THE COMMON MERGANSER: ITS WINTERING DISTRIBUTION AND PREDATION IN A WARM WATER RESERVOIR

By

STEVEN WILLIAM MILLER

Bachelor of Science

Utah State University

Logan, Utah

1971

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
December, 1973

THE COMMON MERGANSER: ITS WINTERING DISTRIBUTION AND PREDATION IN A WARM WATER RESERVOIR

Thesis Approved:

John S Barclay
Thesis Adviser

John A. Morrison

Troy C Dorris

W D Durham
Dean of the Graduate College

PREFACE

The purpose of this study was to establish baseline information on the ecology of wintering common mergansers. The specific wintering distribution of this waterfowl was documented, and an attempt was made to quantify the role of the merganser as a fish predator in warm water reservoirs.

I wish to express my appreciation to Dr. John S. Barclay for his counsel and encouragement as my major advisor. Drs. Troy C. Dorris and John A. Morrison served on the committee and provided valuable assistance throughout the study. Thanks is given to Dr. Robert C. Summerfelt, leader, Oklahoma Cooperative Fisheries Unit, Oklahoma State, for the use of facilities during the pen study. I sincerely thank Joe Carroll, Greg Butts, Clayton Bratt, and others for their assistance in the field. A special note of gratitude is extended to the persons and agencies in Appendix A for their invaluable cooperation and assistance in sending me information on common mergansers. I also thank Mrs. Konda DeLancey for typing the final manuscript.

This study was supported by an Environmental Protection Agency Traineeship in Aquatic Ecology administered by the Reservoir Research Center, Oklahoma State University. Additional assistance was also provided by the Oklahoma Cooperative Wildlife Research Unit.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

Statement of the Problem and Objectives

The common merganser (Mergus merganser americanus) is a large duck whose diet consists principally of fish. This species of waterfowl and other fish-eating birds are often viewed as harmful to fish populations (Valdykov 1943), despite inadequate examination of their fish-eating capacities (Mills 1967). Qualitative evidence is abundant but sound quantitative determinations of food requirements are lacking for many of these avian predators. Furthermore, adequate evaluation of predation is difficult without concomitant examination of the many other factors controlling the abundance and well-being of a prey population.

The present study was designed to develop baseline information on the role of mergansers as a fish predator in warm water reservoirs and had the following objectives:

1.) to compile information on the migratory and wintering distributions of the common merganser with particular emphasis on areas of concentration,

2.) to determine the daily food-consumption of the common merganser,

3.) to initiate an evaluation of the effect of merganser predation on fish populations by examining merganser numbers

and consumption of prey on one reservoir, Lake Carl Blackwell, Oklahoma.

Mills (1967:391), in reviewing predation on fish by animals other than fish, has suggested that future work on predation "be concerned with the habits, distribution, population density, and general biology of the predator and the relationship with its prey". The general ecology of the common merganser has not been studied this extensively. The distribution and life history of this duck outside of its northern nesting area has been poorly documented.

Review of Related Literature

Previous work on common mergansers has largely been limited to food habits studies (Alcorn 1953, Coldwell 1939, Fritsch and Iven 1958, Heard and Curd 1959, Munro and Clemens 1936, 1937, 1939; Salyer and Lagler 1940, Timken and Anderson 1969, White 1957, Huntington and Roberts 1959). These studies have usually attempted in some manner (i.e. frequency of occurrence, weight, numbers or volume) to draw conclusions about the importance of this duck as a fish predator. The occurrence of game fish in the merganser's diet has been the major criterion for judgement.

In Europe, the goosander (M. merganser) was considered to be detrimental to young salmon in Sweden (Lindroth 1955), and in some salmon streams in Scotland (Mills 1962). In Denmark, however, the goosander was found to consume mainly cyprinoids and eels (Madsen 1957). Madsen believed this might harm the eel fishery, but Coldwell (1939) considered the common merganser a benefit to the salmon fishery in British Columbia, Canada, because it did eat eels.

The relationship between common merganser predation and the number of young Atlantic salmon (Salmo salar) has received considerable attention in the Maritime Provinces of Canada (Elson 1962, White 1957, Erskine 1972, Hunstman 1941). Salyer and Lagler (1940) and White (1957) concluded that common mergansers select for trout and salmon when on streams supporting these fishes. Elson (1962) and White (1957) have reported increased Atlantic salmon smolt production following merganser control. Elson (1962) found that controlling mergansers from an undisturbed population density of one per 2.5 ha of stream to one per 20 ha resulted in a five fold increase in the production of smolts on the Pollett River, New Brunswick over production without control. Further observations by Elson, based on a consumption of one pound of fish per day per merganser, revealed that the food requirement of mergansers using the Pollett River was greater than the number of salmon parr the river could support.

Game fish appear to be an insignificant food component of common mergansers in warm water impoundments (Timken and Anderson 1969, Heard and Curd 1959, Huntington and Roberts 1959). Forage fish, primarily gizzard shad (Dorosoma cepedianum) were the principal species consumed by mergansers in the above studies. Huntington and Roberts (1959) found mergansers generally selected a prey species in relation to its abundance in New Mexico reservoirs. The above studies suggested that predation upon forage and coarse fish may be beneficial to game fish populations in warm water reservoirs. However, there have been no published accounts on the proportion of fish consumed by mergansers using warm water reservoirs.

A search of the literature provided little information on

specific wintering areas of common mergansers. Much general, descriptive information exists in the various bird guide books for the states, but only a few citings of specific concentration areas for this merganser were found. In general, this duck winters throughout most of the United States where there is sufficient food and open water (see Kortright 1943 for range map). However, as with other waterfowl, there may be areas of concentrated use, particularly in the wintering distribution. In such areas, the quantity of fish consumed may be considerable and possibly have some impact (good or bad) on fish populations. Theoretically, such an area must provide a large accessible food supply and open water throughout the winter. Table 1 summarizes papers which list areas frequented by common mergansers in large numbers. A recent paper by Erskine (1972) dealt with the distribution and movements of common mergansers in northeastern Canada where much attention has been given to predation by this bird on Atlantic Salmon.

Description of Study Area

Lake Carl Blackwell is a turbid reservoir located 11 km west of Stillwater, Payne County, Oklahoma (latitude 36 ^{o}N, longitude 97 ^{o}W). The lake is situated in the oak-hickory savannah-tall grass prairie ecotone of north central Oklahoma (Bruner 1931). Physical descriptions and the ecological history of the lake are given in de Gruchy (1952), Leonard (1950) and Norton (1968). The surface area of the lake varied between 514 ha and 669 ha (mean 647 ha) during the study period 1971-73. Mean surface area during the 1972-73 winter was considerably reduced from the 1971-72 area, 612 ha and 668 ha, respectively (Ree,

Table 1. A summary of papers mentioning areas of common merganser concentration.

Source	Time of Year and Area(s) of Concentration	Description Given as to Number of Birds Present
Salyer and Lagler 1940	Fall - western end of Lake Erie; Indiana Lakes; Illinois River; Upper Mississippi River; Crescent Lake Region, Nabraska; Upper Klamath Lake, Oregon	large numbers
	Winter - Salton Sea, California; Rio Grande Reservoirs, New Mexico and Texas; Laguna Madre, Texas; Mississippi Delta Region, Louisiana; Mobile Bay, Alabama; Apalachee Bay, Florida; The South Atlantic Coastal Bays.	areas of usual winter concentrations
Huntington and Roberts 1959	Winter - Elephant Butte Reservoir, New Mexico	possibly to 15,000, usually 3,000 to 5,000
Timken and Anderson 1969	Fall Migration - discharge areas of Missouri River dams, South Dakota.	large concentrations (several hundred birds)
Anderson and Timken 1972	Late Fall and Early Spring - North Central Oklahoma	abundant

W., Director, 1973, Outdoor Hydraulic Laboratory, U.S.D.A., Oklahoma State University, Stillwater, personnal communication concerning water level of Lake Carl Blackwell).

Lake Blackwell was chosen for study because: (1) mergansers consistently use it for wintering, (2) a substantial amount of biological information about the lake has accumulated for many years, and (3) the lake is readily accessible.

The lake was impounded in 1937 and originally served waterfowl as a feeding and resting area. However, the lake's water quality gradually deteriorated to its present turbed condition and waterfowl now use Lake Carl Balckwell primarily for resting. Common mergansers were reported on the lake as early as 1940 (Baumgartner 1952), but their numbers or dates of occurrence have not been recorded regularly.

CHAPTER II

PROCEDURE

Migratory and Wintering Distribution of the Common Merganser

I compiled information on the nationwide numbers and distribution of migratory and wintering common mergansers from approximately 200 sources (Appendix A). A request was sent to all of the state game agencies (except Hawaii), 140 wildlife refuges, and certain individuals asking for all census data available on the common merganser for that particular refuge or state. This request was somewhat demanding and in some cases impossible to complete.

All existing band return data for common mergansers were obtained from the Migratory Bird Populations Station, Laurel, Maryland. From this same source I learned that the midwinter waterfowl inventories, conducted in early January, do not distinguish between species of mergansers and therefore were largely useless for this study.

Two types of information were received on merganser numbers and distribution. The first consisted of just a statement or brief summary on the occurrence of common mergansers in a state or on a particular refuge. These responses were obtained most often from areas in which mergansers were uncommon, such as the southeast, and from most of the state game agencies. The other type of response consisted

of actual census data varying in duration from 2 to over 15 years. I desired longterm quantitative data, but for the common merganser such data were relatively scarce and incomplete throughout the entire country. Certain refuges and the state of Kansas were the primary sources of longterm data. It should be mentioned, however, that many states probably contain information in their files which could have contributed to the results reported here. However, for logistic reasons it was impossible for all of these data to be extracted, summarized, and sent to me. Most state game agencies sent a summary that described the relative numbers and general dates of movement through the state.

All census data were adjusted to correspond to a standard calendar year (Table 2) for expediency in analysis and in comparing use between areas. My standard calendar year was designed on a week-ending basis. Thus, mergansers censused during the week 7 January to 13 January were assigned to the week-ending 13 January. Census data for national wildlife refuges were already recorded on a week-ending basis, so conversion of these data was fairly simple. Census data were assigned to the closest week-ending as naturally occurred. After adjustment of census data to the standard year, I analyzed the acquired information for; (1) areas of concentration, (2) movements of banded birds, and (3) chronology of migration.

Areas of concentration were defined as areas which annually receive large (2000 or more) seasonal populations of common mergansers. Trends in migratory movement were visualized by plotting band return data on maps.

I developed a fall and spring migration chronology for the midwest

Table 2. Standard calendar year - for use in designating the time common mergansers are present in any specified location.

Week	Week Ending[1]	Week	Week Ending[1]
1	1/6	27	7/6
2	1/13	28	7/13
3	1/20	29	7/20
4	1/27	30	7/27
5	2/3	31	8/3
6	2/10	32	8/10
7	2/17	33	8/17
8	2/24	34	8/24
9	3/2	35	8/31
10	3/9	36	9/7
11	3/16	37	9/14
12	3/23	38	9/21
13	3/30	39	9/28
14	4/6	40	10/5
15	4/13	41	10/12
16	4/20	42	10/19
17	4/27	43	10/26
18	5/4	44	11/2
19	5/11	45	11/9
20	5/18	46	11/16
21	5/25	47	11/23
22	6/1	48	11/30
23	6/8	49	12/7
24	6/15	50	12/14
25	6/22	51	12/21
26	6/29	52	12/28

[1] Week-ending means inclusion of that date and the six previous days.

United States, which included the Mississippi and Central Flyways. Midwestern areas having sufficient census data were systematically tabulated in a north to south sequence. The mean number of mergansers present per week on each area was computed from all years of census data and listed for each week-ending according to the standard calendar year. Midwestern areas were also grouped according to latitude and longitude, and graphs were made of each area within these regions. A migration chronology for the northern Mississippi Valley region was also developed in the same manner.

Predation on Lake Carl Blackwell

Quantifying predation by wintering common mergansers on Lake Carl Blackwell required information on at least four variables; the number of mergansers present during the winter, the food habits of mergansers on the lake, the amount and composition of the prey, and the daily food-consumption per merganser.

Observations on Lake Carl Blackwell

Numbers of common mergansers on Lake Carl Blackwell were determined by directly counting birds during the winters of 1971-72 and 1972-73. I made counts on at least three days each week during the period when mergansers were present on the lake. On some days two counts were taken (morning and evening), but on most days there was only one count. Counts were often made on four or five days a week. I also recorded observations on sex and age ratios (adult males to non-adult males), feeding behavior, location on the lake, activity and time of day, and weather during each counting period.

Four main observations points were chosen for counting and observing mergansers (Figure 1.) which together gave excellent visual coverage of the lake. A minimum of ten minutes was spent at each observation point and all points were visited during each count unless bad road conditions prevented access to a particular point. Ten minutes were sufficient in which to spot any visible waterfowl, but usually more time was required for counting. I made all observations with 7 x 50 binoculars and a variable-power, 15x to 60x, Bausch and Lomb spotting scope.

Double counting of mergansers was rarely a problem, and by noting the position of the mergansers before leaving an observation point this problem was almost eliminated. Under most weather conditions mergansers observed from one observation point could also be observed, but less distinctly, from the adjacent observation point, helping to eliminate double counting. There were a few occasions, however, when mergansers would change their position on the lake and mix with uncounted birds while I was intransit to another observation point. In these instances the count was repeated.

A merganser use day (Elson 1962) was defined as one merganser counted on Lake Carl Blackwell for one day. I assumed that if a merganser was counted on the lake it was also feeding on the lake. The number of birds counted on a given day thus became an estimate of the daily predation pressure when multiplied by the average daily food-consumption of a merganser. For those days on which no counts were made, the average of the two embracing counts was considered the use days for each of those days. Summation then gave the total number of use days for a given period of time. The total number of use days

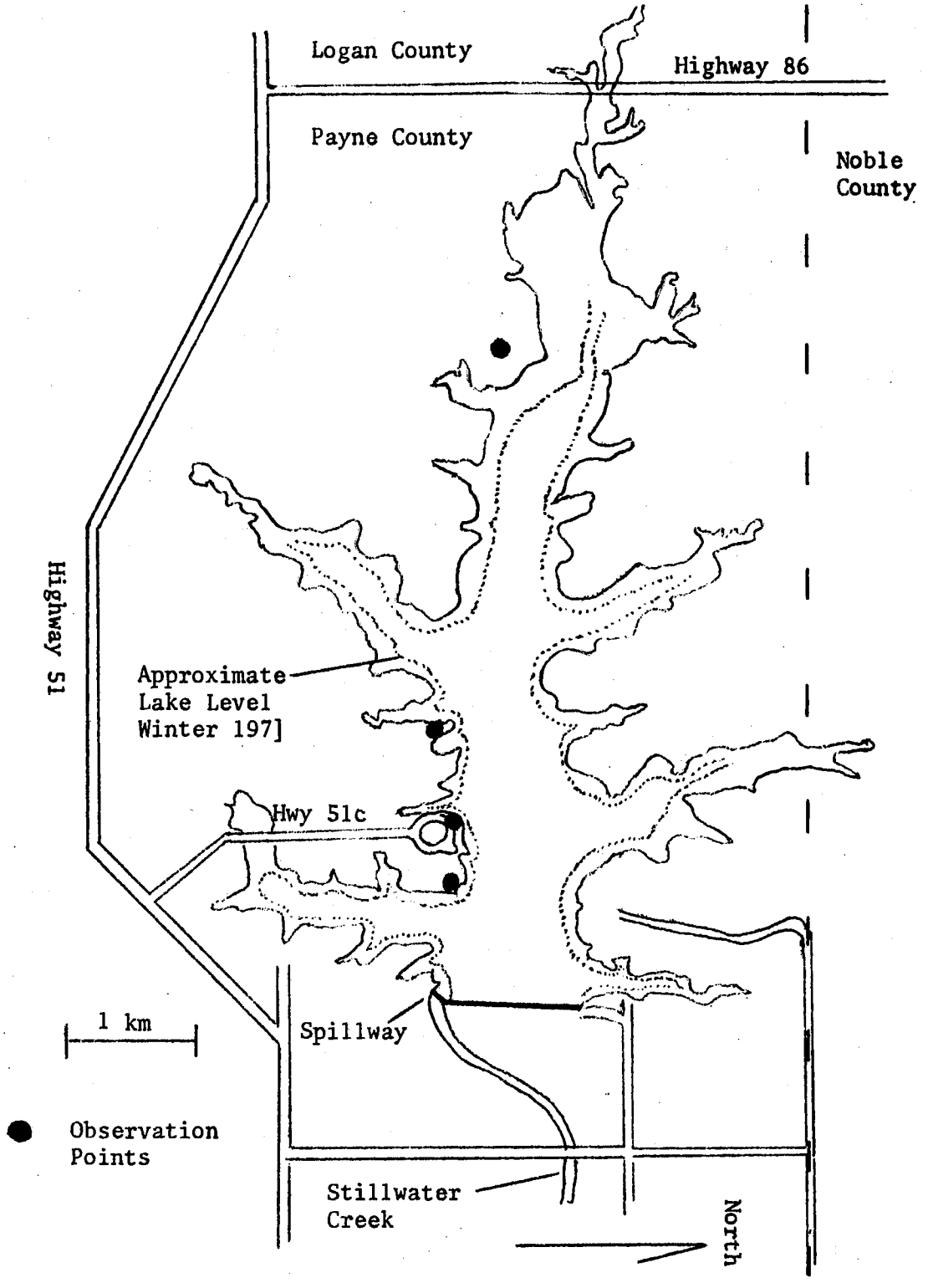

Figure 1. Map of Lake Carl Blackwell, Oklahoma, showing actual and spillway levels, and the location of observation points.

for a year multiplied by the mean daily food-consumption per bird provided an estimate of the total predation by mergansers on the fish population of Lake Carl Blackwell. I apportioned total predation among the major prey species by multiplying the proportion that each prey species comprised of the mergansers' diet by the total consumption for each winter.

Food Habits

Stomach analyses of common mergansers were conducted in order to estimate the relative species composition of the prey while on the lake. I collected forty-three common mergansers from Lake Carl Blackwell for food habits study; 29 during the 1971-72 winter and 14 during the 1972-73 winter. The esophagus and stomach contents were removed from each bird and preserved in formalin until analysis. Identifiable food items were recorded by species, and total length measurements were taken for all sufficiently intact fishes or estimated from remains. My results were combined with the results of Heard and Curd (1959) for a better representation of the mergansers' food habits on Lake Carl Blackwell. The combined results were converted to a weight basis using the mean length of individuals for each species and the live weights for that particular mean length as derived from Carlander (1969) and unpublished data for Lake Carl Blackwell (D. W. Toetz, Oklahoma State University, Stillwater, personnal communication). The forage ratio of Hess and Swartz (1940) was used to relate the consumption of prey to its availability in the lake.

Composition of Potential Prey

Standing crop estimates of fishes in Lake Carl Blackwell (Table 3) were obtained from rotenone samples in late summer 1971 (unpublished thesis data, J. N. Johnson, Oklahoma State University, Stillwater). These estimates provide an approximation of the quantity and composition of the prey potentially available to wintering mergansers on Blackwell. However, these estimates taken at the end of the summer are probably greater than the standing crops during the winter period in which mergansers were present on the lake.

Determination of Daily Food Consumption

The purpose of the food-consumption study was to determine the daily food requirement necessary to maintain a constant weight. My hypothesis, based upon the work of Salyer and Lagler (1940), White (1957), and Latta and Sharkey (1966), was that 454 g of food per day is necessary to maintain weight in a free-ranging common merganser.

I designed the food-consumption study to be conducted outdoors with mergansers housed singly in a series of outdoor pens. However, this facility was not built when the first four mergansers were captured in February 1972, and the birds were housed indoors in a small empty warehouse. The indoor facility consisted of a small stock tank, lined with plastic and surrounded on two sides and one end by wooden platforms at water level, with the remaining end serving as an access point (Figure 2). The structure was enclosed with chicken wire and closely resembled a pen described by Cornwell and Hartung (1963). Maintenance involved hosing the pen daily to remove feces, and

Table 3. Mean standing crop estimates of fishes in Lake Carl Blackwell based on four rotenone samples during late summer 1971.

Species of Fish	Mean Standing Crop (kg/ha)
Gizzard Shad	63.222
Carp	37.830
River Carpsucker	29.876
Freshwater Drum	10.111
Largemouth Bass	4.061
White Crappie	3.343
Bluegill	1.799
Longear Sunfish	1.251
Green Sunfish	1.043
White Bass	0.857
Flathead Catfish	0.244
Orangespotted Sunfish	0.195
All Fish	153.832

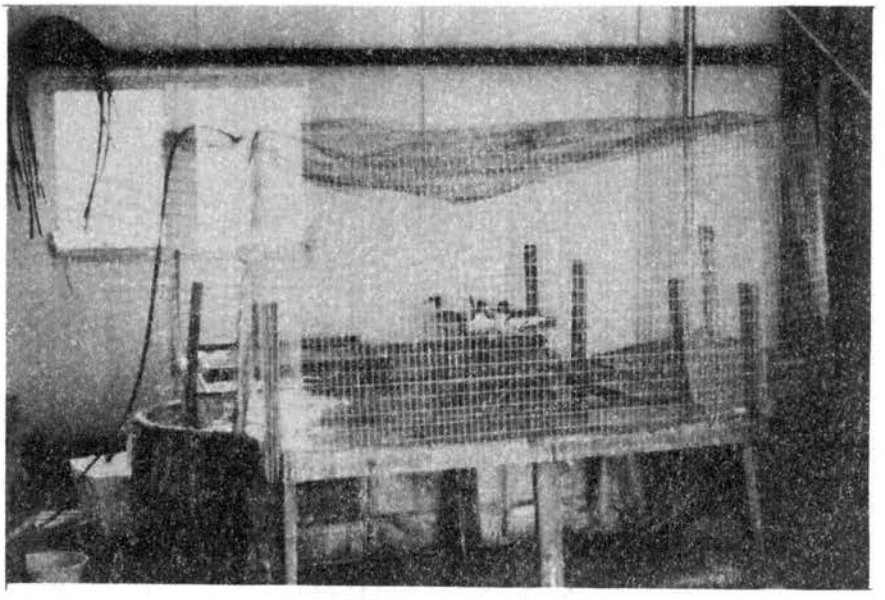

Figure 2. Indoor pen facility used to house Mergansers I, II, III, and IV from 20 February to 11 September 1972.

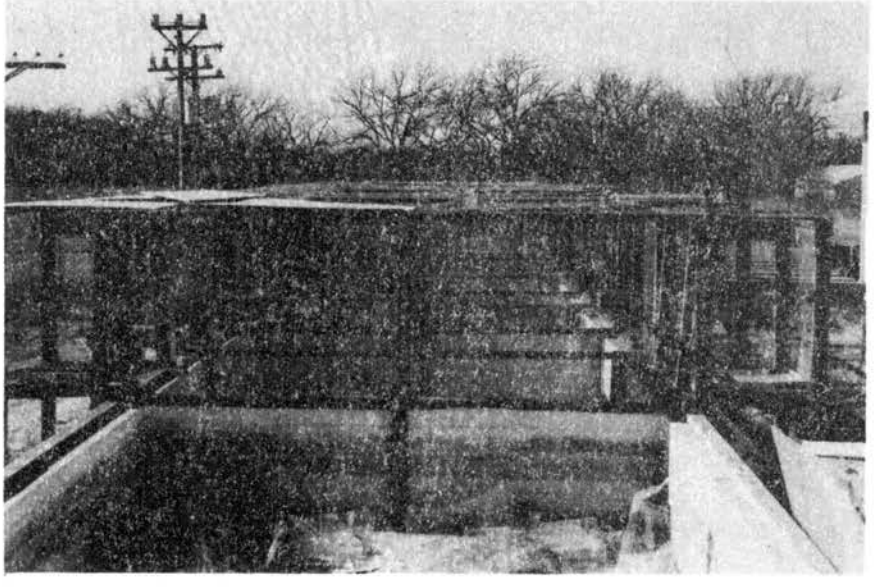

Figure 3. Outdoor pen facility used to house all mergansers after 12 September 1972.

siphoning debris from the tank as needed. The entire pen was cleaned with a disinfectent and the tank completely drained every five days. Tap water flowed into the tank continuously at a slow rate.

The outdoor facility was completed on 12 September 1972 and all captured mergansers were from then on maintained in this facility, each in a separate pen. The outdoor pens were constructed around four adjoining cement-block fish tanks each measuring approximately 3 m x 3.6 m x 0.6 m. The ponds were made available through the Oklahoma Cooperative Fisheries Unit. Four pens were built over each pond giving a total of sixteen pens (Figure 3). The pens were constructed of chicken wire and each measured 1.5 m x 1.8 m x 1.2 m, with a 1 m^2 resting platform. Thus each pen had 2.7 m^2 of water area 0.6 m deep, and 1 m^2 of resting platform adjoining the water. In addition, a shallow box of sand was placed on the resting platform of each pen as a source of grit. Water was continuously run into the ponds which were drained and cleaned as needed.

The outdoor facility was constructed so that up to 16 common mergansers could be used in the food-consumption study. I desired that, if possible, the 16 mergansers would be adults (8 males and 8 females). Mergansers were to be assigned randomly to one of three feeding treatments; (1) 227 g per day, (2) 454 g per day, and (3) 908 g per day. Daily food-consumption was to be determined for two day intervals, and the weight of each bird would be taken every five days. From this design I planned that the daily food requirement for maintaining a constant weight could be determined. However, this experimental design was not followed because only two mergansers were captured in 1973. Because of the lack of birds the food-consumption

study as planned had to be abandoned and all mergansers received the proposed food requirement of 454 g per day.

The first four mergansers, captured in February 1972, were fed live fish from February until 27 June 1972. Live fish was the desired food for the entire study but obtaining and maintaining suitable quantities became very difficult. Thus, the diet was replaced with frozen gizzard shad starting on 27 June 1972. The live fish, mostly stunted sunfish (Lepomis spp.), had been seined from ponds in the Stillwater area. Gizzard shad were electroshocked from Lakes Keystone and Carl Blackwell during the summer of 1972. Also, some shad were obtained from rotenone samplings conducted by the Fisheries Division of the Oklahoma Department of Wildlife Conservation. The shad were packaged in 454 g quantities and frozen for future use. Six hundred and forty kilograms of gizzard shad were stockpiled during the summer of 1972 for anticipated use during the winter of 1972-73.

All mergansers used in the food-consumption study were to receive 454 g of fish per day. However, when live fish were used this was not done because of the difficulties in obtaining a consistent supply of fish. Consequently, from February 1972 until 27 June 1972 live fish were not supplied in sufficient quantity to adequately maintain the first four mergansers studied. The 454 g per day per bird schedule was easily maintained once frozen fish were used. I measured consumption by weighing uneaten fish at two or three day intervals. The first four mergansers studied were confined in the same indoor pen from February 1972 until 12 September 1972, and daily food-consumption per bird was the average of the amount eaten by all. Weights of the first four birds were taken monthly whereas the weights of the two

captured in 1973 were taken every five days. A B-complex vitamin supplement was also given, at each weighing, to the mergansers captured in 1973 (see page 51).

Capture Methods

Attempts to collect common mergansers alive for determining the daily food-consumption primarily involved nightlighting. The equipment I used in this study was similar to that used by others in nightlighting waterfowl (Bishop and Barratt 1969, Lindemeir and Jensen 1961, Cummings and Hewitt 1964). The equipment consisted of a 1000 watt, gas powered generator and six 150 watt outdoor spotlights. The lights were mounted on a board and secured to the bow of a small boat (Figure 4). A boat handler and netter were the only personnel required.

Mergansers were captured in dip nets having 2 m handles, and nets 0.8 m deep by 0.6 m wide. In 1972-73 a net was used which had a 4.6 m handle which allowed the netter a much longer reach. Also, in 1972-73, a throw net was constructed of 10 cm-mesh gill net (Figure 5) and was used during the last three nightlight efforts of that year. This net was simple to use and might have increased the success of capturing mergansers had it been devised and used earlier. It was possible to toss this net up to 10 m with considerable accuracy. Captured mergansers were placed in a burlap bag, weighed and color banded the same evening as captured.

I attempted mist netting with decoys three times but was unsuccessful. On each attempt the net, 3 m x 18 m with 5 shelves and 10 cm mesh (Beleitz Wildlife Foundation, Hollywood California) was positioned

Figure 4. Nightlighting rig attached to 4.3 m Boston Whaler.

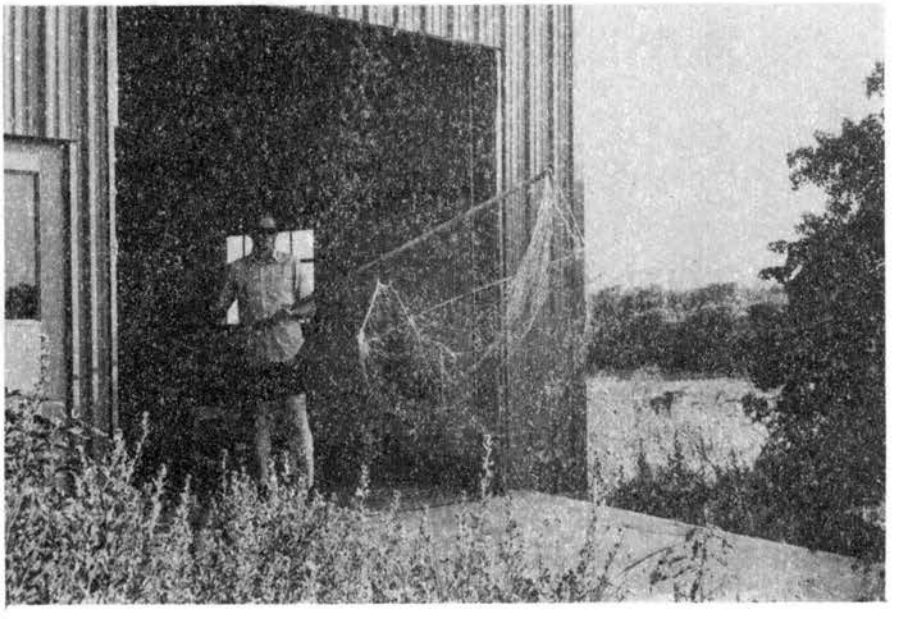

Figure 5. Throw net constructed of 10 cm gill net used to capture Merganser VI.

over open water, close to shore, in areas known to be frequented by mergansers. Cannon netting of mergansers was not tried in this study but was attempted during late December and early January 1972-73 at the Great Salt Plains National Wildlife Refuge, Oklahoma by Bertin W. Anderson (B. W. Anderson, Eastern Michigan University, Ypsilanti, Michigan, personnal communication). Anderson reported no success.

CHAPTER III

RESULTS

Distribution of the Common Merganser

Areas of Concentration

Table 4 lists areas found to have large seasonal populations of common mergansers. Four main regions were found to have large numbers of mergansers during late fall, winter, or early spring; the northwest, the southern Great Plains, the Upper Mississippi and Illinois River Valleys, and the Southern Great Lakes. It is interesting to note that the latter three regions occur in the midwest United States. In the east only the Connecticut River was found to have large seasonal concentrations of mergansers. The range in peak numbers is quite variable for most of the locations in Table 4. This might be due to inconsistent censusing in each location, but perhaps is related to year to year variability in weather and food conditions as discussed by Bellrose and Crompton (1970:222-223) for mallards wintering in the Mississippi Flyway.

Table 4 is an incomplete listing of areas receiving large concentrations of common mergansers. There are probably other reservoirs, lakes, and rivers around the country which receive much use by mergansers that I did not locate in this survey. Appendix B summarizes all responses received in this survey on the distribtion and abundance of

Table 4. Specific areas in the United States Containing large (2,000 or more) seasonal populations of common mergansers.

Location	Peak Numbers (range)	Period of Peak Concentrations	Years of Data
Colorado River from Yuma to Bullhead City, Ariz.	3,000 - 12,000	12/21 - 2/28	10
Klamath Basin NWR, Calif.	2,000 - 10,000 1,500 - 3,500	2/17 - 4/6 11/9 - 12/7	5
Stillwater Waterfowl Mgt. Area, Nevada	500 - 3,000	winter	10
American Falls Reservoir and Snake R., Idaho	5,000 at Amer. F. Res., local conc. on Snake R.	mid-November	-
Minidoka NWR, Idaho	500 - 2,500 500 - 3,400	3/16 - 4/13 11/9 - 12/7	10
Deer Flat NWR, Idaho	1,000 - 5,000 1,000 - 10,000	2/3 - 4/6 11/9 - 12/21	11
Leech Lake, Lake Pepin, Minnesota	3,000 - 5,000 est.	fall	-
Upper Mississippi NWR, Minn.	3,000 - 18,000 3,000 - 15,000	Nov. to late Dec. March and April	10
Mississippi River, Moline to Alton (primarily Keokuk Pool)	up to 11,000	mid-December	11
Mark Twain NWR, Mo. (Calhoun Division)	1,500 - 10,000	early February	11
Illinois River Valley, Spring Valley to Hardin, Ill.	up to 13,000	mid-December	11
Crab Orchard NWR, Ill.	3,500 - 10,000	Jan. and Feb.	12
Tennessee NWR, Tenn.	2,000 - 10,000	January	10
Kentucky Lake, Ky.	2,000 - 3,000	Jan. and Feb.	-

Table 4. continued.

Saginaw Bay, Lake St. Clair, The Lower Detroit River, Lake Erie (western end), Southern Lake Michigan; Michigan	est. 3,000 - 10,000 in each area	fall and winter	-
Southwestern end of Lake Erie and Sandusky Bay; Ohio	10,000 - 30,000 (possibly more)	Nov. and early Dec.	-
Lake McConaughy, Neb.	2,500 - 18,000	Dec. and Jan.	8
Kansas (whole state)	minimum of 25,000 to 75,000	late Dec. and February	10
Kansas (specific areas):			
Cheyenne Bottoms WMA	3,000 - 62,000	February	10
Lake McKinney	2,000 - 8,000	February	10
Flint Hills NWR	2,000 - 7,000	December	7
	2,000 - 16,000	February	
Toronto Reservoir	up to 8,000	Dec. to Feb.	4
Fall River Reservoir	2,000 to 25,000	Dec. to Feb.	9
Neosho Reservoir	up to 5,000	Feb. to March	9
Kirwin NWR	8,000 - 25,000	December	10
	3,000 - 7,000	late Feb. to March	
Webster Reservoir	5,000 - 30,000	December	9
	5,000 - 20,000	late Feb. to March	
Oklahoma: most of the larger reservoirs; Ft. Cobb, Ft. Gibson, Grand Lake, Keystone, Oologah, Canton	3,500 - 24,000 on each	mid to late Jan.	-
Great Salt Plains NWR, Okla.	3,000 - 16,000	lat Dec. to mid-Jan.	19
Washita NWR, Okla.	4,000 - 10,000 (occasionally to 35,000)	January	8
Coastal Connecticut and Lower Connecticut River	1,000 - 3,5000	Jan. and Feb.	5

common mergansers. From a brief review of the various bird books for each state, the information in Appendix B appears additive to the information already contained in these books. The description of merganser distribution and abundance in the bird books for each state is normally qualitative while Appendix B is quanitative where possible. Appendix B is briefly outlined in the following paragraphs and provides an overview of the migratory and wintering distribution of the common merganser in the United States.

The common merganser is an uncommon-to-rare migrant and winter resident in the southeastern United States and most of Texas. Along the mid-Atlantic Coast the abundance of common mergansers is somewhat obscure. Correspondence from federal refuges in this area indicates that common mergansers are present in locally small concentrations (not more than 600 per concentration). However, common mergansers may be more numerous in some of the bay areas along the east coast (Stewart 1962) than was found in this survey.

In New England, common mergansers are common and occasionally locally abundant. Nesting occurs in northern New England, but in winter mergansers leave this area and possibly gather along the coast and on some of the major rivers in southern New England such as the Connecticut River.

Mergansers use the southern Great Lakes heavily during migrations but less so for wintering. Peaks of up to 110,000 common and red-breasted mergansers (Mergus serrator) have been reported for southwestern Lake Erie.

Common mergansers are present in the northern plains states primarily as migrants. Local buildups of a few hundred birds were

reported for the tailwaters of dams in the Dakotas, but there were no records of large concentrations on any reservoirs in these states.

Mergansers are locally abundant in some areas of the west, most noticeably Idaho. They are permanent residents in the states of Idaho, Washington, Oregon, and California, but occur primarily as winter residents on large rivers and reservoirs in New Mexico and Arizona.

The upper Mississippi Valley, the Illinois River Valley, and areas to the southwest throughout Kansas and Oklahoma appear to be the major wintering areas for common mergansers in the midwest. The greatest number of common mergansers and the largest number of areas used by these birds were found in Kansas and Oklahoma. The data indicate that Kansas and Oklahoma are the primary wintering states for common mergansers in the midwest United States.

No correspondence was received from areas south of Oklahoma and the Texas panhandle mentioning merganser concentrations in the winter. Thus, from the data obtained, I concluded that the main southern distribution of wintering common mergansers in the midwest terminates in the southern Great Plains, from eastern New Mexico along the southern state line of Oklahoma to the Tennessee National Wildlife Refuge on Kentucky Lake in western Tennessee (Figure 6). The range map for this species in Kortright (1943) shows almost the same southern wintering distribution limit as present here. This was not discovered, however, until after I decided on the southern limit as drawn in Figure 6.

Movements of Banded Birds

From 1924 through 1971 there have been only 1,950 bandings of common mergansers; of which 236 have been recovered. Returns from

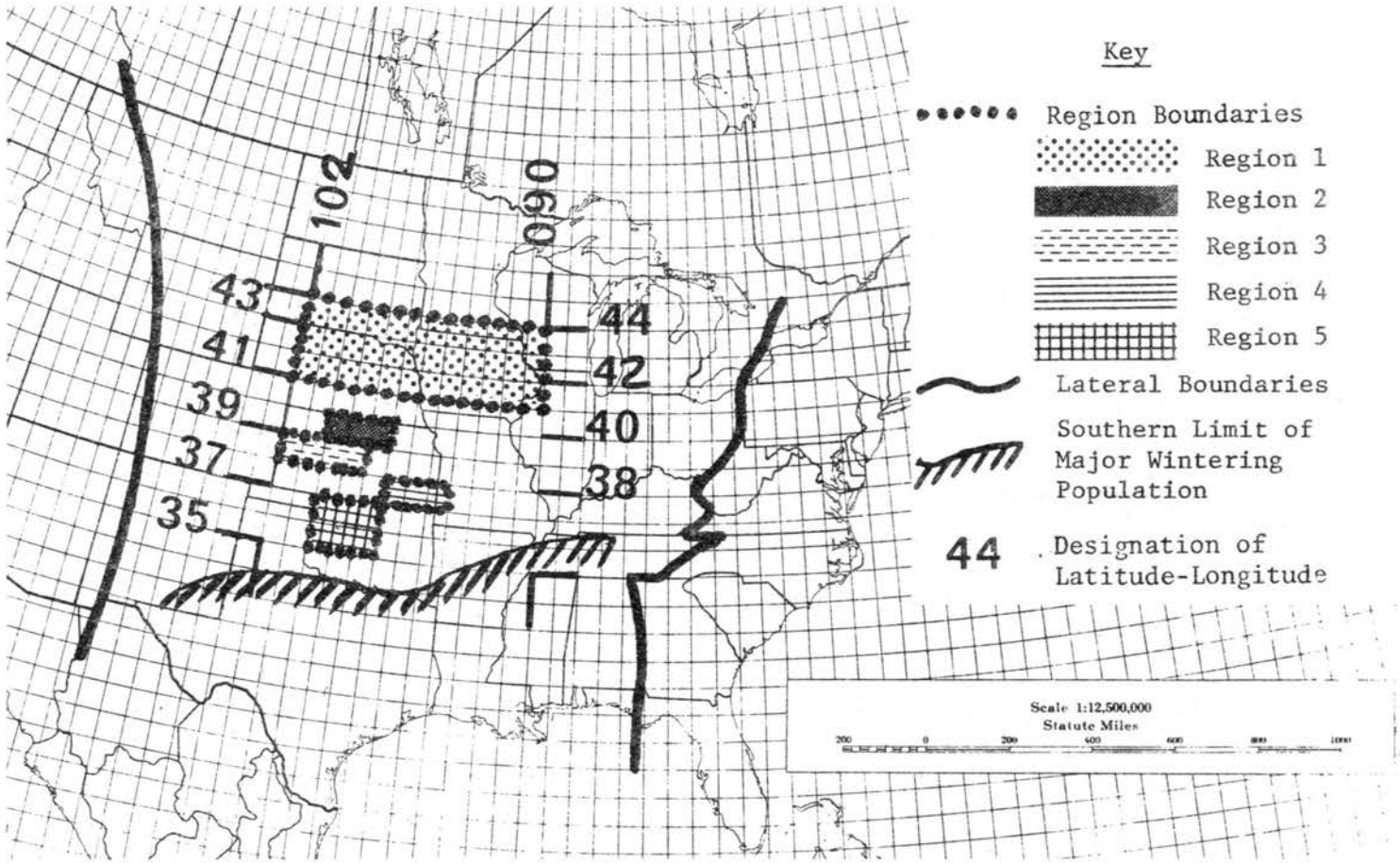

Figure 6. Location of latitude-longitude regions in the mid-United States used to develop a chronology of migration (Figures 10, 11, 12, 13, 14, and 15).

bandings in Oklahoma, New York, Nova Scotia, and New Brunswick account for 217 of the 236 recoveries. The remaining 19 came from a few scattered locations in the United States and Canada, and in most instances the banded birds were recovered at or near the banding site in the same year that banding occurred. Recoveries were not separated into age and sex classes, nor into indirect or direct recovery groups. The four locations inadequately represent the mergansers breeding and wintering range, so they cannot provide definite migratory routes (Crissy 1955).

Band recoveries from common mergansers banded in Nova Scotia and New Brunswick exhibit the same distributional pattern (Figure 7). Mergansers in both areas appear to be largely permanent residents. Mergansers leaving Maritime Canada appear to move generally south to coastal southern New England and the northern mid-Atlantic States. Erskine (1972) has discussed in detail the band recoveries for mergansers banded in Nova Scotia.

Figure 8 shows the recovery locations of 40 common mergansers which were banded in April 1957 in southwestern New York. The tendency for migration is from mid and eastern Canada to the mid-Atlantic Coastal region with some movement into the south Atlantic states. The relatively large number of recoveries in the Lake Erie region probably reflects both large numbers of mergansers (see Appendix B, Michigan and Ohio) and a high density of hunters.

The recoveries from winter bandings in Oklahoma during the years 1938, 1939, 1940, and 1941 are shown in Figure 9. The pattern is for almost straight north-to-south flight. A close examination of the recovery records showed that nine indirect recoveries of the total 36

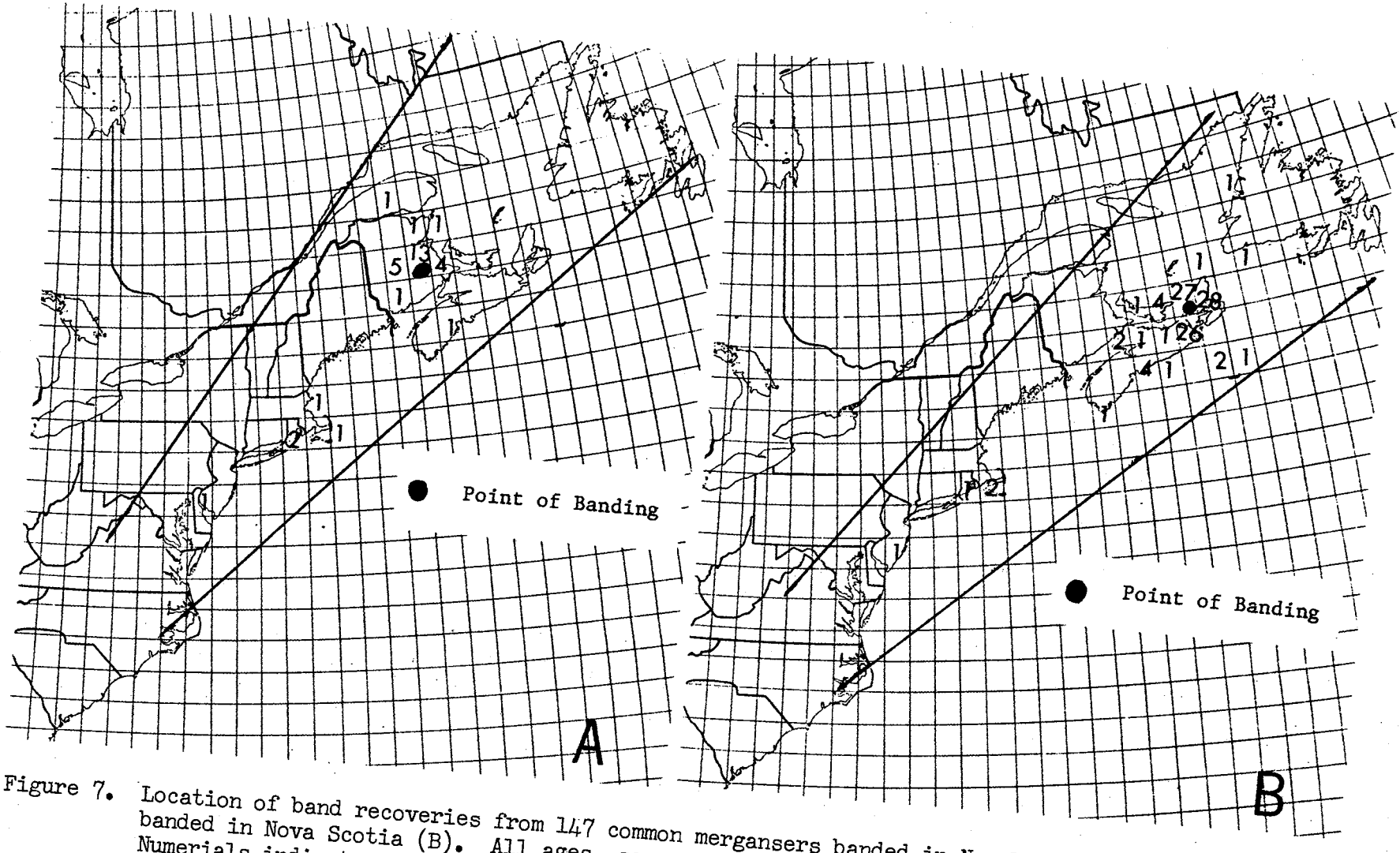

Figure 7. Location of band recoveries from 147 common mergansers banded in New Brunswick (A) and 589 banded in Nova Scotia (B). All ages, sexes, direct, and indirect recoveries included. Numerials indicate the number of recoveries in a degree block.

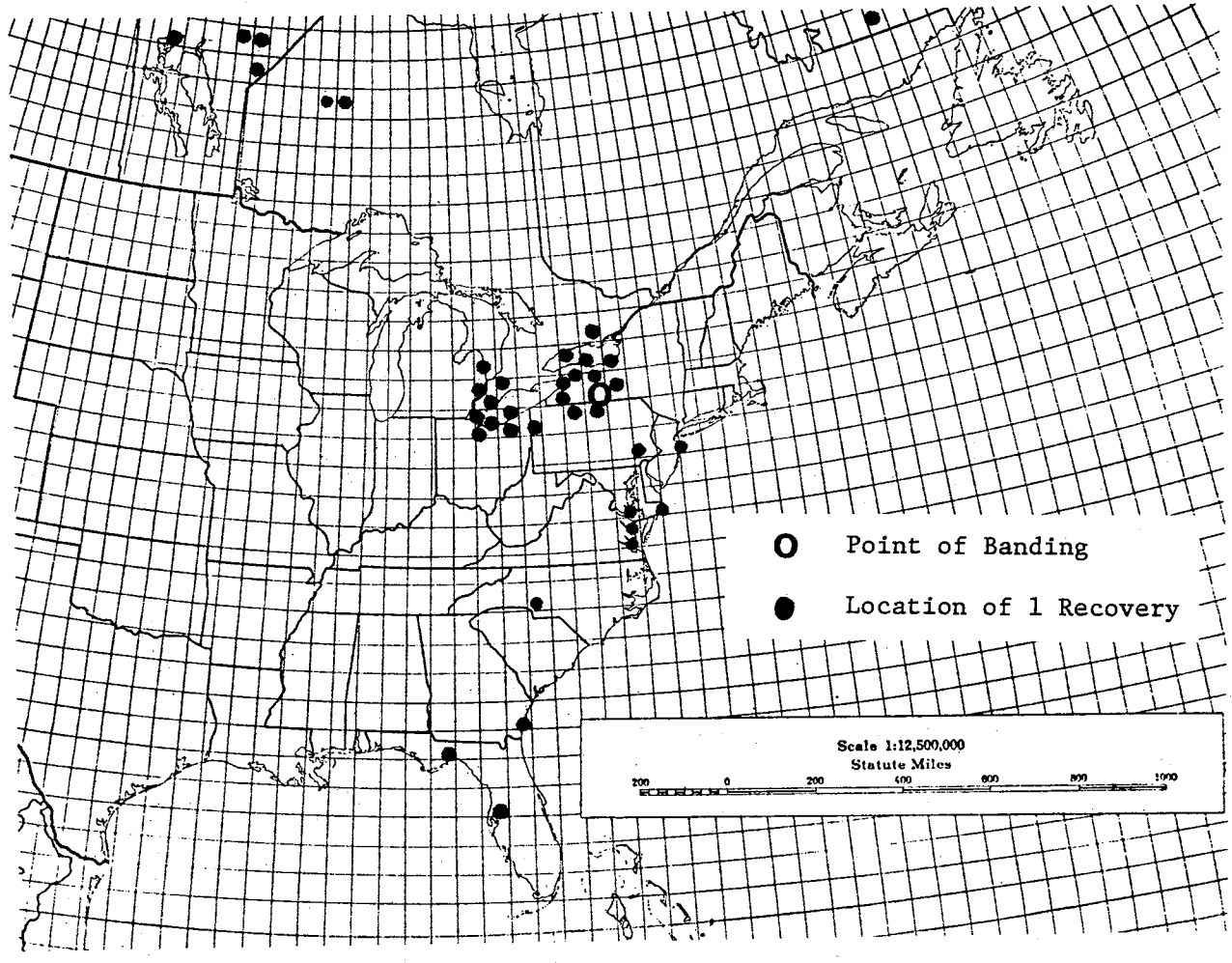

Figure 8. Location of band recoveries from 660 common mergansers banded in southwestern New York, all ages, sexes, direct, and indirect recoveries included.

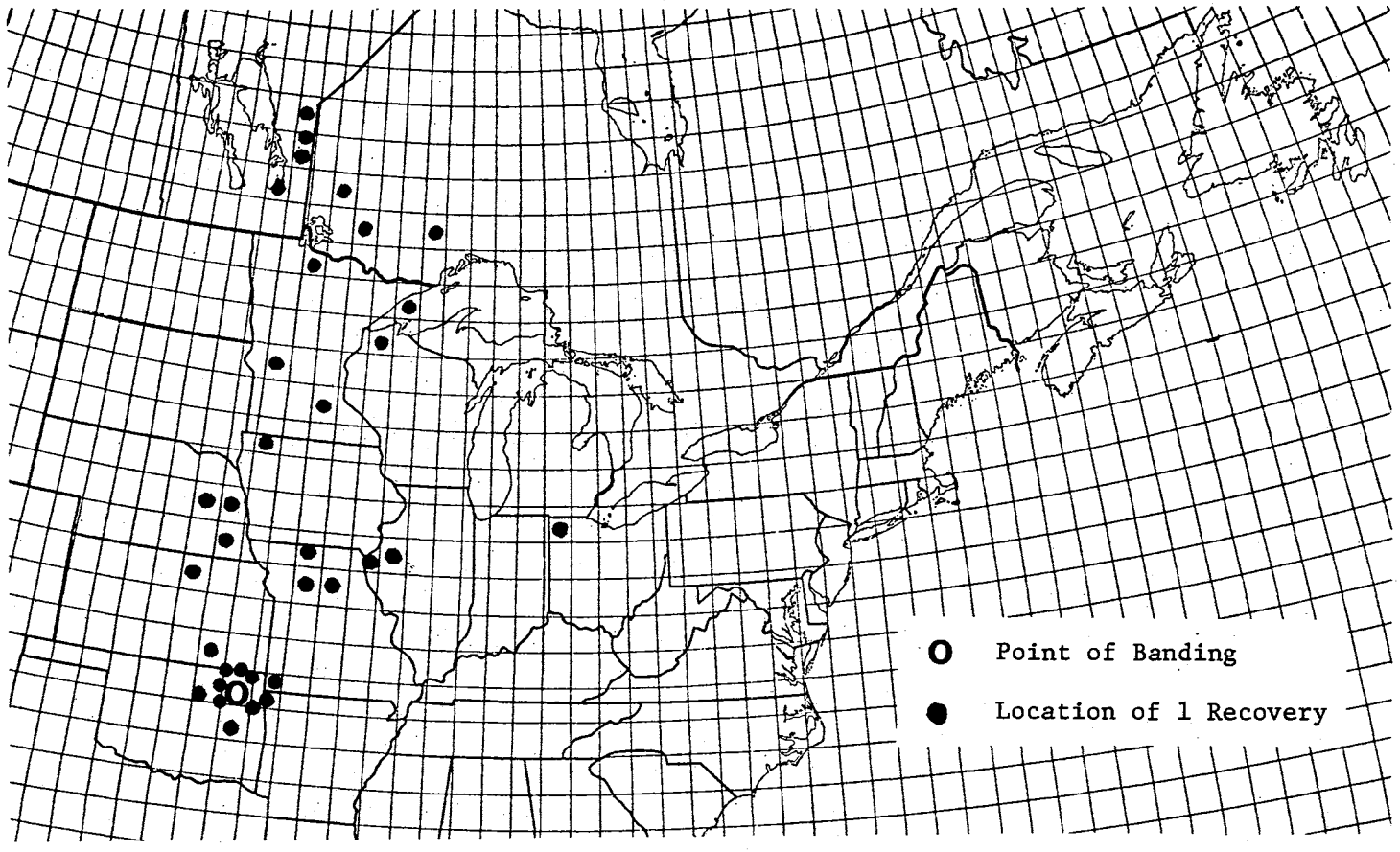

Figure 9. Location of band recoveries from 284 common mergansers banded in Oklahoma, all ages, sexes, direct, and indirect recoveries included.

recoveries were within the same degree of latitude and one degree of longitude as the banding site. Common mergansers may thus exhibit a homing tendency to wintering areas much the same as discussed for other waterfowl by Bellrose and Crompton (1970).

Migrational Chronology

The midwestern areas I used to develop a fall and spring migration chronology are listed in Table 5 along with the mean number of merganser per week. The regions for which chronologies were made are shown in Figure 6, and the chronology of merganser migration for specific areas in each region are graphed in Figures 10, 11, 12, 13, and 14. Adequate census data were available for only a few areas within each of the regions shown in Figure 6 (see Table 5). However, I assumed that these areas, for which seasonal census data were available, are probably indicative of the general movement of mergansers through the entire region. If the foregoing assumption is valid, the development of a chronology of seasonal movement for a large region based on a few specific areas with good census records is probably adequate.

The fall and spring migration of common mergansers in the midwest can be visualized from Table 5 and Figures 10 thru 14. The graphs allow comparison of dates of arrival, peak numbers and departures of mergansers between areas within a region, and between areas in different regions. Table 5 provides an informative analysis when for each area listed the peak number in spring and fall, and the encompassing two or three dates are circled. It can be readily seen that peak periods occur closer together as one goes from north to south.

Table 5. Mean number of common mergansers per week for areas in the mid-United States. Encircled numbers denote peak periods.

Area	Lat. (°N)	Long. (°W)	Years Data	Mean Number of Mergansers Per Week-Ending Per Area																														
				10-5	10-12	10-19	10-26	11-2	11-9	11-16	11-23	11-30	12-7	12-14	12-21	12-28	1-6	1-13	1-20	1-27	2-3	2-10	2-17	2-24	3-2	3-9	3-16	3-23	3-30	4-6	4-13	4-20	4-27	5-4
Lake Andes NWR, S.D.	431	0983	10					1	1	100	215	250	330	12	12	2	0	0	0	0	0	0	0	2	15	58	390	743	283	280	280	280	83	3
Upper Mississippi NWR, Minn.	430	0910	10	21	21	70	70	272	713	1377	2562	3241	4424	2926	1980	1043	563	560	504	470	433	377	437	474	820	1600	2928	4424	6557	6000	3440	1253	397	111
Crescent Lake NWR, Neb.	415	1022	8						1	183	180	116	5	25	0	0	0	0	0	0	0	37	80	70	26	163	100	50	33	27	13	2	2		
Desoto NWR, Iowa	413	0960	14				1	1	6	16	23	45	50	41	14	7	4	2	1	1	1	1	2	3	9	173	166	263	132	116	36	16	4		
Lovewell Reservoir, Kan.	395	0981	9				6		33	44	66	136	314	655	511	755	318	196	411	520	415	417	1295	917	1500	1027	340	500	722	122	61	5	5		
Kirwin NWR, Kan.	394	0992	10		5	1	1	38	82	1453	2277	3752	6788	7253	6394	7386	1275	1257	229	1000	594	473	1513	1142	1106	1849	1608	410	266	35	4	1	1		
Webster Reservoir, Kan.	393	0993	9					23	248	952	1434	5946	6518	7350	4427	2210	2077	810	210	640	376	946	2720	2268	4272	6218	3390	2190	763	272	116	2			
Swan Lake NWR, Mo.	393	0931	16					1		1	20	71	45	196	146	109	81	1	3	13	2	12	135	137	139	91	104	99	44	42	83	75	66	2	
Mark Twain NWR, Mo. (Calhoun Division only)	385	0903	11					1		35	64	167	373	604	915	773	1158	875	904	1068	1945	1566	906	787	510	424	139	125	38						
Cedar Bluff Reservoir, Kan.	384	0994	8									121	352	425	453	431	456	746	534	325	350	340	1016	618	806	938	628	314	273					
Cheyenne Bottoms WMA, Kan.	383	0984	11	1	1	1	1	161	131	252	290	726	856	1167	1048	916	510	459	269	290	3812	8150	5780	2962	9830	4031	4126	1034	500	162	182	38	1	
Marias des Cygnus WMA, Kan.	383	0953	10				1	2	1	4	3	4	42	75	53	40	356	67	70	40	38	117	203	215	627	1670	987	709	538	5	1	7			
Flint Hills NWR, Kan.	382	0955	7						240	58	385	527	1387	3201	2601	850	346	646	678	1312	3990	4102	5437	3512	1746	2246	1220	377	323	30	1			
Lake McKinney, Kan.	375	1012	5				50	30	21	21	570	605	180	580	550	45	230	55	60	163	1157	1505	2660	2560	3360	2150	1510	1800	3285	1287	590	80	50		
Fall River Reservoir, Kan.	374	0960	9						1	11	17	38	62	466	911	1288	566	783	861	927	815	1274	1400	2100	2928	2738	1516	1275	720	210	183	15			
Toronto Reservoir, Kan.	374	0960	4							2	47	11	242	75	800	2787	1062	1687	1762	1900	1825	1587	2375	1625	1625	1587	340	225	25						
Neosho Reservoir, Kan.	372	0951	9									3	53	120	45	1100	123	31	38	35	58	118	430	567	1456	1455	1011	722	347	133	8	5			
Great Salt Plains NWR, Okla.	364	0981	19						1	35	105	939	2143	2858	2892	4035	3150	2417	3712	2972	1625	1184	1222	961	741	350	250	163	71	18	16	22	3		
Tennessee NWR, Tenn.	361	0880	10		2	6	23	53	53	340	350	360	665	720	810	1050	1790	3110	2290	1810	1710	1660	1350	1160	1125	760	285	112	61	28	15	2	1		
Washita NWR, Okla.	353	0991	8							18	41	130	153	490	1331	1736	2009	4402	3527	3349	2593	2289	564	455	310	487	312	14	1						
Buffalo Lake NWR, Texas	345	1015	10							4	14	105	162	787	579	466	567	780	841	735	635	634	688	656	695	400	207	60	42	20					
Tishomingo NWR, Okla.	340	0964	4							200	250	266	233	266	242	283	200	225	225	225	173	183	183	141	161	133	75	40	10						

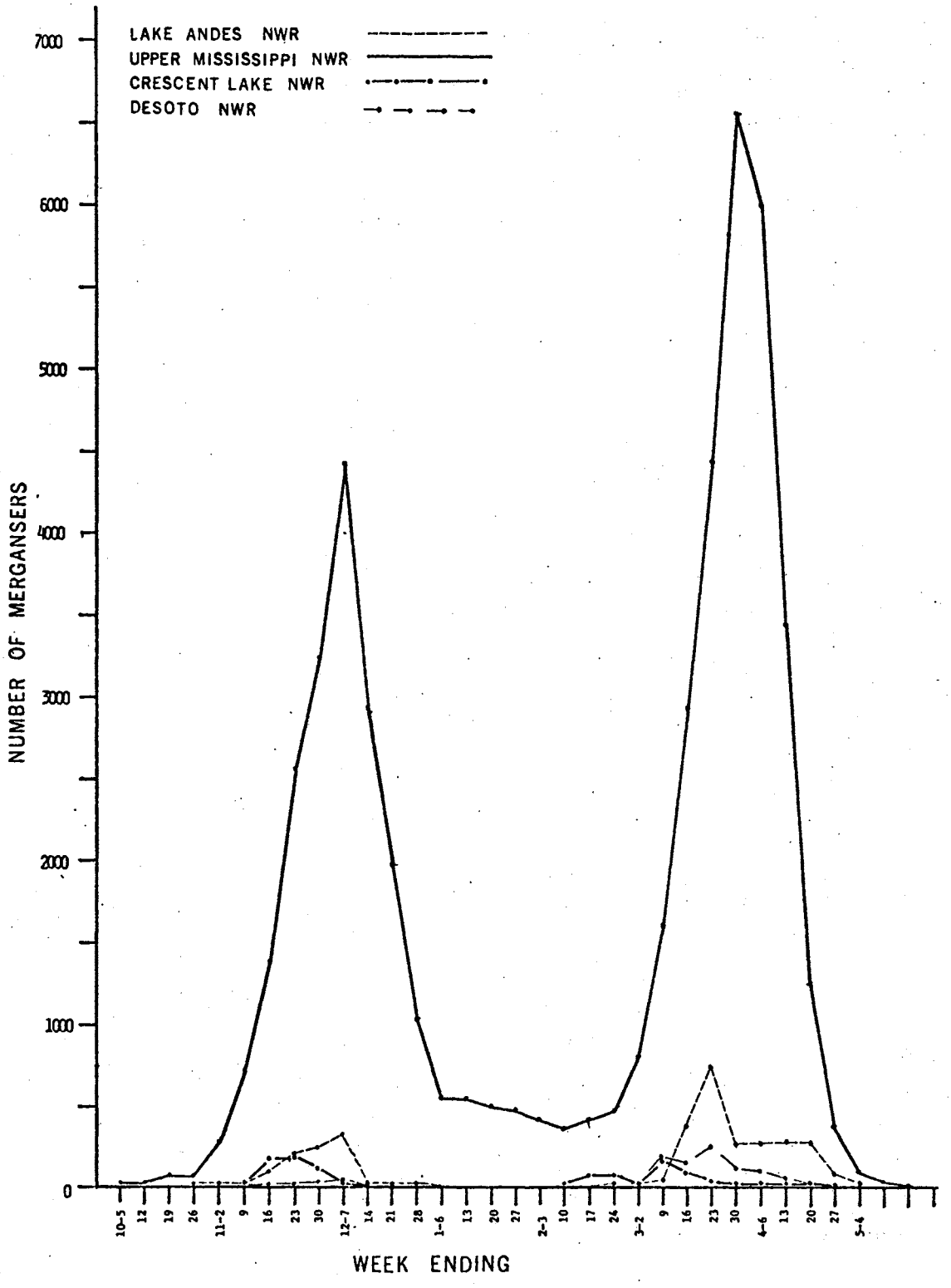

Figure 10. Migration chronology of the common merganser for specific areas in Region 1; latitude 41° - 44° N, longitude 90° - 102° N (see Figure 6).

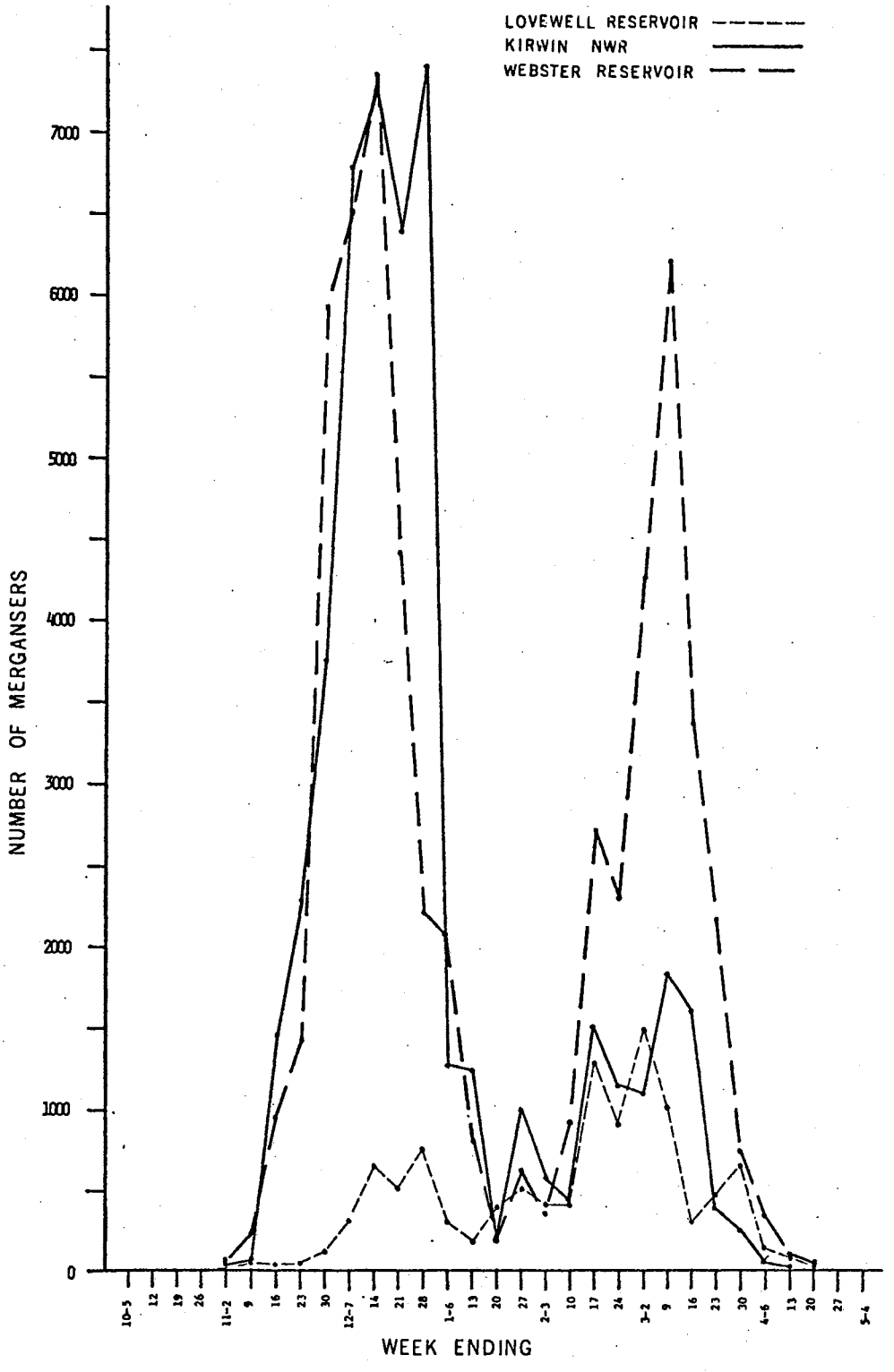

Figure 11. Migration chronology of the common merganser for specific areas in Region 2; latitude 39° - 40° N, longitude 90° - 100° W (see Figure 6).

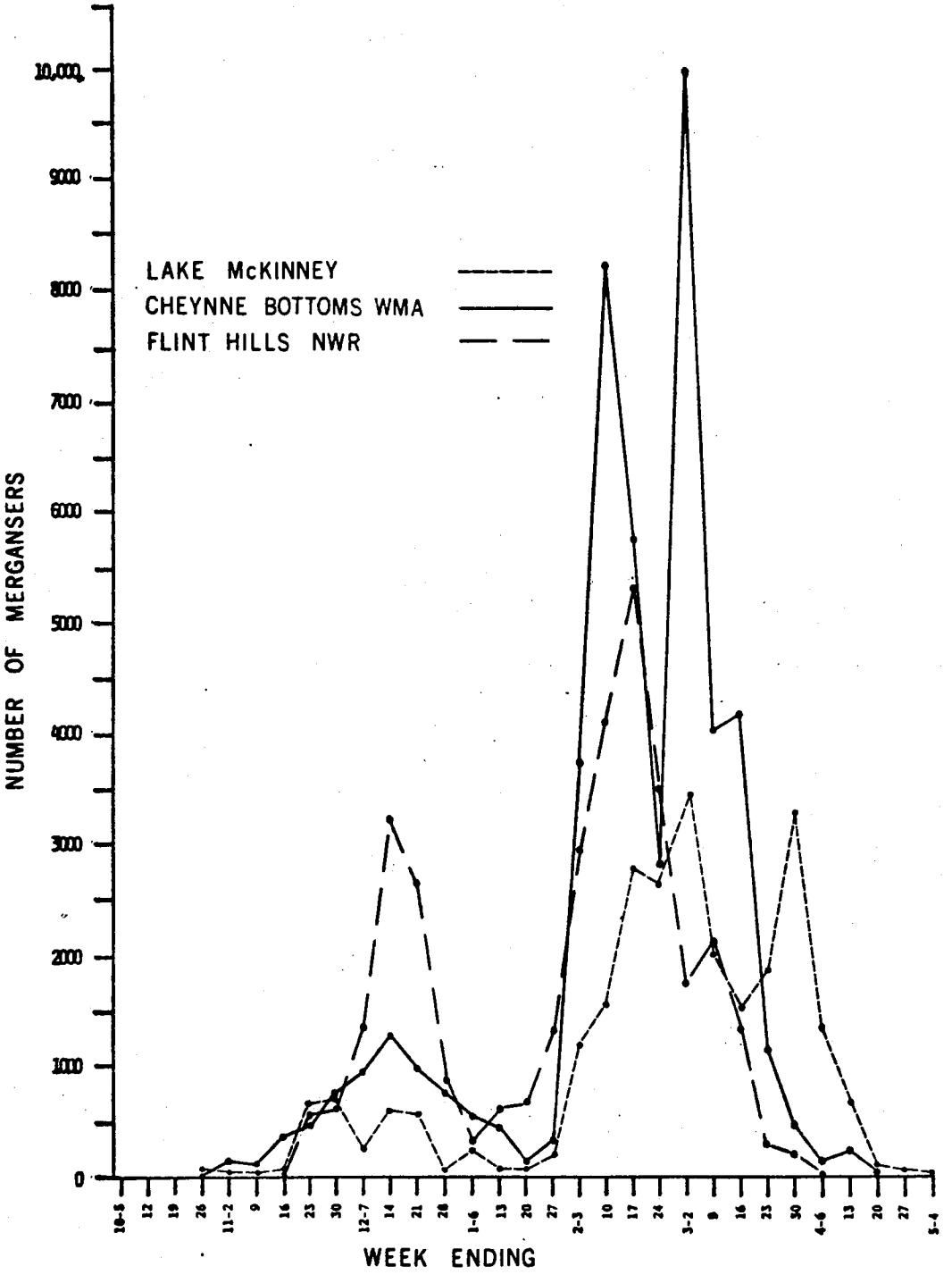

Figure 12. Migration chronology of the common merganser for specific areas in Region 3; latitude 38^{o} - 39^{o} N longitude 98^{o} - 102^{o} W (see Figure 6).

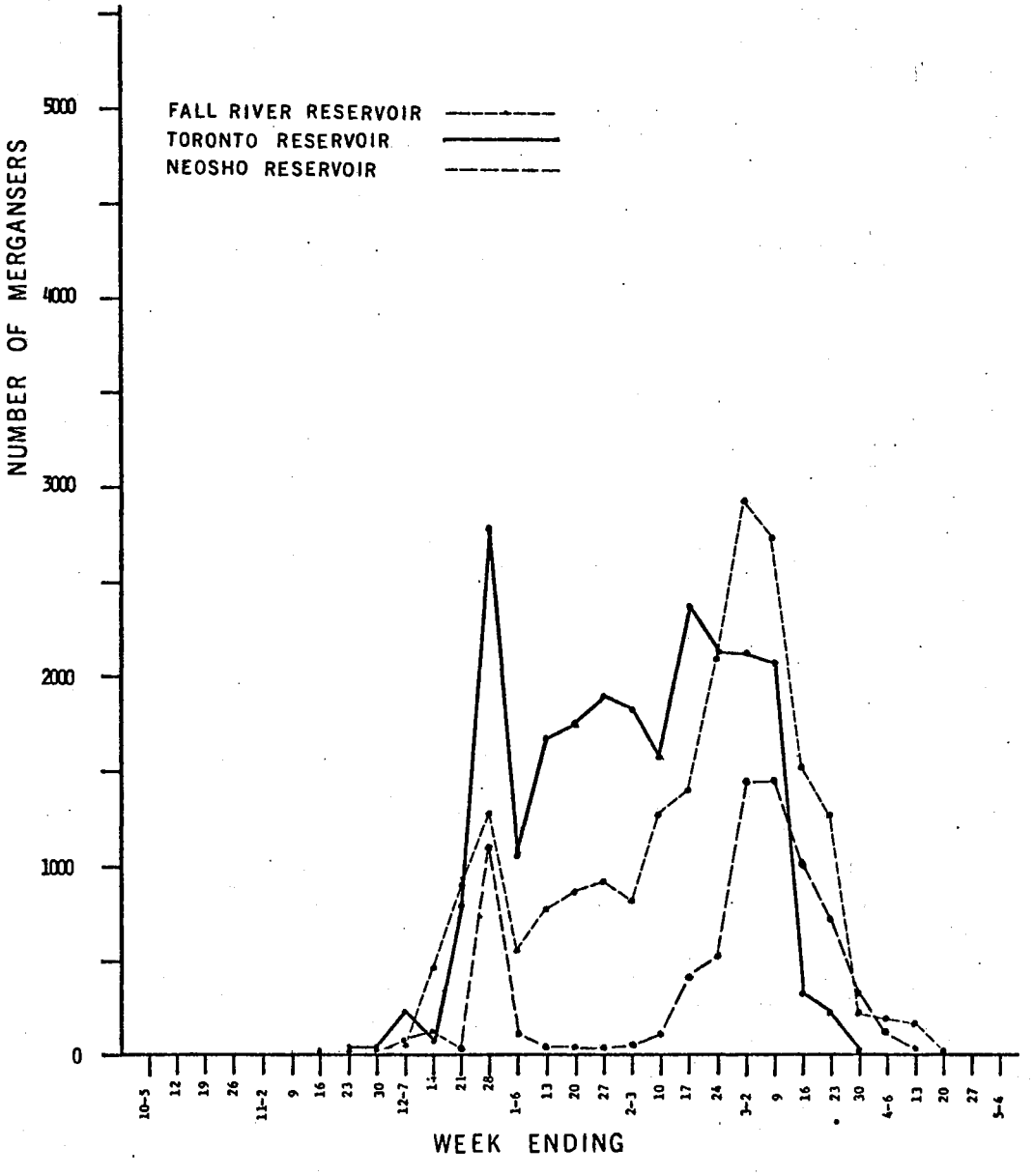

Figure 13. Migration chronology of the common merganser for specific areas in Region 4; latitude 36° - 37° N, longitude 94° - 97° W (see Figure 6).

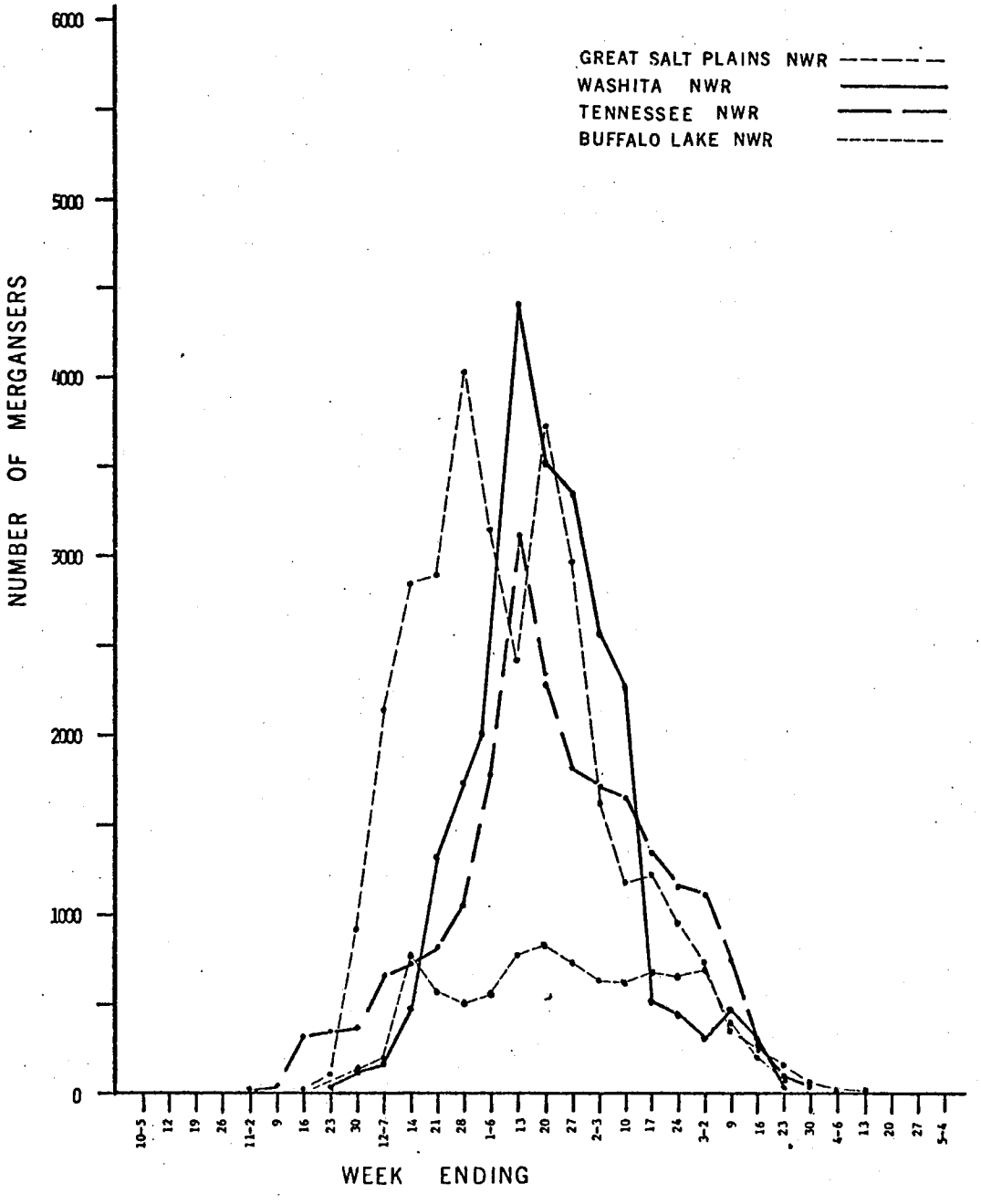

Figure 14. Migration chronology of the common merganser for specific areas in Region 5; latitude 35° - 37° N, longitude 97° - 100° W (see Figure 6).

Essentially only one peak occurs for those areas in Oklahoma, the Tennessee National Wildlife Refuge, Buffalo Lakes National Wildlife Refuge, and the Bitter Lake National Wildlife Refuge. One peak period is expected of a terminal wintering area where waterfowl increase, peak, then decrease as spring migration begins.

Within a particular region the peak periods for individual areas correlate well with one another indicating that migration takes place uniformly in time throughout each region (Figures 10, 11, 12, 13, 14). I did not attempt to correlate weather patterns and migratory movements in each region, but subfreezing temperatures causing lakes to freeze over probably have a direct influence on fall migration by reducing the availability of food.

Figure 15 compares the general pattern of merganser migration between the regions in Figure 6. This graph was developed by summing the mean census data for the specific areas within each region. The numerical scale is relative to the specific areas in each region but does not necessarily mean a greater or lesser abundance of common mergansers in one region as compared to another. It appears that fall migration of common mergansers in the northern midwest latitudes of 41 ^{o}N to 44 ^{o}N commences in early November. Peak migration periods occur progressively later for successive southern latitudes, and the wintering peak in latitude 35 ^{o}N to 37 ^{o}N occurs from early to late January. Spring migration commences in early February and northward movement is in progress until May.

The chronology of migration in the northern Mississippi Valley (Figure 16) nearly coincides with the chronology in Figure 15. The peaks for the terminal wintering areas in both Figures 15 and 16 occur

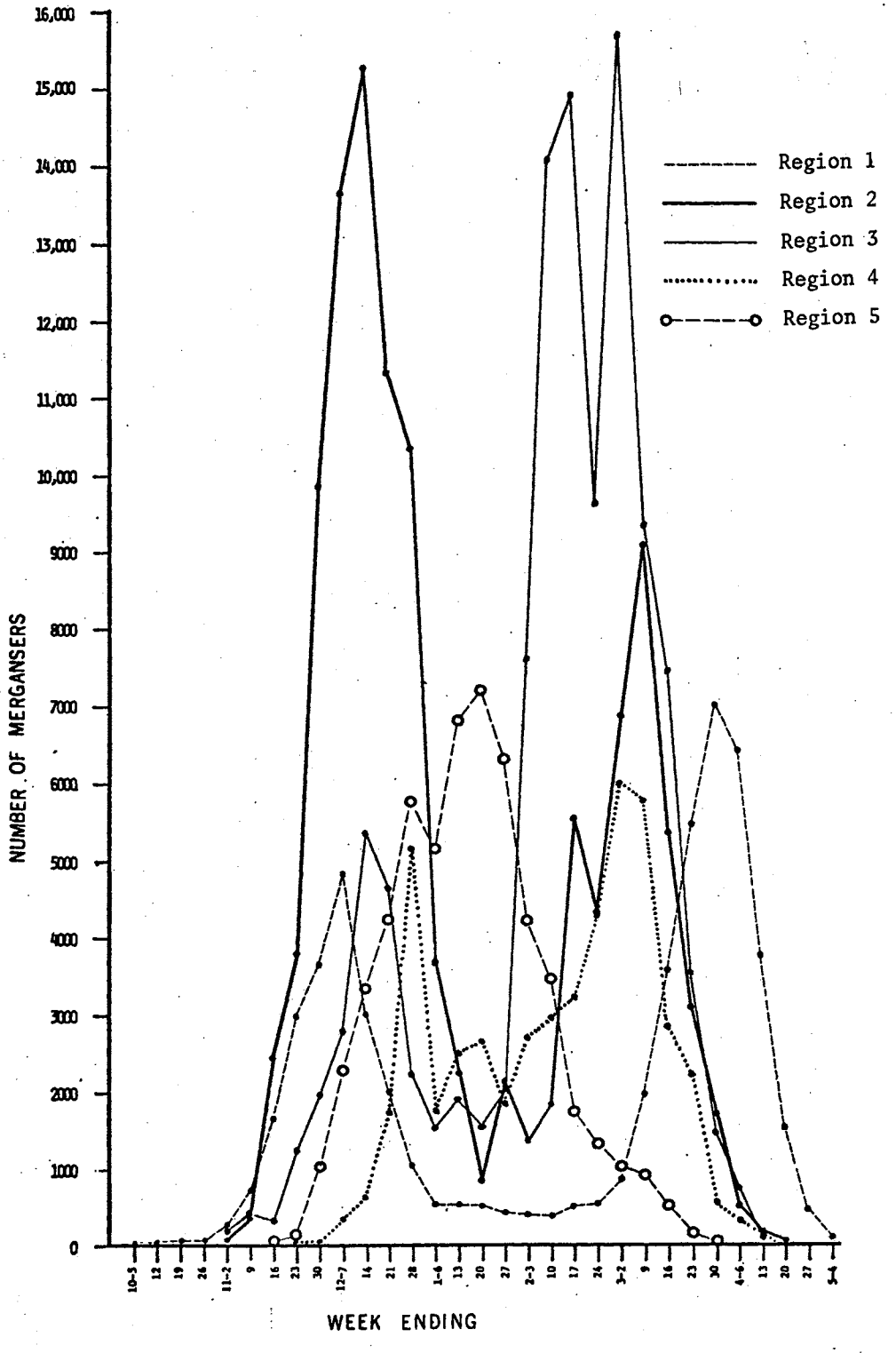

Figure 15. Migration chronology of the common merganser for the regions in Figure 6.

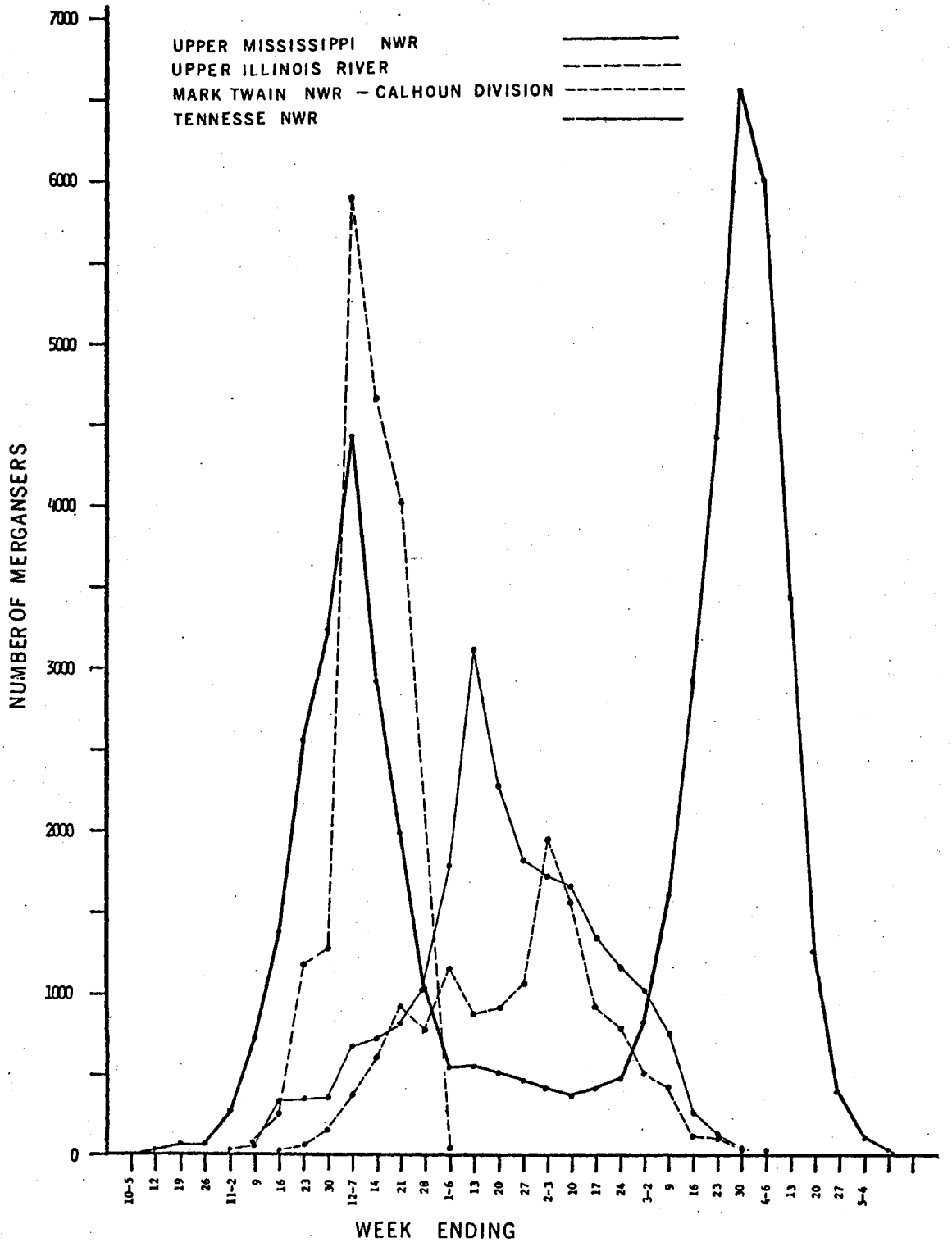

Figure 16. Migration chronology of the common merganser in the northern Mississippi Valley region; latitude 30°-44° N, longitude 88°-91° W.

in early January. Thus, throughout the midwest, mergansers migration may be somewhat uniform. However, it should be remembered that Figures 15 and 16 were based on mean census data. Migration in waterfowl is affected by annual weather conditions (Lawrence 1964), and, therefore, the chronology of migration as presented here can be considered an average, but expected to vary on a yearly basis for a region and a specific area.

Common Mergansers on Lake Carl Blackwell

Numbers of Mergansers on the Lake

Common mergansers were first sighted in this study on Lake Carl Blackwell in the winter of 1971-72 on 27 November 1971 and were last seen on 10 March 1972 (Figure 17). The total use days were 27,500. The peak occurred on 1 February 1972 and the mean number of mergansers present during this peak period was 769 (range 300-2895). A total of 66 counts were taken on 57 days (nine days included two counts). Each count and observation period averaged a little more than one hour.

During the 1972-73 winter mergansers were sighted first on 20 November 1972 and seen last on 7 March 1973 (Figure 18). The total use days were 13,100. Two periods of maximum abundance occurred; the first from 26 December 1972 to 8 January 1973 ($\bar{x}$ = 469, range 142-920), and the second from 18 January 1973 to 1 February 1973 ($\bar{x}$ = 262, range 203-310). There was a total of 67 counts in 57 days (10 days with two counts). Actual observation time for each count was, as in 1972, approximately one hour.

These two years of population counts probably give a reasonable

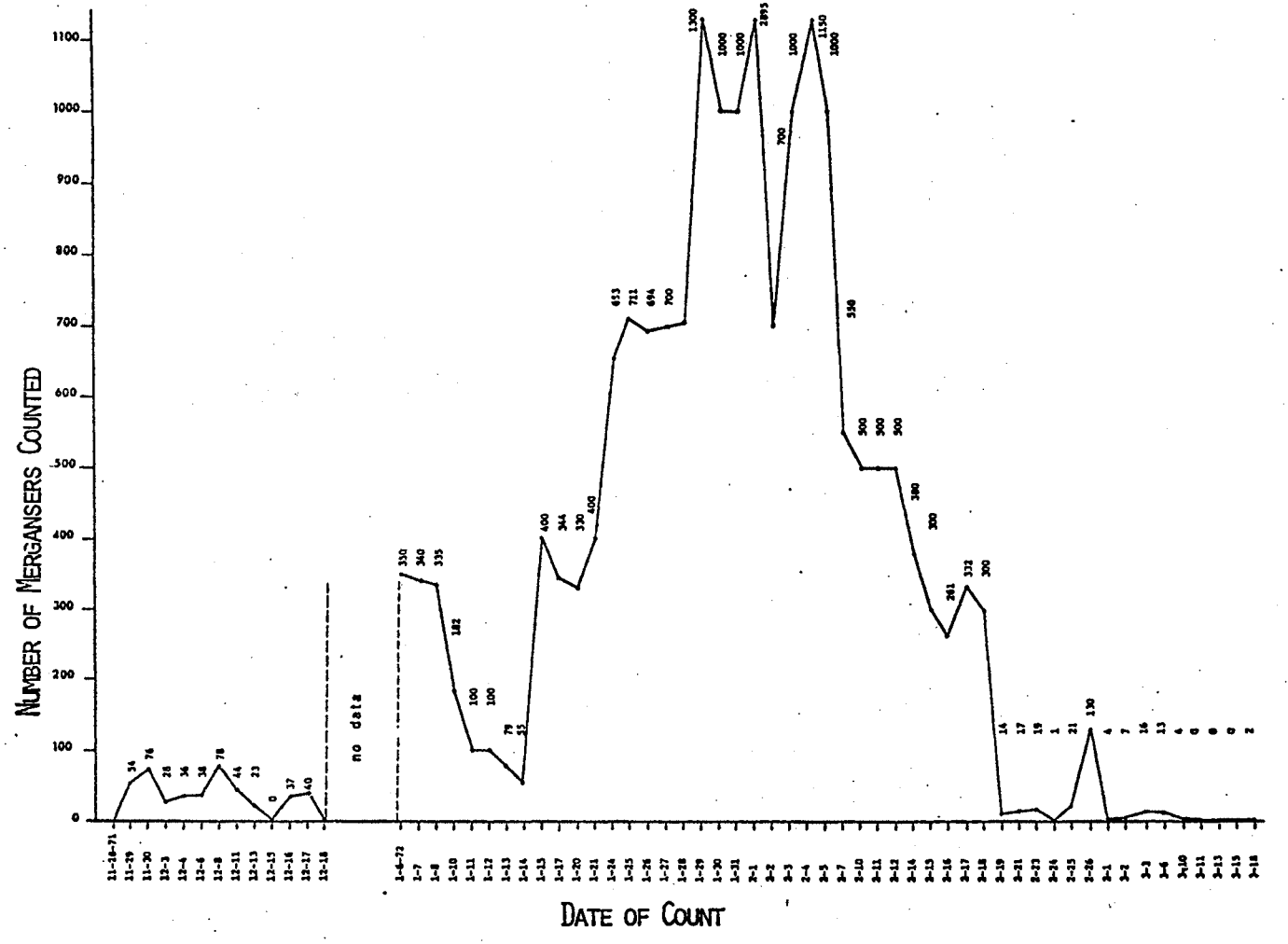

Figure 17. Numbers and chronology of common mergansers on Lake Carl Blackwell during the winter 1971-72. Total use days = 27,500.

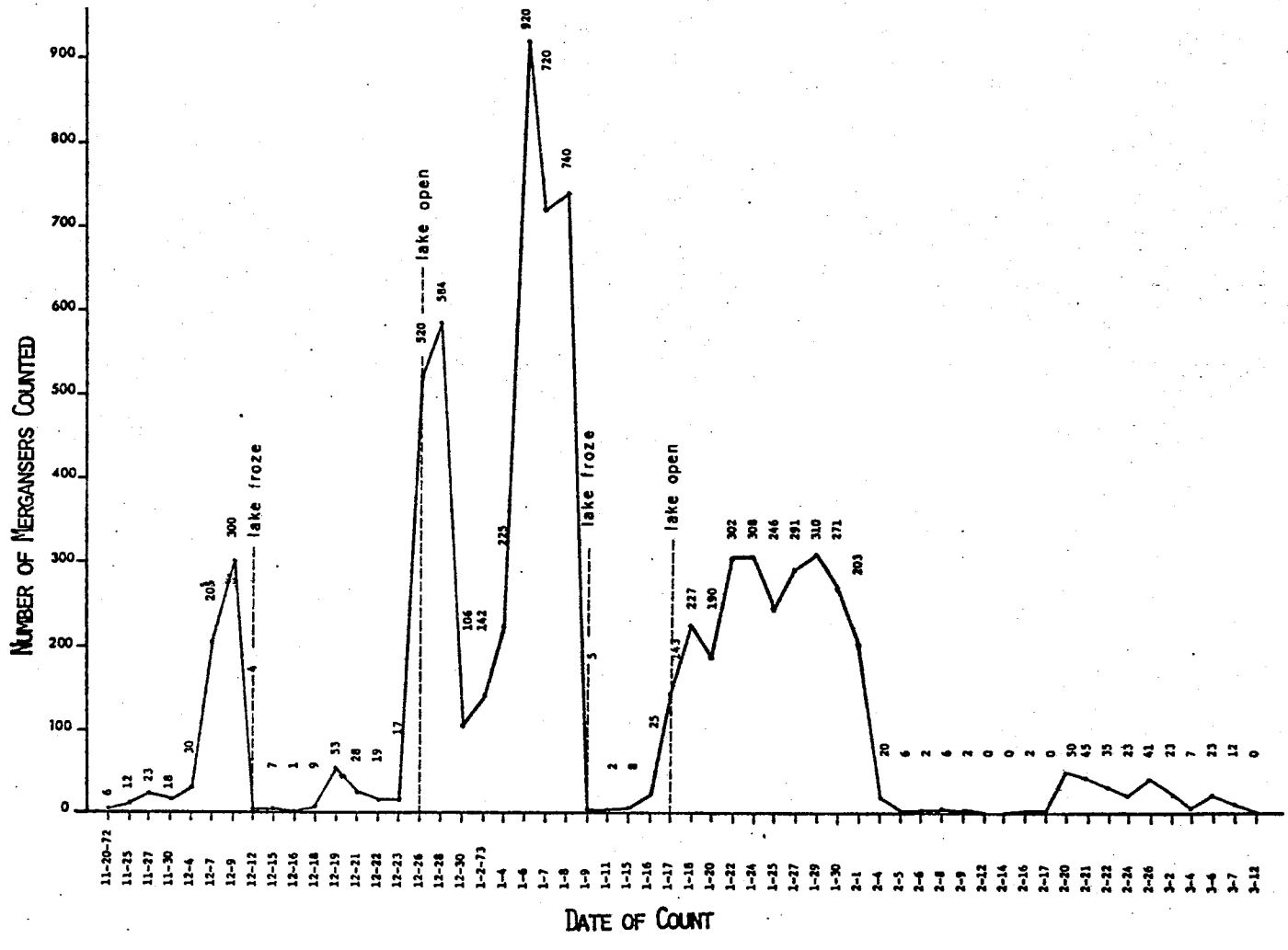

Figure 18. Numbers and chronology of common mergansers on Lake Carl Blackwell during the winter 1972-73. Total use days = 13,100.

approximation of the amount of use, hence, an estimated degree of predation pressure, that common mergansers gave Lake Carl Blackwell. Whether the estimate is high or low is difficult to determine since counts were not taken on all days mergansers were present on the lake and there was no way to measure the daily influx and outflux of mergansers on the lake.

However, I suspected that daily movements of mergansers to and from the lake for feeding involved few birds. I saw no evidence of groups of mergansers leaving Blackwell as if to feed elsewhere, nor did I see evidence of mergansers arriving from other areas to feed on Blackwell. Lake Carl Blackwell is the largest lake in the Stillwater, Oklahoma area. Smaller reservoirs and numerous farm ponds in the Stillwater area do not receive appreciable use by common mergansers (Mike Slimak, Zoology Department, Oklahoma State University, personnal communication, and author's personnal observations).

The difference in the amount of use Lake Carl Blackwell received from mergansers during the two years of study was probably caused by differences in weather conditions. The average temperatures for the months of November through March show that the 1972-73 winter was colder than the 1971-72 winter (Table 6). Ice covered the lake completely on two occasions during the 1972-73 winter (12 December 1972 to 26 December 1972, and 9 January 1973 to 17 January 1973), and this did not occur during the 1971-72 winter. During January 1972 up to 80 percent of the lake surface froze on several occasions (29 and 31 January) but this did not reduce the number of mergansers on the lake (Figure 17). When the lake was frozen during the 1972-73 winter only a small opening in the ice remained. Mergansers were present only in small numbers

during these times (less than 20). Numbers quickly increased following ice thaw much the same as reported by Anderson and Timkin (1972), but never became as large as in the 1971-72 winter.

Table 6. Average monthly temperatures[1/] for the winter months of 1971-72 and 1972-73.

Year	Mean Monthly Temperature (°C)				
	Nov.	Dec.	Jan.	Feb.	Mar.
1971-72	6.1	5.6	0.6	4.4	11.1
1972-73	5.6	0.6	-0.3	3.3	11.1
Normal	9.4	5.0	3.3	5.6	10.0

[1/] source: "Climatological Data", NOAA, U.S. Dept. of Commerce.

Feeding Behavior

The most remarkable and noticeable behavior I observed was cooperative feeding. This type of feeding has been reported for the double crested cormorant (*Phalacrocorax auritus*) (Bartholomew 1943) and the red-breasted merganser (DesLauriers and Brattstrom 1965, Emlen and Ambrose 1970). Cooperative feeding consists of coordinated flock movements by fish-eating birds during feeding. Flock movements are highly organized and indicate that the birds are following and possibly

herding fish. Feeding behavior of this nature was regularly performed by mergansers wintering on Lake Carl Blackwell. The only other report of cooperative feeding behavior for the common merganser on its wintering areas is that given by Roberts (Huntington and Roberts 1959). His discussion on feeding flocks of mergansers is essentially the same as I observed on Lake Carl Blackwell. Thus, this behavior is probably typical of mergansers wintering on large reservoirs. White (1957) mentioned cooperative feeding by mergansers on large rivers and Lake Erie during fall migration. Salyer and Lagler (1940) observed stream feeding behavior of wintering common merganser in Michigan, but did not mention cooperative feeding.

Food Habits

Table 7 shows the similarity between the food-habits results in this study, and Heard and Curd (1959). Gizzard shad was the most important food item in both studies. No whole identifiable drum (Aplodinotus grunniens) remains were found in this study, but otoliths were recovered which indicated that drum were utilized to some extent. No white crappie (Pomoxis annularis) were recovered in this study as compared with Heard and Curd, but this may be due to my smaller sample size. Converting the combined results (Table 7) to a weight basis (Table 8) showed gizzard shad to comprise by weight, 84 percent of the mergansers' food on Lake Carl Blackwell. Computed forage ratios (Table 9) were greater than two for gizzard shad and white crappie, and one or less for all other fishes.

Table 7. Results of stomach analysis of common mergansers collected from Lake Carl Blackwell.

Food Item	Total Number	Percent of Total Food	Frequency of Occurrence (%)
This Study[1]			
Gizzard shad	42	81	85
Minnow	5	10	5
Unidentifiable Fish Remains	5	10	5
Heard and Curd, 1959[2]			
Gizzard Shad	229	75	91
Freshwater Drum	16	5	22
White Crappie	25	8	22
Channel Catfish	2	1	4
Unidentifiable Fish Remains	32	10	40
Both Studies Combined[3]			
Gizzard Shad	271	76	89
Freshwater Drum	16	4	15
White Crappie	25	7	15
Channel Catfish	2	1	3
Minnow	5	1	2
Unidentifiable Fish Remains	37	10	32

[1] 20 stomachs - collected the winters of 1971-72 and 1972-73.

[2] 45 stomachs - collected the winter of 1957-58.

[3] 65 total stomachs.

Table 8. Conversion of combined stomach analysis results (Table 7) from numbers to weight.

Food Item	Total Number	Mean Length (mm)	Weight for Mean Length (g)	Total Weight (g)	Percent of Total Food (weight)
Gizzard Shad	271	110	11.3	3062	84.2
Freshwater Drum	16	128	14	224	6.2
White Crappie	25	98	7	175	4.8
Channel Catfish	2	72	8	16	0.4
Minnow	5	70	2.5	12.5	0.4
Unidentified Fish Remains	37	-	4	148	4.1
				3637.5	100.0

Table 9. Forage ratios, by weight, of prey species in Lake Carl Blackwell for the common merganser.

Prey Species	Percent in Food (weight)	Percent in Lake (weight)	Ratio
Gizzard Shad	84.2	41.1	2.05
Freshwater Drum	6.2	6.6	0.94
White Crappie	4.8	2.2	2.18
All Other Fish Species	4.8	50.2	0.1

Daily Food Consumption

I used six common mergansers in the food-consumption study. They were captured on Lake Carl Blackwell during four of 15 nightlighting attempts, seven during the 1971-72 winter and eight during the 1972-73 winter. Mergansers I, II, and III were captured on 7 February 1972, Merganser IV on 15 February 1972, Merganser V on 30 December 1972, and Merganser VI on 20 February 1973. Merganser II was recovered after first being shot, but the remaining five were captured unharmed. Nightlighting proved a relatively unsuccessful method of live capturing mergansers in this study.

Mergansers I, II, III, and IV, captured in February 1972, died in October 1972 shortly after being released into the outdoor pens on 12 September 1972. The specific cause of death is unknown. No signs of illness were apparent and the deaths were unexpected. Necropsy of each

bird by the Oklahoma State University College of Veterinary Medicine failed to reveal any abnormalities of the outer or inner body except for a marked lack of body and internal fat in each bird, which suggests a deficiency in the diet of frozen gizzard shad fed to the birds. DeLaRhonde and Greichus (1972), and Call (personnal communication, letter dated 6 December 1972 from Daniel J. Call, Biochemistry Department, South Dakota State University, Brookings, South Dakota) have mentioned that a diet of frozen fish is deficient in the B-complex vitamins must be supplemented to fish-eating birds maintained on this diet. The B-complex vitamins are essential in the energy metabolism of animals without which they lose both appetite and weight (Maynard and Loosli 1969). A shortage of B-vitamins possibly caused the death of these mergansers. Other factors to be considered are; the overall stress of captivity, the loss of one third of their body weight in the first month of captivity (subsequently recovered in part), and moving the birds outside after they had been confined in an indoor pen for seven months.

The last merganser to die, Number II, was observed on the day of its death. The bird seemed unaware of its observers and exhibited a lack of control over its neck and head. The bird had spasms in which its head and neck were swung wildly around and laid on its back. It would lose its balance and roll over in the water. Evenutally the bird drowned. One other duck was found dead in the water while the other two were found dead out of the water.

Mergansers V and VI were given two B-complex vitamin pills every five days to alleviate this problem, and they maintained good health while in captivity. They were banded and released on Lake Carl

Blackwell on 25 May 1973 at the end of the study.

Weight histories of the six mergansers studied are shown in Figures 19 and 20, and the food-consumption study is summarized in Table 10.

All birds exhibited a marked decrease in body weight during the first month of captivity (up to one third), after which the weights tended to stabilize somewhat. Weight histories of eight mergansers studied by Latta and Sharkey (1966:Figure 1) showed this same general pattern of weight loss followed by relative stabilization below the weight at capture. Initial weight loss followed by stabilization is interesting and possibly an adjustment to the conditions of captivity. Longcore and Cornwell (1964) found that increased food-consumption with decreasing air temperature did not result in weight gains for canvasbacks (Aythya valisineria) and lesser scaups (Aythya affinis) held in captivity. They suggested that this was because the ducks were at a maximum weight for experimental conditions and were receiving adequate food supplies.

The weights of Mergansers V and VI decreased with increasing time in captivity and increasing mean daily temperature (Figure 20). Owen (1970) found that captive blue-winged teal (Anas discors) slowly lost weight from January to April during which time the mean daily temperature also rose. The continual decrease in weight of Mergansers I, II, III, and IV from 20 February to 27 June 1972 (Figure 19) was probably directly related to food availability more than to any other factor. After frozen gizzard shad were fed to these birds, their weights increased until they were released into the outdoor pens on 12 September 1972. While in the outdoor pens the weights of Mergansers I,

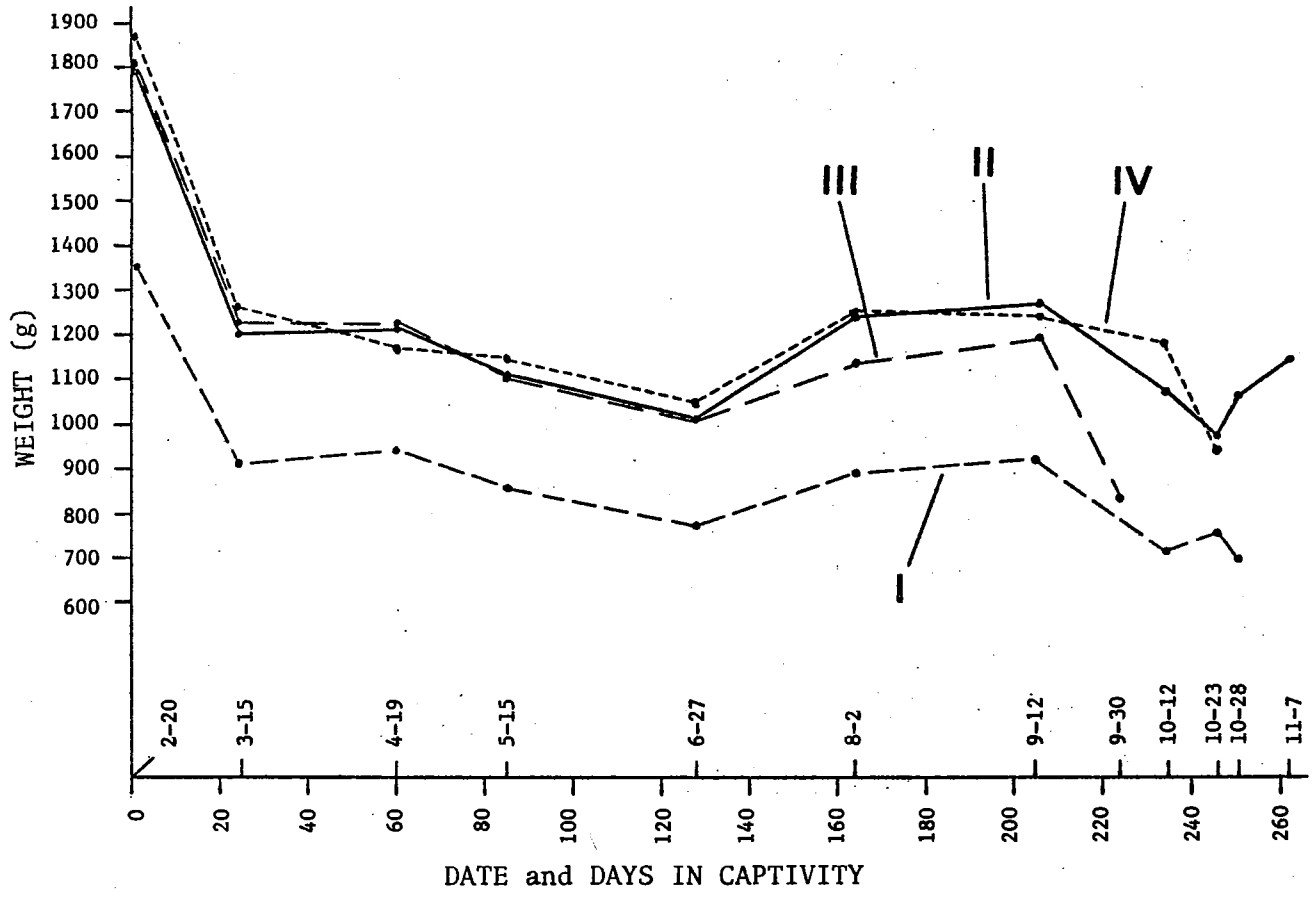

Figure 19. Weight and time in captivity for Mergansers I, II, III, and IV.

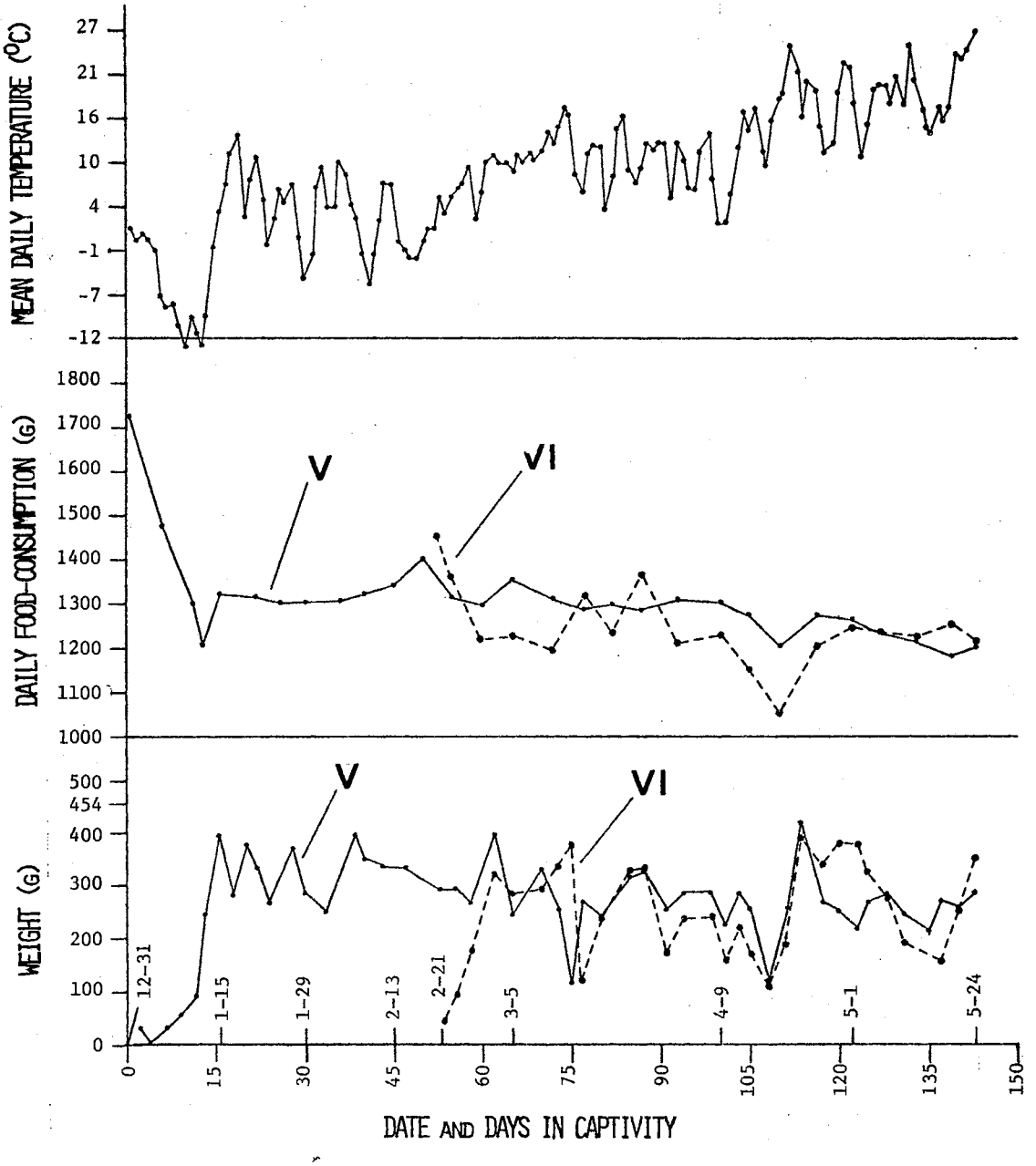

Figure 20. Weight and daily food-consumption for Mergansers V and VI as compared with the mean daily temperature during captivity.

Table 10. Summary of the food-consumption study on six common mergansers.

	Bird Number					
	I	II	III	IV	V	VI
Age and sex	Adult F	Adult M	Adult M	Adult M	Juv. M	Juv. M
Days in study	251	261	223	246	143	93
Capture weight (g)	1350	1780	1807	1870	1729	1453
Release or death weight[1/]	693 d	1138 d	832 d	943 d	1195 r	1211 r
Mean weight during study period	880	1198	1189	1220	1303	1239
Mean daily food consumption during study period (g)	229	242	229	241	261	245
Mean daily consumption as a percent of the mean weight	26.0	20.0	19.3	19.8	20.0	19.8

[1/] d = death weight, r = release weight

II, III, and IV generally declined until their respective deaths. The weight fluctuations of Mergansers II, III, and IV (all males) were essentially the same in degree and timing, and the female (Number I) followed the same pattern except that she was below the males in weight (Figure 19).

Mean daily food-consumption for the six mergansers was within approximately 30 g of one another, and the mean daily consumption as a percent of the mean weight was nearly identical for the five males but somewhat higher for the female (Table 10). Daily consumption averaged slightly more than one-half of the hypothesized food requirement of 454 g per day, and daily consumption was also quite variable for all mergansers (Figures 20 and 21). In general, Mergansers V and VI appeared to decrease their daily food intake with increased time in captivity and increasing mean daily temperature (Figure 20).

Mergansers I, II, III, and IV occasionally consumed 454 g per day or greater (Figure 21), but Mergansers V and VI only rarely consumed as much as 400 grams daily. Mergansers I, II, III, and IV had a generally high daily consumption after receiving a consistent supply of fish starting on 27 June 1972 (Figure 21), and this may be reflective of a malnourished condition before 27 June. Jordan (1953) reported that mallards (Anas platyrhynchos) intentionally starved for 25 days regained their lost weight in approximately two weeks. During the first three weeks of the "rehabilitation period" his starved ducks had average weekly food intakes of 178, 146, and 54 percent, respectively, greater than non-starved mallards. By the fourth week food intake was essentially the same as that of non-starved mallards. The increase in weight of Mergansers I, II, III, and IV after 27 June 1972

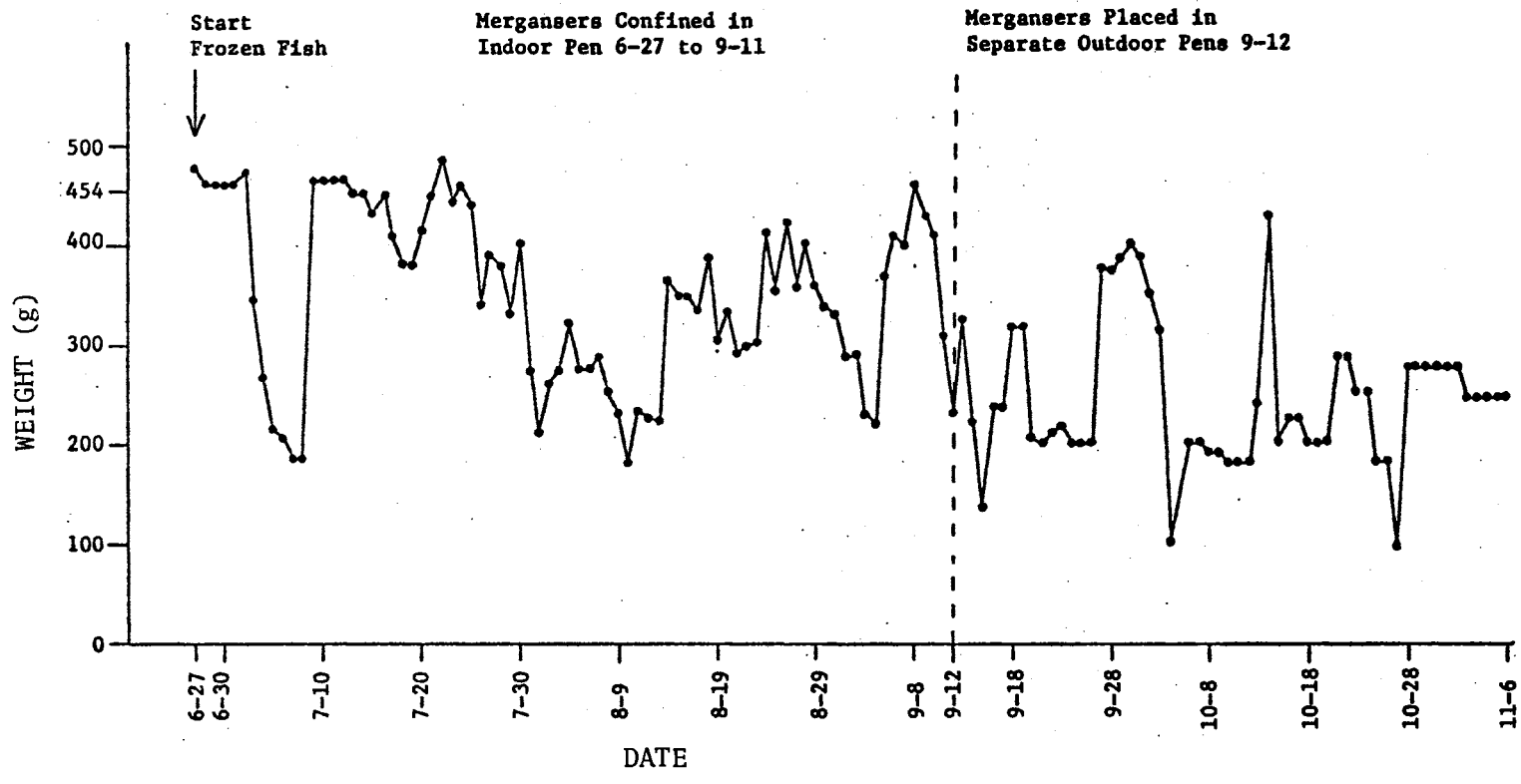

Figure 21. Average daily food-consumption for Mergansers I, II, III, and IV from 27 June 72 until their deaths in October 72.

was a response similar to that found by Jordan.

The results reported here for daily food-consumption in captivity are comparable to those of Latta and Sharkey (1966) (Table 11). Their eight mergansers averaged 217 g per day, approximately one-half the hypothesized value in this study. The average daily food-consumption for both the eight mergansers studied by Latta and Sharkey and the six used in this study is 227 g.

Mergansers used by Latta and Sharkey, and in this study, were subjected to captive conditions in which activity was essentially nil as compared to a wild free state. In both instances flying was eliminated and the ducks were not required to find, pursue, and capture their prey. Existence metabolism is the amount of food necessary to maintain a constant weight (Kendeigh 1969). This value differs between captive and wild birds, being higher in the latter. The average daily consumption of 227 g for the 14 mergansers of both studies is probably a reasonable estimate of the existence metabolism for common mergansers under captive conditions allowing minimal activity. Thus, 227 g is a minimum estimate of the daily food-consumption for mergansers in a wild state.

White (1957) found the average daily consumption of three immature common mergansers raised in captivity to be 310 g per bird. These mergansers were able to fly around somewhat in their large pen and this probably accounts for the greater daily intake. Intuitively, it is expected that monitoring food intake and permitting some activity under captive conditions would better approximate the daily food requirement for a wild existence. White (1957) also kept a wild but tame merganser which consumed nearly 454 g per day. Salyer and Lagler

Table 11. Summary of food consumption for eight common mergansers studied by Latta and Sharkey (1966).

	Bird Number							
	1	2	3	4	5	6	7	8
Sex	Female	Female	Male	Female	Female	Female	Female	Female
Weight at capture (g)	1419	1362	1702	1461	1220	1064	965	936
Mean weight during study (g)	966	908	1521	1242	1000	930	959	935
Mean daily consumption (g)	248	244	272	246	186	181	188	171
Mean daily consumption as a percent of the mean weight	25.7	26.9	17.9	19.8	18.6	19.5	19.6	18.3

(1940) found stomachs of many common mergansers to contain a considerable quantity of fish and this convinced them that this duck will eat 400 g to 500 g of fish per day.

Sincock (1962:217) stated "the average food-consumption per bird (waterfowl) per day could be estimated, in dry-weight, as 10 percent of the wet body weight". Assuming a live weight of 1500 g for a common merganser, the daily dry-weight consumption of fish is 150 g. Live organisms are approximately two-thirds or more water (Odum 1971:32); therefore, the daily wet-weight consumption of fish is 450 g per bird.

On the basis of the foregoing discussion, I concluded that 454 g is a reasonable daily food-consumption for free-ranging common mergansers. And, I used this value in estimating the amount of fish mergansers consumed from Lake Carl Blackwell during the 1971-72 and 1972-73 winters.

Estimating the Amount of Predation

Predation was interpreted as a flow of fish (x_1) from the environment (the lake) to the mergansers (x_2), expressed as $x_1 \xrightarrow{F_{12}} x_2$, where $F_{12} = \theta_{12} x_2$. For one merganser, θ_{12} is the mean daily rate of food-consumption (454 g), and x_2 is the number of mergansers preying upon the fish population for some period of time, or, as in this case, the number of use days for a wintering period. The amount of fish consumed for a given number of use days is F_{12}. It follows that total consumption is equivalent to 12,474 kg for 1971-72 and 5,942 kg for 1972-73. This is a consumption of 12.5 and 6.0 percent of the mean, late summer standing crop of fish in Lake Carl Blackwell for the respective years. When predation was divided among the prey species

it became evident (Table 12) that mergansers consumed a large percentage of the standing crop of shad and white crappie in 1971-72. However, predation was reduced by approximately one-half in the 1972-73 winter probably because of ice cover during that winter which reduced the total number of mergansers wintering on Lake Carl Blackwell.

Table 12. Fish consumption by common mergansers on Lake Carl Blackwell for the winters 1971-72 and 1972-73.

Prey Species	Standing Crop (kg/ha)	Percent of Food by Weight	kg/ha consumed		Percent of Standing Crop Consumed	
			71-72	72-73	71-72	72-73
All Fish	153.832	-	19.2	9.2	12.5	6.0
Gizzard Shad	63.222	84.2	16.2	7.7	25.6	12.2
Freshwater Drum	10.111	6.2	1.20	0.57	11.9	5.6
White Crappie	3.343	4.8	0.92	0.92	27.5	13.2

CHAPTER IV

DISCUSSION

Predation in Warm Water Reservoirs

The forage ratios for gizzard shad and white crappie (Table 9) indicate that mergansers consumed these fish in greater proportion than would be expected on the basis of abundance alone. Some factor(s) apparently made shad and crappie more vulnerable to feeding mergansers. Jester and Jensen (1971) reported that gizzard shad move to deeper water during winter and become relatively inactive at water temperatures below 14 ^{o}C. White crappie also congregate in deeper or warmer water during winter (Grinstead 1965). Thus, mergansers may have selected prey on the basis of relative abundance and avilability. Largely inactive in winter, these congregated prey would appear to provide readily available food for mergansers once located.

Locating prey is probably a cooperative effort among common mergansers wintering on reservoirs. Group feeding behavior has been observed to be highly organized and may be an advantage to individual birds. Agregations of fish would seemingly have greater difficulty in eluding a group of mergansers rather than a single individual. Mergansers probably select aggregations of fish when feeding on reservoirs in larg groups, and it is possible that this selectivity, under special circumstances, could result in predation detrimental to

a fish species (e.g. white crappie concentrated in a warm water discharge area, Grinstead 1965).

However, predation is one of a system of factors acting upon a population and it is difficult to evaluate its impact unless measured concomitantly with other controlling factors. Predation by mergansers is limited to sizes of fish which can be swallowed, girth being more critical than length (Latta and Sharkey 1966). Fish recovered from mergansers during stomach analyses had maximum total lengths of 185 mm and a mean length of 115 mm. The natural size restriction of prey means that mergansers are feeding upon only a part of a prey population. Fish larger than the maximum swallowable size are unavailable to mergansers. Thus, the available quantity of prey fish in Lake Carl Blackwell was less than the standing crops listed in Table 3. Subsequently, the impact of predation (as measured by percent of standing crop consumed) would have been greater than the 25 percent for shad and crappie in Table 12.

The actual effect of avian predation upon fish remains to be documented (Hynes 1972). The results here do not show whether or not a consumption of one-fourth the standing crop of shad and crappie is significant. Mills (1967) stated that predation by fish on other fish is probably more serious than predation on fish by other animals. Errington (1946) expressed the opinion that predators of vertebrates remove a doomed surplus, and Bennett (1971) suggested that the impact of fish eating birds is likely beneficial on most waters.

Jester and Jensen (1971) stated that despite heavy predation by common mergansers and western grebes (Aechmophorus occidentalis), gizzard shad in Elephant Butte Reservoir, New Mexico, continued to

provide necessary forage for game fish populations. They suggested that adaptability and high reproductive potential maintains gizzard shad populations in most reservoirs where established populations occur. Stunting of shad in Elephant Butte Reservoir was apparently not relieved by avian predators but was reduced by the establishment of additional fish predators in the lake (Jester and Jensen 1971).

Ricker (1952:5) discussed three types of predator-prey relationships; "A.) predators of any given abundance take a fixed number of the prey species during the time they are in contact, enough to satiate them and the surplus prey escapes, B.) predators at any given abundance take a fixed fraction of prey species present, as though there were captures at random encounters, C.) predators take all the individuals of the prey species that are present, in excess of a certain minimum number."

Elson (1962) stated that Ricker's Type C predation generally corresponds to mergansers using salmon streams in northeastern Canada. He remarked that mergansers utilized some streams until it was no longer profitable for feeding and would then leave.

Bennett (1971:161) commented that "whenever and wherever numbers of fish eating birds are concentrated Type C predation probably is taking place." Bennett continued by saying Type C predation occurs around nesting colonies and during migrations of some birds such as pelicans, herons, cormorants, and mergansers. Both Bennett and Elson characterized predators involved in Type C situations as highly mobile and having a great capacity for taking advantage of concentrations of prey species. Activities of Type C predators result in a thinning of fish populations to a point allowing any remaining fish to find

adequate food to make rapid growth and reach large sizes (Bennett 1971:161). Bennett also stated that the reproduction potential of warmwater fish is geared to Type C predation and many problems of fish management are a result of its loss.

This study has shown that large concentrations (5,000 to 10,000 and more) of mergansers annually winter on many of the reservoirs in Kansas and Oklahoma. The length of time such large numbers of mergansers are actually utilizing a reservoir varies from a week or two to more than a month. It is obvious that with large concentrations of mergansers and with a daily consumption of 454 g per day per bird, wintering mergansers can consume an enormous amount of fish from one reservoir.

Wintering Distribution

The distribution of any species is, in part, governed by the availability of adequate food. Accordingly, mergansers are found in areas where their energy requirements can be met and are probably more abundant in areas where food is easily obtained. The results of this investigation have shown Kansas and Oklahoma to be areas which apparently satisfy two of the most important ecological requirements of wintering mergansers, namely open water and food.

Kortright (1943:356) stated that common mergansers winter only as far south as they are forced by ice, and in the spring follow the retreat of winter northward. This implies that the areas used for wintering are variable, and that in any given winter use of an area will be influenced by the severity of the weather, especially sub-freezing weather. Huntington and Roberts (1959) listed the mean

January temperatures for the states in the Central Flyway. New Mexico has a mean January temperature of 4.4 °C, Oklahoma 3.3 °C, and Kansas 0 °c. From these data it seems clear that most lakes in New Mexico and Oklahoma are ice free during a normal winter. Kansas, with a mean January temperature at freezing is a marginal wintering locality because reservoirs in that state are expected to freeze in most winters.

In Oklahoma, in general, the common merganser occurs as a transient and winter resident from late October to late May, and Figure 15 shows January to be the period of peak numbers. A January peak in Oklahoma corresponds with frozen reservoirs in Kansas and supports the comment by Kortright (1943:363) that mergansers winter as far north as open water is available. Figures 11, 12 and 13 show that areas in Kansas typically exhibit two peaks in merganser numbers; spring and fall. During Janaury mergansers are much less common in Kansas than during the migration periods.

Sutton (1967) stated that the number of common mergansers in Oklahoma has increased with the impounding of 301,500 ha of water in the past thirty years (Oklahoma Water Resources Board 1970). However, it is not known if the apparent increase in mergansers in Oklahoma is a result of a greater number wintering in the state or merely a redistribution of mergansers which formerly wintered on the rivers flowing through Oklahoma and adjacent states. Gizzard shad are an abundant forage fish in most of the reservoirs throughout the midwest (Carlander 1955) and provide a large and accessible food source for mergansers in Kansas and Oklahoma. Thus, it is possible that before the many reservoirs were constructed in Kansas and Oklahoma common mergansers were less numerous in those states than they are now. However, I have

been unable to compile sufficient evidence to further substantiate this theory.

Trautman (1935, cited in Salyer and Lagler 1940) mentioned areas of usual winter concentrations of common mergansers (for listing see Table 1 in this study under Salyer and Lagler 1940). Trautman made his survey in the early 1930's. My review of common merganser distribution provided no evidence to support Trautman's areas as being areas used currently by concentrations of wintering common mergansers. The common merganser is presently considered uncommon to rare in the wintering areas described by Trautman. Thus, mergansers may have altered their wintering distribution in response to the construction of the reservoirs in the Southern Great Plains. In any event, the reservoirs in Kansas and Oklahoma are presently serving large numbers of common mergansers as wintering areas. The large fish populations provide an abundant food supply and probably reduce the possibility of serious depredations upon any one fish species.

CHAPTER V

SUMMARY AND CONCLUSIONS

The present study has viewed the common merganser as a fish predator in warm water impoundments, and has also attempted to identify areas used by migrating and wintering common mergansers. The stated objectives were considered fulfilled, and the conclusions are as follows:

1.) Information on the nationwide numbers and distribution of migratory and wintering common mergansers was compiled from state and federal sources. Numerous areas throughout the country were found to have large concentrations of common mergansers during the migration periods or for wintering. Kansas and Oklahoma were found to receive the largest numbers of wintering mergansers in the midwest. The Great Lakes, the Illinois River Valley, and the Upper Mississippi River Valley appear to be major areas of merganser concentration during migrations. Recoveries from banded mergansers were insufficient to adequately determine routes of migration. Banding of common mergansers has been very light and more work is needed in this area. A migrational chronology was developed for common mergansers in the midwest and the northern Mississippi Valley. The main wintering distribution of common mergansers in the midwest was found to terminate along a line from the southern state line of Oklahoma, through northern Arkansas to Kentucky Lake, Tennessee.

The main area for wintering common mergansers in the midwest is Kansas and Oklahoma. These states have many large man-made impoundments containing large populations of fish. Many of the reservoirs in this area (primarily Oklahoma) do not freeze over completely during winter. Thus, this area appears highly suited for large numbers of wintering mergansers. It is not known if the construction of reservoirs in Kansas and Oklahoma has attracted mergansers from other wintering areas or has merely caused a redistribution of birds that formerly wintered on rivers in each state. Ecologically, it appears that mergansers are utilizing a wintering area highly suited to their energy needs.

2.) Six common mergansers were captured alive by nightlighting and used for determining the daily food-consumption of a free-ranging common merganser. Nightlighting proved to be a relatively unsuccessful method of live-capturing wintering mergansers in this study. All mergansers captured lost approximately one-third of their at-capture body weight during the first month of captivity. The average daily food consumption for all birds was 240 g. The food-consumption results of this study were closely comparable to those of Latta and Sharkey (1966) Factors affecting daily food intake under captive and wild conditions were discussed, and it was concluded that 454 g is a reasonable daily consumption for free-ranging common mergansers.

3.) Common mergansers consumed a minimum estimated 12.5 and 6.0 percent of the total mean standing crop of fish from Lake Carl Blackwell during the winters of 1971-72 and 1972-73 respectively. Mergansers consumed at least 25.6 and 27.5 percent of the standing crop of gizzard shad and white crappie, respectively, during the 1971-72 winter, and

12.2 and 13.2 percent of each fish, respectively, during the 1972-73 winter. It was suggested that cooperatively feeding groups of common mergansers select for aggregations of fish, and that this selectively made gizzard shad and white crappie more vulnerable to feeding mergansers on Lake Carl Blackwell.

The meaning of predation was discussed but final conclusions are indifinite. It is probable that common mergansers normally consume a portion of the annual surplus which dies even if predation is absent. However, very large numbers (20,000 and up) of these birds sometimes gather on a particular reservoir for extended periods of time. In such instances the amount of fish consumed is enormous and mergansers could be reducing the standing crop to a point allowing an increased growth rate in the remaining fish.

LITERATURE CITED

Alcorn, J. R. 1953. Food of the common merganser in Churchill County, Nevada. The Condor 55:151-152.

Anderson, B. W. and R. L. Timken. 1972. Sex and age ratios and weights of common mergansers. J. Wildl. Manage. 36:1127-1133.

Bartholomew, G. A. Jr. 1942. The fishing activities of double-crested cormorants on San Francisco Bay, Condor 44:13-21.

Baumgartner, F. M. 1942. An analysis of waterfowl hunting at Lake Carl Blackwell, Payne County, Oklahoma, for 1940. J. Wildl. Manage. 6:83-91.

Bellorise, F. C. and D. Crompton. 1970. Migrational behavior of mallards and black ducks as determined from banding. Illinois Natural History Survey Bull. 30:167-234.

Bennett, G. W. 1971. Management of lakes and ponds. Van Nostrand Reinhold Company, New York. 375 pp.

Bishop, R. A. and R. Barratt. 1969. Capturing waterfowl in Iowa by nightlighting. J. Wildl. Manage. 33:956-960.

Bruner, W. E. 1931. The vegetation of Oklahoma. Ecol. Mongr. 1:99—188.

Carlander, K. D. 1955. The standing crop of fish in lakes. J. Fish. Res. Bd. Canada. 12:543-570.

Carlander, K. D. 1969. Handbook of freshwater fishery biology. The Iowa State Univ. Press, Ames, Iowa. 752 pp.

Coldwell, C. 1939. The feeding habits of American mergansers. Can. Field. Nat. 52:55.

Cornwell, G. and R. Hartung. 1963. A holding pen for diving ducks. J. Wildl. Manage. 27:290-292.

Crissy, W. F. 1955. The use of banding data in determining waterfowl migration and distribution. J. Wildl. Manage. 19:75-84.

Cummings, G. E. and O. H. Hewitt. 1964. Capturing waterfowl and marsh birds at night with light and sound. J. Wildl. Manage. 20:120-126.

de Gruchy, J. H. B. 1952. Water fluctuations as a factor in the life of the higher plants of a 3300 acre lake in the Permian Red Beds of central Oklahoma. Ph.D. Thesis. Oklahoma State Univ. 117 pp.

DeLaRhonde, G. G. and Y. A. Greichus. 1972. Care and behavior of penned double-crested cormorants. The Auk 89:644-650.

Des Lauries, J. R. and B. H. Brattstrom. 1965. Cooperative feeding behavior in red-brested mergansers. The Auk 82:639.

Elson, P. F. 1962. Predator-prey relationships between fish easting birds and Atlantic salmon (with a supplement on fundamentals of merganser control). Fish. Res. Bd. Can. Bull. 113. 87 pp.

Emlen, S. T. and H. W. Ambrose, III. 1970. Feeding interaction of snowy egrets and red-breasted mergansers. The Auk 78:164-165.

Errington, P. D. 1946. Predation and vertebrate populations. Q. Rev. Biol. 21:144-177, 221-245.

Erskine, A. J. 1972. Populations, movements, and seasonal distribution of mergansers. Can. Wildl. Serv. Rep. Ser. 17. 36 pp.

Fritsch, L. E. and O. B. Irven. 1958. Food of the American merganser in Unakiuk Inlet, Alaska. Condor 60:410-411.

Grinstead, B. G. 1965. The vertical distribution of the white crappie, Pomoxis annularis, in the Buncombe Creek arm of Lake Texoma. M.S. Thesis. Univ. of Oklahoma. 90 pp.

Heard, W. R. and M. R. Curd. 1959. Stomach contents of American mergansers, Mergus merganser americanus Linnaeus, caught in gill nets in Lake Carl Blackwell, Oklahoma. Proc. Okla. Acad. Sci. 39:197-200.

Hess, A. D. and A. Swartz. 1940. The forage ratio and its use in determining the food grade of streams. Trans. N. Am. Wildl. Conf. 5:162-164.

Huntington, E. H. and A. A. Roberts. 1959. Food habits of the merganser in New Mexico. New Mexico Dept. Game and Fish Bull. 9. 36 pp.

Huntsman, A. G. 1941. Cyclical abundance and birds versus salmon. J. Fish. Res. Bd. Canada. 5:227-235.

Hynes, H. B. N. 1972. The ecology of running waters. University of Toronto Press. 55 pp.

Jester, D. B. and B. L. Jensen. 1972. Life history and ecology of gizzard shad, Dorosoma cepedianum (Le Sueur), with reference to Elephant Butte Lake. New Mexico State Univ. Agric. Exp. Stn. Res. Rep. 218. 56 pp.

Jordan, J. S. 1953. Effects of starvation on wild mallards. J. Wildl. Manage. 17:304-311.

Kendeigh, S. C. 1969. Energy responses of birds to their thermal environment. The Wilson Bulletin. 81:441-449.

Kortright, F. H. 1943. The ducks, geese, and swans of North America. Amer. Wildl. Inst. Washington, D. C. 476 pp.

Latta, W. C. and R. F. Sharkey. 1966. Feeding behavior of the American merganser in captivity. J. Wildl. Manage. 30:17-23.

Lawrence, R. G. 1964. Relationship of certain climatological factors to autumn migration of waterfowl in the central flyway. Ph.D. Thesis, Oklahoma State Univ. 171 pp.

Leonard, E. M. 1950. Limnological features and successional changes of Lake Carl Blackwell, Oklahoma. Ph.D. Thesis. Oklahoma State University., Stillwater. 76 pp.

Lindmeier, J. P. and R. L. Jessen. 1961. Results of capturing waterfowl in Minnesota by spotlighting. J. Wildl. Manage. 25:430-431.

Lindroth, A. 1955. Mergansers as salmon and trout predators in the river Indasalven. Rep. Inst. Freshwat. Res., Drottningholm 36: 126-132.

Longcore, J. R. and G. W. Cornwell. 1964. The consumption of natural foods by captive canvasbacks and lesser scaups. J. Wild. Manage. 28:527-531.

Madsen, F. J. 1957. On the food habits of some fish-eating birds in Denmark. Dan. Rev. Game Biol. 3:19-83.

Maynard, L. A. and J. K. Loosli. 1969. Animal Nutrition. McGraw-Hill Book Company, New York. 613 pp.

Mills, D. H. 1962. The goosander and red-breasted merganser as predators of salmon in Scottish waters. Scient. Invest. Freshwat. Salm. Fish. Res. Scott. Home Dept. 29:1-10.

Mills, D. H. 1967. Predation on fish by other animals. Pages 377-397. In S. D. Gerking, ed. The biological basis of freshwater fish production. Blackwell Scientific, Oxford. 495 pp.

Munro, J. A. and W. A. Clemens. 1936. Food habits of the American merganser (Mergus merganser americanus) in British Columbia. Can. Field. Nat. 50:34-36.

Munro, J. A. and W. A. Clemens. 1937. The American merganser in British Columbia and its relation to the fish population. Bull. Fish. Res. Bd. Can. 55:1-50.

Munro, J. A. and W. A. Clemens. 1939. The food and feeding habits of the red-breasted merganser in British Columbia. J. Wildl. Manage. 3:46-53.

Norton, J. L. 1968. The distribution, character, and abundance of sediments in a 3000 acre impoundment in Payne County, Oklahoma. M.S. Thesis. Oklahoma State Univ. 76 pp.

Odum, E. P. 1971. Fundamentals of Ecology. W. B. Saunders Company, Philadelphia, Pa. 574 pp.

Oklahoma Water Resources Board. 1970. Oklahoma Water Resources. Oklahoma City, Okla. 69 pp.

Owen, R. B. 1970. The bioenergetics of captive blue-winged teal under controlled and outdoor conditions. The Condor 72:153-163.

Ricker, W. E. 1952. Numerical relations between abundance of predators and survival of prey. Can. Fish. Cult. 13:5-9.

Salyer, J. C. and K. F. Lagler. 1940. Food habits of the American merganser during winter in Michigan considered in relation to fish management. J. Wildl. Manage. 4:186-219.

Sincock, J. L. 1962. Estimating consumption of food by wintering waterfowl populations. Proc. Southeastern Assoc. Game and Fish Commissioners 16:217-221.

Stewart, W. E. 1962. Waterfowl populations in the Upper Chesapeake Region. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Wildl. 20. 208 pp.

Sutton, G. M. 1967. Oklahoma Birds. Univ. of Oklahoma Press, Norman. 647 pp.

Timken, R. J. and B. W. Anderson. 1969. Food habits of common mergansers in the north central United States. J. Wildl. Manage. 33: 87-91.

Trautman, M. B. 1935. Concentrations of ducks on some of the trout streams of the northern part of the Lower Michigan Peninsula during the 1934-35 winter. Inst. Fish. Res. Rept. No 283, 8 pp. Typewritten.

White, H. C. 1957. Food and natural history of mergansers on salmon waters in the Maritime Provinces of Canada. Fish. Res. Bd. Can. Bull. 116 pp.

Vladykov, V. D. 1943. Relation between fish and fish-eating birds. Can. Field Nat. 57:124-132.

APPENDIX A

LISTING OF SOURCES OF INFORMATION USED IN THIS STUDY ON THE DISTRIBUTION OF COMMON MERGANSERS

List of National Wildlife Refuge Respondents:

Alabama - Choctaw
Wheeler

Arkansas - White River
Wapanocca
Holla Bend
Big Lake

California - Klamath Basin
Sacramento
Farallon Islands
Colusa
Sutter
Delevan
San Luis
Merced
Kesterson
Kern
Pixley
Cibola
Salton Sea

Colorado - Browns Park
Monte Vista
Arapahoe

Delaware - Bombay Hook
Prime Hook

Florida - St. Vincent
St. Marks
Chassahowitzka
Cedar Keys
Lake Woodruff
Merritt Island
J.N. "Ding" Darling
South Florida

Georgia - Eufaula
Okefenokee

Idaho - Minidoka
Grays Lake
Bear Lake
Camas
Deer Flat
Kootenai

Illinois - Crab Orchard
Chautauqua

Indiana - Muscatatuck

Iowa - Union Slough
DeSoto

Kansas - Kirwin
Flint Hills
Quivira

Louisiana - Cathoula
Locassine
Sabine
Delta Gulf Islands

Maine - Moosehorn

Maryland - Eastern Neck
Black Water

Massachusetts - Park River
Monomoy
Great Meadows
Ninigret
Salt Meadows

Michigan - Seney

Minnesota - Tamarac
Sherburne
Agassiz
Rice Lake

Mississippi - Yazoo
Noxubee

Missouri - Swan Lake
Benton Lake
Red Rock Lakes
Charles M. Russell

Nebraska - Crescent Lake
Ft. Niobrara

New Jersey - Brigantine
Great Swamp

List of Refuges contd.:

New Mexico - Las Vegas
Maxwell
Bitter Lake

New York - Target Rock
Morton
Oyster Bay
Wertheim
Montezuma
Iroquois

North Carolina - Pungo
Pee Dee
Pea Island

North Dakota - Tewaukon
Slade
Audubon
Lostwood
Arrowwood
Des Lacs
Upper Souris
J. Clark Salyer

Oklahoma - Great Salt Plains
Tishomingo
Washita
Sequoyah

Oregon - Umatilla
McKay Creek
Cold Springs
William L. Finley

South Carolina - Carolina Sandhills
Cape Romain
Santee
Savannah

South Dakota - Waubay
Lake Andes
LaCreek
Sand Lake

Tennessee - Tennessee
Cross Creeks
Hatchie
Reelfoot

Texas - Muleshoe
Brazoria
Aransas
Anahuac
Buffalo Lake

Utah - Ouray
Fish Springs
Bear River

Vermont - Missisquoi

Virginia - Chincoteague
Back Bay
Presquile

Washington - Columbia
McNary
Toppenish
Conboy Lake
Ridgefield
Willapa

List of State Respondents:

Alabama Department of Conservation and Natural Resources - W. Walter Beshears, Jr.

Alaska Department of Fish and Game - Dan Timm

Arizona Game and Fish Department - Donald R. Berlinski

California Department of Fish and Game - Frank M. Kozlik

Connecticut Department of Environmental Protection - James S. Bishop

Delaware Department of Natural Resources and Environmental Control - H. Lloyd Alexander, Jr.

Florida Game and Fresh Water Fish Commission - Michael J. Fogarty

Idaho Fish and Game Department - Dick Norell

Illinois Department of Conservation - George Arthur

Indiana Department of Natural Resources - Herald A. Demaree

Iowa Conservation Commission - Ron Andrews

Kansas Forestry, Fish and Game Commission - Leland M. Queal

Kentucky Department of Fish and Wildlife Resources - F. H. Diffle

Louisiana Wildlife and Fisheries Commission - Hugh Bateman

Maine Department of Inland Fisheries and Game - Howard E. Spencer

Maryland Department of Natural Resources, Wildlife Administration - Vernon D. Stotts

Massachusetts Division of Fisheries and Game - H. W. Heusmann

Michigan Department of Natural Resources - Edward Mikula

Minnesota Department of Natural Resources - Robert L. Jessen

Mississippi Game and Fish Commission - W. H. Turcotte

Missouri Department of Conservation - Ken Babcock

Montana Department of Fish and Game - Dale Witt

Nebraska Game and Parks Commission - George Schildman

Nevada Department of Fish and Game - Larry Barngrover

List of States contd.:

New Hampshire Fish and Game Department - Harold C. Lacaillade

New Jersey Department of Environmental Protection - Fred Ferrigno, Sr.

New Mexico Department of Game and Fish - J. L. Sands

New York State Department of Environmental Conservation - Stephen Browne

North Carolina Wildlife Resources Commission - Jack A. Donnelly

North Dakota Game and Fish Department - Charles H. Schroeder

Ohio Department of Natural Resources, Division of Wildlife - Karl E. Bednarik

Oklahoma Department of Wildlife Conservation - Lem Due

Oregon Game Commission - Chester E. Kebbe

Pennsylvania Game Commission - Billy A. Drasher

Rhode Island Division of Fish and Wildlife

South Carolina (reply sent by; H. M. Steels, Agent in Charge, Law Enforcement, South Carolina, Bureau of Sport Fisheries and Wildlife)

South Dakota Department of Game, Fish and Parks - Bruce Harris

Tennessee Game and Fish Commission - Ron Fox

Texas Parks and Wildlife Department - P. B. Uzzell

Utah Department of Natural Resources, Division of Wildlife Resources - F. Clair Jensen

Vermont Fish and Game Department - Thomas R. Myers

West Virginia Department of Natural Resources - Richard L. Hall

Wisconsin Deparmtent of Natural Resources - James R. March

Wyoming Game and Fish Commission - George F. Wakestraw

Other contributors:

Frank C. Bellrose, Illinois Natural History Survey

Milton B. Trautman, The Ohio State University

APPENDIX B

A COMPENDIUM ON THE DISTRIBUTION OF THE COMMON MERGANSER

COMPILED FROM INFORMATION RECEIVED FROM SOURCES

LISTED IN APPENDIX A

Alabama

state - estimate 500 to 1000 in state in any given winter. Arrive first part of November, peak in mid-December and leave by first of February. Areas normally found: Mobile Bay, TVA Lakes, and small scattered bunches in state.

Choctaw NWR - no recorded use.

Wheeler NWR - present every winter, 25 to 30 birds.

Alaska

state - no data (see book "Birds of Alaska" for general information).

Arizona

state - Most common mergansers found in western part of state along the Colorado River from Yuma to Bullhead City; the three main locations being Martinez Lake, Havasu Lake, and Topock Swamp. Roosevelt Lake in Central Arizona gets a few birds. Arrive in small numbers in September, peak in February, and by end of March are leaving the state.

Arkansas

state - no information.

White River NWR - rare, occasionally get a few birds. Said to be common at minnow farms around Lonoke, Ark.

Wapanocca NWR - rare, 1 record of 150 on 2 Nov. 1968.

Holla Bend NWR - uncommon, if seen are usually less than 20 in number and in January or February.

Big Lake NWR - a few seen occasionally.

California

state - count 3,000 to 6,000 during winter surveys. Winter along coast, on the foothill reservoirs, and along rivers. Arrive on wintering grounds in late November and leave in March. Some nesting in state. No special effort made to census these ducks so actual numbers in state cannot be estimated.

Klamath Basin NWR - regularaly gets many mergansers. Possibly an important migratory stop for this species in the Pacific Flyway.

Sacramento NWR - other refuges under this jurisdiction are: Delevan, Farallon Islands, Colusa, Sutter. Common mergansers do not occur at the Farallon Islands and are found only in small numbers at the other areas.

San Luis NWR - no recorded use. Other refuges under this jurisdiction, Merced and Kesterson, get occasional use.

Kern and Pixley NWR - uncommon.

Cibola NWR - a small amount of use each year, present for only brief periods, less than 100 in numbers.

Salton Sea NWR - virtually no use, if present less than 25.

Colorado

state - no information received.
Browns Park NWR - between 50 and 100 present during winter, occasional in summer.
Monte Vista NWR - to 50 birds from January to May, no nesting.
Arapaho NWR - less than 50 present, primarily use area for nesting.

Connecticut

state - most mergansers found along coast, Connecticut River, and Long Island Sound, only a few reported inland. Data show peak populations of 2000 to 3500 along the coast and the lower Conn. River from mid-December to late March.

Delaware

state - no information.
Bombay Hook and Prime Hook NWR - light use, less than 200 birds. Forced off refuges by ice, appear again during a thaw. Fall peak around end of December, spring peak in March.

Florida

state - considered rare in state.
St. Vincent NWR - rare, 1 record in past 5 years.
St. Marks NWR - rare, none recorded in past 10 years.
Chassahowitza NWR - rare.
Cedar Keys NWR - rare.
Lake Woodruff NWR - no recorded use.
Merritt Island NWR - rare.
J. N. "Ding" Darling NWR - rare, 1 or 2 sightings in refuge history.
South Florida NWR - rare.

Georgia

state - no information received.
Eufaula NWR - 50 birds or less in any given winter.
Okefenokee NWR - peak numbers to 180 in any given winter.

Idaho

state - common in all of state. Both nesting and wintering birds, with largest concentrations occurring in mid-November during migration. 19 year mid-winter inventory average is 5,554 which was said to be less than the summer or fall population.
Minidoka NWR - year round use, peaks in the fall to 3000.
Gray's Lake NWR - uncommon.
Bear Lake NWR - mean populations in fall of 60-80 birds.
Deer Flat NWR - receives much use by migrating and wintering mergansers. Fall peaks (mid-Nov. to mid-Dec.) to 10,000, spring peaks (February to April) up to 5,000.
Camas NWR - low use, less than 200 birds present from November to April.
Kootenai NWR - normally less than 50 birds. Remain as long as open water available.

Illinois

state - common in state during fall migration, winter, and spring migration. Very common in Illinois River Valley and along the Mississippi River. Peak period of use is from early December to late January, numbers censused up to 13,000 for each area.
Crab Orchard NWR - peaks of 10,000 recorded in late January to early February. Winter on refuge if open water available.
Chautauqua NWR - no wintering.

Indiana

state - found only in small numbers in the state, generally less than 300 for all of state. Recorded in scattered bunches.
Muscatatuck NWR - a new refuge with no large bodies of water yet available for ducks such as mergansers.

Iowa

state - uncommon in the interior, recorded along the Mississippi River and Missouri River.
DeSoto NWR - light use, peaks generally less than 500. Fall peak in early December, spring peak in March.
Union Slough NWR - peaks in the fall (Oct. to Nov.) and spring (March to April) of around 200 birds.

Kansas

state - a major migratory stopover and wintering area. Abundant throughout the state during late fall, winter, and early spring. Almost all of the major reservoirs in the state receive much use by this duck. Areas of highest recorded use are: The Cheyenne Bottoms Waterfowl Management Area (up to 60,000 +), Lake McKinney, The Flint Hills NWR, Toronto Reservoir, Neosho Reservoir, Kirwin NWR, Webster Reservoir (up to 30,000 +). Peaks of 10,000 + can be expected in any of these areas. Other lakes in the state probably receive use but census data are lacking.

Kentucky

state - most numerous on Kentucky Lake in eastern part of the state. Peak numbers of 3,000 - 5,000 during January, February, and March. Both red-breasted and common mergansers present. Other major reservoirs in state reportedly receive light use by common mergansers.

Louisiana

state - uncommon in the state as a whole.
Catahoula NWR - no recorded use.
Lacassine NWR - never more than 50 birds present at any one time from November to January.
Delta-Gulf Islands NWR - rare, not more than 10 seen in any winter.
Sabine NWR - rare, 93 total recorded in past 10 years.

Maine

state - present year round, breeds in good numbers on inland lakes especially in the northern two-thirds of the state. Common along the coast in winter, but more numerous during spring and fall migrations. 500-1,000 considered a minimum estimate of wintering population.

Moosehorn NWR - present year round, nesting occurs, up to 200 seen at one time.

Maryland

state - no specific information

Eastern Neck NWR - sporadic use in winter, peaks rarely to 300.

Black Water NWR - present in December, peaks rarely exceed 500 during this time.

Massachusetts

state - a few may winter along the coast and more may be present along the Connecticut River in the western part of the state.

Parker River NWR - occasionally present in the fall, usually not. Never more than 50 counted.

Monomoy NWR - normally present in early winter and early spring. Peaks are less than 450 in number.

Great Meadows NWR - present only in spring (late March-early April), numbers 30 or less.

Ninigret and Salt Meadows NWR - no recorded use.

Michigan

state - nests and winters in the state. Reported concentration areas are: Saginaw Bay, Lake St. Clair, the lower Detroit River, western end of Lake Erie, and southern Lake Michigan (numbers range from 2,000 to 10,000 or more in each of these areas, (see also Salyer and Lagler 1940).

Seney NWR - nests on refuge, mean population of 150 to 200 from March to November. Leave refuge with ice cover.

Minnesota

state - can be found throughout most of the state usually in flocks of 25 to 75 and often associated with winter kill lakes where the numerous small fishes are a possible attraction. Leech Lake and Lake Pepin attract a few thousand birds each fall and are possibly the main areas of merganser concentration in the state.

Tamarac NWR - an occasional fall visitor.

Sherburne NWR - occur in small numbers up to 500 in the fall and spring. Leave with freeze up and arrive at or near the time of the spring thaw.

Agassiz NWR - no nesting recorded, spring peak (mid-April) averages around 500 birds, fall peak (end-October) only around 50.

Rice Lake NWR - no nesting, spring peak around 400, but in fall are uncommon with less than 50 seen.

Mississippi

state - uncommon to rare in state.
Noxubee NWR - rare.
Yazoo NWR - rare, 2 records.

Missouri

state - occurs throughout most of the state during late fall and winter. Possibly most numerous on the Lake of the Ozards.
Swan Lake NWR - fall peak in late December of around 250, spring peak of 200 or less around March. Occasionally peaks of 1,000.
Mark Twain NWR - Calhoun Division gets the most mergansers, other divisions receive small numbers (less than 150). Calhoun gets one peak in early February of up to 10,000. The number of mergansers recorded by this refuge are probably considerably less than the actual number of mergansers using this portion of the Mississippi River.
Mingo NWR - a rare winter and spring visitor.

Montana

state - winter on most of the major rivers in the state and are present year round in the state.
Ul Bend-Bowdoin NWR - present every year in low numbers, 200 or less. Usage is from after ice-out in the spring to freez-up in the fall.
Benton Lake NWR - pass through but do not stop due to the lack of food on the refuge for mergansers. Moderate numbers reported to occur along the Missouri River south of the refuge.
Red Rocks Lakes NWR - present every year, numbers estimated at less than 200.
Charles M. Russell NWR - present in fall below the Ft. Peck dam, around 500 or so counted.

Nebraska

state - occur along the Platte River during the winter and throughout the state during the spring and fall migrations. Lake McConaughy possibly receives the most use of any area in the state by this duck. Numerous on the Platte River during winter from Grand Island west.
Crescent Lake NWR - minor usage, generally less than 400 in spring peak (early March) and fall peak (mid November).
Ft. Niobrara NWR - winter in small numbers on the Niobrara River on refuge.

Nevada

state - occur during winter and migrations on the following areas: Stillwater Waterfowl Management Area (500-3,000), Lake Mead (100-5,000), Walker Lake (100-500), Humbolt Waterfowl Management Area (100-300), Lahonton Reservoir (50-300).
Ruby Lake NWR - primarily occur during winter months numbers less than 50; have been recorded in all months.
Stillwater NWR - from fall to spring are present in varying numbers, depending upon ice conditions, from 100 to 4,000.

New Hampshire
state - occur throughout the state in moderate numbers.

New Jersey
state - fairly abundant in inland waters in late winter (January to March).
Brigantine NWR - occur in moderate numbers (50 to 500) from November through March.
Great Swamp NWR - at present rare on this new refuge, occur if at all in late winter and early spring.

New Mexico
state - arrive in November, peak in early January and by February are moving back north. Up to 20,000 are counted in mid-winter inventories (see also Huntington and Roberts 1959). Some birds remain during summer.
Las Vegas NWR - present in January and February, numbers less than 200.
Maxwell NWR - occur in January and February, numbers less than 200.
Bitter Lake NWR - present from November to April, peaks up to 500 primarily in January.

New York
state - breeds in the northern part of the state but not in large numbers.
Target Rock NWR - no recorded use.
Morton NWR - no recorded use.
Oyster Bay NWR - occasional.
Werthein NWR - occasional.
Montezuma NWR - present from February to December, numbers probably less than 500 during peak periods.
Iroquois NWR - new refuge, no water developments and consequently mergansers are rare.

North Carolina
state - unknown in state except for rare sightings by bird watchers.
Pea Island NWR - rare.
Pungo NWR - rare.
Pee Dee NWR - no recorded use.

North Dakota
state - winters in very small numbers in state. Common throughout the state during migrations. Some nesting occurs during the summer.
Tewaukon NWR - occurs in spring (late March to early May) and in fall (November) only. Numbers in both seasons peak at 250.
Slade NWR - April and November use only, numbers between 50 and 500.
Audubon NWR - present in April and November, numbers 50-200.
Lostwood NWR - no fish in ponds on refuge, so no mergansers.
Arrowood NWR - no wintering, present spring and fall.

North Dakota contd.

Des Lacs NWR - no wintering, migratory populations (November and April) 50 to 200.

Upper Souris NWR - no wintering, 300-400 present during spring and fall migrations.

J. Clark Salyer NWR - some nesting on refuge, 100 to 200 present during migrations.

Ohio

state - greatest numbers occur in western Lake Erie and Sandusky Bay. In this area are intermixed with red-breased mergansers. About 10,000 to 110,000 censused in fall and 10,000 to 20,000 in spring. Fall peak is about the third week of November and the spring peak is in the first two weeks of March. In the spring and fall all of the deeper inland lakes and large rivers are used, numbers vary from 25 to 1500 in any area.

Milton B. Trautman (Ohio State University) - "The common merganser is an inhabitant of moderate-sized streams and rivers and nests primarily along streams...During migrations the common merganser temporarily visits the smaller lakes but is confined largely to the small streams in Ohio... I lived for 17 years on South Bass Island in western Lake Erie and would not see more than a dozen common mergansers during a spring or fall migration on the open waters of Lake Erie, but would see up to 20,000 red-breasted mergansers... during the height of the migration before 1940, I could see as many as 2,000 common mergansers in the smaller bays of Lake Erie or streams on the mainland. Before 1940 the common merganser was an abundant migrant throughout eastern North America... Then something happened and the population decreased drastically and has never fully recovered, but the population has increased somewhat during the past 5 years. Concerning their wintering on reservoirs... I believe it entirely possible for this stream-oriented merganser to adapt to stream impoundments. I see no evidence of this in Ohio, probably because only migrants can utilize our impoundments, these waters being frozen in winter." (M. B. Trautman, personnal communication, letter dated 26 March 1973, Ohio State University, Columbus).

Oklahoma

state - common to abundant on the large reservoirs in the state from late December to early March. Some reservoirs are recorded as annually receiving large concentrations: Canton 15,000; Ft. Cobb 11,000; Ft. Gibson 5,000; Oologah 3,500; Grand Lake 24,000; Keystone 18,000.

Great Salt Plains NWR - present from November to April, peaks vary from 3,000 to 16,000 during late December and early January.

Tishomingo NWR - present from November to April, numbers not more than 500.

Washita NWR - present from November to late March, peak numbers recorded to 30,000, average around 4,000 to 10,000 in late January.

Sequoyah NWR - a new refuge, present in winter, peaks of 300 recorded.

Oregon
state - occurs in state year round. Uses coastal bays and rivers heavily during winter.
Umatilla NWR - present year round, most common in fall and winter, numbers never more than 600.
McKay Creek NWR - sporadic use during winter and spring, numbers less than 50.
Cold Springs NWR - no recorded use.
William L. Finley NWR - occur in small numbers, less than 50.

Pennsylvania
state - possibly occurs regularly in good numbers in the Susquehanna and Delaware Rivers in eastern Pa.

Rhode Island
state - no information.

South Carolina
state - a few winter in the coastal marshes. Suggested that wintering populations are heaviest in the New York - New Jersey coastal areas.
Carolina Sandhills NWR - no recorded use.
Cape Romain NWR - considered rare on refuge.
Santee NWR - present in small numbers 50-150 from November through February.
Savannah NWR - no recorded use.

South Dakota
state - winters along the Missouri River in moderate numbers, 100 or more birds, from Oahe Dam to the Iowa Border. Nesting occurs occasioanlly. Spring migration peaks out around late March, and fall migration lasts from late October till December.
Waubay NWR - rare in the fall but common migrants in spring (March to April). Numbers from 50 to 200.
Lake Andes NWR - Primary use is in the spring (March to April), peaks of 1500 birds are normal. Fall use (November to December) is more uncertain and is probably influenced by the date of freeze up.
LaCreek NWR - up to 200 birds present during some winters, otherwise present only during migrations.
Sand Lake NWR - fall numbers 200-500, spring numbers to 500 primarily in early April.

Tennessee
state - considered uncommon in the state, occurring in small numbers during winter.
Tennessee NWR - peaks in early January of up to 10,000 birds, normal range is from 4000 to 5000.
Cross Creeks NWR - uncommon from February to March.
Hatchie NWR - no recorded use.
Reelfoot NWR - uncommon.

Texas
state - no information.
Muleshoe NWR - very light use, normally less than 10 birds January to March.
Brazoria NWR - rare.
Anahuac NWR - no recorded use.
Aransas NWR - rare, no more than 10 ever seen.
Buffalo Lakes NWR - present every winter. Peaks to 2000, normally 600-800 birds present in any given winter.

Utah
state - main area of concentration appears to be the Green River below Flaming Gorge Dam.
Fish Springs NWR - present in fall and spring, numbers 50 to 100.
Ouray NWR - little use in spring, numbers less than 50.
Bear River NWR - some winter on refuge, primary use is in spring from February to March, numbers to 500.

Vermont
state - no information.
Missisquoi NWR - occasional use, numbers 50 or less. Lake Champlain to south of refuge is used more consistently by this duck.

Virginia
state - no information received.
Chincoteague NWR - occur during migrations, numbers 50 or less.
Back Bay NWR - present from November to May, numbers to 60 birds.
Presquile NWR - present from November to April, numbers to 200.

Washington
state - no information received.
Columbia NWR - no nesting, occur in moderate numbers (to 200) from January to April, rest of year less than 100 birds present. Columbia River in this area said to get more use than indicated by this refuge.
McNary NWR - occur from October to May, peak in January to 500.
Toppenish NWR - present but no records on numbers.
Conboy Lake NWR - present but no records on numbers.
Ridgefield NWR - present throughout year, numbers usually 50 or less.
Willapa NWR - present but no records of numbers.

West Virginia
state - occur on rivers in state during winter, numbers unknown.

Wisconsin
state - found on the larger bodies of water in the state during fall, Lake Michigan, and the larger rivers in winter. Some nesting in the state. Most mergansers not counted in survey flights because concentration areas of this duck are not censused (large rivers and Lake Michigan)
Horicon NWR - occur primarily in spring in limited numbers, to 200.

Wisconsin contd.

Necedah NWR - present in fall (mid-November) and spring (late April and early May) in numbers usually less than 300.

Wyoming

state - common in state throughout year.
Pathfinder NWR - present all year, nesting, numbers peak in summer to 200.
Hutton Lake NWR - present year round, nesting, numbers 50 or less.
Seedskadee NWR - present year round, nesting, numbers to 600 in winter.

VITA

Steven William Miller

Candidate for the Degree of

Master of Science

Thesis: THE COMMON MERGANSER: ITS WINTERING DISTRIBUTION AND PREDATION IN A WARM WATER RESERVOIR

Major Field: Wildlife Ecology

Biographical:

Personal Data: Born in Lakewood, Ohio, September 1, 1949, the son of Mr. and Mrs. William G. Miller.

Education: Graduated from Valley Forge High School, Parma Hts., Ohio, in June, 1967; Received Bachelor of Science degree in Wildlife and Fisheries Management from Utah State University in June, 1971; completed requirements for the Master of Science degree at Oklahoma State University in December, 1973.

Professional Experience: Engineering Aid, Flathead National Forest, Kalispell, Montana, summer, 1968; Undergraduate Research Assistant, Wildlife Department, Utah State University, summer, 1971; Biological Aid, Utah Department of Natural Resources, Wildlife Resources Division, summer, 1971; Environmental Protection Agency Trainee, August, 1971 - August, 1973; Graduate Research Assistant, Oklahoma Cooperative Fisheries Unit, Oklahoma State University, September, 1973 - December, 1973.