requirements of coots differ from those for ducks is unknown to us. Bellrose (1959:246) concluded that outbreaks of lead poisoning during the spring have seldom been noted among waterfowl. Principal losses in spring have occurred among swans and geese, not ducks or coots. Specific reasons for this differential mortality among groups of waterfowl are not understood well. We believe normal or above average water levels in spring make lead pellets in many water areas unavailable to puddle ducks but accessible to longer-necked geese and swans.

Coccidiosis has been encountered infrequently in Wisconsin. In one instance it was the main cause of death of a hundred or more ducks, principally canvasback and scaup. Between

1938 and 1958, only two cases of coccidiosis came to the attention of fieldmen. In December 1938, one wild mallard died from the disease at Horicon Marsh. In the spring of 1956, on the Mississippi River in Crawford and Vernon counties, an estimated minimum of 100 diving ducks died of coccidiosis. According to the late refuge manager Ray Steele (pers. comm., 1957), over 25,000 ducks, of which most were divers, used the pool where the diseased birds were gathered. Mr. Steele believed the birds picked up the disease before arriving on the river. Rising water levels at the time the migrating birds arrived in Wisconsin appeared to rule out the possibility of the birds picking up the disease organism on the Mssissippi River. Autopsies performed by both Wisconsin and U.S. Fish and Wildlife Service pathologists gave the same results. According to R. W. Burwell (U.S. Fish and Wildl. Serv., in litt., 16 May 1956), Carlton M. Herman reported that "The coccidia infections were the heaviest . . . ever observed in any species of waterfowl." Canvasback and scaup made up the bulk of the losses. Some of the birds autopsied were also infected with aspergillosis and other intestinal parasites. Dr. Herman concluded that while coccidiosis in itself was capable of causing all the losses that occurred, the findings of these other conditions indicated that it may not have been the only cause involved. The Animal Disease Diagnostic Laboratory in Wisconsin reported that the organism causing coccidiosis was *Tyzzeria perniciosa.* The importance of coccidiosis in diving ducks is unknown. This is one of the rare instances when it has been recorded.

Equally rare is the mortality of 600 coots in April of two years (1961–62) on Lake Butte des Morts. Fatalities were attributed to a species of trematode of the genus *Sphaeridiotrema,* presumably *S. globulus* (Trainer and Fisher, 1963). Cumulative effects of the fluke infestations, and stresses of migration and the prebreeding season resulted in the losses. This trematode had not previously been identified as a mortality factor of coots.

Wisconsin's Management Problems and Contribution

There are no major problems associated with the spring migrant duck and coot populations in Wisconsin. Crop depredations have been rare. On one occasion coots were reported feeding on and damaging alfalfa in a field. In the future, management must (1) help maintain the production of foods (plant and indirectly animal) on those aquatic areas most heavily used by ducks and coots, (2) encourage continued cooperation of the public to help reduce further illegal killing, and (3) maintain and develop adequate laws, and support efficient enforcement of them to safeguard the birds.

Wisconsin contributes to the welfare of the birds while they are enroute to their breeding grounds by supplying them with a variety and abundance of food. The primary and secondary agricultural regions of the state accommodate the bulk of the waterfowl. Within this area the quantity of available food varies from year to year depending upon (1) the acreage of unplowed, harvested corn fields remaining in localities where stubble feeders concentrate and radiate out to feed, (2) the amount of temporary water that floods land containing acorns, and weed and crop seeds, and (3) the amount of food produced the previous growing season by aquatic plants within and on the shores of permanent waters.

Summary

Characteristics of spring migration through Wisconsin were determined on the basis of our own limited field observations and reports secured from approximately 130 co-operators located in the state's 71 counties. Migrant ducks usually arrive in Wisconsin in late February. Common goldeneyes are the first to arrive. Peak populations of ducks and coots are present in April. Except for the scaup and possibly some blue-winged teal and ringnecks, migrant ducks and coots have largely departed from Wisconsin by May 5–10.

The bulk of the spring migrants are found in the primary and secondary agricultural regions in approximately the southern two-thirds of the state. Open water of certain streams provides the resting and feeding sites for the earliest migrants. As other types of water areas become ice-free, some of them are utilized. Use of specific aquatic sites in spring appears to be governed primarily by (1) available open water, (2) the presence, abundance, and availability of food within the open water, and (3) traditions established by the birds to use some sites more than others.

Death of ducks and coots in Wisconsin in spring has involved nine identified pathological factors: aspergillosis, gizzard worms, flukes, pneumonia, round worms, sarcocystis, tapeworms, coccidiosis, and lead poisoning. None of these factors are known to consistently cause mortality of major extent. Illegal killing of ducks and coots is also believed to be a minor factor. Steel trapping of muskrats in spring apparently kills largely local breeding ducks. Therefore, unless muskrat populations must be controlled to benefit aquatic vegetation, conventional steel trapping on major waterfowl breeding sites should be avoided in spring. The alternative is to use trapping techniques which preclude the possibility of accidentally catching waterfowl.

At this time, there are no major problems associated with the spring migrant duck and coot populations in Wisconsin.

APPENDIX C

Wisconsin Aquatic Habitat Resources of Important Value to Ducks and Coots

TABLE 91

Lakes, Flowages, and Sections of Streams of Importance to Ducks and Coots*

(In the column "Relative Value": M = moderate; H = High)

Geographic Province, County and Area Name	Streams		Lakes and Flowages		Relative Value
	Miles	Acreage	Number	Acreage	
NORTHERN HIGHLAND					
Ashland County					
Bear Lake				175	M
Bear Trap Creek	1	4			H
East Fork Chippewa	4	48			H
Honest John Lake				100	H
Kakagon River	1	4			H
Kakagon Slough				7,085	H
Wood Creek	2.5	20			H
Bayfield County					
Bony Lake				220	M
Eagle Lake				286	M
Hart Lake				286	M
Lower Eau Claire Lake				776	H
McGary Lake				100	M
Middle Eau Claire Lake				804	H
Millicent Lake				204	M
Mud Lake				168	M
Namekagon Lake				3,137	H
Owen Lake				1,396	H
Pike Lake				136	M
Star Lake				235	M
Totagatic Lake				558	H
Twin Bear Lake				264	M
Upper Eau Claire Lake				1,080	H
White River	12	96			H

TABLE 91 (Cont.)

Geographic Province, County and Area Name	Streams		Lakes and Flowages		Relative Value
	Miles	Acreage	Number	Acreage	
Douglas County					
Gordon (St. Croix) Flowage				2,500	H
Mulligan Lake				90	M
St. Croix Lake				876	M
St. Croix River	8	256			H
Forest County					
Atkins Lake				195	M
Bishop Lake				278	M
Hiles Mill Pond				107	M
Little Rice Lake				220	H
Metonga Lake				3,513	M
Pickerel Lake				1,299	M
Pine Lake				1,667	H
Rice Lake				218	M
Riley Lake				217	H
Wabikon Lake				129	H
Wolf River	4	15			M
Iron County					
Big Pine Lake				620	M
Flambeau Flowage				17,800	H
Giles Flowage				4,000	M
Trude Lake				908	M
Turtle Flowage				4,000	M
Langlade County					
Rolling Stone Lake				688	M
Lincoln County					
Alice Lake				1,491	M
Mohawksin Lake				1,898	M
Marathon County					
Big Eau Pleine Flowage				5,000	M
DuBay Flowage				6,700	M
Wausau Lake				1,900	H
Marinette County					
Menominee River	3	80			H
Noquebay Lake				2,419	H
Peshtigo River	2	19			H
Oconto County					
White Potato Lake				975	M
Oneida County					
Buckskin Lake				626	M
Gilmore Lake				293	M
Nokomis Lake				2,500	M
Pelican Lake				3,585	H
Rainbow Flowage				2,099	H
Rhinelander Flowage				734	H
Shiskebogama Lake				697	M
Spur Lake				106	M
Squirrel Lake				1,375	M
Tomahawk Lake				3,656	M
Willow Flowage (Reservoir)				5,215	M

TABLE 91 (Cont.)

Geographic Province, County and Area Name	Streams		Lakes and Flowages		Relative Value
	Miles	Acreage	Number	Acreage	
Price County					
Blockhouse Lake				216	M
Hultman Lake				190	M
North Fork Flambeau River	3	655			H
Pearson Lake				20	M
Pike Lake				734	H
Spirit Lake				122	H
Stone Lake				88	M
Wilson Flowage				304	H
Rusk County					
Chain Lake				440	H
Chippewa River	3	309			H
Clear Lake				95	M
Island Lake				520	M
Ladysmith Flowage				256	M
Little Rice Lake				205	H
McCann Lake				111	M
Sand Lake				189	M
Sawyer County					
Barker Lake				216	M
Big Lac Court Oreilles Lake				4,827	H
Big Sissabagama Lake				830	H
Blueberry Lake				322	M
Chetac Lake				2,177	H
Chippewa Flowage				17,248	H
Couderay River	12	96			H
Grindstone Lake				3,304	M
Lower Twin Lake				221	H
Namekagon River	8	64			H
Round Lake				3,276	M
Sand Lake				984	H
Totagatic Flowage (Nelson Lake)				2,500	M
Upper Twin Lake				235	M
West Fork Chippewa River	7	84			H
Shawano County					
Loon Lake				320	M
Mud Lake				160	M
Shawano Lake				6,178	H
White Lake				230	M
White Clay Lake				360	M
Taylor County					
Anderson Lake				41	M
James Lake				47	M
Long Lake				28	M
Mondeaux Flowage				790	M
North Harper Lake				60	M
North Spirit Lake				94	M
Spirit Lake				100	M
Vilas County					
Allequash Lake				405	M
Amik (Rice) Lake				187	M
Aurora Lake				92	H
Big Lake				850	M
Chewalah (Spruce) Lake				35	H
Devine Lake				116	H
East Ellarson Lake				137	H

TABLE 91 (Cont.)

Geographic Province, County and Area Name	Streams		Lakes and Flowages		Relative Value
	Miles	Acreage	Number	Acreage	
Vilas County (cont.)					
Fence Lake				3,465	M
Haskell Lake				90	M
Ike Walton Lake				1,414	M
Lac Vieux Desert				2,853	H
Little Trout Lake				991	M
Trout Lake				3,870	M
Total Northern Highland	71	1,750	106	160,147	
CENTRAL PLAIN					
Barron County					
Bear Lake				2,055	H
Beaver Dam Lake				1,397	M
Big Sand Lake				370	M
Lake Chetek				1,131	M
Lower Turtle Lake				290	M
Montanis				200	H
Mud Lake				300	M
Pokegama Lake				475	M
Prairie Lake				1,040	M
Red Cedar Lake				1,908	H
Rice Lake				545	M
Staples Lake				340	M
Stump Lake				110	H
Tuscobia Lake				195	H
Upper Turtle Lake				430	M
Burnett County					
Austin Lake				77	M
Bass Lake				40	M
Bass Lake				280	H
Bass Lake				50	M
Bass Lake				47	H
Bass Lake				174	H
Benoit Lake				274	H
Big Bear Lake				175	M
Big Doctor Lake				155	H
Big Sand Lake				1,390	H
Big McGraw Lake				190	M
Birch Island Lake				444	H
Birlingame Lake (Burlingame)				62	M
Briggs Lake				82	H
Buffalo Lake				85	M
Clam Lake				902	H
Clam River Flowage				600	H
Cranberry Lake				100	M
Crooked Lake				195	H
Crystal Lake				27	H
Deer Lake				154	M
Des Moines Lake				221	M
Devil's Lake				1,056	H
Doctor Lake				53	M
Eagle Lake				40	M
Elbow Lake				254	H
Fish Lake				40	H
Fish Lake				294	H
Gaslyn Lake				169	H

TABLE 91 (Cont.)

Geographic Province, County and Area Name	Streams		Lakes and Flowages		Relative Value
	Miles	Acreage	Number	Acreage	
Burnett County—(Cont.)					
Godfrey Lake				53	M
Green Lake				194	H
Ham Lake				275	H
Hanscome Lake				155	H
Holmes Lake				50	M
Johnson Lake				240	H
Kriner Lake				30	M
Lily Lake				165	H
Lipsett Lake				401	H
Little Bear Lake				111	M
Little McGraw Lake				50	M
Little Wood Lake				216	H
Little Yellow Lake				285	H
Long Lake				175	H
Long Lake				310	H
Long Lake				40	H
Loon Creek	15	91			H
Loon Lake				82	H
Lost Lake				20	H
Love Lake				50	H
Lower Clam Lake				387	H
Lower Clam River	7	106			H
Lower Twin Lake				55	H
Lower Yellow River	8	291			H
Mallard Lake				72	M
McKenzie Lake				960	H
Middle McKenzie Lake				535	H
Minerva Flowage				285	H
Mud Hen Lake				500	H
Nicaboyne Lake				302	H
Nigger Heel Lake				27	H
Oak Lake				186	H
Owl Lake				172	H
Pine Lake				114	H
Pine Lake				60	M
Point Lake				87	H
Pokegama Lake				198	M
Rice Lake				286	H
Rice Lake				112	H
Rice Lake				85	M
Rooney Lake				311	H
Round Lake				225	M
St. Croix River	6	364			H
Sand Lake				1,390	H
Shoal Lake				200	M
Spencer Lake				167	M
Spirit Lake				485	H
Staples Lake				52	M
Tabor Lake				187	H
Tanda Lake				47	H
Trade Lake				315	H
Twenty-Six Lake				204	M
Upper Clam River	7	85			H
Upper Twin Lake				60	H
Upper Yellow River	40	606			H
Viola Lake				274	M
Warner Lake				202	M
Webb Lake				673	H
Wood Lake				515	M
Yellow Lake				2,372	H

TABLE 91 (Cont.)

Geographic Province, County and Area Name	Streams		Lakes and Flowages		Relative Value
	Miles	Acreage	Number	Acreage	
Chippewa County					
Chain Lake				440	H
Chippewa Flowage				947	H
Chippewa River	3	364			H
Chippewa River	6	727			H
Cornell Flowage				577	H
Cornell Lake				192	M
Finley Lake				60	M
Holcombe Flowage				4,250	H
Long Lake				1,060	H
Loon Lake				129	M
Marshmiller Lake				438	H
Mud Lake				25	M
Popple Lake				97	M
Rock Lake				94	M
Round (Bass) Lake				215	M
Salisbury Lake				76	M
Sand Lake				286	M
Lake Wissota				6,200	H
Yellow River	2	24			H
Clark County					
Lake Arbutus				698	M
Dunn County					
Chippewa River	11	200			H
Elk Lake				62	H
Hay River	5	45			H
Menomin Lake				620	H
Tainter Lake				1,848	H
Eau Claire County					
Lake Eau Claire				966	M
Jackson County					
Black River	25	303			H
Horseshoe Lake Flowage				30	H
Juneau County					
Castle Rock Flowage				16,640	H
Petenwell Flowage				23,040	H
Yellow River	16	48			H
Marquette County					
Buffalo Lake				2,373	M
Harrisville Millpond				205	M
Neshkoro Millpond				288	M
Outagamie County					
Fox River	2	960			H
Polk County					
Apple River Flowage				2,100	H
Balsam Branch	3	55			H
Balsam Lake				937	H
Bass Lake				83	M
Bear Trap Lake				190	H
Big Butternut Lake				387	H
Big Round Lake				988	H

TABLE 91 (Cont.)

Geographic Province, County and Area Name	Streams		Lakes and Flowages		Relative Value
	Miles	Acreage	Number	Acreage	
Polk County—(Cont.)					
Blake Lake				369	M
Bloom Lake				60	H
Bone Lake				1,724	H
Cedar Lake				1,285	H
Clam Falls Flowage				25	M
Coon Lake				20	M
Diamond Lake				160	H
Half Moon Lake				582	H
Horseshoe Lake				732	H
Largin Lake				165	M
Little Butternut Lake				183	H
Long Trade Lake				70	H
Lower Apple River	5	364			H
McKenzie Lake				39	M
Mud Lake				75	H
Nigger Heel Lake				33	H
North Twin Lake				105	H
Pike Lake				110	H
Pine Lake				110	M
Pine Lake				50	M
Pipe Lake				207	M
Rice Bed Creek	1.5	18			H
Rice Lake				135	H
St. Croix River	1.5	109			H
South Twin Lake				20	H
Straight Lake				110	M
Straight River	10	91			H
Twin Lakes				40	H
Upper Apple River	10	121			H
Wapogasset Lake				1,130	H
White Ash Lake				340	M
Wild Goose Lake				280	H
Wolf Lake				93	M
Washburn County					
Balsam Lake				329	M
Gilmore Lake				425	M
Long Lake				3,950	H
Nancy Lake				590	H
Nancy Lake Flowage				813	H
Pokegama Lake				560	H
Rice Lake				185	H
Shell Lake				2,432	M
Spooner Lake				1,212	H
Waupaca County					
Clintonville Pond				95	M
Cynco Lake (Cincoe)				115	H
Iola Millpond				150	M
Manawa Millpond				70	M
Marion Millpond				65	M
Partridge Lake				990	H
Partridge Crop Lake				263	M
White Lake				1,120	M
Wolf River	5	182			H
Waushara County					
Auroraville Pond				170	H
Clark's Millpond				70	H
Fish Lake				177	H
Fish Lake				290	M
Kossel Lake (Kusel)				79	M

TABLE 91 (Cont.)

Geographic Province, County and Area Name	Streams		Lakes and Flowages		Relative Value
	Miles	Acreage	Number	Acreage	
Wood County					
Hemlock Creek	8	15			H
Yellow River	8	24			H
Total Central Plain	205	5,193	181	122,363	
WESTERN UPLAND					
Buffalo County					
Buffalo River	12	58			H
Chippewa River	13	236			H
Trempealeau River	3	18			H
Waumandee River	8	29			H
Crawford County					
Wisconsin River	30	19,200			H
Grant County					
Wisconsin River	Figures are listed in Crawford and Richland counties.				
La Crosse County					
Black River	15	364			H
Pierce County					
Rush Lake	6	44			H
Richland County					
Wisconsin River	30	14,400			H
St. Croix County					
Apple River	10	73			H
Bass Lake				425	H
Burkhardt Flowage				150	H
Cedar Lake				330	H
Hatfield Lake				155	M
Mallalieu Lake				240	M
Middle Flowage				156	M
Oak Ridge Lake				190	H
St. Croix Lake				2,586	H
Total Western Upland	127	34,422	8	4,232	
EASTERN RIDGES AND LOWLANDS					
Brown County					
Fox River	15	3,182			H
Calumet County					
Grass Lake				20	H
Columbia County					
Dates Millpond				153	H
Goose Lake				10	H
Grassy Lake				75	H
Mud Lake				1,000	H
Wisconsin Lake				5,328	M
Dane County					
Barney Lake				54	H
Bass Lake				75	H
Crystal Lake				410	M
Fish Lake				216	M
Goose Lake				45	H
Lake Kegonsa				2,716	H

TABLE 91 (Cont.)

Geographic Province, County and Area Name	Streams		Lakes and Flowages		Relative Value
	Miles	Acreage	Number	Acreage	
Dane County (Cont.)					
Lake Mendota				9,730	H
Monona Lake				3,335	M
Mud Lake				160	H
Mud Lake				195	M
Rice Lake				155	H
Turtle Lake				35	H
Waubesa Lake				2,113	H
Yahara River	3.5	25			H
Dodge County					
Beaver Dam Lake				5,440	M
Beaver Dam River	12	291			H
Chub Lake				20	H
Fox Lake				2,456	M
Hustisford Lake (Sinissippi)				1,711	H
Mud Lake				85	H
Rock River	7	255			H
Door County					
Kangaroo Lake				1,377	M
Lake Mackaysee (on Chambers Island)				350	M
Mud Lake				135	M
Fond du Lac County					
Mullet Lake				271	M
Green Lake County					
Green Lake				7,325	M
Maria Lake				499	H
Puckaway Lake				5,433	H
Jefferson County					
Bark River	7	51			H
Goose Lake				75	H
Koshkonong Lake				10,089	H
Mud Lake (s.w.)				75	H
Red Cedar Lake				419	H
Ripley Lake				428	M
Rock Lake				1,142	M
Kenosha County					
Camp Lake				482	H
Elizabeth Lake				688	M
Powers Lake				460	M
Silver Lake				499	M
Kewaunee County					
Kewaunee River	4	97			M
Manitowoc County					
West Twin River	4	145			M
Ozaukee County					
Hurias Lake				27	H
Milwaukee River	1	73			H
Cedar Creek	1	24			H

TABLE 91 (Cont.)

Geographic Province, County and Area Name	Streams		Lakes and Flowages		Relative Value
	Miles	Acreage	Number	Acreage	
Racine County					
Brown's Lake				396	M
Eagle Lake				530	H
Fox River	3.5	212			H
Long Lake				124	H
Tichigan Lake				391	H
Wind Lake				988	H
Rock County					
Clear Lake				87	M
Gibbs Lake				65	H
Grass Lake				70	M
Stone Lake				80	H
Turtle Creek	1	3			M
Walworth County					
Beulah Lake (chain)				570	M
Como Lake				1,123	H
Delavan Lake				1,038	H
Geneva Lake				5,239	H
Loraine Lake				91	H
North Lake				153	H
Number 10 Lake				12	H
Silver Lake				85	H
Turtle Creek	8	29			H
Whitewater Lake				620	H
Waukesha County					
Ashippun Lake				65	H
Beaver Dam Lake				56	M
Big Muskego Lake				592	H
Keesus Lake				227	M
LaBelle Lake				1,274	H
Little Muskego Lake				495	H
Lower Phantom Lake				243	M
Nagawicka Lake				918	H
Oconomowoc Lake				721	M
Okauchee Lake				1,104	H
Pewaukee Lake				2,502	H
School Section Lake				52	M
Silver Lake				232	M
Winnebago County					
Butte des Morts Lake				4,505	H
Fox River	10	848			H
Poygan Lake				10,992	H
Winnebago Lake				137,708	H
Winneconne Lake				3,264	H
Little Butte des Morts Lake				1,306	M
Rush Lake				3,070	H
Wolf River	5	242			H
Total Eastern Ridges and Lowlands	82	5,477	79	246,299	
Totals for Wisconsin	485	46,842	374	533,041	

* Mile and acreage figures are from (1) game managers and (2) Wis. Conserv. Dept. (1958).

TABLE 92

Federal and State Waterfowl Management Areas of Importance to Ducks and Coots*

Geographic Province and Area Name	County	Acreage			
		Total Controlled	Important Water and Wetland	Agricultural Crops and Pasture	Important to Ducks and Coots
Northern Highland					
Hoffman Lake	Ashland	5,562	500	0	500
Little Rice Flowage	Forest	2,600	500	0	500
Ackley	Langlade	2,100	50	50	100
Lang Forest Crop Land	Langlade	82	82	0	82
Merrill City Forest	Lincoln	920	100	0	100
George W. Mead	Marathon	20,795	2,000	300	2,300
McMillan Marsh	Marathon	5,700	1,700	0	1,700
Lake Noquebay	Marinette	1,300	900	0	900
Peshitgo	Marinette	4,000	2,000	50	2,050
Pensaukee Brook	Oconto	360	300	60	360
Peshtigo Harbor	Oconto	3,697	300	20	320
Spring Creek	Price	550	150	0	150
Potato Creek	Rusk	729	266	5	271
Ten Mile Creek	Rusk	40	40	0	40
Washington Creek	Rusk	516	232	0	232
Navarino	Shawano	5,500	50	50	100
Pershing	Taylor	4,895	500	5	505
Bear Springs	Vilas	200	53	0	53
Mann Creek	Vilas	200	109	0	109
Powell Marsh	Vilas	14,000	4,015	200	4,215
Stevenson Creek	Vilas	200	200	0	200
Whitney Lake	Vilas	320	175	0	175
Subtotal (22)		74,266	14,222	740	14,962
Central Plain					
Colburn	Adams	7,680	200	0	200
New Auburn	Barron	555	225	0	225
Amsterdam Slough	Burnett	3,737	280	0	280
Crex Meadows	Burnett	23,115	10,270	300	10,570
Fish Lake	Burnett	8,932	576	0	576
Keizer Lake	Burnett	1,350	247	0	247
Drywood Creek	Chippewa	40	0	0	0
Mud Lake	Dunn	131	20	0	20
Augusta	Eau Claire	2,000	600	0	600
Black River State Forest	Jackson	10,090	3,112	418	3,530
Meadow Valley	Juneau, Jackson, Monroe	58,000	3,200	800	4,000
Necedah National Refuge**	Juneau	39,608	11,200	2,249	13,449
Germania Marsh	Marquette	2,373	1,000	104	1,104
Outagamie	Outagamie	1,490	180	8	188
Rice Bed Creek	Polk	1,751	126	0	126
Poygan Marsh	Waushara	899	800	0	800
Sandhill Wildlife Area	Wood	9,350	1,000	300	1,300
Wood County	Wood	20,000	2,000	30	2,030
Subtotal (18)		191,101	35,036	4,209	39,245
Western Upland					
Tiffany	Buffalo	8,955	1,500	140	1,640
Blue River	Grant	2,784	1,353	0	1,353
Albany	Green	516	80	20	100
Browntown	Green	423	80	10	90
Avoca	Iowa	1,440	161	0	161

TABLE 92 (Cont.)

Geographic Province and Area Name	County	Acreage			
		Total Controlled	Important Water and Wetland	Agricultural Crops and Pasture	Important to Ducks and Coots
Yellowstone Lake	Lafayette	1,888	560	40	600
Van Loon	La Crosse	4,000	250	0	250
Bakkens Pond	Sauk	2,775	440	0	440
Upper Mississippi Refuge**	Buffalo, Trempealeau, La Crosse, Vernon, Crawford, Grant	88,307	43,452	0	43,452
Subtotal (9)		111,088	47,876	210	48,086
Eastern Ridges and Lowlands					
Sensiba	Brown	450	280	0	280
French's Creek	Columbia	1,882	800	0	800
Grassy Lake	Columbia	709	400	0	400
Mud Lake	Columbia	1,741	900	0	900
Pine Island	Columbia	5,000	100	331	431
Bass Lake	Dane	539	75	9	84
Deansville	Dane	2,500	39	0	39
Horicon Marsh	Dodge	10,846	9,000	1,000	10,000
Horicon National Refuge**	Dodge, Fond du Lac	20,796	12,275	8,466	20,741
Mud Lake	Dodge	2,629	150	0	150
Shaw Marsh	Dodge	641	40	0	40
Westford	Dodge	1,073	107	0	107
Eldorado Marsh	Fond du Lac	5,509	50	50	100
Mullet Marsh	Fond du Lac	1,200	400	0	400
Supple's Marsh	Fond du Lac	321	321	0	321
Grand River	Green Lake	1,299	600	100	700
Lake Mills	Jefferson	200	200	0	200
Princess Point	Jefferson	1,300	500	28	528
Rome Pond	Jefferson	1,000	800	0	800
Collins Marsh	Manitowoc	4,185	650	0	650
Killsnake Marsh	Manitowoc	1,900	1,600	0	1,600
Tichigan Marsh	Racine	1,089	200	0	200
Avon Bottom	Rock	1,341	120	0	120
Hanover	Rock	1,094	22	0	22
Lima Marsh	Rock	1,742	126	0	126
Storr's Lake	Rock	891	83	0	83
Turtle Creek	Rock	313	38	0	38
Sheboygan Marsh	Sheboygan	100	?	?	?
Allenton Marsh	Washington	1,907	60	9	69
Jackson Marsh	Washington	2,000	10	10	20
Theresa Marsh	Washington, Dodge	4,699	200	53	253
Big Muskego	Waukesha	3,200	2,000	0	2,000
Scuppernong	Waukesha	3,237	500	160	660
Vernon Marsh	Waukesha	2,846	250	200	450
Subtotal (34)		90,179	32,896	10,416	43,312
State Totals (83)		466,634	130,030	15,575	145,605

* Figures for U.S. Fish and Wildlife Service National Refuges are for 1958 and for Wisconsin Conservation Department projects for July 1962.

** Denotes a U.S. Fish and Wildlife Service National Refuge. All except three management areas are Wisconsin Conservation Department projects.

TABLE 93

Major Municipal Wildlife Management Areas of Importance to Ducks and Coots

Geographic Province and Area Name	County	Acreage (as of 1958) Total Controlled	Water	Agricultural Crops and Pasture	Important to Ducks and Coots
Northern Highland					
Lea Lake	Rusk	200	100	0	100
Central Plain					
Hortonville Mill Pond	Outagamie	80	80	0	80
Eastern Ridges and Lowlands					
Bay Beach Wildlife Sanctuary	Brown	215	80	0	80
Brown County Game Sanctuary	Brown	473	70	0	70
Sheboygan Marsh	Sheboygan	6,500	4,500	0	4,500
State Totals (5)		7,468	4,830	0	4,830

TABLE 94

Major Private Wildlife Management Areas of Importance to Ducks and Coots

Geographic Province and Area Name	County	Acreage (as of 1958) Total Controlled	Water	Agricultural Crops and Pasture	Important to Ducks and Coots
Western Upland					
Delta Fish and Fur Farm	Trempealeau	5,600	2,040	0	2,040
Eastern Ridges and Lowlands					
Better Farms	Fond du Lac	870	55	Waste grain	640
State Totals (2)		6,470	2,095	0	2,680

APPENDIX D

Duck and Coot Day-Use Indices for Certain Wisconsin Fall Concentration Sites*

* Duck and coot day-use indices are based on figures from regular periodic censuses. Figures for each year are the sum of the birds observed on October 1 and 15, November 1 and 15, and December 1. These sums were classified according to the 5-category numerical scale given below.

High = 10,000 or more
Moderately High = 5,000–9,999
Medium = 2,500–4,999
Moderately Low = 500–2,499
Low = 100–499

TABLE 95

Mallard Day-Use Indices for Certain Wisconsin Fall Concentration Sites

Site*	Average**	Yearly Totals[1] 1949	1950	1951	1952	1953	1954	1955	1956	1957
1. Horicon Marsh	37,700	900	6,700	20,400	41,500	33,400	103,800	56,900	27,600	48,500
2. Necedah National Wildlife Refuge	19,800	—	—	—	—	—	5,500	12,200	23,500	38,000
3. Miss. River—Pool 11	13,700	—	—	—	—	—	—	18,500	8,900	—
4. Lake Geneva	13,600	—	—	—	—	—	—	—	24,600	2,600
5. Miss. River—Pool 7	9,600	—	—	—	—	—	—	14,800	4,500	—
6. Lake Koshkonong	8,500	—	—	1,300	8,500	20,100	4,500	10,000	12,400	2,600
7. Bay Beach Sanctuary	7,800	—	—	—	—	—	6,900	8,800	6,200	9,400
8. Lake Poygan	7,700	3,700	14,300	—	—	—	1,900	2,900	20,100	3,400
9. Miss. River—Pool 4	7,500	—	—	—	—	—	—	7,700	7,400	—
10. Miss. River—Pool 9	7,500	—	—	—	—	—	—	7,400	7,700	—
11. Lake Wisconsin (Lake Wis. and Grade Bay)	(7,000)	—	—	—	—	—	—	7,000	—	—
12. Miss. River—Hastings to Red Wing	6,900	—	—	—	—	—	—	3,600	10,300	—
13. Sandhill Wildlife Area	(6,500)	—	—	—	—	—	—	—	6,500	—
14. Big Lake Butte des Morts	5,600	3,800	11,500	—	—	—	2,400	6,000	3,800	6,300
15. Miss. River—Pool 10	5,600	—	—	—	—	—	—	4,500	6,600	—
16. Lake Mendota	5,400	—	—	1,700	5,400	6,500	2,700	2,100	16,100	3,600
17. Miss. River—Pool 6	4,700	—	—	—	—	—	—	7,600	1,800	—
18. Thornton Closed Area	4,500	—	1,000	600	Trace	100	9,100	0	25,500	Trace
19. Lake Delavan	4,400	—	—	—	—	—	—	—	4,100	4,800
20. Miss. River—Pool 8	4,000	—	2,000	700	2,100	—	—	7,500	7,700	—

TABLE 95 (Cont.)

Site*	Average**	Yearly Totals[1] 1949	1950	1951	1952	1953	1954	1955	1956	1957
21. Miss. River—Pool 5	3,600	—	—	—	—	—	—	5,200	1,900	—
22. Lake Kegonsa	3,500	—	—	Trace	1,200	2,500	4,800	8,500	7,000	600
23. Petenwell Flowage	3,400	—	—	—	—	—	600	8,300	1,200	—
24. Lake Puckaway	3,400	2,600	4,900	—	—	—	3,300	5,800	1,400	2,200
25. Crex Meadows Conservation Area	2,700	100	600	700	400	900	200	8,500	7,400	5,500
26. Green Bay	2,100	—	—	1,100	1,700	—	1,800	3,000	2,700	—
27. Brown County Game Sanctuary	1,800	—	—	—	—	—	800	1,900	1,300	3,400
28. Castle Rock Flowage	1,700	—	—	—	—	—	900	3,800	400	—
29. Rush Lake	1,700	500	400	—	—	—	1,000	2,400	3,900	1,800
30. Lake Como	(1,600)	—	—	—	—	—	—	—	—	1,600
31. Lake Waubesa	1,500	—	—	100	700	1,500	500	2,500	4,700	100
32. Lower Twin Lake	1,300	5,900	4,100	Trace	Trace	Trace	Trace	Trace	Trace	—
33. Miss River—Red Wing to Maiden Rock	1,200	—	—	—	—	—	—	500	1,900	—
34. Lake Winneconne	1,100	1,300	2,200	—	—	—	300	1,100	1,500	200
35. Yellow River (segment)	1,100	5,700	400	—	100	Trace	100	1,100	100	—
36. Lake Winnebago	1,000	1,000	800	—	—	—	—	1,300	700	—
37. Beaver Dam Lake	900	Trace	300	100	—	—	—	3,700	200	—
38. Meadow Valley Conservation Area	800	—	—	—	—	—	300	1,200	1,000	—
39. Fish Lake	800	3,400	200	1,600	100	500	100	400	Trace	—
40. Rainbow Flowage	700	—	—	—	900	1,600	900	800	200	Trace
41. Gordon Flowage	(700)	—	—	—	—	—	—	—	700	—
42. Black River Falls State Forest	700	—	—	—	—	—	400	900	900	—
43. Big Sand Lake	600	4,300	100	Trace	Trace	100	Trace	600	Trace	—
44. Oakridge Refuge	(500)	—	—	—	—	—	—	—	—	500
45. Partridge Lake	500	—	—	—	—	—	—	—	600	400
46. Crawfish River (segment)	500	—	—	500	300	700	100	1,100	—	—
47. Grassy Lake	(500)	—	—	—	—	—	—	500	—	—
48. Wood County Public Hunting Grounds	500	—	—	—	—	—	100	900	400	—
49. Mud Lake	400	—	—	—	—	—	500	400	400	300
50. Wis. River—Muscoda to Prairie du Chien	(400)	—	—	—	—	—	—	400	—	—
51. Clam Lake	400	800	1,100	100	200	300	100	500	300	—
52. Miss. River—Maiden Rock to Wabasha	400	—	—	—	—	—	—	300	400	—
53. Fox Lake	400	600	100	—	—	—	—	700	—	—
54. Yellowstone Conservation Area	300	—	—	—	—	—	Trace	300	200	800
55. Oconomowoc Lake	(300)	—	—	—	—	—	—	—	300	—
56. Lake Maria	300	800	100	—	—	—	—	—	—	Trace
57. Big Green Lake	300	200	500	—	—	—	Trace	200	500	—
58. Miss. River—Pool 5a	200	—	—	—	—	—	—	Trace	300	—
59. Thunder Lake	200	—	—	—	1,000	100	Trace	Trace	100	—
60. Flambeau Flowage	(200)	—	—	—	—	—	—	—	—	200
61. Rock Prairie Goose Refuge	200	—	—	—	—	—	0	800	0	0
62. Pine Island Conservation Area	200	—	—	—	—	—	200	200	300	100
63. Wingra Lake	(200)	—	—	200	—	—	—	—	—	—
64. Eagle Lake	(200)	—	—	—	—	—	—	—	200	—
65. Rock Lake	200	—	—	100	100	600	400	Trace	Trace	—
66. Waunakee Marsh	(200)	—	—	—	—	—	—	200	—	—
67. Partridge Crop	(200)	—	—	—	—	—	—	—	—	200
68. Lake Sinissippi	200	—	—	Trace	—	500	0	300	0	—
69. Yellow Lake	200	0	1,000	0	Trace	100	Trace	200	Trace	—
70. Powell Marsh	(200)	—	—	—	—	—	—	—	—	200
71. Lake Beulah	(200)	—	—	—	—	—	—	—	200	—
72. Apple River	(200)	—	—	—	—	—	—	—	—	200
73. Crystal Lake	(100)	—	—	—	—	—	—	100	—	—
74. Lake Arbutus	100	—	—	—	—	—	200	200	Trace	0
75. Pewaukee Lake	(100)	—	—	—	—	—	—	—	100	0
76. Wis. River—Mazomanie to Sauk City	(100)	—	—	—	—	—	—	100	—	—
77. St. Croix River (segment)	100	200	Trace	—	100	100	Trace	200	200	—
78. Yellow River (segment)	100	900	Trace	—	Trace	Trace	Trace	Trace	Trace	—
79. Rice Lake	100	—	Trace	100	200	200	Trace	400	Trace	—
80. Powers Lake	(100)	—	—	—	—	—	—	—	100	—

* A total of 200 aquatic sites was censused periodically in some years between 1949 and 1957. Only those sites averaging 100 or more mallard day-use per year are listed here.

** Explanation of figures in brackets. General field observations for a period of years indicated that relatively few mallards used this site; numerical data were secured for 1 year to help classify the site.

[1] Based on periodic aerial and ground censuses. For each year, population estimates were summed for October 1 and 15, November 1 and 15, and December. 1. Dash indicates that data were unavailable or available for only part of the 5 census dates. All figures are rounded to the nearest hundred.

TABLE 96

Black Duck Day-Use Indices for Certain Wisconsin Fall Concentration Sites

Site*	Average**	Yearly Totals[1] 1949	1950	1951	1952	1953	1954	1955	1956	1957
1. Horicon Marsh	9,800	400	6,200	11,400	22,600	12,200	18,200	8,300	3,400	5,200
2. Lake Poygan	5,300	2,500	12,800	—	—	—	1,500	3,200	9,500	2,400
3. Big Lake Butte des Morts	5,000	2,500	9,900	—	—	—	1,600	2,500	6,400	7,400
4. Necedah National Wildlife Refuge	4,000	—	—	—	—	—	2,100	3,000	6,700	4,200
5. Lake Koshkonong	3,600	—	—	1,100	5,400	11,000	1,200	4,200	2,200	400
6. Bay Beach Sanctuary	3,600	—	—	—	—	—	3,200	5,100	2,900	3,100
7. Green Bay	2,200	—	—	1,100	2,000	—	3,400	2,600	2,000	—
8. Lake Winnebago	2,000	1,000	1,200	—	—	—	—	4,900	900	—
9. Lake Geneva	1,900	—	—	—	—	—	—	—	2,900	1,000
10. Lake Puckaway	1,700	1,100	4,900	—	—	—	2,000	1,000	400	900
11. Lake Mendota	1,400	—	—	1,100	1,700	1,500	1,200	1,100	2,700	500
12. Sandhill Wildlife Area	(1,300)	—	—	—	—	—	—	—	1,300	—
13. Lake Kegonsa	1,200	—	—	Trace	900	2,000	1,100	3,500	700	400
14. Miss. River—Pool 7	1,200	—	—	—	—	—	—	2,100	200	—
15. Lake Delavan	1,100	—	—	—	—	—	—	—	1,000	1,100
16. Lake Winneconne	1,000	1,200	1,800	—	—	—	300	1,300	700	800
17. Lake Wisconsin (Grade Bay to Lake Wisconsin)	(1,000)	—	—	—	—	—	—	1,000	—	—
18. Lake Waubesa	900	—	—	100	500	900	1,000	2,900	1,000	Trace
19. Miss River—Pool 8	800	—	700	300	1,600	—	—	500	600	—
20. Petenwell Flowage	70	—	—	—	—	—	200	1,200	700	—
21. Brown County Game Sanctuary	700	—	—	—	—	—	300	800	500	1,300
22. Rainbow Flowage	700	—	—	—	900	1,400	1,300	600	200	Trace
23. Miss. River—Pool 9	700	—	—	—	—	—	—	1,100	300	—
24. Castle Rock Flowage	500	—	—	—	—	—	300	900	400	—
25. Thornton Closed Area	500	—	1,000	500	100	Trace	200	0	2,300	Trace
26. Oakridge Refuge	(500)	—	—	—	—	—	—	—	—	500
27. Miss. River—Pool 5	400	—	—	—	—	—	—	700	200	—
28. Flambeau Flowage	(400)	—	—	—	—	—	—	—	—	400
29. Rush Lake	400	200	400	—	—	—	400	400	600	600
30. Miss. River—Hastings to Red Wing	300	—	—	—	—	—	—	400	300	—
31. Miss. River—Pool 4	300	—	—	—	—	—	—	400	200	—
32. Big Green Lake	300	200	500	—	—	—	0	200	500	—
33. Miss. River—Pool 6	200	—	—	—	—	—	—	200	100	—
34. Miss. River—Pool 11	200	—	—	—	—	—	—	300	100	—
35. Black River Falls State Forest	200	—	—	—	—	—	Trace	200	400	—
36. Meadow Valley Conservation Area	200	—	—	—	—	—	Trace	200	400	—
37. Thunder Lake	200	—	—	—	700	100	200	Trace	100	—
38. Beaver Dam Lake	200	Trace	100	100	—	—	—	700	Trace	—
39. Pewaukee Lake	(200)	—	—	—	—	—	—	—	200	—
40. Powell Marsh	(200)	—	—	—	—	—	—	—	—	200
41. Fish Lake	100	400	100	700	Trace	Trace	Trace	0	0	Trace
42. Lower Twin Lake	100	300	500	0	Trace	0	0	0	0	—
43. Wood County Public Hunting Grounds	100	—	—	—	—	—	Trace	100	200	—
44. Lake Wingra	(100)	—	—	100	—	—	—	—	—	—
45. Crawfish River (segment)	100	—	—	100	200	200	Trace	200	—	—
46. Lake Maria	100	300	100	—	—	—	—	—	—	Trace
47. Partridge Lake	100	—	—	—	—	—	—	—	100	100
48. Gordon Flowage	(100)	—	—	—	—	—	—	—	100	—

* A total of 200 aquatic sites was censused periodically in some years between 1949 and 1957. Only those sites averaging 100 or more black duck day-use per year are listed here.

** Explanation of figures in brackets. General field observations for a period of years indicated that relatively few black ducks used this site; numerical data were secured for 1 year to help classify the site.

[1] Based on periodic aerial and ground censuses. For each year, population estimates were summed for October 1 and 15, November 1 and 15, and December 1. Dash indicates that data were unavailable or available for only part of the 5 census dates. All figures are rounded to the nearest hundred.

TABLE 97

Blue-winged Teal Day-Use Indices for Certain Wisconsin Fall Concentration Sites

Site*	Average**	Yearly Totals[1]								
		1949	1950	1951	1952	1953	1954	1955	1956	1957
1. Miss. River—Pool 10	1,500	—	—	—	—	—	—	2,700	300	—
2. Miss. River—Pool 11	1,300	—	—	—	—	—	—	2,000	600	—
3. Miss. River—Pool 7	1,000	—	—	—	—	—	—	1,700	400	—
4. Green Bay	1,000	—	—	400	500	—	500	700	3,000	—
5. Horicon Marsh	1,000	1,200	200	3,400	600	1,000	200	900	500	800
6. Miss. River—Pool 9	900	—	—	—	—	—	—	1,300	600	—
7. Lake Poygan	900	800	400	—	—	—	700	2,100	500	800
8. Lake Koshkonong	700	—	—	2,900	100	Trace	700	400	500	100
9. Necedah National Wildlife Refuge	500	—	—	—	—	—	Trace	300	700	900
10. Miss. River—Pool 5	500	—	—	—	—	—	—	700	200	—
11. Miss. River—Pool 6	500	—	—	—	—	—	—	800	100	—
12. Big Lake Butte des Morts	500	200	400	—	—	—	Trace	1,100	200	800
13. Miss. River—Pool 8	400	—	Trace	100	300	—	—	600	800	—
14. Mud Lake (Columbia County)	400	—	—	—	—	—	700	300	300	400
15. Big Muskego Lake	(400)	—	—	—	—	—	—	—	400	—
16. Miss. River—Red Wing to Maiden Rock	400	—	—	—	—	—	—	400	300	—
17. Oakridge Refuge	(300)	—	—	—	—	—	—	—	—	300
18. Lake Puckaway	300	100	500	—	—	—	100	500	200	500
19. Waunakee Marsh	(300)	—	—	—	—	—	—	300	—	—
20. Rush Lake	300	100	Trace	—	—	—	700	500	300	100
21. Lake Winnebago	300	300	Trace	—	—	—	—	700	100	—
22. Gordon Flowage	(300)	—	—	—	—	—	—	—	300	—
23. Yellowstone Conservation Area	300	—	—	—	—	—	0	100	300	600
24. Miss. River—Hastings to Red Wing	300	—	—	—	—	—	—	200	300	—
25. Miss. River—Pool 4	300	—	—	—	—	—	—	200	300	—
26. Flambeau Flowage	(200)	—	—	—	—	—	—	—	—	200
27. Crawfish River (segment)	200	—	—	0	Trace	300	200	300	—	—
28. Wood County Public Hunting Grounds	200	—	—	—	—	—	Trace	200	200	—
29. Thunder Lake	100	—	—	—	500	Trace	Trace	0	0	—
30. Miss. River—Maiden Rock to Wabasha	100	—	—	—	—	—	—	100	100	—
31. Meadow Valley Conservation Area	100	—	—	—	—	—	Trace	200	100	—
32. Crex Meadows Conservation Area	100	Trace	300	Trace	Trace	Trace	0	200	300	100
33. Clam Lake	100	200	400	100	Trace	100	Trace	200	200	—
34. Pine Island Conservation Area	100	—	—	—	—	—	200	0	300	0
35. Lake Winneconne	100	100	100	—	—	—	0	100	600	0
36. Lake Mendota	100	—	—	Trace	200	0	500	0	Trace	200

* A total of 200 aquatic sites was censused periodically in some years between 1949 and 1957. Only those sites averaging 100 or more blue-winged teal day-use per year are listed here.

** Explanation of figures in brackets. General field observations for a period of years indicated that relatively few blue-winged teal used this site; numerical data were secured for 1 year to help classify the site.

[1] Based on periodic aerial and ground censuses. For each year, population estimates were summed for October 1 and 15, November 1 and 15, and December 1. Dash indicates that data were unavailable or available for only part of the 5 census dates. All figures are rounded to the nearest hundred.

TABLE 98

American Widgeon Day-Use Indices for Certain Wisconsin Fall Concentration Sites

Site*	Average**	Yearly Totals[1] 1949	1950	1951	1952	1953	1954	1955	1956	1957
1. Horicon Marsh	49,000	5,300	5,100	22,500	28,100	21,700	135,800	81,300	114,200	26,700
2. Miss. River—Pool 7	6,800	—	—	—	—	—	—	9,700	3,900	—
3. Miss. River—Pool 5	4,500	—	—	—	—	—	—	4,900	4,000	—
4. Big Lake Butte des Morts	3,500	5,200	6,200	—	—	—	2,100	1,200	2,000	4,400
5. Lake Poygan	3,000	3,500	5,900	—	—	—	2,500	1,300	700	4,200
6. Miss. River—Pool 9	2,500	—	—	—	—	—	—	2,800	2,100	—
7. Necedah National Wildlife Refuge	2,300	—	—	—	—	—	900	1,100	1,300	5,900
8. Miss. River—Pool 11	2,000	—	—	—	—	—	—	3,000	900	—
9. Miss. River—Pool 4	1,800	—	—	—	—	—	—	2,600	1,100	—
10. Partridge Crop Lake	(1,700)	—	—	—	—	—	—	—	—	1,700
11. Rush Lake	1,600	1,500	1,200	—	—	—	0	100	600	6,500
12. Lake Winneconne	1,300	100	Trace	—	—	—	Trace	6,600	1,200	100
13. Miss. River—Pool 8	1,100	—	200	100	Trace	—	—	2,200	3,100	—
14. Miss. River—Hastings to Red Wing	800	—	—	—	—	—	—	800	900	—
15. Green Bay	800	—	—	1,300	1,100	—	700	200	800	—
16. Lake Puckaway	800	1,600	1,400	—	—	—	Trace	600	100	—
17. Miss. River—Pool 6	400	—	—	—	—	—	—	600	300	—
18. Miss. River—Maiden Rock to Wabasha	300	—	—	—	—	—	—	0	600	—
19. Fox Lake	300	600	200	—	—	—	—	0	—	—
20. Oakridge Refuge	(300)	—	—	—	—	—	—	—	—	300
21. Lake Koshkonong	200	—	—	400	Trace	100	700	Trace	200	300
22. Lake Mendota	200	—	—	600	100	100	100	100	Trace	—
23. Cincoe Lake	200	—	—	—	—	—	—	—	300	100
24. Lake Winnebago	100	300	300	—	—	—	—	100	0	—

* A total of 200 aquatic sites was censused periodically in some years between 1949 and 1957. Only those sites averaging 100 or more American widgeon day-use per year are listed here.

** Explanation of figures in brackets. General field observations for a period of years indicated that relatively few American widgeon used this site; numerical data were secured for 1 year to help classify the site.

[1] Based on periodic aerial and ground censuses. For each year, population estimates were summed for October 1 and 15, November 1 and 15, and December 1. Dash indicates that data were unavailable or available for only part of the 5 census dates. All figures are rounded to the nearest hundred.

TABLE 99

Gadwall Day-Use Indices for Certain Wisconsin Fall Concentration Sites

Site*	Average**	Yearly Totals[1] 1949	1950	1951	1952	1953	1954	1955	1956	1957
1. Horicon Marsh	5,200	0	200	0	100	41,800	1,600	800	1,600	1,000
2. Miss. River—Pool 7	600	—	—	—	—	—	—	800	300	—
3. Miss. River—Pool 9	500	—	—	—	—	—	—	700	200	—
4. Miss. River—Pool 8	300	—	100	100	200	—	—	200	1,000	—
5. Miss. River—Pool 11	300	—	—	—	—	—	—	500	200	—
6. Lake Wisconsin (Grade Bay and Lake Wisconsin)	(300)	—	—	—	—	—	—	300	—	—
7. Necedah National Wildlife Refuge	300	—	—	—	—	—	0	100	600	400
8. Miss. River—Pool 5	100	—	—	—	—	—	—	100	100	—
9. Oakridge Refuge	(100)	—	—	—	—	—	—	—	—	100

* A total of 200 aquatic sites was censused periodically in some years between 1949 and 1957. Only those sites averaging 100 or more gadwall day-use per year are listed here.

** Explanation of figures in brackets. General field observations for a period of years indicated that relatively few gadwalls used this site; numerical data were secured for 1 year to help classify the site.

[1] Based on periodic aerial and ground censuses. For each year, population estimates were summed for October 1 and 15, November 1 and 15, and December 1. Dash indicates that data were unavailable or available for only part of the 5 census dates. All figures are rounded to the nearest hundred.

TABLE 100

Pintail Day-Use Indices for Certain Wisconsin Fall Concentration Sites

Site*	Average**	Yearly Totals[1] 1949	1950	1951	1952	1953	1954	1955	1956	1957
1. Horicon Marsh	5,800	2,500	2,900	1,600	9,000	4,400	22,400	3,600	3,700	2,300
2. Necedah National Wildlife Refuge	3,400	—	—	—	—	—	500	3,400	2,900	6,700
3. Big Lake Butte des Morts	3,200	3,100	11,000	—	—	—	800	100	900	3,500
4. Miss. River—Pool 7	1,800	—	—	—	—	—	—	3,400	300	—
5. Miss. River—Pool 5	1,800	—	—	—	—	—	—	2,600	900	—
6. Lake Poygan	1,700	4,200	4,000	—	—	—	500	300	200	900
7. Miss. River—Pool 6	1,600	—	—	—	—	—	—	3,100	100	—
8. Miss. River—Pool 4	1,500	—	—	—	—	—	—	2,300	700	—
9. Miss. River—Hastings to Red Wing	1,300	—	—	—	—	—	—	600	2,100	—
10. Miss. River—Pool 9	1,000	—	—	—	—	—	—	900	1,100	—
11. Lake Puckaway	800	800	100	—	—	—	100	2,100	100	1,500
12. Rush Lake	700	800	200	—	—	—	300	300	400	2,100
13. Miss. River—Pool 11	600	—	—	—	—	—	—	1,000	300	—
14. Miss. River—Pool 8	300	—	100	200	100	—	—	700	600	—
15. Petenwell Flowage	300	—	—	—	—	—	0	400	100	—
16. Oakridge Refuge	(300)	—	—	—	—	—	—	—	—	300
17. Lake Koshkonong	300	—	—	100	600	200	400	300	100	100
18. Sandhill Wildlife Area	(300)	—	—	—	—	—	—	—	300	—
19. Partridge Crop Lake	(300)	—	—	—	—	—	—	—	—	300
20. Lake Maria	200	600	Trace	—	—	—	—	—	—	0
21. Lake Wisconsin (Grade Bay to Lake Wisconsin)	(200)	—	—	—	—	—	—	200	—	—
22. Lake Winneconne	200	700	300	—	—	—	Trace	—	Trace	0
23. Black River Falls State Forest	200	—	—	—	—	—	0	100	300	—
24. Brown County Game Sanctuary	200	—	—	—	—	—	0	Trace	100	500
25. Green Bay	200	—	—	300	200	—	Trace	Trace	300	—
26. Lake Winnebago	100	400	200	—	—	—	—	0	0	—
27. Waunakee Marsh	(100)	—	—	—	—	—	—	100	—	—
28. Bay Beach Game Sanctuary	100	—	—	—	—	—	Trace	200	200	100
29. Miss. River—Red Wing to Maiden Rock	100	—	—	—	—	—	—	100	100	—
30. Miss. River—Pool 10	100	—	—	—	—	—	—	300	Trace	—

* A total of 200 aquatic sites was censused periodically in some years between 1949 and 1957. Only those sites averaging 100 or more pintail day-use per year are listed here.

** Explanation of figures in brackets. General field observations for a period of years indicated that relatively few pintails used this site; numerical data were secured for 1 year to help classify the site.

[1] Based on periodic aerial and ground censuses. For each year, population estimates were summed for October 1 and 15, November 1 and 15, and December 1. Dash indicates that data were unavailable or available for only part of the 5 census dates. All figures are rounded to the nearest hundred.

TABLE 101

Green-winged Teal Day-Use Indices for Certain Wisconsin Fall Concentration Sites

Site*	Average**	Yearly Totals[1] 1949	1950	1951	1952	1953	1954	1955	1956	1957
1. Necedah National Wildlife Refuge	800	—	—	—	—	—	0	0	400	2,700
2. Miss. River—Pool 9	500	—	—	—	—	—	—	500	500	—
3. Miss. River—Pool 11	300	—	—	—	—	—	—	600	Trace	—
4. Miss. River—Pool 6	300	—	—	—	—	—	—	500	100	—
5. Miss. River—Pool 7	200	—	—	—	—	—	—	400	100	—
6. Clam Lake	200	Trace	1,200	100	100	Trace	Trace	Trace	100	—
7. Green Bay	200	—	—	Trace	100	—	0	0	700	—
8. Miss. River—Pool 10	200	—	—	—	—	—	—	Trace	300	—
9. Horicon Marsh	100	100	Trace	100	100	100	0	Trace	800	100
10. Miss. River—Pool 4	100	—	—	—	—	—	—	200	100	—
11. Brown County Game Sanctuary	100	—	—	—	—	—	0	0	0	400

* A total of 200 aquatic sites was censused periodically in some years between 1949 and 1957. Only those sites averaging 100 or more green-winged teal day-use per year are listed here.

** Explanation of figures in brackets. General field observations for a period of years indicated that relatively few green-winged teal used this site; numerical data were secured for 1 year to help classify the site.

[1] Based on periodic aerial and ground censuses. For each year, population estimates were summed for October 1 and 15, November 1 and 15, and December 1. Dash indicates that data were unavailable or available for only part of the 5 census dates. All figures are rounded to the nearest hundred.

TABLE 102

Canvasback Day-Use Indices for Certain Wisconsin Fall Concentration Sites

*Site	Average**	Yearly Totals[1] 1949	1950	1951	1952	1953	1954	1955	1956	1957
1. Lake Poygan	27,400	3,500	8,300	—	—	—	10,800	69,800	56,600	15,300
2. Lake Mendota	24,000	—	—	7,800	16,100	19,200	51,700	40,300	18,200	14,500
3. Lake Butte des Morts	7,500	1,700	2,100	—	—	—	1,200	12,500	3,900	23,900
4. Lake Winneconne	7,000	4,500	900	—	—	—	6,600	16,500	12,100	1,300
5. Green Bay	3,500	—	—	5,800	3,000	—	3,700	3,200	2,000	—
6. Lake Pepin	3,200	—	—	—	—	—	—	700	5,800	—
7. Miss. River—Pool 5	3,000	—	—	—	—	—	—	2,600	3,400	—
8. Lake Pewaukee	(2,000)	—	—	—	—	—	—	—	2,000	—
9. Lake Koshkonong	1,200	—	—	Trace	2,600	1,600	200	0	3,700	100
10. Lake Puckaway	1,100	1,100	Trace	—	—	—	200	2,800	1,000	1,400
11. Lake Geneva	900	—	—	—	—	—	—	—	1,500	300
12. Miss. River—Pool 8	600	—	500	100	200	—	—	1,300	1,000	—
13. Lake Winnebago	500	400	200	—	—	—	—	Trace	1,400	—
14. Miss. River—Pool 11	400	—	—	—	—	—	—	600	200	—
15. Lake Kegonsa	300	—	—	0	0	1,700	100	Trace	400	100
16. Miss. River—Pool 9	300	—	—	—	—	—	—	200	300	—
17. Yellow Lake	300	600	700	200	100	300	200	200	200	—
18. Clam Lake	200	200	Trace	100	200	100	Trace	400	300	—
19. Fox Lake	200	100	300	—	—	—	—	200	—	—
20. Miss. River—Pool 6	200	—	—	—	—	—	—	400	100	—
21. Partridge Crop	(200)	—	—	—	—	—	—	—	—	200
22. Crystal Lake	(100)	—	—	—	—	—	—	100	—	—
23. Lake Waubesa	100	—	—	0	100	100	0	Trace	500	Trace
24. Lake Wisconsin	(100)	—	—	—	—	—	—	100	—	—
25. Lake Okauchee	(100)	—	—	—	—	—	—	—	100	—
26. Lake Elizabeth	(100)	—	—	—	—	—	—	—	100	—
27. Miss. River—Pool 7	100	—	—	—	—	—	—	200	0	—

* A total of 200 aquatic sites was censused periodically in some years between 1949 and 1957. Only those sites having 100 or more canvasback day-use per year are listed here.

** Explanation of figures in brackets. General field observations for a period of years indicated that relatively few canvasbacks used this site; numerical data were secured for 1 year to help classify the site.

[1] Based on periodic aerial and ground censuses. For each year, population estimates were summed for October 1 and 15, November 1 and 15, and December 1. Dash indicates that data were unavailable or available for only part of the 5 census dates. All figures are rounded to the nearest hundred.

TABLE 103

Redhead Day-Use Indices for Certain Wisconsin Fall Concentration Sites

Site*	Average	Yearly Totals[1] 1949	1950	1951	1952	1953	1954	1955	1956	1957
1. Lake Poygan	5,800	3,200	Trace	—	—	—	1,700	20,200	6,100	3,400
2. Lake Winneconne	3,700	3,900	100	—	—	—	0	12,400	5,800	200
3. Lake Pepin	2,600	—	—	—	—	—	—	700	4,600	—
4. Lake Puckaway	1,000	2,500	Trace	—	—	—	100	1,100	500	2,100
5. Green Bay	900	—	—	1,300	1,200	—	300	1,100	700	—
6. Lake Mendota	900	—	—	500	800	1,300	200	1,900	1,300	300
7. Miss. River—Pool 7	900	—	—	—	—	—	—	500	1,200	—
8. Miss. River—Pool 8	600	—	400	700	800	—	—	500	400	—
9. Miss. River—Pool 11	500	—	—	—	—	—	—	500	500	—
10. Yellow Lake	300	900	500	100	Trace	100	200	500	200	—
11. Fox Lake	300	700	200	—	—	—	—	Trace	—	—
12. Lake Winnebago	200	400	0	—	—	—	—	Trace	300	—
13. Horicon Marsh	200	0	0	Trace	Trace	100	1,300	200	500	0
14. Miss. River—Pool 9	200	—	—	—	—	—	—	300	Trace	—
15. Rush Lake	100	100	Trace	—	—	—	Trace	0	500	200
16. Green Lake	100	100	0	—	—	—	200	200	0	—
17. Lake Maria	100	400	Trace	—	—	—	—	—	—	0
18. Partridge Lake	100	—	—	—	—	—	—	—	Trace	200

* A total of 200 aquatic sites was censused periodically in some years between 1949 and 1957. Only those sites having 100 or more redhead day-use per year are listed here.

[1] Based on periodic aerial and ground censuses. For each year, population estimates were summed for October 1 and 15, November 1 and 15, and December 1. Dash indicates that data were unavailable or available for only part of the 5 census dates. All figures are rounded to the nearest hundred.

TABLE 104

Ring-necked Duck Day-Use Indices for Certain Wisconsin Fall Concentration Sites

Site*	Average**	Yearly Totals[1] 1949	1950	1951	1952	1953	1954	1955	1956	1957
1. Miss. River—Pool 7	12,200	—	—	—	—	—	—	18,400	5,900	—
2. Lake Pepin	10,600	—	—	—	—	—	—	2,000	19,300	—
3. Lake Poygan	7,300	400	Trace	—	—	—	100	28,000	13,800	1,500
4. Miss. River—Pool 11	4,600	—	—	—	—	—	—	7,300	2,000	—
5. Horicon Marsh	3,000	100	0	0	Trace	Trace	Trace	9,500	17,400	0
6. Lake Butte des Morts	3,000	400	1,100	—	—	—	100	8,800	1,300	6,200
7. Lake Mendota	3,000	—	—	4,600	7,500	200	1,000	5,400	1,500	700
8. Miss. River—Pool 9	2,500	—	—	—	—	—	—	3,200	1,800	—
9. Miss. River—Pool 8	2,200	—	0	0	0	—	—	4,800	6,100	—
10. Necedah National Refuge	1,400	—	—	—	—	—	800	2,800	2,200	0
11. Lake Puckaway	1,200	900	Trace	—	—	—	100	3,600	900	2,000
12. Sandhill Wildlife Area	(1,000)	—	—	—	—	—	—	—	1,000	—
13. Lake Winneconne	1,000	300	0	—	—	—	0	2,000	3,100	500
14. Yellow Lake	1,000	2,800	2,100	600	400	300	400	1,000	600	—
15. Thunder Lake	700	—	—	—	1,100	500	400	700	800	—
16. Lower Twin Lake	700	1,000	4,000	100	Trace	Trace	Trace	0	200	—
17. Pelican Lake	700	—	—	—	400	0	300	1,600	1,200	—
18. Green Lake (Burnett Co.)	700	Trace	100	400	2,600	2,300	Trace	Trace	0	—
19. Lake Koshkonong	700	—	—	Trace	3,700	Trace	100	300	900	100
20. Clam Lake	600	1,200	300	800	500	300	100	1,300	400	—
21. Lake Wisconsin	(600)	—	—	—	—	—	—	600	—	—
22. Lac Vieux Desert	600	—	—	—	Trace	100	500	600	2,000	—
23. Fish Lake (Burnett Co.)	500	100	200	1,700	500	400	500	600	Trace	200
24. Green Lake	500	100	2,000	—	—	—	0	Trace	300	—
25. Petenwell Flowage	500	—	—	—	—	—	100	1,100	300	—
26. Pewaukee Lake	(500)	—	—	—	—	—	—	—	500	—
27. Big Sand Lake	400	2,600	100	Trace	Trace	Trace	0	200	100	—
28. Amsterdam Slough	(400)	—	—	—	—	—	—	—	—	400
29. Wapogasset	(400)	—	—	—	—	—	—	—	—	400
30. Buckhead Lake	300	Trace	Trace	2,500	Trace	100	Trace	100	Trace	—
31. Lake Ripley	300	—	—	1,000	0	0	0	300	—	—
32. Bishop Lake	300	—	—	—	300	—	Trace	600	100	—
33. Crex Meadows	200	Trace	Trace	700	100	100	Trace	100	200	200
34. Crystal Lake	(200)	—	—	—	—	—	—	200	—	—
35. Pine Lake	200	—	—	—	Trace	Trace	100	600	200	—
36. Castle Rock	200	—	—	—	—	—	100	200	200	—
37. Meadow Valley	200	—	—	—	—	—	200	400	100	—
38. Black River Falls State Forest	200	—	—	—	—	—	100	100	300	—
39. Wood County Public Hunting Grounds	200	—	—	—	—	—	100	300	100	—
40. Lake Geneva	200	—	—	—	—	—	—	—	300	100
41. Partridge Lake	200	—	—	—	—	—	—	—	300	Trace
42. Lake Winnebago	200	200	200	—	—	—	—	300	200	—
43. Big Round Lake	(200)	—	—	—	—	—	—	—	—	200
44. Mudhen Lake	200	200	100	300	500	200	200	Trace	Trace	—
45. Rush Lake	200	100	0	—	—	—	100	100	300	400
46. Lower Phantom Lake	(100)	—	—	—	—	—	—	—	100	—
47. Keizer Lake Chain	100	0	200	400	100	100	100	Trace	100	200
48. North Sand Lake	100	0	Trace	100	500	Trace	100	Trace	100	—
49. East Lake	(100)	—	—	—	—	—	—	—	—	100
50. Green Bay	100	—	—	500	Trace	—	Trace	Trace	100	—

* A total of 200 aquatic sites was censused periodically in some years between 1949 and 1957. Only those sites having 100 or more ring-necked duck day-use per year are listed here.

** Explanation of figures in brackets. General field observations for a period of years indicated that relatively few ringnecks used this site; numerical data were secured for 1 year to help classify the site.

[1] Based on periodic aerial and ground censuses. For each year, population estimates were summed for October 1 and 15, November 1 and 15, and December 1. Dash indicates that data were unavailable or available for only part of the 5 census dates. All figures are rounded to the nearest hundred.

TABLE 105

Scaup Day-Use Indices for Certain Wisconsin Fall Concentration Sites

Site*	Average**	Yearly Totals[1] 1949	1950	1951	1952	1953	1954	1955	1956	1957
1. Miss. River—Pool 7	13,800	—	—	—	—	—	—	18,600	8,900	—
2. Miss. River—Pool 11	11,400	—	—	—	—	—	—	21,500	1,300	—
3. Lake Mendota	5,500	—	—	6,500	4,900	9,600	4,100	11,600	1,200	400
4. Lake Pepin	4,500	—	—	—	—	—	—	4,800	4,300	—
5. Green Bay	3,600	—	—	7,100	1,200	—	5,900	2,200	1,500	—
6. Miss. River—Pool 8	3,400	—	800	100	400	—	—	12,100	3,500	—
7. Lake Poygan	3,300	5,500	600	—	—	—	5,900	300	5,600	1,600
8. Miss. River—Pool 9	3,100	—	—	—	—	—	—	5,600	600	—
9. Lake Butte des Morts	2,900	2,100	9,500	—	—	—	3,000	200	200	2,700
10. Yellow Lake	2,900	10,500	3,500	900	1,300	500	1,000	4,600	900	—
11. Lake Winnebago	2,000	900	800	—	—	—	—	5,700	500	—
12. Big Round Lake	(1,800)	—	—	—	—	—	—	—	—	1,800
13. Green Lake (Burnett Co.)	1,200	Trace	100	100	6,200	2,800	Trace	100	0	—
14. Wapogasset Lake	(1,200)	—	—	—	—	—	—	—	—	1,200
15. Thunder Lake	1,100	—	—	—	3,300	700	700	600	Trace	—
16. Lake Wisconsin	(1,100)	—	—	—	—	—	—	1,100	—	—
17. Necedah National Refuge	1,000	—	—	—	—	—	0	1,900	1,700	300
18. Pelican Lake	900	—	—	—	800	1,000	1,500	1,000	Trace	—
19. Lake Winneconne	900	2,100	1,300	—	—	—	700	300	800	200
20. Balsam Lake	(800)	—	—	—	—	—	—	—	—	800
21. Sandhill Wildlife Area	(800)	—	—	—	—	—	—	—	800	—
22. Lac Vieux Desert	600	—	—	—	Trace	1,200	400	900	200	—
23. Miss. River—Pool 10	600	—	—	—	—	—	—	1,200	0	—
24. Clam Lake	600	600	100	400	400	700	800	1,500	200	—
25. Lower Twin Lake	600	3,500	1,100	Trace	Trace	0	Trace	100	100	—
26. Lake Puckaway	600	1,600	100	—	—	—	900	100	400	400
27. Green Lake	600	100	2,500	—	—	—	0	500	Trace	—
28. Lake Koshkonong	500	—	—	0	3,000	Trace	100	0	400	0
29. Big Sand Lake	500	2,400	Trace	Trace	100	100	400	1,000	400	—
30. Petenwell Flowage	400	—	—	—	—	—	100	1,000	200	—
31. Pine Lake	400	—	—	—	100	500	300	1,100	0	—
32. Pike Lake	(400)	—	—	—	—	—	—	—	—	400
33. East Lake	(300)	—	—	—	—	—	—	—	—	300
34. Powell Marsh	(300)	—	—	—	—	—	—	—	—	300
35. Lake Geneva	300	—	—	—	—	—	—	—	600	100
36. Crystal Lake	(300)	—	—	—	—	—	—	300	—	—
37. Castle Rock	200	—	—	—	—	—	Trace	500	Trace	—
38. North Sand Lake	200	400	100	400	Trace	Trace	100	700	Trace	—
39. Buckhead Lake	200	Trace	0	1,500	0	100	Trace	Trace	0	—
40. Fox Lake	200	Trace	500	—	—	—	—	100	—	—
41. Big Butternut Lake	(200)	—	—	—	—	—	—	—	—	200
42. White Ash Lake	(200)	—	—	—	—	—	—	—	—	200
43. Yellowstone Conservation Area	200	—	—	—	—	—	Trace	700	100	100
44. Lost Lake	(200)	—	—	—	—	—	—	—	—	200
45. Flambeau Flowage	(100)	—	—	—	—	—	—	—	—	100
46. Mudhen Lake	100	Trace	100	200	100	Trace	100	300	100	—
47. Fish Lake	100	Trace	0	1,000	Trace	0	100	200	Trace	Trace
48. Bishop Lake	100	—	—	—	600	0	0	Trace	0	—

* A total of 200 aquatic sites was censused periodically in some years between 1949 and 1957. Only those sites having 100 or more scaup day-use per year are listed here.

** Explanation of figures in brackets. General field observations for a period of years indicated that relatively few scaup used this site; numerical data were secured for 1 year to help classify the site.

[1] Based on periodic aerial and ground censuses. For each year, population estimates were summed for October 1 and 15, November 1 and 15, and December 1. Dash indicates that data were unavailable or available for only part of the 5 census dates. All figures are rounded to the nearest hundred.

TABLE 106

Ruddy Duck Day-Use Indices for Certain Wisconsin Fall Concentration Sites

Site*	Average**	Yearly Totals[1] 1949	1950	1951	1952	1953	1954	1955	1956	1957
1. Lake Winnebago	7,700	0	7,000	—	—	—	—	3,000	20,700	—
2. Green Bay	6,900	—	—	17,400	6,900	—	2,200	4,300	3,800	—
3. Crystal Lake	(200)	—	—	—	—	—	—	200	—	—
4. Big Green Lake	200	0	0	—	—	—	0	0	800	—
5. Big Lake Butte des Morts	100	0	400	—	—	—	Trace	0	400	0

* A total of 200 aquatic sites was censused periodically in some years between 1949 and 1957. Only those sites having 100 or more ruddy duck day-use per year are listed here.

** Explanation of figures in brackets. General field observations for a period of years indicated that relatively few ruddy ducks used this site; numerical data were secured for 1 year to help classify the site.

[1] Based on periodic aerial and ground censuses. For each year, population estimates were summed for October 1 and 15, November 1 and 15, and December 1. Dash indicates that data were unavailable or available for only part of the 5 census dates. All figures are rounded to the nearest hundred.

TABLE 107

Bufflehead Day-Use Indices for Certain Wisconsin Fall Concentration Sites

Site*	Average	Yearly Totals[1] 1949	1950	1951	1952	1953	1954	1955	1956	1957
1. Green Bay	600	—	—	Trace	0	—	700	700	1,400	—
2. Miss. River—Pool 8	200	—	Trace	Trace	700	—	—	100	100	—
3. Miss. River—Red Wing to Maiden Rock	200	—	—	—	—	—	—	0	300	—
4. Lake Geneva	100	—	—	—	—	—	—	—	200	Trace

* A total of 200 aquatic sites was censused periodically in some years between 1949 and 1957. Only those sites averaging 100 or more bufflehead day-use per year are listed here.

[1] Based on periodic aerial and ground censuses. For each year, population estimates were summed for October 1 and 15, November 1 and 15, and December 1. Dash indicates that data were unavailable or available for only part of the 5 census dates. All figures are rounded to the nearest hundred.

TABLE 108

Common Goldeneye Day-Use Indices for Certain Wisconsin Fall Concentration Sites

Site*	Average**	Yearly Totals[1] 1949	1950	1951	1952	1953	1954	1955	1956	1957
1. Green Bay	1,500	—	—	400	Trace	—	700	5,100	1,300	—
2. Miss. River—Pool 8	1,300	—	—	—	—	—	—	400	2,200	—
3. Lake Mendota	1,100	—	—	600	Trace	2,500	1,700	1,500	700	500
4. Miss. River—Pool 11	1,000	—	—	—	—	—	—	1,500	500	—
5. Miss. River—Pool 9	800	—	—	—	—	—	—	600	1,000	—
6. Lake Geneva	400	—	—	—	—	—	—	—	600	200
7. Miss. River—Maiden Rock to Wabasha	300	—	—	—	—	—	—	100	600	—
8. Yellow Lake	300	1,100	200	400	100	100	400	300	Trace	0
9. Devil's Lake	200	300	300	200	200	Trace	300	400	Trace	—
10. Big Round Lake	(200)	—	—	—	—	—	—	—	—	200
11. Lake Kegonsa	100	—	—	0	Trace	Trace	800	200	0	Trace
12. Miss. River—Pool 5	100	—	—	—	—	—	—	100	200	—
13. Wapogasset Lake	(100)	—	—	—	—	—	—	—	—	100
14. Pelican Lake	100	—	—	—	100	0	100	200	200	—
15. Pine Island Conservation Area (Wis. River)	100	—	—	—	—	—	0	0	500	0

* A total of 200 aquatic sites was censused periodically in some years between 1949 and 1957. Only those sites averaging 100 or more common goldeneye day-use per year are listed here.

** Explanation of figures in brackets. General field observations for a period of years indicated that relatively few common goldeneye used this site; numerical data were secured for one year to help classify the site.

[1] Based on periodic aerial and ground censuses. For each year, population estimates were summed for October 1 and 15, November 1 and 15, and December 1. Dash indicates that data were unavailable or available for only part of the 5 census dates. All figures are rounded to the nearest hundred.

TABLE 109

Coot Day-Use Indices for Certain Wisconsin Fall Concentration Sites

Site*	Average**	Yearly Totals[1] 1949	1950	1951	1952	1953	1954	1955	1956	1957
1. Horicon Marsh	87,800	12,800	18,000	26,800	52,100	45,100	149,300	213,000	239,900	33,300
2. Lake Mendota	54,400	—	—	48,200	109,400	31,400	34,100	87,800	51,400	18,600
3. Miss. River—Pool 7	45,200	—	—	—	—	—	—	20,200	70,300	—
4. Okauchee Lake	(40,900)	—	—	—	—	—	—	—	40,900	—
5. Miss. River—Pool 4	35,900	—	—	—	—	—	—	36,500	35,400	—
6. Miss. River—Pool 5	34,500	—	—	—	—	—	—	17,700	51,300	—
7. Lake Poygan	23,900	13,600	12,200	—	—	—	21,300	43,700	41,600	10,900
8. Pewaukee Lake	(21,200)	—	—	—	—	—	—	—	21,200	—
9. Lake Puckaway	20,900	43,700	11,100	—	—	—	13,400	30,100	11,900	15,400
10. Lake Winneconne	19,100	5,400	8,100	—	—	—	6,500	53,000	39,600	2,100
11. Rock Lake	17,700	—	—	9,800	7,900	25,400	19,400	18,300	25,300	—
12. Miss. River—Pool 6	17,300	—	—	—	—	—	—	22,100	12,400	—
13. Partridge Lake	15,400	—	—	—	—	—	—	—	20,400	10,400
14. Miss. River—Pool 8	14,300	—	6,500	2,500	8,300	—	—	27,600	26,400	—
15. Lake Koshkonong	13,200	—	—	11,100	3,100	20,100	23,900	7,200	19,300	7,500
16. Clam Lake	12,700	20,500	11,400	4,300	5,100	12,600	3,100	11,900	32,700	—
17. Big Lake Butte des Morts	12,400	22,200	18,600	—	—	—	3,300	14,500	9,800	5,700
18. Miss. River—Pool 9	11,800	—	—	—	—	—	—	9,300	14,200	—
19. Miss. River—Pool 11	11,300	—	—	—	—	—	—	6,800	15,800	—
20. Rush Lake	10,100	8,900	13,600	—	—	—	11,800	2,000	11,400	13,000
21. Wapogasset Lake	(9,500)	—	—	—	—	—	—	—	—	9,500
22. Miss. River—Hastings to Red Wing	9,000	—	—	—	—	—	—	8,400	9,600	—
23. Necedah National Refuge	8,300	—	—	—	—	—	1,300	1,400	15,900	14,500
24. Yellow Lake	8,200	17,000	7,800	3,000	10,300	8,800	4,600	9,000	5,300	—
25. Big Round Lake	(8,000)	—	—	—	—	—	—	—	—	8,000
26. Miss. River—Red Wing to Maiden Rock	7,800	—	—	—	—	—	—	3,700	11,800	—
27. Lake Geneva	(7,100)	—	—	—	—	—	—	—	7,100	—
28. Fox Lake	6,800	6,900	6,400	—	—	—	—	6,900	—	—
29. Lake Nagawicka	(6,200)	—	—	—	—	—	—	—	6,200	—
30. Big Muskego Lake	(5,400)	—	—	—	—	—	—	—	5,400	—
31. Oakridge Refuge	(4,500)	—	—	—	—	—	—	—	—	4,500
32. Green Bay	4,300	—	—	7,600	6,400	—	0	2,900	4,400	—
33. Oconomowoc Lake	(3,300)	—	—	—	—	—	—	—	3,300	—
34. Wind Lake	(2,900)	—	—	—	—	—	—	—	2,900	—
35. Lake Waubesa	2,800	—	—	400	2,700	7,600	2,300	2,500	3,700	400
36. Big Sand Lake	2,700	9,700	2,400	100	200	900	2,400	2,100	4,300	—
37. Miss. River—Pool 10	2,400	—	—	—	—	—	—	3,500	1,300	—
38. Yellowstone Conservation Area	2,300	—	—	—	—	—	1,400	3,600	2,500	1,900
39. Lake Maria	2,300	3,400	3,400	—	—	—	—	—	—	0
40. Mudhen Lake	2,000	1,500	1,000	200	1,200	2,000	1,700	3,200	5,200	—
41. Lake Winnebago	2,000	2,400	3,500	—	—	—	—	500	1,700	—
42. Lake Elizabeth	(2,000)	—	—	—	—	—	—	—	2,000	—
43. Lake Wisconsin	(1,900)	—	—	—	—	—	—	1,900	—	—
44. Castle Rock Flowage	1,900	—	—	—	—	—	Trace	5,700	100	—
45. Petenwell Flowage	1,900	—	—	—	—	—	600	4,600	600	—
46. Lower Phantom Lake	(1,800)	—	—	—	—	—	—	—	1,800	—
47. Silver Lake	(1,700)	—	—	—	—	—	—	—	1,700	—
48. Lake LaBelle	(1,500)	—	—	—	—	—	—	—	1,500	—
49. East Lake	(1,400)	—	—	—	—	—	—	—	—	1,400
50. Rice Lake	1,400	—	300	300	1,300	200	100	7,700	200	—
51. Miss. River—Maiden Rock to Wabasha	1,100	—	—	—	—	—	—	1,200	1,000	—
52. Tichigan Lake	(1,000)	—	—	—	—	—	—	—	1,000	—
53. Lake Beulah	(1,000)	—	—	—	—	—	—	—	1,000	—
54. Lake Kegonsa	900	—	—	200	500	700	300	2,000	1,900	900
55. Partridge Crop	(800)	—	—	—	—	—	—	—	—	800
56. Lake Delavan	(800)	—	—	—	—	—	—	—	800	—
57. Fireside Lake	800	—	—	—	—	—	—	—	900	600
58. Pelican Lake	700	—	—	—	300	600	200	400	2,200	—
59. Mud Lake	700	3,700	1,400	600	0	0	0	0	0	—
60. Yellow River (segment)	700	4,700	Trace	—	Trace	Trace	100	Trace	Trace	—
61. Cincoe Lake	600	—	—	—	—	—	—	—	500	700
62. Dushack's Marsh	600	—	—	400	600	1,600	400	0	—	—
63. Gaslyn Lake	500	—	—	Trace	300	1,400	400	500	300	—
64. Powers Lake	(300)	—	—	—	—	—	—	—	300	—
65. Dates Mill Pond	(300)	—	—	—	—	—	—	300	—	—
66. Potter's Lake	(300)	—	—	—	—	—	—	—	300	—
67. White Ash Lake	(300)	—	—	—	—	—	—	—	—	300
68. Brown's Lake	(300)	—	—	—	—	—	—	—	300	—
69. Red Cedar Lake	300	—	—	100	300	100	300	500	—	—
70. Mud Lake	(300)	—	—	—	—	—	—	—	300	—
71. Pine Lake	300	—	—	—	300	100	0	700	200	—

TABLE 109 (Cont.)

Site*	Average**	Yearly Totals[1] 1949	1950	1951	1952	1953	1954	1955	1956	1957
72. Fish Lake	(200)	—	—	—	—	—	—	200	—	—
73. Thunder Lake	200	—	—	—	800	400	0	100	Trace	—
74. Bishop Lake	200	—	—	—	300	—	100	400	100	—
75. Lake Ripley	200	—	—	Trace	100	100	700	100	—	—
76. Camp Lake	(200)	—	—	—	—	—	—	—	200	—
77. Straight River	(200)	—	—	—	—	—	—	—	—	200
78. Goose Lake	(200)	—	—	—	—	—	—	200	—	—
79. North Mud Lake	200	—	—	—	—	—	—	—	300	0
80. Horse Lake	(100)	—	—	—	—	—	—	—	—	100
81. Crex Meadows Conservation Area	100	0	Trace	Trace	200	Trace	300	100	500	100
82. Fish Lake	100	400	400	100	100	100	Trace	Trace	0	Trace
83. Bear Trap Lake	(100)	—	—	—	—	—	—	—	—	100
84. Lake Arbutus	100	—	—	—	—	—	Trace	400	0	0
85. Lac Vieux Desert	100	—	—	—	Trace	300	Trace	100	100	—
86. Grassy Lake	(100)	—	—	—	—	—	—	100	—	—
87. Little Muskego Lake	(100)	—	—	—	—	—	—	—	100	—
88. Lake Sinissippi	100	—	—	500	—	Trace	100	0	0	—

* A total of 200 aquatic sites was censused periodically in some years between 1949 and 1957. Only those sites averaging 100 or more coot day-use per year are listed here.

** Explanation of figures in brackets. General field observations for a period of years indicated that coots used this site; numerical data were secured for 1 year to help classify the site.

[1] Based on periodic aerial and ground censuses. For each year, population estimates were summed for October 1 and 15, November 1 and 15, and December 1. Dash indicates that data were unavailable or available for only part of the 5 census dates. All figures are rounded to the nearest hundred.

APPENDIX E*

A Chronological Summary of Certain Wisconsin Waterfowl Hunting Regulations, 1850–1963

* Data were assembled by O. S. Bersing and L. R. Jahn from unpublished records of the Wisconsin Conservation Department, J. C. Bartonek (pers. comm., 1963), Leopold (1940), Palmer (1912), Scott (1937a, 1937b, 1937c, 1937d, 1937e, 1938).

TABLE 110

Dates and Lengths of Wisconsin Hunting Seasons for Ducks and the Coot*

Year(s)	Open Season		Exceptions for Species and Other Major Factors
	Dates	Length (days)	
1851–59	All year	365	None
1860	All year	365	First time any ducks were protected in Wisconsin. No person, except "Indians not civilized" could destroy, catch, kill, etc., wood ducks between December 1 and the first Tuesday in July.
1861–69	All year	365	None
1870	All year	365	Season on wood duck, mallard, and teal closed Feb. 1–Sept. 1 (7 months) in the counties of Dane, Grant, Green, Jefferson, Kenosha, Lafayette, Milwaukee, Racine, Rock, Walworth and Waukesha.
1871	All year	365	All protective laws of 1870 were repealed.
1872–73	All year	365	Season on wood duck, mallard, teal, and ring-necked duck closed in spring for 5 months in the counties of Dane, Dodge, Fond du Lac, Grant, Green, Green Lake, Jefferson, Kenosha, Lafayette, Milwaukee, Racine, Richland, Rock, Walworth, Waukesha, Waupaca, Waushara, and Winnebago.
1874–77	All year	365	Season closed statewide on wood duck, mallard, and teal for 7 months.
1878–79	All year	365	Closed season statewide on wood duck, mallard, and teal for 7 months and 25 days.
1880–86	All year	365	Closed season on wood duck, mallard, and teal for 7½ months in all counties north of the north boundary of Vernon, Sauk, Columbia, Dodge, Washington, and Ozaukee Counties.
1887–90	Sept. 1–Nov. 30	91	Spring shooting abolished in 1887 and reopened later.
1891–94	Sept. 1–April 30	242	Open statewide season on wood duck, mallard, and teal remains as Sept. 1 through Nov. 30 (91 days); all other species of ducks and coot covered by general statewide regulations. Spring shooting again permitted on most species.
1895–98	Sept. 1–April 30	242	Open statewide season on wood duck, mallard, and teal: in 1895–96 from Aug. 20 through Nov. 30 (103 days); in 1897–98 from Sept. 1 through Nov. 30 (91 days).
1899–1902	Sept. 1–Dec. 31	122	None
1903–04	Sept. 1–Dec. 31	122	Special spring season from Apil 10 to April 25 on all ducks, except the wood duck, mallard, and teal. This was the last spring season on ducks.

TABLE 110 (Cont.)

Year(s)	Open Season: Dates	Open Season: Length (days)	Exceptions for Species and Other Major Factors
1905–12	Sept. 1–Dec. 31	122	None
1913–14	Sept. 7–Nov. 30	85	None
1915–16	Sept. 7–Nov. 30	85	First time wood duck was protected throughout the year.
1917–18	Sept. 16–Dec. 10	86	Closed season on wood duck
1919–20	Sept. 16–Dec. 10	86	Closed season on wood duck. Open season on coot from Sept. 16 to Dec. 20 (95 days).
1921–28	Sept. 16–Dec. 20	96	Closed season on wood duck.
1929–30	Sept. 16–Dec. 20	96 (82)**	No hunting on Wednesdays. Closed season on wood duck.
1931	Oct. 1–Oct. 31	31 (27)**	No hunting on Wednesdays. Closed season on wood duck.
1932	Oct. 1–Nov. 30	61 (52)**	No hunting on Wednesdays. Closed season on wood duck, ruddy duck, and bufflehead. First emergency action taken by the Wisconsin Conservation Commission to reduce the season length by 35 days because the population status of ducks and coots indicated such action was necessary.
1933	Sept. 21–Nov. 20	61 (53)**	No hunting on Wednesdays. Closed season on wood duck, ruddy duck and bufflehead.
1934	Oct. 3–Nov. 11	40 (30)**	Closed season on wood duck, ruddy duck, and bufflehead. No hunting on Mondays and Tuesdays which were declared "rest days."
1935	Oct. 21–Nov. 19	30	Closed season on wood duck, ruddy duck, bufflehead, and coot.
1936	Oct. 10–Nov. 8	30	Closed season on wood duck, ruddy duck, bufflehead, redhead, canvasback, and coot.
1937	Oct. 9–Nov. 7	30	Closed season on wood duck, ruddy duck, bufflehead, and canvasback.
1938–39	Oct. 1–Nov. 14	45	Closed season on wood duck.
1940–41	Oct. 1–Nov. 29	60	Closed season on wood duck.
1942	Sept. 26–Dec. 4	70	Part of Horicon Marsh closed for first time by a government agency for waterfowl management purposes.
1943	Sept. 25–Dec. 3	70	None
1944–45	Sept. 20–Dec. 8	80	None
1946	Oct. 5–Nov. 18	45	None
1947[1]	Oct. 7 (Tues)–Nov. 5	30	Season closed from October 23–24 (2 days) in forest protection districts to meet extreme forest fire hazard.
1948	Oct. 15 (Fri.)–Nov. 13	30	Season closed from Oct. 30 (7:00 a.m.)–Nov. 4 (12:00 noon) in forest protection districts to meet extreme forest fire hazard. Season extended to Nov. 18 in all forest protection districts and all of Lincoln and Marathon counties.
1949	Oct. 14 (Fri.)–Nov. 22	40	None
1950	Oct. 14 (Sat.)–Nov. 16	34	None
1951	Oct. 13 (Sat.)–Nov. 25	44	None
1952	Oct. 4 (Sat.)–Nov. 27	55	None
1953	Oct. 3 (Sat.)–Nov. 26	55	None
1954	Oct. 2 (Sat.)–Nov. 25	55	Closed season on wood duck
1955	Oct. 1 (Sat.)–Dec. 9	70	Closed season on wood duck
1956	Oct. 1 (Mon.)–Dec. 9	70	Closed season on wood duck
1957	Oct. 1 (Tues.)–Dec. 9	70	Closed season on wood duck
1958	Oct. 1 (Wed.)–Dec. 9	70	Closed season on wood duck
1959	Oct. 7 (Wed.)–Nov. 25	50	None
1960	Oct. 7 (Fri.)–Nov. 25	50	Closed season on canvasback and redhead
1961	Oct. 14 (Sat.)–Nov. 12	30	Closed season on canvasback and redhead
1962	Oct. 13 (Sat.)–Nov. 6	25	Closed season on canvasback and redhead
1963	Oct. 5 (Sat.)–Nov. 8	35	Closed season on canvasback and redhead

* All statements refer to the general statewide regulations; exceptions for small localities are not cited.

** Days in brackets are actual hunting days, with "rest days" subtracted from the overall number of days listed.

[1] Season was originally established for October 2–November 19, but public pressure resulted in having the season dates changed at "the last minute."

TABLE 111

Wisconsin Daily Bag and Possession Limits on Ducks and the Coot*

Year(s)	Coot Limits		Duck Limits		Wood Duck		Exceptions and Comments on Duck Limits
	Bag	Poss.**	Bag	Poss.**	Bag	Poss.**	
1850–1902	No bag and possession limits on any unprotected species.						See Table 110 for species protected.
1903–04	No limits		15 for April season	?	Closed in April season only		Closed season on mallard and teal in April season only.
1905–06	No limits in 1905; in with ducks in 1906.[1]		30, plus a mixed limit of 50 birds, not exceeding the individual limit of any species	Same as bag limit	No limits		None
1907–10	In with ducks		25	25	No limits		A mixed bag, possession, and transportation limit of 30 birds, not exceeding the individual limit of any species.
1911–14	In with ducks		15	15	No limits		None
1915–16	In with ducks		15	15	Closed season		First time wood duck was protected throughout the year.
1917–18	In with ducks		15	15	Closed season		None
1919–31	In with ducks		15	15	Closed season		None
1932	In with ducks		15	15	Closed season		Closed season on ruddy duck and bufflehead. Bag limit 10, in the aggregate, for canvasback, redhead, scaup, ringneck, blue-winged teal, green-winged teal, gadwall, and shoveler.
1933	In with ducks		12	12	Closed season		Closed season on ruddy duck and bufflehead. Bag limit 8 for canvasback, redhead, scaup, ringneck, blue-winged teal, green-winged teal, gadwall, and shoveler, singly or in the aggregate.
1934	In with ducks		12	12	Closed season		Closed season on ruddy duck and bufflehead. Bag limit 5, singly or in the aggregate, for canvasback, redhead, scaup, ringneck, blue-winged teal, green-winged teal, gadwall, and shoveler.
1935	In with ducks		10	10	Closed season		Closed season on ruddy duck and bufflehead.
1936	In with ducks		10	10	Closed season		Closed season on ruddy duck, bufflehead, canvasback, and redhead.
1937	In with ducks		10	10	Closed season		Closed season on ruddy duck, bufflehead, canvasback, and redhead.
1938	In with ducks		10	20	Closed season		Bag limit 3, singly or in the aggregate, for canvasback, redhead, bufflehead, and ruddy duck. Possession limit 6, singly or in the aggregate, for canvasback, redhead, bufflehead, and ruddy duck.
1939–41	25	25	10	20	Closed season		Same as for 1938
1942–43	25	25	10	20	1	1	Same as for 1938
1944	25	25	10	20	1	1	Bag limit: in addition to 10, 5, singly or in the aggregate, of mallard, pintail, or widgeon, and 25, singly or in the aggregate, of common or red-breasted mergansers. Possession limit: in addition to 20, 10, singly or in the aggregate, of mallard, pintail, or widgeon, and 25, singly or in the aggregate of common or red-breasted mergansers.
1945	25	25	10	20	1	1	Bag limit: in addition to 10, 25, singly or in the aggregate, of common or red-breasted

TABLE 111 (Cont.)

Year(s)	Coot Limits		Duck Limits		Wood Duck		Exceptions and Comments on Duck Limits
	Bag	Poss.**	Bag	Poss.**	Bag	Poss.**	
							mergansers. No possession limit on common or red-breasted mergansers.
1946	25	25	7	14	1	1	Bag limit: in addition to 7, 25, singly or in the aggregate, of common or red-breasted mergansers. No possession limit on common or red-breasted mergansers.
1947	25	25	4	8	1	1	Bag limit: in addition to 4, 25, singly or in the aggregate, of common or red-breasted mergansers. No possession limit on common or red-breasted mergansers.
1948	15	15	4	8	1	1	Same as in 1947
1949–52	10	10	4	8	1	1	Same as in 1947 and 1948
1953	10	10	4	8	1	1	Bag limit: in addition to 4, 25, singly or in the aggregate of common or red-breasted mergansers; not more than 1 hooded merganser. Possession limit: 25 singly or in the aggregate common or red-breasted mergansers and not more than 1 hooded merganser.
1954–57	10	10	4	8	Closed season		Not more than 1 hooded merganser in the bag and possession limit.
1958	10	10	4	8	Closed season		Bag limit: of the 4, not more than 1 hooded merganser, or 2 canvasback or redhead, singly or in the aggregate. Possession limit: of the 8, not more than 1 hooded merganser, or 4 canvasback or redhead, singly or in the aggregate.
1959	3	6	3	6	1	1	Bag limit: of the 3, not more than 1 wood duck and 1 hooded merganser, and 1 canvasback or 1 redhead or 1 ruddy duck. Possession limit: of the 6, not more than 1 wood duck and 1 hooded merganser, and 1 canvasback or 1 redhead or 1 ruddy duck.
1960	6	12	3	6	1	1	Bag limit: of the 3, not more than 1 wood duck and 1 hooded merganser. Possession limit: of the 6, not more than 1 wood duck and 1 hooded merganser.
1961	6	6	2	4	1	1	Bag limit: of the 2, not more than 1 wood duck and 1 hooded merganser. Possession limit: of the 4, not more than 1 wood duck and 1 hooded merganser.
1962	6	6	2	4	2	2	Bag limit: of the 2, not more than 1 mallard or black duck and 1 hooded merganser; in addition to 2, 2 additional scaup. Possession limit: of the 4, not more than 2 wood ducks, 1 hooded merganser, and 2 mallards or black ducks or 1 of each; in addition to 4, 4 additional scaup.
1963	8	16	4	8	2	2	Bag limit: of the 4, not more than 1 hooded merganser, 2 wood ducks, and 2 mallard or black ducks, singly or in the aggregate. Possession limit: of the 8, not more than 2 wood ducks, and 4 mallards or black ducks, singly or in the aggregate.

* All statements refer to the general statewide regulations; exceptions for small localities are not cited.

** Unless otherwise indicated, on opening day of the season a person could not possess any migratory game birds in excess of the daily bag limit.

[1] Coots are included in the daily bag limit for ducks until 1939, when Wisconsin established a separate bag limit for the coot.

TABLE 112

Wisconsin Daily Shooting Hours for Ducks, Coots, and Geese*

Year(s)	General Statewide Shooting Hours	Exceptions to General Hours
1850–76	No restrictions; take birds any hour of day or night.	None
1877–85	No restrictions; take birds any hour of day or night.	On Lake Koshkonong, the Rock River, and in Jefferson' Dane, and Rock counties duck hunting prohibited between 8:00 p.m. and 3:00 a.m. This law, calculated in part to stop moonlight hunting and shining with lights, was effective until 1885.
1886–96	No restrictions; take birds any hour of day or night.	None
1897–1930	Sunrise to sunset. No hunting on Wednesdays in 1929 and 1930.	None
1931–32	Sunrise to sunset. No hunting on Wednesdays.	12:00 (noon) opening hour on first day
1933	Half hour before sunrise to 4:00 p.m. in the counties of Adams, Brown, Calumet, Columbia, Dane, Dodge, Door, Green, Green Lake, Jefferson, Kenosha, Kewaunee, Juneau, Langlade, Manitowoc, Marinette, Fond du Lac, Marquette, Oconto, Outagamie, Ozaukee, Racine, Rock, Sauk, Shawano, Sheboygan, Walworth, Washington, Waukesha, Waupaca, Waushara and Winnebago. Half hour before sunrise to sunset in the counties of Ashland, Barron, Bayfield, Buffalo, Burnett, Chippewa, Clark, Crawford, Douglas, Dunn, Eau Claire, Florence, Forest, Grant, Iowa, Iron, Jackson, La Crosse, Lafayette, Lincoln, Marathon, Monroe, Oneida, Pepin, Pierce, Polk, Portage, Price, Richland, Rusk, St. Croix, Sawyer, Taylor, Trempealeau, Vilas, Washburn, Wood and Vernon.	12:00 (noon) opening hour on first day in all counties
1934	Sunrise to sunset	12:00 (noon) opening hour on first day in all counties. Sunrise to 4:00 p.m. in counties of Barron, Buffalo, Burnett, Calumet, Columbia, Crawford, Dane, Dodge, Door, Dunn, Fond du Lac, Grant, Green, Green Lake, Iowa, Jefferson, Kenosha, Kewaunee, La Crosse, Lafayette, Manitowoc, Marquette, Monroe, Ozaukee, Pepin, Pierce, Polk, Racine, Richland, Rock, St. Croix, Sauk, Sheboygan, Trempealeau, Vernon, Walworth, Washington, Waukesha, Waupaca, Waushara, and Winnebago.
1935–39	7:00 a.m. to 4:00 p.m.	None
1940–41	Sunrise to 4:00 p.m.	None
1942	Sunrise to sunset	None
1943–45	Half-hour before sunrise to sunset	None
1946	Half-hour before sunrise to one-half hour before sunset	None
1947	Sunrise to one hour before sunset	12:00 (noon) opening hour on first day
1948–49	Half-hour before sunrise to one hour before sunset	12:00 (noon) opening hour on first day
1950–52	Half-hour before sunrise to one hour before sunset	1:00 p.m. opening hour on first day
1953–54	Half-hour before sunrise to sunset	1:00 p.m. opening hour on first day
1955	Half-hour before sunrise to half-hour before sunset	12:00 (noon) opening hour on first day
1956	Half-hour before sunrise to 4:00 p.m.	12:00 (noon) opening hour on first day
1957–58	Half-hour before sunrise to 4:00 p.m.	12:00 (noon) opening hour on first day; closing hour at 2:00 p.m. in special area in Dodge and Fond du Lac counties.
1959	Sunrise to sunset	12:00 (noon) opening hour on first day, except in areas with a delayed opening date in parts of Fond du Lac, Dodge, Juneau and Monroe counties; closing hour at 2:00 p.m. in special area in Dodge and Fond du Lac counties.
1960	Half-hour before sunrise to sunset	12:00 (noon) opening hour on first day; closing hour at 2:00 p.m. in special area in Dodge and Fond du Lac counties.
1961–63	Sunrise to sunset	Same as in 1960

* All statements refer to the general statewide regulations; exceptions for small localities are not cited.

APPENDIX F

Daily Distribution of Hunting Pressure and Duck Kill for Certain Years and Stations in Wisconsin

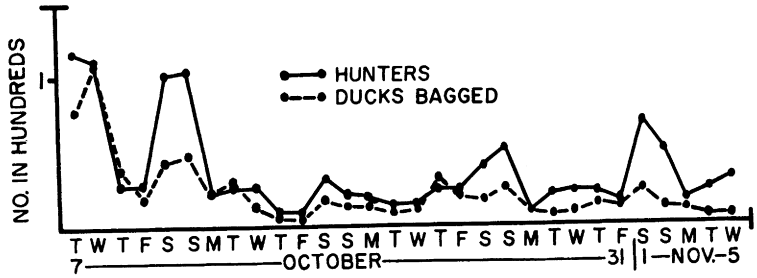

Figure 55. Daily distribution of hunting pressure and duck kill, Horicon Marsh, main ditch, 1947.

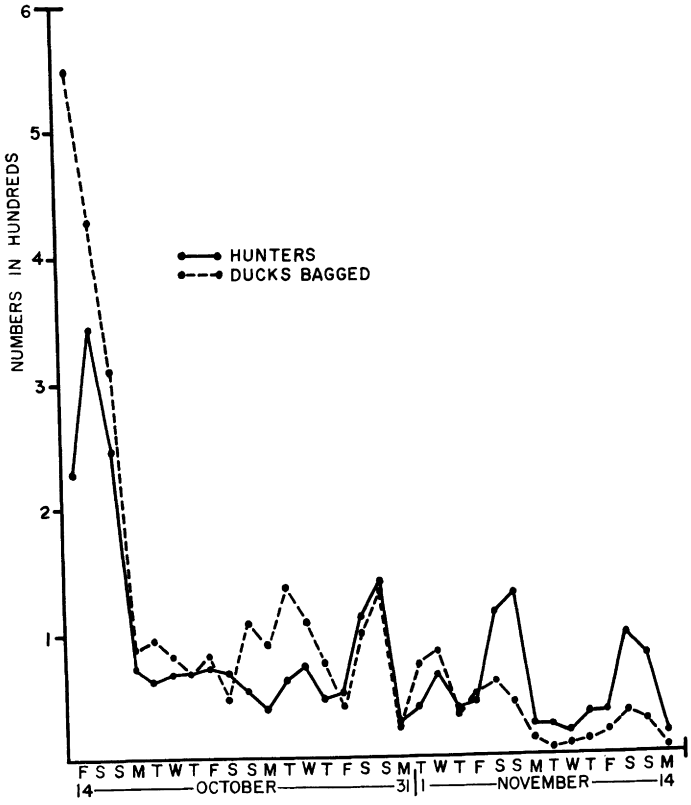

Figure 56. Daily distribution of hunting pressure and duck kill, Horicon Marsh, main ditch, 1949.

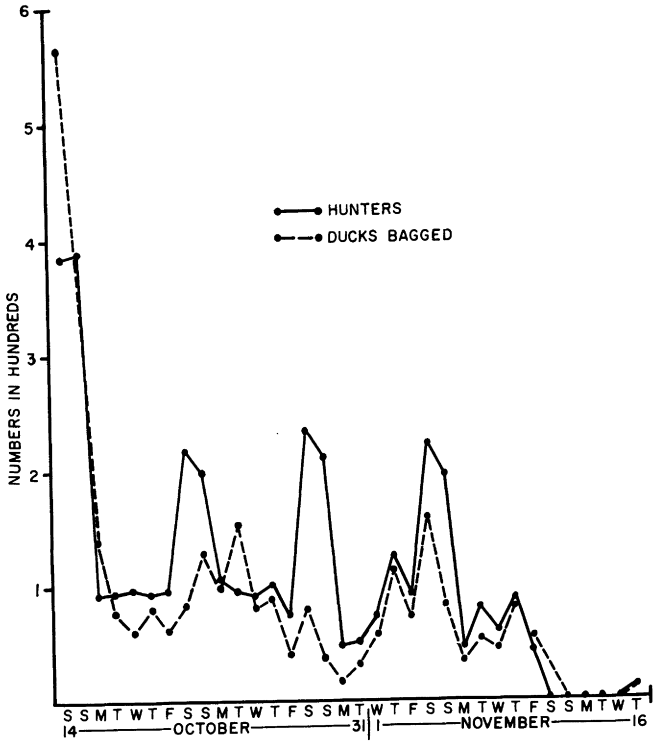

Figure 57. Daily distribution of hunting pressure and duck kill, Horicon Marsh, main ditch, 1950.

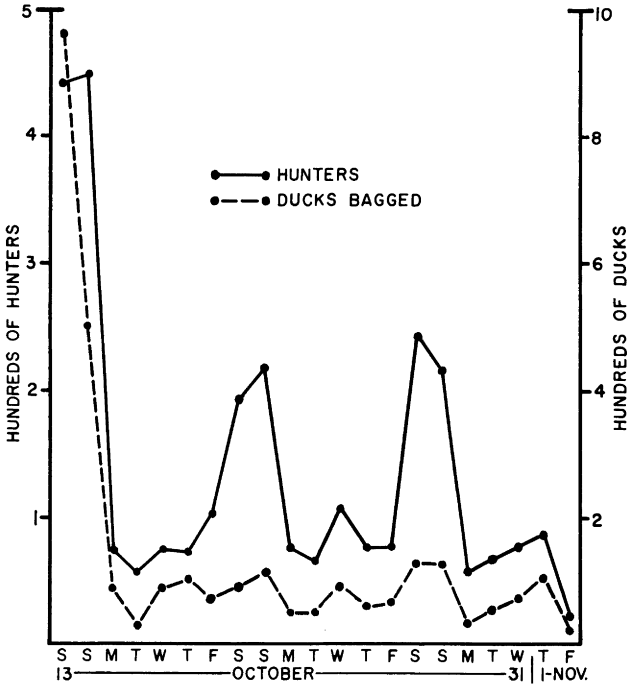

Figure 58. Daily distribution of hunting pressure and duck kill, Horicon Marsh, main ditch, 1951.

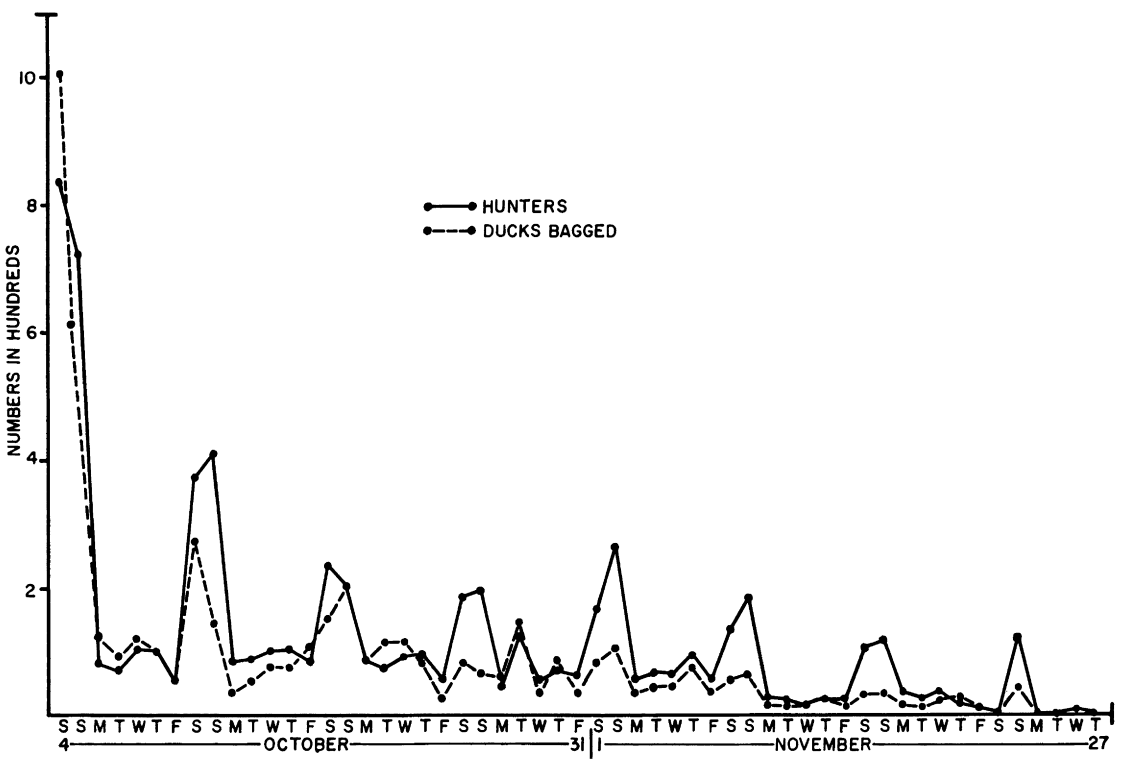

Figure 59. Daily distribution of hunting pressure and duck kill, Horicon Marsh, main ditch, 1952.

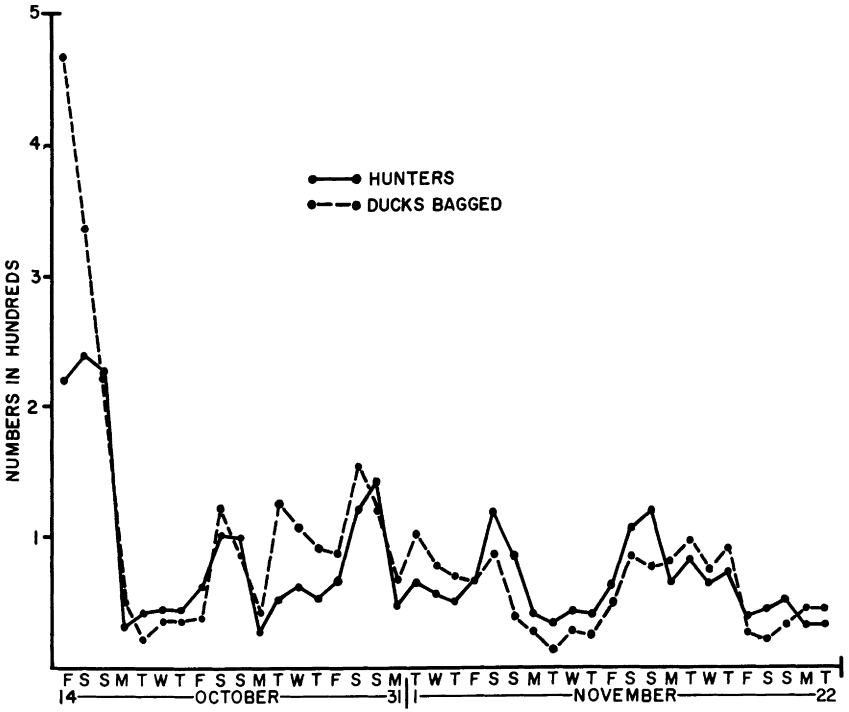

Figure 60. Daily distribution of hunting pressures and duck kill, Mississippi River, Goose Island, 1949.

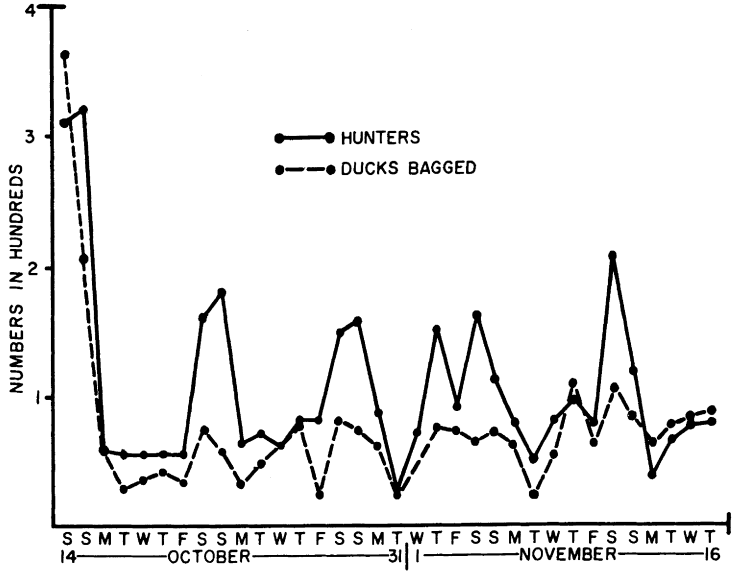

Figure 61. Daily distribution of hunting pressure and duck kill, Mississippi River, Goose Island, 1950.

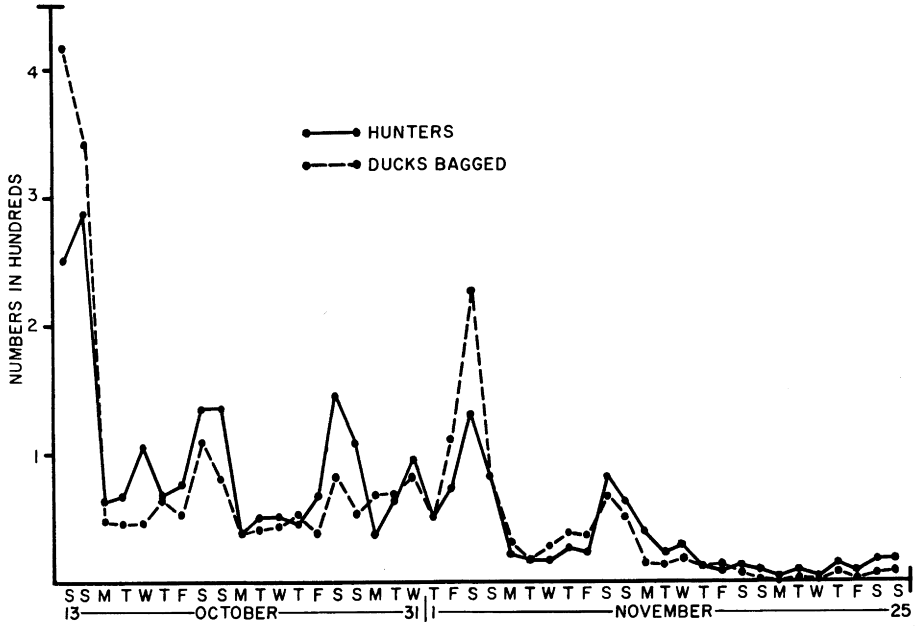

Figure 62. Daily distribution of hunting pressure and duck kill, Mississippi River, Goose Island, 1951.

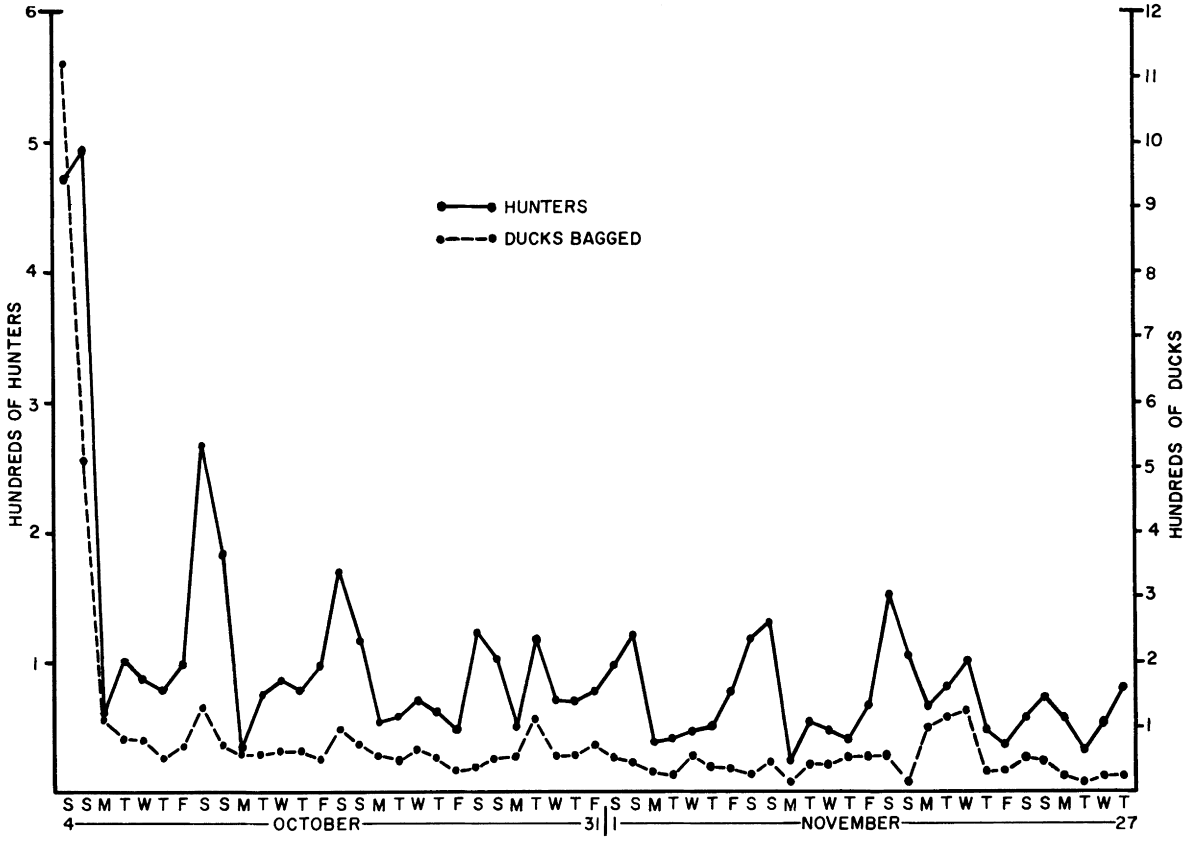

Figure 63. Daily distribution of hunting pressure and duck kill, Mississippi River, Goose Island, 1952.

APPENDIX G

Daily Distribution of Hunter Success for Certain Years and Stations in Wisconsin

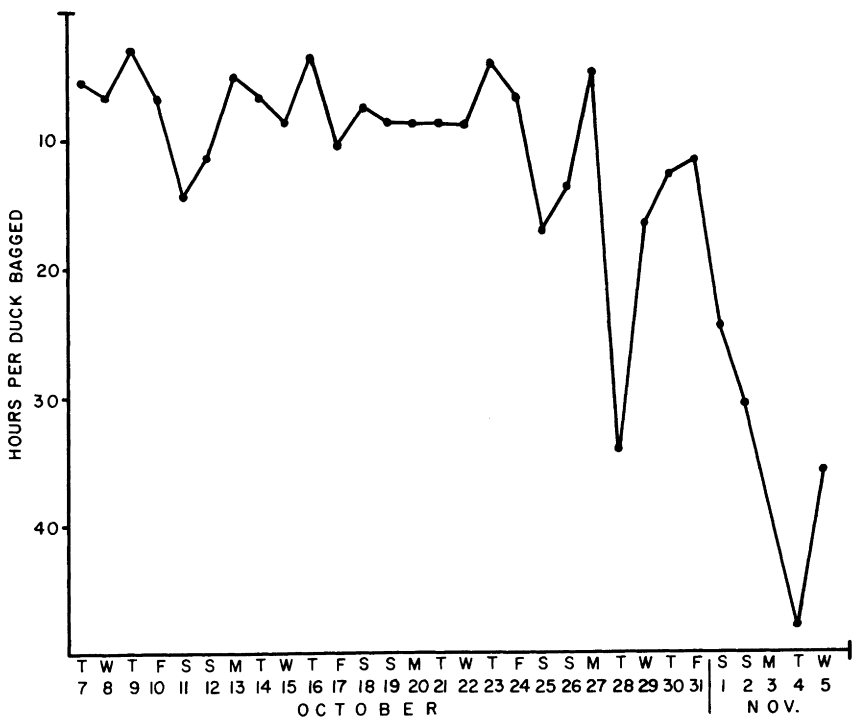

Figure 64. Daily distribution of hunter success, Horicon Marsh, main ditch, 1947.

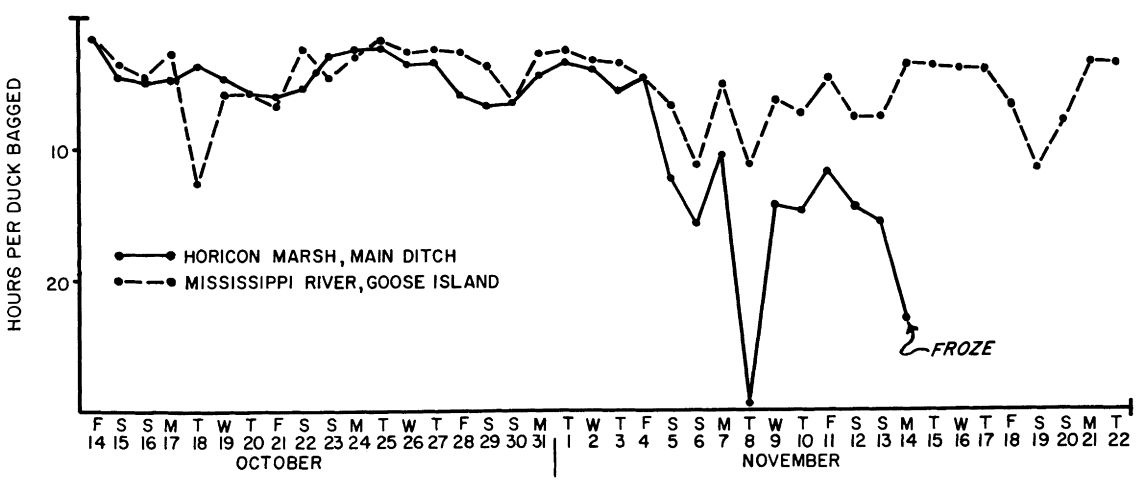

Figure 65. Daily distribution of hunter success, Horicon Marsh, main ditch and Mississippi River, Goose Island, 1949.

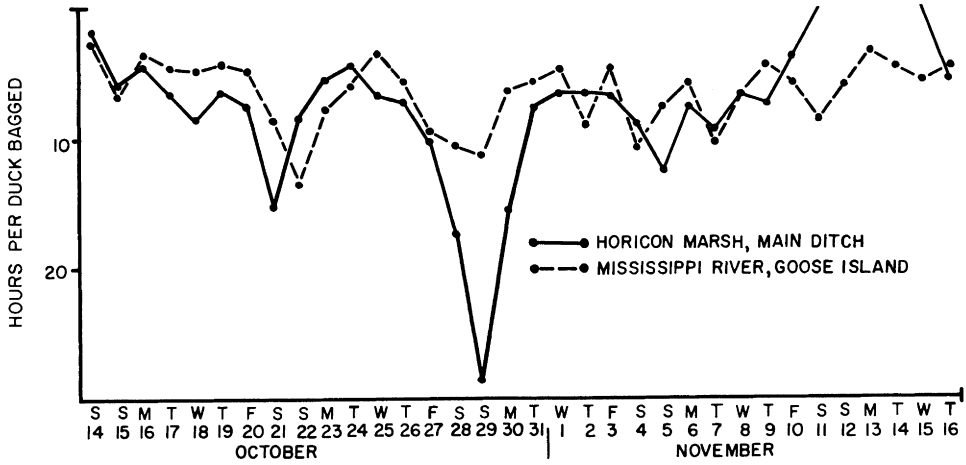

Figure 66. Daily distribution of hunter success, Horicon Marsh, main ditch and Mississippi River, Goose Island, 1950.

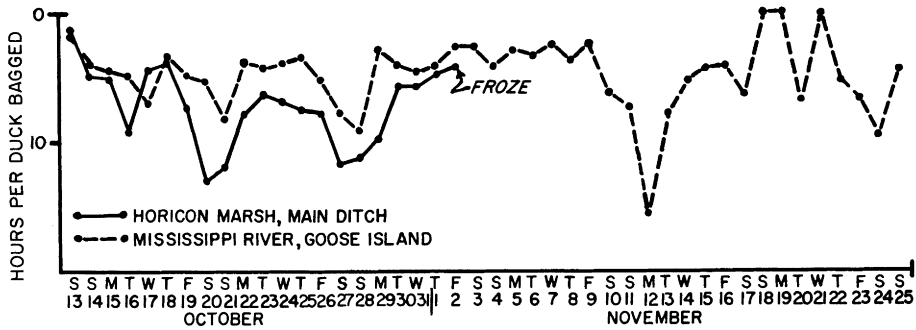

Figure 67. Daily distribution of hunter success, Horicon Marsh, main ditch and Mississippi River, Goose Island, 1951.

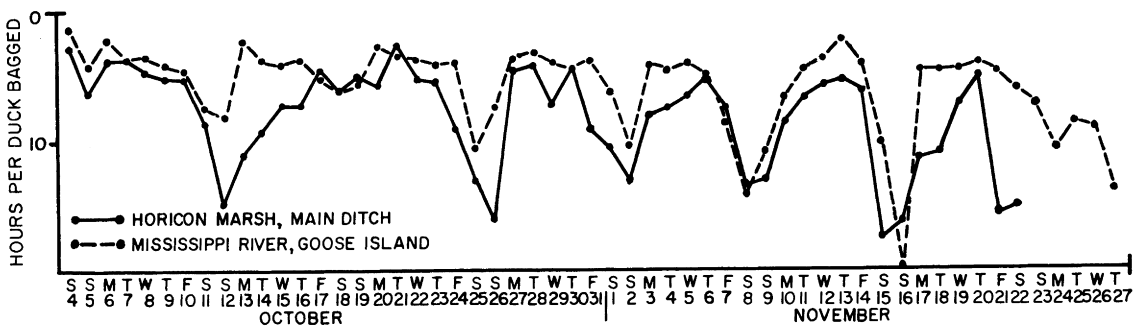

Figure 68. Daily distribution of hunter success, Horicon Marsh, main ditch and Mississippi River, Goose Island, 1952.

APPENDIX H

Reported Identification of Ducks and Coots Bagged by Wisconsin Hunters*

Bander's Identification			Hunter's Identification		
Species	Sex	Sample Size	Species	Number	Percentage
Mallard	?	5	Mallard	3	
			Black duck	1	
			Greenhead	1	
	Male	191	Mallard	184	
			Black duck	1	
			Pintail	1	
			Black-mallard	1	
			Greenhead	3	
			Hawk	1	
	Female	129	Mallard	124	
			Black duck	2	
			Black-mallard	1	
			Greenhead	1	
			Gray-mallard	1	
Total mallard		325	Mallard	311	96
			Black duck	4	1
			Pintail	1	Trace
			Black-mallard	2	1
			Greenhead	5	2
			Gray-mallard	1	Trace
			Hawk	1	Trace
Black duck	?	2	Mallard	1	
			Greenhead	1	
	Male	59	Black duck	19	
			Mallard	16	
			Redhead	1	
			Black-mallard	23	
	Female	29	Black duck	9	
			Mallard	10	
			Black-mallard	10	
Total black duck		90	Black duck	28	31
			Mallard	27	30
			Greenhead	1	1
			Redhead	1	1
			Black-mallard	33	37
Gadwall	Male	1	Pintail	1	
American widgeon	Male	9	Am. widgeon	1	
			Widgeon	8	
	Female	4	Am. widgeon	1	
			Pintail	1	
			Widgeon	1	
			Bluebill	1	
Total American widgeon		13	Am. widgeon	2	
			Widgeon	9	
			Pintail	1	
			Bluebill	1	
Pintail	Male	14	Pintail	13	
			Bluebill	1	
	Female	12	Mallard	4	
			Pintail	8	
Total pintail		26	Pintail	21	
			Bluebill	1	
			Mallard	4	
Green-winged teal	Male	5	G-winged teal	4	
			Cinnamon teal	1	
	Female	2	G-winged teal	2	
Total green-winged teal		7	G-winged teal	6	
			Cinnamon teal	1	
Blue-winged teal	?	6	B-winged teal	5	
			New Mexican duck	1	
	Male	81	B-winged teal	61	
			G-winged teal	4	
			Teal	16	
	Female	89	B-winged teal	56	
			G-winged teal	6	
			Teal	27	
Total blue-winged teal		176	B-winged teal	122	69
			G-winged teal	10	6
			Teal	43	24
			New Mexican duck	1	1
Shoveler	Male	1	Shoveler	1	
Wood duck	Male	3	Wood duck	3	
	Female	2	Wood duck	1	
			Mallard	1	
Total wood duck		5	Wood duck	4	
			Mallard	1	
Redhead	Male	63	Redhead	59	
			Canvasback	2	
			Mallard	1	
			Bluebill	1	
	Female	42	Redhead	35	
			Canvasback	2	
			Bluebill	2	
			Pintail	1	
			Scaup	1	
			Widgeon	1	
Total redhead		105	Redhead	94	90
			Canvasback	4	3
			Bluebill	3	3
			Mallard	1	1
			Pintail	1	1
			Scaup	1	1
			Widgeon	1	1
Ring-necked duck	?	5	Bluebill	4	
			Wood duck	1	
	Male	11	Scaup	4	
			Bluebill	3	
			Ringneck	2	
			Ringbill	2	
	Female	4	Bluebill	3	
			Ringbill	1	

APPENDIX H (Cont.)

Bander's Identification			Hunter's Identification		
Species	Sex	Sample Size	Species	Number	Percentage
Total ring-necked duck		20	Bluebill	10	
			Scaup	4	
			Ringbill	3	
			Ringneck	2	
			Wood duck	1	
Canvasback	?	1	Canvasback	1	
	Male	46	Canvasback	44	
			Redhead	2	
	Female	33	Canvasback	29	
			Redhead	3	
			Goldeneye	1	
Total canvasback		80	Canvasback	74	
			Redhead	5	
			Goldeneye	1	
Scaup	Male	35	Scaup	4	
			Bluebill	30	
			Broadbill	1	
	Female	13	Scaup	2	
			Bluebill	10	
			Ruddy	1	
Total scaup		48	Scaup	6	
			Bluebill	40	
			Broadbill	1	
			Ruddy	1	
Bufflehead	Male	1	Bufflehead	1	
Coot	?	29	Coot	26	
			Mud hen	2	
			Pheasant	1	

* Based on information taken from U.S. Bureau of Sport Fisheries and Wildlife band recovery slips. Percentages are given only where the total number of a species is 90 or more.

APPENDIX I

Summary of Duck and Coot Weights in Wisconsin, 1947–52

(All weights are presented in pounds and ounces)

At intervals during the course of our investigations, the general physical condition of various species of wild ducks and the coot was checked by securing weights of the birds. All birds were weighed on springless scales accurate to the nearest half-ounce. "Wet" birds were excluded. Months included in the different seasons are as follows: spring = March 1–May 31; summer = July 1–August 31; fall = September 1–November 30. Over 80 percent of the weights were taken in April, September, and October. The weights secured are summarized here to make them available to other investigators.

Species, Season and Type of Handling	Weights, by Sex and Age Class															
	Adult								Immature							
	Male				Female				Male				Female			
	No.	Avg.	Min.	Max.	No.	Avg.	Min.	Max.	No.	Avg.	Min.	Max.	No.	Avg.	Min.	Max.
Mallard																
Spring-trapped	51	2–13	2–3	3–8	7	2–6	2–3	2–10	0	——	——	——	0	——	——	——
Summer-trapped	3	2–14	2–8	3–7	8	2–5	1–15	2–11	30	2–8	1–14	3–3	30	2–5	1–6	2–12
Fall-trapped	30	2–14	2–5	3–8	35	2–5	1–7	2–14	194	2–9	1–14	3–13	253	2–5	1–6	3–1
Fall-shot	160	2–14	2–1	3–12	303	2–9	1–9	3–13	511	2–11	1–7	3–7	438	2–6	1–2	3–13
Black duck																
Spring-trapped	14	2–13	2–5	3–7	2	2–11	2–7	2–15	0	——	——	——	0	——	——	——
Summer-trapped	2	3–0	2–15	3–2	1	2–7	——	——	13	2–12	2–5	3–5	0	——	——	——
Fall-trapped	11	3–0	2–4	3–8	12	2–9	2–3	2–15	67	2–10	2–0	3–1	52	2–4	1–13	3–10
Fall-shot	86	2–15	1–12	3–7	80	2–9	2–0	3–2	185	2–11	1–13	3–12	172	2–7	1–8	3–14
Blue-winged teal																
Spring-trapped	54	0–13	0–9	1–2	22	0–13	0–9	1–0	0	——	——	——	0	——	——	——
Summer-trapped	5	0–14	0–12	0–15	10	0–13	0–11	0–13	78	0–13	0–9	1–0	101	0–11	0–9	0–15
Fall-trapped	6	0–14	0–12	1–0	34	0–14	0–9	1–0	98	0–13	0–9	1–3	141	0–13	0–9	0–3
Fall-shot	10	1–0	0–12	1–3	77	0–14	0–8	1–3	93	1–0	0–8	1–5	216	0–15	0–8	1–5
Wood duck																
Summer-trapped	77	1–8	1–1	1–13	22	1–4	1–1	1–7	17	1–6	1–1	1–10	2	1–4	1–1	1–10
Fall-trapped	19	1–8	1–3	1–13	1	1–3	——	——	9	1–5	1–0	1–10	0	——	——	——
Fall-shot	49	1–9	1–6	1–15	27	1–8	1–3	1–15	23	1–8	1–4	1–13	3	1–6	1–1	1–13
American widgeon																
Spring-trapped	27	1–13	1–4	2–2	0	——	——	——	0	——	——	——	0	——	——	——
Fall-shot	29	2–0	1–8	2–10	28	1–15	1–6	2–15	173	1–15	1–1	2–15	146	1–11	0–14	2–13
Pintail																
Fall-trapped	0	——	——	——	0	——	——	——	3	1–10	1–6	1–13	7	1–10	1–4	1–13
Fall-shot	96	2–4	1–6	3–0	76	1–13	1–6	2–10	180	2–0	1–1	2–10	155	1–11	1–1	2–7
Green-winged teal																
Spring-trapped	1	0–12	——	——	0	——	——	——	0	——	——	——	0	——	——	——
Fall-trapped	1	0–11	——	——	0	——	——	——	3	0–9	0–8	0–11	4	0–9	0–8	0–11
Fall-shot	45	0–12	0–8	1–0	33	0–11	0–4	1–2	149	0–12	0–6	1–5	114	0–11	0–6	0–15
Shoveler																
Fall-shot	5	1–9	1–4	1–15	9	1–7	1–3	1–11	20	1–8	1–3	1–15	33	1–6	0–11	2–2
Gadwall																
Fall-shot	5	2–0	1–9	2–8	7	1–15	1–8	2–5	10	2–1	1–11	2–10	15	1–15	1–8	2–5
Ring-necked duck																
Spring-trapped	5	1–8	1–6	1–10	0	——	——	——	0	——	——	——	0	——	——	——
Fall-shot	8	1–9	1–6	1–15	10	1–8	1–4	1–15	24	1–8	1–3	1–13	23	1–8	1–1	2–5
Canvasback																
Fall-shot	4	3–0	2–14	3–2	3	2–7	2–4	2–10	13	2–11	2–1	3–5	4	2–10	2–4	3–0
Lesser scaup																
Fall-shot	2	1–12	1–8	2–2	2	1–7	1–3	1–11	10	1–10	1–6	1–15	9	1–14	1–6	2–5
Redhead																
Summer-trapped	0	——	——	——	0	——	——	——	1	1–13	——	——	2	1–11	1–9	1–13
Fall-shot	3	2–5	2–1	2–13	3	2–3	1–12	2–7	11	2–3	1–9	2–10	4	2–3	1–14	2–13
Ruddy duck																
Fall-shot	4	1–1	1–0	1–3	3	1–3	1–0	1–5	7	1–1	1–0	1–7	1	0–10	——	——
Common goldeneye																
Fall-shot	1	2–5	——	——	0	——	——	——	3	2–0	1–11	2–10	1	1–7	——	——
Bufflehead																
Fall-shot	1	1–0	——	——	1	0–12	——	——	1	0–14	——	——	2	0–12	——	——
Hooded merganser																
Fall-shot	0	——	——	——	0	——	——	——	2	1–6	1–4	1–10	2	0–15	——	——
Common merganser																
Fall-shot	1	2–6	——	——	1	1–6	——	——	0	——	——	——	0	——	——	——
White-winged scoter																
Fall-shot	0	——	——	——	0	——	——	——	1	2–3	——	——	1	3–1	——	——
Coot																
Fall-shot	32	1–8	1–1	1–15	21	1–5	0–15	1–13	231	1–4	0–15	1–13	257	1–3	0–12	1–13

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