


**WATERFOWL USAGE OF CROSS CREEKS NATIONAL  
WILDLIFE REFUGE: THE FIRST THIRTY YEARS**

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**ROBERT LLOYD MOSER**

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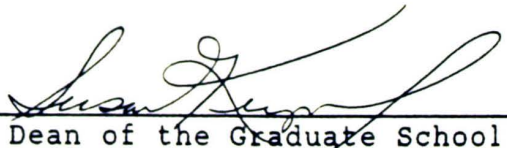
  
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WATERFOWL USAGE OF CROSS CREEKS NATIONAL WILDLIFE  
REFUGE: THE FIRST THIRTY YEARS

A Thesis  
Presented for the  
Master of Science  
Degree  
Austin Peay State University

Robert Lloyd Moser  
May 1994

## ACKNOWLEDGEMENTS

I would like to express my appreciation to Dr. David H. Snyder, Professor of Biology at Austin Peay State University, for his assistance and guidance during this study as well as for his many ideas. Appreciation is extended to Dr. Edward W. Chester and Dr. A. Floyd Scott, both Professors of Biology at Austin Peay State University, for their assistance in the preparation of this manuscript.

I would like to thank the employees of Cross Creeks National Wildlife Refuge for their willing assistance in retrieving past documents and for their generous sharing of their knowledge of the refuge.

I thank my wife, Tammy, for her love, support, and understanding during this study and throughout my entire educational career. I would also like to acknowledge my parents and the rest of my family for their support throughout my collegiate career.

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## ABSTRACT

Cross Creeks National Wildlife Refuge (CCNWR), created in 1962, is located east of Dover, Tennessee, in Stewart County. The refuge consists of 3586 ha of Cumberland River floodplain and adjacent, mostly wooded uplands. The primary purpose of the refuge is to provide feeding and resting habitat for overwintering waterfowl. The refuge was established to mitigate the loss of parts of Kentucky Woodlands National Wildlife Refuge (KWNWR) that were flooded when Lake Barkley was created. Various management techniques are used to provide suitable habitat for wintering waterfowl. One such technique is the manipulation of water levels in the refuge's 16 water impoundments to promote the growth of moist-soil plants. Various cropping practices are used as well. The purpose of this study was to analyze waterfowl usage of the refuge for the first thirty years, except for the winter of 1968/69, of its existence. Thirty-three of the 48 species of waterfowl recorded from North America have been documented on the refuge since 1962. Nine of these (Mute Swan [Cygnus olor], Brant [Branta bernicla], Barnacle Goose [Branta leucopsis], Ross' Goose [Chen rossii], Cinnamon Teal [Anas cyanoptera], Fulvous Whistling Duck [Dendrocygna bicolor], Greater Scaup [Aythya marila], Oldsquaw [Clangula hyemalis], and White-

winged Scoter [Melanitta fusca]), each recorded but once or twice, are considered accidentals. The Tundra Swan (Cygnus columbianus) and Eurasian Wigeon (Anas penelope) have been observed at the refuge more than twice, but probably also should be considered accidentals.

The duck population at CCNWR for the period 1962 through 1980 was inversely correlated with winter temperatures on their breeding grounds ( $R_s = 0.534$ ). No correlation is apparent in the data for goose populations. Peak weekly duck populations ranged from 1,000 (1962/63) to 111,000 (1964/65), and occurred in December. The duck population in recent years, although erratic, appears to be declining. Peak weekly goose populations ranged from 40 (1962/63) to 74,000 (1989/90), and occurred in January.

Goose populations in recent years show a general upward trend. A typical mid-winter (January) duck population is dominated by Mallards (Anas platyrhynchos) (74%) and American Black Ducks (Anas rubripes) (15%). American Wigeons (Anas americana), Ring-necked Ducks (Aythya collaris), Northern Pintails (Anas acuta), and Gadwalls (Anas strepera) collectively make up 8%. Canada Geese (Branta canadensis) comprise 99.9% of the goose population using the refuge during winter.

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## Chapter 1

### INTRODUCTION AND LITERATURE SURVEY

#### Introduction

The term "waterfowl" refers to all members of the family Anatidae (ducks, geese, and swans). Forty-three species of anatids are native breeders in North America and five more species regularly visit from Eurasian breeding grounds (Bellrose 1980). Scientific names for waterfowl species are given in Table 1 (p. 18).

Each fall, most North American waterfowl leave their breeding grounds and fly south to winter. The winter habitat must provide open water, food, and refuge to ensure that the birds survive the winter, if they are to return to their breeding grounds in the spring. Habitat conditions on wintering areas and along migration routes may have a direct effect on the reproductive success of waterfowl (U.S. Dept. of Interior, Fish and Wildlife Service, and Environment of Canada, Wildlife Service 1986). Studies suggest that much of the pair bonding in many species of ducks takes place on their wintering grounds (Soutiere et al. 1972; Hepp and Hair 1983).

Management and conservation of North American waterfowl populations are complicated because most species use two different habitats during their lifetimes; the breeding grounds are likely to be in Canada, and the wintering grounds in the United States or Mexico. Breeding ground

surveys suggest that 80% of North America's ducks are produced in Canada and Alaska, whereas winter surveys show that about 90% of these ducks winter in the United States and 10% in Mexico (Glover 1964). Because waterfowl populations typically utilize two or even three countries, effective waterfowl management has been a cooperative effort. The United States and Great Britain (on behalf of Canada) signed a treaty in 1916 to protect waterfowl that move seasonally between the United States and Canada. A similar treaty was signed with Mexico in 1936 (Briggs 1964). The North American Waterfowl Management Plan of 1986 is the most recent cooperative management effort between the United States and Canada. This plan provides the framework for the conservation and management of North American waterfowl populations and also established population goals to be reached by the year 2000 (U.S. Dept. of Interior, Fish and Wildlife Service, and Environment of Canada, Wildlife Service 1986).

A major concern in waterfowl management has been the drainage of wetlands which are necessary for waterfowl breeding and wintering. Sanderson (1980) cites wetland destruction as the principal reason for the decline of North American duck populations in the 20th Century. The contiguous United States originally contained 127 million acres of wetlands (Briggs 1964); this had been reduced to 103.3 million acres by the mid-1980s (Dahl and Johnson

1991). From the mid-1780s to the mid-1980s, Tennessee lost 59% of its wetlands (Dahl and Johnson 1991). The pace of wetland destruction has been slowed somewhat by the implementation of projects such as the Swampbuster Program of the Food Security Act of 1985.

In the face of this destruction of wetlands, it became imperative that measures be taken to preserve some of the rapidly disappearing waterfowl habitat. Much relief came in the form of the national wildlife refuge system, which established refuges at key locations in the breeding and wintering grounds of waterfowl. The refuge system was created in 1903 under President Theodore Roosevelt, when he established the Pelican Island Refuge in Florida to protect a colony of Brown Pelicans (Pelecanus occidentalis) and other colonial nesting birds (Salyer and Gillett 1964). By July 1967, 317 refuges had been established, of which 250 were managed primarily for wild ducks and geese (Leopold et al. 1974). The first waterfowl unit of the refuge system was created in 1924 when the U.S. Congress appropriated 1.5 million dollars for the purchase of bottomlands along the upper Mississippi River (Leopold et al. 1974). Today over 400 refuges, encompassing nearly 90 million acres, are managed by the U.S. Fish and Wildlife Service (U.S. Dept. of Interior 1991). One of these refuges is Cross Creeks National Wildlife Refuge (CCNWR), located along the Cumberland River (Lake Barkley) in Stewart County,

Tennessee, and established in 1962 (Figure 1). The major purpose of CCNWR is to provide feeding and resting habitat for overwintering waterfowl.

Cross Creeks National Wildlife Refuge was established as a result of mitigation proceedings with the U.S. Army Corps of Engineers when parts of the Kentucky Woodlands National Wildlife Refuge (KWNWR) were flooded due to the impoundment of Lake Barkley in 1965. Approximately 1780 ha of KWNWR was inundated. That 1780 ha is estimated to have supported 25% of the preimpoundment upland game population of KWNWR, and 75% of the waterfowl population (U.S Fish and Wildlife Service 1962). Cross Creeks National Wildlife Refuge was established to compensate for this loss of waterfowl habitat.

Cross Creeks National Wildlife Refuge is located near the center of the Mississippi Flyway (Figure 2). This flyway contains 13 states, most of the Mississippi River, three of the five largest lakes in the world, and embraces 742,000 miles<sup>2</sup> (Hawkins 1964). The flyway concept was established in 1948 by F.C. Lincoln, to aid in the formulation of waterfowl hunting regulations (Glover 1964). Lincoln divided the United States into four principal flyways: Atlantic, Mississippi, Central, and Pacific. The Mississippi Flyway contains much of the prairie pothole region and much of the cornbelt.

## STEWART COUNTY

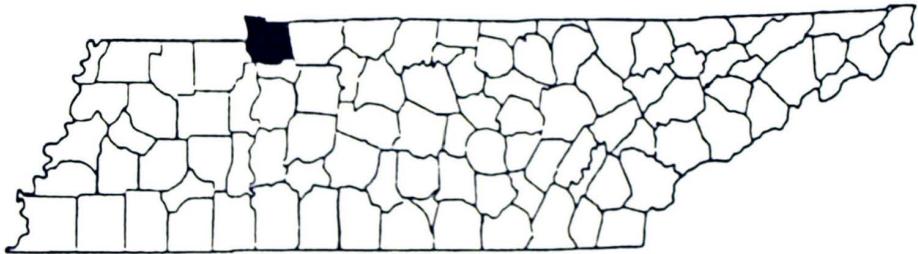
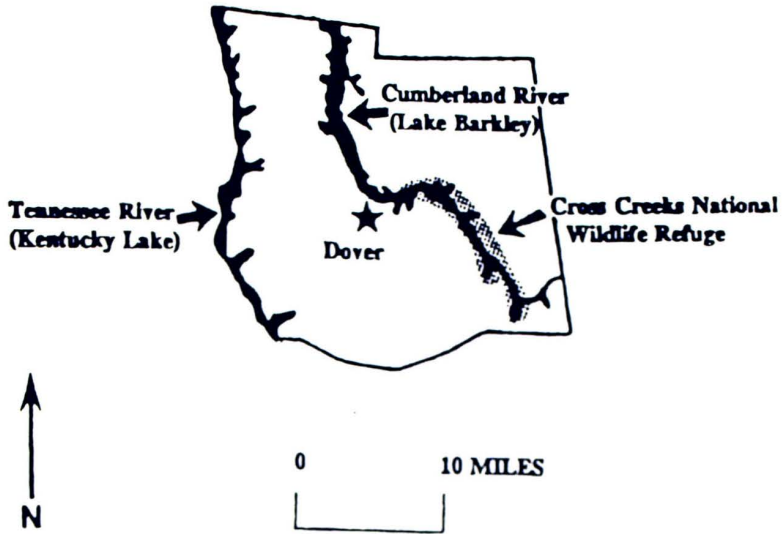


Figure 1. County Outline Map of Tennessee, Showing the Locations of Stewart County and Cross Creeks National Wildlife Refuge within the County. Scale applies only to the map of Stewart County.

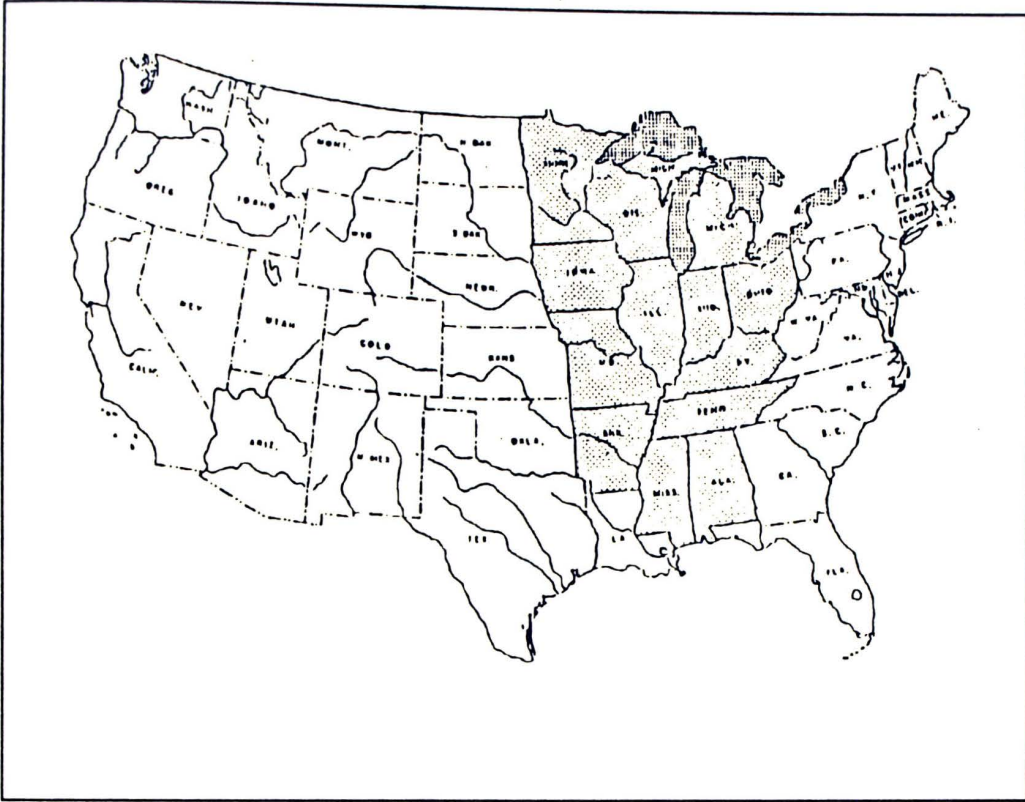


Figure 2. Map of the Contiguous United States, with Mississippi Flyway States Stippled.

November, 1962/63 through 1991/92

	1962/63 to 1967/68	1969/70 to 1973/74	1974/75 to 1979/80	1980/81 to 1985/86	1986/87 to 1991/92	Mean for all 30 years
WODU	641	668	511	280	87	429
AGWT	17	223	424	448	247	274
ABDU	1,915	3,201	3,339	2,371	1,802	2,502
MALL	10,235	13,653	12,956	9,934	5,811	10,410
NOPI	526	342	336	362	170	348
BWTE	13	1	---	4	6	5
GADW	396	391	323	356	785	452
AMWI	1,019	1,960	1,680	913	495	1,188
RNDU	900	224	244	689	1,073	640
LESC	814	67	62	33	18	203
CAGO	531	2,309	4,979	5,942	2,043	3,190

## Goals and Objectives

The main goal of my study was to analyze waterfowl usage of CCNWR for the first thirty years of its existence, excluding the winter of 1968/69. This goal included the following objectives:

1. Computation of waterfowl use for the winters of 1962/63 through 1991/92, excluding 1968/69, by using weekly count data recorded by refuge personnel.
2. Comparison of trends in CCNWR's waterfowl populations to those of North American waterfowl as a whole.
3. Comparison of post-1962 waterfowl usage of CCNWR to pre-1962 usage of KWNWR.
4. Correlation of waterfowl usage of CCNWR to annual weather patterns.
5. Determination of 30-year trends in waterfowl usage of Cross Creeks for the total number of ducks and geese as well as for individual species.

## Literature Survey

Much of the published literature on wintering waterfowl deals primarily with feeding ecology (Jorde et al. 1983; Paulus 1982), physiological condition (Rave and Baldassare 1991; Hohman et al. 1988), and activity budgets (Rave and Baldassare 1989; Paulus 1988). There is relatively little

literature on use of refuges and other sanctuaries, particularly national wildlife refuges, by wintering waterfowl. Although waterfowl use of national wildlife refuges is routinely documented by refuge employees, little of this information has been published. Robinson (1991) studied bird utilization (all species--not just waterfowl) of wetland impoundments at CCNWR. Robinson and Blunk (1989) documented waterfowl use of CCNWR and the rest of Stewart County.

## Chapter 2

### STUDY SITE

The headquarters of Cross Creeks National Wildlife Refuge is located four miles east of Dover, Tennessee, in Stewart County. The refuge consists of 3586 ha of Cumberland River floodplain and adjacent, mostly wooded uplands. CCNWR extends on both sides of the Cumberland River from river mile 91 in the northwest to river mile 101 in the southeast (Figure 3). It contains 16 managed water impoundments that range in size from 4 to 147 ha (Robinson 1991). The water levels of these pools are manipulated to promote the growth of moist-soil plants. In addition to the 16 managed water pools, the refuge also contains five reservoirs that provide permanent, deep water habitat.

#### Physiography, Geology, and Soils

Cross Creeks National Wildlife Refuge occurs within the Western Highland Rim Section of the Interior Low Plateau Physiographic Province as described by Fenneman (1938). The Western Highland Rim is the western half of the plateau that surrounds the Nashville Basin. The highest elevational points of the rim range from 275 m ASL (above sea level) near the Nashville Basin to about 215 m ASL near the Tennessee River valley (Luther 1977).

The refuge is underlain by Mississippian Age St. Louis

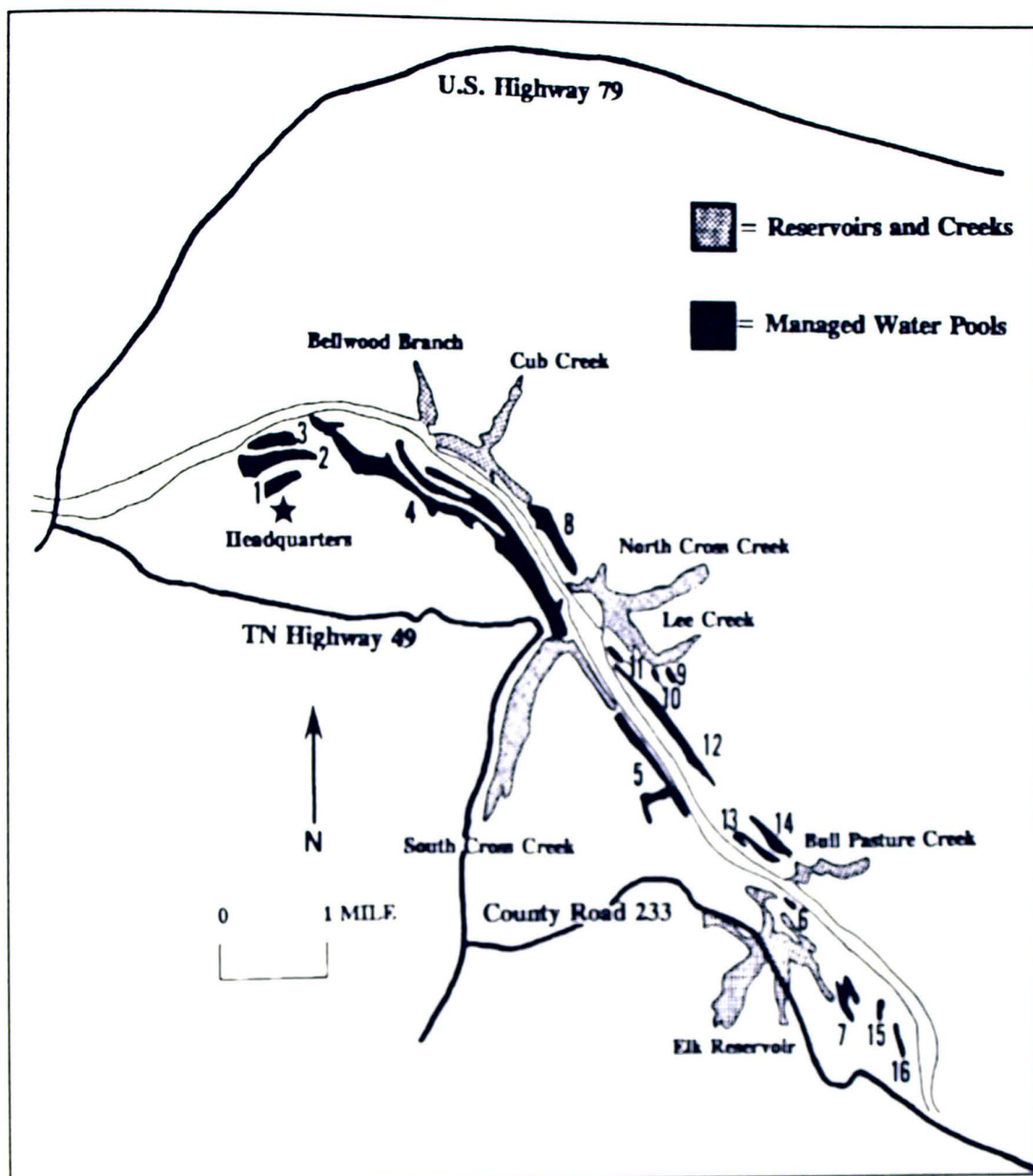


Figure 3. Map of Cross Creeks National Wildlife Refuge Depicting the 16 Water Impoundments (Numbers) and Creeks and Reservoirs.

and Warsaw Limestones (Hardeman 1966). Outcroppings of these limestones occur along the Cumberland River. The high content of limonite in the limestone allowed Stewart County to become one of the great iron producing regions in the United States in the nineteenth Century (until the Civil War, in the 1860's) (Luther 1977). Quaternary Age alluvial deposits, up to 18 m thick, occur along the river (Hardeman 1966).

The soils occurring along the Cumberland River in Stewart County belong to the Baxter-Mountview-Dickson Association (Springer and Elder 1980). Baxter soils make up 25% of the association, Mountview 15%, and Dickson soils 10% (Springer and Elder 1980). Various other soil types comprise the remaining 50%.

### Vegetation

Cross Creeks National Wildlife Refuge is located within the Western Mesophytic Forest Region of the Eastern Deciduous Forest as delineated by Braun (1950). Braun (1950) describes this region as a transition zone from the more easterly, mixed mesophytic communities and the western oak-hickory forest communities. Cross Creeks National Wildlife Refuge contains a mixture of upland and bottomland forests. The upland forests are dominated by oaks (Quercus) and hickories (Carya) while the bottomlands consist of more mesophytic species such as shagbark hickory (Carya ovata),

American beech (Fagus grandifolia), cherrybark oak (Quercus pagoda), and swamp chestnut oak (Quercus michauxii). The Western Mesophytic Forest Region is characterized by having a relatively high tree species diversity rather than being dominated by a single species (Braun 1950).

### Climate

The climate of Stewart County is mild. The summers are long and warm, and the winters short and mild. Weather records from the Dover, Tennessee weather station show that the mean annual temperature is about 15° C, while the mean summer and winter temperatures are 25° C and 4° C, respectively (U.S. Dept. of Agriculture 1953). Mean annual precipitation is 122 cm and is well distributed among the seasons (U.S. Dept. of Agriculture 1953).

## Chapter 3

### METHODS

Published data on wildlife refuges, waterfowl management practices, and waterfowl were obtained through computer and manual searches of the literature.

Most of the information for this study was gleaned from weekly waterfowl surveys kept by refuge personnel since 1962. Data were obtained for all thirty years except for the winter of 1968/69 for which no weekly waterfowl surveys were found. The majority of these waterfowl surveys were recorded in October through March, months in which waterfowl use is highest at CCNWR. For the purpose of this study, the winter season includes the months of October through March. Weekly waterfowl surveys give the species of waterfowl and the numbers present. Both descriptive and inferential statistics were used to analyze the data from these reports.

Descriptive statistics included calculating mean numbers of ducks and geese recorded on weekly surveys for the months of October through March, 1962/63 through 1991/92, excluding 1968/69. Mean numbers recorded on weekly surveys were calculated for total ducks and geese, not individual species. Peak waterfowl numbers were used to examine 30-year trends (except 1968/69) for individual species.

Spearman's rank correlation (.05 alpha level) was used

to correlate annual weather patterns with peak duck and goose counts at CCNWR to determine if more waterfowl were recorded during colder winters. Spearman's rank correlation was calculated using Key Stat (Eckblad 1986). Annual weather data considered were average winter temperatures at breeding grounds and at CCNWR. The average winter temperature for a particular winter was calculated by averaging the mean monthly temperatures for October through March.

Weather data for CCNWR were obtained for the Dover, Tennessee weather station for the entire 30-year period. These data were obtained in Climatological Data Annual Summaries for Tennessee (U.S. Dept. of Commerce 1962 to 1992). Breeding ground temperatures for ducks were obtained for the Regina, Saskatchewan weather station. The Regina station was used because it is centrally located within the prairie pothole region, an area that produces 50% of North America's ducks (Smith et al. 1964). These ducks (Mallard, American Wigeon, Northern Pintail, Gadwall, Ring-necked Duck, and Lesser Scaup) comprise over 80% of the refuge's duck population. Temperatures at Canada Goose breeding grounds were obtained for the Moosonee, Manitoba weather station. The Moosonee weather station is located in the breeding grounds of the Southern James Bay Population of Canada Geese, the population that winters at CCNWR. Weather data for the Regina and Moosonee weather stations were

located in World Weather Records: North America (U.S. Dept. of Commerce 1979 and 1989). Weather data for duck and goose breeding grounds were obtained only for the winters of 1962/63 through 1979/80.

North American waterfowl population data were found in the 1992 Fall Flight Forecast (U.S. Dept. of Interior, Fish and Wildlife Service, and Environment of Canada, Wildlife Service 1992). These data include breeding population estimates for many of the common species of ducks and geese wintering in the United States from 1955 to 1992.

Spearman's rank correlation (.05 alpha level) was used to correlate a species' continental breeding population with the species' refuge population. This correlation was calculated for Green-winged Teal, Mallards, American Wigeons, and Gadwalls.

Waterfowl use data for the Kentucky Woodlands National Wildlife Refuge were obtained from weekly waterfowl reports recorded by KWNWR personnel. These reports are deposited at the U.S. Fish and Wildlife Service's regional office in Atlanta, Georgia.

Raw data from the weekly waterfowl reports were entered and stored in a PC-III database program at the Biology Department at Austin Peay State University in Clarksville, Tennessee. Results of the weekly waterfowl surveys, 1962/63 to 1991/92 (except 1968/69), are stored in three-ring binders in the Austin Peay State University Museum of

Zoology. Some of the raw data, for 11 of the main species, were condensed and are listed in the Appendix.

## Chapter 4

### RESULTS

#### CCNWR vs KWNWR

In the first 30 years, excluding 1968/69, of CCNWR's existence, peak waterfowl usage averaged around 78,000 per year. A twenty-year average (1944 to 1964) for the KWNWR was approximately 40,000 waterfowl per year.

Thirty-three (2 swans, 6 geese, and 25 ducks) of the 48 species of waterfowl (43 native breeders and 5 vagrants) that have been documented in North America have been reported at CCNWR since 1962 (Table 1). Nine of these (Mute Swan, Brant, Barnacle Goose, Ross' Goose, Cinnamon Teal, Fulvous Tree Duck, Greater Scaup, Oldsquaw, and White-winged Scoter) have been reported from the refuge three or fewer times and may be considered accidentals. The Tundra Swan and Eurasian Wigeon have occurred at CCNWR more than thrice but should probably also be considered accidentals.

#### Swans

The two swan species documented from the refuge are the Mute Swan and the Tundra Swan. Two Mute Swans were reported in 1978, and one in 1984. At least one Tundra Swan was reported from CCNWR during 16 of the first 30 years of the refuge's existence, excluding data for the winter of 1968/69. Most reports of Tundra Swans are of one or two

Table 1. Species of Waterfowl Reported from Cross Creeks National Wildlife Refuge from 1962 through 1992, excluding 1968/69.

---

### SWANS

- Tundra Swan (Cygnus columbianus)  
 \*Mute Swan (Cygnus olor)

### GEESE

- Greater White-fronted Goose (Anser albifrons)  
 Snow Goose (Chen caerulescens)  
 \*Ross' Goose (Chen rossii)  
 Brant (Branta bernicla)  
 \*Barnacle Goose (Branta leucopsis)  
 Canada Goose (Branta canadensis)

### DUCKS

- \*Fulvous Whistling Duck (Dendrocygna bicolor)  
 Wood Duck (Aix sponsa)  
 Green-winged Teal (Anas crecca)  
 American Black Duck (Anas rubripes)  
 Mallard (Anas platyrhynchos)  
 Northern Pintail (Anas acuta)  
 Blue-winged Teal (Anas discors)  
 \*Cinnamon Teal (Anas cyanoptera)  
 Northern Shoveler (Anas clypeata)  
 Gadwall (Anas strepera)  
 Eurasian Wigeon (Anas penelope)  
 American Wigeon (Anas americana)  
 Canvasback (Aythya valisineria)  
 Redhead (Aythya americana)  
 Ring-necked Duck (Aythya collaris)  
 \*Greater Scaup (Aythya marila)  
 Lesser Scaup (Aythya affinis)  
 \*Oldsquaw (Clangula hyemalis)  
 \*White-winged Scoter (Melanitta fusca)  
 Common Goldeneye (Bucephala clangula)  
 Bufflehead (Bucephala albeola)  
 Hooded Merganser (Lophodytes cucullatus)  
 Common Merganser (Mergus merganser)  
 Red-breasted Merganser (Mergus serrator)  
 Ruddy Duck (Oxyura jamaicensis)
- 

Asterisk (\*) indicates those species reported three times or less. Species are in order according to the American Ornithologist's Union (AOU), 1983.

individuals, but 11 were recorded in February, 1979.

### Geese

Mean numbers of geese recorded on weekly surveys for the months of October through March, 1962/63 through 1991/92 (excluding 1968/69), are shown in Figure 4. The highest weekly means (about 12,000) occurred in January. Figure 4 also shows the increase of geese at CCNWR from fall to winter and the decrease from winter to spring, reflecting the fact that CCNWR is primarily an overwintering area for waterfowl.

Of the six species of geese documented, three (Brant, Barnacle Goose, and Ross' Goose) were reported on three or fewer occasions, and should probably be considered accidentals. Two Brant were reported from the refuge on 17 December 1981; one of these birds lingered throughout 1982 and was last seen on 4 January 1983 (Robinson and Blunk 1989).

The Barnacle Goose was reported from CCNWR during three winters (2 birds in 1975/76, 1 in 1983/84, and 10 in 1990/91). Ross' Goose was first observed at CCNWR (and in Tennessee) on 20 November 1986 (Robinson and Blunk 1989). The Ross' Goose has since been observed twice (1987/88 and 1990/91), with one individual being seen both times.

The Greater White-fronted Goose and Snow Goose have

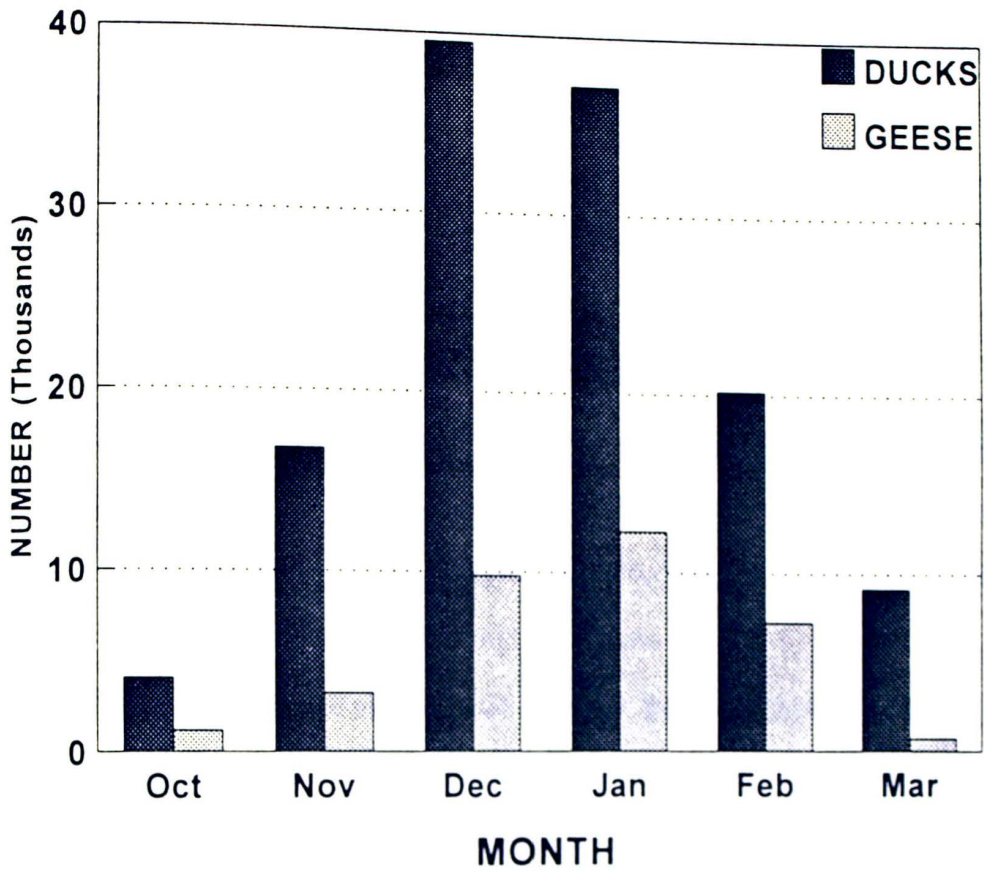


Figure 4. Mean Numbers of Ducks and Geese Recorded on Weekly Waterfowl Surveys at CCNWR for the Months of October through March, 1962 through 1992 (Excluding 1968/69).

been observed more frequently than the three preceding species. The Greater White-fronted Goose was reported in 11 of the first 30 winters, excluding 1968/69 (maximum count = 11 individuals).

Snow Geese (Figure 5) occurred at CCNWR during nearly every year, but usually in low numbers (mean of yearly peak counts = 144).

Canada Geese comprised 99.9% of the mid-winter (January) goose population recorded on weekly surveys during the 30-year period, excluding 1968/69. Peak Canada Goose counts from the refuge averaged approximately 19,000, with a high of 73,500 and a low of 40 (Figure 6).

Southern James Bay Canada Goose population figures, based on December surveys from 1969 through 1991, are also shown in Figure 6. These December surveys, although not conducted at James Bay, provide an estimate of the size of the Southern James Bay population. The surveys were conducted throughout the Mississippi Flyway in December of each year. Based on banding records, the majority of Canada Geese reported from CCNWR are members of the Southern James Bay Population (Figure 7).

I attempted to determine if fluctuations in CCNWR's Canada Goose population were correlated with annual weather patterns, specifically average winter temperatures at Dover, Tennessee and breeding ground winter temperatures at Moosonee, Manitoba (Table 2). At the .05 alpha level,

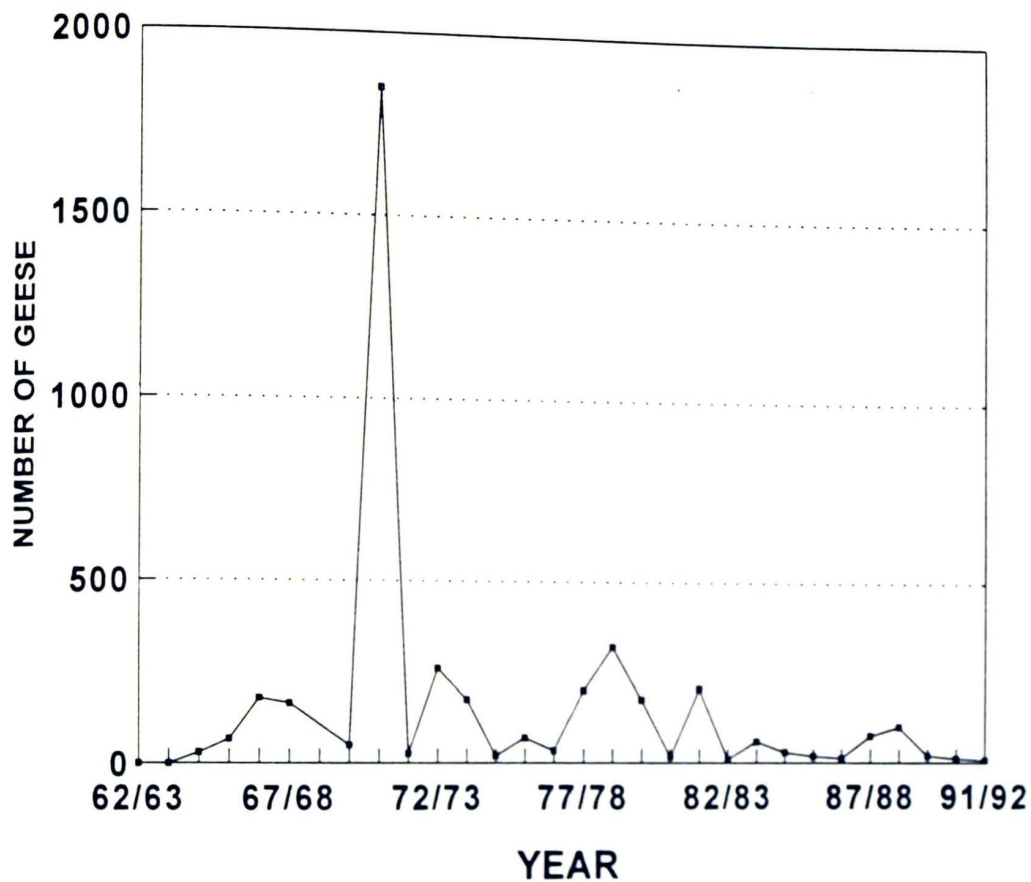


Figure 5. Thirty-year Trend (Except 1968/69) of Peak Snow Goose Counts at Cross Creeks National Wildlife Refuge from 1962/63 through 1991/92.

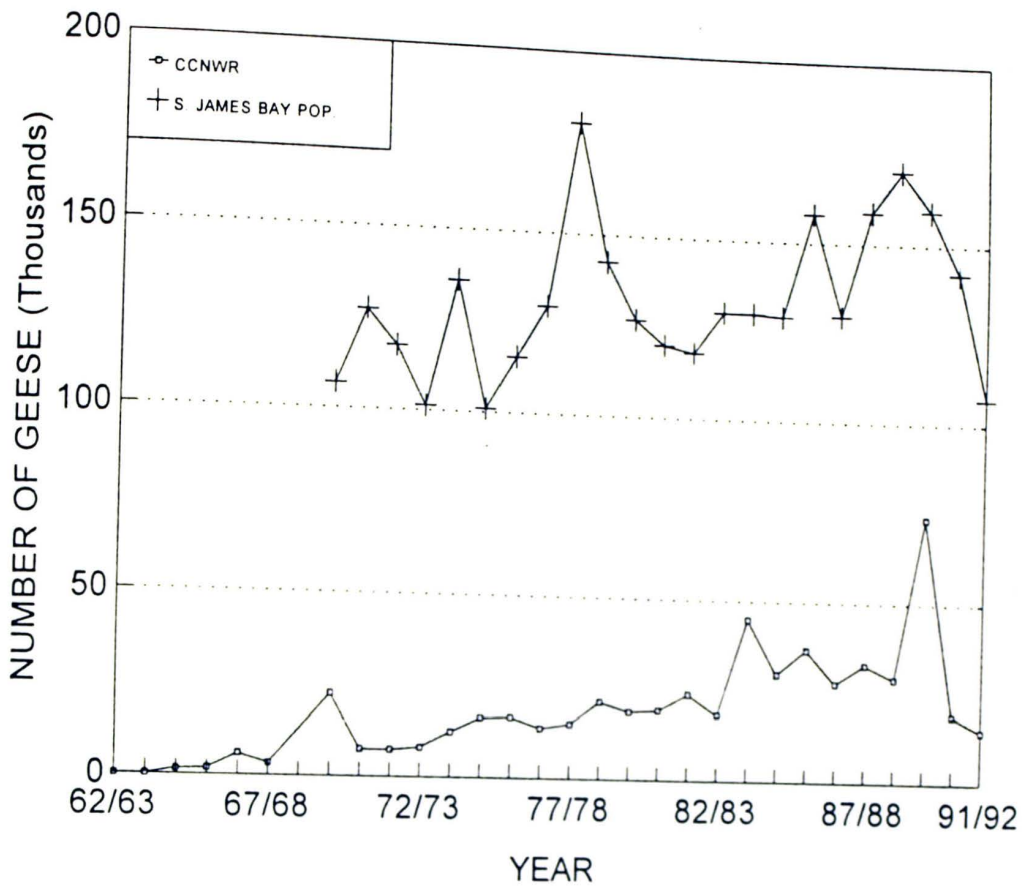


Figure 6. Thirty-year Trends of Peak Canada Goose Counts at Cross Creeks National Wildlife Refuge (Excluding 1968/69), and of the Breeding Population at Southern James Bay. Data for the Southern James Bay population were obtained from the U.S. Fish and Wildlife Service's 1992 Fall Flight Forecast.

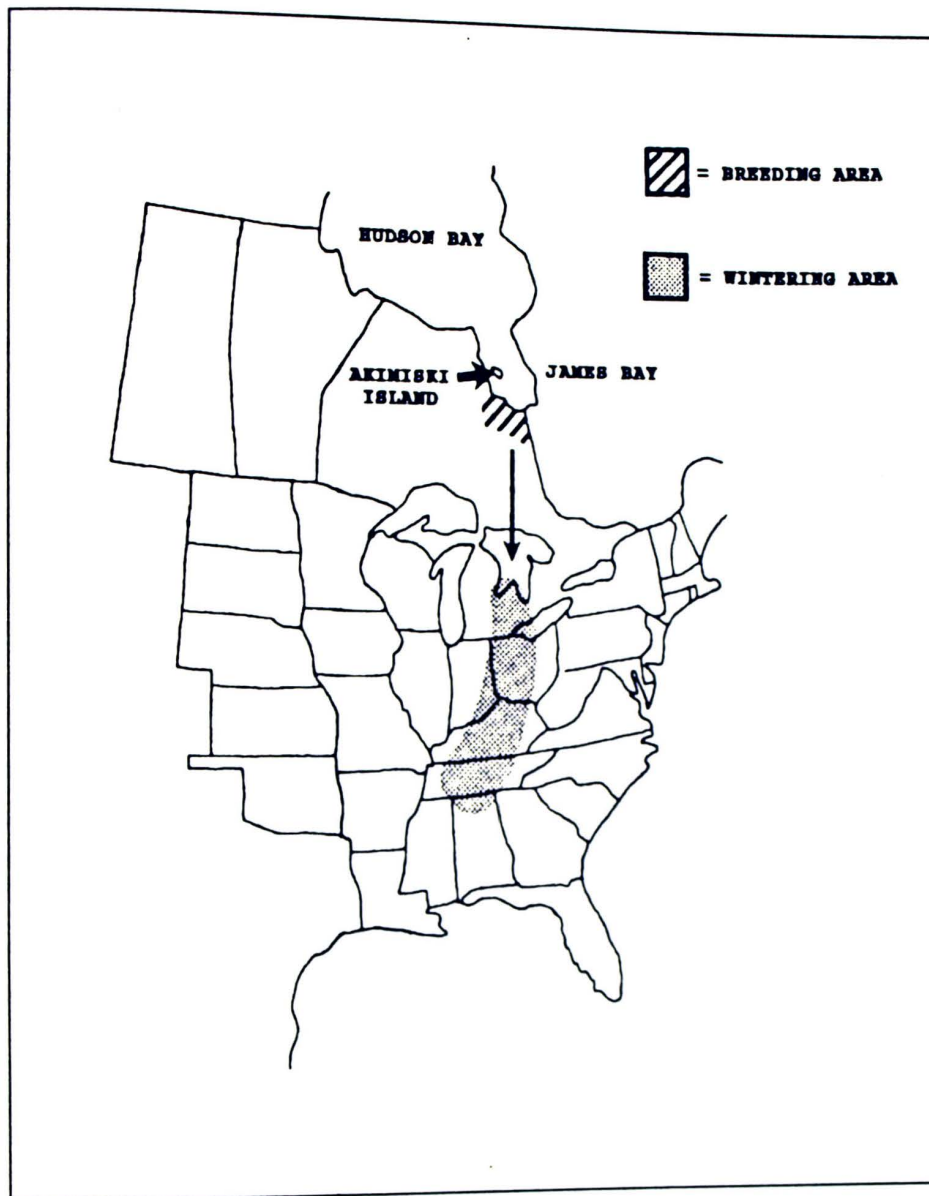


Figure 7. Map of the United States and Canada Depicting the Breeding and Wintering Areas of the Southern James Bay Population of Canada Geese.

**Table 2.** Results of the Spearman's Rank Correlation Test between Peak Duck and Goose Numbers Recorded at CCNWR and Mean Winter Temperatures (air) at CCNWR, 1962 to 1992, and Mean Winter Temperatures (October through March) at Duck and Goose Breeding Grounds, 1962 to 1980 (excluding 1968/69).

	$R_s$	Critical Value
Duck use vs TN temperatures	.020	.368
Duck use vs Regina temperatures	.534*	.485
Goose use vs TN temperatures	.102	.368
Goose use vs Moosonee temperatures	.057	.485

Duck and goose breeding ground temperatures were obtained for the Regina, Saskatchewan and Moosonee, Manitoba weather stations, respectively.  $R_s$  is the Spearman's Rank Correlation value. An asterisk (\*) indicates a significant correlation at the .05 alpha level.

neither of these temperature data sets correlated with Canada Goose numbers at the refuge. However, fluctuations in CCNWR's population were correlated (.05 alpha) with fluctuations in the Southern James Bay Population.

### Ducks

The mean numbers of ducks recorded on weekly surveys for the months of October through March, 1962/63 through 1991/92 (excluding 1968/69), are shown in Figure 4. The highest weekly means (about 39,000) occurred in December. The thirty-year trend of peak duck counts at CCNWR, 1962/63 through 1991/92 (excluding 1968/69), is shown in Figure 8.

I attempted to correlate peak numbers of ducks at CCNWR with average winter temperatures at the duck's breeding grounds (Regina, Saskatchewan) and at CCNWR (Dover, Tennessee). At the .05 alpha level, peak duck numbers at CCNWR were inversely correlated with average winter temperatures on their breeding grounds, but not with CCNWR temperatures (Table 2).

Duck populations recorded at CCNWR on an average weekly survey in September (fall) were dominated by Wood Ducks (72%) and Blue-winged Teal (15%) (Figure 9). Ducks documented on an average weekly survey in January (winter) were mostly Mallards (74%) and American Black Ducks (15%) with Gadwalls, American Wigeons, Ring-necked Ducks, and Northern Pintails collectively comprising another 8%

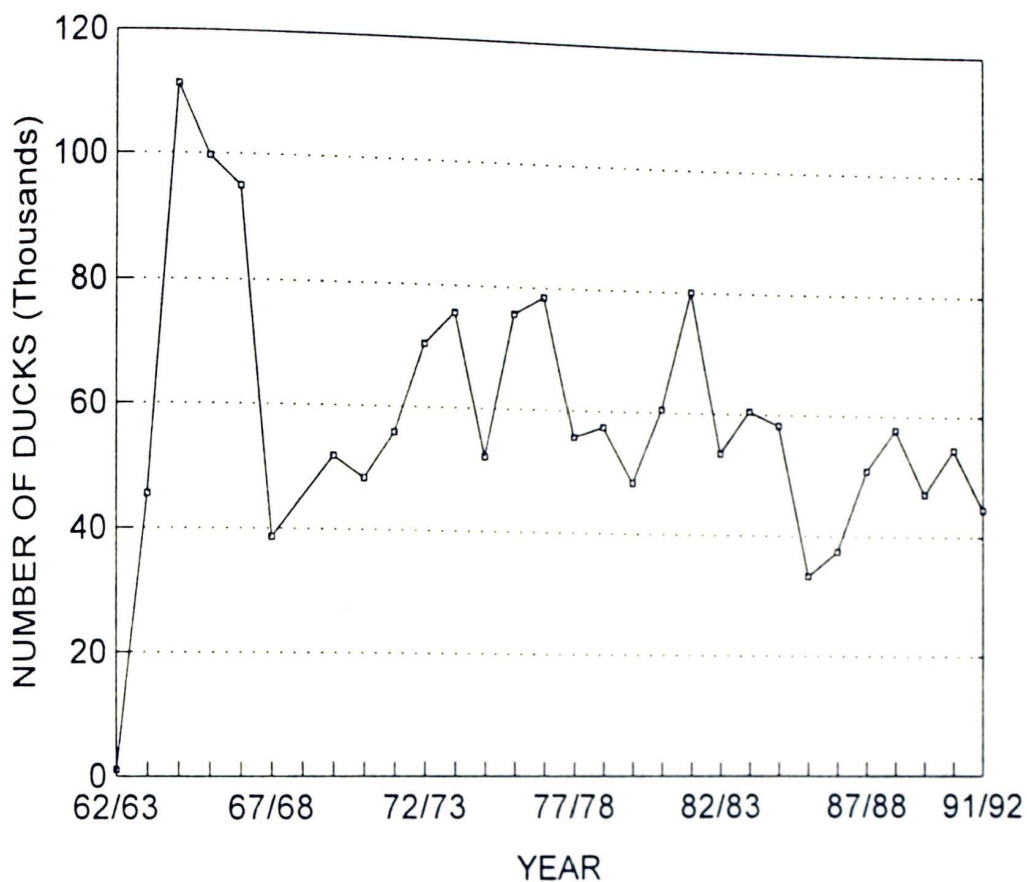


Figure 8. Thirty-year Trend of Peak Duck Counts at Cross Creeks National Wildlife Refuge from 1962/63 through 1991/92, Excluding 1968/69.

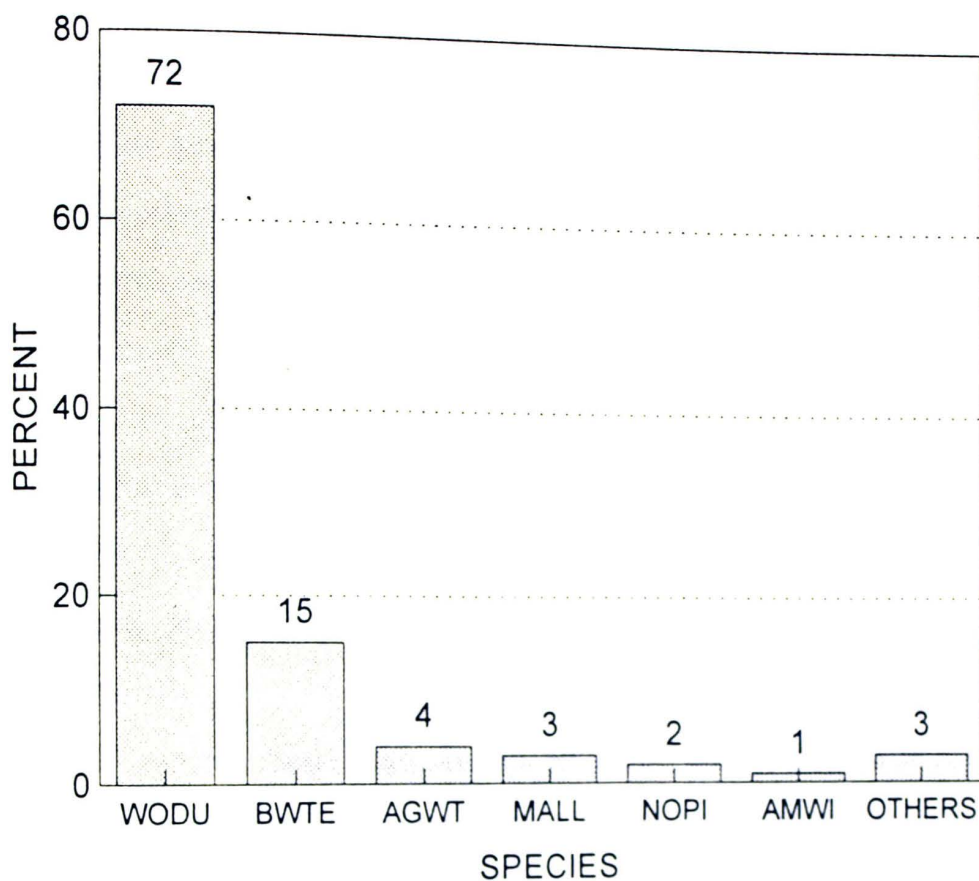


Figure 9. Species Composition of a Typical September Duck Population at Cross Creeks National Wildlife Refuge. Percentages are based on the mean number of each species recorded on weekly waterfowl surveys in September, 1962/63 through 1991/92, excluding 1968/69. (WODU = Wood Duck, BWTE = Blue-winged Teal, AGWT = American Green-winged Teal, MALL = Mallard, NOPI = Northern Pintail, AMWI = American Wigeon).

(Figure 10). A typical weekly survey in March (spring) was still dominated by Mallards (61%) and American Black Ducks (8%), but their percentage of the duck population was decreasing (Figure 11). Whereas the percentage of Mallards and American Black Ducks decreased from January to March, by 13% and 7% respectively, absolute numbers of these two species decreased by 80% and 87%, respectively. Blue-winged Teal comprised a larger percentage of the duck population in March than in January, as that species began to migrate to its northern breeding grounds. Mean numbers of ducks recorded on a weekly survey in the months of September, January, and March for 18 of the most common species are shown in Table 3.

The Cinnamon Teal, Eurasian Wigeon, Fulvous Whistling Duck, Greater Scaup, Oldsquaw, and White-winged Scoter have all been recorded but once or twice at CCNWR and are accidental there. The Cinnamon Teal has been recorded twice on the refuge; one bird in 1973/74 and two in 1989/90. The Eurasian Wigeon was first documented at CCNWR in 1982/83, and since then at least one individual was seen during seven of the subsequent nine winters. The Fulvous Whistling Duck has been recorded but once at the refuge, in 1964/65. This bird was well documented because it was captured several times in a swim-in trap (Robinson and Blunk 1989). At least one Greater Scaup was documented at the refuge during the winter of 1981/82 (Robinson and Blunk 1989). More Greater

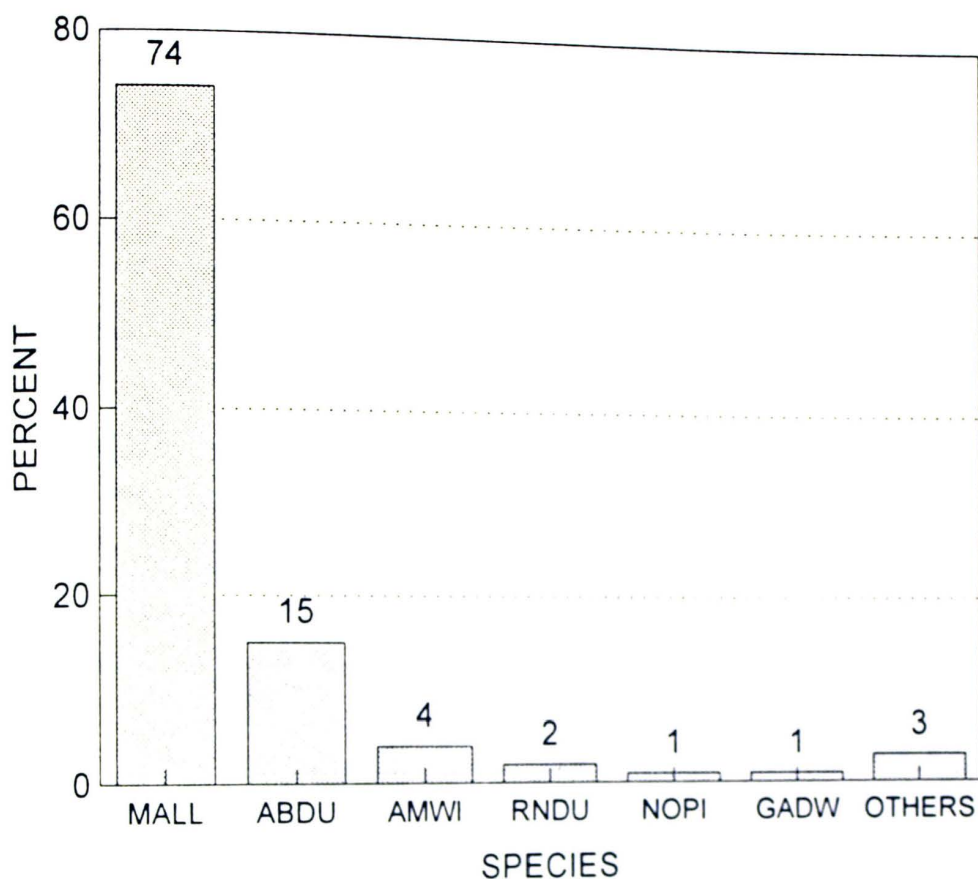


Figure 10. Species Composition of a Typical January Duck Population at Cross Creeks National Wildlife Refuge. Percentages are based on the mean number of each species recorded on weekly waterfowl surveys in January, 1962/63 through 1991/92, excluding 1968/69. (MALL = Mallard, ABDU = American Black Duck, AMWI = American Wigeon, RNDU = Ring-necked Duck, NOPI = Northern Pintail, GADW = Gadwall).

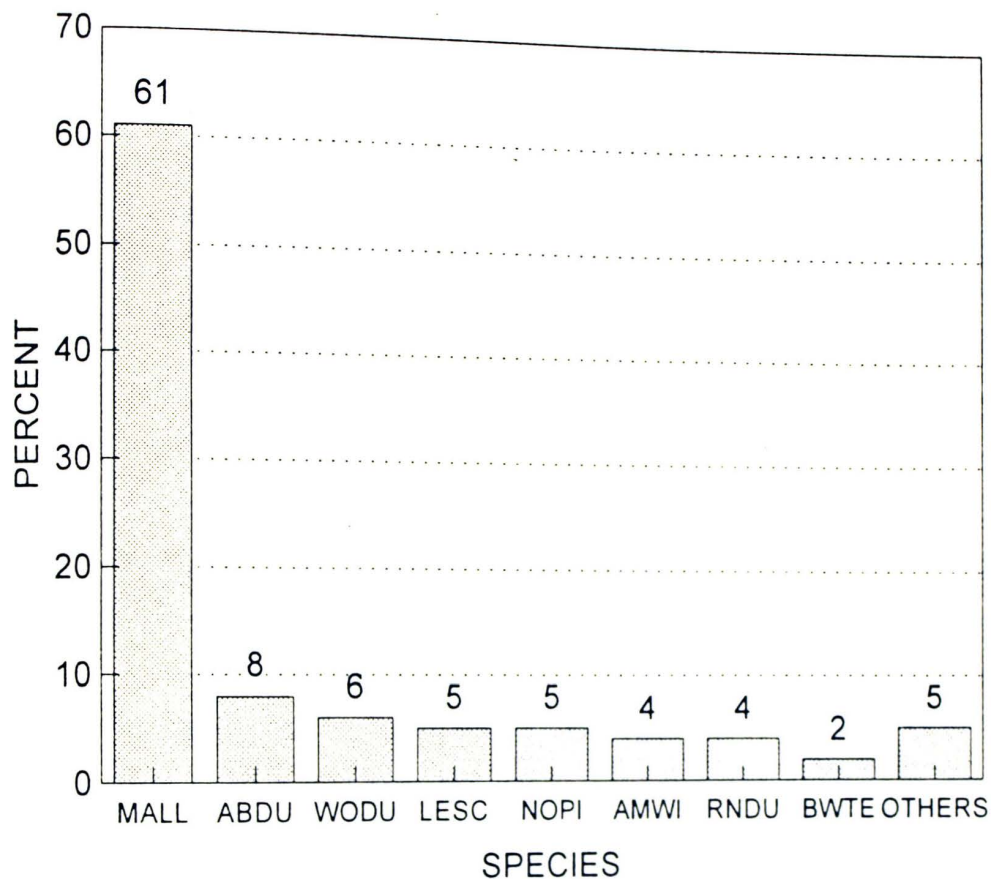


Figure 11. Species Composition of a Typical March Duck Population at Cross Creeks National Wildlife Refuge. Percentages are based on the mean number of each species recorded on weekly waterfowl surveys in January, 1962/63 through 1991/92, excluding 1968/69. (MALL = Mallard, ABDU = American Black Duck, WODU = Wood Duck, LESC = Lesser Scaup, NOPI = Northern Pintail, AMWI = American Wigeon, RNDU = Ring-necked Duck, BWTE = Blue-winged Teal).

Table 3. Mean Numbers of Individuals for 18 Species of Ducks Recorded at CCNWR on Weekly Surveys During Three Different Months over a 30-Year Period (1962 to 1992, excluding 1968/69).

SPECIES	FALL (Sept.)	WINTER (Jan.)	SPRING (March)
WODU	1,140 (72)	340 (<1)	575 (6)
AGWT	67 (4)	130 (<1)	78 (<1)
ABDU	21 (1)	5,750 (15)	760 (8)
MALL	52 (3)	27,400 (74)	5,550 (61)
NOPI	32 (2)	440 (1)	420 (5)
BWTE	250 (16)	.5 (<1)	190 (2)
NSHO	13 (<1)	28 (<1)	110 (1)
GADW	4 (<1)	430 (1)	135 (2)
AMWI	10 (<1)	1,300 (4)	400 (4)
CANV	--	75 (<1)	6 (<1)
REDH	--	6 (<1)	15 (<1)
RNDU	--	770 (2)	355 (4)
LESC	--	340 (<1)	500 (5)
COGO	--	19 (<1)	7 (>1)
BUFF	--	7 (<1)	6 (<1)
HOME	--	110 (<1)	14 (<1)
RBME	--	4 (<1)	4 (<1)
RUDU	--	4 (<1)	4 (<1)
TOTALS	1589	37153.5	9129

Percentage of the duck population comprised by each species, for each of these three months, is shown in parentheses. (WODU = Wood Duck, AGWT = Green-winged Teal, ABDU = American Black Duck, MALL = Mallard, NOPI = Northern Pintail, BWTE = Blue-winged Teal, NSHO = Northern Shoveler, GADW = Gadwall, AMWI = American Wigeon, CANV = Canvasback, REDH = Redhead, RNDU = Ring-necked Duck, LESC = Lesser Scaup, COGO = Common Goldeneye, BUFF = Bufflehead, HOME = Hooded Merganser, RBME = Red-breasted Merganser, RUDU = Ruddy Duck)

Scaup may have occurred at the refuge, but were overlooked due to the difficulty of distinguishing this species from the Lesser Scaup. Six Oldsquaws were counted in 1971/72 and one in 1989/90. One White-winged Scoter was observed during the winter of 1985/86.

Eleven species of ducks were frequently documented at the refuge but collectively comprise less than three percent of the records from weekly January surveys. The mean annual peak count of Green-winged Teal was 775 and for Blue-winged Teal it was 820. Thirty-year trends, excluding 1968/69 data, for these two species are shown in figures 12 and 13, respectively. Peak annual counts of Canvasbacks, Hooded Mergansers, and Northern Shovelers averaged between 200 and 260 individuals. Fewer than 60 individuals of each of the following species were recorded annually on peak counts: Common Goldeneye, Common Merganser, Redhead, Red-breasted Merganser, and Ruddy Duck.

The following eight species comprised 98% of the duck population recorded on January weekly surveys for the 30-year period, excluding 1968/69: American Black Duck, American Wigeon, Gadwall, Lesser Scaup, Mallard, Northern Pintail, Ring-necked Duck, and Wood Duck.

Mallards (Figure 14) were the most abundant wintering duck with an average annual peak of 45,000 birds. American Black Ducks (Figure 15) were a distant second with a mean annual peak of 9200. Average annual peak counts for the

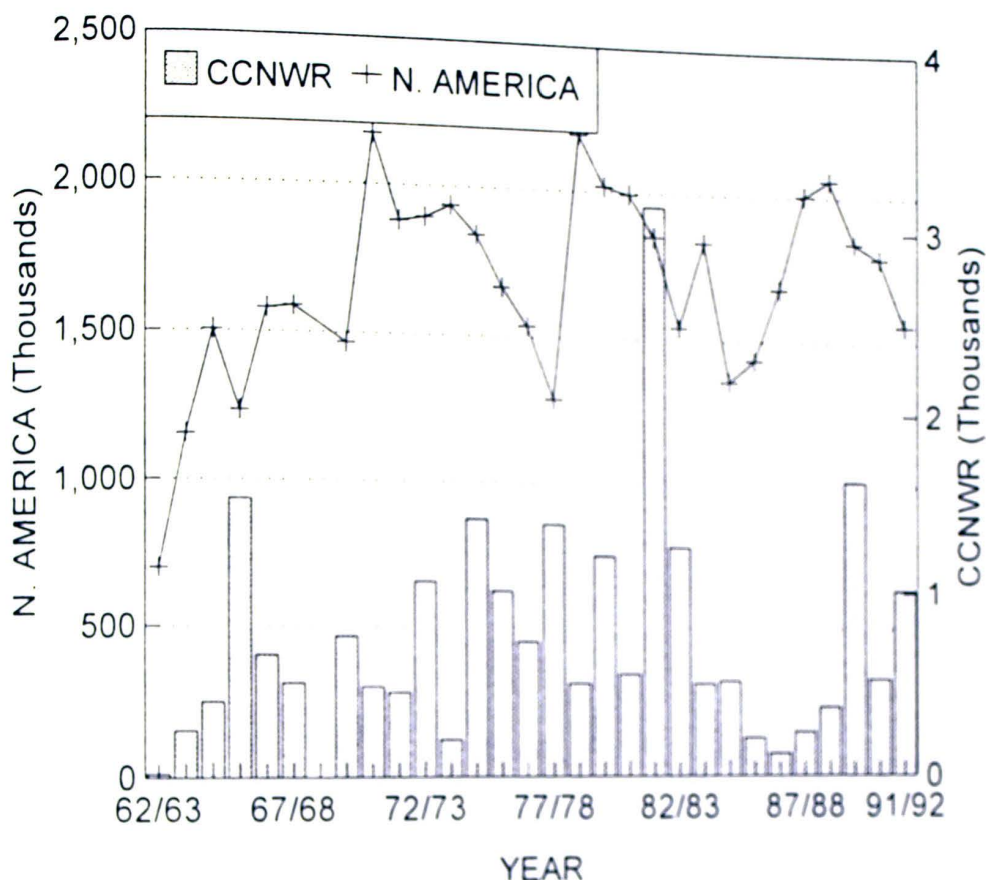


Figure 12. Thirty-year Trends of Peak Green-winged Teal Counts at Cross Creeks National Wildlife Refuge, and of the North American Breeding Population, 1962/63 through 1991/92, Excluding 1968/69. North American breeding population data were obtained from the U.S. Fish and Wildlife Service's 1992 Fall Flight Forecast. At the .05 alpha level, there was no significant correlation between the sizes of these two populations.

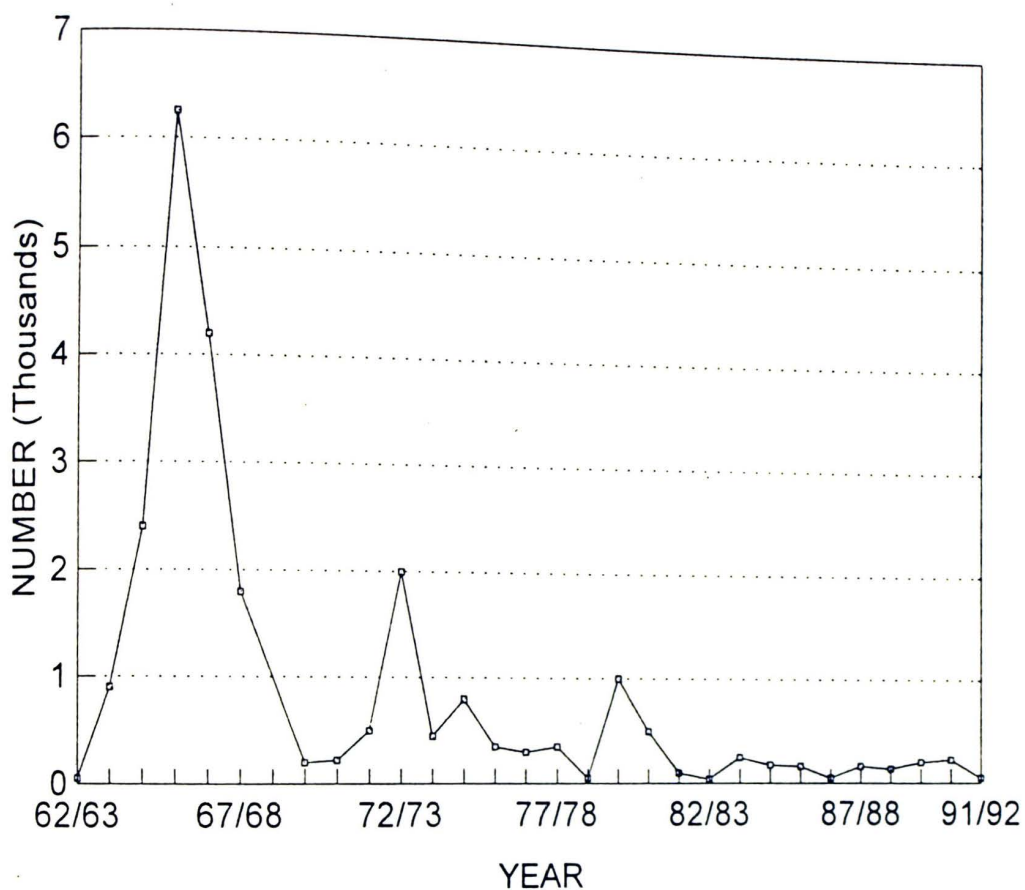


Figure 13. Thirty-year Trend of Peak Blue-winged Teal Counts at Cross Creeks National Wildlife Refuge from 1962/63 through 1991/92, Excluding 1968/69.

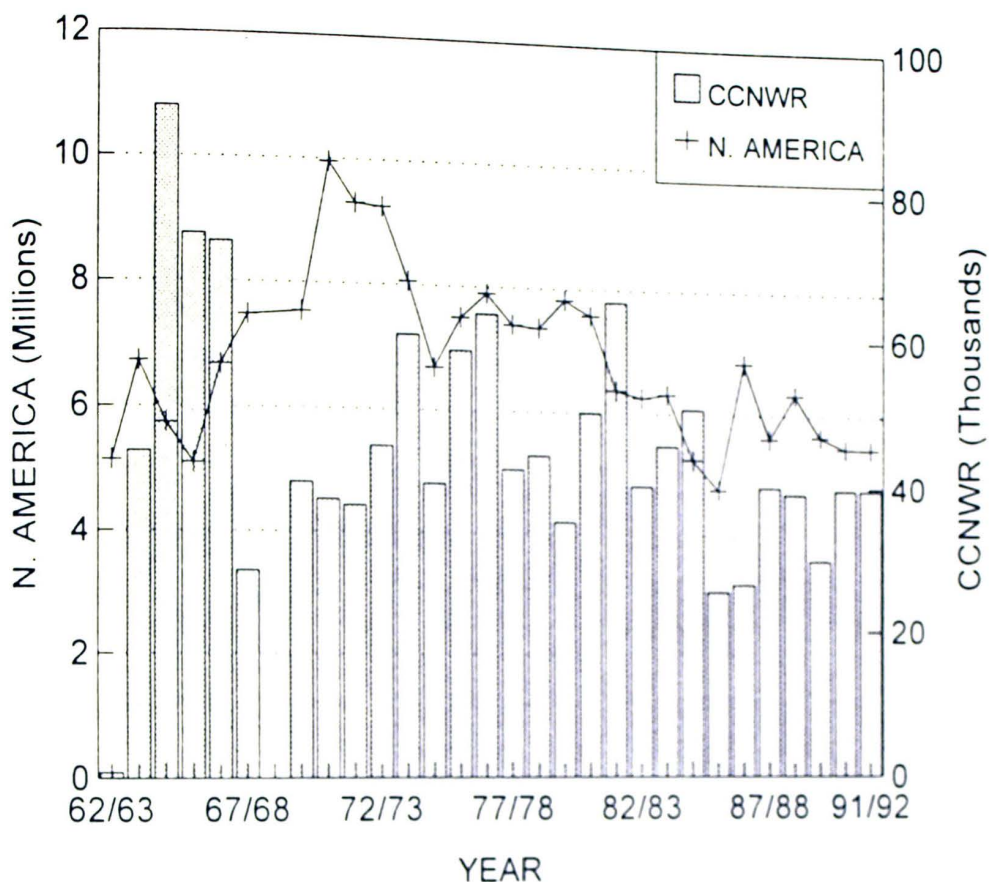


Figure 14. Thirty-year Trends of Peak Mallard Counts at Cross Creeks National Wildlife Refuge, and of the North American Breeding Population, 1962/63 through 1991/92, Excluding 1968/69. North American breeding population data were obtained from the U.S. Fish and Wildlife Service's 1992 Fall Flight Forecast. At the .05 alpha level, there was no significant correlation between the sizes of these two populations.

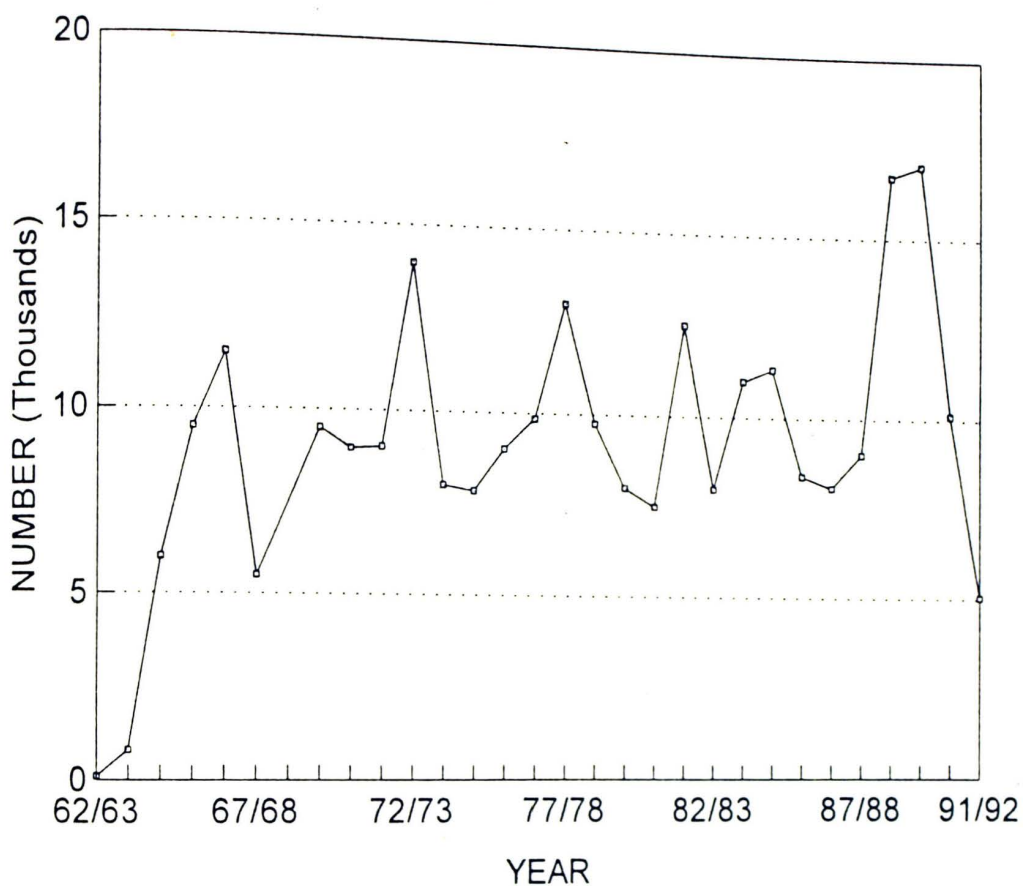


Figure 15. Thirty-year Trend of Peak American Black Duck Counts at Cross Creeks National Wildlife Refuge from 1962/63 through 1991/92, Excluding 1968/69.

remaining species, in order of decreasing abundance were:  
American Wigeon (3300), Ring-necked Duck (2350), Northern  
Pintail (1600), Gadwall (1500), Lesser Scaup (1020), and  
Wood Duck (990). Thirty-year trends for these species are  
shown in Figures 16 to 21.

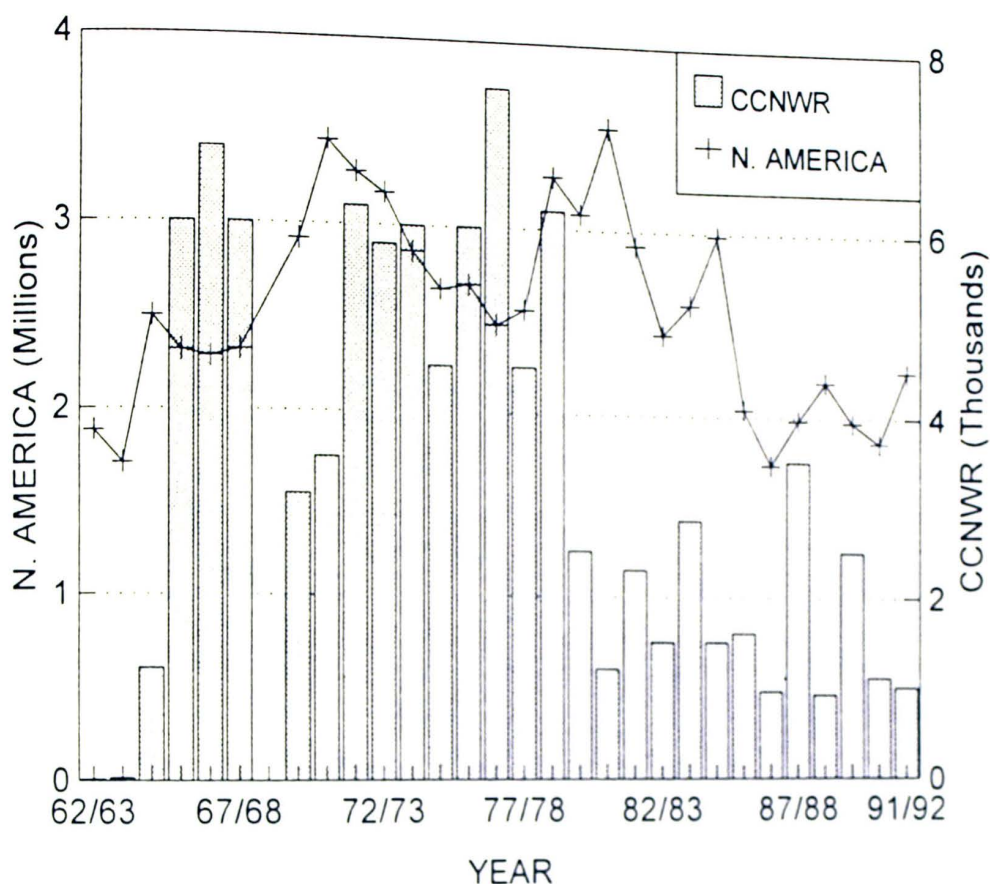


Figure 16. Thirty-year Trends of peak American Wigeon Counts at Cross Creeks National Wildlife Refuge, and of the North American Breeding Population, 1962/63 through 1991/92, Excluding 1968/69. North American breeding population data were obtained from U.S. Fish and Wildlife Service's 1992 Fall Flight Forecast. At the .05 alpha level, there was no significant correlation between the sizes of these two populations.

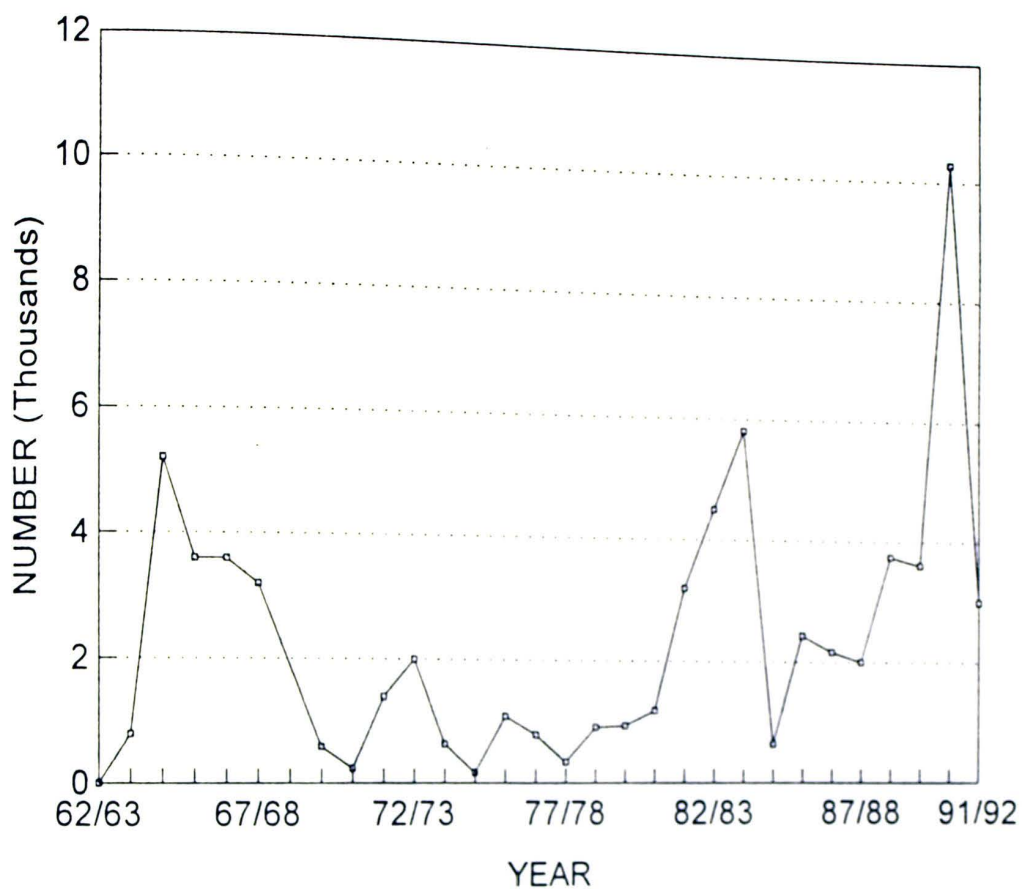


Figure 17. Thirty-year Trend of Peak Ring-necked Duck Counts at Cross Creeks National Wildlife Refuge from 1962/63 through 1991/92, Excluding 1968/69.

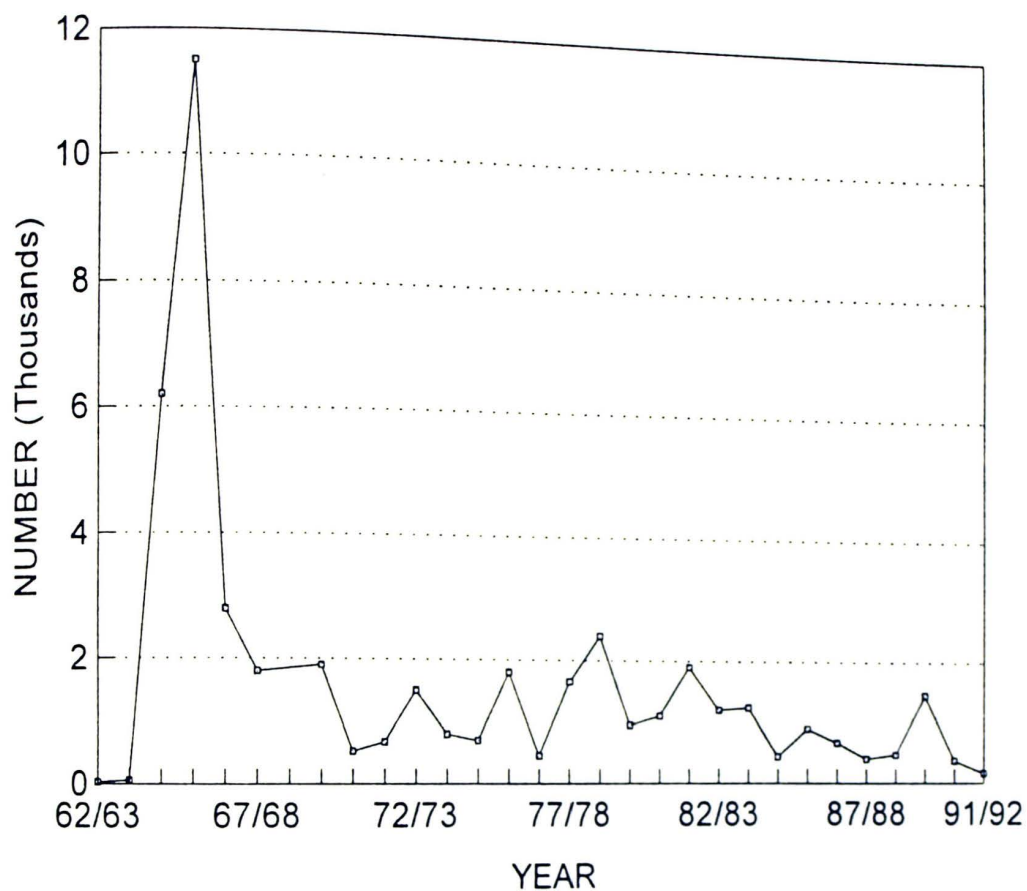


Figure 18. Thirty-year Trend of Peak Northern Pintail Counts at Cross Creeks National Wildlife Refuge from 1962/63 through 1991/92, Excluding 1968/69.

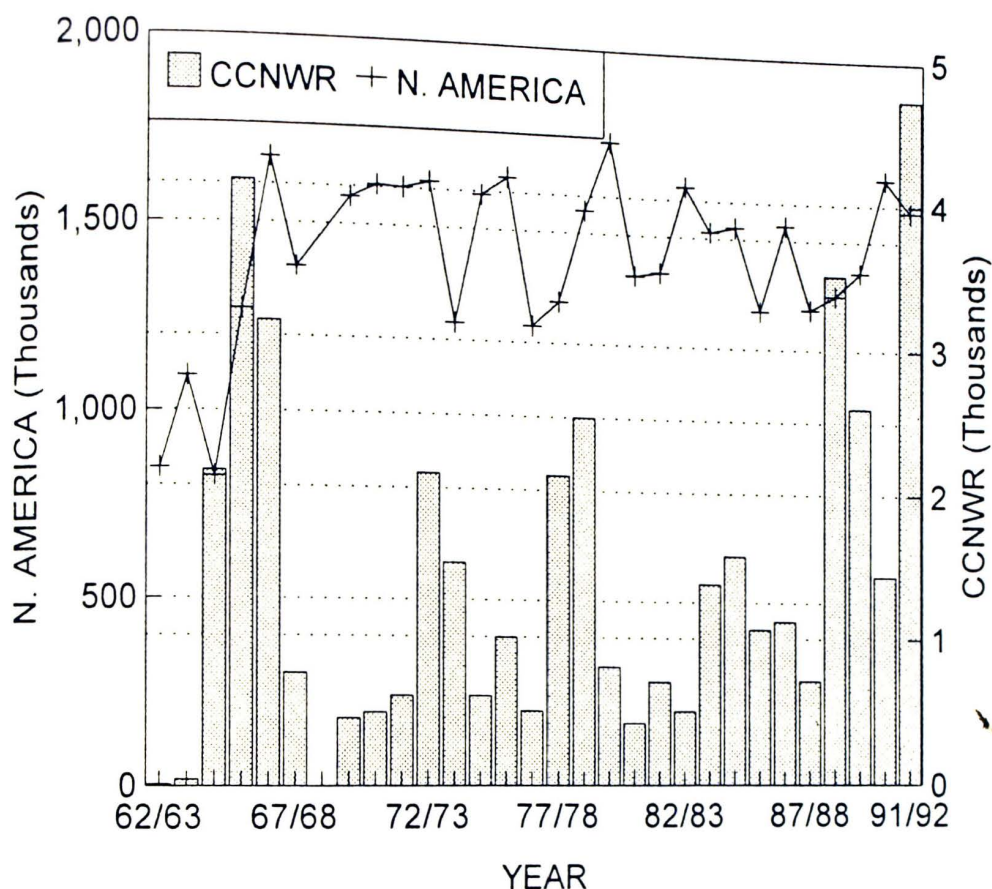


Figure 19. Thirty-year Trends of Peak Gadwall Counts at Cross Creeks National Wildlife Refuge, and of the North American Breeding Population, 1962/63 through 1991/92, Excluding 1968/69. North American breeding population data were obtained from the U.S. Fish and Wildlife Service's 1992 Fall Flight Forecast. At the .05 alpha level, there was no significant correlation between the sizes of these two populations.

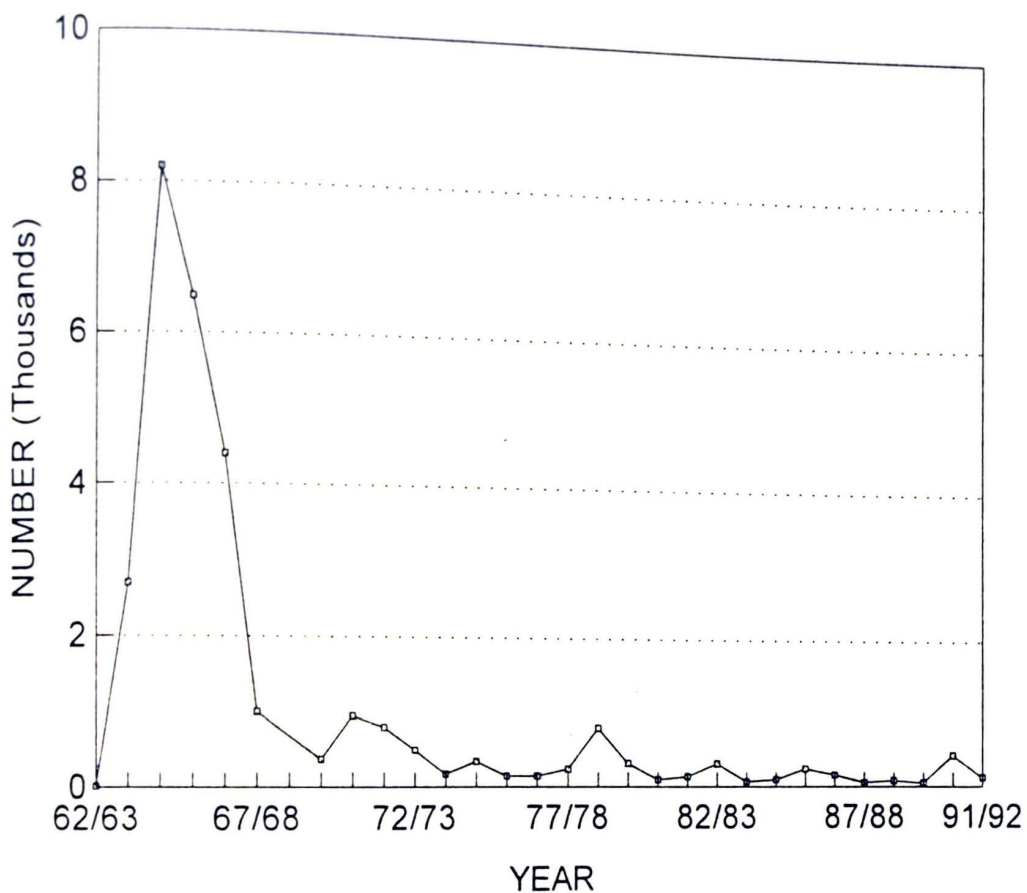


Figure 20. Thirty-year Trend of Peak Lesser Scaup Counts at Cross Creeks National Wildlife Refuge from 1962/63 through 1991/92, Excluding 1968/69.

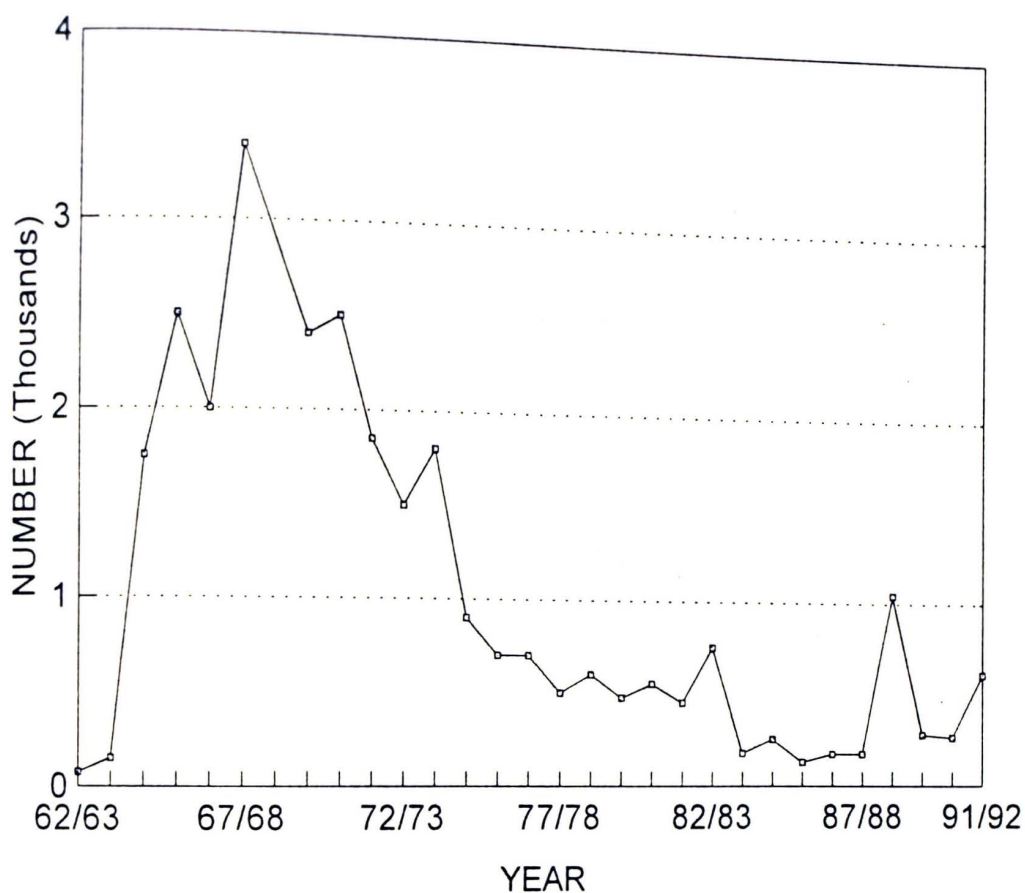


Figure 21. Thirty-year Trend of Peak Wood Duck Counts at Cross Creeks National Wildlife Refuge from 1962/63 through 1991/92, Excluding 1968/69.

## Chapter 5

### DISCUSSION

#### CCNWR vs KWNWR

Peak counts of waterfowl during a typical year at CCNWR were nearly double the peak counts during a typical year at KWNWR. One reason for the greater use of CCNWR by waterfowl may be its extensive network of water impoundments. Unlike CCNWR, KWNWR was not intended to serve primarily as a wintering waterfowl refuge, and therefore did not contain as many water impoundments. Instead, KWNWR contained much upland game habitat that provided homes for many species other than waterfowl.

#### Swans

Two populations of Mute Swans have been established in North America; one in Michigan, and one along the East Coast from Massachusetts to New Jersey. Neither of these populations is known to migrate much more than a hundred miles (Bellrose 1980). Since the Mute Swan is the common swan of parks and zoos, the two records of this species at CCNWR may represent birds from one of these sanctuaries rather than strays from one of the two established North American populations.

Most of the continental population of Tundra Swans winters in the Pacific Flyway (51%) or the Atlantic Flyway (48%) (Bellrose 1980). Individuals occurring elsewhere are

considered vagrants. Bellrose (1980) stated that most vagrants are immatures that have lost their family flocks and have wandered from traditional migration routes. Although vagrants are usually immatures, Bellrose (1980) mentions that entire family flocks have been known to wander from normal migration routes. The 11 birds recorded in February of 1979 may have been a family flock that misoriented from their traditional migration route.

### Geese

Canada Geese were by far the most abundant goose species occurring at CCNWR. Because of their feeding habits, Canada Geese have benefited from man's agricultural practices more than has any other species of waterfowl. The location of CCNWR, in an area that contains much of the nation's best agricultural land, is probably responsible in significant part for the fact that Canada Goose numbers at CCNWR have increased steadily since 1962. Canada Goose populations in the Mississippi Flyway increased 169.5% from 1955 to 1974 (Bellrose 1980). In recent years, CCNWR's Canada Goose population has experienced a slight decline. This decline may reflect decreases in the Southern James Bay Population, which has declined during the same period due to poor nesting conditions, primarily late snow melts (U.S. Dept. of Interior, Fish and Wildlife Service, and Environment of Canada, Wildlife Service 1992).

The long-term outlook for this population appears good, due to increased nesting activity on Akimiski Island (U.S. Dept. of Interior, Fish and Wildlife Service, and Environment of Canada, Wildlife Service 1992).

The three records of the Barnacle Goose at CCNWR are significant because Bellrose (1980) stated that since the turn of the century there have been fewer than 20 records of this goose in North America. Since three records of this goose have been reported from CCNWR since 1962, it appears that the Barnacle Goose is occurring in North America with increasing frequency.

Mean yearly peak Snow Goose counts at CCNWR over the 30-year period treated in this study are deceptively high due to exceptionally large numbers recorded on the refuge in 1970/71 (Figure 5).

### Ducks

There are two major groups of ducks: dabblers and divers. Dabblers (puddle ducks) are those that tip up (tip vertically in the water so that their head is below and their tail above the water's surface) to feed, and can spring directly into flight from the water's surface. Divers, as their name implies, obtain most of their food by diving below the water's surface. Divers cannot spring directly into flight, and need to "run" on the water's surface to lift into flight. By having their legs attached

farther back on their bodies, divers are morphologically better adapted to diving than are dabblers.

Some dabbling duck species are: American Black Duck, Green-winged Teal, American Wigeon, Blue-winged Teal, Gadwall, Mallard, Northern Pintail, and Northern Shoveler. Diving duck species include: Bufflehead, Canvasback, Common Goldeneye, Lesser Scaup, Redhead, and Ring-necked Duck. A third group of ducks, called mergansers, are also considered divers but are more specialized than the preceding divers. The Wood Duck and Fulvous Whistling Duck fit in neither of these categories. Dabblers comprised the greatest number of individual ducks recorded on mean weekly surveys at CCNWR over the period of this study, but divers comprised the greatest number of species. Many of CCNWR's water impoundments are shallow and provide habitat more suitable to dabblers than to divers.

Many of the fluctuations in the thirty-year trend of peak duck counts at CCNWR (Figure 7) may be due to fluctuations in annual weather patterns. At the .05 alpha level, peak duck numbers at CCNWR were inversely correlated with mean winter temperatures at duck breeding grounds.

Lowest peak numbers of ducks occurred during the first winter (1962/63) of the refuge's existence. This low number was probably due to lack of water impoundments and the fact that hunting was allowed on the refuge during that winter because the U.S. Army Corps of Engineers had not yet turned

over jurisdiction to the U.S. Fish and Wildlife Service. The few ducks recorded at CCNWR during that first winter were documented in the spring when the Cumberland River had flooded the surrounding bottomlands. The highest peak number of ducks occurred in 1964/65, the third year of the refuge's existence. The third winter (1964/65) was the first winter in which the water impoundments were intact and filled. When these pools were first flooded, many invertebrates, which provide food for ducks, probably occurred in the pools. Duck numbers then decreased during the fourth winter and remained relatively stable until a slight decrease occurred the last few years. This recent decrease may reflect a decreasing national duck population (Figure 22), milder winters, or a combination of these factors.

Mallards (Figure 13) peaked at 111,000 in 1964/65, the first year of the existence of water impoundments at the refuge, but have since declined. This decline in CCNWR's Mallard population may be due to either milder winters (inducing more ducks to winter farther north) or to a declining continental Mallard population. The Mallard is one of three permanent resident ducks at the refuge, the other two being the Wood Duck and Hooded Merganser. Although considered a permanent resident, few Mallards occur at the refuge during the summer.

American Black Duck numbers (Figure 14) at the refuge

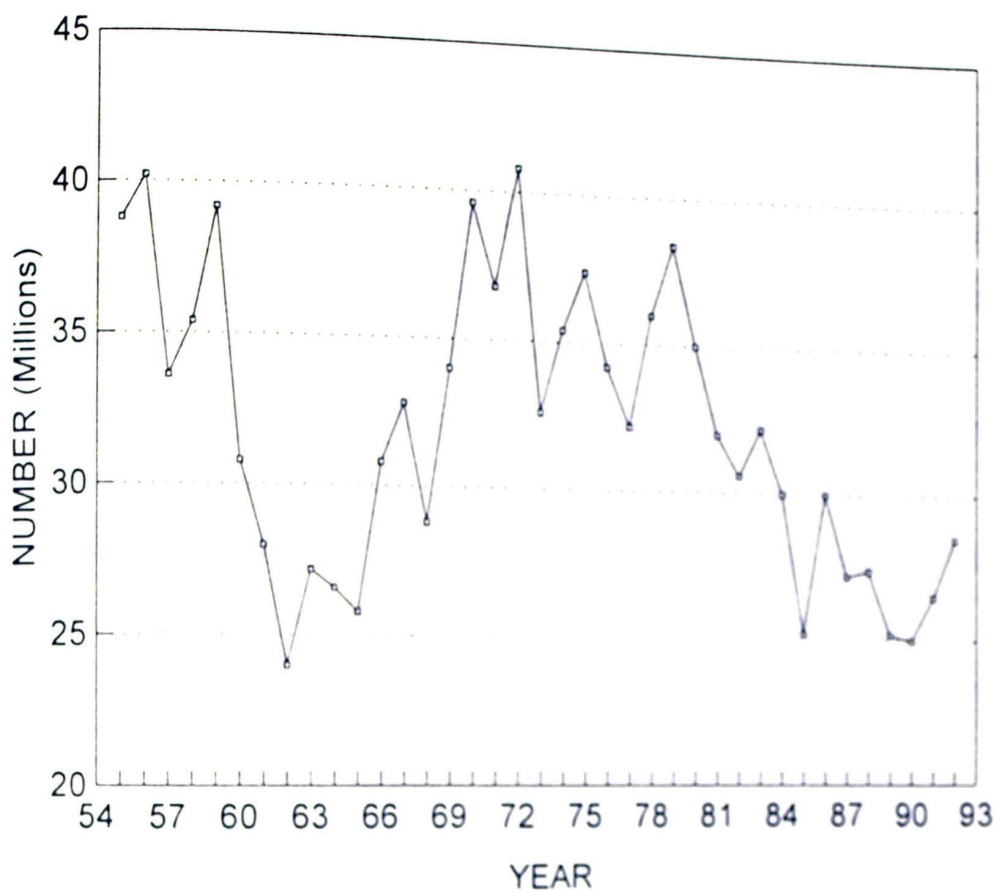


Figure 22. Trends in the Breeding Duck Population of North America for 1955 to 1992. Excludes scoters, eiders, mergansers, and oldsquaws. Graph was redrawn from U.S. Fish and Wildlife Service, 1992.

have been relatively stable. CCNWR's black duck population declined slightly during the last two years of the study period. The low numbers for those last two winters may reflect milder winters experienced at and north of the refuge during those years. National American Black Duck populations (Figure 23) have been generally decreasing for the last three decades (U.S. Dept. of Interior, Fish and Wildlife Service, and Environment of Canada, Wildlife Service 1992), but despite this decline CCNWR's population has remained stable. One possible explanation for the stable American Black Duck population at CCNWR may be that the population of this species using CCNWR did not experience the decline apparent in the national population. Or it may be that the American Black Duck population at Cross Creeks was too small to reflect changes occurring in the national population.

The thirty-year trend for CCNWR's American Wigeon population (Figure 15) reflects some unusual changes. Peak annual American Wigeon counts for the first 17 years at CCNWR averaged 4500, whereas peak counts for the last 13 years averaged 1800. National American Wigeon numbers, during the first few years of decline at CCNWR, were some of the highest recorded since 1955; however, national levels have been low the last six years (U.S. Dept of Interior, Fish and Wildlife Service, and Environment of Canada, Wildlife Service 1992). At the .05 alpha level, the size of

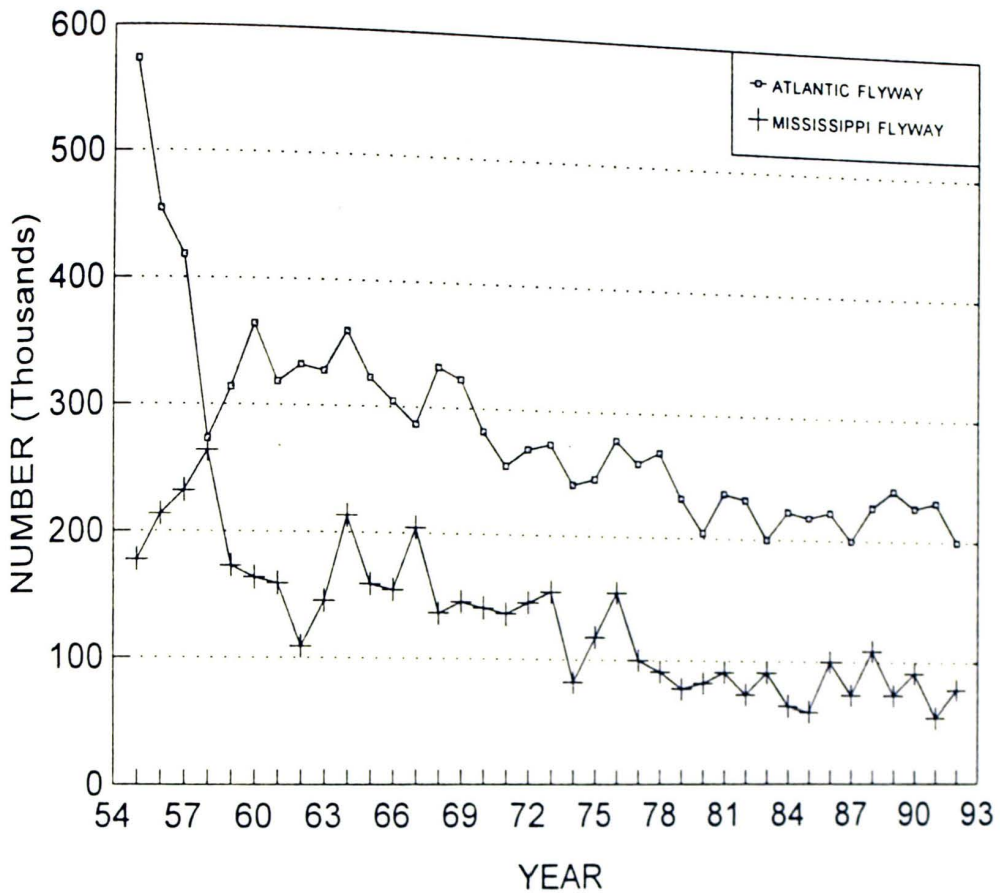


Figure 23. Trends in American Black Duck Populations for 1955 to 1992. Numbers are based on mid-winter counts in the Mississippi and Atlantic Flyways. Graph was redrawn from U.S. Fish and Wildlife Service, 1992.

the North American Wigeon population was not correlated with the size of CCNWR's American Wigeon population. Although no correlation was found, the decreasing North American population may have had some effect on CCNWR's population. The dramatic decrease in the refuge's American Wigeon population may also be due to recent mild winters; or, as Bellrose (1980) mentioned, yearly local abundance of American Wigeons varies more than do those of many other dabbling duck species, because segments of the population may alter their migration pattern from year to year. American Wigeons which once used CCNWR may have altered their migration routes and consequently no longer occur at CCNWR in the numbers that they once did.

The Northern Pintail is a species of concern to the U.S. Fish and Wildlife Service because it has been declining over most of its range for much of the last three decades. CCNWR's Northern Pintail population has also declined during that period (Figure 17). Northern Pintail numbers at CCNWR peaked at 11,500 in 1965/66 but have gradually declined since then. The decline in CCNWR's Northern Pintail population probably reflects the decrease in the national population, but milder winters may also have played a role in the reduction of this species at CCNWR. Low recruitment of young appears to have been one of the main reasons for the decline in the national population of Northern Pintails (U.S. Dept. of Interior, Fish and Wildlife Service, and

Environment of Canada, Wildlife Service 1992). This low recruitment was probably due to destruction of breeding habitat.

The Gadwall is one of the few species of waterfowl at CCNWR whose population has been generally increasing (Figure 18). According to Bellrose (1980), Gadwall populations regularly, and for unknown reasons, undergo cycles of abundance and scarcity. The increasing Gadwall population at CCNWR may reflect increases in the national Gadwall population. At a time when other species were declining at CCNWR, Gadwall numbers were increasing. One reason for this increase was the Gadwall's nesting success; according to Bellrose (1980) the Gadwall typically has the highest nesting success of all dabbling ducks, in part because it is a late nester (thus fewer nests are lost to inclement weather) and nests in very tall, dense vegetation (thus fewer nests are lost to predators).

Ring-necked Ducks are one of two diving duck species that constitute a considerable portion of CCNWR's duck population. Although a diver, the Ring-necked Duck exhibits many dabbling duck characteristics and is often seen feeding with dabbling ducks. This behavioral trait may explain in part why this diver occurs in larger numbers at CCNWR than do other diving species. Although the refuge contains diving duck habitat (deep reservoirs), it is more suited to dabbling ducks because of the many small, shallow water

impoundments. Among all ducks, the Ring-necked Duck ranks fourth in abundance at the refuge, and has been increasing in recent years (Figure 16).

The Lesser Scaup is the other diving species, besides the Ring-necked Duck, that constitutes a considerable portion of CCNWR's mid-winter duck population. Mean numbers of Lesser Scaup recorded on peak counts at CCNWR are misleadingly high due to large numbers (8200) which occurred in 1964/65. With the 1964/65 count data included, Lesser Scaup was the seventh most abundant duck; excluding the 1964/65 data, Lesser Scaup ranked eleventh in abundance.

Wood Ducks were the most abundant of the three permanent resident duck species. Because it is a permanent resident, the Wood Duck population undergoes little seasonal fluctuation in size. Large numbers of Wood Ducks were found at the refuge in the late 1960s and early 1970s, but since then this species has declined (Figure 20). The creation of Lake Barkley in 1965 flooded large tracts of bottomland forests, creating good Wood Duck habitat. As the trees in these flooded tracts died, rotted, and fell, these once wooded swamps became open water, thus reducing the amount of Wood Duck habitat.

## Chapter 6

### SUMMARY

In a time when many species of waterfowl are declining, areas such as Cross Creeks National Wildlife Refuge become increasingly important. Established to compensate for the loss of winter waterfowl habitat that occurred with the impoundment of Lake Barkley and the closing of Kentucky Woodlands National Wildlife Refuge, CCNWR has experienced a two-fold increase in the rate of waterfowl usage over the KWNWR figures, despite the fact that KWNWR was almost eight times larger than CCNWR. Although smaller, CCNWR contains a more extensive network of managed water impoundments, which is probably the major reason more waterfowl have used CCNWR.

Of the 33 species of waterfowl recorded at the refuge, nine (Mute Swan, Atlantic Brant, Barnacle Goose, Ross' Goose, Cinnamon Teal, Fulvous Whistling Duck, Greater Scaup, Oldsquaw, and White-winged Scoter) have been recorded three or fewer times, and should be considered accidentals. The Tundra Swan and Eurasian Wigeon have been recorded more than thrice but also probably should be considered accidentals.

Canada Geese comprised 99.9% of the mid-winter (January) goose population recorded on weekly surveys during the 30-year period, excluding 1968/69. Cross Creeks' Canada Goose population has been steadily increasing since 1962, except for a slight decrease within the last few years.

Fluctuations in CCNWR's Canada Goose population were positively correlated (.05 alpha) with fluctuations in the southern James Bay population but not with average winter temperatures at the James Bay breeding ground.

Of the 25 species of ducks documented at the refuge, eight (American Black Duck, American Wigeon, Gadwall, Lesser Scaup, Northern Pintail, Mallard, Ring-necked Duck, and Wood Duck) made up 98% of the duck population recorded on January weekly surveys for the 30-year period. Mallards (74%) and American Black Ducks (15.5%) dominated a typical mid-winter duck population. Peak duck numbers at CCNWR were inversely correlated (.05 alpha) with breeding ground temperatures (Regina, Saskatchewan).

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## APPENDIX

Condensed raw data from the weekly waterfowl surveys conducted at Cross Creeks National Wildlife Refuge from October through March, 1962/63 through 1991/92 (excluding the winter of 1968/69), are shown in the following six tables. The data consist of mean numbers recorded, for 11 of the main species of waterfowl, on a weekly survey for the months of October through March. Mean numbers are given for six year intervals as well as for the entire 30-year period. WODU = Wood Duck, AGWT = American Green-winged Teal, ABDU = American Black Duck, MALL = Mallard, NOPI = Northern Pintail, BWTE = Blue-winged Teal, GADW = Gadwall, AMWI = American Wigeon, RNDU = Ring-necked Duck, LESC = Lesser Scaup, CAGO = Canada Goose.

## October, 1962/63 through 1991/92

	1962/63 to 1967/68	1969/70 to 1973/74	1974/75 to 1979/80	1980/81 to 1985/86	1986/87 to 1991/92	Mean for all 30 years
WODU	982	1,348	616	300	115	649
AGWT	35	140	165	201	122	132
ABDU	201	440	436	813	234	424
MALL	1,424	2,205	2,729	3,182	729	2,049
NOPI	117	133	57	149	44	99
BWTE	212	34	41	38	34	73
GADW	96	87	89	45	93	82
AMWI	239	544	565	593	84	400
RNDU	147	10	7	28	6	41
LESC	94	83	7	15	4	39
CAGO	164	863	1,925	2,018	673	1,138

Appendix continued

December, 1962/63 through 1991/92

	1962/63 to 1967/68	1969/70 to 1973/74	1974/75 to 1979/80	1980/81 to 1985/86	1986/87 to 1991/92	Mean for all 30 years
WODU	726	519	461	260	97	409
AGWT	121	358	572	308	235	318
ABDU	2,895	7,118	6,705	5,279	6,817	5,716
MALL	25,183	32,288	31,417	28,018	22,616	27,753
NOPI	486	547	786	531	260	521
BWTE	6	---	---	---	---	1
GADW	1,000	592	514	440	703	652
AMWI	2,113	3,561	3,077	914	707	2,023
RNDU	1,429	458	270	1,930	2,223	1,290
LESC	2,067	286	86	12	25	503
CAGO	530	5,229	10,687	14,604	17,021	9,766

## Appendix continued

January, 1962/63 through 1991/92

	1962/63 to 1967/68	1969/70 to 1973/74	1974/75 to 1979/80	1980/81 to 1985/86	1986/87 to 1991/92	Mean for all 30 years
WODU	707	494	344	178	24	350
AGWT	23	177	214	201	39	131
ABDU	3,818	7,192	5,654	6,680	5,646	5,798
MALL	30,097	27,437	25,805	36,419	17,300	27,412
NOPI	999	474	377	254	113	443
BWTE	2	---	---	---	---	.50
GADW	473	539	380	398	375	433
AMWI	1,125	2,890	1,501	849	431	1,359
RNDU	1,068	280	218	626	1,557	750
LESC	1,473	183	6	5	3	334
CAGO	603	8,625	12,422	22,872	16,322	12,169

Appendix continued

February, 1962/63 through 1991/92

	1962/63 to 1967/68	1969/70 to 1973/74	1974/75 to 1979/80	1980/81 to 1985/86	1986/87 to 1991/92	Mean for all 30 years
WODU	742	630	320	189	33	383
AGWT	120	98	113	60	26	83
ABDU	3,055	3,741	2,218	4,089	1,802	2,981
MALL	32,408	10,100	8,375	17,210	4,602	14,539
NOPI	1,539	229	119	136	25	410
BWTE	1	---	---	---	---	.20
GADW	325	215	96	134	87	171
AMWI	1,113	1,528	401	403	87	706
RNDU	848	70	69	213	448	330
LESC	1,668	40	9	2	1	344
CAGO	955	6,204	6,814	14,871	6,976	12,169

March, 1962/63 through 1991/92

	1962/63 to 1967/68	1969/70 to 1973/74	1974/75 to 1979/80	1980/81 to 1985/86	1986/87 to 1991/92	Mean for all 30 years
WODU	945	1,084	489	219	68	561
AGWT	130	96	68	51	34	76
ABDU	2,188	408	532	298	103	706
MALL	20,671	1,268	1,835	820	142	4,947
NOPI	1,692	38	55	34	4	365
BWTE	395	184	186	112	45	184
GADW	375	114	38	67	33	125
AMWI	1,300	257	121	144	20	368
RNDU	1,288	33	25	110	131	317
LESC	2,058	35	27	23	24	433
CAGO	862	960	1,053	319	709	12,169