INFLUENCES OF UNITED STATES ARMY CORPS OF ENGINEERS RESERVOIRS ON WATERFOWL POPULATIONS IN OKLAHOMA

By

WALTER EUGENE GORHAM II

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Texas A&M University

College Station, Texas

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Thesis Approved:

John L Barclay

R E McMurphy

James C Lewis

N N Durham

Dean of the Graduate College

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*Oklahoma Department of Wildlife Conservation, Oklahoma State University, U. S. Fish and Wildlife Service, and the Wildlife Management Institute cooperating.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

Oklahoma, as well as many other states, has undergone drastic alterations in land form. An important part of these alterations has been in the construction of numerous large reservoirs by the United States Army Corps of Engineers. Prior to reservoir construction, waterfowl habitat in Oklahoma consisted mainly of existing rivers, and small natural bodies of water. Since the construction of these impoundments, there has been a tremendous increase in total water surface. Nearly 0.4 million acres are currently inundated by Corps of Engineers reservoirs in Oklahoma (U. S. Army Corps of Engineers, 1968). The extent to which this increased water surface has altered waterfowl habitat is not known.

The construction of large artificial reservoirs has many effects on the environment. The most obvious of these is that they inundate large land areas. In the Southern United States, where large river bottom habitats are prominent, a reservoir usually covers a large amount of this unique habitat type. River bottoms are known for many biological phenomena including their use by waterfowl. Whether or not reservoir use compensates for the lost bottomland use is not known.

This study was the first in a proposed series of research undertakings designed to evaluate the influences of Corps of Engineers reservoirs on waterfowl populations in Oklahoma. Therefore, the purpose

of this study was to begin quantifying reservoir-waterfowl-human relationships in order that well designed studies can be undertaken subsequently to evaluate all of the ecological relationships involved. To this end, it was essential to gather pertinent information relevant to reservoir characteristics, current waterfowl use of the reservoirs, and human use of the reservoir and waterfowl resources.

The specific objectives of this study were to: (1) assimilate, classify, and evaluate information already available on the relationships involved, (2) inventory seasonal waterfowl populations currently utilizing Corps of Engineer reservoirs, and (3) determine hunter numbers, success, and distribution during a current season.

CHAPTER II

REVIEW OF LITERATURE

While the literature is voluminous on various aspects of waterfowl ecology, there is relatively little printed matter dealing specifically with waterfowl-reservoir relationships. The generalization has been made that depending on location, size, mode of operation, and adjacent land use practices, reservoir projects may have beneficial, adverse or insignificant effects on numbers, distribution, and movements of waterfowl (White and Malaber, 1964). But with only minimal supportive data, this same statement could be made about any man-induced environmental changes. Such an oversimplification does not solve the problem. The majority of research undertakings involving waterfowl and artificial reservoirs have dealt with Tennessee Valley Authority projects. Research findings include those by Wiebe (1946, 1950), Stennis (no date), and Barstow (1963 [1965]). All of these papers dealt with management programs and evaluations of habitat characteristics relative to waterfowl on TVA impoundments. The outstanding point common to these papers was best summarized by Wiebe et al. (1950, p. 117) when he said:

> Experience has shown that...reservoirs built and operated for navigation, flood control, without additional specific development work and changes in the mode of operation do not offer good habitat for waterfowl - either to preserve or kill.

At least three international papers dealt with the general subject matter. Mills and MacIver (1964) discussed waterfowl use of

hydroelectric reservoirs. Waterfowl reservoir relationships in Great Britain were discussed by Atkinson-Willes (1964). However, the reservoirs referred to by Atkinson-Willes were small (250-1250 acres) compared to those found in Oklahoma (3000-100,000 acres). Anan'in (1960) pointed out that after a steady decline of waterfowl use on the Kama River due to intensive development of industry and transportation in the area, populations of ducks and coastal birds increased sharply after the construction of the Pershoe reservoir on this river. All three of these authors noted increased waterfowl use of reservoir locations after construction. Possibly a similar increase has occurred in Oklahoma.

Three masters theses have dealt with man-made reservoirs and waterfowl. Pre-impoundment recreational use patterns and waterfowl occurrence in Iowa were studied on the Saylorville reservoir area by Lenning (1970). Recreational uses other than waterfowl hunting were emphasized. Limited information was gathered on waterfowl occurrence. The other two studies were conducted in Oklahoma. The utilization of Tishomingo National Wildlife Refuge by waterfowl and hunters was investigated by Burks (1965). This refuge is located on Lake Texoma, a Corps reservoir in south central Oklahoma. The phenology of waterfowl migration on Fort Gibson reservoir and vicinity was studied by Landes (1961). This Fort Gibson study not only revealed information on gross migrational changes in species composition and numbers, but also provided some information on local feeding activities.

Although not specifically related to the influences of reservoirs on waterfowl populations, there were numerous references to the environmental effects of reservoir construction. Yeager (1946) emphasized the

permanent nature of reservoirs and pointed out the loss of valuable land by inundation. Duck (1947) discussed some of the laws relevant to reservoir construction and wildlife conservation coordination with government agencies. Peterson (1953) presented evidence showing that small watershed structures are more efficient for flood prevention than are large artifical reservoirs. Eklund (1954) discussed the responsibility of wildlife conservation on large reservoirs. He concluded that it is everyone's responsibility--including the Corps of Engineers. Stuart (1969) discussed the various laws governing wildlife resources and reservoir construction. He said that the states were supporting an unfair share of the expense burden for wildlife conservation practices on federal water projects. Many of the problems related to water resource management were discussed by Giles et al. (1970) and Allen and Leedy (1970). They concluded that not enough is known of ultimate human needs to permit further extensive and irreversible changes in our landscape. In essence these authors simply posed questions relevant to the construction of large reservoirs. What are the environmental effects of large water impoundments due to their permanency? Who is responsible for wildlife management at reservoir sites? Are there alternatives to reservoir construction based on human needs? Probably most important, what are the human needs for the future? By documenting current conditions on reservoirs, waterfowl and hunter use, this current study may begin to provide information through which these questions can be answered.

CHAPTER III

STUDY AREA

Reservoirs have been constructed by the Tulsa District of the U. S. Army Corps of Engineers in nearly all sections of Oklahoma except the extreme west and southwest. In this study emphasis was placed upon those reservoirs found in the eastern one-third of the state since most of the completed impoundments (13 of 17) are found in this region (Figure 1). This eastern, more humid portion, is comprised of varying local habitat types, but in total is primarily a portion of the eastern deciduous forest biome. The climate is temperate. Because of its southerly location, this eastern one-third of Oklahoma includes river drainages that form southern hardwood bottomlands. In contrast to arid locations, larger reservoirs found in humid regions have a restricted chance of improving wildlife habitat because of lost bottomland and wooded areas (Yeager 1946). Therefore, reservoirs in the eastern one-third of the state were deemed most important to the current study. Time and physical limitations also necessitated restricting the geographical scope of this initial study. Since some informational sources, mostly government records, contained data regarding reservoirs in other portions of the state, this information was included where applicable.

A situation, unique in Oklahoma in the eastern portion of the state, is the recent construction of the Arkansas River Waterway Navigation System. This project, by the Corps of Engineers, consists of

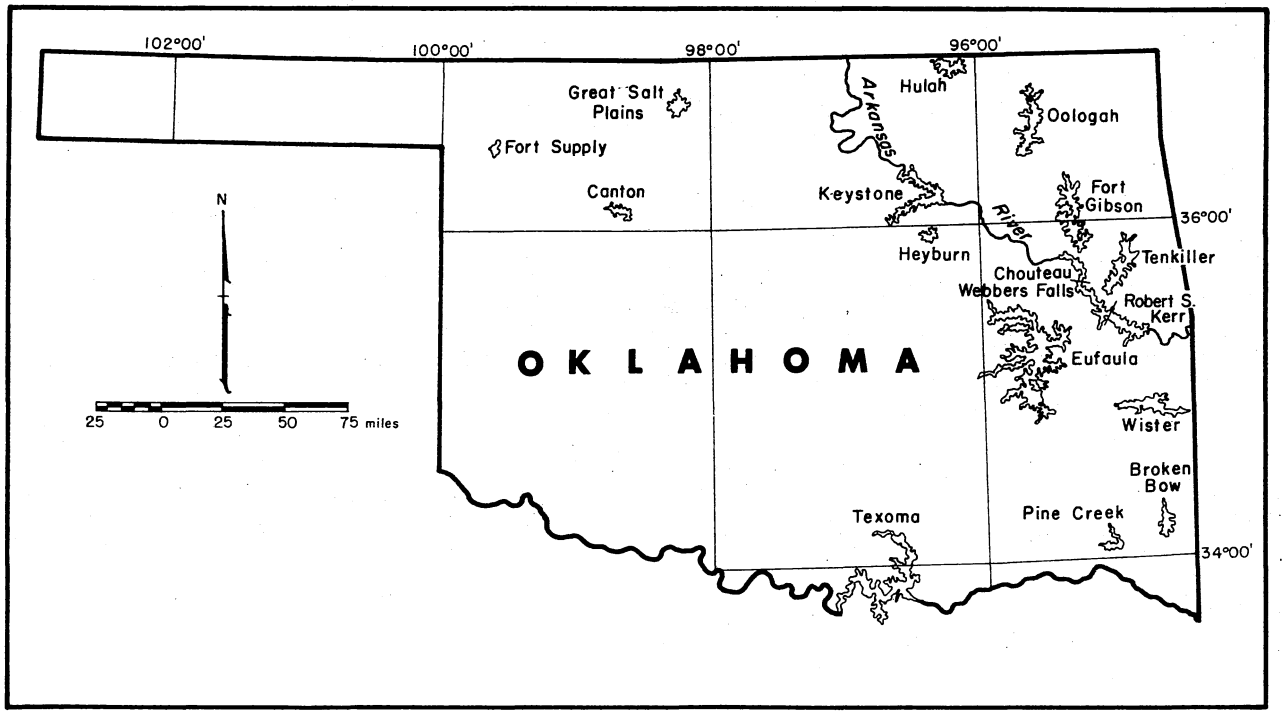


Figure 1. Completed U. S. Army Corps of Engineer Reservoirs in Oklahoma

five lock and dam structures, on the Arkansas and Verdigris rivers from the Oklahoma-Arkansas border to Tulsa, Oklahoma. With the aid of the locks and dams, river channelization, and numerous large reservoirs, a waterway has been created to allow for commercial shipping operations from New Orleans, Louisiana to Tulsa. The two primary study reservoirs for this study are directly involved with the navigation system. Robert S. Kerr Reservoir, on the Arkansas River, contains the navigation channel. Eufaula Reservoir provides specified water releases, via the Canadian River, to maintain water levels within the navigation system.

CHAPTER IV

METHODS

Background Information

In order to fulfill the first objective of this study an attempt was made to assimilate, classify, and evaluate information already available concerning waterfowl-reservoir relationships pertinent to Oklahoma. This was accomplished to prevent repetition of efforts, and to provide basic information for future investigators. Information was evaluated in terms of relevance, the time it was compiled, and its extent. It was provided almost exclusively by governmental agencies. The primary sources of information were (1) Migratory Bird Populations Station (MBPS), Laurel, Maryland, (2) Tulsa District, U. S. Army Corps of Engineers, Tulsa, Oklahoma, (3) Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma, and (4) U. S. Department of Agriculture, Statistical Reporting Service, Oklahoma City, Oklahoma. Different types of information were provided by each agency although some overlap was noted.

Migratory Bird Populations Station

Duck stamp sales data for Oklahoma and waterfowl band return reports were provided by the MBPS. Duck stamp sales information was obtained for fiscal years 1958-1971 for individual post offices

throughout the state. These sales reports were used to evaluate the significance of any detectable differences in waterfowl hunter numbers in reservoir areas and in the state for various years. A computer tape containing data regarding all waterfowl band returns for Oklahoma was obtained. The tape included all returns from the advent of such records (approximately 1914) through 1970. Each coded computer listing indicated banding and recovery sites by area (state or province) and longitude and latitude, date of each recovery, and species. The listings were decoded with the aid of the Bird Banding Manual (MBPS, 1961). The exact geographic location of each Corps reservoir was determined with the aid of Corps reservoir maps. A rectangle was drawn around each structure to include all of the water surface area. The precise longitudes and latitudes comprising the rectangle were then determined. A computer program was used to extract all band recoveries included within the specified longitude and latitude descriptions of Corps reservoirs. The resulting computer listing was used to detect changes through time in rates of band recoveries, changes in bird origins (original banding sites), and changes in species composition.

U. S. Army Corps of Engineers

This agency provided reservoir maps, statistics regarding reservoir size, age, and operating procedures, as well as information on water level fluctuations and duck blind registrations. Reservoir maps were used to determine hunter access points and to plan aerial survey routes. Statistics regarding reservoir characteristics such as size, age, and operating procedures were used to categorize each structure on the basis of differences in the same characteristics. These statistics were used

to determine which factors most affect waterfowl use of reservoirs when they were compared to seasonal waterfowl inventory data. Water level fluctuations were documented to show the magnitude of these periodic changes in water depth. The extent and rate of water level fluctuation directly affects vegetational characteristics in reservoir areas. The tremendous water level fluctuations on a Corps reservoir in Mississippi prompted a competent biologist to call this reservoir a biological desert (Bumstead 1954). Duck blind registrations were obtained in order to note registrant numbers on each reservoir and to obtain the addresses of these registrants so that they could be included in a mail questionnaire survey.

Oklahoma Department of Wildlife Conservation

Information was obtained, through Pittman-Robertson annual job completion reports for the state of Oklahoma, on waterfowl numbers and hunter success for the years 1950-1970. However, this information proved to be of little value. These reports were designed to show information for the entire state. Hunting license stubs were utilized to acquire a random sample of harvest. Oklahoma Corps reservoirs are not distributed randomly. Waterfowl numbers were included for specific Corps reservoirs, but not for all reservoirs for all years. The information provided in these reports did serve as comparisons for the data gathered by the investigator through aerial surveys, mail questionnaire analyses, and personal interviews. Information was also obtained on current waterfowl management practices conducted by the state.

United States Department of Agriculture

Primarily, two services of this agency were contacted: Statistical Reporting Service, Oklahoma City, Oklahoma and various Agricultural Stabilization and Conservation Services (ASCS) offices in the eastern portion of the state. The objective was to obtain information on the types and amounts of crops suitable for waterfowl utilization that were being grown in the state, especially in the eastern one-third. There is ample evidence that large reservoirs in association with grain-farming areas have delayed southward waterfowl migrations (White and Malaher 1964); but it is not known how far waterfowl species will fly in their daily feeding activities (Bossenmaier and Marshall, 1958). Although a waterfowl feeding habits study in relation to large reservoirs was beyond the scope of this initial investigation, the author felt that this information was vitally important to the overall research project. Therefore, basic information concerning crops and acreages of suitable waterfowl foodstuffs that were currently grown in reservoir vicinities was included.

Seasonal Inventory of Waterfowl Populations

The necessity to quantify reservoir influences on waterfowl populations required the investigator to obtain additional information on actual waterfowl utilization. Aerial surveys were conducted in order to measure total waterfowl numbers as well as species composition utilizing Corps structures. Flights were made over each eastern Oklahoma reservoir, on a biweekly basis, from October 1971 through April 1972 (Flights I-XII). Thus, the fall and spring migration periods and the wintering period were surveyed. On four occasions the investigator accompanied

personnel of the Oklahoma Department of Wildlife Conservation on their regularly scheduled flights for October, November, December, and January. Their flight plan was modified in order that all Corps reservoirs could be included in the survey.

The surveys were conducted in a Cessna 172 high-wing aircraft. On each flight the total visible number of birds as seen only by the investigator were tallied. Species of birds were also readily determined from the aircraft. In order to cover all reservoirs during a similar time period (0800-1200), each flight was divided into a two-day period. The northern one-half was covered first and the southern one-half the following day (Figure 2). All flights could not be made on schedule. Survey four was not attempted due to inclement weather. Survey seven was completed in the afternoons of the days indicated (1200-1700). Only the northern one-half of survey eight was completed due to subsequent inclement weather. Due to the expense of the surveys, and the relatively low numbers of waterfowl observed, Broken Bow, Pine Creek, and Tenkiller reservoirs were eliminated from the survey route following the second survey. Only 639 birds were seen on all three of these reservoirs on surveys one and two.

The numbers and species of birds counted were used to determine changes in species composition over time. Censuses were made on individual reservoirs, consequently the population figures were used as a measure of each reservoir's attractiveness to waterfowl. Where possible, the results of these surveys were compared to data obtained by state personnel in previous years. In addition, changes in species composition as determined by the survey were compared to the species composition of the waterfowl harvest as determined from bag checks.

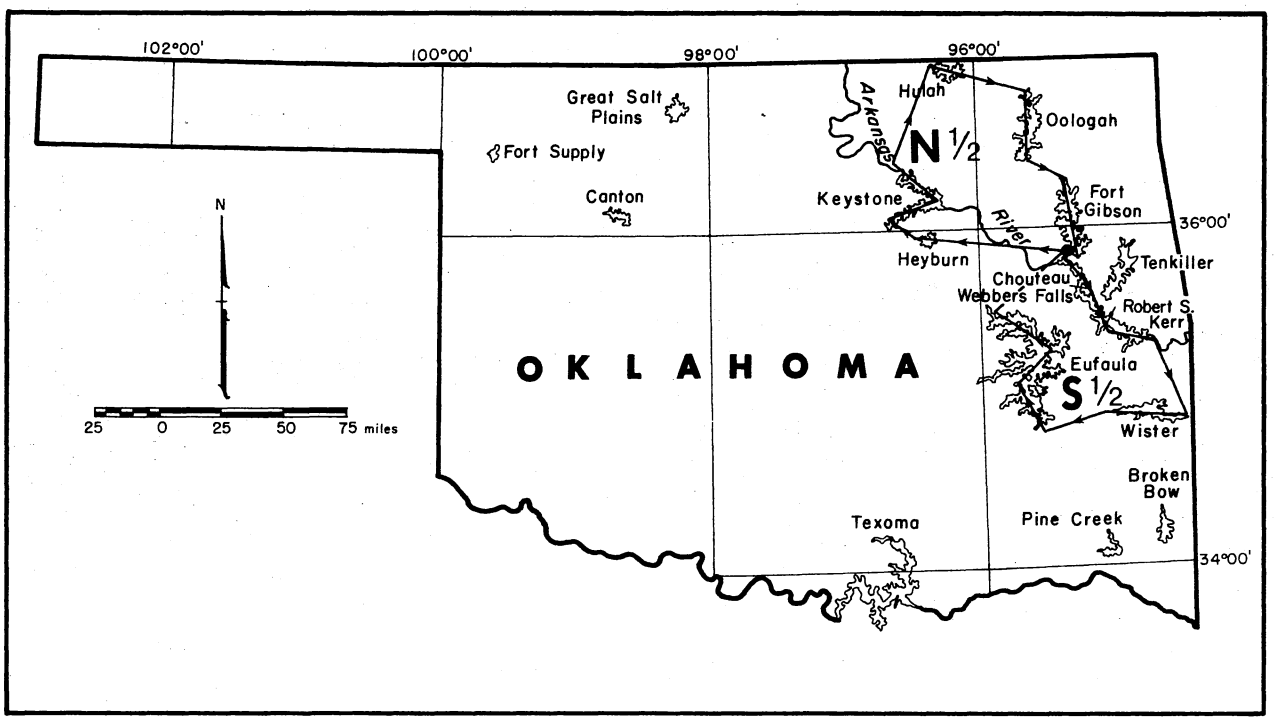


Figure 2. Flight Routes Used to Inventory Seasonal Waterfowl Population Changes Indicating Northern (N) and Southern (S) Halves of Each Survey

While flying over each reservoir, data were collected on hunter numbers and activities, and apparent bird behavior as affected by habitat characteristics, hunting activities, and changes in water levels.

Hunter Numbers, Success and Distribution

Several methods were employed to fulfill this objective, but in essence all stemmed from a personal interview approach. In this initial study an attempt was made to contact the maximum numbers of hunters that utilized eastern Oklahoma Corps reservoirs for waterfowl hunting during the current 1971-72 season. To this end, interviews were conducted by federal game management officers, Corps of Engineers reservoir rangers, and by the investigator. Two additional information sources were used. The Corps of Engineers issues duck blind permits (one per person) for their completed reservoirs and navigation projects, and this information was utilized. The second informational source was a post-hunting season mail-questionnaire that was sent to all persons who were interviewed, and to those people who had acquired duck blind permits.

Federal Game Officer and Reservoir Ranger Interviews

Federal game management officers travel over the entire state with a primary objective of contacting waterfowl hunters, and there are one to several Corps reservoir rangers on each Corps reservoir. The assistance of these persons would enable the investigator to obtain information on hunter numbers and distribution in the eastern part of the state, by actual field observation and/or contact by these people.

The three federal game officers in the state and all of the reservoir rangers stationed on Corps reservoirs in eastern Oklahoma were given hunter-check cards (Figure 3). The cards were designed so that all pertinent information could be easily recorded and then mailed to the investigator. Information made available from these cards included date and location of hunting, the number in the hunting party, their hunting success, and their names and addresses that could be used for the mail questionnaire at the end of the hunting season.

Interviews by the Investigator

The personal interview approach has been shown to be a reliable method of obtaining recreational use data (Wandell 1946, Hunter 1949, Crawford 1951, Shafer and Hamilton 1967). This method, therefore, was included in order to obtain accurate information regarding hunter numbers, success, and distribution. The technique allowed the investigator to obtain data free of individual hunter bias, because hunters were confronted while in the field, and little or no "memory" was required of the hunters.

For several reasons, two reservoirs (Eufaula, Robert S. Kerr) were chosen as sites for personal interviews. First, the aid of federal game officers and reservoir rangers would serve as the source of total hunter numbers and distribution information for other eastern Oklahoma reservoirs. Second, physical limitations prevented the investigator from covering all 13 reservoirs. All possible hunter access points on Eufaula and Robert S. Kerr reservoirs could not be continually observed. The access points where the maximum number of hunters could be contacted served as the locations for all investigator interviews (Figures 4, 5).

Ranger- 1
Date- Mon Day Year
___ ___ ____

Kill Data
No. of Ducks-_____
No. of Geese-_____
No. of coots-_____

Location - County-
Corps of Engineers Reservoir yes no (circle one)
Privately owned body of water yes no
Stream or River yes no

Hunter Names and Addresses

_____

_____

_____

_____

Ranger - 2

Kill Data

Reservoir-_____
Mon Day Year
Date - ___ ___ ____

No. of Ducks-___
No. of Geese-___
No. of Coots-___

Hunting from a registered blind yes no (circle one)
Using boat and/or motor yes no (circle one)

Hunter names and addresses (number of hunters if not interviewed)

_____

_____

_____

_____

Figure 3. Hunter Check Cards Provided for Federal Game Management Officers (1) and Reservoir Rangers (2)

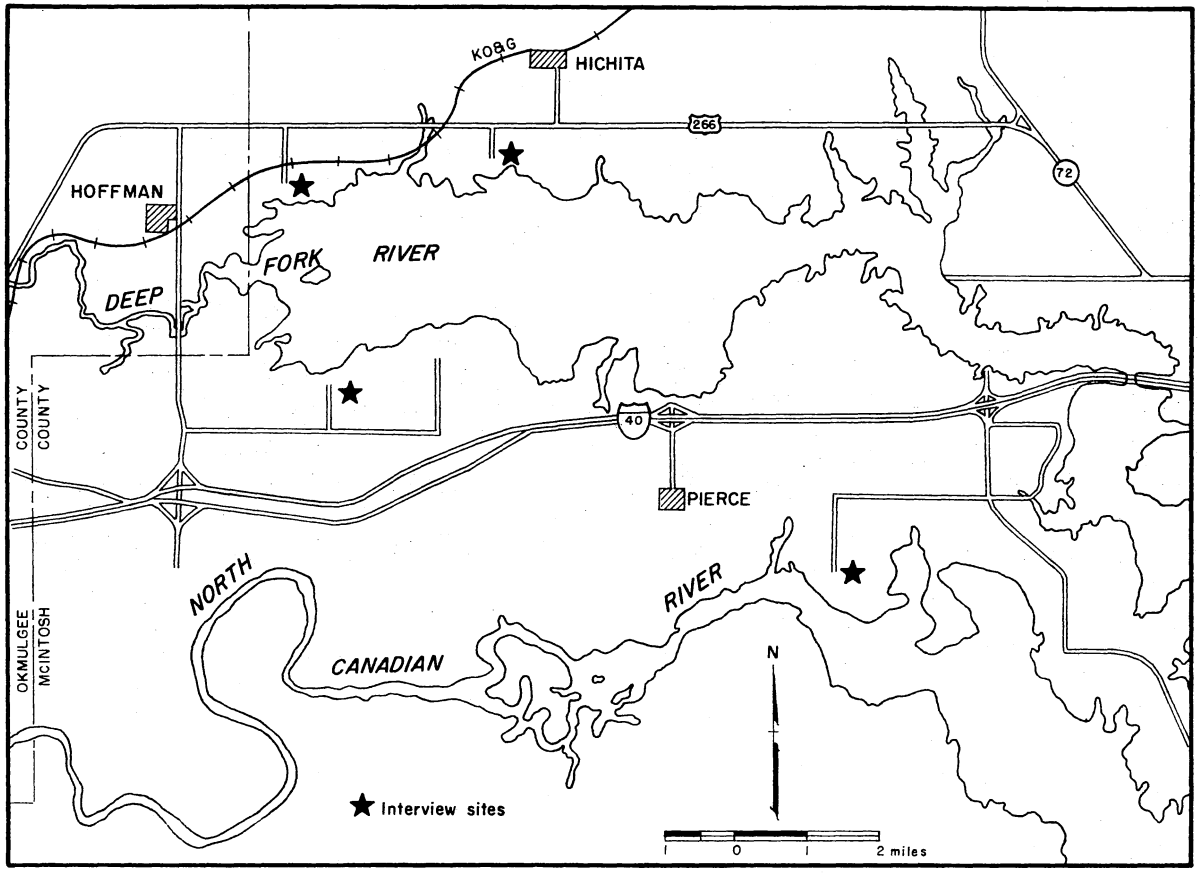


Figure 4. Hunter Access Sites Used to Obtain Personal Interviews on Eufaula Reservoir

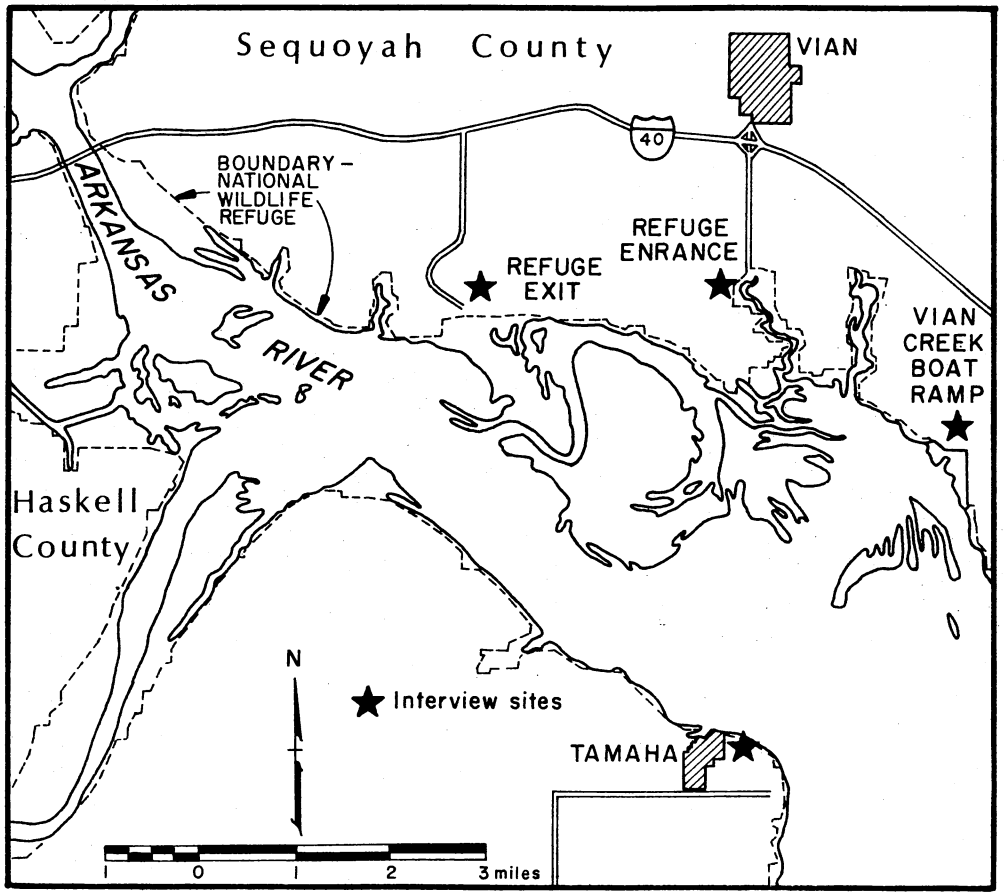


Figure 5. Hunter Access Sites Used to Obtain Personal Interviews on Robert S. Kerr Reservoir

These access points were predetermined with the aid of reservoir ranger personnel. Third, in order to obtain interviews from the maximum number of hunters, the two reservoirs that could best provide these data were chosen. Reservoir rangers and federal game management officers believed that these two reservoirs (Eufaula, Robert S. Kerr) would provide maximum contact with hunters. In addition, the proximity of these two reservoirs minimized the investigator's travel time between the two.

Interviews were conducted throughout the 1971-72 waterfowl hunting season including the early teal season (September 11-19) and the split regular season (October 16 - November 25, December 11 - January 8). Interviews were conducted on 35 days of the total 79 hunting days which included both weekdays and weekends. The interviews were conducted solely by the investigator excepting the opening weekend of the early teal season and part one of the regular duck season. Due to the volume of hunters on those two occasions, help was provided by Oklahoma Cooperative Wildlife Research Unit personnel.

The sites chosen for personal interviews were locations where the largest portion of hunters were known to enter the reservoir proper, either with boats or on foot. A check-station type of system was used in order to contact individual hunting parties. The investigator met the majority of hunters as they returned to their automobiles. Some hunting parties were contacted as they were going out to hunt, and these too were interviewed. Obviously, no kill information could be obtained from these individuals unless they were also seen when they completed their hunting for the day. Information was obtained also on hunting parties that were seen but not interviewed. The investigator often saw hunting parties on the reservoirs that had used different access

sites. In these cases, only data on the size of the hunting party could be obtained.

The size of individual hunting parties interviewed was determined simply by counting members. Hunting success (kill) data was acquired by clipping one wing from each bird bagged. This allowed for a total count of birds as well as determination of species composition of the kill. Additional information was obtained during the interview in an attempt to obtain more information about the population of waterfowl hunters utilizing Corps reservoirs. Questions regarding former hunting activities were included and the opportunity was provided for hunters to voice opinions about waterfowl hunting experiences on Corps reservoirs. The questions were asked of all hunters, regardless of their age. Similar information was also requested on the mail questionnaire survey following the hunting season; the interviews therefore, served as a partial check on responses to the questionnaire.

Duck Blind Permits

The United States Army Corps of Engineers issues duck blind permits (one per person) to persons who want to construct a temporary hunting blind on a Corps project. This practice is primarily for safety reasons, so reservoir personnel can contact blind holders to remove blinds in the event of rising water levels. This assures that no blinds become free floating hazards in the reservoir. For the hunter, registration for blind construction assures a specified hunting area unavailable to other persons. The permits are issued on a first come first serve basis. It should be emphasized, however, that only a portion of hunters utilizing Corps reservoirs actually register or use

a duck blind.

The duck blind registration system initiated by the Corps of Engineers provided the names and addresses of persons known to be active duck hunters on Corps projects. The inclusion of this "known" quantity of hunters was essential for the objectives of the project. In addition to providing hunter numbers on specific reservoirs, the addresses made it possible to include all duck blind registrants in the post-season mail questionnaire survey. Carbon copies of permits for all reservoirs for the 1971-72 hunting season were obtained from each Corps project in the state.

Mail Questionnaire

The mail questionnaire has been shown to be a reliable method of obtaining recreational use information. It is the primary means by which hunter data are obtained by the federal government and many states, including Oklahoma. Atwood (1956), and Sen (1973) pointed out that certain biases (usually positive) are involved with surveys of this type. However, it has also been shown that if an occasional 10 to 15 percent discrepancy from comparable personal interview values is acceptable, the mail questionnaire is a very reliable substitute (Shafer and Hamilton, 1967). The author also feels that this is an appropriate substitute due to the very large sample size obtainable and the relative inexpense as compared to the personal interviews. In addition, a post-season mail survey allows obtaining information for the entire season.

The Tulsa District of the U. S. Army Corps of Engineers provided all of the materials necessary for the mail survey. These included postage, a letter of explanation, the questionnaire, a postage-paid

pre-addressed return envelope, and a reminder postcard. The letter of introduction, although written by the investigator, was signed by the Chief of Operations of the Tulsa District (Figure 6). This was done in order to make the survey appear more formal and to elicit a larger response. The questionnaire was printed on standard government paper (8 x 10.5 inches [Figure 7]). An attempt was made to obtain the maximum amount of information, without ambiguities, and with minimum respondent effort by restricting the questionnaire to a single page.

The questionnaire was sent to four categories of people: (1) persons interviewed by reservoir rangers, (2) persons interviewed by federal game officers, (3) persons interviewed by the investigator, and (4) those persons who registered duck blinds with the Corps of Engineers. Each return envelope was coded with a small number (1, 2, 3 or 4) in order that responses could be differentiated according to source. Since it has been shown that a reminder card can significantly increase questionnaire response (Shafer and Hamilton, 1967), a postcard reminder was sent to all questionnaire recipients (Figure 8). The questionnaires were mailed on January 25, 1972 approximately three weeks after the close of the hunting season. The reminder cards were mailed February 11, 1972.

DEPARTMENT OF THE ARMY
TULSA DISTRICT, CORPS OF ENGINEERS
POST OFFICE BOX 61
TULSA, OKLAHOMA 74102

SWTOD-R

January 1972

Dear Sir:

One of the primary requirements in the sport of waterfowl hunting is a place to hunt. The construction of reservoirs by the United States Army Corps of Engineers has provided such places. In order to provide high quality hunting opportunities, the Corps of Engineers must have accurate information about existing hunting sites and activities. Only waterfowl hunters can provide this information.

Our records indicate that during the past hunting season you hunted at least once on a Corps of Engineers' reservoir. Consequently, from confidential information which you can provide on the attached questionnaire, biologists can make better recommendations for waterfowl management.

Would you please fill out all categories on the attached questionnaire, place it in the inclosed postage paid envelope, and mail it at your earliest convenience? The information you provide will go to Mr. Walter Gorham, a biologist on our staff. His job will be to summarize all responses and prepare a report on current waterfowl hunting practices, hunting success, and hunters' problems on Corps reservoirs.

The Oklahoma Department of Wildlife Conservation and the Bureau of Sport Fisheries and Wildlife also conduct sportsmen mail surveys. If, by chance, you are also selected for one or both of their surveys, please answer each of them. The information you provide is needed by each agency if you, other sportsmen, and the waterfowl resource are to benefit.

Thank you.

Sincerely yours,

Ira E. Williams

IRA E. WILLIAMS
Chief, Operations Division

2 Incl
As stated

Figure 6. Letter of Introduction for the Post-Hunting Season Mail Questionnaire

UNITED STATES ARMY CORPS OF ENGINEERS

Tulsa District

1971-72 CONFIDENTIAL WATERFOWL HUNTER SURVEY

IMPORTANT! - Please fill out the questionnaire as completely and as accurately as possible. Fill in the correct number, circle the best answer, or make a check mark, as indicated.

1. How many days did you hunt waterfowl this season? ____ days
   a. How many days did you hunt on Corps of Engineers reservoirs? _____ days
   b. The remaining days (if any) when you hunted on non-Corps land, this hunting took place on: (please circle each type on which you hunted and record the number of days on each)
   farm ponds____ rivers or streams____ agricultural land____ other_____ ____
   c. Which Corps reservoirs did you hunt on? (please circle each one you hunted on and record the number of times on each)
   Eufaula___ Webbers Falls___ Oologah___ Wister___ Heyburn___ Fort Gibson___
   Robert S. Kerr___ Lock & Dam 17___ Texoma___ Hulah___ Keystone___ Others___
   d. Please estimate the total number of hours you hunted on Corps of Engineers reservoirs. _____ total hours
   e. Please estimate the total number of hours you hunted waterfowl. _____ hours

2. What did you bag this year during the regular duck season?
   a. What did you bag on Corps reservoirs? total no. of ducks____ tot. no. geese_____
   b. When not on Corps land? total no. of ducks_____ total no. of geese_____
   (If you remember the numbers and kinds of birds you bagged, please list them on the back of this sheet. Please list those bagged on Corps land separately)

3. Did you hunt during the September Teal season? Yes No (circle one)
   a. How many days on Corps reservoirs? _____days. How many Teal?_____
   b. How many days on non-Corps land? _____days. How many Teal?_____

4. Is waterfowl hunting now: (check one) better____ about the same____ worse_____ than it was before Corps reservoirs were constructed in your area?

5. Has the construction of Corps reservoir(s) provided you (check one) more_____ same_____ fewer_____ places to hunt waterfowl in your area?

6. Since the construction of Corps reservoir(s) in your area do you hunt (check one) more_____ same_____ less_____ frequently than you did before their construction?

7. How many different persons did you hunt with during the year? _____different people
   a. How many people did you usually hunt with each time? _____person(s)
   b. How many members in your household also hunt waterfowl? _____person(s)

8. Was some type of aquatic vehicle used to hunt? Yes No Sometimes (circle one)
   a. What type of vehicle was it? boat amphibious vehicle air boat canoe (circle 1)
   b. How many times did you hunt on Corps land without such a vehicle? (walked in) _____ times

9. Did you use decoys while hunting? Every time Sometimes Not at all (circle one)

10. On the back of this page please list any comments, criticisms, and problems you have had concerning waterfowl hunting on Corps of Engineers reservoirs.

Figure 7. Post-Hunting Season Mail Questionnaire

Dear Sir:

Approximately three weeks ago you received a waterfowl hunter questionnaire from the United States Army Corps of Engineers. If you have not already filled out this questionnaire and returned it (to Walter E. Gorham, Oklahoma Cooperative Wildlife Research Unit, 404 LSW, Oklahoma State University at Stillwater, Oklahoma 74074), would you please do so at this time. If you have done so, please excuse this reminder.

Thank you again for your cooperation and your interest in the improvement of waterfowl populations.

Sincerely yours,

IRA E. WILLIAMS
Chief, Operations Division

Figure 8. Mail Questionnaire Reminder Card

CHAPTER V

RESULTS AND DISCUSSION

Background Information

Migratory Bird Populations Station

Duck Stamps. If the assumption can be made that migratory bird stamp sales (duck stamp sales) accurately reflect statewide waterfowl hunting pressure, then little change in this pressure was noted over the period 1934-47 as compared to the period 1958-71 (Table I). The 14 year average showed only a 10.2 percent increase in sales during the later period. This minor increase could be accounted for on the basis of changes in total human population if an additional assumption can be made; this being that the proportion of the human population that purchases duck stamps is relatively constant. The state population in 1940 was 2,336,000 while in 1970 it was 2,559,000 (USDC 1973). This increase in population was 9.5 percent which closely approximates the 10.2 percent increase in stamp sales.

These preceding figures were noted in spite of the fact that the majority of the Corps of Engineers reservoirs were constructed since the 1934-47 stamp sales period (Table I). It is apparent that the construction of 13 reservoirs and establishment of the associated public hunting land had little effect on total waterfowl hunting pressure within the state. This fact does not, however, negate the possibility

TABLE I

MIGRATORY BIRD STAMP SALES FOR OKLAHOMA 1934-1947[a] AND 1958-1971[b]
AND THE COMPLETION DATES FOR OKLAHOMA CORPS RESERVOIRS

Year	Reservoirs constructed	Number of stamps sold	Year	Reservoirs constructed	Number of stamps sold
1934		27,862	1958		51,831
1935		8,824	1959		43,458
1936		5,967	1960		30,664
1937		21,005	1961		30,553
1938		19,675	1962		23,692
1939		19,740	1963	Oologah	14,204
1940		25,199	1964	Eufaula, Keystone	19,567
1941	Great Salt Plains	28,769	1965		21,222
1942	Fort Supply	29,443	1966		20,057
1943		19,974	1967		24,405
1944	Texoma	32,442	1968		33,140
1945		37,851	1969	Pine Creek, Broken Bow	29,654
1946		48,823	1970		29,654
1947		33,935	1971	Robert S. Kerr, Webbers Falls, Chouteau	28,809
		$\bar{x}$ = 25,679			$\bar{x}$ = 28,300

1948-1957: Canton (1948), Wister (1949), Heyburn (1950), Tenkiller (1952), Fort Gibson (1953)

[a]Data from Oklahoma Game and Fish Department Biennial Report July 1, 1946 to June 30, 1948.

[b]Data provided in mimeograph form from the Migratory Bird Populations Station, Laurel, Md.

that hunter concentration increased in specific reservoir areas. Duck stamp sales information from reservoir areas revealed that this is possibly the case.

Five reservoirs were completed between 1958 and 1971 that allowed for an analysis of duck stamp sales over a five year time period. The reservoirs were Broken Bow, Eufaula, Keystone, Oologah, and Pine Creek. The yearly stamp sales averages for the two years preceeding reservoir construction and the two years after completion are given in Table II. Also included are the percentages of change in human populations, in the counties in which the reservoirs lie, over the five year time period. The data show that with each reservoir there was a 40-160 percent increase in sales while the human population increased a maximum of 30 percent. It is noteworthy that during the same time periods, statewide duck stamp sales decreased or remained nearly constant (Table I). It is not known if the increase in sales in local areas was due to increased purchases by local residents or by visitors to these areas that had come to hunt. In either case, if an additional assumption can be made that duck stamp purchasers tend to hunt in the area where duck stamps are acquired, hunting pressure did become more concentrated in reservoir areas after construction.

Band Returns. In addition to duck stamp sales data, waterfowl band return information was obtained from the MBPS. With this information, an attempt was made to document changes in band return characteristics for pre- and post-construction periods for each reservoir in the state. Waterfowl banding began early in this century, but was not carried out in a large scale, at least with mallards (Anas platyrynchos), until 1922 (Anderson and Henny 1972). As with

TABLE II

CHANGES IN THE VOLUME OF DUCK STAMP SALES AND IN HUMAN POPULATIONS FOR THE TWO YEARS PRIOR TO AND AFTER CONSTRUCTION FOR SELECTED CORPS RESERVOIRS IN OKLAHOMA

Reservoir	Two year average sales		Percent change	Human population percent change[a]
	Before construction	After construction		
Broken Bow	118	300	156	30
Eufaula	537	1265	136	4
Keystone	2358	3451	46	25
Oologah	275	380	38	21
Pine Creek	172	435	153	29

[a]Data from U.S.D.C., 1973. Characteristics of the population--Oklahoma.

many states, the mallard is Oklahoma's principle wintering species of wildfowl. Hence, band return quantities for this study, for pre- and post-construction periods, were based upon the years 1922 to date of completion and completion date through 1970.

The number of returns and percentages of total returns for each reservoir, pre- and post-construction, are indicated in Table III. Nine of 13 reservoirs showed an increase in the number of returns. In only four cases, Eufaula, Pine Creek, Oologah and Keystone, were more returns reported prior to reservoir construction. However, noting the age of these reservoirs, little time had elapsed in which band returns could accrue. The percentages of total returns show the relative portion of returns that have occurred since construction; nearly all returns in some instances. Post-construction recoveries amounted to 78.4 percent of all band returns.

Rate of band returns may be more indicative of reservoir influences than total return numbers. Band return dates (returns/year) from all areas increased noticeably after construction (Table IV). Return rate increases ranged from three fold (Heyburn) to over 100 fold (Great Salt Plains). Overall, a nearly 10 times greater post-construction return rate average was noted for all reservoirs. Portions of two reservoirs, however, Great Salt Plains and Lake Texoma, harbor national wildlife refuges upon which waterfowl are concentrated. Consequently, data which includes these reservoirs are biased upward. But, neither refuge contains the entire reservoir. Also, reservoir construction preceeded refuge initiation in both cases and band return rate increases were noted on reservoirs without such refuges. Therefore, data concerning these two Corps structures were included.

TABLE III

WATERFOWL BAND RECOVERIES FROM CORPS RESERVOIR AREAS IN OKLAHOMA (PRE-CONSTRUCTION - 1922 TO YEAR OF COMPLETION, POST-CONSTRUCTION - COMPLETION YEAR THROUGH 1970). PERCENTAGES OF TOTAL RECOVERIES FOR EACH PERIOD ARE INDICATED

Reservoir	Completion Date	Band Recoveries			
		Pre-construction		Post-construction	
		Number	% of total	Number	% of total
Great Salt Plains	1942	6	0.6	974	99.4
Lake Texoma	1944	19	2.5	726	97.5
Wister	1949	9	14.8	52	85.2
Fort Supply	1950	1	6.3	15	93.7
Heyburn	1950	5	35.7	9	64.3
Hulah	1951	3	6.0	47	94.0
Tenkiller	1952	15	12.5	105	87.5
Fort Gibson	1953	89	30.3	205	69.7
Canton	1956	2	20.0	8	80.0
Oologah	1963	91	70.5	38	29.5
Eufaula	1964	230	51.2	219	48.8
Keystone	1964	44	78.6	12	21.4
Pine Creek	1969	7	63.6	4	36.4
	Totals	521	21.6	2414	78.4

TABLE IV

WATERFOWL BAND RECOVERY RATES FROM CORPS RESERVOIR AREAS IN OKLAHOMA (PRE-CONSTRUCTION - 1922 TO YEAR OF COMPLETION, POST-CONSTRUCTION - COMPLETION YEAR THROUGH 1970)

Reservoir	Completion Date	Band Recovery Rate (returns/year)	
		Pre-construction	Post-construction
Great Salt Plains	1942	0.30	33.59
Eufaula	1974	5.48	31.28
Lake Texoma	1944	0.86	26.89
Fort Gibson	1953	2.87	11.39
Tenkiller	1952	0.50	5.53
Oologah	1963	2.22	4.75
Wister	1949	0.35	2.26
Hulah	1951	0.11	2.24
Pine Creek	1969	0.15	2.00
Keystone	1964	1.05	1.71
Fort Supply	1950	0.04	0.71
Canton	1956	0.06	0.53
Heyburn	1950	0.18	0.43
	$\bar{x}$ returns/year	1.08	9.48

Differences were noted in the species composition of kill after reservoir construction (Table V). The data indicated only relative changes because the number of banded birds that could potentially use these reservoir areas was unknown. Most species showed little change, but there were some exceptions. Mallard returns increased in proportion to total returns. Wood duck (Aix sponsa) returns, however, increased by a factor of 10 which is greater than would be expected. The flooding of green timber early in a reservoir's life, thereby creating excellent wood duck habitat, may at least partially explain this increased use as reflected in band returns. The unusually high post-construction increase in Canada goose (Branta canadensis) kill is due almost entirely to the hunting provided in the vicinity of Great Salt Plains and Tishomingo National Wildlife Refuges. The increased snow/blue goose (Chen caerulescens) kill is noteable because of the location of their harvest. Their increase was dispersed over seven of 13 reservoirs, not just near the reservoirs containing national wildlife refuges.

Discrete changes in bird origins could not be detected at this time. The majority of birds, both prior to and since construction, originated from southern Saskatchewan and Alberta, Canada and North and South Dakota. There appeared to be a slight increase in recoveries of birds which were banded in Kansas and Nebraska. Possibly this is explained by increased banding efforts during migration periods.

Waterfowl band return rates have been used primarily to compare reported versus unreported band returns by hunters (Bellrose 1955, Atwood and Geis 1960, Geis and Atwood 1961). The use of return rates to pinpoint specific areas of bird origin in order to detect differences

over time has probably not been used because of the inherent problems involved. Are changes in return characteristics (rates, species changes, origin shifts) indicative of true area changes or simply functions of changes in the quantity of banding or hunting pressure? The many variables associated with band return analyses severely limit their speculative value. For example, the number of banded birds that could potentially be recovered from a reservoir area in Oklahoma is unknown. The total number of birds banded over the entire continent would not eliminate this variable. A bird banded in Maine could potentially be recovered in Oklahoma, but this would be unlikely. In this study, no assumptions were made about these factors; only that the number of returned bands do indicate relative changes in the magnitude of bird movements in reservoir areas.

TABLE V

WATERFOWL BAND RETURN TOTALS FOR SELECTED SPECIES THAT WERE RECOVERED IN OKLAHOMA IN CORPS RESERVOIR AREAS BEFORE AND AFTER CONSTRUCTION

Species	Pre-construction	Post-construction
Mallard (*Anas platyrynchos*)	346	1206
Wood Duck (*Aix sponsa*)	8	78
Snow/Blue goose (*Chen caerulescens*)	20	74
Canada goose (*Branta canadensis*)[a]	10	853

[a]Includes all subspecies.

The use of band return data for monitoring waterfowl numbers and species changes in reservoir areas may be debated. Crissey (1955) stated that data resulting from banding during migration periods are not recommended as a means of determining migration and distribution. But, this may be exactly what is needed in order to understand the influences of reservoirs on waterfowl. Crissey (1955) also mentioned that many authors have assumed that a band returned from one location means the same as a band returned in another. With the advent of large water impoundments, and more being constructed each year, it may be that a band returned from the same location as another, but at a later time, may now take on a different meaning. Hunters now enjoy greater mobility and also have access to new public hunting lands previously unavailable due to private land holdings. Reservoir construction has resulted in increased harvest rates of banded birds in reservoir areas. The increased harvest rates are most likely due to an increased utilization of reservoir areas by both waterfowl and by hunters.

United States Army Corps of Engineers

The information regarding physical attributes and operating procedures of Corps reservoirs was obtained from the district office of the U. S. Army Corps of Engineers, Tulsa, Oklahoma, personal interviews with reservoir managers, and reservoir description brochures that were available for each reservoir in the state. Although many and varied facts were obtained, those specific characteristics deemed most directly related to waterfowl and hunter use were most actively sought. These included age, size, water depth, and shoreline length (Table VI). Operating procedures on individual reservoirs such as hydroelectric

TABLE VI

SELECTED PHYSICAL CHARACTERISTICS OF THE COMPLETED CORPS RESERVOIRS IN OKLAHOMA[a]

Reservoir	Age (years)[b]	Shoreline length (miles)	Flood Pool			Conservation (normal) Pool			Hydroelectric power	Navigation	Waterfowl management
			Surface acres	Storage volume (acre/ feet)	Average water depth (feet)[c]	Surface acres	Storage volume (acre/ feet)	Average water depth (feet)			
Broken Bow	3	180	18,000	918,800	51.0	14,200	450,000	31.7	+	-	-
Canton	24	45	15,800	267,600	16.9	7,900	118,400	15.0	-	-	-
Chouteau	2	65	----	----	--	1,190	17,300	14.5	-	+	-
Eufaula	8	600	143,000	1,481,000	10.4	102,500	1,470,000	14.3	+	-	-
Fort Gibson	19	225	51,000	919,200	18.0	19,100	365,200	19.1	+	-	+
Fort Supply	29	26	5,730	90,700	15.8	1,800	11,100	6.2	-	-	+
Great Salt Plains	30	41	28,240	280,200	9.9	8,890	37,500	4.2	-	-	+
Heyburn	22	50	3,700	49,100	13.3	980	8,200	8.4	-	-	-
Hulah	11	62	13,000	257,900	19.8	3,600	33,400	9.3	-	-	+
Keystone	8	330	55,400	1,879,000	33.9	26,300	663,000	25.2	+	-	-
Oologah	9	75	43,200	936,000	21.7	5,850	58,000	9.9	-	-	-
Pine Creek	3	74	17,200	412,000	24.0	3,800	53,800	14.2	-	-	-
Robert S. Kerr	2	250	----	----	--	42,000	493,000	11.8	+	+	+
Tenkiller	19	130	20,800	641,000	30.8	12,500	589,800	47.2	+	-	-
Texoma	28	580	143,300	2,666,000	18.6	89,000	1,613,000	18.8	+	-	+
Webbers Falls	2	157	----	----	--	10,900	165,200	15.2	+	+	-
Wister	23	115	23,000	400,000	17.4	4,000	30,000	7.5	-	-	+

[a]Information obtained from U. S. Army Corps of Engineers reservoir brochures.

[b]From year of completion to 1972.

[c]Calculated by dividing storage volume by surface area (acre/feet ÷ acres).

power generation, commercial navigational use, and active state or federal waterfowl management activities were also documented.

The physical characteristics of Corps reservoirs in Oklahoma obviously influenced their use by waterfowl. Whether this influence was due to provision of food, cover, or other biological needs is unknown. However, an attempt to correlate these characteristics with the quantity of waterfowl use during the current wintering period is included in the waterfowl census section of this thesis (page 56).

The operating procedures on reservoirs conceivably influence waterfowl and hunter use in several ways. Hydroelectric power generation substantially alters surface acreages and water depth on reservoirs. This in turn affects the amount and quality of cover (Figures 9, 10) and possibly the type and amount of submergent vegetation as well. Commercial navigation use by large vessels and barges poses a disturbance threat to waterfowl and hunters. Such vehicles observed by the investigator did not appear to alter waterfowl or hunter behavior. Navigational use of reservoirs does insure that constant water levels will be maintained. Robert S. Kerr (Lock and Dam 15), Webbers Falls (Lock and Dam 16), and Chouteau (Lock and Dam 17) had mean monthly water level fluctuations of 4.1, 4.0, and 4.2 feet from January 1969 through initiation of navigational use in January 1971. From January 1971 through June 1972 the mean fluctuations were only 0.5, 0.4 and 0.5 feet, respectively. This unique situation of relatively constant water levels on these reservoirs will undoubtedly have a large impact on the aquatic vegetation in and around these structures. Waterfowl management activities also influenced the number of wintering birds (see page 45).

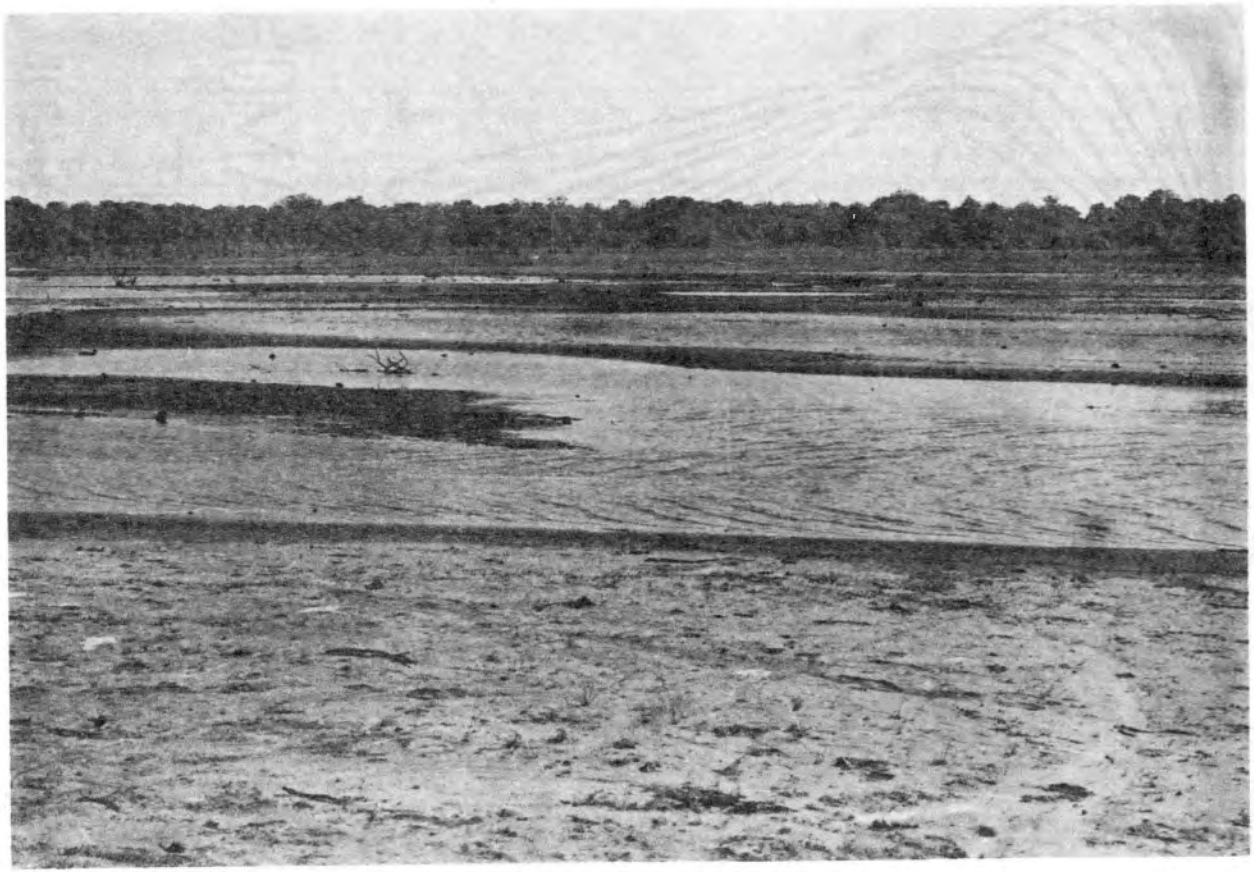


Figure 9. Large Denuded Area Exposed on Eufaula Reservoir Due to the Lake Water Level

Figure 10. Smartweed Growth Along the Water Edge of Eufaula Reservoir

The Corps of Engineers district office provided information on water level fluctuations from January 1969 through June 1972 on all reservoirs in Eastern Oklahoma. Readings taken at the dam site the first and fifteenth day of each month at 0800 were used to calculate the mean amount of water level change (feet/month) and the maximum change for any one month (Table VII). The tremendous amount of water level change, over 30 feet in some cases, can have several effects on a reservoir. For example, a denuded flat may last for several weeks (Figure 9). Proper timing of mud flat exposure, however, can mean that extensive areas of suitable waterfowl feed such as smartweed (Polygonum hydropiperiodes) will become available (Figure 10). Planned manipulation of the water levels on large reservoirs may be the single most practical and economical waterfowl management tool available. Currently this practice is not carried out on Oklahoma reservoirs, except for small state and federal management areas on some reservoirs.

Analysis of the duck blind permit information that also was provided by the Corps of Engineers is included with the hunter numbers, success, and distribution analyses (page 70).

Oklahoma Department of Wildlife Conservation

Waterfowl Surveys. The total number of ducks and geese in Oklahoma, based on four monthly population surveys (mid-October, November, December, and early January), are indicated in Table VIII. This information, included in Pittman-Robertson Annual Reports, was obtained by game rangers, refuge managers, and state biologists, who conducted ground counts and aerial surveys. It was difficult to determine how the data were gathered for some years, especially prior to 1965. The lack of

TABLE VII

MEAN MONTHLY WATERLEVEL FLUCTUATIONS AND MAXIMUM FLUCTUATIONS FOR COMPLETED CORPS RESERVOIRS IN OKLAHOMA FROM JANUARY 1969 THROUGH JUNE 1972

Reservoir	Mean water level fluctuation	Maximum water level fluctuation
	Feet/month	Feet
Pine Creek	5.5	32.0
Tenkiller	3.0	8.1
Wister	2.9	29.4
Oologah	2.8	19.0
Chouteau	2.7	22.8
Kerr	2.6	17.3
Broken Bow	2.4	30.2
Webbers Falls	2.4	9.9
Keystone	1.8	16.1
Hulah	1.6	13.1
Eufaula	1.1	5.5
Fort Gibson	1.1	4.3
Texoma	0.9	4.3
Canton	0.8	4.8
Heyburn	0.5	6.7
Fort Supply	0.2	0.7
Great Salt Plains	0.2	1.6

TABLE VIII

WATERFOWL SURVEY POPULATION TOTALS AS DETERMINED BY THE OKLAHOMA DEPARTMENT OF WILDLIFE CONSERVATION DURING MID-OCTOBER, NOVEMBER, DECEMBER, AND EARLY JANUARY FOR THE YEARS 1950-1971

Year	Number of Ducks	Number of Geese
1950-51	1,031,994	155,458
1951-52	760,756	211,567
1952-53	629,055	157,099
1953-54	771,614	255,666
1954-55	629,307	189,602
1955-56	922,409	207,606
1956-57	No Survey	No Survey
1957-58	117,380	37,556
1958-59	258,678	35,994
1959-60	339,787	90,471
1960-61	No Survey	No Survey
1961-62	No Survey	No Survey
1962-63	482,485	167,437
1963-64	491,661	194,503
1964-65	654,930	152,092
1965-66	570,760	124,216
1966-67	567,090	115,675
1967-68	629,921	135,849
1968-69	421,189	121,363
1969-70	579,654	150,073
1970-71	594,821	170,345

data gathering uniformity and the inclusion of values for the entire state severely restricted the usefulness of the population data. Also, it was not until 1965 that waterfowl numbers were included for specific Corps of Engineer reservoirs considered in this study. And, at this time, only seven eastern Oklahoma reservoirs were included; namely Eufaula, Fort Gibson, Hulah, Keystone, Oologah, Tenkiller, and Wister.

Prior to 1965, state waterfowl surveys ended with the December counts. In 1965 the early January flight was added to the survey and it revealed that peak waterfowl numbers were in the state at that time. The investigator's aerial survey data showed peak numbers in late January and February, three weeks after the close of the hunting season. Possibly this has been the case all along; only through standardization of data gathering techniques has the true situation been revealed.

It was not always possible to determine the species composition of surveyed waterfowl in Pittman-Robertson reports. The mallard was the major wintering species of duck in the years prior to 1965. After 1965, the percentage of total duck numbers comprised by mallards ranged from 85.6 to 96.0. This investigator's data revealed only 69.4 percent. This may be explained by the fact that the investigator's surveys did not include all of the state. Second, the investigator's surveys included flights early in October and flights in February, March, and early April. On these early and late season flights a high percentage of non-mallard species were using the reservoirs, apparently for resting during migration. The lack of survey flights during early and late migration periods apparently biased state species composition data because they missed these non-mallard migrants.

Hunter Harvest. Waterfowl hunter success data for the years 1950-1970 were obtained from Pittman-Robertson annual reports. These data, in turn, were obtained from a mail questionnaire survey conducted by the Oklahoma Department of Wildlife Conservation. A presumably random sample of approximately 10 percent of the entire Oklahoma hunter population was routinely mailed questionnaires. Approximately three percent of statewide waterfowl hunter population generally responded. A direct comparison of state waterfowl hunter success data to that obtained by the investigator is not valid, because Corps of Engineer reservoirs are not distributed randomly over the entire state. However, a comparison of statewide totals obtained through the state questionnaire survey, compared to values obtained in this study from Corps reservoirs, did reveal substantial differences. The number of ducks and geese harvested per hunter as indicated by state questionnaire data are included in Table IX. Analagous data from the investigator's questionnaire survey are discussed in the hunter success section (page 74). It will be shown that hunter success on Corps reservoirs was substantially greater.

Waterfowl Management. According to Pittman-Robertson annual reports, a waterfowl management program is being conducted in Fort Gibson, Hulah, and Wister reservoirs by the Oklahoma Department of Wildlife Conservation. This program includes a share-cropping program whereby local residents may plant crops on the management area. The crops must be suitable waterfowl foodstuffs, such as corn (Zea mays) or grain sorghum (Sorghum bicolor). Upon harvest, the sharecropper must leave 40 percent of the crop standing. The second management activity consists of constructing low water dikes around crop acreages for the

TABLE IX

WATERFOWL HUNTER SUCCESS AS DETERMINED BY THE OKLAHOMA DEPARTMENT OF WILDLIFE CONSERVATION FOR THE YEARS 1950-1971[a,b]

Year	Ducks		Geese	
	Ducks per hunter per year	Total state harvest	Geese per hunter per year	Total state harvest
1950-51	8.5	---	0.3	---
1951-52	14.7	---	0.3	---
1952-53	---	---	0.5	---
1953-54	10.5	---	---	---
1954-55	9.9	---	0.5	---
1955-56	11.4	---	0.3	---
1956-57	---	---	0.3	---
1957-58	7.6	167,034	---	---
1958-59	6.3	167,330	---	---
1959-60	4.8	121,075	1.4	10,886
1960-61	4.3	90,855	1.5	14,238
1961-62	5.5	96,850	1.2	9,827
1962-63	1.3	12,911	1.5	14,054
1963-64	4.9	36,938	2.1	10,463
1964-65	6.1	83,439	1.4	10,519
1965-66	6.4	89,414	1.6	11,457
1966-67	8.1	147,987	0.9	7,650
1967-68	8.0	184,964	1.5	13,301
1968-69	5.7	109,868	0.6	5,047
1970-71	8.3	226,904	1.2	13,786

[a]Data from Pittman-Robertson Annual Reports - Oklahoma.

[b]Data were not available for all years.

purpose of flooding these during the waterfowl wintering period (Figure 11). The goal is to provide food for these birds and to encourage them to remain for the winter. In addition, a Canada goose stocking program has been initiated on Fort Gibson Waterfowl Management Area in an attempt to establish a local flock and to encourage more migrating geese to stop.

As mentioned earlier by Wiebe et al. (1950), only through management practices such as those just mentioned can a reservoir realize its greatest potential for waterfowl utilization. However, they can only be of value if conscientiously applied. During the course of this study both of the previously mentioned management practices were conducted only on Fort Gibson reservoir. It appeared that the sharecropping program was initiated, but the land not inundated as scheduled on Hulah and Wister reservoirs. The diked area on Wister reservoir was inundated once during the year, but this was due to an unforseen lake level rise that covered the diked area to such an extent that it could not be located from the air. It appears to the investigator that such rising lake levels could be put to an advantageous use with a minimum of proper planning. With proper timing of water releases by the Corps of Engineers, as directed by the state game department, areas within the flood plain could be inundated on a scheduled basis thereby realizing the greatest potential of controlled water levels.

United States Department of Agriculture

The feeding habits of migratory waterfowl utilizing Corps reservoirs is largely unknown. Agricultural land may play a large role in these feeding habits. The types and acreages of suitable waterfowl

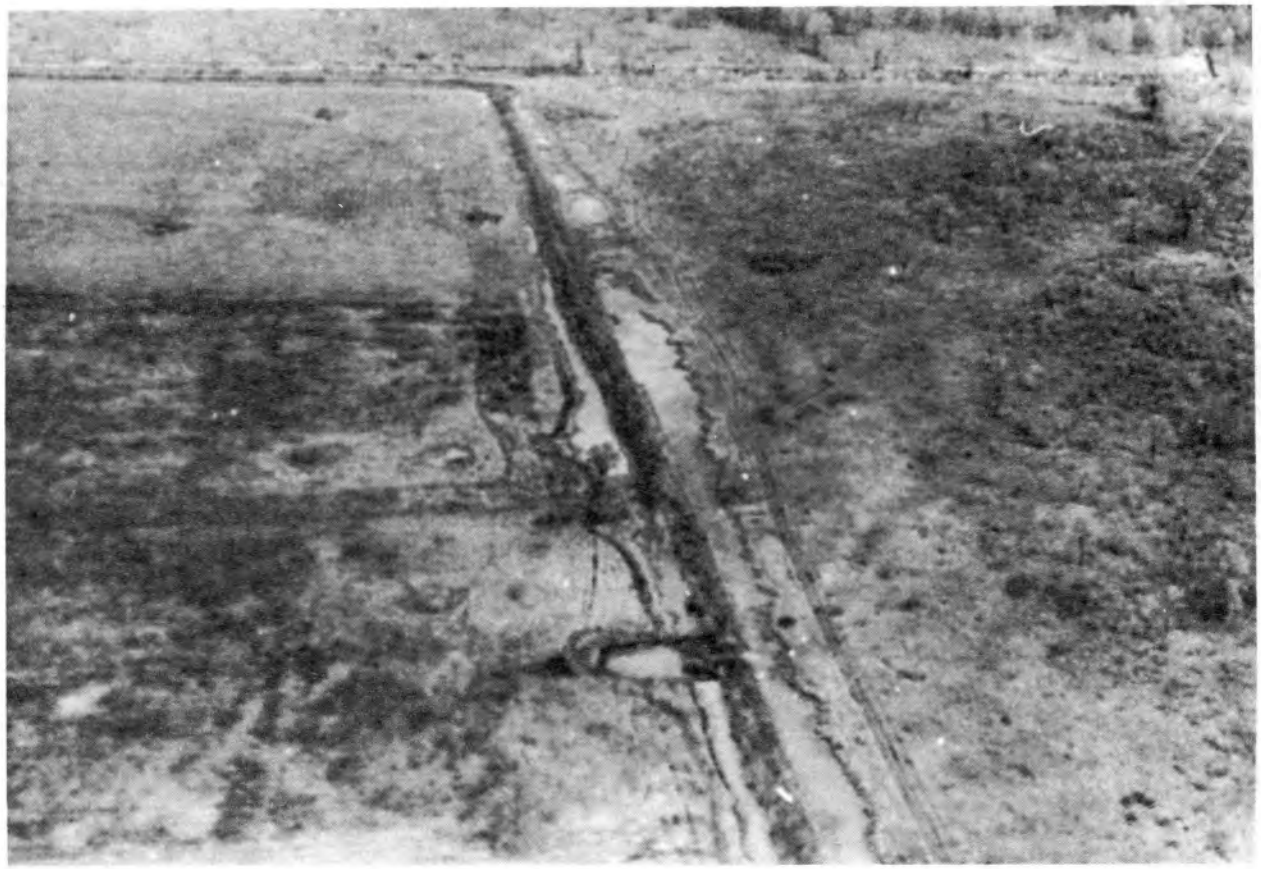


Figure 11. Diked Area of Wister Reservoir Utilized for Flooding Agricultural Crops During Waterfowl Wintering Period

foodstuffs would have a significant bearing on waterfowl usage. Crop acreage information relating to suitable waterfowl feeds that were currently being grown in eastern Oklahoma are indicated in Table X.

Field feeding by waterfowl has been reported in Oklahoma (Landes 1961), and has been observed by the investigator. Wheat (Triticum spp.) depredation problems have occurred in Oklahoma (Lemuel Due, personal communication). The investigator has observed waterfowl feeding in peanut (Arachis hypogaea) fields in western Oklahoma. No field feeding by waterfowl was observed during aerial surveys of reservoirs, except in the management area of Fort Gibson reservoir where corn and grain sorghum were being consumed. Waterfowl were observed feeding on soybeans (Glycine max) along the roadside near Robert S. Kerr reservoir.

The total land acreage represented by the three regions included in Table X amounts to approximately 32 percent of the state. Soybean acreage for these three regions, however, amounted to 94.6 percent of the state's total soybean acreage. Since soybeans are best adapted to alluvial soils, and this soil type predominates in reservoir locals, the potential is present for providing an excellent food source that could be readily inundated for maximum waterfowl use.

Seasonal Inventory of Waterfowl Populations

Aerial survey data obtained specifically for purposes of this study are presented in an Appendix. Incidental species of waterfowl observed included Bufflehead (Bucephala albeola), Cinnamon Teal (Anas clangula), and Ruddy Duck (Oxyura jamaicensis). However, these species and unidentified waterfowl accounted for less than two percent of all birds observed and were not included in tabular form.

TABLE X

REGIONAL ACREAGES AND PERCENTAGES OF STATE TOTAL ACREAGES FOR FIVE SELECTED FOODSTUFFS SUITABLE FOR WATERFOWL UTILIZATION THAT WERE GROWN IN OKLAHOMA IN 1970 IN THE PRIMARY STUDY AREA[a]

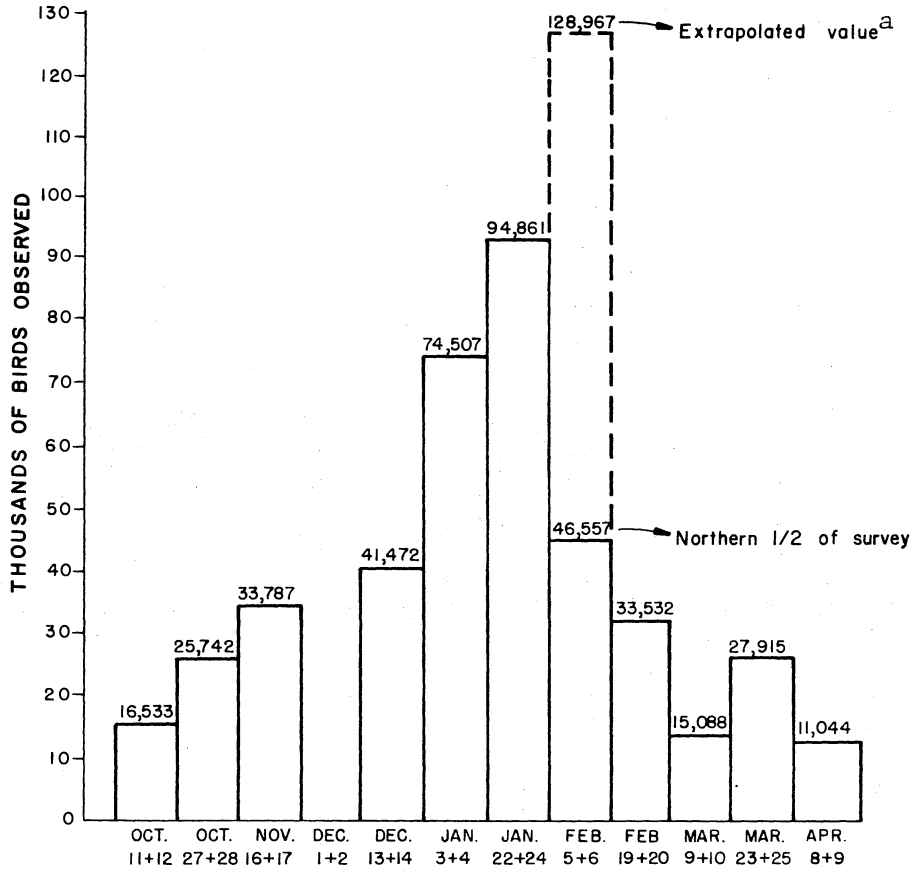
Crop	Acreages				Percentage of total state production
	Northeast Oklahoma	East Central Oklahoma	Southeast Oklahoma	Total	
Corn (Zea mays)	12,000	6,000	1,500	19,500	3.5
Peanuts (Arachis hypogaea)	20	22,330	3,530	25,850	19.5
Sorghum (Sorghum bicolor)	90,400	39,800	4,000	134,200	14.3
Soybeans (Glucine max)	86,500	76,600	26,100	189,200	94.6
Wheat (Triticum spp.)	150,400	17,100	3,800	171,300	21.2

[a]Oklahoma Agriculture - 1971 by the U.S. and Oklahoma Departments of Agriculture.

In addition to recording the total numbers of waterfowl using Corps reservoirs, documentation of migration timing was an important aspect of the aerial surveys (Figure 12). Landes (1961), Dobson (n.d.) and Pittman-Robertson reports prior to 1965 indicated that peak waterfowl numbers occurred in November and December. Since 1965 the Pittman-Robertson reports showed peak waterfowl numbers in early January. Surveys by the investigator revealed peak waterfowl numbers in late January and early February.

Species composition was another important aspect of the population surveys. Ducks far outnumbered geese and coots, each by a ratio of 25:1. The mallard was by far the most abundant species, and represented 63.7 percent of all birds observed or 69.4 percent of all ducks (Table XI). The biweekly percentages of total duck numbers comprised by mallards is indicated in Figure 13. Similar to the findings of Landes (1961), the common merganser ranked second in abundance with 10.9 percent. The merganser was unique in that it was first noticed on the reservoirs in large numbers on survey seven. This was approximately one week after the close of the hunting season. Non-mallard species were most abundant in October and March. It appears that these birds utilized reservoirs predominantly for resting during migration. Puddle ducks comprised 84 percent of total duck numbers while divers comprised only 14 percent. Nearly 90 percent of all divers were mergansers.

Robert S. Kerr reservoir was the most attractive to waterfowl based on total number of birds observed during aerial surveys (Table XII). In addition, this same reservoir was the most attractive to ducks, Fort Gibson to geese, and Oologah to coots. The large numbers



[a]Only the northern one-half of this survey was conducted, but this extrapolated value was included because the southern one-half routinely provided 64 percent of total bird numbers.

Figure 12. Timing of Waterfowl Migration Based on Bi-weekly Surveys

TABLE XI

TOTAL NUMBERS OF BIRDS OBSERVED AND PERCENTAGES OF TOTAL BIRDS COMPRISED BY EACH SPECIES FROM BIWEEKLY AERIAL SURVEYS OF EASTERN OKLAHOMA CORPS RESERVOIRS FROM OCTOBER 1971 TO APRIL 1972

Species	Total number observed	Percentage of total observed
Mallard	270,006	63.7
Merganser	46,161	10.9
Gadwall	34,101	8.0
Greenwing teal	12,310	2.9
Scaup	5,713	1.4
Widgeon	5,659	1.3
Shoveler	4,971	1.2
Pintail	4,569	1.1
Bluewing teal	3,302	0.8
Wood duck	1,337	0.3
Redhead	554	0.1
Canvasback	82	tr
Total ducks	388,765	92.3
Coot	16,960	4.0
Snow/Blue	10,664	2.5
Canada	4,538	1.1
White-fronted	131	tr
Total geese	15,333	3.6
Total birds	421,058	99.9

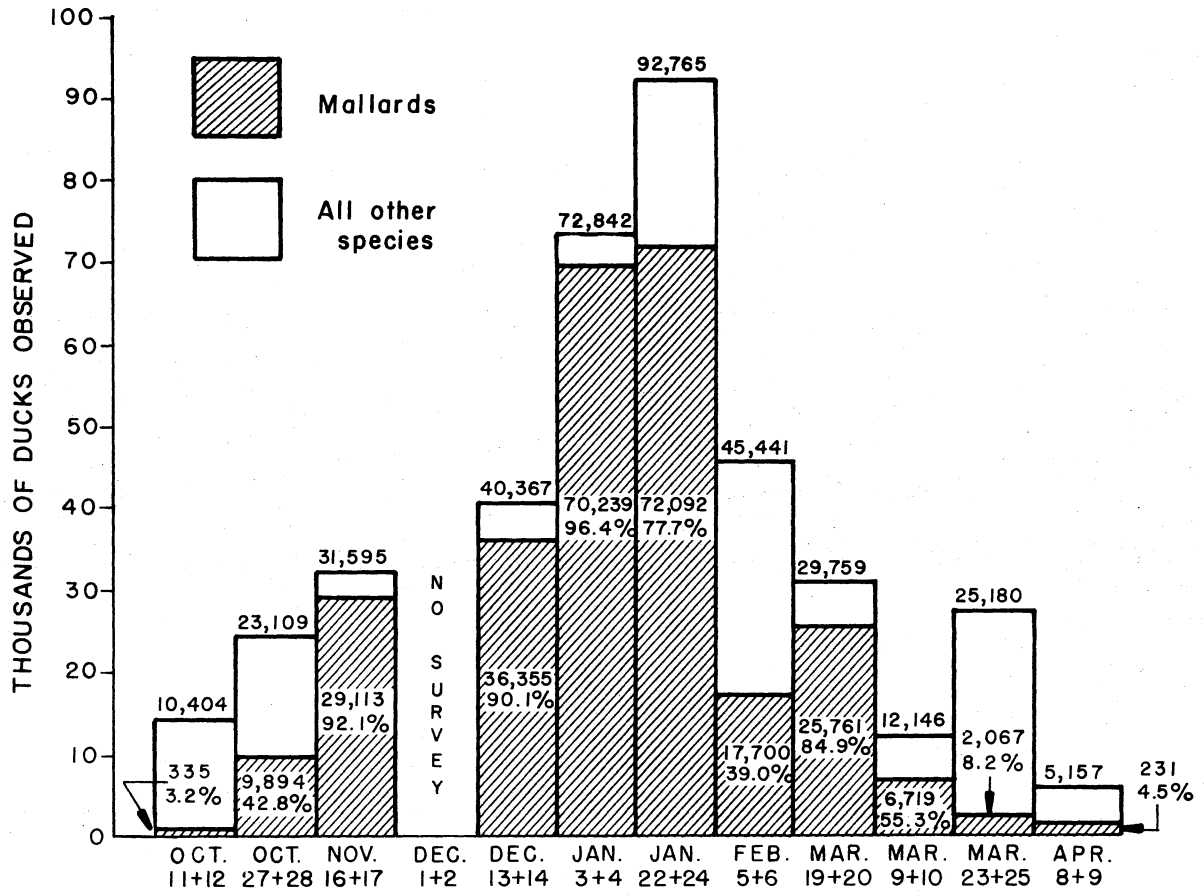


Figure 13. Comparison of Percent Mallards to Other Ducks Observed on Each Aerial Survey

TABLE XII

THE RELATIVE VALUE OF CORPS RESERVOIRS TO WATERFOWL BASED ON THE TOTAL NUMBER OF BIRDS OBSERVED ON THESE STRUCTURES DURING AERIAL SURVEYS--SELECTED RESERVOIR PHYSICAL CHARACTERISTICS ARE INCLUDED

Reservoir	Total number of birds observed	Number of birds per acre	Size (acres)	Age (years)	Average water depth (feet)
Robert S. Kerr	118,566	3	42,000	2	11.8
Oologah	65,314	11	5,850	9	9.9
Fort Gibson	62,350	3	19,100	19	19.1
Eufaula	53,686	1	102,500	8	14.3
Webbers Falls	49,229	5	10,900	2	15.2
Keystone	35,821	1	26,300	8	25.2
Wister	17,360	4	4,000	23	7.5
Hulah	15,195	4	3,600	11	9.3
Chouteau	2,645	2	1,190	2	14.5
Heyburn	902	1	980	22	8.4

of geese on Fort Gibson are at least partially explained by the goose management program on this reservoir. No single attribute of Robert S. Kerr, or Oologah has yet been determined to explain their attractiveness to ducks and coots respectively. Newly flooded conditions on these structures in 1970 may partially explain their heavy use by waterfowl.

An attempt was made to correlate the total numbers of birds observed with the physical attributes previously determined for each reservoir (Table XII). The size of a reservoir could affect its use by waterfowl with respect to observability of the lake from the air and/or the escape cover or loafing sites that a large reservoir affords. The age of reservoirs would obviously affect vegetational succession changes and could subsequently affect waterfowl use. The average water depth, as a measure of the amount of shallow water, would have a direct bearing on aquatic foods available. Results of this study failed to show a significant ($\alpha = 0.05$) relationship between total waterfowl numbers and the physical characteristics of size, age, and average water depth (Figures 14, 15, 16). However, size was positively correlated and age was negatively correlated; also size appeared to be more important than age. The positive, but insignificant, correlation between total numbers and average water depth may have been more a reflection of the imprecise water depth data than of any lack of correlation. The actual amount of shallow water suitable for waterfowl feeding would be more meaningful, but was unobtainable.

Some facets of waterfowl behavior on large reservoirs were revealed during the aerial surveys. First, barge and ship traffic did not disturb resting waterfowl. On several occasions large rafts of

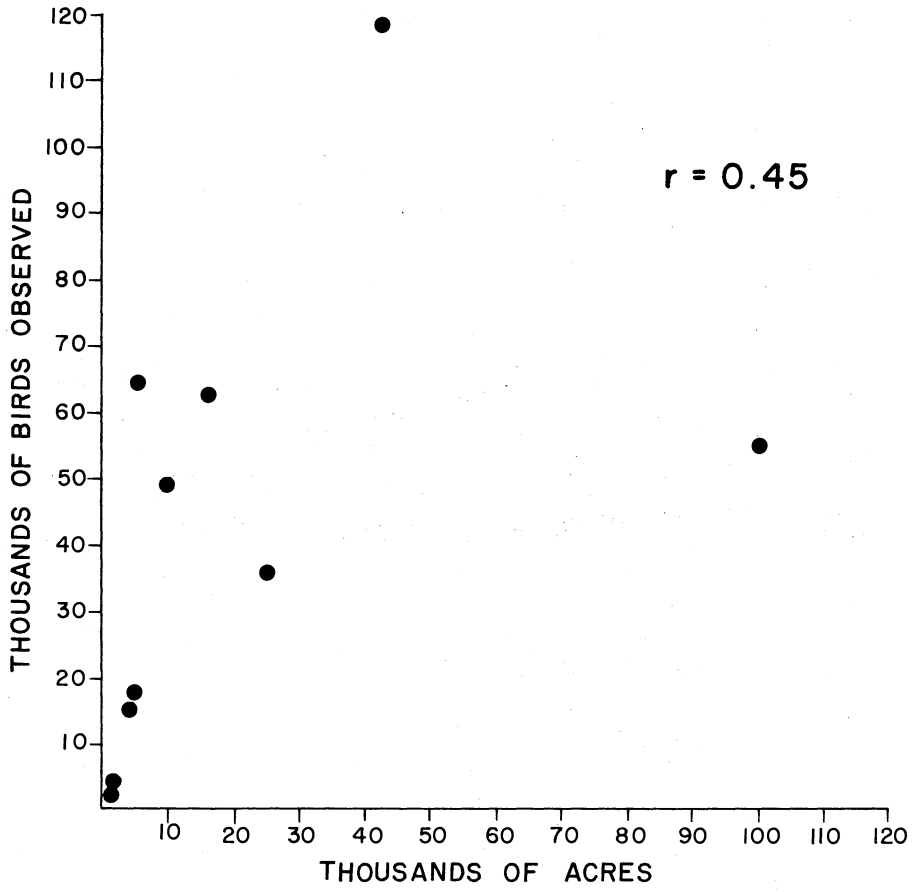


Figure 14. Relationship Between Waterfowl Numbers and Reservoir Size

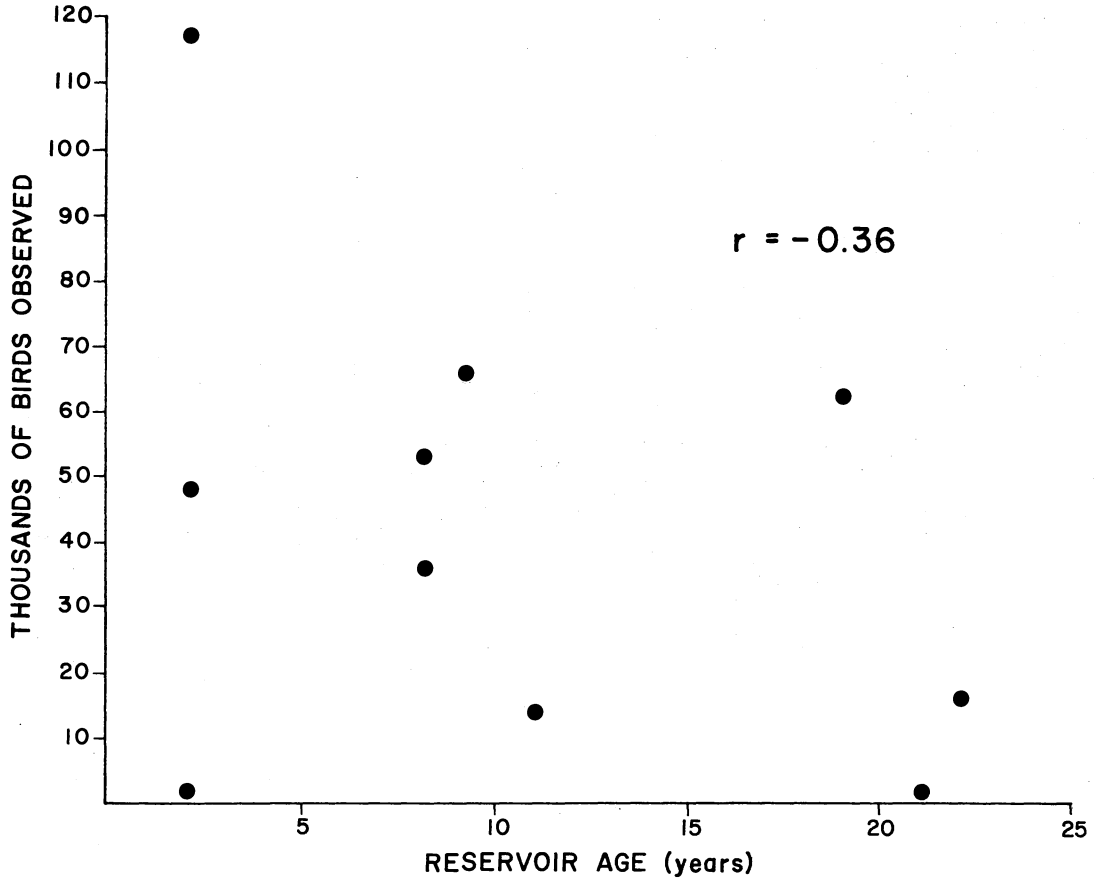


Figure 15. Relationship Between Waterfowl Numbers and Reservoir Age

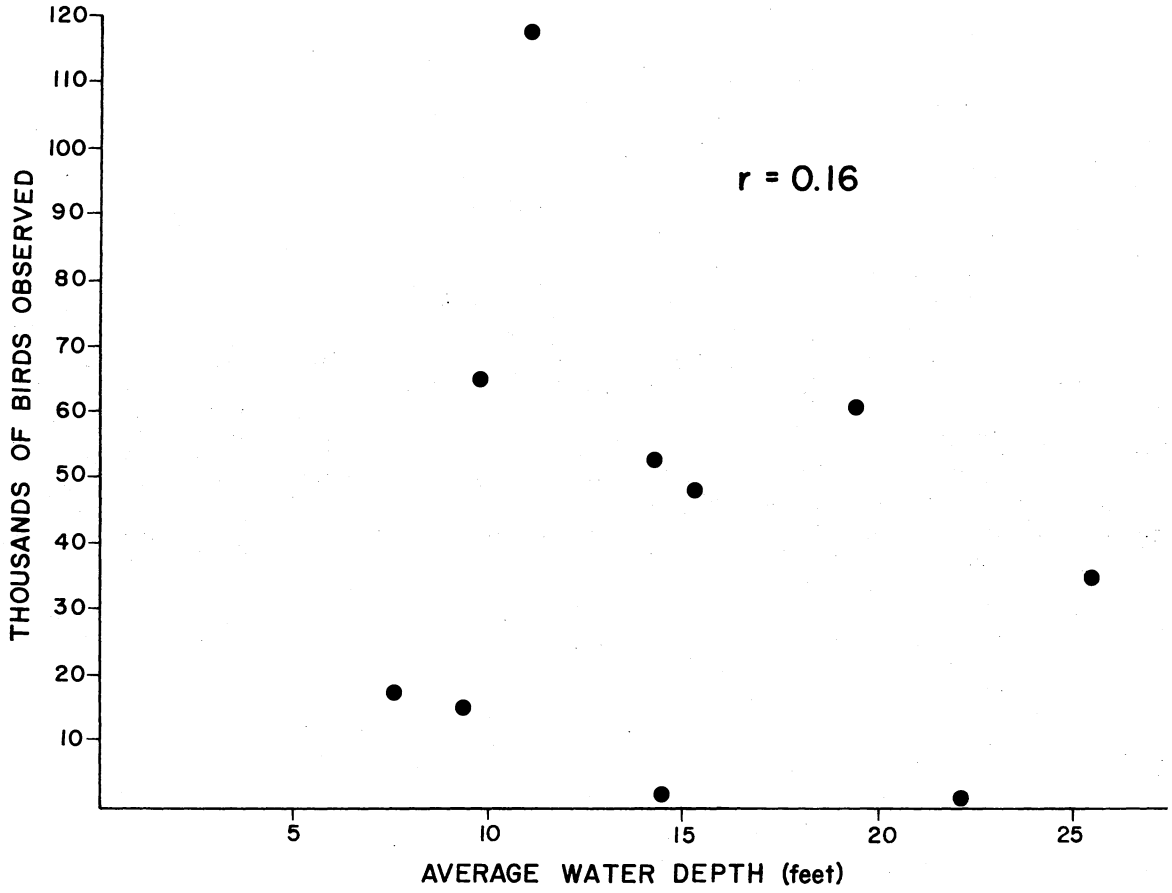


Figure 16. Relationship Between Waterfowl Numbers and Average Water Depth

ducks simply swam to the side as a large vessel passed. Fishing size craft or pleasure boats, on the other hand, invariably sent the birds flying for safety. Hunting parties also apparently interferred with waterfowl's routine activities. Even during inclement weather such as high winds and rough water, large concentrations of birds were observed in open choppy water if hunters were active in the more protected areas. On the following survey, thousands of ducks would be seen in the same cove formerly occupied by hunters. It was observed that waterfowl readily take advantage of newly flooded areas. This was especially noticeable on Oologah and Wister reservoirs when lake levels rose prior to survey five (Figure 17).

Hunter Numbers, Success and Distribution

Federal Game Officer and Reservoir Ranger Interviews

Federal Game Management Officers. These individuals provided information for both the early teal season and the regular duck season. Data regarding hunter numbers, size of hunting parties, and hunting success for the early teal season were provided (Table XIII). Most of their interviews were conducted on Oologah reservoir, and all of these were conducted on the opening weekend of the season. The remaining two interviews were from Fort Gibson reservoir on the closing weekend of the season. Analogous data for the regular duck season were obtained from six Corps of Engineers reservoirs, and are indicated in Table XIV. These reservoirs included Robert S. Kerr, Eufaula, Fort Gibson, Texoma, Webbers Falls and Oologah with total number of interviews on each of

Figure 17. Newly Flooded Area on Wister Reservoir Used Extensively by Waterfowl

TABLE XIII

HUNTER INTERVIEW INFORMATION FROM THE EARLY TEAL SEASON, SEPTEMBER 11-19, 1971

Interviewer	People interviewed	Hunting parties interviewed	Average size of hunting party	Birds bagged	Average birds per hunter	Average birds per hunting trip	Hunting party trips with no kill	Percentage hunting trips with no kill
Federal Game Management Officers	34	16	2.12	59	1.74	3.69	3	18.75
Reservoir Rangers	7	12	1.71	39	3.25	5.57	0	---
Investigator	59	24	2.46	75	1.27	3.12	3	12.50
Total	100	52	1.92	173	1.73	3.27	6	11.54

TABLE XIV

HUNTER INTERVIEW INFORMATION FOR THE REGULAR DUCK SEASON, OCTOBER 16 - NOVEMBER 25, AND DECEMBER 11 - JANUARY 8, 1972

Interviewer	People interviewed	Hunting parties interviewed	Average size of hunting party	Birds bagged	Average birds per hunter	Average birds per hunting trip	Hunting party trips with no kill	Percentage hunting trips with no kill
Federal Game Management Officers	227	99	2.29	289	1.27	2.92	30	30.30
Reservoir Rangers	87	49	1.78	159	1.83	3.24	12	24.49
Investigator	492	204	2.41	667	1.58	3.81	48	23.51
Total	806	352	2.29	1115	1.38	3.17	90	25.57

34, 19, 17, 13, 11 and 5 respectively. Twenty hunting party interviews were conducted during the first one-half of the season; thirty-one were conducted during the second one-half.

It was not possible to determine species composition of hunter's bag from their data, because all federal game officer interview cards were not complete with respect to species of birds killed. They did report 12 coots and one goose in their bag checks. The investigator did not observe any geese in hunter bag checks and only four coots.

Reservoir Rangers. All data from these individuals concerning hunter numbers and success for the early teal season were obtained on Wister reservoir (Table XIII). All of their hunting party interviews were conducted on the opening and closing weekends of the teal season. Analogous data for the regular duck season are indicated in Table XIV. Forty of 49 total interviews by rangers during the regular duck season were obtained during week days; 42 of 49 were obtained during the first one-half of the season. The interviews by reservoir rangers were distributed over eight reservoirs. The numbers of interviews on each reservoir were Robert S. Kerr (12), Oologah (9), Eufaula (8), Wister (8), Texoma (5), Keystone (4), Pine Creek (2), and Hulah (1).

In addition to hunter numbers and success information, reservoir rangers provided data on hunting methods. Thirty-nine (80 percent) hunting parties interviewed were using a boat in their waterfowl hunting activities. The remaining 10 parties simply walked into the reservoir area to hunt. Also, 11 hunting parties (22 percent) during the regular duck season were hunting from a registered blind. None of the hunting parties interviewed by reservoir rangers during the early teal season were utilizing a boat or a registered blind.

Reservoir rangers were not asked to determine species of birds in hunter bag checks because many of them had had little experience in identifying waterfowl. One ranger from Wister reservoir did report, however, that 12 geese were bagged by a hunting party of three. The investigator observed no geese in bag checks.

It became obvious that the utilization of federal game management officers and reservoir rangers to gather waterfowl hunter information on all Corps of Engineer reservoirs had certain limitations. Federal game officers attempted, as is their primary duty, to contact the maximum number of hunters. Consequently, they did not obtain interviews from all Corps reservoirs in eastern Oklahoma. Reservoir rangers obtained most of their interviews during the week, yet this study revealed that hunters utilize the reservoirs most during weekends. The number of interviews obtained during the first one-half of the regular duck season by federal game officers, reservoir rangers, and by the investigator was much greater than that obtained during the second one-half. However, with the former two sources, the difference that is attributable to amount of effort expended is not ascertainable. Despite the limitations, these people provided valuable information on waterfowl hunting activities on various Corps of Engineer reservoirs that would not have been available without their aid.

Interviews by the Investigator

One hundred and sixty-four interviews were obtained on Eufaula reservoir, and 64 were obtained on Robert S. Kerr. The results of these interviews compared favorably with those obtained by the federal

game officers and the reservoir rangers (Tables XIII, XIV). The combined interview data for all seasons and all sources showed no large discrepancies in size of hunting parties, birds bagged, or percentage of unsuccessful hunting trips, especially when the sample sizes are taken into consideration (Table XV). The sample size obtained by the investigator was nearly twice as large as that of the combined interviews of federal game officers and reservoir rangers. The slight differences in values obtained may be attributable to differences in sample sizes. Questionnaire data, which included an even larger sample size, revealed values similar to those from interviews.

Facts relating to hunting methods on large reservoirs were revealed by the investigator's interviews. Only one hunting party of 24 parties interviewed during the early teal season used a boat while hunting. On the other hand, 100 parties (nearly 50 percent) used a boat during the regular duck season. This latter finding indicates that nearly one-half of the regular season hunters on reservoirs simply drive to the lake and then walk in to hunt. Only 17 hunting parties interviewed (8 percent) during the regular duck season used a registered blind from which to hunt. No hunting parties used a registered blind during the early teal season. It is apparent that the majority of hunters do not use a registered blind for waterfowl hunting while on Corps of Engineer reservoirs.

The timing of hunting activities and the amount of time spent hunting were determined. Of the interviews obtained on Eufaula reservoir during the regular season, 75 percent were obtained during the first one-half of the season compared to 60 percent on Robert S. Kerr. However, the large proportion of early season interviews is

TABLE XV

COMBINED HUNTER INTERVIEW INFORMATION FOR THE EARLY TEAL SEASON AND THE REGULAR DUCK SEASON

Interviewer	People interviewed	Hunting parties interviewed	Average size of hunting party	Birds bagged	Average birds per hunter	Average birds per hunting trip	Hunting party trips with no kill	Percentage hunting trips with no kill
Federal Game Management Officers	261	115	2.27	348	1.33	3.03	33	28.70
Reservoir Rangers	94	63	1.49	198	2.11	3.14	12	19.05
Investigator	551	228	2.42	742	1.35	3.25	51	22.37
Total	906	406	2.23	1288	1.42	3.17	96	23.64

partially explained by the fact that the aid of eight additional Oklahoma Cooperative Wildlife Research Unit personnel enabled the investigator to obtain 67 interviews during the opening weekend. Of the 228 total interviews for the early teal season and the regular duck season, 73 percent were hunting during the morning hours. Twenty-one percent of the hunters indicated at that time that they would also hunt during the afternoon. The 228 interviewed parties hunted an average of 4.2 hours per hunting trip; morning hunters averaged 3.5 hours per trip while the evening hunters averaged 5.7 hours (hunting parties interviewed when they were just going out to hunt were excluded from this analysis). Species composition of the kill throughout the season did not coincide with changes in species composition as observed on aerial surveys. For example, 128 green-winged teal appeared in hunter's bags during the first week of the regular duck season. This comprised 65 percent of all green-winged teal bagged, yet this species was most numerous on Eufaula and Robert S. Kerr reservoirs during December and January, respectively. Possibly this was due to the point system of harvest where teal only counted 10 points. As the season progressed, the mallard comprised an increasing percentage of the hunters' bags. During the final week of the season, 43 of 48 birds harvested were mallards. Non-mallard species comprised the largest percentage of hunters' bags early in the hunting season. No mergansers appeared in hunter bags even though they were the second most numerous species observed on aerial surveys. This may be explained by the timing of merganser migration and utilization of Corps reservoirs and the general inaccessability of mergansers to most hunters.

TABLE XVI

SPECIES COMPOSITION OF THE WATERFOWL HARVESTED ON EUFAULA AND ROBERT S. KERR RESERVOIRS DURING THE REGULAR DUCK SEASON AS DETERMINED FROM HUNTER INTERVIEWS

Species	Number	Percent of total kill
Mallard	276	41
Green-winged teal	196	30
Wood duck	50	7
Widgeon	36	5
Pintail	34	5
Gadwall	33	5
Blue-winged teal	17	3
Shoveler	9	2
Scaup	7	1
Redhead	5	1
Coot	4	tr
Total	667	100

In addition to the hunters interviewed, hunting parties were observed during times when it was impossible to talk to the hunters personally. These times occurred while the investigator was traveling around Eufaula and Robert S. Kerr reservoirs and while flying on the aerial surveys. A total of 162 hunting parties were observed while flying over the reservoirs. To show the timing and distribution of interviews and observations a summary of all interviews by all personnel and all hunting parties observed on all reservoirs for weekly intervals throughout the regular hunting season is included in Table XVII. No waterfowl hunter interviews or observations were made on Chouteau, Broken Bow, Heyburn, or Tenkiller reservoirs.

Duck Blind Permits

Based on the number of duck blind registrations, Fort Gibson reservoir was the most popular with hunters that register a blind with the Corps of Engineers (Table XVIII). Personal interviews by the investigator showed that the majority of hunters do not register a duck blind. Only 17 (8 percent) hunting parties interviewed utilized a registered blind on Eufaula and Robert S. Kerr reservoirs. Whether or not a similar proportion of total hunters on other Corps reservoirs registered a duck blind was not determined. The major contribution of the duck blind permits to the current study was the provision of 531 different names and addresses that were included in the post-hunting season mail questionnaire. Thirty-one duplications in hunter names and addresses from interview data and duck blind registrants were eliminated from the mail questionnaire.

TABLE XVII

NUMBER OF HUNTING PARTIES INTERVIEWED OR OBSERVED BY WEEKLY INTERVALS THROUGHOUT THE 1971-72 REGULAR DUCK HUNTING SEASON ON CORPS RESERVOIRS IN EASTERN OKLAHOMA

	Number of Hunting Parties Interviewed or Observed									
	Early Season					Late Season				
Reservoir	Oct. 16 thru Oct. 22	Oct. 23 thru Oct. 30	Oct. 31 thru Nov. 6	Nov. 7 thru Nov. 14	Nov. 15 thru Nov. 22	Dec. 11 thru Dec. 18	Dec. 19 thru Dec. 25	Dec. 26 thru Jan. 1	Jan. 2 thru Jan. 8	Total
Eufaula	59	90	86	11	18	32	22	24	14	356
Robert S. Kerr	35	14	11	32	1	3	3	7	2	108
Oologah	1	--	4	6	--	6	--	--	5	22
Webbers Falls	1	4	5	--	4	4	--	--	1	19
Fort Gibson	--	1	--	2	6	1	3	--	4	17
Texoma	--	--	--	3	7	--	--	3	3	16
Wister	2	5	1	--	--	--	--	--	--	8
Keystone	--	--	1	1	5	--	--	--	--	7
Hulah	--	1	--	--	--	--	--	--	3	4
Pine Creek	--	--	1	--	1	--	--	--	--	2
Total	104	119	116	64	46	52	35	41	36	559

TABLE XVIII

NUMBER OF DUCK BLIND PERMITS ISSUED ON CORPS RESERVOIRS FOR THE 1971-72 WATERFOWL HUNTING SEASON

Reservoir	Number of blind permits issued
Fort Gibson	146
Oologah	126
Keystone	66
Hulah	60
Robert S. Kerr	53
Webbers Falls	34
Eufaula	31
Texoma	21
Heyburn	14
Pine Creek	7
Chouteau	4
Total	562

Mail Questionnaire

Eleven hundred and ninety-four questionnaires were mailed on January 25, 1972. Six hundred and sixty-three were sent to people known to have hunted at least one day on an eastern Oklahoma Corps of Engineers reservoir. Five hundred and thirty-one questionnaires were sent to people that had registered a duck blind on one of these reservoirs. The number of usable questionnaires returned totaled 780 for a return rate of 65 percent. The return rates for the four original sources of names and addresses were: reservoir rangers - 27 of 44 (61 percent), federal game officers - 161 of 252 (62 percent), investigator interviews - 217 of 360 (60 percent), and duck blind registrants - 375 of 531 (70 percent). All questionnaire responses from these four information sources appeared to be similar. But, in order to detect any differences, a Chi-square test was performed. The parameters chosen for the test were (1) total number of ducks harvested, (2) total number of hunting days, and (3) total number of hours hunted during each trip. In all cases, calculated Chi-square values were less than tabular values (0.90, 3 d.f.). Since the investigator could detect no significant differences in responses obtained from these four sources, analysis was completed on all 780 usable returns.

The first portion of the questionnaire was designed to determine the location of hunting activities and the amount of hunting on Corps reservoirs. Since it was possible for hunters to hunt waterfowl in places other than on Corps reservoirs, respondents were provided space to include this hunting activity. The reason for this was to discourage the lumping of all waterfowl hunting within the report. The respondents

reported that they hunted waterfowl for a total of 11,575 man days or an average of 15 hunting days per person for the year. They hunted an average of 12 days, for a total of 9,352 man days, on Corps of Engineer reservoirs. The proportion of total hunting days on lands other than Corps reservoirs was 2,223 man days or 19 percent of their total waterfowl hunting effort. This non-reservoir effort was divided between farm ponds (40 percent), rivers or streams (23 percent), agricultural land (15 percent), and other lands (22 percent). Reservoir hunting effort in terms of hours spent hunting averaged 66 hours per hunter, or 5.2 hours per hunting trip. Personal interview data showed that most hunters averaged only 3.5 hours per trip while hunting on Corps reservoirs. Possibly travel time to the hunting location was not excluded from mail questionnaire responses. Hunting effort by days on each Corps of Engineers reservoir and percentage of total hunting effort on each reservoir are indicated in Table XIX.

Two hundred and thirty respondents (30 percent) hunted during the early teal season on Corps reservoirs. Eighty-one people hunted teal on lands other than Corps structures. A total of 1,491 days were spent teal hunting; this was 16 percent of the total waterfowl hunting effort on Corps reservoirs. Teal hunters averaged two days for teal. Seventy-six percent of the reported teal hunting days were on Corps reservoirs, while 24 percent occurred on other lands.

The next portion of the questionnaire was utilized to measure hunting success. Early teal season hunters averaged 5.65 birds per season or 2.96 teal per day on Corps reservoirs. On non-Corps land they averaged only 1.01 birds per day. Reservoir waterfowl hunters reported harvesting an average of 27.37 ducks and 0.49 geese for the

TABLE XIX

QUESTIONNAIRE REPORTED NUMBER OF DAYS HUNTED ON EACH CORPS RESERVOIR AND THE PERCENTAGE OF TOTAL HUNTING DAYS ON EACH

Reservoir	Days hunted on	% of total
Eufaula	3054	32.8
Oologah	1510	16.2
Fort Gibson	1185	12.8
Robert S. Kerr	1140	12.2
Webbers Falls	492	5.3
Hulah	433	4.7
Keystone	306	3.3
Wister	133	1.5
Chouteau	119	1.3
Heyburn	75	0.8
Others	853	9.1
Total	9352	100.0

season. Therefore, these hunters averaged 2.28 ducks and 0.04 geese per day. This total season duck harvest average is three times greater than that determined in the Oklahoma Department of Wildlife Conservation's surveys for the several years prior to and including the 1970-71 hunting season (Table IX). The harvest rate in terms of ducks per day is approximately 65 percent larger than that determined by investigator personal interviews (1.38 ducks/day). This higher harvest rate may be due to a positive bias on the part of questionnaire respondents, similar to that reported by Sen (1973). However, the respondents represented hunting efforts on several Corps reservoirs; the investigator's data represented efforts on only two reservoirs. Possibly, the average daily bag is higher than that shown by personal interviews. The data suggest that either the hunting success on Corps of Engineer reservoirs was substantially greater than the state average or that the wildlife department estimates are low.

The species composition of the waterfowl harvest during the regular duck season on Corps reservoirs was included on 208 of the returned questionnaires. The reported goose kill was 85 total birds of which there were 56 Canada geese, 16 snow/blue, and 13 white-fronted geese. The geese bagged were reported by 26 hunters for an average of 3.27 geese per successful hunter or 0.41 geese per hunter counting all respondents. The reported kill for ducks was 6,643 birds. For the 208 hunter sample, the range was from 1 to 238 ducks per hunter, with a mean of 31.94 ducks per hunter. A summary of the reported duck harvest including rank by species, percent of total kill, and percent of duck hunters who reported killing at least one representative of the various species is depicted in Table XX. The mallard ranked first in

TABLE XX

REPORTED DUCK KILL FOR THE 1971-72 WATERFOWL HUNTING SEASON ON CORPS RESERVOIRS IN EASTERN OKLAHOMA. BASED ON 208 RESPONDENTS, A RANKING IS GIVEN BY SPECIES, TOTAL NUMBERS, PERCENTAGE OF TOTAL KILL, AND PERCENTAGE OF HUNTERS REPORTED KILLING EACH SPECIES

Species	Number	% of total kill	% of hunters [208] killing this species
Mallard	4054	67.80	89.90
Teal[a]	966	14.54	52.40
Wood duck	243	3.66	28.85
Gadwall	218	3.28	21.15
Pintail	202	3.04	21.63
Widgeon	132	1.99	12.50
Scaup	116	1.75	15.38
Shoveler	62	.93	12.98
Merganser[b]	46	.69	5.29
Ring-necked duck	43	.65	7.69
Redhead	38	.57	8.17
Canvasback	31	.47	3.85
American coot	18	.27	2.40
Buffle head	16	.24	3.36
Ruddy duck	5	.08	.96
Goldeneye	3	.04	.96
Total	6643	100.00	---

[a]Includes all three species (Green-winged, Blue-winged, Cinnamon).

[b]Includes all three species (Hooded, Common, Red-breasted).

the questionnaire responses, followed by teal and then wood ducks. This was identical to the results obtained from personal interviews by the investigator. However, it was not possible to separate early teal season data from the regular season in the questionnaire sample.

In an attempt to obtain a measure of hunter attitudes about hunting on Corps reservoirs, and a measure of the changes in hunting activities that the construction of reservoirs had upon their hunting activities, three questions were posed to the respondents that required value judgements. In response to whether or not hunting had improved with the construction of large reservoirs, 562 (72 percent) said hunting was "better", 130 (17 percent) said hunting was the "same", and 88 (11 percent) said hunting was now "worse". Six hundred and forty-three hunters (82 percent) reported that Corps reservoirs had provided "more" places for them to hunt, 92 (12 percent) said the "same" number of places, and 55 (7 percent) reported they now had "fewer" places to hunt waterfowl. With respect to hunting frequency, 467 (60 percent) hunters said they now hunted "more", 255 (33 percent) hunted the "same", and 58 (7 percent) responded that since reservoir construction, they now hunted "less".

On the questionnaire section set aside for any comments about waterfowl hunting experiences on Corps reservoirs, the responses were as varied, sometimes as confusing, and as lengthy as the responses were to the identical question that was posed to investigator interviewees. However, it was observed that the same complaints as mentioned previously, were again most numerous. One hundred and seventeen (15 percent) people complained about fluctuating water levels, 80 (10 percent) people complained about access to hunting sites, and

56 (7 percent) people complained about problems associated with other hunters.

The final portion of the questionnaire revealed information regarding the number of waterfowl hunters and their hunting methods. The hunters reported that they hunted with an average of 4.9 different individuals during the year. Also, they reported that on the average, one other member of their household also hunted waterfowl. The size of the average hunting party was reported to be 1.95 hunters per trip or nearly two as determined by personal interviews. Five hundred and twenty people used some type of aquatic vehicle during at least a portion of their hunting activities, 311 (40 percent) hunters used a vehicle every time they hunted, and 260 (33 percent) hunters used no type of aquatic vehicle in their hunting activities. Hunters simply walked into the reservoir area to hunt, for a total of 3,689 man-days of hunting. This type of hunting amounted to 40 percent of the reported total waterfowl hunting effort on Corps of Engineers reservoirs in eastern Oklahoma. This was similar to the 50 percent as determined by the investigator's personal interviews.

CHAPTER VI

SUMMARY AND CONCLUSIONS

This was the initial study in a proposed series of research projects to evaluate the influences of Corps of Engineer reservoirs on migrating and wintering waterfowl populations in Oklahoma. Due to the number and distribution of Corps reservoirs in the state, this study was limited to those completed reservoirs in eastern Oklahoma. The specific objectives were to locate and evaluate relevant information already available, to inventory seasonal waterfowl population changes, and to determine hunter numbers, success and distribution during the current season. These initial objectives were designed to elucidate current waterfowl and waterfowl hunter activities on Corps lakes. With this information, the framework would be established for future studies to evaluate more of the ecological relationships involved. Also, by meeting these objectives, specific waterfowl management potentials on reservoirs could be delineated.

Sources of background information included the Migratory Bird Population Station, United States Army Corps of Engineers, United States Department of Agriculture, and the Oklahoma Department of Wildlife Conservation. Background data from the Migratory Bird Population Station included duck stamp sales for previous years and waterfowl band return information from Oklahoma. Statewide duck stamp sales have remained relatively constant despite the construction of

Corps reservoirs. Stamp sales from reservoir area post offices have increased, indicating growth in reservoir area hunting pressure. Waterfowl band return data indicated that there is a definite increase in the number of band returns in a reservoir area following reservoir construction. Information obtained from the United States Army Corps of Engineers dealt with the physical characteristics and operating procedures of each reservoir. Also, duck blind registration information was acquired. The United States Department of Agriculture provided information relevant to suitable waterfowl feedstuffs currently grown in reservoir areas. The Oklahoma Department of Wildlife Conservation provided data on statewide waterfowl numbers, hunter numbers, hunter success, and current state waterfowl management procedures at Corps of Engineer reservoirs. However, wildlife department waterfowl census data proved to be inadequate for this study; all Corps reservoirs are not routinely surveyed. Also, statewide hunter success information differed significantly from that obtained only on Corps reservoirs. The investigator observed that state waterfowl management programs on reservoirs are not always actively carried out.

Seasonal changes in waterfowl populations were determined by biweekly aerial surveys during the migrating and wintering periods (October, 1971 - April, 1972). Duck numbers far exceeded goose numbers throughout the surveys. Although the mallard was the most numerous species overall, there was a predominance of non-mallard duck species on the early and the late aerial surveys. Peak numbers of waterfowl were observed three weeks following the hunting season. No significant correlation could be determined between total waterfowl numbers and physical attributes of the reservoirs, although reservoir size was

positively correlated and age was negatively correlated.

Current hunter numbers, success, and distribution data were obtained primarily with personal interviews and a post-hunting season mail questionnaire. Personal interviews were conducted by federal game management officers, reservoir rangers, and the investigator. The officers and rangers interviewed waterfowl hunters throughout eastern Oklahoma. Investigator interviews were restricted to two reservoirs, Eufaula and Robert S. Kerr, in order to contact the maximum number of hunters. Even with cooperation of officers and rangers it was not possible to determine the total number of waterfowl hunters on Corps reservoirs. Interviews were obtained with 663 different individuals during the season. Corps reservoir duck blind registrants and all people interviewed were contacted with a post-hunting mail questionnaire. A total of 1194 individuals, which represents 4 percent of the total 28,809 people that purchased duck stamps for the 1971-72 hunting season in Oklahoma, were interviewed or mailed a questionnaire. Interview and questionnaire data were similar in most respects concerning hunter success and hunting methods. Interview data showed average hunter harvest to be 1.38 ducks/day while questionnaire responses showed 2.28 ducks/day. This 65 percent higher daily bag average reported on the questionnaires may be due to a positive bias often associated with questionnaire responses, or harvest data for all reservoirs may be substantially larger than that determined by the investigator on only two reservoirs.

Waterfowl hunters engaged in hunting activities on all eastern Oklahoma Corps reservoirs except Broken Bow, and Tenkiller. The reservoirs upon which most hunting occurred were Eufaula, Robert S.

Kerr, Oologah, and Fort Gibson. Fifteen percent of all waterfowl hunting activities occurred during the early teal season. Most hunting during the regular duck season occurred early in the season. The mallard was the most numerous bird in hunters' bags. Relatively few geese were harvested on Corps structures; only 0.04 goose per hunter per day. Hunter success with respect to birds harvested was nearly three times as great as the statewide averages for recent years. The average hunting party contained approximately two people. Most individuals hunted from a boat, however, nearly 40 percent of all hunters on Corps reservoirs simply walked into the area to hunt. Hunters on Corps reservoirs complained most frequently about fluctuating water levels, lack of access sites, and the conduct of other hunters.

The information obtained in this study indicates that United States Army Corps of Engineer reservoirs fall far short of their potential for waterfowl management. It appears that virtually nothing is done, especially with respect to water level control and manipulation, unless such activities are conducted by federal or state wildlife conservation agencies. If conducted, these activities are restricted to a very small portion of the reservoir. In reality, the entirety of each reservoir is a potential waterfowl area capable of temporarily flooding varied amounts of land, and doing so with a ready-made multi-million dollar controlling device, the main dam itself. The author realizes the complexities involved with manipulation of water levels on large reservoirs. Stream maintenance flows, hydroelectric power generation, navigational waterway maintenance, and many other procedures enter into the problem. The investigator would contend, however, that with proper planning and an absolute minimum of additional expense (and possibly

even less total expenditures), substantial land areas could be made available upon which water levels could be regulated at the dam site, to provide shallow water feeding areas for migrating waterfowl. If we are to make optimum use of our conservation dollar, whether it be for the conservation of water or waterfowl, comprehensive planning must be initiated.

An additional fact, related at least indirectly to reservoir water levels, specifically relates to waterfowl feeding activities while using Corps reservoirs. There is no quantitative nor qualitative information available concerning the feeding habits of the large concentrations of waterfowl that frequent the Corps reservoirs in Oklahoma; only speculation and undocumented personal observations. If we are to understand the influences of Corps reservoirs on waterfowl populations, surely this unknown facet must rank high in research priorities.

Another serious deficiency in our knowledge of reservoir influences was vividly realized during this study. The author went about busily trying to determine how construction of reservoirs had influenced Oklahoma's waterfowl populations. Yet, no population data at reservoir sites were available for periods prior to construction of the lakes. The point is that several reservoirs in Oklahoma are still in the planning stage. The timing could not be more apt to acquire pre-construction waterfowl population information. Not doing so in actuality negates much effort to truly understand a reservoir's impact on waterfowl.

Finally, this study revealed that there is a wealth of information already available on various aspects of waterfowl-reservoir-human interrelationships. The volumes of waterfowl banding data available

from the Migratory Bird Station are an excellent example, as are the crop data and other agronomic information that is available from the state and federal departments of agriculture. An analysis of the true ecological relationships depends upon full utilization of such informational sources.

More reservoirs are planned for Oklahoma by the Corps of Engineers, and some are currently under construction. For the present study to realize its primary intent, it is of utmost importance that the following recommendations be executed as soon as possible:

1. Initiate waterfowl population studies in proposed reservoir locations.
2. Determine the feasibility of controlled water level manipulations on specific reservoir sites prior to construction.
3. Determine the feeding habits of migratory waterfowl utilizing Corps reservoirs in Oklahoma.
4. Evaluate and analyze the additional information already available from various governmental agencies.

The large and numerous reservoirs constructed by the United States Army Corps of Engineers in Oklahoma have obviously had a significant impact on migrant waterfowl populations. The large bird concentrations (over 30,000 in some cases) observed on a single reservoir and the increased hunter concentration in reservoir areas attest to this fact. The question then is what is the magnitude of the influences, and more importantly, what do we want the influences to be? Although the investigator personally strongly favors more public lands for hunting purposes, somewhere a saturation point exists. Natural hardwood bottomlands are the most productive lands and soils found in this

nation. Inundation by reservoirs negates most of their production capacity. We must determine our priorities and our needs before any more such valuable land is lost.

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APPENDIX

AERIAL SURVEY WATERFOWL CENSUS DATA

TABLE XXI

NUMBERS AND SPECIES OF WATERFOWL OBSERVED ON CHOUTEAU RESERVOIR DURING BIWEEKLY AERIAL SURVEYS FROM OCTOBER 1971 TO APRIL 1972

Species	Survey / Dates	Numbers of Waterfowl Observed												
		I Oct. 11-12	II Oct. 27-28	III Nov. 16-17	IV Dec. 1-2	V Dec. 13-14	VI Jan. 3-4	VII Jan. 22&24	VIII Feb. 5-6	IX Feb. 19-20	X Mar. 9-10	XI Mar. 23&25	XII Apr. 8-9	Total
Canvasback (*Aytha valisineria*)		---	---	---	N	---	---	---	N	---	---	---	---	---
Gadwall (*Anas strepera*)		98	21	---	0	---	---	---	0	---	20	36	---	175
Mallard (*Anas platyrynchos*)		---	---	16		24	10	560		1107	211	37	---	1965
Merganser (*Mergus merganser*)		---	---	---	S	---	---	---	S	---	---	---	---	---
Pintail (*Anas acuta*)		---	---	---	U	---	---	---	U	---	---	---	---	---
Redhead (*Aytha americana*)		---	---	---	R	---	---	---	R	---	---	---	---	---
Scaup (*Aytha spp.*)		---	---	---	V	---	---	---	V	---	---	---	---	---
Shoveler (*Spatula clypeata*)		---	---	---	E	---	---	---	E	---	5	63	11	79
Teal, Bluewing (*Anas discors*)		---	11	---	Y	---	---	---	Y	---	---	39	17	67
Teal, Greenwing (*Anas carolinensis*)		---	---	---		---	---	35		---	15	200	8	258
Widgeon (*Mareca americana*)		---	---	---		---	---	---		---	40	---	---	40
Wood duck (*Aix sponsa*)		---	2	10		10	2	---		4	14	5	2	49
Total		98	34	26		34	12	595		1111	305	380	38	2633
Canada geese (*Branta canadensis*)		---	12	---		---	---	---		---	---	---	---	-12
Snow/blue geese (*Chen caerulescens*)		---	---	---		---	---	---		---	---	---	---	---
White-fronted (*Anser albifrons*)		---	---	---		---	---	---		---	---	---	---	---
Total		---	12	---		---	---	---		---	---	---	---	12
Coot (*Fulica americana*)		---	---	---		---	---	---		---	---	---	---	---

TABLE XXII

NUMBERS AND SPECIES OF WATERFOWL OBSERVED ON EUFAULA RESERVOIR DURING BIWEEKLY AERIAL SURVEYS FROM OCTOBER 1971 TO APRIL 1972

Species	Survey / Dates	Numbers of Waterfowl Observed												
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
		Oct. 11-12	Oct. 27-28	Nov. 16-17	Dec. 1-2	Dec. 13-14	Jan. 3-4	Jan. 22&24	Feb. 5-6	Feb. 19-20	Mar. 9-10	Mar. 23&25	Apr. 8-9	Total
Canvasback (*Aytha valisineria*)		---	---	---	N	---	---	---	N	---	---	---	---	---
Gadwall (*Anas strepera*)		867	3490	---	O	2	200	---	O	---	65	2395	240	7259
Mallard (*Anas platyrynchos*)		71	3012	4276		4782	14364	7305		728	2	---	1	34541
Merganser (*Mergus merganser*)		---	---	3	S	---	45	65	S	65	---	---	---	578
Pintail (*Anas acuta*)		10	821	---	U	440	40	---	U	35	9	8	16	1379
Redhead (*Aytha americana*)		75	---	---	R	---	---	---	R	---	---	---	---	75
Scaup (*Aytha spp.*)		---	540	190	V	442	---	160	V	---	---	225	---	1557
Shoveler (*Spatula clypeata*)		---	140	---	E	---	---	---	E	---	15	325	39	519
Teal, Bluewing (*Anas discors*)		10	15	---	Y	---	---	---	Y	---	25	55	96	201
Teal, Greenwing (*Anas carolinensis*)		150	775	---		1163	338	398		---	65	95	28	3012
Widgeon (*Mareca americana*)		155	1135	---		18	---	---		---	---	1185	---	2493
Wood duck (*Aix sponsa*)		---	---	3		---	45	465		---	65	---	---	578
Total		1338	9928	4472		6847	15032	8793		828	246	4288	420	52192
Canada geese (*Branta canadensis*)		---	---	---		13	6	34		12	85	175	---	325
Snow/blue geese (*Chen caerulescens*)		35	---	---		---	---	---		---	---	61	---	96
White-fronted (*Anser albifrons*)		---	---	---		---	---	---		---	---	---	---	---
Total		35	---	---		13	6	34		12	85	236	---	421
Coot (*Fulica americana*)		489	230	---		---	60	---		---	6	40	248	1073

TABLE XXIII

NUMBERS AND SPECIES OF WATERFOWL OBSERVED ON FORT GIBSON RESERVOIR DURING BIWEEKLY AERIAL SURVEYS FROM OCTOBER 1971 TO APRIL 1972

Species	Survey Dates	Numbers of Waterfowl Observed												
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
		Oct. 11-12	Oct. 27-28	Nov. 16-17	Dec. 1-2	Dec. 13-14	Jan. 3-4	Jan. 22&24	Feb. 5-6	Feb. 19-20	Mar. 9-10	Mar. 23&25	Apr. 8-9	Total
Canvasback (*Aytha valisineria*)		---	---	---	N	---	---	---	---	---	---	---	---	---
Gadwall (*Anas strepera*)		25	485	35	O	---	---	220	---	---	10	105	105	985
Mallard (*Anas platyrynchos*)		15	4341	10500		3775	11402	4205	7450	1275	2570	8	8	45549
Merganser (*Mergus merganser*)		---	---	---	S	170	225	945	1560	985	77	4	---	3966
Pintail (*Anas acuta*)		---	---	---	U	21	---	---	---	---	---	20	---	41
Redhead (*Aytha americana*)		---	---	---	R	---	---	---	---	---	---	---	---	---
Scaup (*Aytha spp.*)		---	---	---	V	---	---	---	---	---	---	---	---	---
Shoveler (*Spatula clypeata*)		---	---	---	E	---	---	---	---	---	10	---	265	275
Teal, Bluewing (*Anas discors*)		---	75	---	Y	---	---	---	---	---	60	---	---	135
Teal, Greenwing (*Anas carolinensis*)		---	155	40		---	---	---	---	---	20	65	---	280
Widgeon (*Mareca americana*)		---	285	---		35	---	---	---	---	---	---	---	320
Wood duck (*Aix sponsa*)		---	---	---		---	---	---	---	---	---	---	---	---
Total		40	5341	10575		4001	11627	5370	9010	2260	2747	202	378	51551
Canada geese (*Branta canadensis*)		175	250	1100		500	279	375	450	230	300	45	---	3700
Snow/blue geese (*Chen caerulescens*)		80	310	390		400	850	750	---	2175	1200	160	---	6275
White-fronted (*Anser albifrons*)		---	28	50		---	35	---	---	---	---	---	---	113
Total		255	588	1500		900	1160	1125	450	2405	1500	205	---	10088
Coot (*Fulica americana*)		75	55	---		---	---	---	---	---	---	111	470	711

TABLE XXIV

NUMBERS AND SPECIES OF WATERFOWL OBSERVED ON HEYBURN RESERVOIR DURING BIWEEKLY AERIAL SURVEYS FROM OCTOBER 1971 TO APRIL 1972

Species	Survey Dates	Numbers of Waterfowl Observed												
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
		Oct. 11-12	Oct. 27-28	Nov. 16-17	Dec. 1-2	Dec. 13-14	Jan. 3-4	Jan. 22&24	Feb. 5-6	Feb. 19-20	Mar. 9-10	Mar. 23&25	Apr. 8-9	Total
Canvasback (*Aytha valisineria*)		---	---	---	N	---	---	---	---	---	---	---	---	---
Gadwall (*Anas strepera*)		---	270	---	O	---	2	---	---	---	2	85	---	359
Mallard (*Anas platyrynchos*)		7	15	---		---	2	18	55	15	5	7	---	124
Merganser (*Mergus merganser*)		---	---	---	S	---	---	---	---	---	---	7	---	7
Pintail (*Anas acuta*)		---	---	---	U	---	---	---	---	---	---	44	---	44
Redhead (*Aytha americana*)		---	---	---	R	---	---	---	---	---	---	---	---	---
Scaup (*Aytha spp.*)		---	50	---	V	---	---	---	---	---	---	10	---	60
Shoveler (*Spatula clypeata*)		---	---	---	E	---	---	---	---	---	---	24	11	35
Teal, Bluewing (*Anas discors*)		---	---	---	Y	---	---	---	---	---	---	50	17	67
Teal, Greenwing (*Anas carolinensis*)		---	---	---		---	---	---	---	---	8	9	8	25
Widgeon (*Mareca americana*)		---	---	---		---	---	---	---	---	---	---	---	---
Wood duck (*Aix sponsa*)		---	12	2		4	4	4	1	5	---	3	2	37
Total		7	347	2		4	8	22	56	20	15	239	38	758
Canada geese (*Branta canadensis*)		---	---	---		---	---	---	---	---	---	---	---	---
Snow/blue geese (*Chen caerulescens*)		---	---	---		---	---	---	---	---	10	---	---	10
White-fronted (*Anser albifrons*)		---	---	---		---	---	---	---	---	---	---	---	---
Total		---	---	---		---	---	---	---	---	10	---	---	10
Coot (*Fulica americana*)		---	---	---		3	---	---	---	---	---	---	131	134

TABLE XXV

NUMBERS AND SPECIES OF WATERFOWL OBSERVED ON HULAH RESERVOIR DURING BIWEEKLY AERIAL SURVEYS FROM OCTOBER 1971 TO APRIL 1972

Species	Survey Dates	Numbers of Waterfowl Observed												
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
		Oct. 11-12	Oct. 27-28	Nov. 16-17	Dec. 1-2	Dec. 13-14	Jan. 3-4	Jan. 22&24	Feb. 5-6	Feb. 19-20	Mar. 9-10	Mar. 23&25	Apr. 8-9	Total
Canvasback (*Aytha valisineria*)		---	---	---	N	5	---	---	---	---	---	---	---	5
Gadwall (*Anas strepera*)		3000	200	---	O	---	---	18	---	---	---	247	---	3465
Mallard (*Anas platyrynchos*)		---	5	---		39	22	962	1675	630	412	331	75	4151
Merganser (*Mergus merganser*)		---	---	---	S	---	---	173	3010	76	59	55	---	3373
Pintail (*Anas acuta*)		100	000	000	U	6	---	---	284	20	---	---	24	434
Redhead (*Aytha americana*)		---	---	---	R	---	---	---	---	---	---	---	---	---
Scaup (*Aytha spp.*)		---	---	---	V	---	---	---	---	---	---	---	350	350
Shoveler (*Spatula clypeata*)		---	---	---	E	---	---	---	---	---	12	750	60	822
Teal, Bluewing (*Anas discors*)		100	---	---	Y	---	---	---	---	---	15	510	25	650
Teal, Greenwing (*Anas carolinensis*)		80	---	---		---	---	---	---	---	16	345	---	441
Widgeon (*Mareca americana*)		300	---	---		---	---	---	---	---	---	145	---	445
Wood duck (*Aix sponsa*)		---	---	---		---	---	---	---	---	---	---	---	---
Total		3580	205	---		50	22	1153	4969	726	514	2383	534	14136
Canada geese (*Branta canadensis*)		---	---	---		---	---	75	21	---	---	---	---	96
Snow/blue geese (*Chen caerulescens*)		---	---	---		---	---	---	150	---	---	---	---	150
White-fronted (*Anser albifrons*)		---	---	---		---	---	---	---	---	---	---	---	---
Total		---	---	---		---	---	75	171	---	---	---	---	246
Coot (*Fulica americana*)		400	150	2		11	---	---	---	---	---	195	55	813

TABLE XXVI

NUMBERS AND SPECIES OF WATERFOWL OBSERVED ON KEYSTONE RESERVOIR DURING BIWEEKLY AERIAL SURVEYS FROM OCTOBER 1971 TO APRIL 1972

Species	Survey Dates	Numbers of Waterfowl Observed												
		I Oct. 11-12	II Oct. 27-28	III Nov. 16-17	IV Dec. 1-2	V Dec. 13-14	VI Jan. 3-4	VII Jan. 22&24	VIII Feb. 5-6	IX Feb. 19-20	X Mar. 9-10	XI Mar. 23&25	XII Apr. 8-9	Total
Canvasback (*Aytha valisineria*)		---	---	---	N	---	---	---	75	---	---	---	2	77
Gadwall (*Anas strepera*)		1310	120	---	O	4	7	---	---	---	---	470	19	1930
Mallard (*Anas platyrynchos*)		60	26	24		83	1063	420	59	24	---	111	---	1870
Merganser (*Mergus merganser*)		---	---	---	S	2	22	9730	18640	780	99	52	---	29325
Pintail (*Anas acuta*)		---	55	---	U	---	16	---	4	---	---	18	---	93
Redhead (*Aytha americana*)		20	1	---	R	---	---	---	---	---	---	75	---	96
Scaup (*Aytha spp.*)		---	90	---	V	---	4	35	715	---	---	500	---	1344
Shoveler (*Spatula clypeata*)		---	---	---	E	---	---	---	---	---	---	110	---	110
Teal, Bluewing (*Anas discors*)		15	1	---	Y	---	---	---	---	---	---	105	5	126
Teal, Greenwing (*Anas carolinensis*)		20	---	---		15	8	27	---	---	---	110	---	180
Widgeon (*Mareca americana*)		---	---	---		15	---	---	---	---	---	350	---	365
Wood duck (*Aix sponsa*)		---	---	---		---	---	30	---	---	---	---	---	30
Total		1425	293	24		119	1120	10242	19493	804	99	1901	26	35546
Canada geese (*Branta canadensis*)		---	15	---		---	---	---	---	---	---	---	---	15
Snow/blue geese (*Chen caerulescens*)		---	---	---		---	---	---	---	---	---	---	---	---
White-fronted (*Anser albifrons*)		---	---	---		---	---	---	---	---	---	---	---	---
Total		---	15	---		---	---	---	---	---	---	---	---	15
Coot (*Fulica americana*)		150	25	---		---	---	---	---	---	---	---	75	250

TABLE XXVII

NUMBERS AND SPECIES OF WATERFOWL OBSERVED ON OOLOGAH RESERVOIR DURING BIWEEKLY AERIAL SURVEYS FROM OCTOBER 1971 TO APRIL 1972

Species	Survey / Dates	Numbers of Waterfowl Observed												
		I Oct. 11-12	II Oct. 27-28	III Nov. 16-17	IV Dec. 1-2	V Dec. 13-14	VI Jan. 3-4	VII Jan. 22&24	VIII Feb. 5-6	IX Feb. 19-20	X Mar. 9-10	XI Mar. 23&25	XII Apr. 8-9	Total
Canvasback (*Aytha valisineria*)		---	---	---	N	---	---	---	---	---	---	---	---	---
Gadwall (*Anas strepera*)		615	955	19	O	8	15	160	---	---	220	1497	110	3599
Mallard (*Anas platyrynchos*)		---	1540	4668		1284	7891	10725	8461	1323	815	81	42	36830
Merganser (*Mergus merganser*)		---	---	---	S	52	---	4360	3267	340	5	44	---	8068
Pintail (*Anas acuta*)		---	700	---	U	---	---	---	---	---	17	85	---	802
Redhead (*Aytha americana*)		---	35	---	R	---	---	---	---	---	280	---	---	315
Scaup (*Aytha spp.*)		---	90	429	V	119	85	---	---	230	70	360	139	1522
Shoveler (*Spatula clypeata*)		---	---	---	E	4	---	---	---	---	30	425	38	497
Teal, Bluewing (*Anas discors*)		---	43	---	Y	---	---	---	---	---	40	130	79	297
Teal, Greenwing (*Anas carolinensis*)		115	522	58		88	225	---	185	---	110	447	45	1795
Widgeon (*Mareca americana*)		100	---	75		---	---	---	---	---	40	235	191	641
Wood duck (*Aix sponsa*)		---	---	---		5	---	2	---	---	---	---	---	7
Total		830	3885	5249		1560	8216	15247	11913	1893	1627	3304	644	54368
Canada geese (*Branta canadensis*)		55	---	---		---	---	---	35	---	---	65	---	155
Snow/blue geese (*Chen caerulescens*)		---	---	6		---	80	250	460	450	650	465	---	2361
White-fronted (*Anser albifrons*)		---	---	---		---	---	---	---	---	---	18	---	18
Total		55	---	6		---	80	250	495	450	650	548	---	2534
Coot (*Fulica americana*)		3330	1285	127		22	258	57	---	31	210	1060	2032	8412

TABLE XXVIII

NUMBERS AND SPECIES OF WATERFOWL OBSERVED ON ROBERT S. KERR RESERVOIR DURING BIWEEKLY AERIAL SURVEYS FROM OCTOBER 1971 TO APRIL 1972

Species	Survey Dates	Numbers of Waterfowl Observed												
		I Oct. 11-12	II Oct. 27-28	III Nov. 16-17	IV Dec. 1-2	V Dec. 13-14	VI Jan. 3-4	VII Jan. 22&24	VIII Feb. 5-6	IX Feb. 19-20	X Mar. 9-10	XI Mar. 23&25	XII Apr. 8-9	Total
Canvasback (*Aytha valisineria*)		---	---	---	N	---	---	---	N	---	---	---	---	---
Gadwall (*Anas strepera*)		1270	255	647	O	243	360	695	O	131	620	2499	493	7213
Mallard (*Anas platyrynchos*)		30	295	9440		23000	20703	28420		10644	752	110	---	103394
Merganser (*Mergus merganser*)		---	---	---	S	---	---	---	S	150	---	---	---	150
Pintail (*Anas acuta*)		---	225	---	U	---	150	235	U	---	156	---	---	766
Redhead (*Aytha americana*)		---	---	---	R	---	---	---	R	---	---	28	---	28
Scaup (*Aytha spp.*)		---	25	---	V	---	---	---	V	---	150	---	---	175
Shoveler (*Spatula clypeata*)		---	---	2	E	---	---	---	E	---	40	255	785	1082
Teal, Bluewing (*Anas discors*)		---	16	---	Y	---	---	---	Y	---	85	51	32	184
Teal, Greenwing (*Anas carolinensis*)		250	190	300		358	510	450		---	215	145	26	2444
Widgeon (*Mareca americana*)		---	100	---		---	---	---		---	155	226	---	481
Wood duck (*Aix sponsa*)		---	---	57		43	225	---		38	115	19	---	497
Total		1550	1106	10446		23644	31948	29800		10963	2288	3333	1336	116414
Canada geese (*Branta canadensis*)		---	100	---		11	---	---		---	---	23	---	134
Snow/blue geese (*Chen caerulescens*)		---	40	---		---	---	25		---	55	---	---	120
White-fronted (*Anser albifrons*)		---	---	---		---	---	---		---	---	---	---	---
Total		---	140	---		11	---	25		---	55	23	---	254
Coot (*Fulica americana*)		790	37	557		90	101	---	---	---	20	57	246	1898

TABLE XXIX

NUMBERS AND SPECIES OF WATERFOWL OBSERVED ON WEBBERS FALLS RESERVOIR DURING BIWEEKLY AERIAL SURVEYS FROM OCTOBER 1971 TO APRIL 1972

Species	Survey / Dates	Numbers of Waterfowl Observed												
		I Oct. 11-12	II Oct. 27-28	III Nov. 16-17	IV Dec. 1-2	V Dec. 13-14	VI Jan. 3-4	VII Jan. 22&24	VIII Feb. 5-6	IX Feb. 19-20	X Mar. 9-10	XI Mar. 23&25	XII Apr. 8-9	Total
Canvasback (*Aytha valisineria*)		---	---	---	N	---	---	---	N	---	---	---	---	---
Gadwall (*Anas strepera*)		1072	510	---	O	376	---	595	O	31	920	4098	800	8402
Mallard (*Anas platyrynchos*)		152	510	---		2408	2762	11427		9083	1944	1222	105	29613
Merganser (*Mergus merganser*)		---	---	---	S	---	---	235	S	453	---	---	---	688
Pintail (*Anas acuta*)		---	---	---	U	---	---	---	U	99	170	---	30	299
Redhead (*Aytha americana*)		---	---	---	R	---	---	---	R	---	40	---	---	40
Scaup (*Aytha spp.*)		---	200	---	V	---	---	---	V	---	10	---	---	210
Shoveler (*Spatula clypeata*)		---	---	---	E	---	---	---	E	---	43	291	407	741
Teal, Bluewing (*Anas discors*)		---	75	---	Y	---	---	---	Y	---	135	1132	36	1378
Teal, Greenwing (*Anas carolinensis*)		50	---	25		25	---	260		335	268	902	220	2085
Widgeon (*Mareca americana*)		57	---	---		---	---	---		---	67	425	35	584
Wood duck (*Aix sponsa*)		---	---	---		40	---	---		4	---	60	3	107
Total		1331	1295	25		2849	2762	12517		10005	3597	8130	1636	44147
Canada geese (*Branta canadensis*)		---	---	---		---	---	---		---	---	31	---	31
Snow/blue geese (*Chen caerulescens*)		---	---	---		---	---	460		875	100	210	---	1645
White-fronted (*Anser albifrons*)		---	---	---		---	---	---		---	---	---	---	---
Total		---	---	---		---	---	460		875	100	241	---	1676
Coot (*Fulica americana*)		550	80	---		75	---	---		---	306	---	2395	3406

TABLE XXX

NUMBERS AND SPECIES OF WATERFOWL OBSERVED ON WISTER RESERVOIR DURING BIWEEKLY AERIAL SURVEYS FROM OCTOBER 1971 TO APRIL 1972

Species	Survey / Dates	Numbers of Waterfowl Observed												
		I Oct. 11-12	II Oct. 27-28	III Nov. 16-17	IV Dec. 1-2	V Dec. 13-14	VI Jan. 3-4	VII Jan. 22&24	VIII Feb. 5-6	IX Feb. 19-20	X Mar. 9-10	XI Mar. 23&25	XII Apr. 8-9	Total
Canvasback (*Aytha valisineria*)		---	---	---	N	---	---	---	N	---	---	---	---	---
Gadwall (*Anas strepera*)		40	200	137	O	---	---	---	O	---	110	210	17	714
Mallard (*Anas platyrynchos*)		---	150	189		960	2020	8050		432	8	160	---	11969
Merganser (*Mergus merganser*)		---	---	---	S	6	---	---	S	---	---	---	---	6
Pintail (*Anas acuta*)		---	---	---	U	15	10	321	U	365	---	---	---	711
Redhead (*Aytha americana*)		---	---	---	R	---	---	---	R	---	---	---	---	---
Scaup (*Aytha spp.*)		---	50	---	V	220	---	---	V	---	---	225	---	495
Shoveler (*Spatula clypeata*)		---	---	---	E	---	35	550	E	---	---	200	26	811
Teal, Bluewing (*Anas discors*)		---	---	---	Y	---	---	---	Y	---	---	138	64	202
Teal, Greenwing (*Anas carolinensis*)		150	---	450		58	---	105		350	590	87	---	1790
Widgeon (*Mareca americana*)		15	275	---		---	---	---		---	---	---	---	290
Wood duck (*Aix sponsa*)		---	---	---		---	30	---		2	---	---	---	32
Total		205	675	776		1259	2095	9026		1149	708	1020	107	17020
Canada geese (*Branta canadensis*)		---	---	---		---	---	70		---	---	---	---	70
Snow/blue geese (*Chen caerulescens*)		---	---	---		---	---	---		---	---	7	---	7
White-fronted (*Anser albifrons*)		---	---	---		---	---	---		---	---	---	---	---
Total		---	---	---		---	---	70		---	---	7	---	77
Coot (*Fulica americana*)		---	16	---		---	---	---		---	---	12	235	263

VITA

Walter Eugene Gorham

Candidate for Degree of

Master of Science

Thesis: INFLUENCES OF UNITED STATES ARMY CORPS OF ENGINEERS RESERVOIRS ON WATERFOWL POPULATIONS IN OKLAHOMA

Major Field: Wildlife Ecology

Biographical:

Personal Data: Born in Winchester, Virginia, February 1, 1948, the son of Fuller R. and Lucy K. Gorham.

Education: Aberdeen High School, Aberdeen, Maryland, 1962-1966; University of Maryland, College Park, Maryland, 1966-1967; Bachelor of Science, Texas A&M University, College Station, Texas, 1970; completed requirements for the Master of Science degree at Oklahoma State University in December, 1975; currently, senior student, College of Veterinary Medicine, Texas A&M University, College Station, Texas.

Professional Experience: Laboratory and field technician, Wildlife Disease Laboratory, Texas A&M University, College Station, Texas, 1969-1970; Teaching assistant in Zoology, Oklahoma State University, Stillwater, Oklahoma, 1971-1972; Laboratory technician, Animal Science Department, Texas A&M University, College Station, Texas, 1972-1973.

Professional Societies: Wildlife Society, Texas Chapter of the Wildlife Society, The Wildfowl Trust, Wildlife Disease Association, and the American Veterinary Medical Association.