WATERFOWL IN THE ASPEN PARKLAND OF CENTRAL BRITISH COLUMBIA

Jean-Pierre L. Savard

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ABSTRACT

The distribution, abundance and breeding chronology of waterfowl were measured from 1980 to 1984 in central British Columbia. Eighteen species bred regularly in the area. Blue-winged Teal (*Anas discors*), Mallard (*A. platyrhyncos*) and American Wigeon (*A. americana*) were the dominant dabbling ducks, whereas Barrow's Goldeneye (*Bucephala islandica*), Bufflehead (*B. albeola*) and Lesser Scaup (*Aythya affinis*) were the dominant diving ducks. Because of the presence of migrants, waterfowl abundance varied significantly throughout the spring with fluctuations often being abrupt and asynchronous among species.

The overall number of breeding dabbling ducks decreased from 1064 adult males in 1980 to around 600 in 1982, 1983 and 1984 due mostly to a decrease in the abundance of Mallards and Blue-winged Teals. Numbers of diving ducks increased slightly from 916 adult males in 1980 to 1161 in 1984. Relationships between adult males, pairs and brood numbers varied between species. The proportion of pairs that produced broods averaged 39% in Barrow's Goldeneye and 53% in Bufflehead.

Breeding chronology varied between species and between years. Canada Geese (*Branta canadensis*), Mallard, Northern Pintail (*Anas acuta*) and Barrow's Goldeneye always nested earlier than Blue-winged Teal, Ring-necked Duck (*Aythya collaris*), Gadwall (*Anas strepera*), Lesser Scaup and Ruddy Duck (*Oxyura jamaicensis*). Early breeders were more affected by April weather than late breeders.

Comparisons of seasonal and yearly fluctuations of waterfowl abundance in three adjacent sub-areas revealed differences between areas. Similar comparisons for waterfowl on lakes smaller and greater than 6 ha respectively, revealed similar fluctuation patterns on both lake sizes. Barrow's Goldeneye and Bufflehead males moved from small to larger lakes in late May prior to their departure for the molting areas. Some Mallard, Blue-winged Teal, Green-winged Teal and Lesser Scaup drakes molted on the study area.

Diving ducks accounted for 56% of the broods observed compared to values of 15% and 17% for prairie habitats in Alberta and Saskatchewan, respectively. The difference is attributed to the low number of deep ponds in the prairies.

The number of adult males can be used for monitoring purposes if the surveys are carried out after the departure of migrants but before the arrival of molters. For each species there is a two to three week window for the counts. However that window varied with spring thaw phenology and between species.

RÉSUMÉ

La distribution, l'abondance et la chronologie de nidification de la sauvagine furent mesurêes de 1980 à 1984 dans le centre de la Colombie Britanique. Dix huit espèces nichèrent régulièrement dans la région. La Sarcelle à ailes bleues (*Anas discors*), le canard Mallard (*A. platyrhyncos*) et le canard sifleur d'Amerique (*A. americana*) ètaient les canards barbotteurs les plus abondants alors que le garrot de Barrow (*Bucephala islandica*), le petit garrot (*B. albeola*) et le petit morrillon (*Aythya affinis*) dominaient les canards plongeurs. L'abondance de la sauvagine variait de façon significative au cours de printemps à cause de la présence d'individus migrateurs. Ces fluctuations ètaient souvent abruptes et généralement non synchronisées entre les espèces.

Le nombre de canard barbotteurs dans la région étudiée diminua de 1064 mâles adultes en 1980 à près de 600 mâles en 1982, 1983 et 1984 dû principalement à une baisse des effectifs de canard mallard et de sarcelle à ailes bleues. Pendant la même période, le nombre de canards plongeurs passa de 916 mâles adultes en 1980 à 1161 en 1984. Les relations entre le nombre de mâles adultes, de couples et de couvées varièrent entre les espèces. En moyenne, seulement 39% des couples de garrot de Barrow produirent une couvée comparativement à 53% chez le petit garrot.

La chronologie de nidification variait selon les espèces et entre les années. La bernache du Canada (*Branta canadensis*), le canard mallard, le canard pilet (*Anas acuta*) et le garrot de Barrow nichèrent toujours plus tôt que la sarcelle à ailes bleues, le morillon à collier (*Aythya collaris*), le canard chipeau (*Anas strepera*), le petit morillon et le canard roux (*Oxyura jamaicensis*). Les espèces nichant tôt ètaient plus affectés par les temperatures du mois d'avril que les espèces nichant tard.

L'analyse des fluctuations saisonnières et annuelles dans l'abondance de la sauvagine entre trois régions adjacentes révèla des differences entre les regions. Une analyse similaire pour les lacs plus petits et plus grands que 6 hectares respectivement indique des patrons de fluctuations similaires sur les deux grandeurs de lacs. Les mâles de garrot de Barrow et de petit garrot se rassemblaient sur les grand lacs a la fin de mai juste avant leur depart pour leur sites de mue. Plusieurs mâles de canard mallard, sarcelle à ailes bleues, sarcelle à ailes vertes et petit morillon muèrent dans la région à l'ètude.

Les canards plongeurs représentaient 56% du nombre total de couvées dans la région d'étude comparativement à seulement 15% et 17% dans le prairies de l'Alberta et de la Saskatchewan, respectivement. Cette différence est atribuée à la faible profondeur des étangs dans les prairies.

Le nombre de mâles adultes peut être utilisé pour recenser les populations à condition que les recensements soit effectués après le départ des migrateurs et avant l'arrivé des oiseaux qui viennent muer. Cette période s'étend sur deux à trois semaines. Cependant la periode exacte varie d'une année à l'autre selon la température et diffère entre les espèces.

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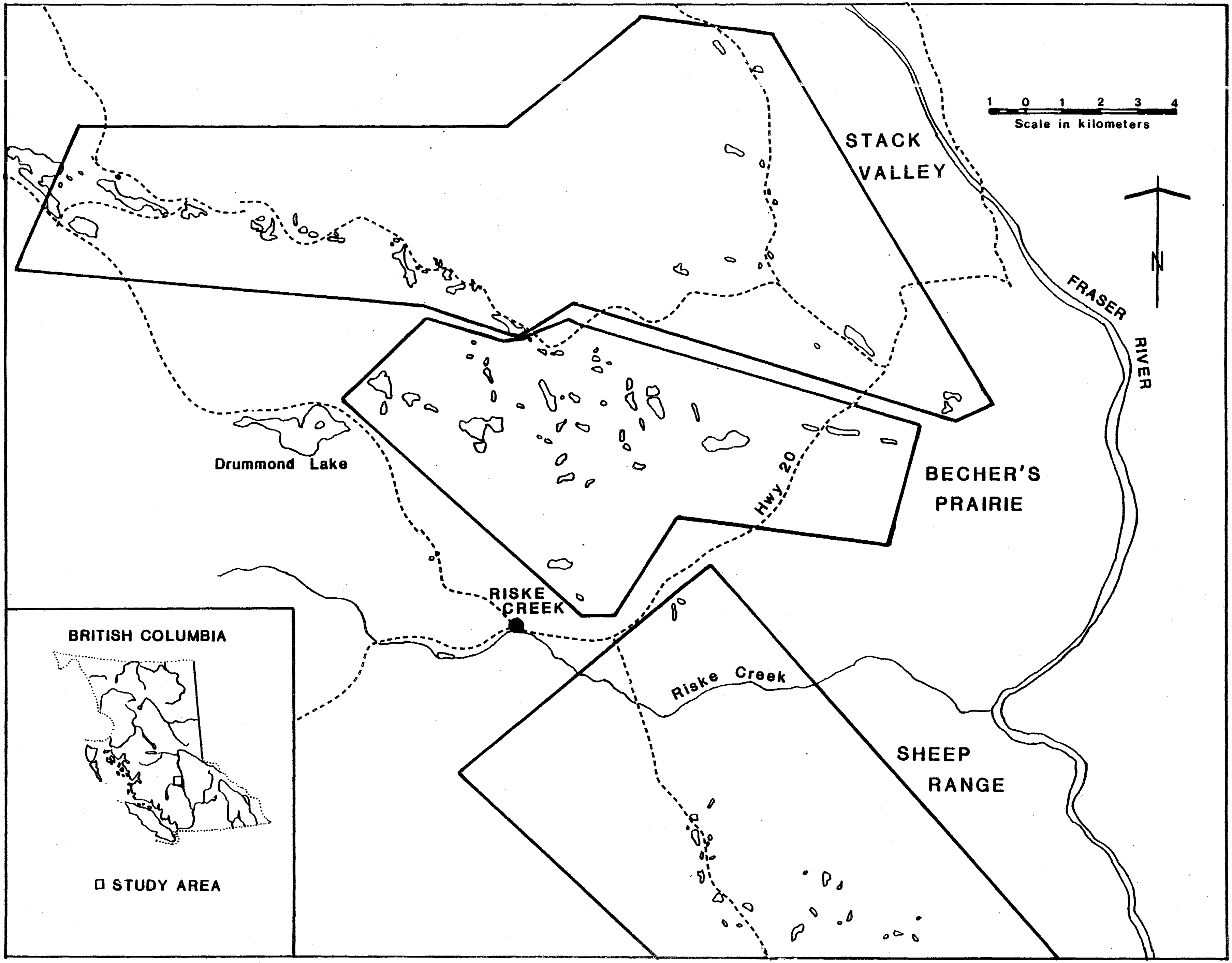


Figure 1. Location of study areas.

INTRODUCTION

The aspen parkland of British Columbia is the most productive region of the province for waterfowl (McKelvey and Munro 1983). Several surveys have confirmed the importance of this region for waterfowl (Can. Wildl. Serv. and Ducks Unlimited unpubl. data) and have stressed the need for more research before monitoring programs could be implemented. Savard (1980) looked at factors affecting the variability of waterfowl counts in this region and showed that breeding phenology affected count accuracy. From 1980 to 1986, during an intensive study of the ecology of Barrow's Goldeneye (*Bucephala islandica*) (Savard 1987a,b, 1988a,b), data were collected on all species of waterfowl in a 150km^2 area near Riske Creek, British Columbia. Although incidentally collected, these data contain pertinent information on the ecology and breeding phenology of waterfowl in the area. They are analysed here with the following objectives:

1. To characterize the waterfowl community breeding near Riske Creek, British Columbia.
2. To evaluate seasonal and annual fluctuations in waterfowl abundance.
3. To evaluate the relationships between adult males, pairs, and brood numbers.
4. To characterize the breeding chronology of waterfowl near Riske Creek.
5. To evaluate the influence of lake size and sub-areas on waterfowl distribution.
6. To compare the waterfowl community of Riske Creek with that of the prairie provinces.

STUDY AREA

The study area is located in central British Columbia, on the Fraser Plateau, within the Interior Douglas-fir biogeoclimatic zone (Krajina 1969, B.C. Min. Forests 1988). This plateau region is characterized by severe winters and warm summers. The mean daily temperature is 2.3°C for the year, and ranges from -11.6°C in January to 13.7°C in July (Topping and Scudder 1977). Vegetation is typically open grassland with mixed stands of conifers and aspen (Munro 1947).

Most lakes surveyed were within a 10km radius of Riske Creek at elevations of 900 to 1,000m (Fig. 1). The lakes differed in size and chemical composition. The surface area of the lakes ranged between 1 and 50 ha and their electric conductivity in early July between 200 and 10,000 micromhos (Boyd and Savard

1987). Topping and Scudder (1977) present a detailed chemical analysis of 12 of the 116 lakes studied (see lakes in their Riske Creek section), whereas Boyd and Savard (1987) and Boyd *et al.* (1989) summarize the most important chemical and physical factors for all 116 lakes. Those lakes characterize well the diversity and complexity of the lakes of the Fraser Plateau. The most striking feature of the lakes of central British Columbia is their considerable chemical heterogeneity. Magnesium and sulphate predominate at higher ionic concentrations, whereas sodium bicarbonate- carbonate and complex mixtures of magnesium, sodium, sulphate, bicarbonate, and carbonate predominate at lower ionic concentrations (Topping and Scudder 1977).

This chemical heterogeneity explains the differences among lakes in the species composition of the invertebrate fauna (Boyd and Smith 1989). Most lakes, however, were devoid of fishes and thus had high densities of invertebrates. Scudder (1969), Reynolds (1979) and Boyd and Smith (1989) discuss in detail the fauna of saline lakes of the Fraser Plateau.

METHODS

Adult surveys

Surveys were conducted, from April to August 1980 to 1986, on 117 ponds located within a 10 km radius of Riske Creek (located 30 km west of Williams Lake), British Columbia. Adult counts were done from vantage points and no efforts were made to flush birds concealed in vegetation to minimize bird movements between ponds. Most lakes (>90%) lacked or had only a thin (<1 m) zone of emergent vegetation, which greatly facilitated counts. All observations were recorded on cassette tapes and transcribed at the end of each survey. The frequency and intensity of counts varied between years (Table 1). Surveys were conducted throughout the day as preliminary surveys indicated little variation in waterfowl numbers, due to time of the day for most species (Savard 1980). Pairs were recorded for Barrow's Goldeneye and Bufflehead (*B. albeola*) in all years, but only in 1978 and 1980 for other species. In other years counts of males and females only were done without identifying pairs.

Table 1. Frequency and dates of waterfowl counts near Riske Creek British Columbia.

Date		1980	1981	1982	1983	1984	1985	1986
April	22	X						
	25	X						
	27		X	X	X	X		
	29		X	X	X			
May	1							X
	3					X	X	
	5							X
	6				X			
	7	X						X
	8						X	
	9			X	X			
	10	X	X			X		
	14						X	
	15			X		X		
	16		X					
	21	X						
	23	X						
	25			X				
	27					X		
June	3	X						
	5	X						
	7		X					
	8				X			
	18	X						
	19		X					
	24			X				
July	2	X						
	7		X					
	9	X						
	17			X				
	21	X						
	24		X					
August	12	X						
Total counts		13	8	7	5	5	3	3
Broods only[1] (date not shown)		2	2	4	10	10	0	0

1 - Counts on which only broods were counted (exact date not shown).

I used fluctuations in the number of males to determine for each species the period that best represented the breeding population of the study area. Patterns differed drastically between species, and differences between years in breeding chronology reduced considerably the number of surveys that could be used to compare waterfowl abundance between years. A detailed presentation of these fluctuations and surveys used for comparisons are presented for each species in Appendix 5.

Brood surveys

Brood surveys were conducted from vantage points and no efforts were made to flush broods from cover. The number of brood counts ranged between 3 and 10 depending on the year. Again, efforts were concentrated on goldeneyes, but all broods observed were recorded. The age of each brood observed was estimated following criteria developed by Gollop and Marshall (1954) (see Taber 1971, Bellrose 1978) and was used to compare the relative breeding phenology of species. Criteria used to derive hatching date and start of incubation are summarized in Table 2.

Most broods were resighted once and some several times, which provided several estimates of hatching dates. Because it is easier to age young broods than older broods, I used the first sighting to estimate hatching date. Weather records were taken from Wineglass Ranch located 10 km west of Riske Creek and are presented in Appendix I.

RESULTS

Waterfowl use of the Riske Creek area

The breeding population of aquatic birds in the Douglas-fir aspen parkland of British Columbia is one of the most diversified in Canada. Twenty-one species breed in the area, 18 regularly. Common Goldeneyes (*Bucephala clangula*), White-winged Scoters (*Melanitta fusca*) are localized breeders which bred in the region (Campbell *et al.* 1990 Munro 1939) but not on the study area (Table 3). The Blue-winged Teal (*Anas discors*), Mallard (*A. platyrhyncos*) and American Wigeon (*A. americana*) were the dominant dabbling ducks whereas Barrow's Goldeneye, Bufflehead and Lesser Scaup (*Aythya affinis*) were the

Table 2. Sources used for incubation period and age class data.

Species	Incubation period[1] (days)	Data sources for transforming age classes into age in days
Canada Goose	28	Yocom and Harris 1965
Mallard	28	Giles 1971
American Wigeon	23	Giles 1971
Green-winged Teal	22	Giles 1971 (used Blue-winged Teal age classes)
Blue-winged Teal	23	Giles 1971
Northern Shoveler	23	Giles 1971
Scaup	22	Giles 1971 (used Lesser Scaup age classes)
Barrow's goldeneye	33	Gibes 1961 (used Common Goldeneye age classes)
Bufflehead	30	Giles 1971 (used Lesser Scaup age classes)
Ruddy Duck	23	Giles 1971 (used Ring-necked Duck age classes)

1 - Taken from Palmer 1976.

Table 3. Average number of aquatic birds seen (± SE) in 1980 in the Riske Creek study area (n=2 counts per survey period).

	April 22-25	May 7-10	May 21-23	June 3-5	Breeder
Common Loon	14 ± 4	4 ± 1	7 ± 1	5 ± 0	X
Red-necked Grebe	13 ± 7	6 ± 2	4 ± 1	4 ± 2	X
Horned Grebe	10 ± 3	24 ± 3	25 ± 3	22 ± 1	X
Eared Grebe	71 ± 41	242 ± 7	252 ± 13	307 ± 7	X
Pied-billed Grebe	2 ± 1	6 ± 0	8 ± 1	5 ± 1	X
Swan	11 ± 11	0 ± 0	0 ± 0	0 ± 0	
Canada Goose	57 ± 22	39 ± 2	37 ± 5	31 ± 8	X
Mallard	440 ± 82	246 ± 5	336 ± 11	393 ± 8	X
Gadwall	7 ± 1	22 ± 4	32 ± 4	42 ± 5	X
American Wigeon	503 ± 23	234 ± 8	163 ± 5	163 ± 15	X
Pintail	353 ± 45	89 ± 3	69 ± 3	72 ± 2	X
Green-winged Teal	342 ± 24	164 ± 20	95 ± 4	105 ± 1	X
Blue-winged Teal	12 ± 5	295 ± 47	646 ± 36	743 ± 28	X
Cinnamon Teal	19 ± 2	22 ± 0	17 ± 1	24 ± 7	X
Northern Shoveler	66 ± 19	156 ± 16	144 ± 2	121 ± 3	X
Redhead	69 ± 12	67 ± 1	58 ± 3	47 ± 9	X
Ring-necked Duck	247 ± 10	71 ± 2	53 ± 4	61 ± 3	X
Canvasback	681 ± 13	29 ± 4	23 ± 3	26 ± 7	X
Scaup	1232 ± 307	819 ± 63	263 ± 33	281 ± 0	X
Common Goldeneye	5 ± 1	0 ± 0	0 ± 0	0 ± 0	
Barrow's Goldeneye	732 ± 66	617 ± 10	683 ± 7	593 ± 71	X
Bufflehead	683 ± 36	363 ± 10	298 ± 1	281 ± 7	X
White-winged Scoter	1 ± 0	2 ± 2	5 ± 5	3 ± 1	
Surf Scoter	22 ± 19	60 ± 7	22 ± 16	3 ± 1	
Hooded Merganser	16 ± 3	4 ± 1	3 ± 2	6 ± 1	X
Ruddy Duck	79 ± 22	174 ± 3	113 ± 2	154 ± 11	X
American Coot	113 ± 11	104 ± 2	96 ± 5	100 ± 6	X
Total	5810	3831	3452	3592	

dominant diving ducks (Table 3). More widespread surveys, covering a broader spectrum of the Cariboo parkland indicate that the study area reflected well the general waterfowl population of the whole region (Table 4).

Species abundance varied through the spring with migrants being abundant in early May and having left the study area by mid-May (Table 3). Fluctuations in numbers were asynchronous between species, and the impact of this on survey efficiency will be analysed in detail. Counts of grebes, Common Loons (*Gavia immer*) and American Coots (*Fulica americana*) are presented in Table 3 to provide an idea of the whole aquatic bird community of the area, but will not be discussed further.

Seasonal Fluctuations in waterfowl numbers

Waterfowl abundance varied significantly throughout the spring. Fluctuations in numbers were often abrupt and asynchronous among species (Table 3, see Appendices 2-4 for details). Several species such as Canvasback (*Aythya valisineria*) and scaups had a migrant component in their population and their numbers decreased drastically during spring. Other species such as the Blue-winged Teal and Gadwall (*Anas strepera*) were late arrivals on the study area, and their numbers peaked in late May. Similar fluctuations were observed in the number of males, females and pairs in early spring. In June, however, males of several species left the study area for their moulting grounds, whereas others came into the study area to moult (Appendix 2). Barrow's Goldeneye and Bufflehead drakes left the study area in mid-June. Mallard and Green-winged Teal (*Anas crecca*) drakes increased in numbers over the same period. These fluctuations in numbers occurred every year of the study but their timing differed between years.

Abundance patterns were more obvious for some species than others. American Wigeon, Green-winged Teal, Northern Pintail (*Anas acuta*), Ring-necked Duck (*Aythya collaris*), Canvasback and Bufflehead had well defined fluctuation patterns with stability in their numbers following the departure of migrants (Appendix 5). For the other species, patterns were less defined and/or more variable between years.

The presence of migrants early in the spring coupled with differences between years in the timing of their departure, impairs the design of adequate monitoring programs based on counts of males. It is

Table 4. Results of counts (number of individuals seen) done in the Cariboo aspen parkland in three different years and covering a wide geographical area. (Meldrum Creek, Green Lake, Alberta Lake and Chimney Lake areas; from Canadian Wildlife Service files).

Species	May 18-31, 1968	May 13-24, 1969	May 14-24, 1970
Common Loon	4	8	4
Red-necked Grebe	6	11	4
Horned Grebe	3	10	14
Eared Grebe	0	3	0
Pied-billed Grebe	1	0	2
Canada Goose	14	22	20
Mallard	123	123	235
Gadwall	8	2	6
American Wigeon	97	114	205
Pintail	27	65	82
Green-winged Teal	40	25	72
Blue-winged Teal	107	51	62
Cinnamon Teal	17	4	36
Northern Shoveler	37	19	22
Redhead	51	63	67
Ring-necked Duck	28	35	71
Canvasback	25	25	60
Scaup	214	241	256
Barrow's Goldeneye	96	219	136
Bufflehead	73	81	139
White-winged Scoter	0	19	0
Surf Scoter	0	1	18
Ruddy Duck	69	81	130
American Coot	51	49	29

obvious that several surveys are needed to ensure that at least a few will be conducted during the proper period for a given species. An added complication is the difference in the breeding chronology of species. For example counts in early May may be adequate for Mallard and Barrow's Goldeneye, but not for Scaup and Blue-winged Teal.

Mallard breeding chronology and migratory patterns varied drastically between years. In 1983, an early year, counts in late April and early May indicated that migrants had already departed the study area. By contrast, in 1982 migrants were still abundant in the study area at that time. Thus counts for Mallards have to occur after the departure of migrants but before moulting birds start concentrating on the study area.

It is obvious from the fluctuations observed that single yearly counts of males would be impossible to interpret as it would be nearly impossible to determine if they were done during the stable period.

Annual fluctuations in waterfowl numbers

<u>Adult males</u>

Because of the annual variability in breeding chronology and in the departure of migrants from the study area, only a small portion of the counts could be used for comparisons. Only counts done after the departure of migrants were used for comparison (see Appendix 5 for details of the selection procedure). Sample sizes varied between years and between species.

The overall density of dabbling ducks decreased from 1,064 adult males in 1980 to around 600 in 1982, 1983 and 1984, due mainly to a decrease in numbers of Mallards and Blue-winged Teals (Table 5). The number of adult male Mallards in the study area decreased by half from 1980 to 1981 to increase again in 1983 and 1984 without reaching the level of 1980. The population declined again by half from 1984 to 1986 (Table 5). Blue-winged Teal numbers varied also significantly, dropping from over 500 adult males in 1980 and 1981 to less than 300 in 1982 and 1983. Unfortunately, no counts were done at the appropriate time for monitoring in 1985 and 1986. Cinnamon Teal (*Anas cyanoptera*) numbers ranged from 9 to 20 drakes between 1980 and 1984 but increased to 52 drakes in 1985 and 44 in 1986. Numbers of other dabbling duck drakes did not fluctuate as drastically although for some species there was possibly

Table 5. Average density of breeding adult male dabbling ducks (±S.E.) in the study area; only those surveys corresponding to the stable period when migrants have left the area and all birds have arrived have been used. See Appendix 5 for details.

Species	1980	1981	1982	1983	1984	1985	1986	X	%
Mallard	176±10	76±13	67± 2	91±8	110± 6	78± 3	51±3	93±15	(12)
(n)	(2)	(3)	(2)	(4)	(4)	(2)	(3)		
Gadwall	71± 1	17± 4	22± 1	17±1	23± 2	20	18±1	19± 1	(2)
	(4)	(3)	(3)	(3)	(3)	(1)	(2)		
American Wigeon	113± 6	95± 5	84± 6	134±8	152± 7	120	159	122±11	(15)
	(4)	(2)	(2)	(2)	(2)	(1)	(1)		
Northern Pintail	51± 4	44± 2	36± 0	36±1	32±12	38± 5	31±4	38± 3	(5)
	(4)	(2)	(2)	(2)	(2)	(2)	(2)		
Green-winged Teal	78± 3	66±12	59± 8	56±6	68± 8	73	64	66± 3	(8)
	(5)	(3)	(2)	(3)	(3)	(1)	(1)		
Blue-winged Teal	520±41	592±10	271±22	272	162	-[1]	-	363±69	(45)
	(5)	(2)	(2)	(1)	(1)				
Cinnamon Teal	16± 2	20± 3	20± 3	19±1	9± 4	52±10	44±1	26± 6	(3)
	(7)	(4)	(4)	(3)	(4)	(3)	(3)		
Northern Shoveler	93± 4	155± 5	68± 9	46±5	53±11	71±10	50±3	71±10	(9)
	(6)	(4)	(3)	(5)	(4)	(3)	(3)		
Total	1064	925	627	671	609	-	-	798	

1 - No counts done during the appropriate period.

a significant annual change in numbers. Northern Shoveler (*Anas clypeata*) and Pintail numbers were lower in 1986 than in 1980.

The overall number of diving duck drakes increased from 916 in 1980 to 1,161 in 1984 (Table 6). Unfortunately counts in 1985 and 1986 were done too early to adequately sample some of the species. Fluctuations in the number of drakes were not as drastic in diving duck species as they were in dabbling ducks. Barrow's Goldeneye numbers increased significantly in 1983 and again in 1984 likely in response to the provision of nest boxes on the study area (Savard 1988b). Numbers of Ring-necked Ducks increased from a low of 34 in 1981 to over 70 in 1984 and 1985. Scaup also seemed to have increased over the same period. Other species remained fairly stable, fluctuating without obvious trends.

Broods

Eight species of dabbling ducks and eight species of diving ducks bred on the study area. Over the 5 years of the study the number of dabbling duck broods ranged between 148 and 210 whereas the numbers of diving duck broods ranged between 180 and 256 (Table 7). Barrow's Goldeneye and Bufflehead dominated, accounting for 20 and 14% of all the broods, respectively. Among dabbling ducks, the most productive species were the Blue-winged Teal (12%), American Wigeon (9%) and Mallard (9%).

Relationships between adult males, pairs and brood numbers

The relationship between the total number of males counted in the spring and the number of broods in the summer varied with the species (Table 8). There was a significant positive correlation for the Northern Shoveler, the Blue-winged Teal, the Ring-necked Duck, the Barrow's Goldeneye and the Canvasback. There was a significant negative correlation for Gadwall. The total number of dabbling duck drakes and of diving duck drakes was not correlated with the number of broods. Among dabbling ducks, the average percent of males that produced a brood over the 5 years of the study ranged between 10.2% in the Northern Pintail and 41.4% in the Mallard. Among diving ducks the average proportion ranged between 8.2% in Ring-necked Ducks and 43.2% in Buffleheads (Table 7).

Table 6. Average number of breeding adult male diving ducks (± S.E.) observed in the study area from 1980 to 1985.

Species	1980	1981	1982	1983	1984	1985	1986	X	(%)
Redhead	37± 2 (4)	39± 6 (2)	54± 2 (3)	25±3 (4)	36± 3 (4)	54 (1)	43±3 (3)	41± 4	(4)
Ring-necked Duck	46± 2 (6)	34± 2 (2)	62±24 (2)	64±6 (2)	71±12 (2)	82 (1)	-1	60± 7	(6)
Canvasback	16± 2 (6)	24± 3 (2)	39± 1 (2)	34± 3 (2)	24± 8 (3)	23± 1 (2)	36±5 (2)	28± 3	(2)
Scaup	209±13 (4)	261±33 (2)	270±23 (2)	241	306±91 (2)	366	-	276±22	(26)
Barrow's Goldeneye	324± 5 (4)	321±12 (4)	323±21 (3)	406±7 (4)	453±24 (5)	387±10 (3)	384±7 (3)	371±19	(35)
Bufflehead	173± 8 (4)	164± 6 (2)	186±26 (2)	158±4 (2)	172±16 (3)	174 (1)	-	171±4	(16)
Ruddy Duck	111±11	153±18	129± 7	143	99	-	-	127±10	(12)
Total	916	996	1063	1071	1161			1074	

1 - No counts done during the appropriate period.

Table 7. Number of broods seen in the Riske Creek study area.

	1980	(%)[1]	1981	(%)	1982	(%)	1983	(%)	1984	(%)	Total no. of broods	(%)[2]	$\bar{x}$ %
Canada Goose	9		8		12		13		16		58	(3)	
Mallard	45	(26)	42	(55)	37	(55)	40	(44)	30	(27)	194	(9)	51.4±6.4
Gadwall	1	(1)	11	(65)	7	(32)	12	(71)	5	(22)	36	(2)	38.2±13.2
American Wigeon	24	(21)	34	(36)	43	(51)	36	(27)	43	(28)	180	(9)	32.6±5.2
Northern Pintail	2	(4)	6	(14)	7	(19)	5	(14)	0	(0)	20	(1)	10.2±3.5
Green-winged Teal	20	(26)	24	(36)	19	(32)	34	(61)	19	(28)	116	(6)	36.6±7.3
Blue-winged Teal	46	(9)	63	(11)	46	(17)	50	(18)	41	(25)	246	(12)	16.0±2.8
Cinnamon Teal	1		0		0		0		2		3	–	
Northern Shoveler	15	(16)	23	(15)	12	(18)	8	(17)	8	(15)	66	(3)	16.2±0.6
Dabbler sp.	1		7		1		0		0		9	–	
Redhead	4	(11)	17	(44)	8	(15)	16	(64)	5	(14)	50	(2)	29.6±10.5
Ring-necked Duck	1	(2)	3	(9)	5	(8)	7	(11)	8	(11)	24	(1)	8.2±1.7
Canvasback	3	(19)	9	(38)	16	(41)	5	(15)	6	(25)	39	(2)	17.6±5.1
Scaup sp.	11	(5)	34	(13)	28	(10)	26	(11)	9	(3)	108	(5)	8.4±1.9
Barrow's Goldeneye	84	(26)	84	(26)	87	(27)	95	(23)	110	(24)	460	(22)	25.2±0.7
Bufflehead	68	(39)	75	(46)	78	(42)	73	(46)	74	(43)	368	(18)	43.2±1.3
Hooded Merganser	0		1		2		0		2		5	–	
Ruddy Duck	9	(8)	19	(12)	32	(25)	23	(16)	13	(13)	96	(5)	14.8±2.9
Total geese	9		8		12		13		16		38	(3)	
Total dabbling ducks	155	(15)	210	(23)	172	(27)	185	(28)	148	(24)	870	(42)	23.4±2.3
Total diving ducks	180	(20)	242	(24)	256	(24)	245	(23)	227	(20)	1150	(53)	22.2±0.9
Total	343	(17)	460	(24)	440	(26)	443	(25)	391	(22)	1078		22.8±1.6

1 Number of broods expressed as the % of adult males.

2 Relative abundance of broods in %.

3 Average percentage of males that produced a brood.

Table 8. Correlation between the number of adult males in the spring and the number of broods in the summer (n=5 years).

Species	Pearson's Correlation	Species	Pearson's Correlation
Mallard	0.36[1]	Redhead	-0.34
Gadwall	-0.84*	Ring-necked Duck	0.84*
American Wigeon	0.12	Canvasback	0.72*
Pintail	-0.02	Barrow's Goldeneye	0.97*
Green-winged Teal	-0.57	Bufflehead	0.34
Blue-winged Teal	0.74*	Ruddy Duck	0.53
Northern Shoveler	0.99*		
Total dabblers	0.15	Total divers	0.58

1) Critical value for (0.05) = 0.755 and for P (0.10) = 0.669.
*

In 1978 and 1980, the number of pairs and broods were counted on thirty ponds (Table 9). There was no simple relationship between the number of pairs present and the number of broods observed. For three species, the Blue-winged Teal, Redhead and Ruddy Duck, the relative proportion of pairs and broods differed significantly between the two years. For the other species there were no statistically significant differences. However, the percentage of pairs that produced broods varied with species (Table 9). In Mallard, only 28% of the pairs produced broods compared to 60-68% of Bufflehead pairs. The proportion of dabbling duck and diving duck pairs producing broods differed significantly in 1978 and 1980, being lower in 1980. In 1980, pairs were counted over the whole study area (Table 10). This sample includes the 30 lakes used in Table 9. It permits an evaluation of the representativeness of the small samples of 1978 and 1980. The proportion of pairs that produced broods was fairly similar for the two samples, differing only from 5-10%. One exception is the American Wigeon with 43% of pairs producing broods in the reduced sample but with only 20% producing broods in the larger sample (Table 10).

The 1980 data, also permits one to relate pair numbers to the number of males. The estimated number of Mallard, Pintail and Green-winged Teal pairs was higher than the number of males on the study area (Table 10). This is likely due to the inclusion of lone females in estimating the number of pairs. In the case of the Blue-winged Teal there was an obvious surplus of males in the breeding population (>50%). Smaller surpluses of males were detected in most diving ducks, especially Scaup and Barrow's Goldeneye.

The only species for which the number of pairs was estimated during the whole study are the Barrow's Goldeneye and the Bufflehead (Table 11). These were also the most abundant species on the study area. The proportion of pairs that produced broods averaged 39% in Barrow's Goldeneye and 53% in Bufflehead, a significant difference ($T(4)=4.4$, $P=0.012$). Both species had a surplus of males in the population and if the brood produced is expressed as a % of males, it averages 25% in Barrow's Goldeneye and 43% in Bufflehead ($T(4)=10.11$, $P=0.000$). More males were paired in Bufflehead ($\bar{x}=82\%$) than in Barrow's Goldeneye ($\bar{x}=65\%$) ($T4=3.9$, $P=0.018$).

Table 9. Relationships between the number of pairs and the number of broods observed on a sample of 30 lakes.

	No. of pairs		No. of broods			
	1978	1980	1978	% of pairs	1980	% of pairs
Mallard	24	36	7	(29)	10	(28)
Gadwall	8	5				
Pintail	8	16				
Green-winged Teal	18	18	8	(44)	4	(22)
Blue-winged Teal	6	39	9	(150)	8	(21)*1
Cinnamon Teal	1	1				
American Wigeon	15	21	8	(53)	9	(43)
Northern Shoveler	15	16	4	(27)		(0)
Redhead	4	10	7	(175)	1	(10)*
Ring-necked Duck	5	6				
Canvasback	3	4	1	(33)		(0)
Scaup	26	20	8	(31)	2	(10)
Barrow's Goldeneye	53	43	23	(43)	15	(35)
Bufflehead	34	35	23	(68)	21	(60)
Ruddy Duck	16	22	10	(63)	3	(14)*
Hooded Merganser			2			
Totals						
Dabbling Ducks	95	152	36	(38)	31	(20)*
Diving Ducks	141	140	74	(52)	42	(30)*

1 X_2 test on actual value * = significant difference in proportion between years at the 0.05 level Yate's correction 0.05 applied.

Table 10. Relationship between the number of pairs and the number of broods on the study area in 1980.

	Number of males ± S.E.	Number of pairs A[1]	B[2]	(n)	Number of broods	Broods as a % of no. of pairs A	B	Broods as a % of no. of males
Mallard	176±10	198	183±9	(2)	45	23	25	26
Gadwall	71±1	17	13±2	(4)	1	6	8	1
Pintail	51±4	60	48±1	(2)	2	3	4	4
Green-winged Teal	78±3	95	53±12	(3)	20	21	38	26
Blue-winged Teal	520±1	242	215±7	(4)	46	19	21	9
Cinnamon Teal	16±2	15	7±1	(3)	1	7	14	6
American Wigeon	113±6	121	116±3	(2)	24	20	21	21
Northern Shoveler	93±4	78	52±3	(6)	15	19	29	16
Redhead	37±2	27	23±3	(3)	4	15	17	11
Ring-necked Duck	46±2	22	15±3	(3)	1	5	7	2
Canvasback	16±2	14	7±0	(3)	3	21	43	19
Scaup	209±13	81	69±10	(6)	11	14	16	5
Barrow's Goldeneye	324±5	212	213±5	(3)	97	46	46	30
Bufflehead	173±8	126	120±2	(2)	71	56	59	41
Ruddy Duck	111±11	81	63±8	(2)	9	11	14	8
Total	2034	1401		1197	350	25%	29%	17%

1 - A = Number of pairs derived by estimating the number of pairs using a given lake based on the 2-6 surveys and summing over all the lakes.

2 - B = Simple average of the estimated number of pairs based on 1 survey (average of 2-6 surveys).

Table 11. Relationship between the number of pairs, males and broods in Barrow's Goldeneye and Bufflehead.

	Barrow's Goldeneye				Bufflehead			
Year	Number of broods	Broods as a % of males	Broods as a % of pairs	Pairs as a % of males	Number of broods	Broods as a % of males	Broods as a % of pairs	Pairs as a % of males
1980	84	26(324)[1]	40(212)[2]	65	68	39(173)[1]	54(126)[2]	73
1981	84	26(321)	42(201)	63	75	46(164)	60(125)	76
1982	87	27(323)	43(201)	62	78	42(186)	46(171	92
1983	95	23(406)	36(265)	65	73	46(158)	59(123)	78
1984	110	24(453)	34(322)	71	74	43(172)	48(155)	90
Average ± S.E.		25.2±0.7	39.0±1.7	65.2±1.6		43.2±1.3	53.4±2.8	81.8±3.9
Coefficient of variation (%)		7	10	5		7	12	11

1 ( ) = Number of males.

2 ( ) = Number of pairs.

Breeding chronology

Breeding chronology varied between species and between years. The nesting chronology of species was similar each year for Canada Goose (*Branta canadensis*), Mallard, Northern Pintail and Barrow's Goldeneye being early nesters and Blue-winged Teal, Ring-necked Duck, Gadwall, Scaup and Ruddy Duck (*Oxyura jamaicensis*) being late nesters (Figs. 2-6). However, the exact period of nesting varied between years depending on weather and the timing of spring thaw (Appendix 6).

Several species nested significantly earlier in 1983 than in 1982, probably as a result of the unusually warm temperatures recorded in April 1983 compared to April 1982 and other years (Appendix 1). In 1983, most ponds were ice free by mid-April. As expected, early migrants were most affected by April weather. Mallard, Barrow's Goldeneye, Bufflehead and American Wigeon nested significantly earlier in 1983 than in other years. Blue-winged Teal and Scaup, two late nesters, were not affected by April temperatures (Appendix 2).

Heavy precipitation in 1980 (Appendix 1.2) possibly negated the effect of warm April temperatures and delayed nesting. In 1984, breeding differed from that of 1983 in spite of warm April temperatures and early opening of the ponds. The cold temperatures of the month of May 1984 delayed nesting of several species and/or extended their laying period.

Mallard and Blue-winged Teal, an early and late migrant, respectively, responded differently to spring temperatures. Mallards were affected by April temperatures but Blue-winged Teals were not. Both species were however, apparently affected by May temperatures, the Blue-winged Teal more so.

Waterfowl distribution

Geographically

The study area could be divided into three sub-areas: Sheep Range, Bechers Prairie and Stack Valley (see Appendix 7 for details). Seasonal fluctuations in the number of males were compared between the sub-areas to assess whether they were equivalent sampling units or whether behaviour varied between the units.

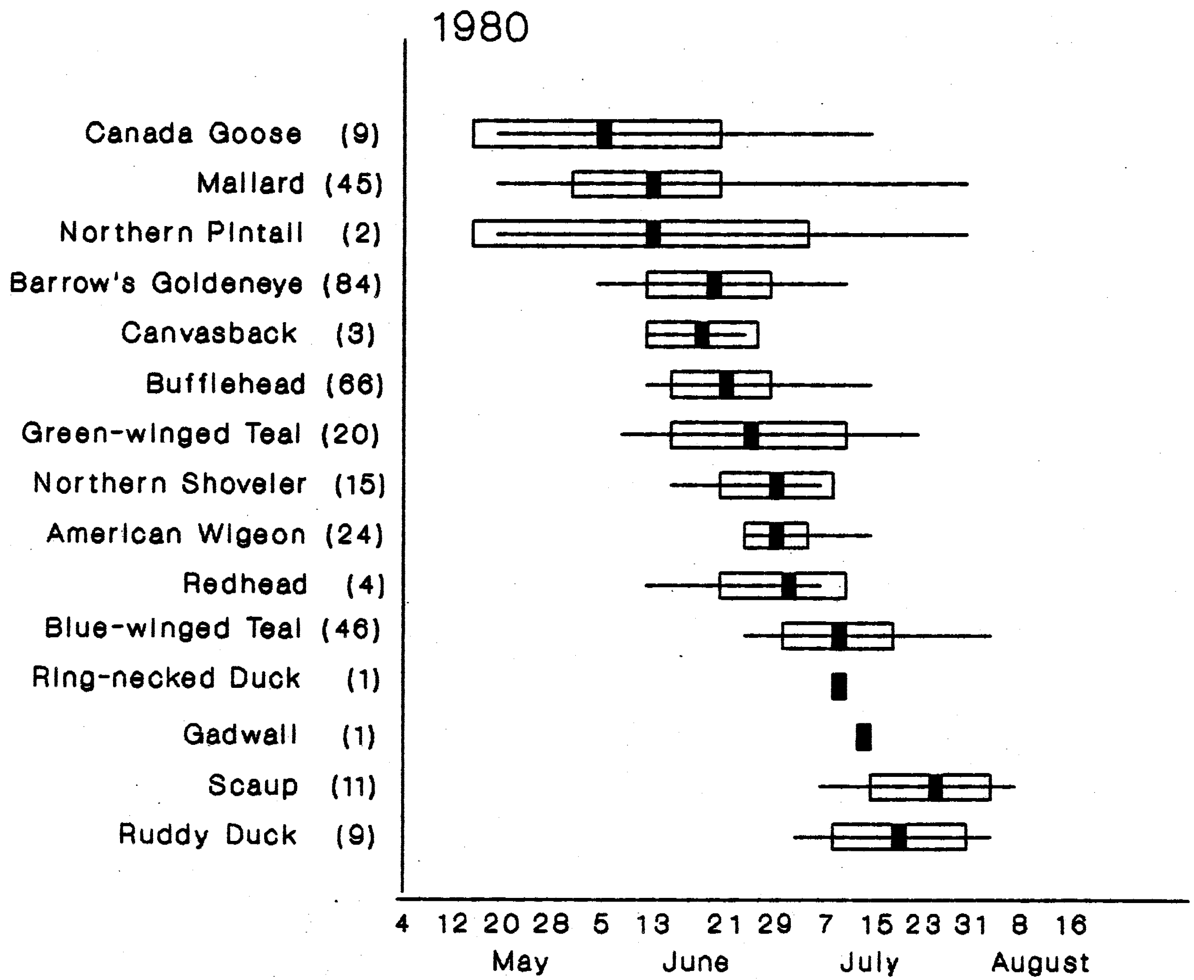


Figure 1. Average hatching date of waterfowl species at Riske Creek in 1980.

Figure 3. Average hatching date of waterfowl species at Riske Creek in 1981.

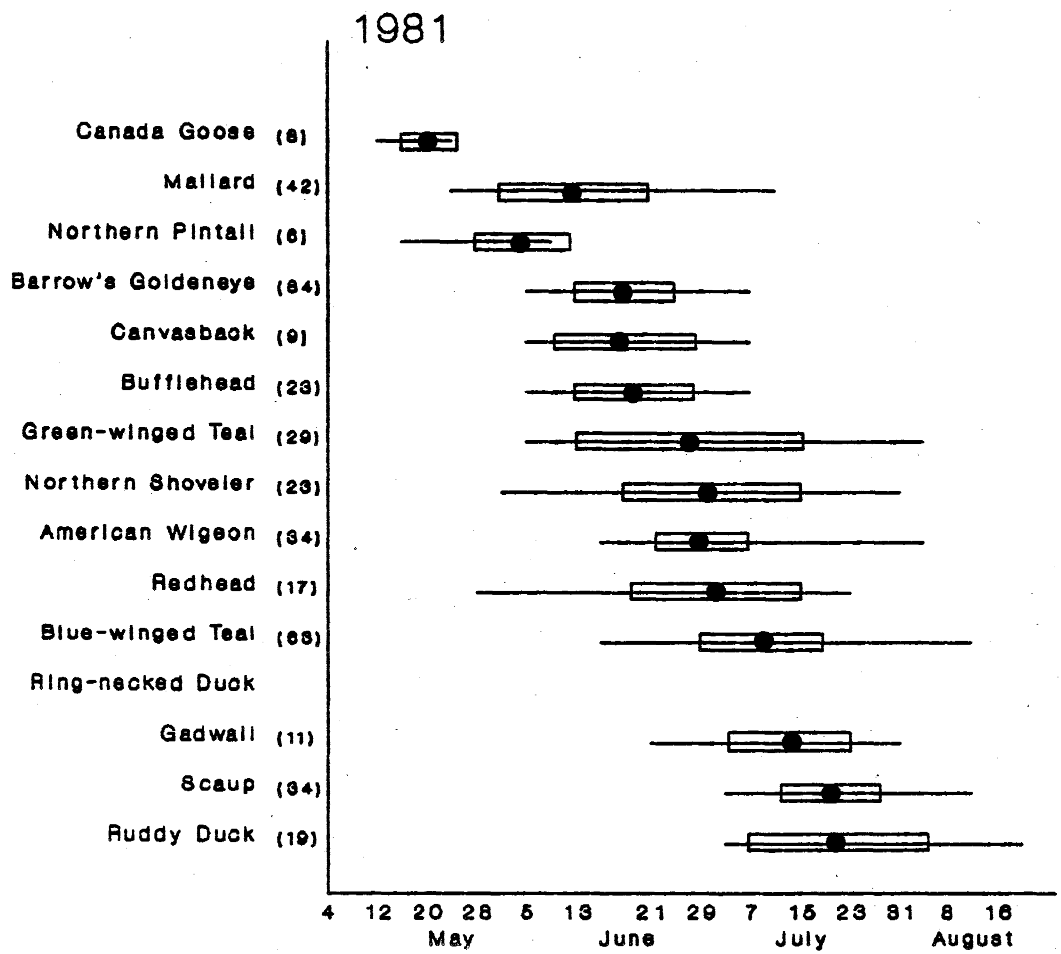


Figure 4. Average hatching date of waterfowl species at Riske Creek in 1982.

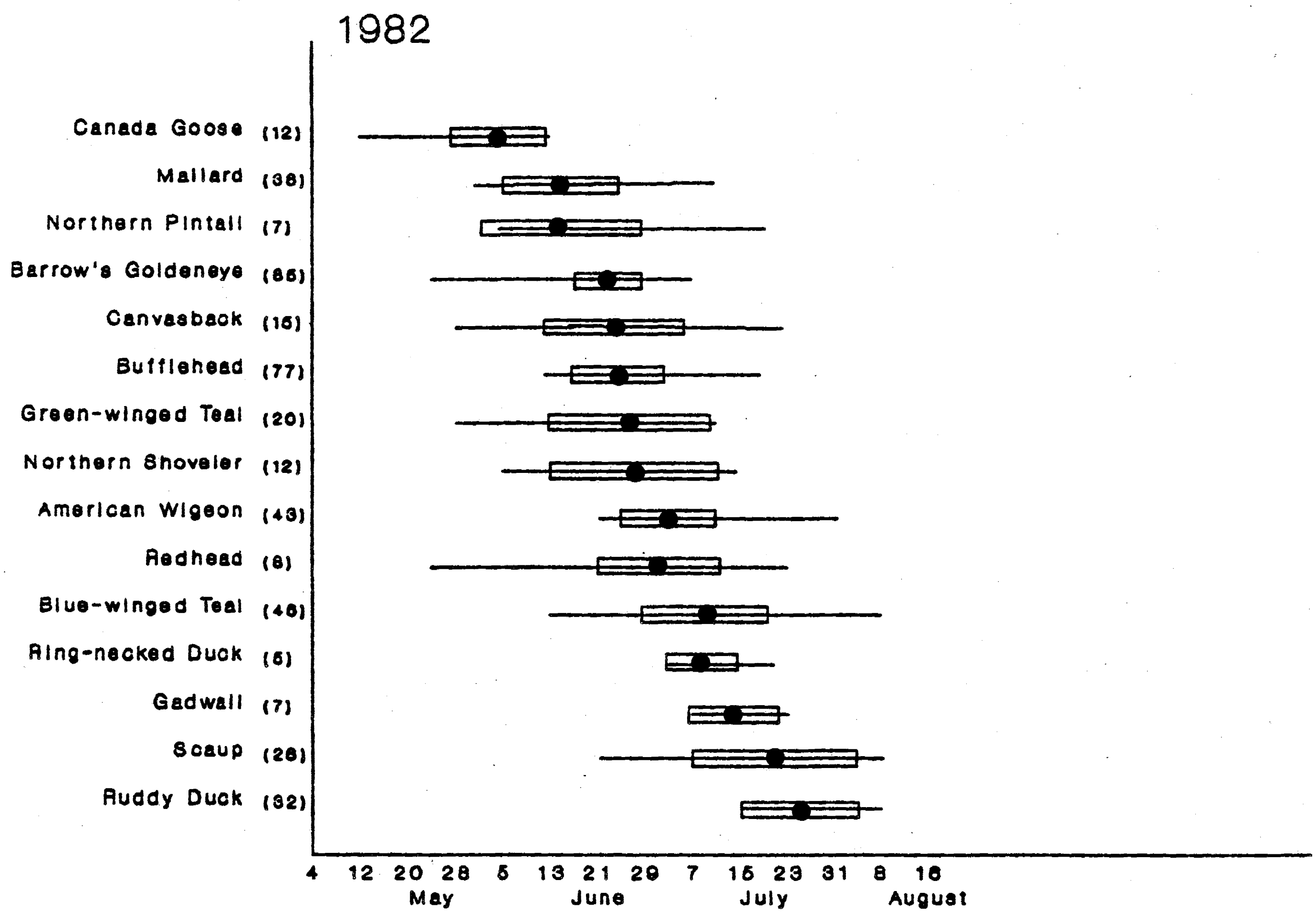


Figure 5. Average hatching date of waterfowl species at Riske Creek in 1983.

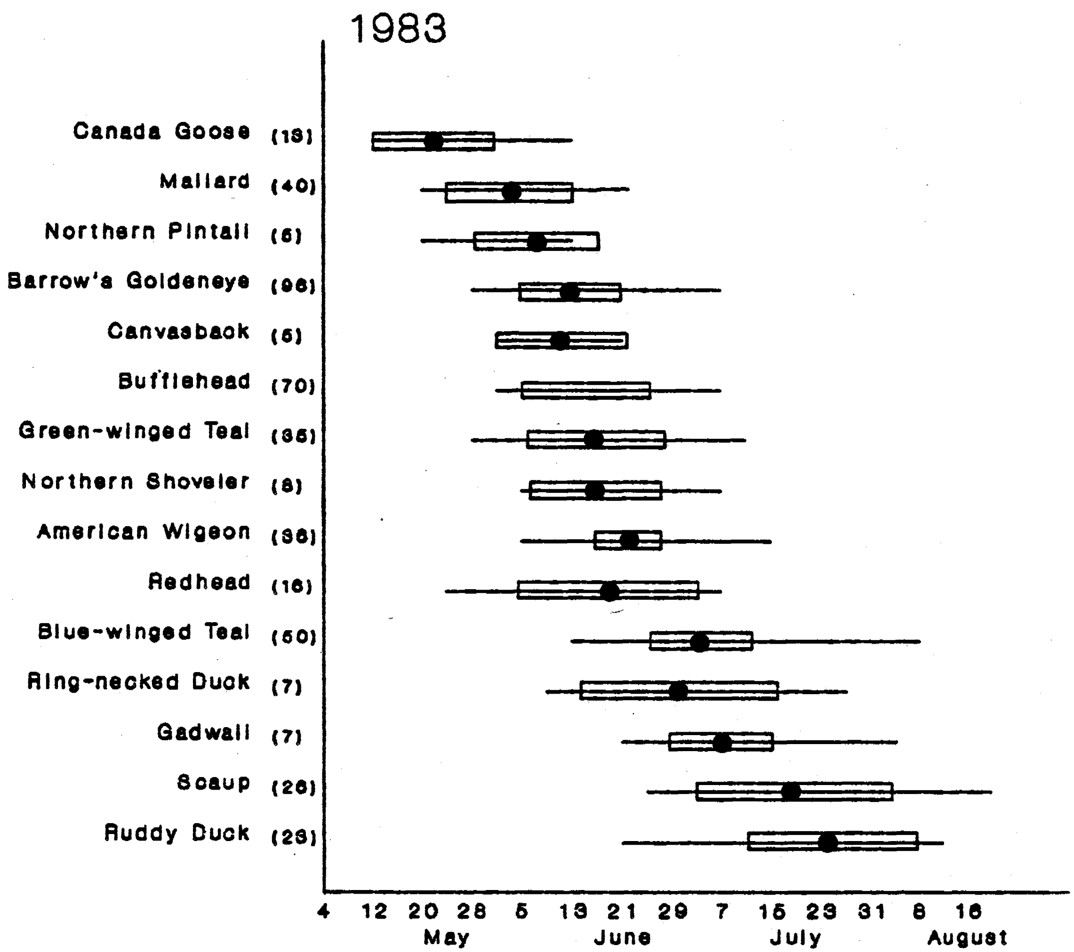
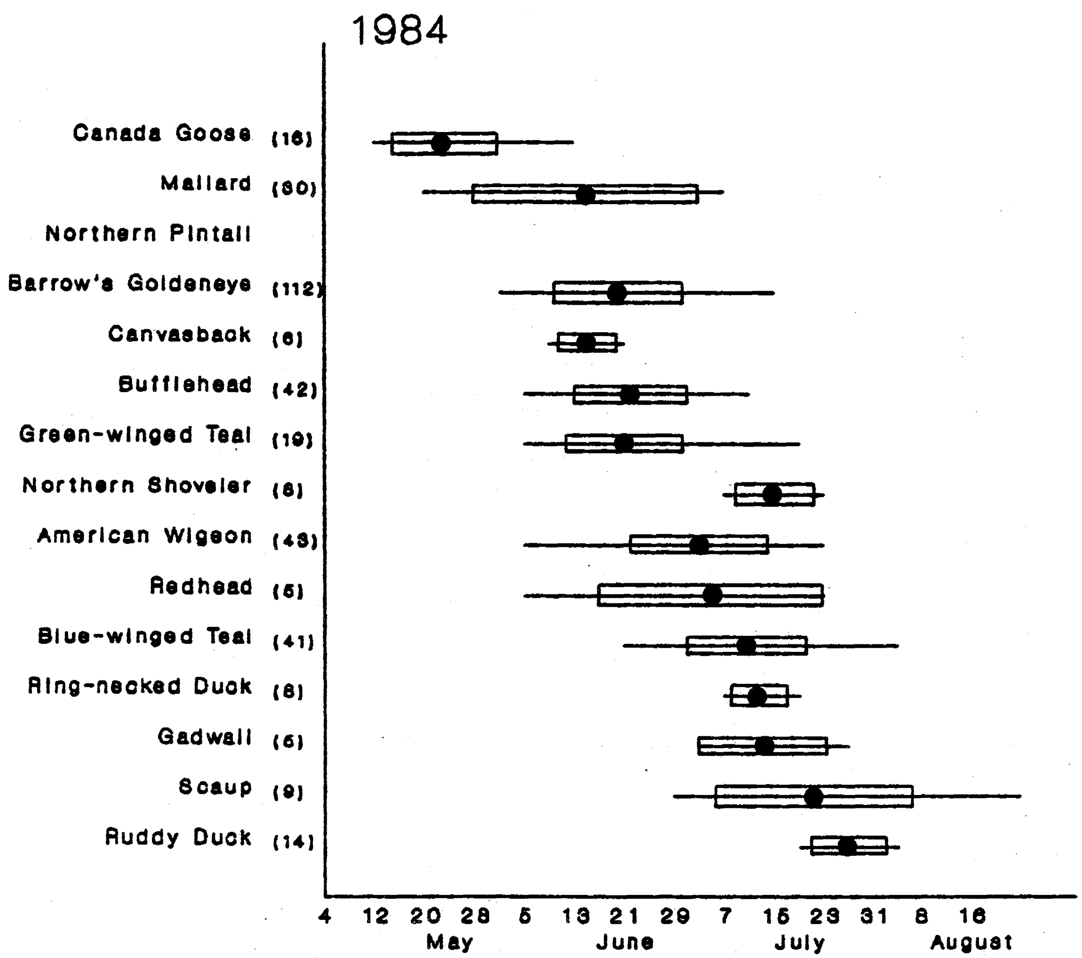


Figure 6. Average hatching date of waterfowl species at Riske Creek in 1984.



Results indicate that the system is complex, with waterfowl numbers fluctuating between sub-areas and between years (Appendix 7). Movements between sub- areas were apparent especially early in May and late in the season. Sheep Range was usually the first sub-area free of ice in the spring and birds tended to concentrate there waiting for the other sub-areas to open. Becher's Prairie attracted birds late in the season possibly as a staging area prior to molt migration and for some species as a molting area. The Sheep Range area supported the fewest number of birds and Becher's Prairie the greatest.

For most species analysed (Appendix 7), patterns of seasonal fluctuation varied between sub-areas. The pattern of arrival of Blue-winged Teal was similar in all three sub-areas in the three years analysed.

According to lake size

We also compared the abundance of males between lakes greater and less than 6 ha to assess waterfowl use. There was a great deal of similarity in fluctuations in the number of males on both lake sizes (Appendix 8). However, there were differences among species in their respective use of small and large lakes.

The relative use of small and large lakes differed between some years but most often was consistent. Numbers of Green-winged Teal and Scaup males fluctuated similarly on both lakes sizes in both 1980 and 1981. For other species such as Bufflehead and Barrow's Goldeneye some fluctuations were similar but others different. Both Bufflehead and Barrow's Goldeneye males appear to move from small lakes to larger lakes in late May prior to their departure for the molting areas. The number of migrant American Wigeon was greater on large lakes than on small lakes in 1981.

Comparison of the waterfowl community with the prairie provinces

The waterfowl community of the aspen parkland of British Columbia is more dominated by diving ducks than the waterfowl communities found in the prairies (Table 12). Diving ducks accounted for 56% of all the broods in the study area but only for 15% in Alberta and 17% in Saskatchewan. It appears that this

Table 12. Comparison of Riske Creek waterfowl habitat and prairie habitat.

	Number of ponds by size class (ha)					Total area of water (ha)	Total No. of broods		% of Divers	Size of study area (Km^2
	0.1-0.4	0.4-0.8	0.8-2.0	2.0-4.0	4.0-40.0		Dabblers	Divers		
Riske Creek (British Columbia)	11	11	29	30	36	591	228	296	56	150.0[1]
Lousana (Alberta)	138	17	13	0	0	55	410	75	15	9.4
Redvers (Saskatchewan)	266	27	13	2	0	68	247	51	17	13.0

1 area of irregular form, measured approximately.

difference is related to the type of ponds found in each area. Both prairie areas were dominated by small ponds less than 0.4 ha in size and lack ponds greater than 2 ha. However, in Riske Creek, and in the Aspen Parkland of British Columbia in general, most ponds are over 2 ha in size. Productivity per unit area is greater in the prairie provinces because of the high density of ponds. However, if we express the density of dabbling ducks in terms of number of broods per pond <0.8 ha, we obtained 10.4 for Riske Creek, 2.7 for Lousana and 0.8 for Redvers. Conversely, if we express the density of diving ducks as number of broods per pond >0.8 ha we obtain 3.1 for Riske Creek, 5.8 for Lousana and 3.8 for Redvers.

DISCUSSION

Adult Surveys

The current unit for surveying waterfowl is the pair or number of estimated pairs as derived from the number of actual pairs, the number of lone males, lone females and groups of males (Dzubin 1969, Savard 1980). This technique involves, however, some subjective judgements as migrant birds have to be identified and separated from breeding birds. This is relatively easy in territorial species such as Barrow's Goldeneye and Bufflehead but more difficult in species like Ruddy Duck and Scaup. However, with training and experience, breeders can, in most cases, be separated from migrants.

When untrained and/or inexperienced observers are used, the data collected becomes more difficult to interpret and one often has to resort to using the total number of birds seen rather than the estimated number of breeding pairs, especially when sample sizes are small. I have analysed here counts done over several years using the total number of males seen as the unit. Because migrants are not separated from breeders, the time of the count becomes crucial if one wants to compare abundance between years. Results indicate clearly that each species has its own breeding phenology relative to each other and that breeding can often be advanced or delayed in a given year due to weather conditions.

Yearly variations in breeding chronology complicate the timing of monitoring studies using the number of males as the monitoring unit. However, as indicated in Appendix 5, a stable period can be identified for most species which corresponds to the time just after migrants have left (i.e. Scaup) or the birds have all arrived (i.e. Blue-winged Teal) and prior to mid-incubation period when males start to concentrate and others leave for their molting areas. If three or more surveys are carried out throughout May, it becomes easier to identify the stable period and thus the count(s) that best represent the resident population of a given species.

Two species have shown quite drastic decreases during the study period: the Mallard and the Blue-winged Teal. Mallard numbers decreased from 1980 to 1982, remaining low thereafter, whereas numbers of Blue-winged Teal were high in 1980 and 1981 but decreased in 1982 by nearly half and remained low throughout 1983 and 1984. The decrease in Mallards paralleled a continent- wide decline in the species between 1980 and 1981 (Reynolds *et al.* 1990). The decline was related to drought conditions in the prairies. Drought was even more severe in 1981 which may have caused the decline in Blue-winged Teal numbers. However, there were normal water conditions on the study area during these years. This suggests some interchange between prairie and B.C. populations.

The increase in the number of Barrow's Goldeneye from 1982 to 1983 and 1984 is attributed to an increase in nest site availability in the study area due to the erection of nest boxes (Savard 1988b).

Brood surveys

The accuracy of brood counts in this data set differs considerably between dabbling and diving ducks. Counts for diving ducks are fairly accurate due to the conspicuousness of these birds and because the study centered on Barrow's goldeneye and Bufflehead. The number of dabbling duck broods presented here is an underestimation, as these broods were noted incidentally and because they study design did not maximize their chance of detection.

One diving duck, the Lesser Scaup was not adequately monitored in some years because of the late hatching of this species and numbers presented here are an underestimate of brood abundance. Similarly, Blue-winged Teal brood numbers may have been underestimated more than those of other dabbling ducks. Another factor contributing to lower accuracy of dabbling duck over diving duck brood counts, is the greater movement between ponds by dabbling duck broods. Finally, the concealment behaviour of broods of Green-winged Teal and Mallard likely impaired the detection of several broods.

The movement of broods between ponds makes it important to try to survey whole areas for monitoring purposes, rather than randomly or systematically selecting wetlands. This would reduce the variability of results.

Relationships between number of males, pairs and broods

The relationships between the number of pairs and the number of broods was highly variable, making it difficult to derive one from the other with any consistency. This is due to nesting success not always being density dependent, and factors such as weather, nesting cover and predator efficiency varying between years. These factors also impact differently on each species.

This weak relationship between pairs and brood numbers, coupled with different nesting and brood mortality between species, cautions against using the relative abundance of pairs to determine the relative abundance of broods in surveys where broods are not identified to species (i.e. prairie aerial surveys).

The proportion of paired males between years tended to be relatively constant for Barrow's Goldeneye (Range 66-71) but not for Bufflehead (Range 73-92), suggesting that this varies between species. There were more unpaired Barrow's Goldeneye males than Bufflehead males.

Breeding chronology

The relative breeding chronology of species was stable from year to year with some species like Mallard and Barrow's Goldeneye always breeding earlier than Blue-winged Teal and Scaup. This chronology is similar to that in the prairies and Northwest Territories at least for dabbling ducks (Murdy 1964, Dzubin 1969), indicating that the relative breeding period of waterfowl is similar throughout their range. For example, Mallards always breed earlier than wigeons wherever they nest. However, breeding chronology of a given species varied between years depending on weather conditions. Breeding was advanced in warm springs and delayed in cold ones. Yocom and Hansen (1960) observed delayed nesting peaks in years with cold springs.

Early nesting species, as expected, were influenced by April temperatures to a greater extent than late nesters which were influenced by May temperatures. Hammond and Johnson (1984) found similar patterns in their study of the influence of weather on breeding ducks in North Dakota.

The longer breeding span observed in 1984 for Mallard, American Wigeon and Barrow's Goldeneye is attributed to the cold weather in May of that year which followed a warm April. Dane (1966) and Dzubin and Gollop (1972) have noted that a brief period of cold weather can interrupt breeding and in some cases produced bimodal nesting curves.

Distribution

All three sub-areas were not used similarly by all waterfowl species. In spring, Sheep Range, being more open, usually had open ponds a few days earlier than Becher's Prairie and Stack valley. There was evidence of waterfowl movements between the sub-areas. Becher's Prairie was also used as a staging area by some species in late May, attracting birds from other sub- areas. Also, some sub-areas had more migrants than others. These differences suggest caution when extrapolating results from small areas.

Fluctuations in the number of males were similar on large and small lakes for Green-winged Teal, Blue-winged Teal and Scaup. For other species, some fluctuations were variable. Large lakes often attracted more migrants than smaller lakes and also tended to attract more staging birds in late May. The cutoff point of 6 ha was somewhat arbitrary and it is possible that larger differences would be found by comparing, for example, lakes <2 ha with other sized lakes.

For most species the departure of migrants and the departure of males for molting areas was obvious from counts on both types of lakes.

Characteristics of the Aspen Parkland waterfowl community

The waterfowl community of the Aspen Parkland of British Columbia differs from that of the prairies by the presence and dominance of cavity nesting species such as the Barrow's Goldeneye and the Bufflehead. American Wigeon are also more predominant among dabbling ducks than they are in the prairies (Stewart and Kantrud 1974, Lokemoen 1973, Smith 1971, Stoudt 1971). Differences in waterfowl communities of different areas appear to be related to wetland types. Lack of cavity nesting waterfowl in the prairies is likely due to a paucity of nesting sites and deep ponds in this region.

This brief analysis reveals and suggests several important characteristics of the waterfowl community of central British Columbia. However, we still know little of the population dynamics of most species. Moulting ecology is also poorly known as is fall staging. Hopefully the data presented here will be useful in the elaboration of more specific and focused research.

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Appendix 1. Weather near the study area.

Weather was extremely variable during the 5 years of the study (Fig. 1.1). The average monthly temperature varied between months in an uncorrelated manner. For example, in 1981, a warm March was followed by a cold April, whereas in 1980 the reverse occurred. The warmest spring occurred in 1983 when April and May temperatures were warmer than usual, resulting in ponds being ice free by mid-April. In 1984 the ice melted early as well, but the month of May was unusually cold.

Precipitation was also highly variable between months and between years, with May 1980 having 65.4 mm of rain compared to only 7.4 mm in 1983 (Figs. 1.1-1.2). The driest spring was in 1986 with a total of only 53.8 mm of precipitation from March to July and the wettest was in 1980 with 213.8 mm for the same period.

Detailed weather records are presented for the months of March to August and the years 1980 to 1986 in Tables 1.3 to 1.8.

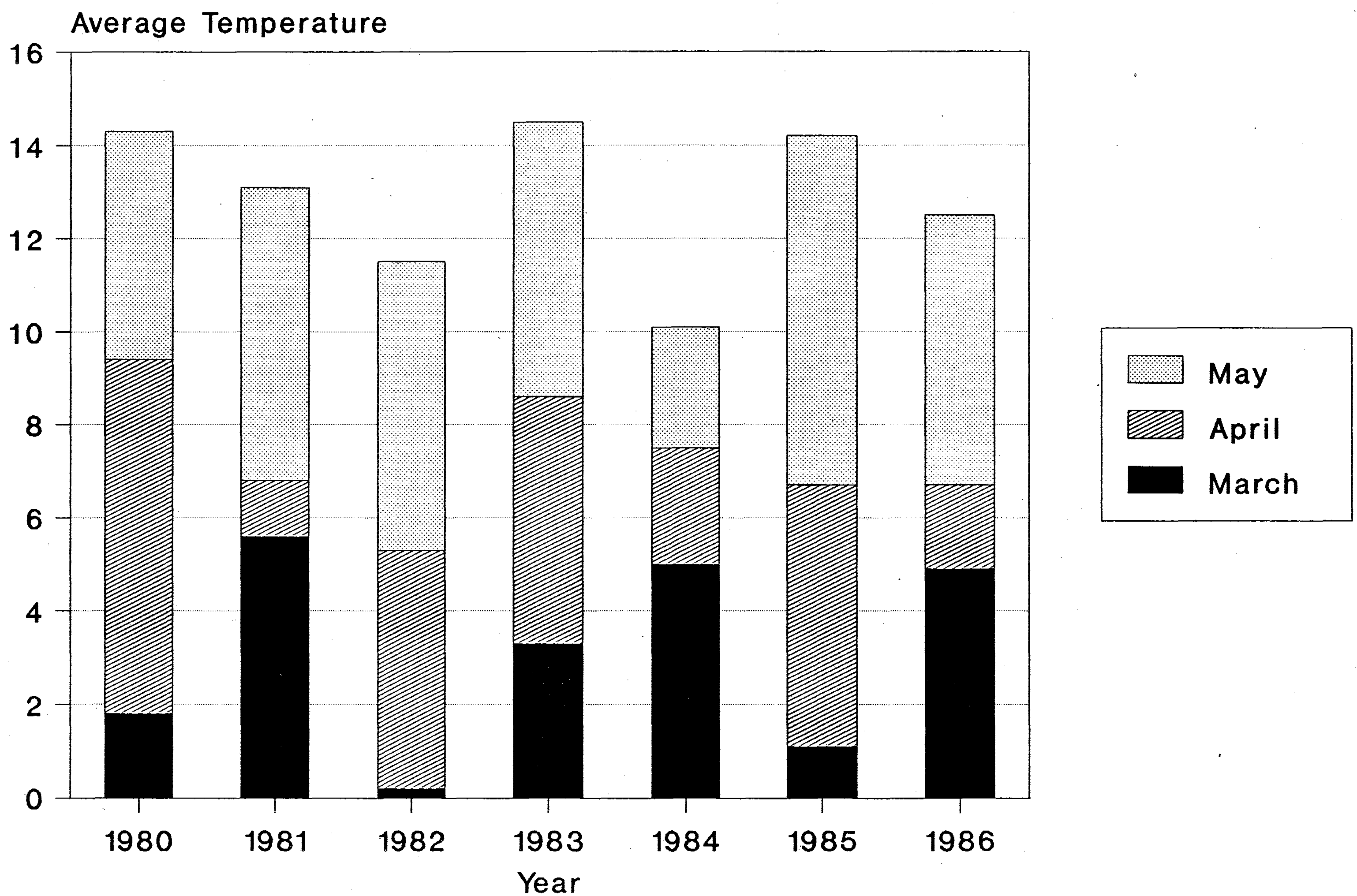


Figure 1.1 Monthly average temperature at Wineglass Ranch near Riske Creek.

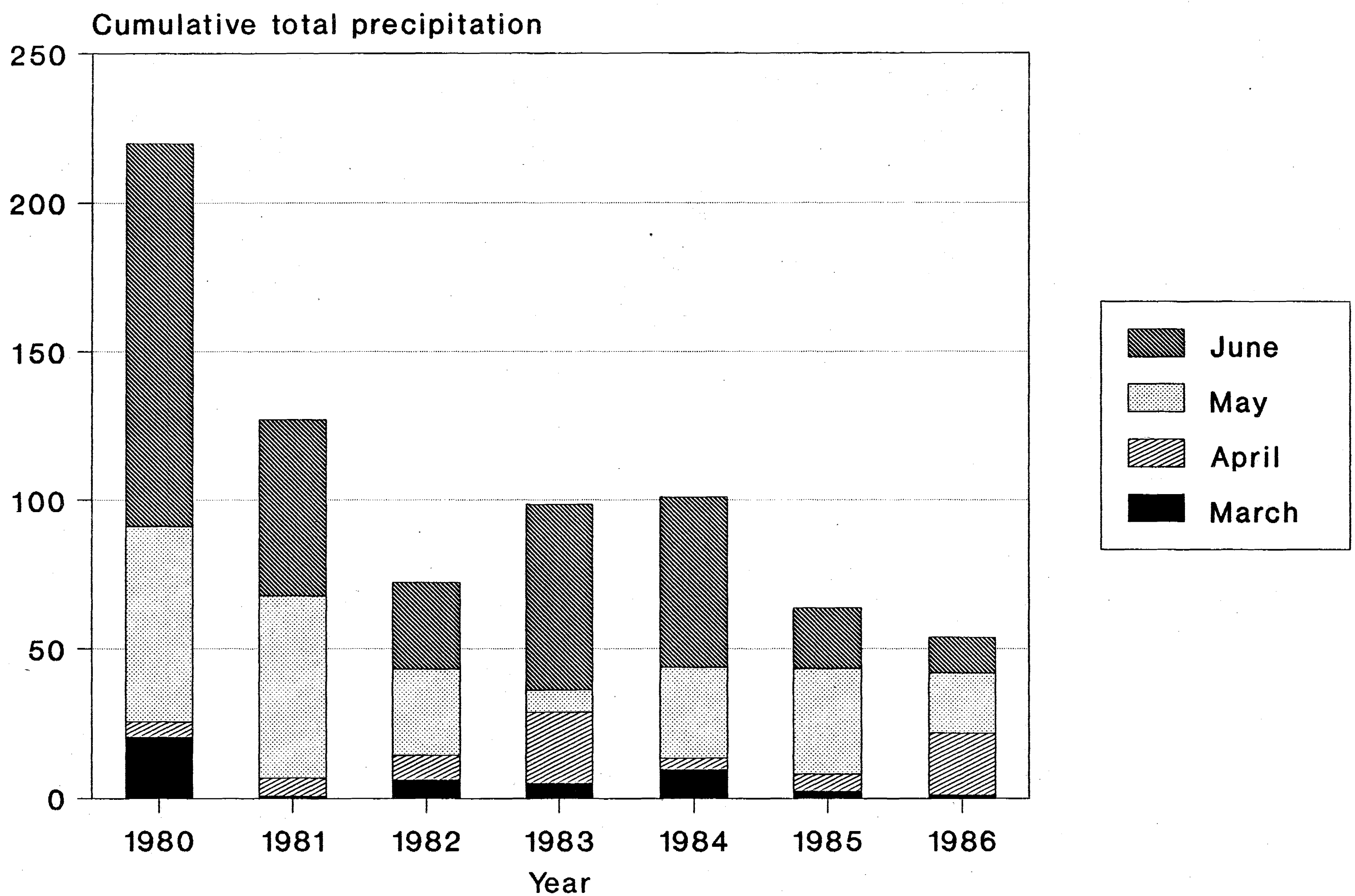


Figure 1.2 Cumulative total precipitation at Wineglass Ranch near Riske Creek.

Table 1.3 Average maximum and minimum monthly temperature and total precipitation in March 1980-1986 at Wine Glass Ranch.

	MARCH Temperature (°C)			
Year	x Maximum	x Minimum	X	Total precipitation
1980	7.8	-4.2	1.8	20.4
1981	13.8	-2.6	5.6	0.6
1982	7.1	-6.7	0.2	6.2
1983	11.0	-4.4	3.3	5.0
1984	12.5	-2.6	5.0	9.6
1985	8.1	-5.9	1.1	2.4
1986	12.5	-2.8	4.9	1.0

Table 1.4 Average maximum and minimum monthly temperature and total precipitation in April 1980-1986 at Wine Glass Ranch.

	APRIL Temperature (°C)			
Year	x Maximum	x Minimum	X	Total precipitation
1980	19.6	-0.8	9.4	5.2
1981	15.4	-1.9	6.8	6.2
1982	13.5	-2.9	5.3	8.2
1983	17.5	-0.3	8.6	23.8
1984	15.3	-0.4	7.5	3.8
1985	15.1	-1.8	6.7	5.6
1986	14.3	-0.9	6.7	20.8

Table 1.5 Average maximum and minimum monthly temperature and total precipitation in May 1980-1986 at Wine Glass Ranch.

	MAY			
	Temperature (°C)			
Year	x Maximum	x Minimum	X	Total precipitation
1980	21.3	7.2	14.3	65.4
1981	20.1	6.0	13.1	61.0
1982	19.3	3.7	11.5	28.8
1983	23.1	5.8	14.5	7.4
1984	17.4	2.7	10.1	30.4
1985	22.4	5.9	14.2	35.4
1986	20.5	4.4	12.5	20.0

Table 1.6 Average maximum and minimum monthly temperature and total precipitation in June 1980-1986 at Wine Glass Ranch.

	JUNE			
	Temperature (°C)			
Year	x Maximum	x Minimum	X	Total precipitation
1980	22.9	9.6	16.3	122.8
1981	20.3	5.9	13.1	59.1
1982	28.0	11.1	19.6	29.0
1983	22.3	10.0	16.2	62.2
1984	22.1	7.8	15.0	57.2
1985	23.8	7.3	15.6	20.4
1986	25.1	8.3	16.7	12.0

Table 1.7 Average maximum and minimum monthly temperature and total precipitation in July 1980-1986 at Wine Glass Ranch.

	JULY			
	Temperature (°C)			
Year	x Maximum	x Minimum	X	Total precipitation
1980	24.6	10.0	17.3	53.0
1981	26.8	11.0	18.4	66.8
1982	25.8	10.9	17.6	128.6
1983	24.5	9.7	17.1	74.2
1984	27.2	10.2	18.7	21.6
1985	30.8	11.7	21.3	6.8
1986	24.2	10.6	17.4	40.2

Table 1.8 Average maximum and minimum monthly temperature and total precipitation in August 1980-1986 at Wine Glass Ranch.

	AUGUST			
	Temperature (°C)			
Year	x Maximum	x Minimum	X	Total precipitation
1980	23.0	9.2	16.1	81.2
1981	29.6	11.8	20.7	17.8
1982	23.5	9.7	16.6	45.6
1983	27.3	9.5	18.4	9.6
1984	25.7	9.6	17.7	49.2
1985				
1986				

Appendix 2. Adult male abundance between April 22 and July 9, 1980.

Species	April		May				June			July	
	22-23	24-25	7-8	10-12	21-22	23-24	3-4	4-6	17-18	1-4	6-9
Mallard	278	200	166	186	250	261	314	319	438	185	143
Gadwall	3	4	9	13	16	18	20	25	23	10	16
American Wigeon	287	253	126	137	105	109	131	106	202	147	141
Northern Pintail	209	173	51	60	42	51	47	51	52	8	5
Green-winged Teal	173	202	108	82	71	70	85	84	154	214	178
Blue-winged Teal	5	14	173	232	461	416	511	560	654	490	416
Cinnamon Teal	10	12	14	12	13	12	15	24	23	14	14
Northern Shoveler	26	50	104	87	97	100	90	80	80	48	9
Redhead	34	46	39	41	30	37	22	32	15	13	5
Ring-necked Duck	170	184	46	46	43	42	47	53	44	66	43
Canvasback	449	457	20	15	12	16	22	12	3	0	0
Scaup	697	1081	586	500	231	171	217	215	292	232	158
Barrow's Goldeneye	467	397	310	332	330	324	321	256	37	3	6
Bufflehead	492	422	193	174	164	159	158	155	97	8	4
Ruddy Duck	41	68	78	86	75	79	100	122	93	76	60
Total dabbling ducks	991	908	751	809	1055	1037	1213	1249	1626	1116	922
Total diving ducks	2350	2655	1272	1194	885	828	887	845	581	398	276
Total	3341	3563	2023	2003	1940	1865	2100	2094	2207	1514	1198

Appendix 3. Adult female abundance between April 22 and July 9, 1980.

	April		May				June			July	
Species	22-23	24-25	7-8	10-12	21-22	23-24	3-4	4-6	17-18	1-4	6-9
Mallard	243	158	75	65	75	86	71	81	11	69	77
Gadwall	3	3	9	12	12	17	17	22	12	9	16
American Wigeon	239	227	100	104	53	59	48	41	47	66	65
Northern Pintail	188	135	35	31	24	20	23	22	33	27	46
Green-winged Teal	145	163	76	62	28	21	21	20	30	40	61
Blue-winged Teal	2	2	75	110	220	194	204	211	253	234	282
Cinnamon Teal	7	9	8	10	5	4	2	7	5	3	2
Northern Shoveler	21	35	67	53	49	42	33	38	27	42	30
Redhead	23	34	27	27	25	24	16	24	10	13	8
Ring-necked Duck	67	73	23	26	13	7	11	11	3	9	7
Canvasback	219	236	13	10	7	9	11	7	7	5	11
Scaup	238	467	290	250	64	59	64	66	60	62	43
Barrow's Goldeneye	322	256	194	180	134	101	57	59	262	218	154
Bufflehead	227	219	126	123	71	55	48	49	149	151	136
Ruddy Duck	16	33	69	58	39	32	43	42	28	23	23
Total dabbling ducks	848	732	445	447	466	443	419	442	418	490	579
Total diving ducks	1112	1318	742	674	353	287	250	258	519	481	382
Total	1960	2050	1187	1121	819	730	669	700	937	971	961

Appendix 4. Pair abundance between April 22 and June 18, 1980.

Species	April 22-23	April 24-25	May 7-8	May 10-12	May 21-22	May 23-24	June 3-4	June 4-6	June 17-18	$\bar{x}$[4]
Mallard[1]	247	191	176	181	224	228	236	155		179±3
Gadwall[2]	3	4	9	12	13	17	26	20		17±3
American Wigeon	228	208	115	118	69	74	70	55		67±4
Northern Pintail	162	113	46	45	27	29	25	15		31±6
Green-winged Teal	140	152	72	58	37	35	32	28		41±6
Blue-winged Teal	2	0	69	100	231	199	208	217	236	218±7
Cinnamon Teal	4	9	8	9	5	3	2	7	4	5±1
Northern Shoveler	18	33	68	54	47	49	53	49		53±3
Redhead[3]	30	33	21	19	29	24	20	19		23±2
Ring-necked Duck	37	37	17	20	9	6	7	11		12±2
Canvasback	66	120	8	6	6	3	5	4		5±1
Scaup	49	104	72	112	46	47	57	60	55	53±4
Barrow's Goldeneye	231	209	234	215	194	168	76	49		203±14
Bufflehead	151	154	125	117	90	74	50	48		102±12
Ruddy Duck	1	4	0	2	7	5	12	13	8	13±1
Total dabbling ducks	804	710	563	577	653	634	652	546		611
Total diving ducks	565	661	477	491	381	327	227	204		411
Total	1369	1371	1040	1068	1034	961	879	750		1022

1 - Mallard pair includes group of 2 to 5 males and lone males.
2 - All other dabbling ducks no group of males observed, lone males included in counts.
3 - Straight pair counts for all diving ducks except for Barrow's Goldeneye and Bufflehead for which lone males could be identified.
4 - Average of the underlined counts.

Appendix 5. Seasonal fluctuation in the number of adult males.

During the study, pair counts were done in 1980 for all species and only for Barrow's Goldeneye and Bufflehead in other years. Thus I used the number of males to compare waterfowl abundance within and between years. Total adult males rather than total birds was used because female numbers decreased when incubation started. It was assumed that the number of adult males would remain constant until the departure for moulting areas. The number of males should reflect fluctuations in the population although it may not correspond directly to the number of breeding pairs.

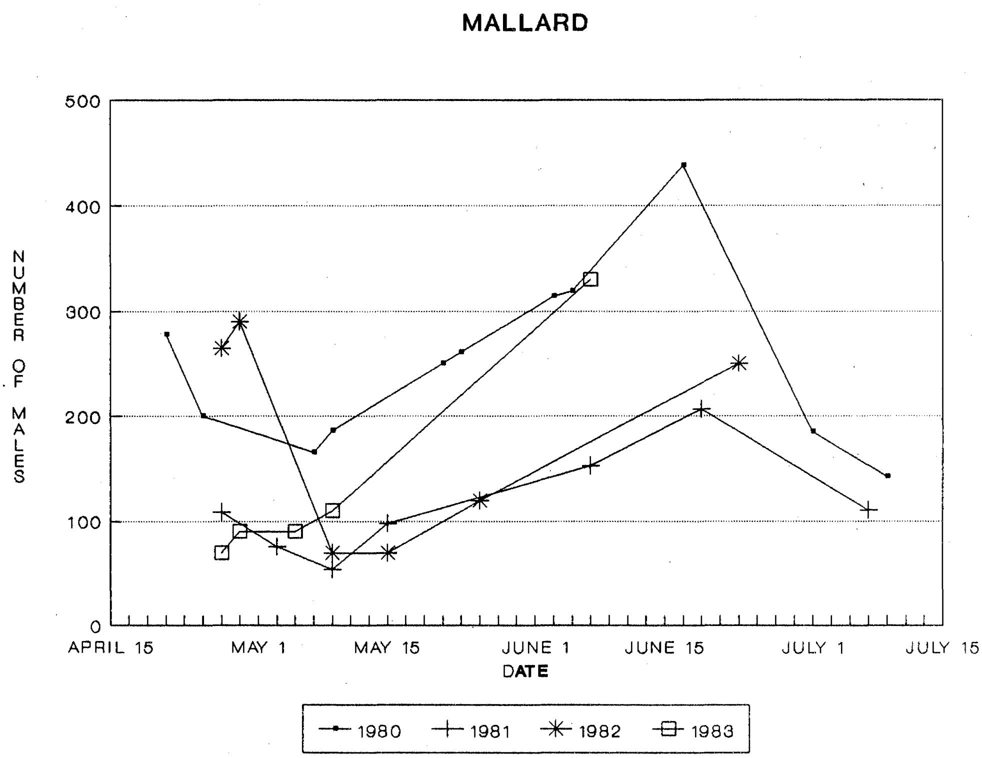
For each species, the number of males was plotted against survey date, that is for 1980 to 1983. Too few surveys were conducted in 1984, 1985 and 1986 to detect patterns. Thus for these years, the period of stability of the population had to be derived from the pattern observed in earlier years. I describe and discuss below the data for the most important species.

Mallard

The number of Mallard drakes on the study area varied considerably within and between years (Fig. 5.1). Migrants affected early counts, and an influx of drakes in late May and early June was also evident. Migration chronology varied between years and the timing of the departure of migrants differed each year. The pattern of departure is clearer in 1980 and 1982 than in 1981 and 1983. This is due in part to the frequency and date of surveys which differed each year. Brood hatching chronology indicates that 1983 was an early year, whereas 1982 a late one (Appendix 6). This is reflected in the number of males seen each year. Based on the results of these four years, the second week of May seems to be the best time to survey Mallard drakes, although in early years the first week of May is also good.

Gadwall

Gadwall were less abundant than Mallards and arrived later on the study area (Fig. 5.1). Numbers of drakes were low in early May and build up until the third week of May. Numbers increased again in early and late June. Whether or not these were breeders is unknown, but they may have been moulters flocking



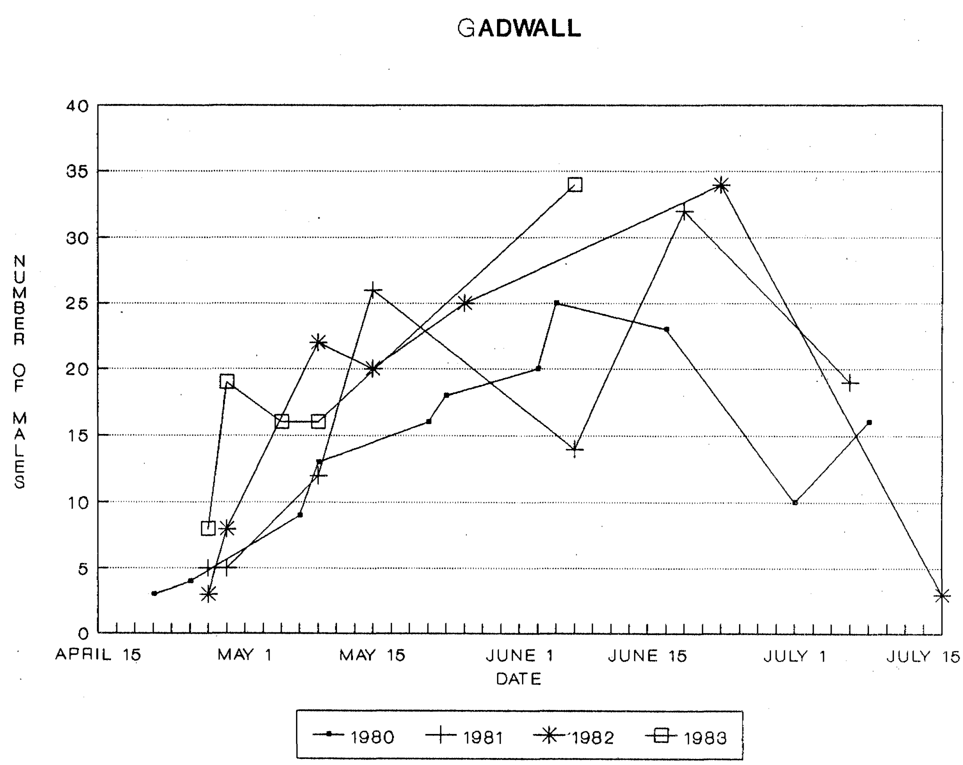


Figure 5.1 Seasonal fluctuations in the number of Mallard and Gadwall males.

to the study area. Data suggest the third and fourth week of May for surveys. However, in 1983, an early year, numbers of Gadwall had arrived on the study area by the second week of May.

American Wigeon

As with Mallards, migrants were present in late April, early May (Fig. 5.2). Again the timing of the departure of migrants varied between years according to spring temperatures. In the cold spring of 1982, numbers of drakes stabilized only in the third and fourth weeks of May, whereas in 1980 and 1983 migrants had left by the second week of May. In years with cold springs, the third week of May would be adequate for surveys, whereas in warm springs the second week may be more suitable.

Northern Pintail

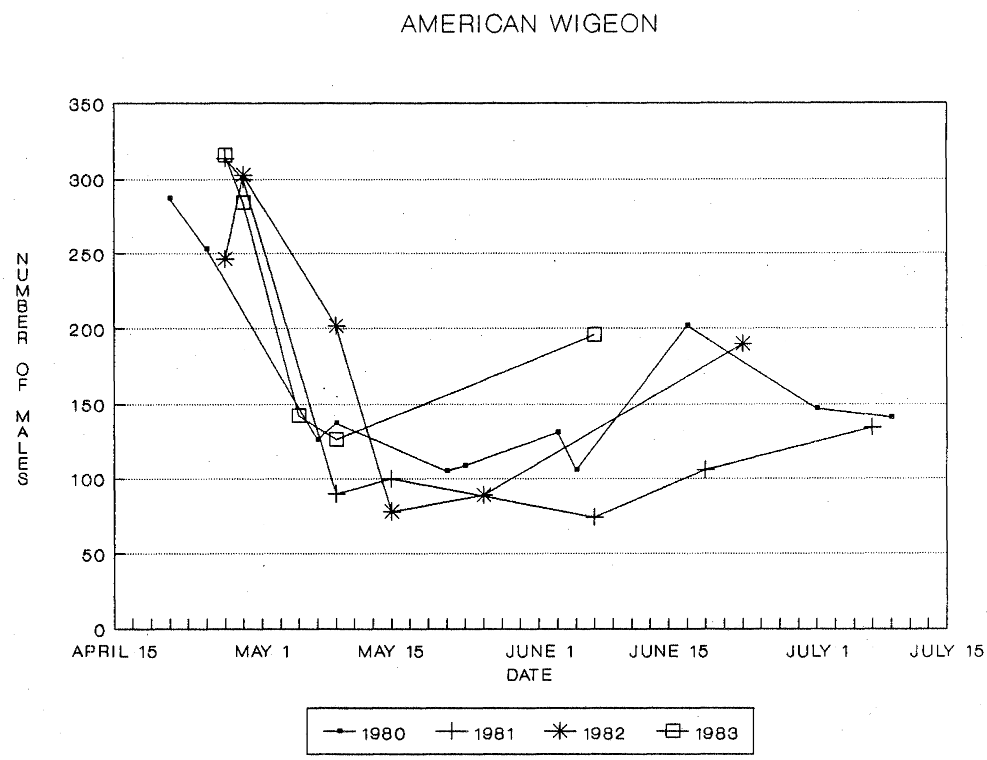
Migrants outnumbered breeders on the study area in late April, early May (Fig. 5.2). Patterns were similar between years although departure dates of migrants differed. There was no obvious influx of moulters on the study area. The second and third weeks of May seem appropriate for surveys although in 1983 migrants had already left by the first week of May.

Green-winged Teal

Migrants were abundant in late April and early May and the number of adult males in the study area was greatly reduced following their departure (Fig. 5.3). The number of males remained stable from the third week of May through the first week of June. In mid and late June males migrated into the study area. The second and third week of June seems to be the best time to survey the species.

Blue-winged Teal

Blue-winged Teals are late migrants and the number of adult males increased gradually throughout May (Fig. 5.3). Total numbers fluctuated greatly from 1980, 1981 to 1982-1983. Although more surveys in late May and early June would be necessary to pin point the period where numbers stabilized, it seems that



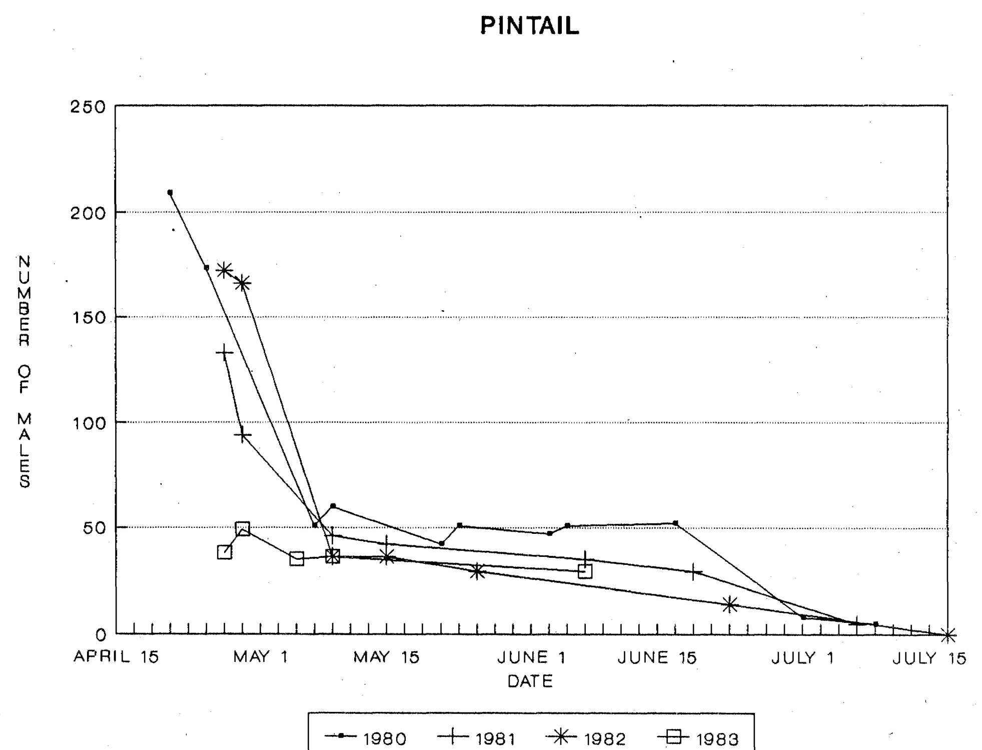


Figure 5.2 Seasonal fluctuations in the number of American Wigeon and Pintail males.

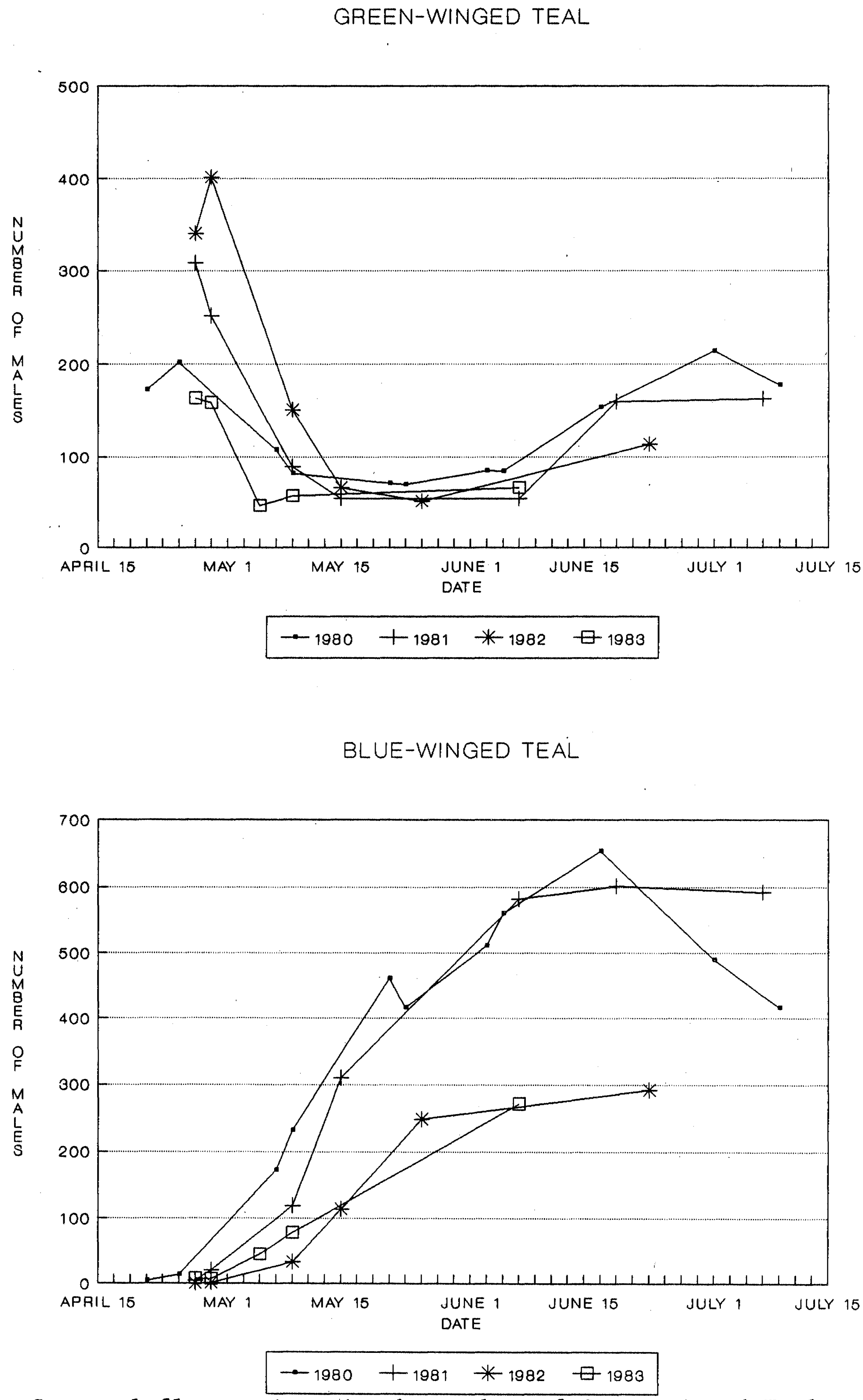


Figure 5.3 Seasonal fluctuations in the number of Green-winged Teal and Blue-winged Teal males.

surveys in the first week of June would be in this period. In some years, counts in the last week of May should yield adequate results. No surveys were done in late May in 1985 and 1986 so that no estimates are available for Blue-winged Teal in these years.

Cinnamon Teal

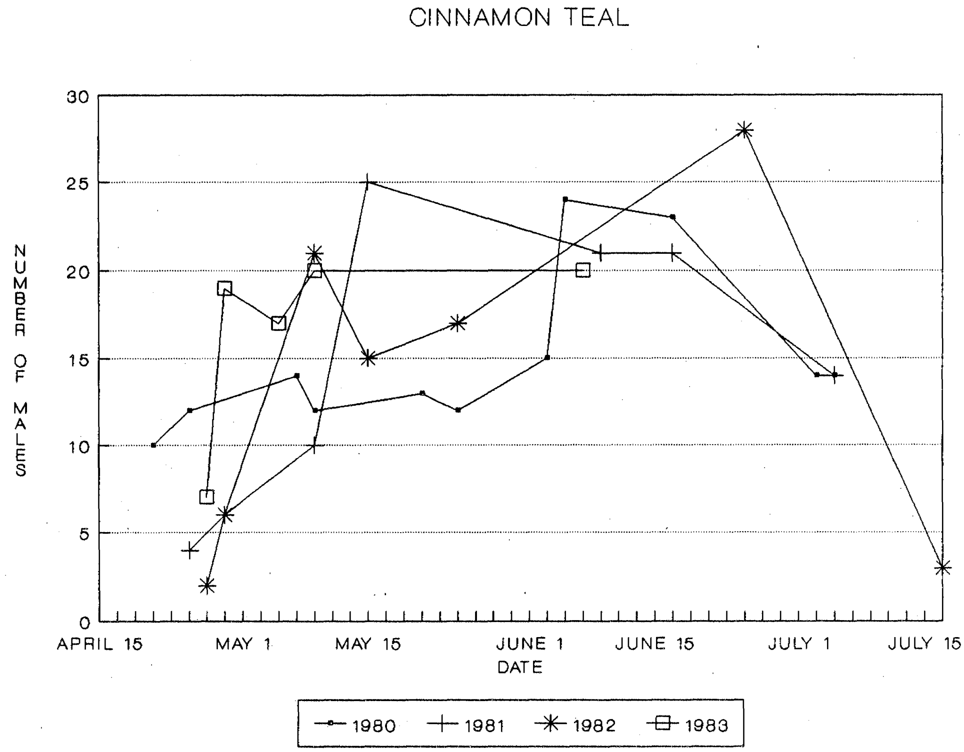
Cinnamon Teal arrived on the study area earlier than Blue-winged Teal, and the number of adult males stabilized by the third week of May and remained fairly stable until the second week of June (Fig. 5.4). However, numbers in the study area are small and this may account for the variability of the counts.

Northern Shoveler

The numbers of adult males increased from late April to the second week of May and remained stable thereafter until early June in 1980 and 1981 (Fig. 5.4). Patterns differed in 1982 and 1983. In 1982 numbers of males reached a peak on May 10 but decreased the following week. In 1983 numbers were stable in late April and early May but decreased in the second week of May. Best survey periods for males varied between years with possibly the second week of May being most often adequate.

Redhead

As with Northern Shoveler, numbers of adult male Redheads fluctuated differently between years with little consistency (Fig. 5.5). This impaired a comparison between years. Possibly some of these fluctuations were due to counting errors, as Redheads frequented lakes with emergent vegetation. Also, because of their feeding habits they are more easily overlooked than dabbling ducks when the surveyor is scanning a lake. Counts in the second and third week of May possibly represent the breeding population.



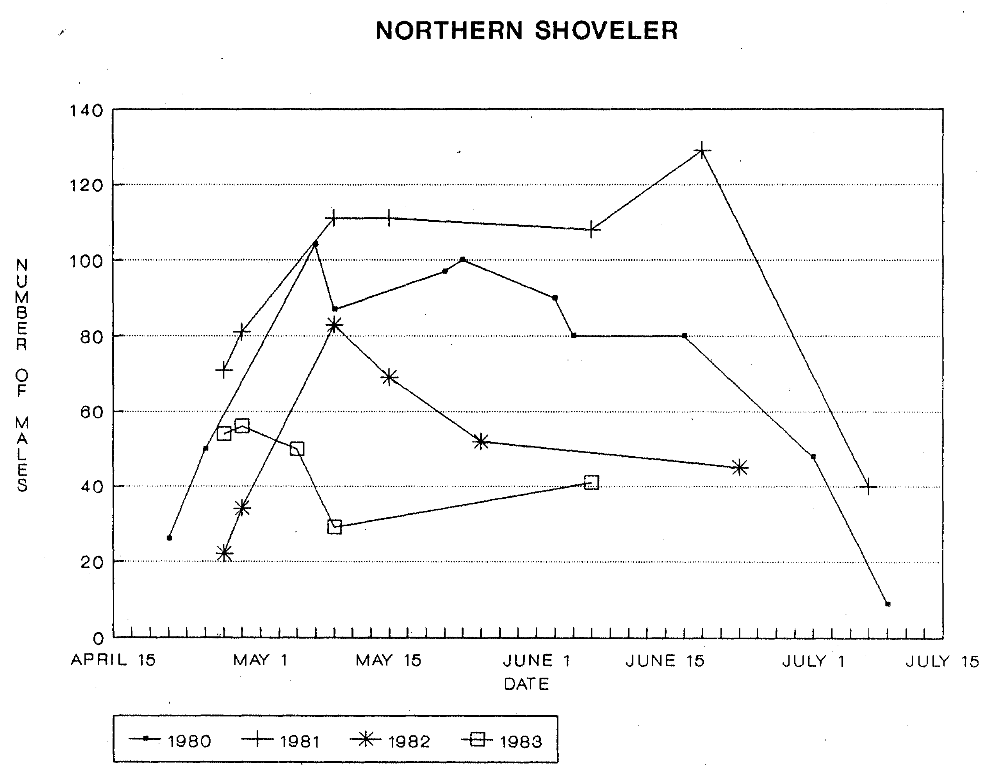
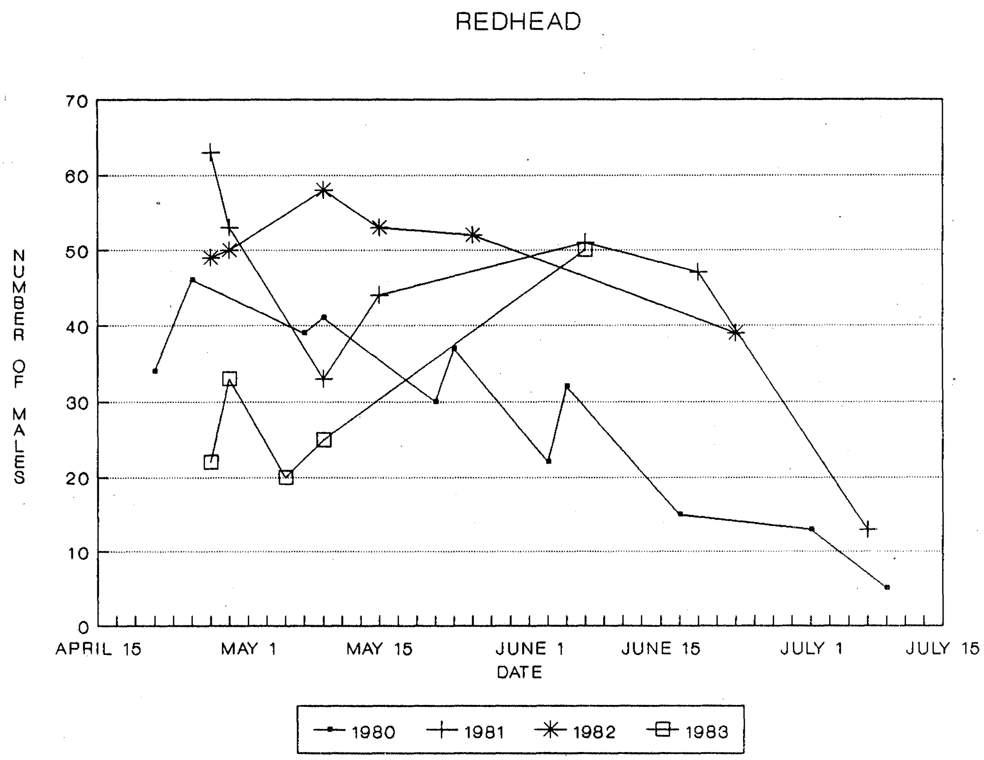


Figure 5.4 Seasonal fluctuations in the number of Cinnamon Teal and Northern Shoveler males.



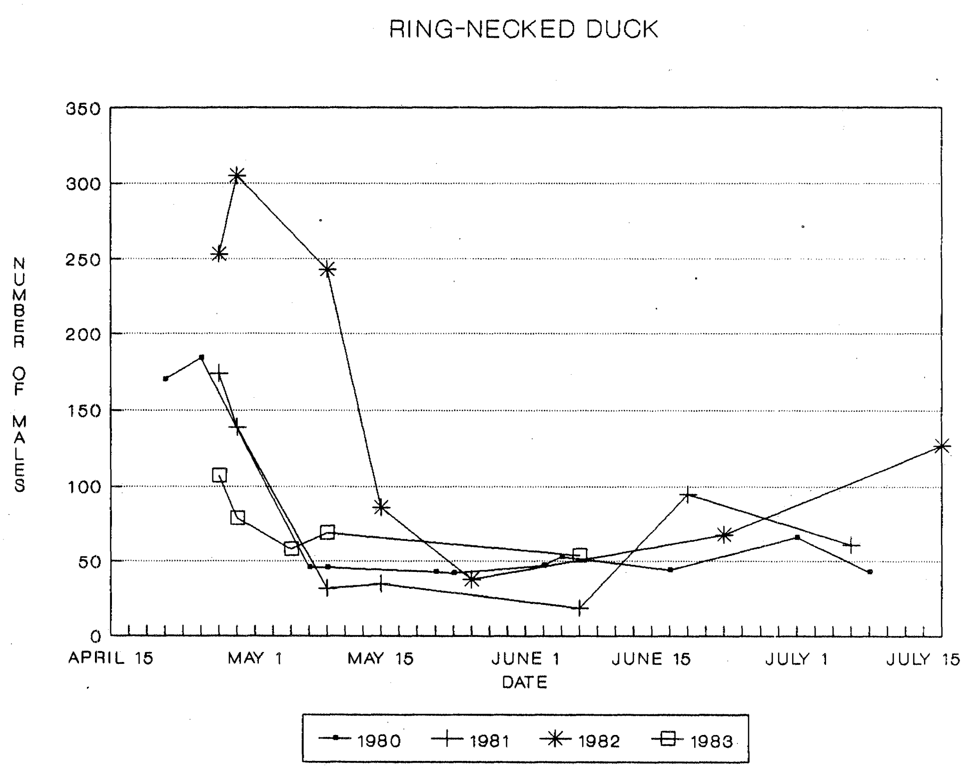


Figure 5.5 Seasonal fluctuations in the number of Redhead and Ring-necked Duck males.

Ring-necked Duck

Fluctuations in numbers of adult male Ring-necked Ducks are similar to those of adult male Green-winged Teal (Fig. 5.5). Migrants have left the study area by the third week of May which, with the first week of June, should be the best time to survey this species. In 1983 spring migrants had left by the second week of May. In some years there was an apparent increase in the number of males in late June.

Canvasback

Migrants totally dominate the population in late April and early May and their departure varies by as much as two weeks between years (Fig. 5.6). Less than 50 males remain in the study area during the breeding season. Counts in the third week of May should provide reliable estimates.

Scaup

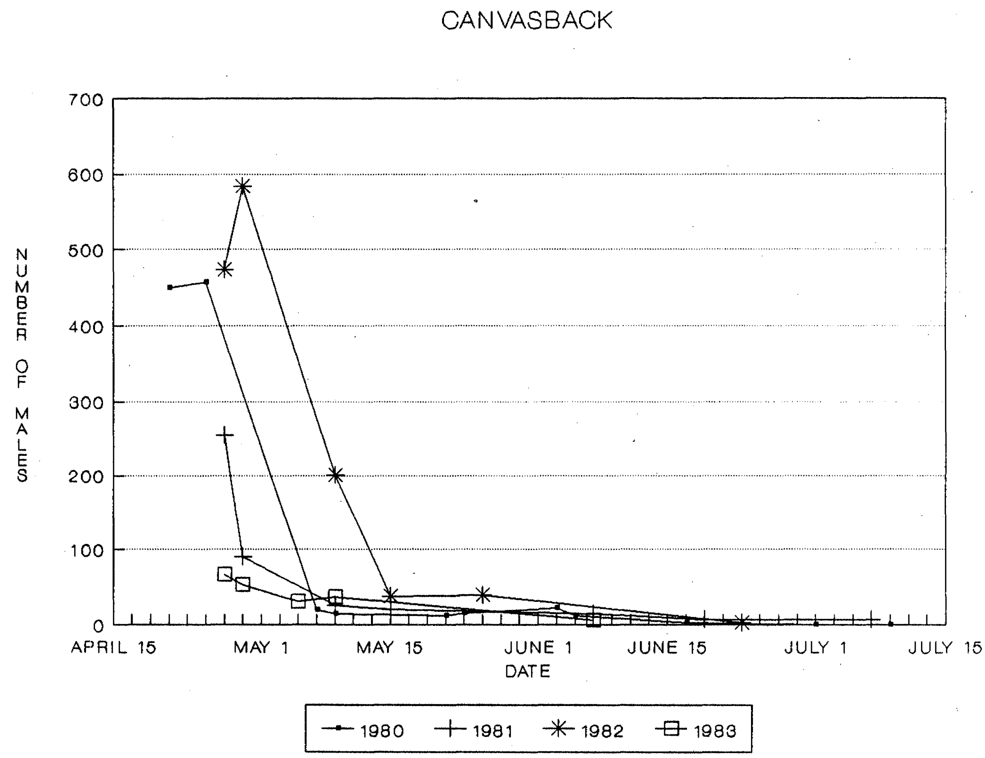
Like Canvasback, the Scaup population contains a great proportion of migrants in early May (Fig. 5.6). In warm springs counts in the third week of May should reflect the breeding population, whereas in cold springs counts should be done in the fourth week of May.

Barrow's Goldeneye

Few Barrow's Goldeneye migrants were present on the study area in early May (Fig. 5.7). However, their presence may affect counts in some years (i.e. 1980). By the second week of May, however, most should have left the study area. In warm springs, counts in the first three weeks of May should reflect the breeding population and in cold years, counts in the last three weeks of May should do. By mid June most males had left the study area.

Bufflehead

Bufflehead migrants represented a significant proportion of the population in early May on the study area (Fig. 5.7). Counts should be done after their departure. In warm springs, counts in the second, third



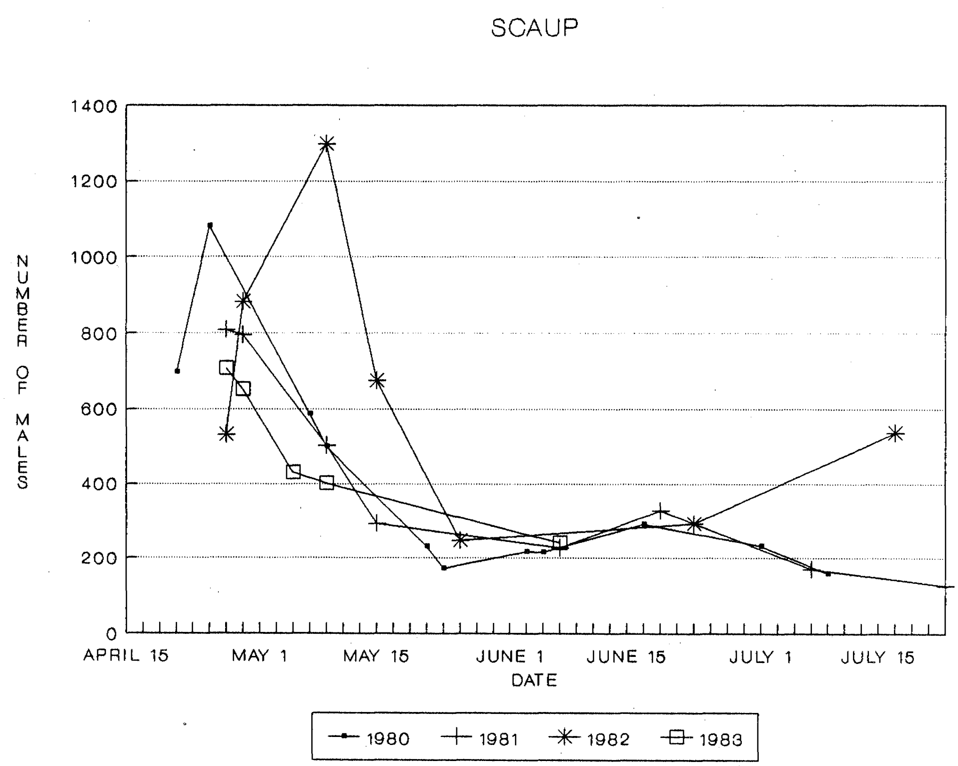


Figure 5.6 Seasonal fluctuations in the number of Canvasback and Scaup males.

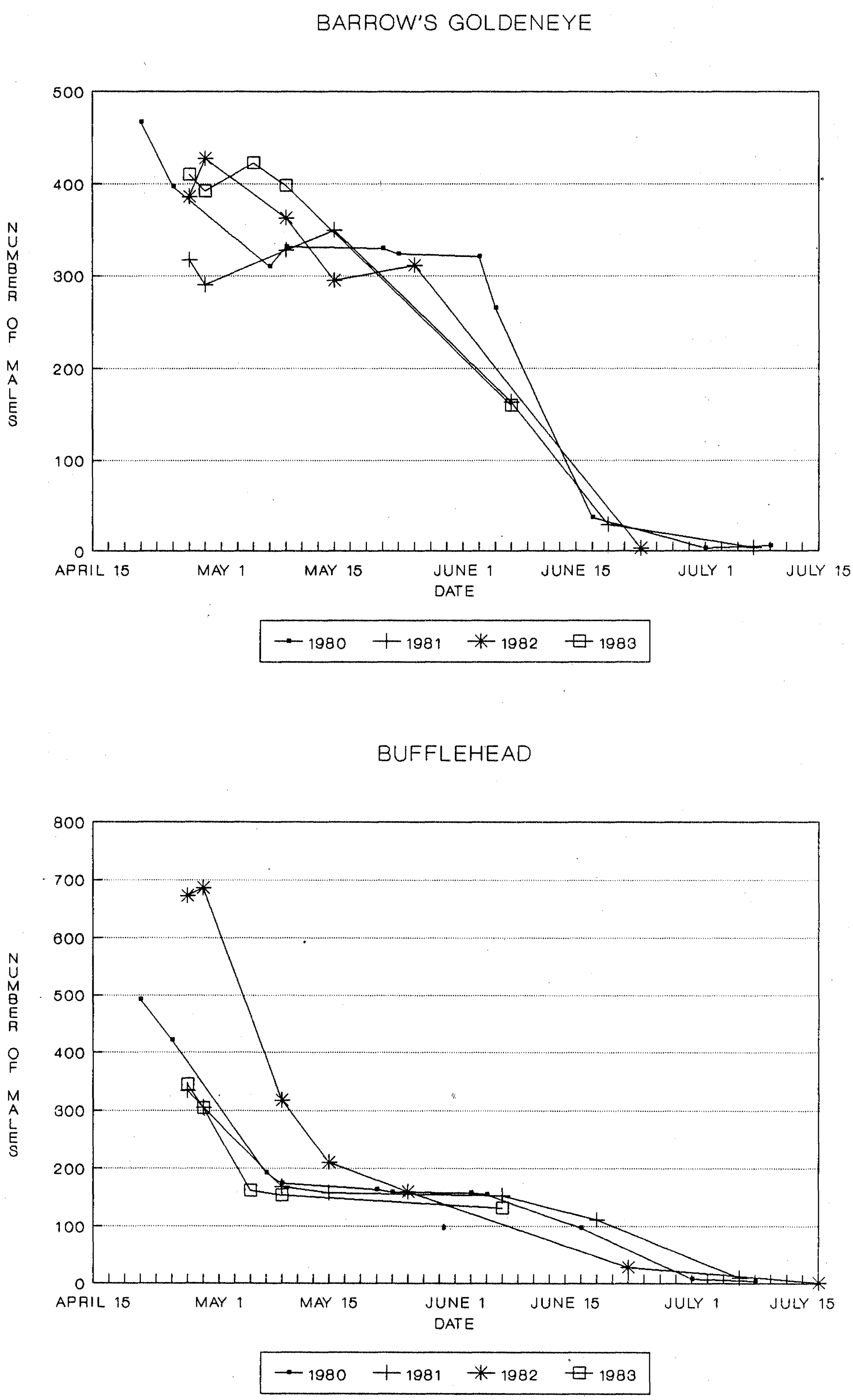


Figure 5.7 Seasonal fluctuations in the number of Barrow's Goldeneye and Bufflehead males.

and fourth weeks of May would be suitable and in cold springs, counts should start in the third week of May. Like Barrow's Goldeneye, male Bufflehead depart from the breeding area in mid June.

Ruddy Ducks

Surveys of Ruddy Ducks were difficult as the birds often occurred in emergent vegetation. Although variable, counts suggested that surveys should be carried out in the last two weeks of May (Fig. 5.8).

The surveys used to estimate the yearly density of adult males during the breeding season are listed in Appendix 5.9 for all species. Surveys used depend on the species, and survey dates vary between years because of breeding phenology.

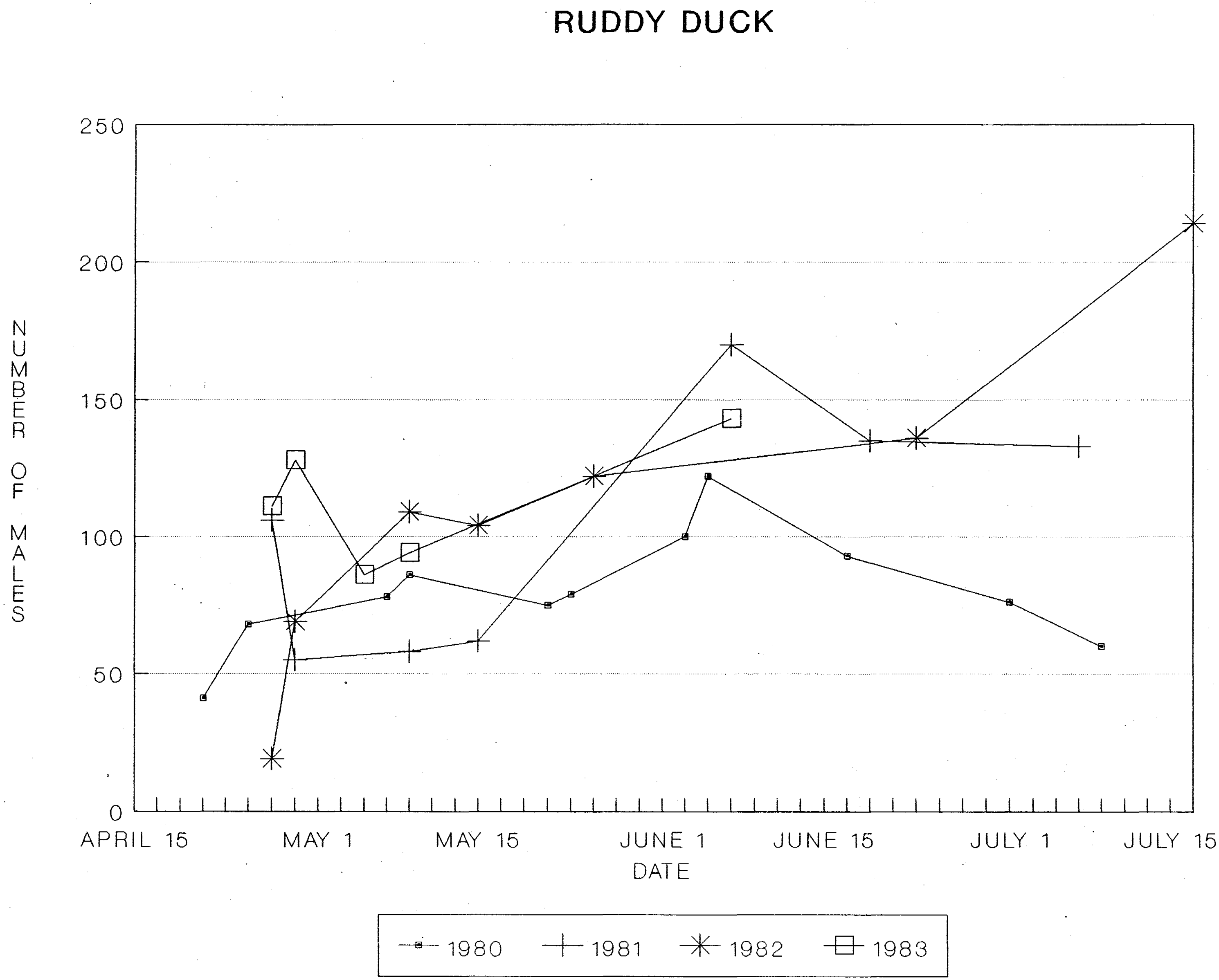


Figure 5.8 Seasonal fluctuations in the number of Ruddy Duck males.

Appendix 5.9. Census used to calculate the abundance of the various species of waterfowl each year.

Date of census																	
1980	April	22A															
		25B															
	May	7C	X		X			X	X		X	X	X		X	X	
		10D	X		X	X		X	X	X	X	X	X		X	X	
		21E		X	X	X	X	X	X	X	X	X	X	X	X	X	
		23F		X	X	X	X	X	X	X	X	X	X	X	X	X	
	June	3G		X	X	X	X	X	X	X		X	X	X			X
		5H		X	X	X	X	X	X			X	X	X			X
		18I					X	X									
1981	April	27A													X		
		29B	X												X		
	May	10C	X	X	X	X		X	X	X	X	X	X		X	X	
		16D	X	X	X	X		X	X	X	X	X	X	X	X	X	
	June	7E				X	X	X	X	X				X			X
		19F					X	X	X								X
1982	April	27A															
		29B															
	May	9C	X		X			X	X	X	X				X		
		15D	X	X	X	X		X	X	X	X	X	X		X	X	
		25E		X		X	X	X	X	X	X	X	X	X	X	X	X
	June	24F					X	X									X
1983	April	27A	X						X		X				X		
		29B	X						X	X	X				X		
	May	6C	X	X	X	X		X	X	X	X	X	X		X	X	
		9D	X	X	X	X		X	X	X	X	X	X		X	X	
	June	8E				X	X	X	X					X			X
1984	April	27A	X								X				X		
	May	3B	X					X	X		X				X		
		10C	X		X	X		X	X	X	X		X		X	X	
		15D	X	X	X	X		X	X	X	X	X	X	X	X	X	
		27E		X		X	X	X	X	X		X	X	X	X	X	
1985	May	3A	X		X			X	X						X		
		8B	X		X			X	X				X		X		
		14C		X		X		X	X	X	X	X	X	X	X	X	
1986	May	1A	X					X	X		X				X		
		5B	X		X			X	X	X	X		X		X		
		7C	X	X	X	X		X	X	X	X		X		X	X	

Appendix 6. Hatching chronology of waterfowl from 1980 to 1984.

Hatching chronology of waterfowl varied from year to year during the study. The hatching chronology of the most abundant waterfowl species is presented here in detail.

Canada Goose

Only 58 broods of Canada Goose were seen over the 5 years of the study. The earliest hatching date recorded was May 9 (in 1984) and the latest was June 19 (in 1982) (Fig. 6.0). The average hatching date varied significantly between years ($F=4.8$, $P=0.0021$) ranging between May 19 and June 5. It was similar in 1980, 1981, 1983 and 1984 but significantly later in 1982.

Mallard

The hatching period of the 195 Mallard broods sighted extended between May 21 and July 31, covering more than 2 months (Fig. 6.1). Average hatching date differed significantly between years ranging between June 4 and June 17 ($F=6.82$, $p<0.0001$). Hatching was significantly earlier in 1983 but was similar in the other years. Hatching was more spread out in 1980 and 1982 where the standard deviation of the average hatching date was respectively 14 and 15 days compared to between 9 and 11 days in the other years. This could be related to an unusually wet spring in 1980 and to the unusually cold month of May in 1984. Both may have delayed the nesting of some birds and/or have been the cause of failure of some early nesting attempts thus increasing the number of renestings.

Gadwall

The earliest estimated hatching date of the 36 broods observed was June 19 and the latest was August 2. Average hatching date did not differ significantly between years ($F=1.0$, $P=0.4074$) but there was a trend toward earlier hatching in 1983 than in 1982 (Fig. 6.2).

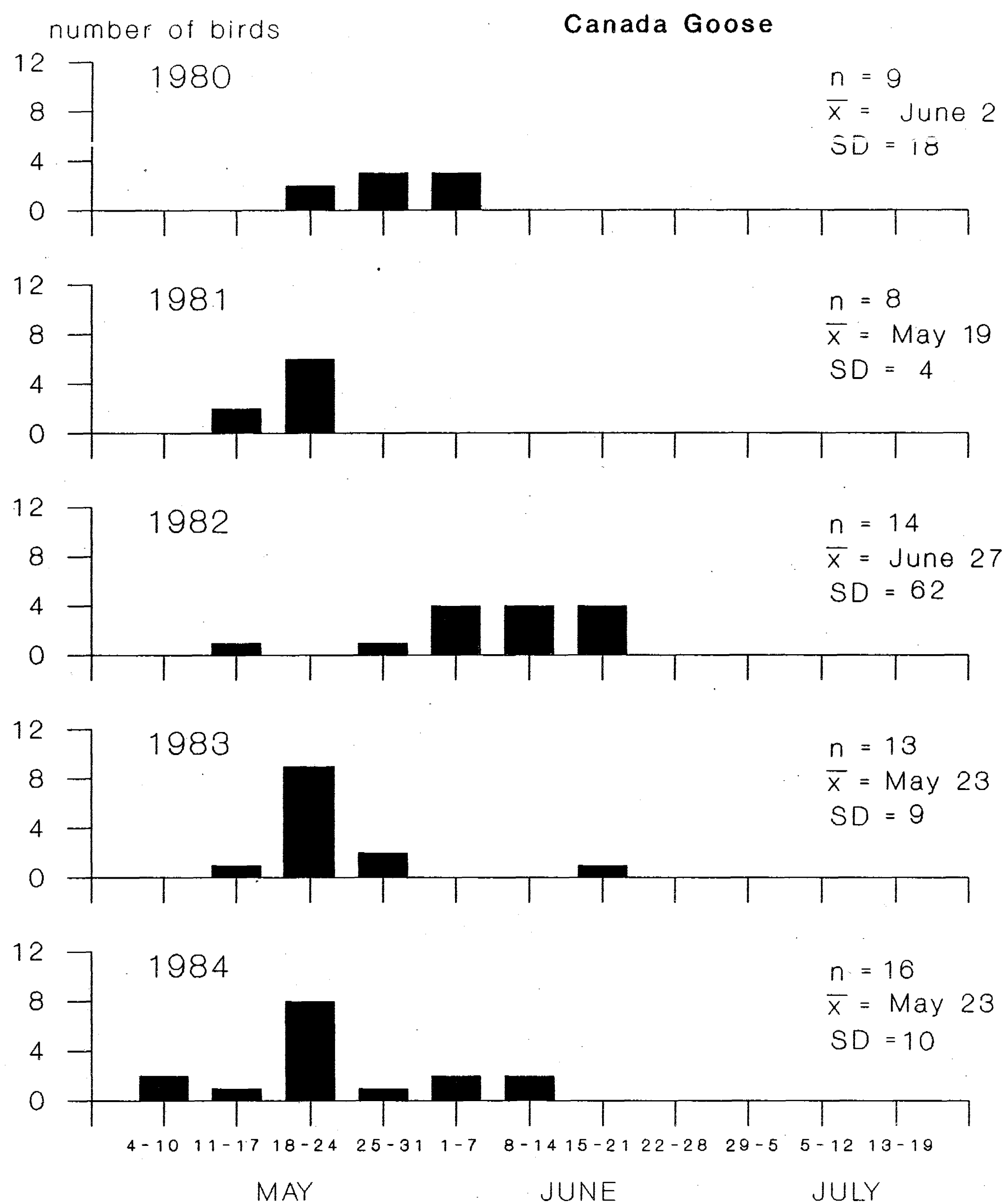


Figure 6.0 Hatching chronology of Canada Goose.

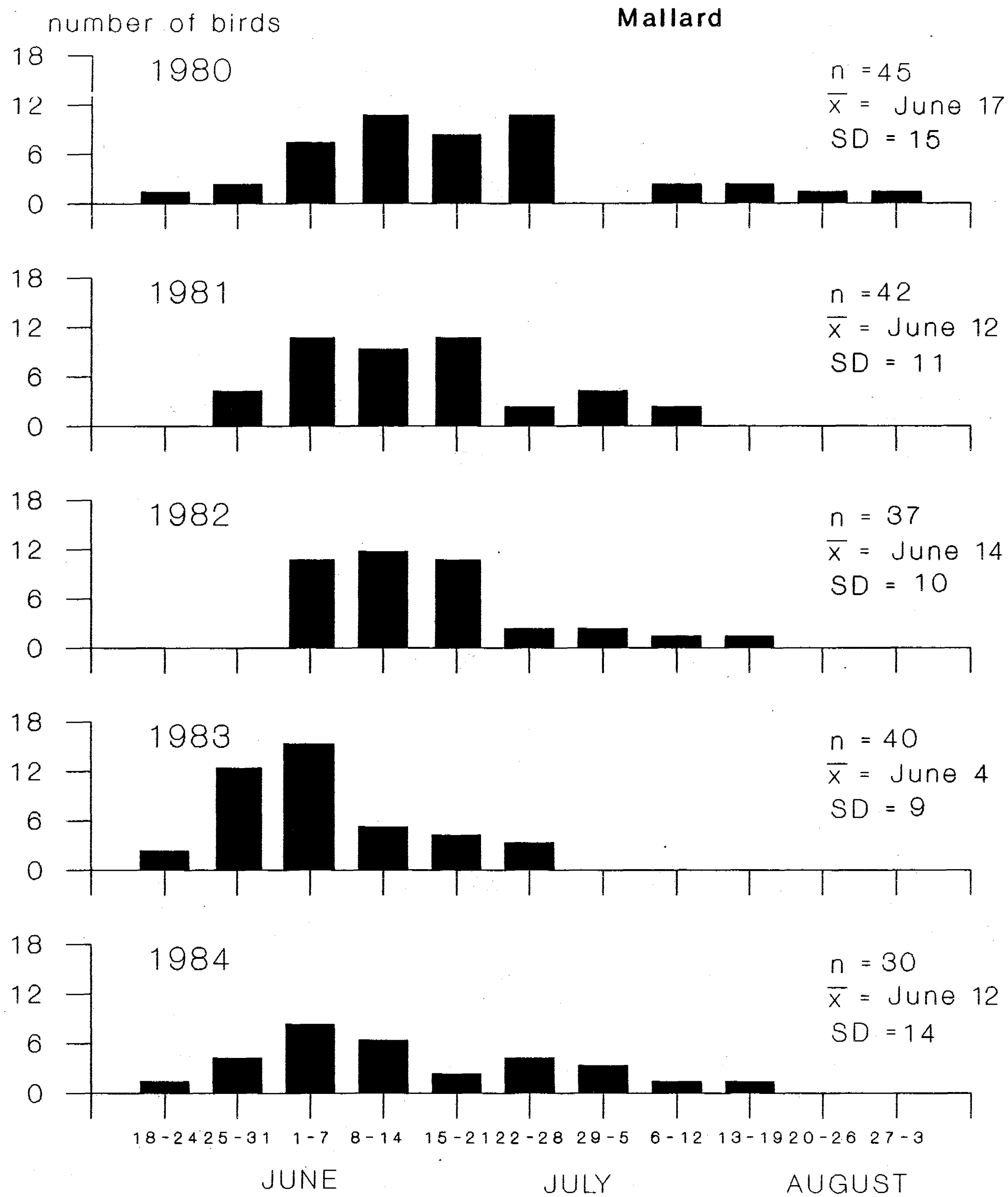


Figure 6.1 Hatcing chronology of Mallard.

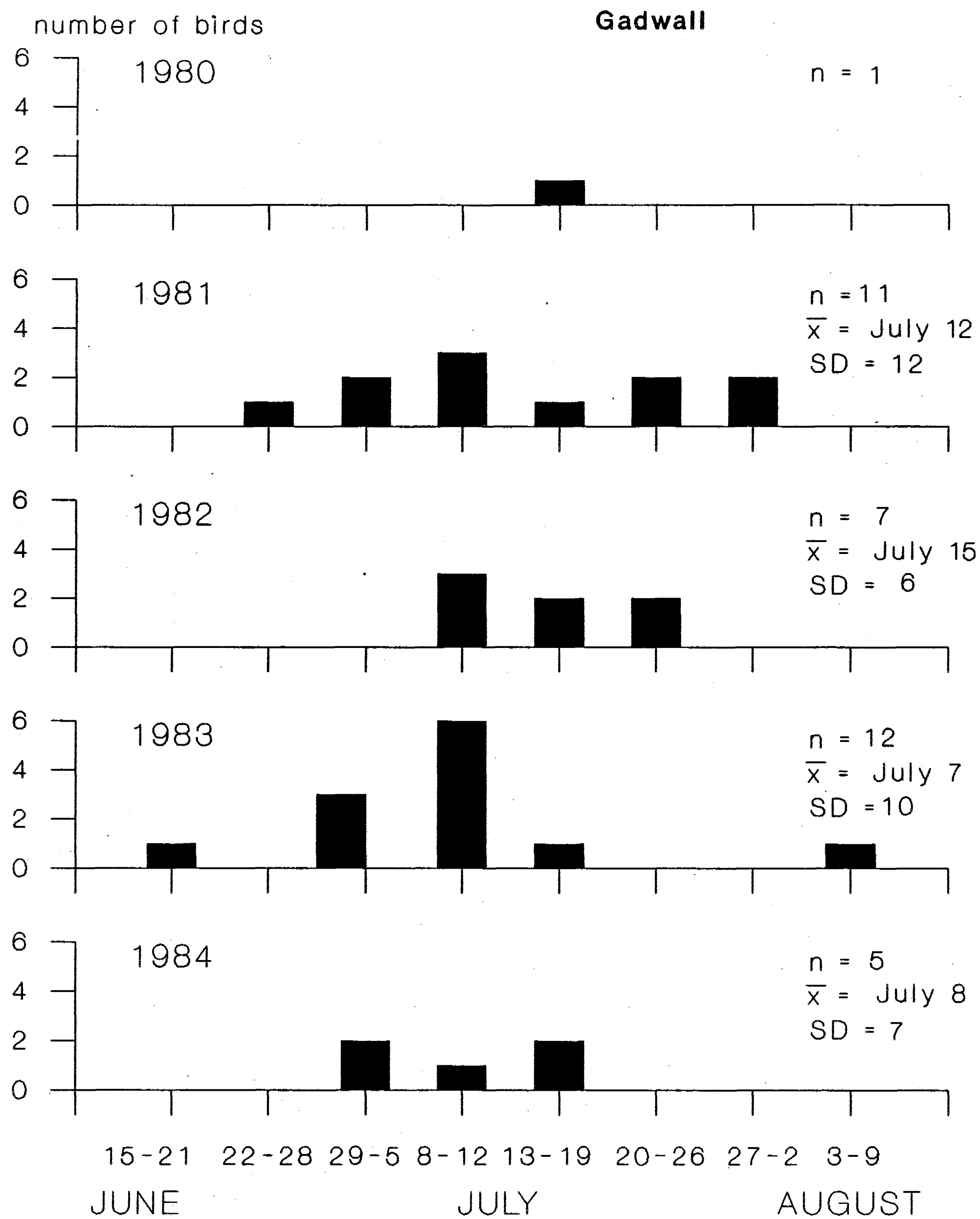


Figure 6.2 Hatching chronology of Gadwall.

American Wigeon

The hatching dates of the 180 broods seen during the study, ranged between June 4 and August 4. The average hatching date was not similar in all years ($F=7.1$, $P<0.0001$), being significantly earlier in 1983 (Fig. 6.3).

Northern Pintail

Only 20 broods of Northern Pintail were sighted. Hatching dates ranged between May 18 and July 19 and the average yearly hatching date between June 4 and 15.

Green-winged Teal

The hatching period of the 123 broods of Green-winged Teal observed ranged between May 29 and August 4. Yearly average hatching dates ranged between June 19 and 28 and differed significantly in some years ($F=5.0$, $P=0.0009$, Fig. 6.4). As with the previous species, hatching was on average earlier in 1983 than in the other years except for 1984 when the difference was not significant.

Blue-winged Teal

Blue-winged Teal were late migrants and nesters. The earliest hatching date among the 246 broods observed was June 15 and the latest August 10. Average hatching date differed significantly in some years ($F=6.4$, $P=0.0001$, Fig. 6.5). Contrary to most other species, there was no significant difference in average hatching date between 1982 and 1983. However, the average hatching date was significantly earlier in 1983 than in 1980, 1981 and 1984 and earlier in 1982 than in 1984 and 1980. Nidification of Blue-winged Teal was probably delayed in 1980 by the heavy rain that occurred that year, and in 1984 by the unusually cold weather in May. While cold weather in April of 1982 delayed nest initiation of early breeding species, it did not affect Blue-winged Teals.

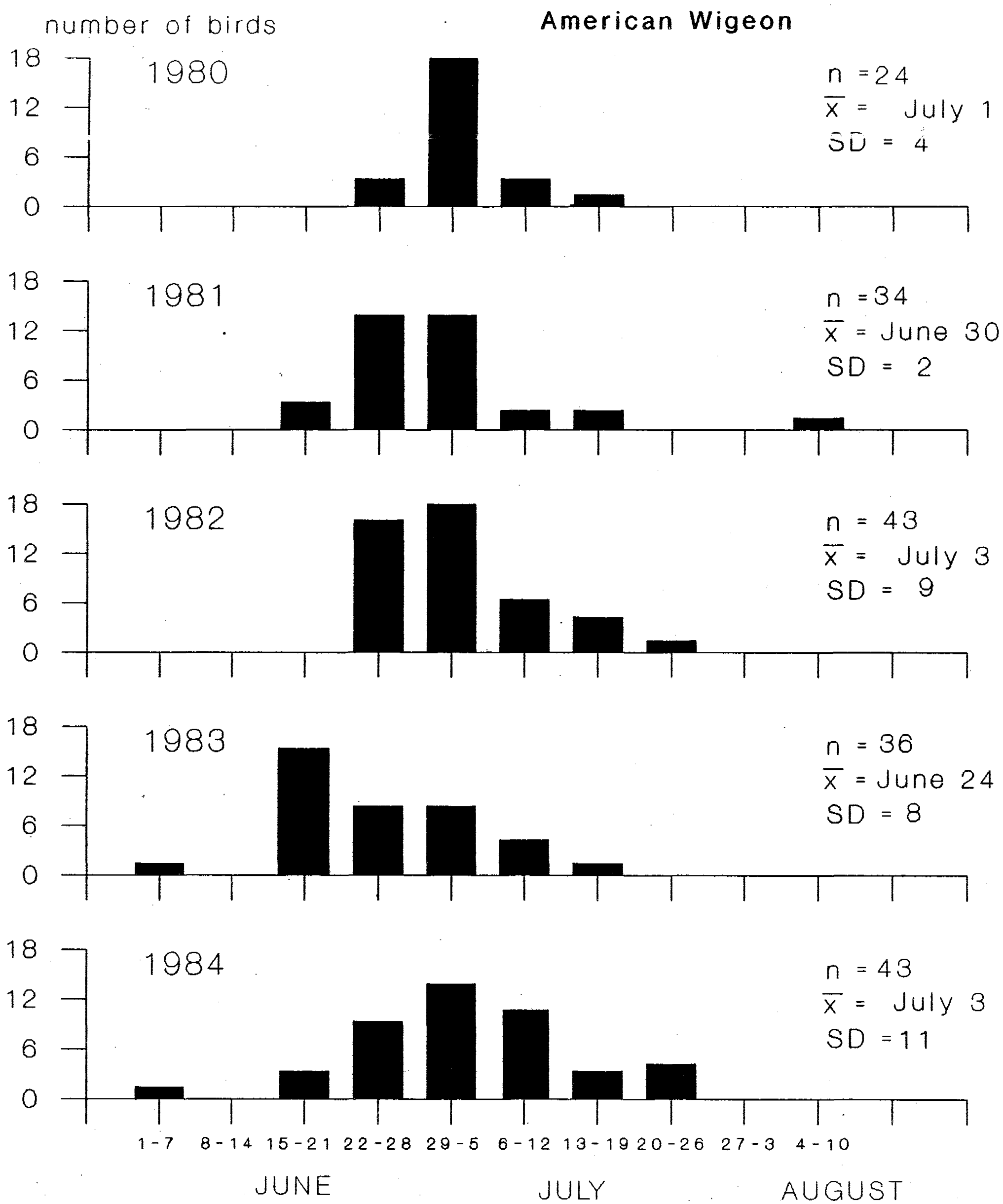


Figure 6.3 Hatching chronology of American Wigeon.

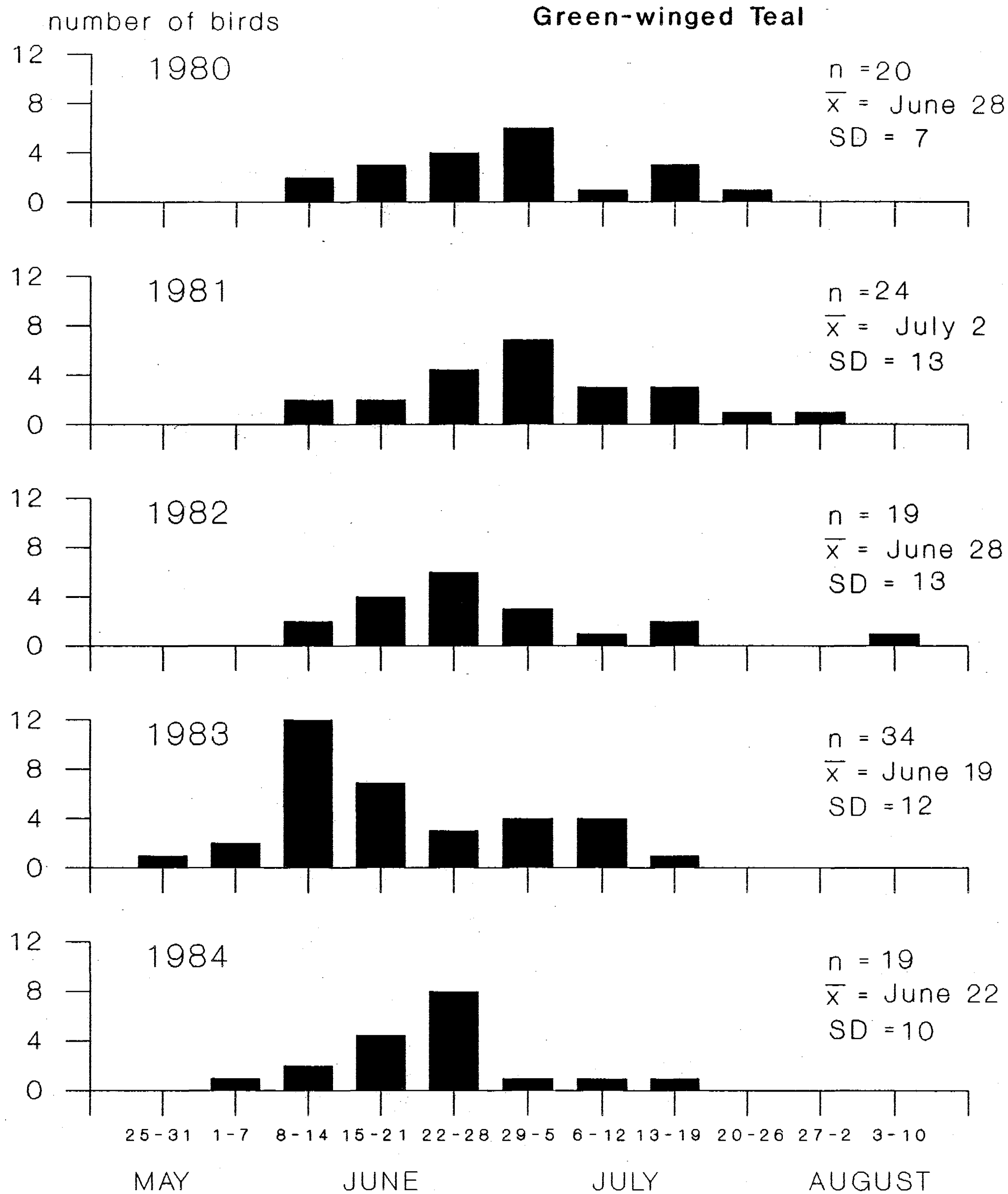


Figure 6.4 Hatching chronology of Green-winged Teal.

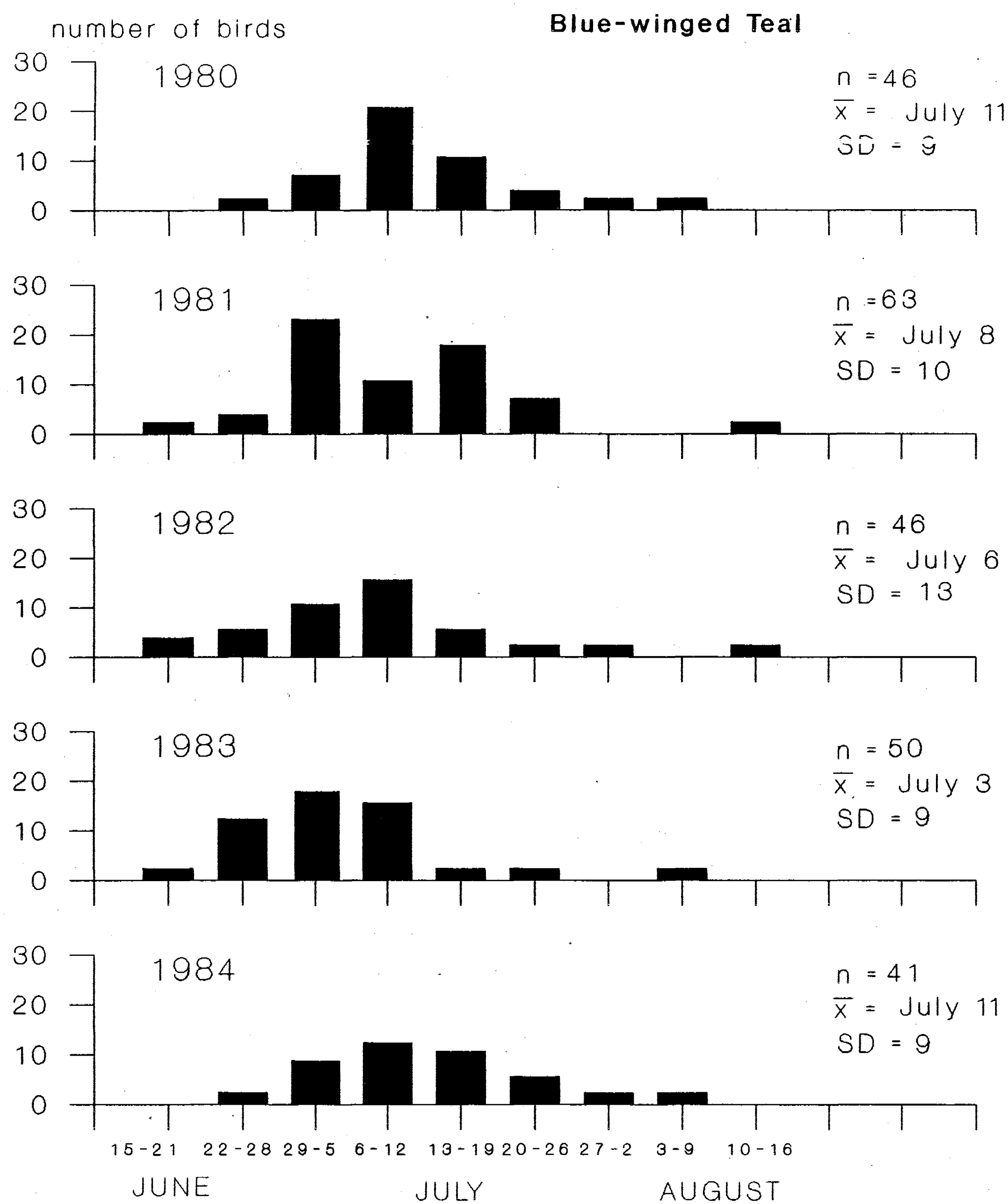


Figure 6.5 Hatching chronology of Blue-winged Teal

Northern Shoveler

Only 66 broods of Northern Shoveler were seen during the study. Average hatching date differed significantly some years (F=5.6, P=0.0006), being later in 1984 than in any other year, and significantly earlier in 1983 than in 1980, 1981 and 1984 (Fig. 6.6). The late hatching observed in 1984 may be related to the unusually cold weather in May of that year. This cold period would have corresponded with the arrival of this species on the study area and may have caused some delays in nest initiation and laying.

Redhead

Only 50 Redhead broods were seen. The earliest hatching date was May 25 and the latest July 25, indicating a long breeding period (Fig. 6.7). Sample sizes were adequate for yearly comparisons in only 2 years: 1981, and 1983. The average hatching date differed significantly, being earlier in 1983 than in 1981 (P<.0001).

Ring-necked Duck

Only 21 broods were seen in the study area. The earliest hatching date was June 10 and the latest July 27. Average hatching date was similar in 1980, 1982 and 1984 but earlier in 1983 than in 1984.

Canvasback

Only 38 Canvasback broods were observed. The earliest brood hatched on June 2 and the latest on July 21. The yearly average hatching date is derived from relatively small sample sizes and ranges between June 11 and 25. There was no significant difference in the average hatching date between years mostly because of small sample sizes (Fig. 6.8).

Scaup

Data for Scaup breeding chronology should be examined critically as in most years the field season was concluded before all broods had hatched. Of the 108 broods observed, the earliest hatched on

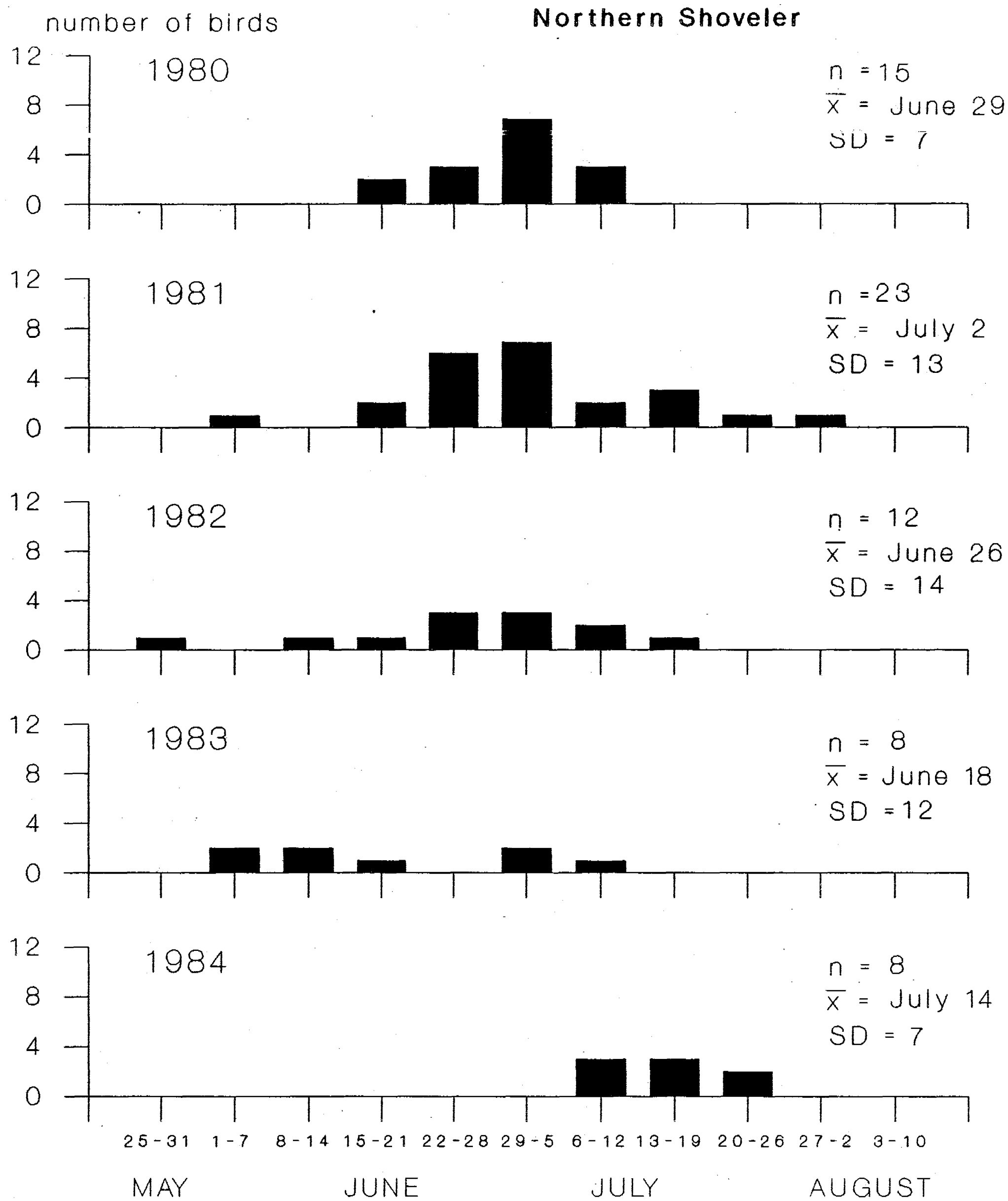


Figure 6.6 Hatching chronology of Northern Shoveler.

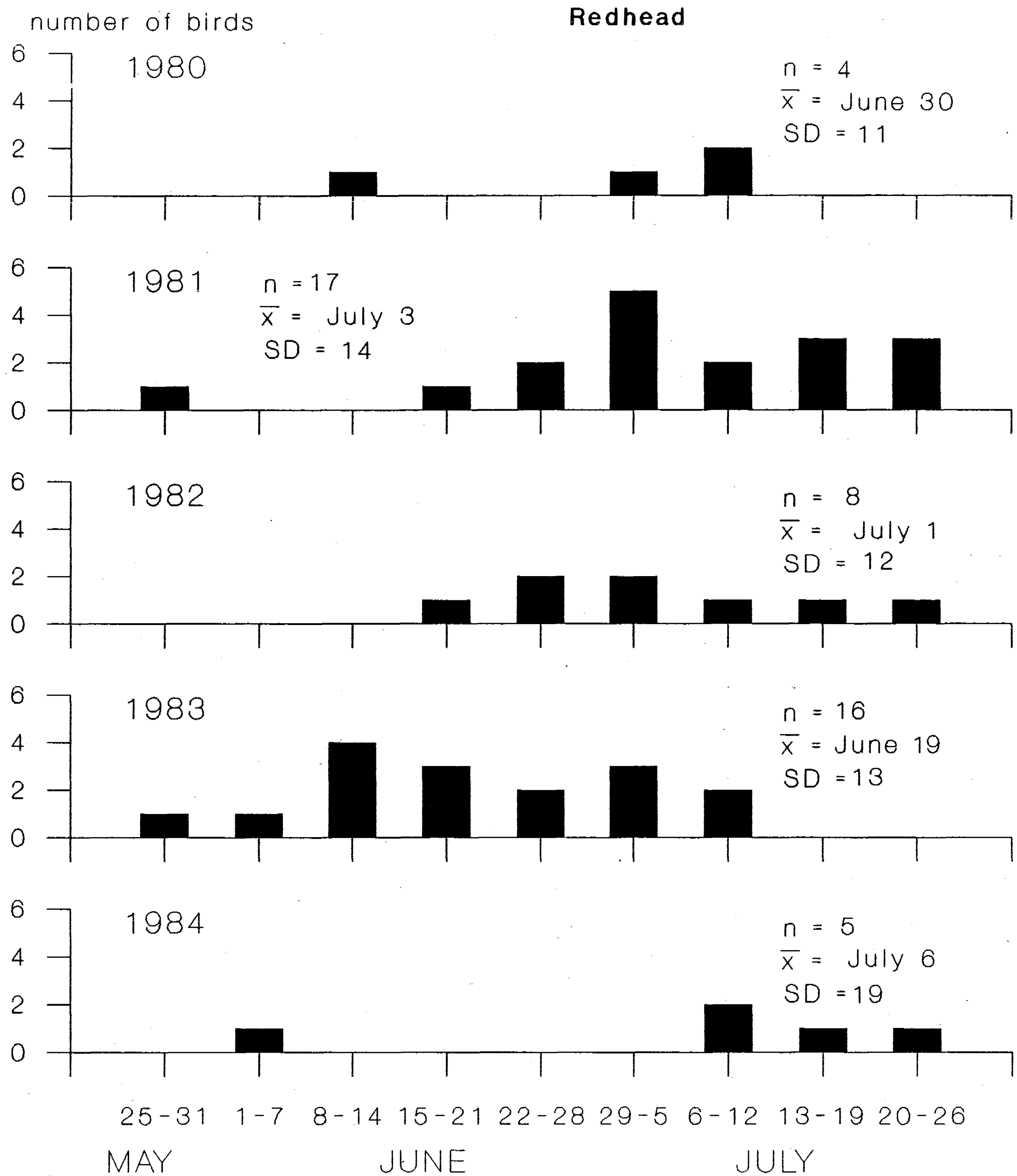


Figure 6.7 Hatcing chronology of Redhead.

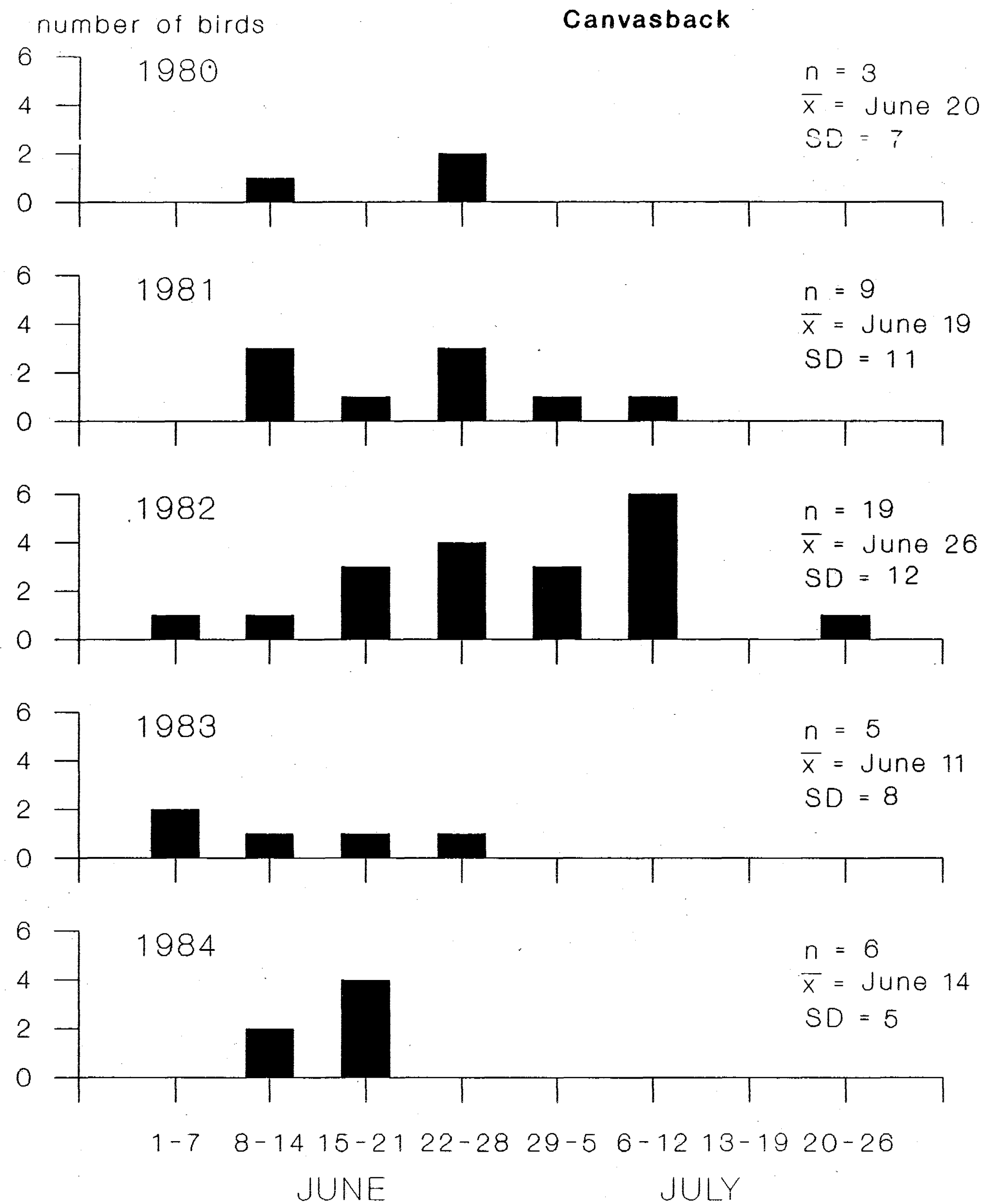


Figure 6.8 Hatching chronology of Canvasback.

June 21 and the latest on August 26. Average hatching dates did not differ significantly between years ($F=0.5$, $P=0.7316$, Fig. 6.9). Thus, as with Blue-winged Teal, late nesting Scaups were apparently not affected by April temperatures.

Barrow's Goldeneye

A total of 461 Barrow's Goldeneye broods was observed in the course of the study. The earliest hatching date was May 30 and the latest July 13. The yearly average hatching date differed significantly between years, ranging from June 14 to June 24 ($F=15.7$, $p<0.0001$). The average hatching date was significantly earlier in 1983 and significantly later in 1982 than in any other year (Fig. 6.10). It was similar in 1981, 1980 and 1984. The earliest hatching in 1983 corresponds with the warmest spring, while the late hatching in 1982 corresponds with the coldest spring (Appendix. 1). The unusually cold period in May 1984 may have caused the more widespread hatching in 1984 than in 1983.

Bufflehead

The earliest hatching date recorded among the 368 Bufflehead broods observed was June 2 and the latest July 17. Yearly average hatching dates were similar to those of Barrow's Goldeneye and varied significantly between years, ranging between June 16 and June 25 ($F=12.6$, $P<0.0001$, Fig. 6.11). The average hatching was significantly earlier in 1983 than in any other year, and significantly later in 1982 than in 1981 and 1984 but not 1980. Between year differences in hatching dates parallel those of Barrow's Goldeneye, indicating that both species are similarly affected by weather.

Ruddy Duck

The number of broods observed on the study area ranged from 9 in 1980 to 32 in 1982 for a total of 96 over the 5 years of the study. The earliest estimated hatching date was June 20 and the latest was August 21. Average hatching dates did not differ significantly among years ($F=1.10$, P-0.3479, Fig. 6.12).

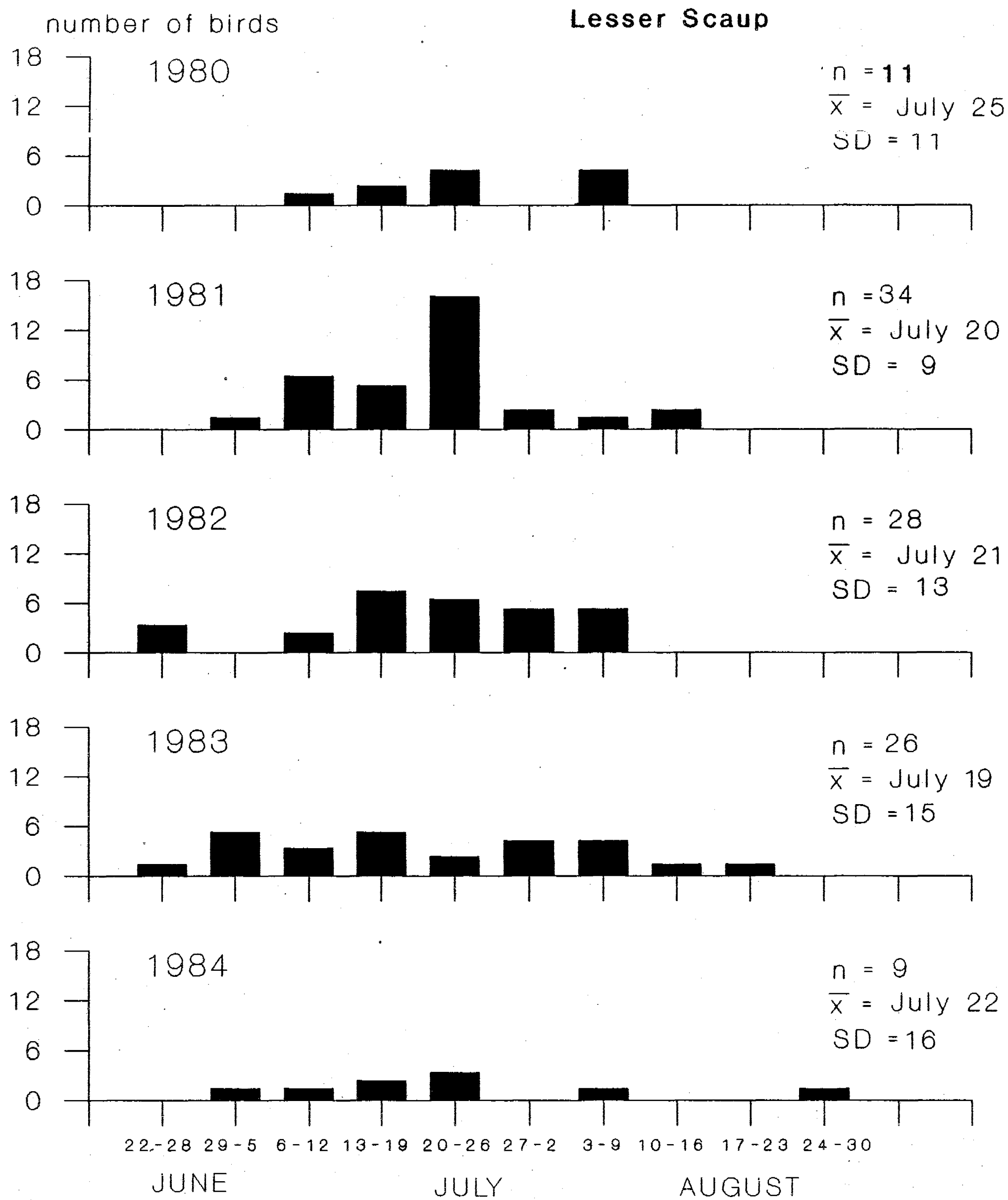


Figure 6.9 Hatching chronology of Scaup.

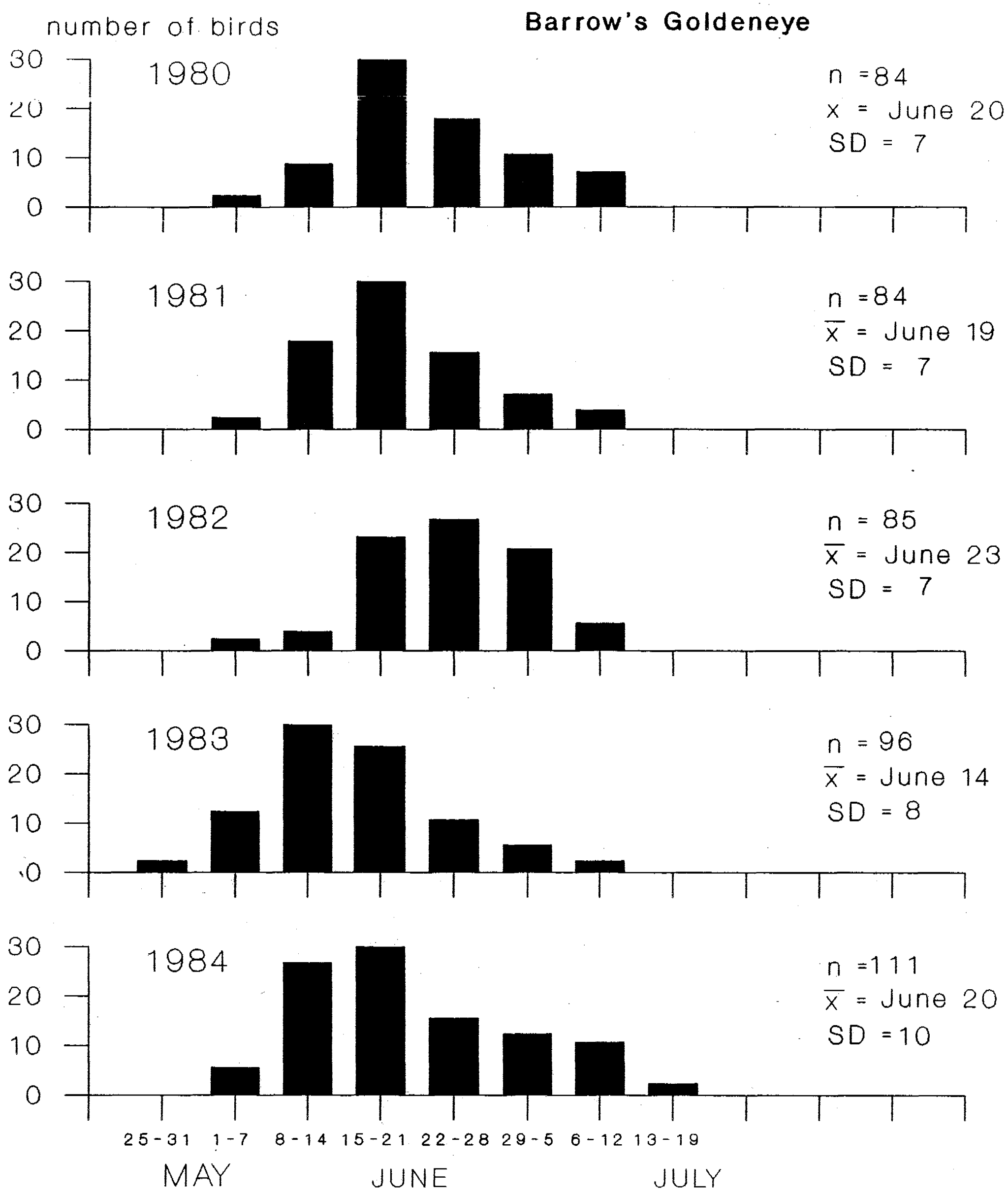


Figure 6.10 Hatching chronology of Barro'w Goldeneye.

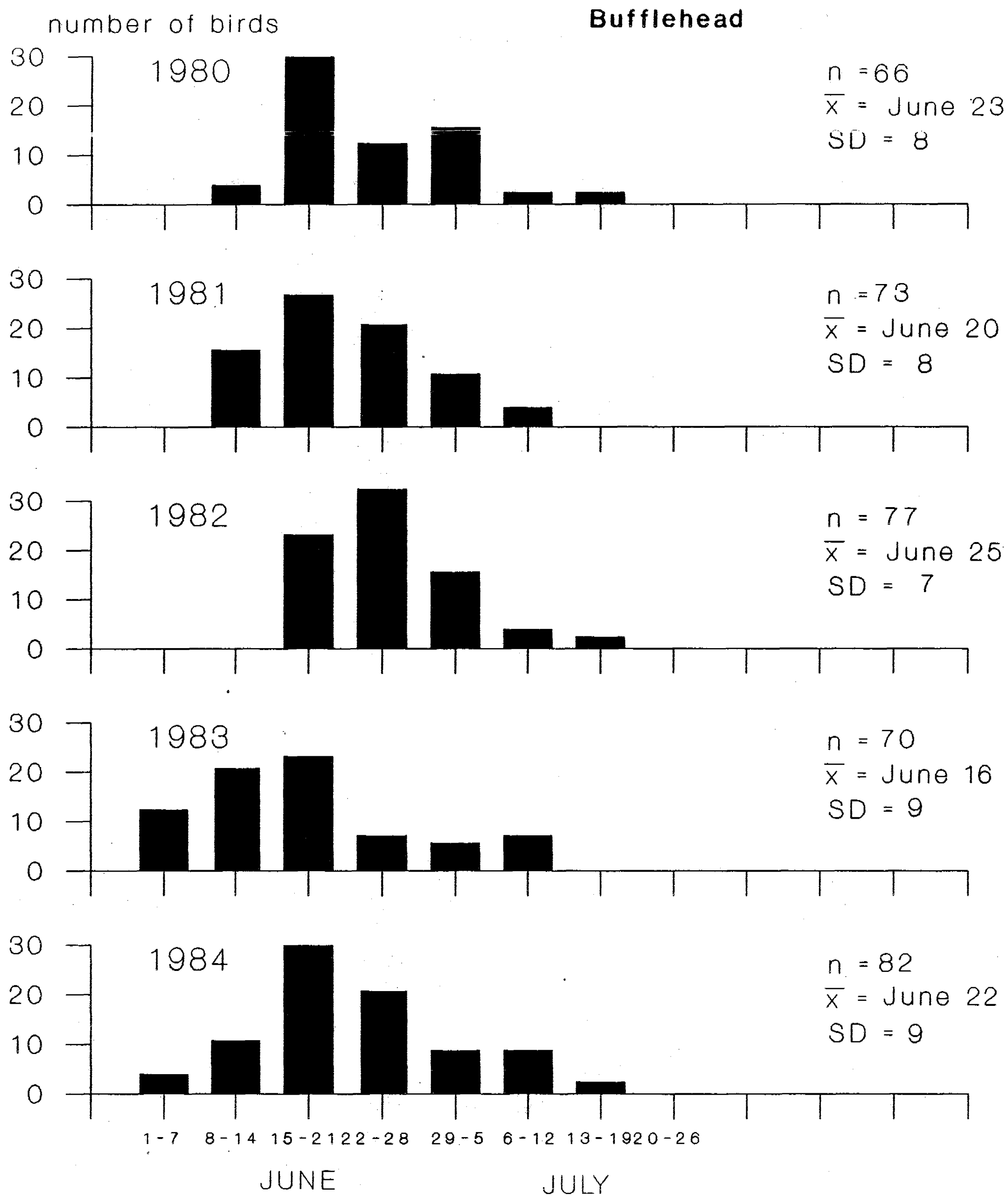


Figure 6.11 Hatching chronology of Bufflehead

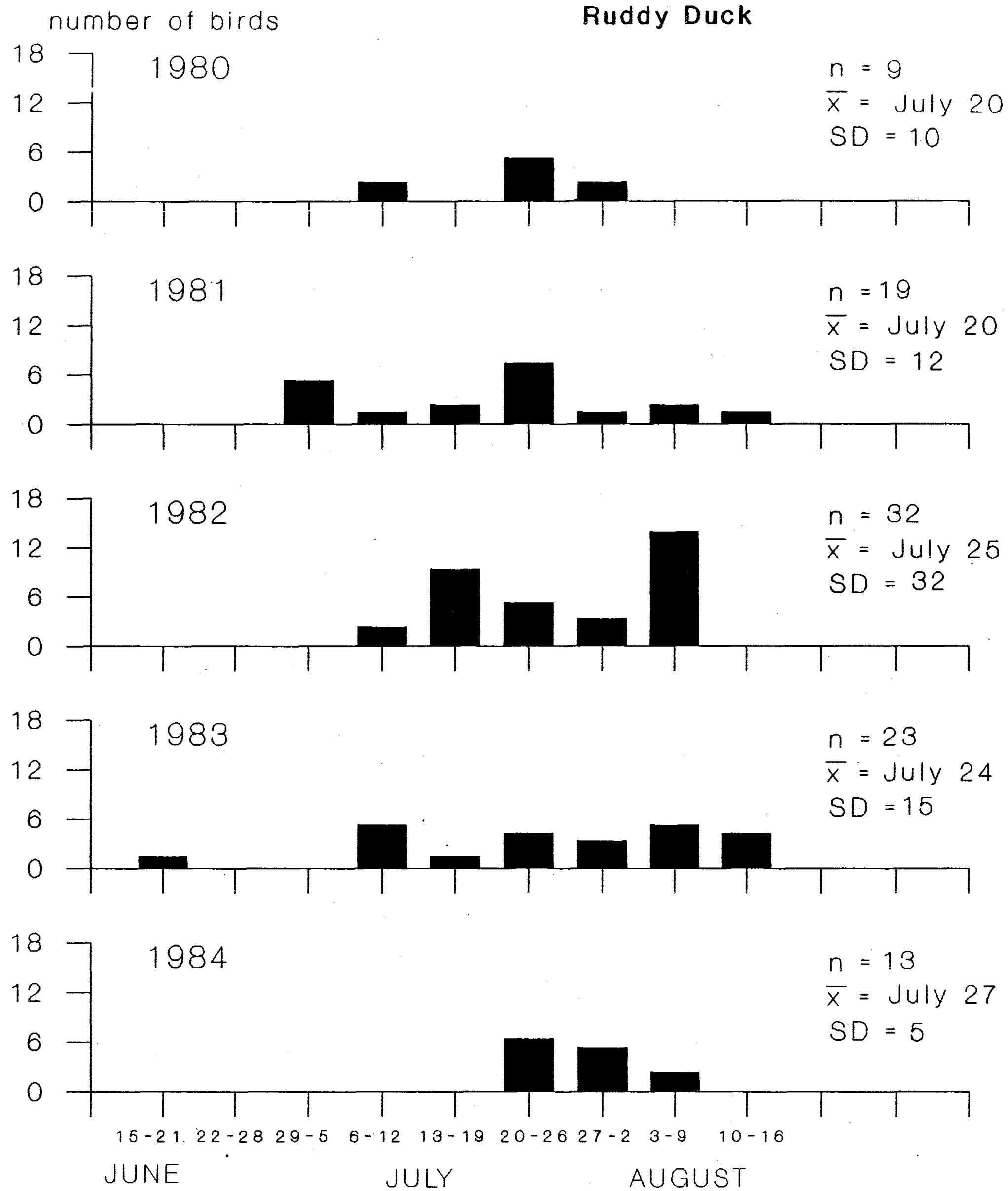


Figure 6.12 Hatching chronology of Ruddy Duck.

Appendix 7. Comparison of seasonal and annual fluctuations in waterfowl abundance in three adjacent areas near Riske Creek, B.C.

7.1 Comparison of seasonal fluctuations in waterfowl abundance between three adjacent areas.

The study area could be divided into three relatively distinct areas: Sheep Range, Becher's Prairie and Stack valley (Fig. 1, Table 7.10). The Sheep Range area was characterized by a lack of forest. All ponds were open and usually lacking emergent vegetation. The area contained 25 ponds with 24 under 6 ha in size. The Becher's Prairie area was the core of the study area and contained 46 ponds 35 of which were under 6 ha in size. Most ponds were open, although not as exposed as on the Sheep Range. Several ponds had small clumps of trees along the edge. The Stack valley area was made up of three distinct areas and contained 44 ponds, 30 of which were under 6 ha. The majority of the ponds were partially surrounded by forest.

I compared waterfowl fluctuations in these three sub-areas to determine whether similar fluctuations could be detected in these smaller survey units as in the larger unit. Also I wanted to compare the relative abundance of some waterfowl species within these units. First, I looked at seasonal fluctuations and then at yearly fluctuations.

7.11 Barrow's Goldeneye

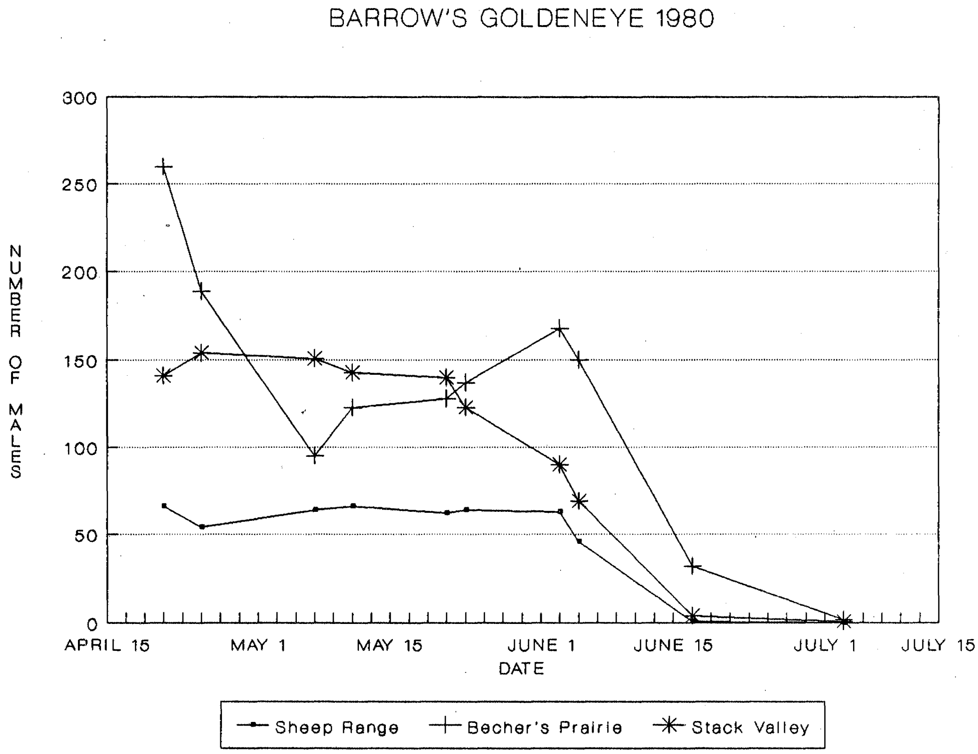
Seasonal fluctuations in the number of Barrow's Goldeneye males in 1980 were greater in Becher's Prairie than in the two other sub-areas (Fig. 7.111). A decrease in the number of males in Stack valley between the third week of May and the first week of June 1980 was paralleled by an increase of the same magnitude in Becher's Prairie, suggesting movements between the two areas. The departure of the males occurred between June 5 and June 18 for all three sub-areas.

In 1981, the pattern of seasonal fluctuation differed between areas (Fig. 7.111). The decline in the number of males in Sheep Range and Stack valley between May 16 and June 7 did not occur in Becher's Prairie. Between April 27 and May 16, 1981, the Stack valley area had the highest number of Barrow's Goldeneye males and the Sheep Range area the lowest.

Table 7.10 Number and identification of lakes included in the three sub- areas.

Sub-area	Number of Lakes	Lake Numbers[1]
Sheep Range	25	87 to 111
Becher's Prairie	46	3 to 42, 53 to 55, 115, 116, 118
Stack valley	44	1, 2, 43 to 52, 56 to 86, 112
Total	115	

See Boyd and Savard 1987 for location of lakes.



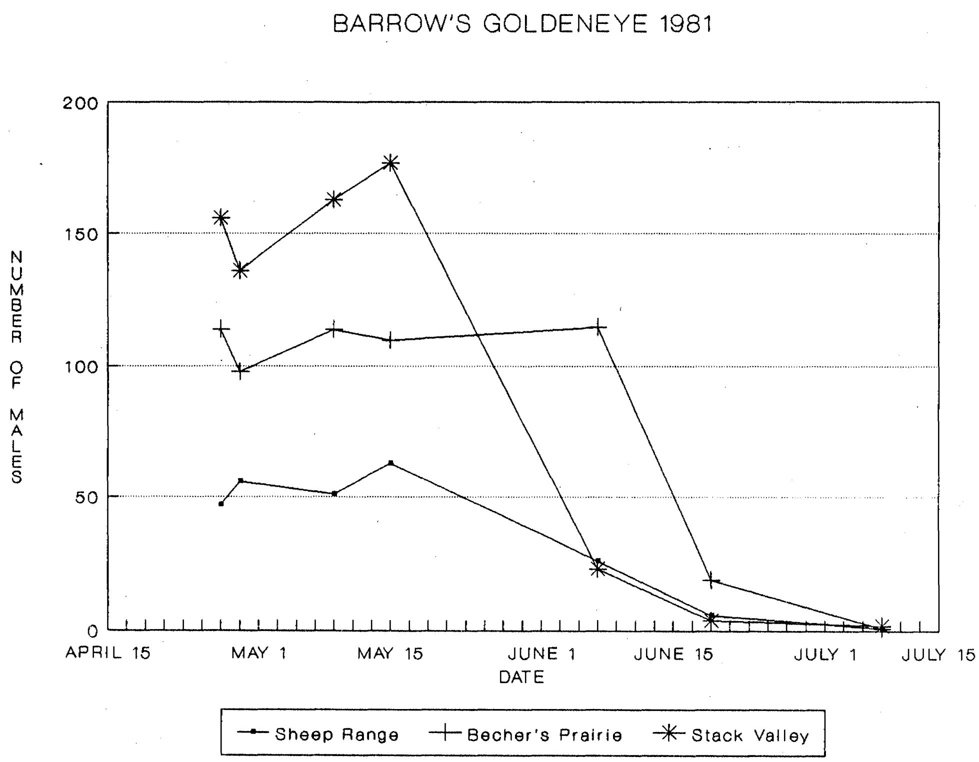


Figure 7.111 Seasonal fluctuations in the number of Barrow;s Goldeneye males in the three sub areas in 1980 and 1981.

1982 was a relatively late year with some ponds still frozen in early May. The first area to open in the spring was Sheep Range, followed shortly by Becher's Prairie and Stack valley. This is reflected by the abundance of goldeneye in these areas in late April 1982 (Fig. 7.112). There were more male goldeneyes in Sheep Range in late April 1982 than in either 1980, 1981. By May 9 numbers of males had dropped to less than half in this area. Between April 29, and May 9, 1982, numbers of goldeneye males decreased in Becher's Prairie and increased in Stack valley, suggesting movement between the two areas.

7.12 Bufflehead

The number of Bufflehead drakes decreased in all three sub-areas between April 25 and May 7, 1980 (Fig. 7.121). Few Bufflehead drakes frequented the Sheep Range area after this decrease in numbers. Fluctuations in the two other sub-areas differed significantly. As with Barrow's Goldeneye, a decrease in the number of males in Stack valley between the third week of May and the first week of June corresponded with an increase of similar size in Becher's Prairie. However, unlike Barrow's Goldeneye, the departure of males for their molting areas was not synchronous among the sub-areas, occurring earlier for the birds of Stack valley.

In 1981, all three-sub areas showed a decrease in the number of Bufflehead males in early May, as they did in 1980 (Fig. 7.121). Between May 16 and June 7, 1981, a decrease in Stack valley was paralleled by an increase in Becher's Prairie, suggesting movement between the two areas.

Results from 1982 confirm the presence of migrants in all three sub-areas in early spring (Fig. 7.122). The decrease in the number of Bufflehead males in the Sheep Range area between April 27 and 29 coincided with an increase of similar numbers in Becher's Prairie during the same period, suggesting possible migrant movements between the two areas. In all three years Becher's Prairie supported the largest number of Bufflehead males, and Sheep Range the lowest.

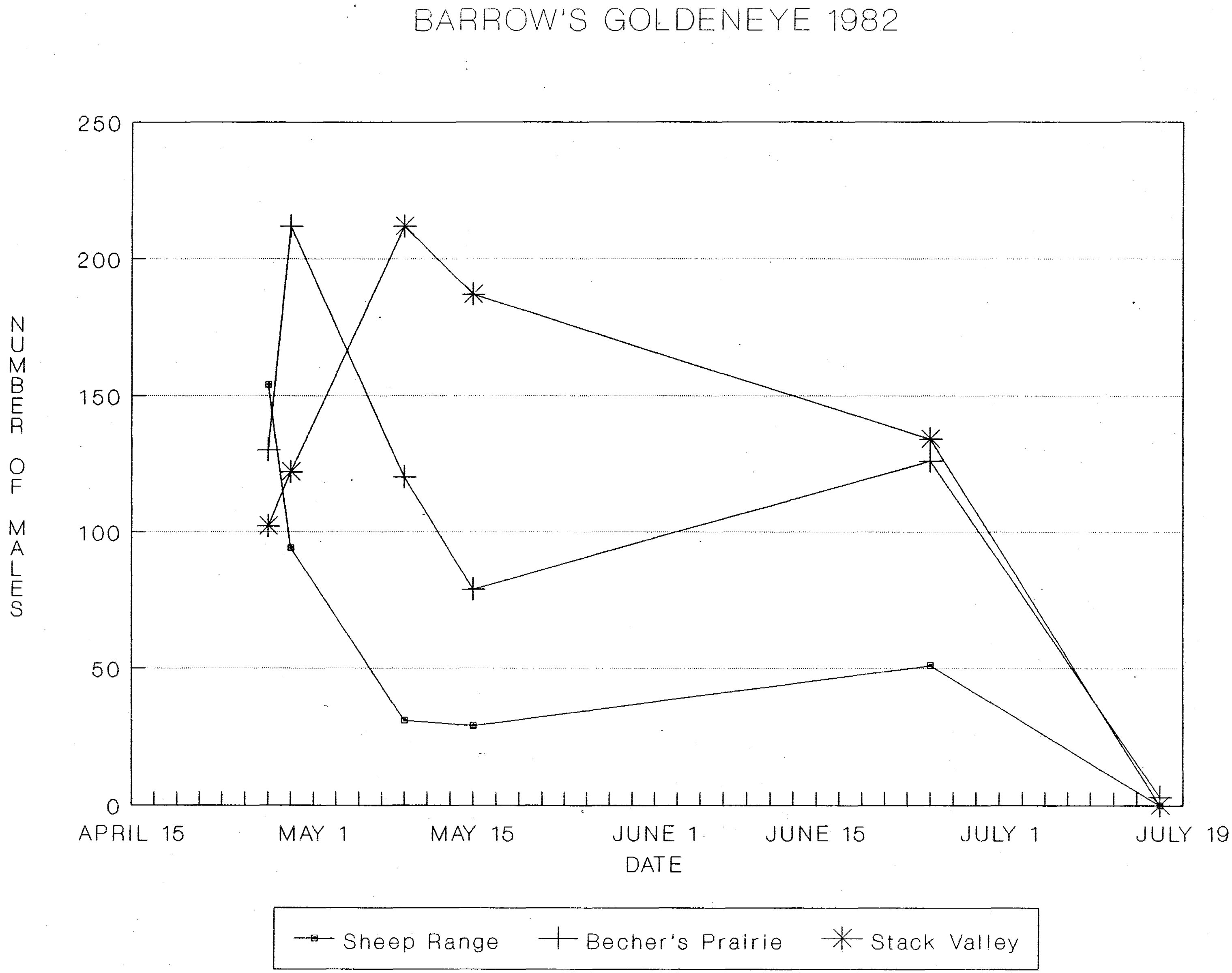
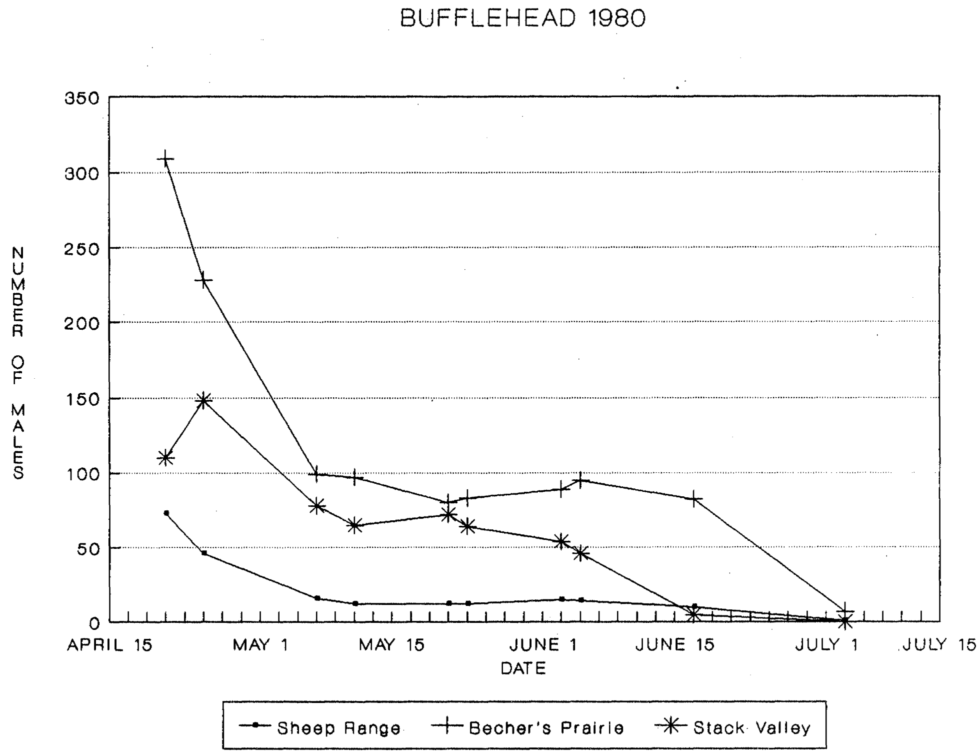


Figure 7.112 Seasonal fluctuations in the number of Barrow's Goldeneye males in the three sub areas in 1982.



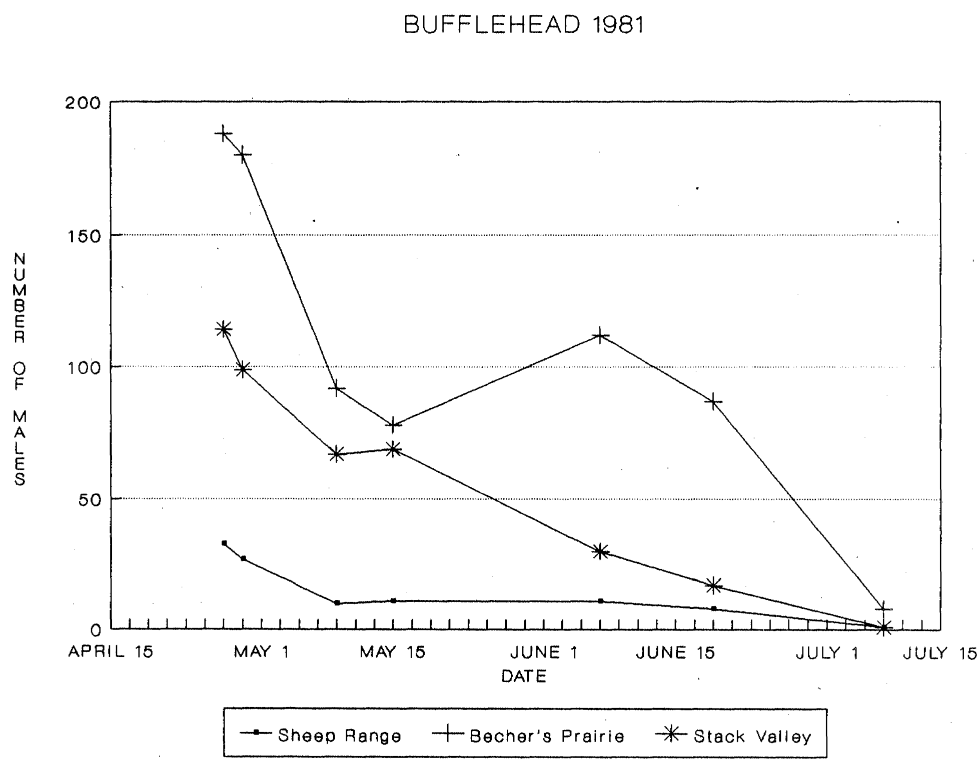


Figure 7.121 Seasonal fluctuations in the number of Bufflehead males in the three sub areas in 1980 and 1981.

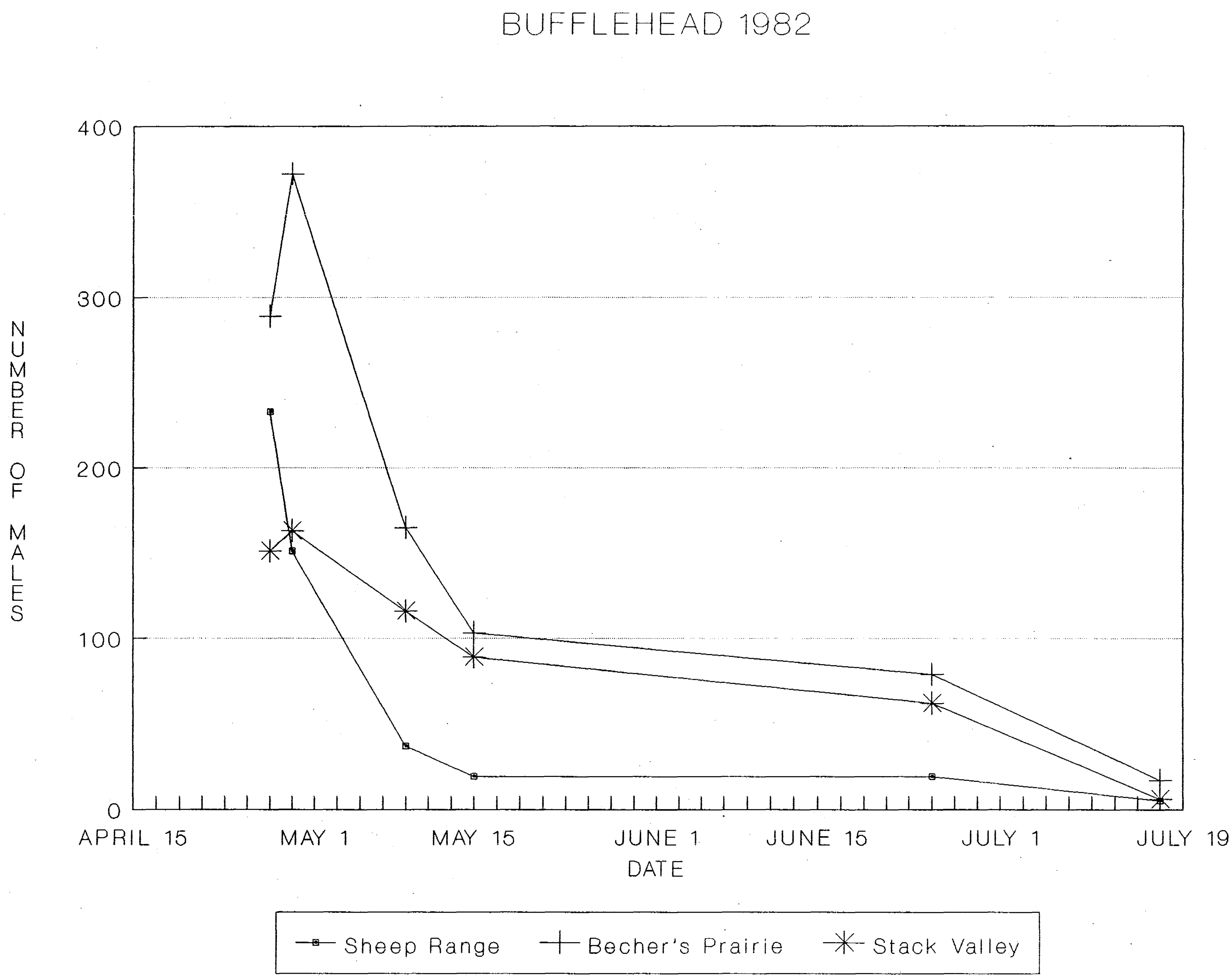


Figure 7.122 Seasonal fluctuations in the number of Bufflehead males in the three sub areas in 1982.

7.13 Scaup

No obvious seasonal patterns in the number of Scaup males could be identified in the Sheep Range sub-area in 1980 because of low numbers (Fig. 7.131). There was an obvious increase in the number of males between April 22 and April 25 in the Becher's Prairie sub-area but not in Stack valley. The departure of migrants from the study area was detected similarly in both Becher's Prairie and Stack valley.

In 1981, the departure of spring migrants was only obvious in Becher's Prairie and may have occurred earlier than April 27 in the two other sub-areas (Fig. 7.131). There was a small influx of males in the Becher's Prairie and Sheep Range areas between May 19 and June 7.

In 1982, a late spring, all three areas reflected the arrival and departure of migrants (Fig 7.132). Sheep Range was again the first area used in the spring.

7.14 Mallard

The number of Mallard males decreased between April 22 and April 25, 1980 in all three sub-areas (Fig. 7.141). Becher's Prairie differed from the two other sub-areas in terms of use by Mallard males. The number of Mallard drakes increased steadily and significantly between the second week of May and June 18 to apparently decrease drastically by July 2. This decrease may represent not only a movement of males out of the area toward molting lakes, but also a decrease in the conspicuousness of males molting on the study area.

In 1981, the number of Mallard drakes on the study area was greatly reduced (maximum of 320 in 1980 for only 110 in 1981). Number of drakes increased in all three sub-areas during May and even in June in Stack valley and Becher's Prairie (Fig. 7.141). Numbers decreased in all areas between June 19 and July 7, 1981.

In 1982, the seasonal fluctuation pattern is more defined and similar in all three sub-areas (Fig. 7.142). The number of males decreased between April 29 and May 9, remaining stable until May 15. Between May 15 and May 25 there was an increase in the number of males, followed by a greater increase between May 25 and June 24.

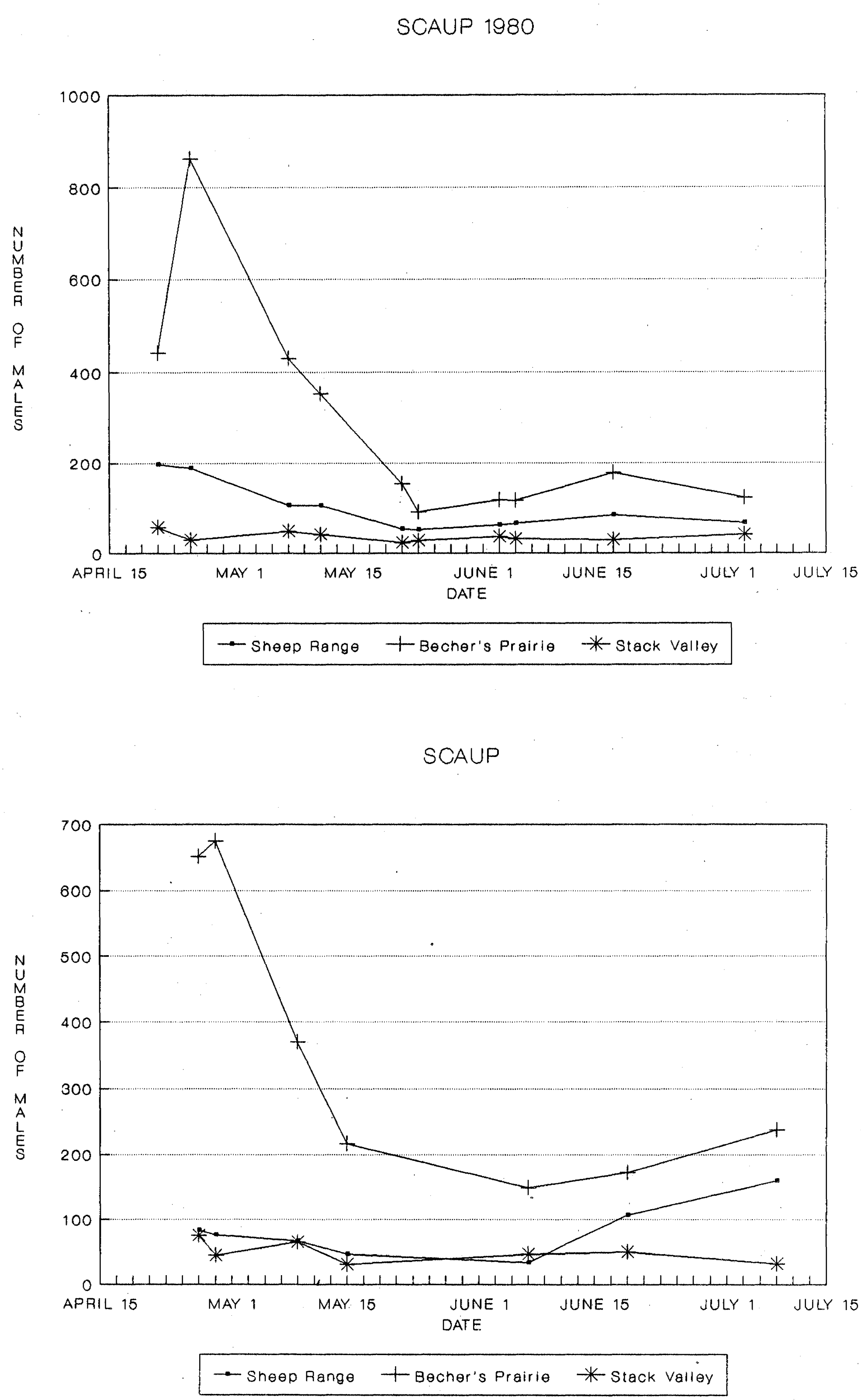


Figure 7.131 Seasonal fluctuations in the number of Scaup males in the three sub areas in 1980 and 1981.

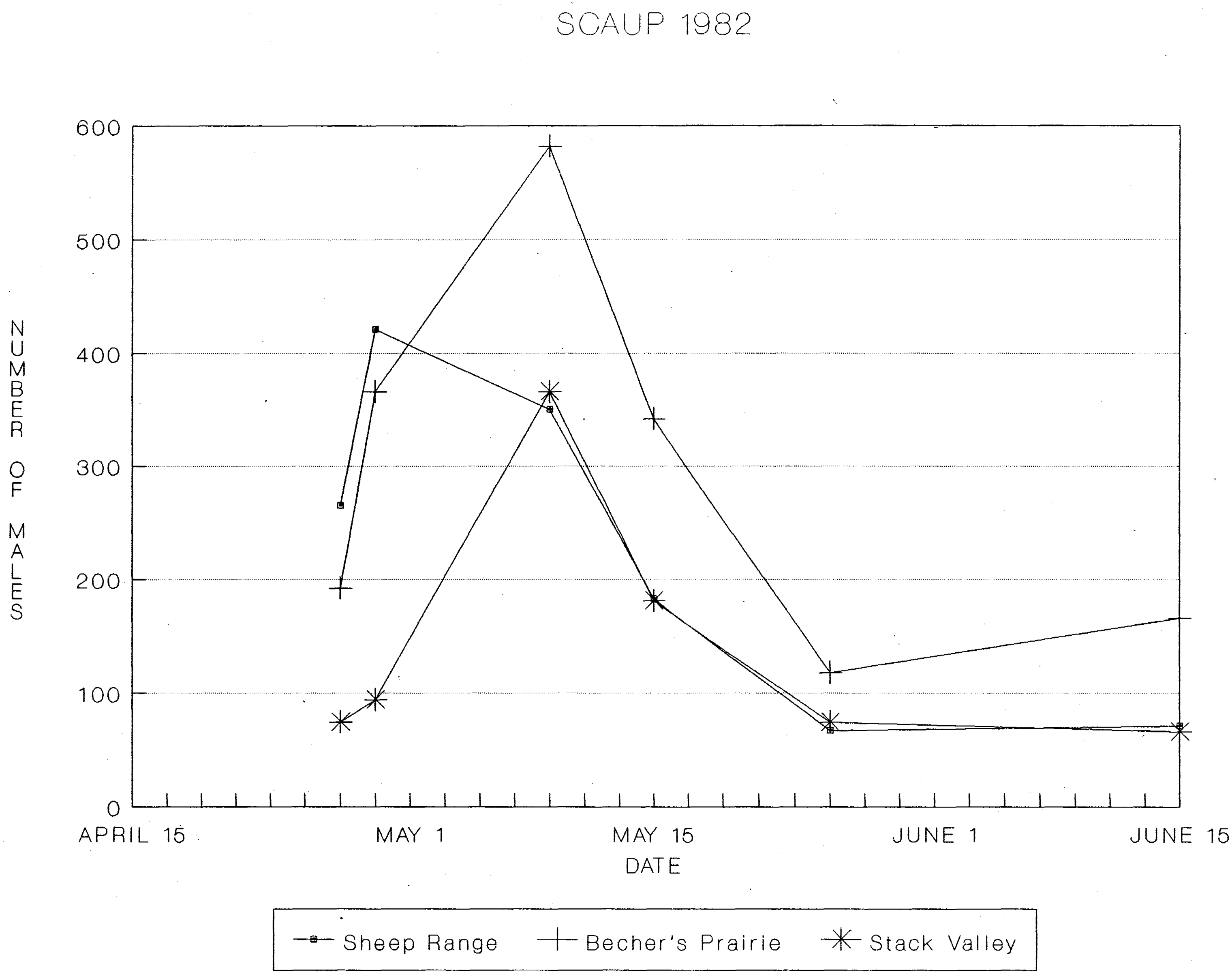
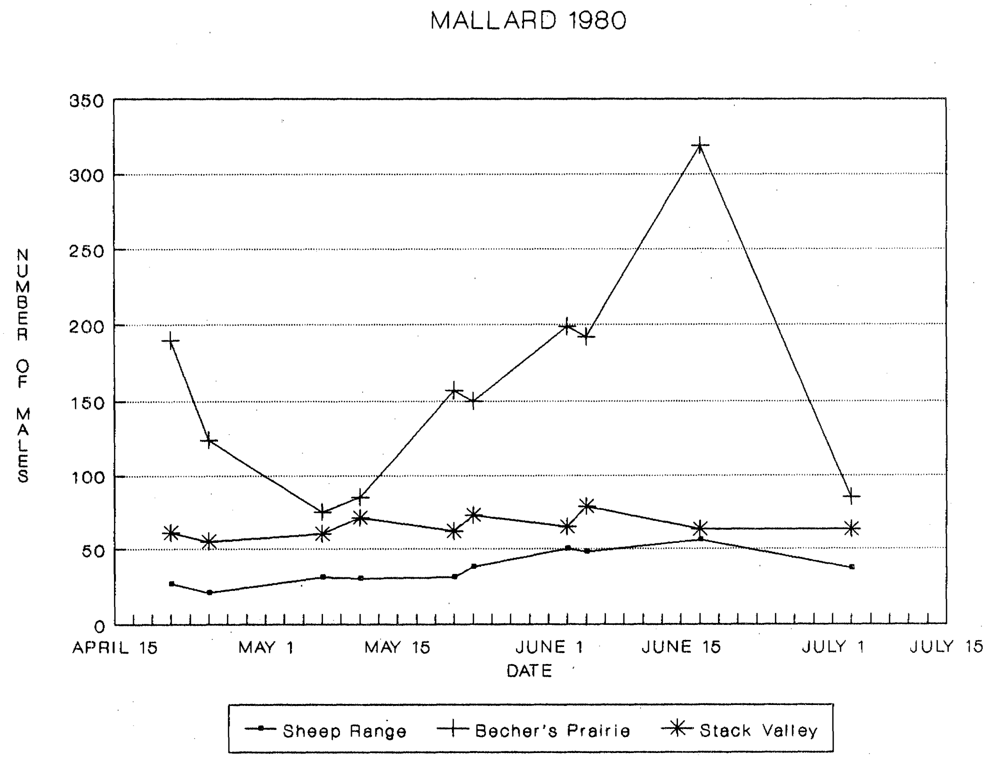


Figure 7.132 Seasonal fluctuations in the number of Scaup males in the three sub areas in 1982.



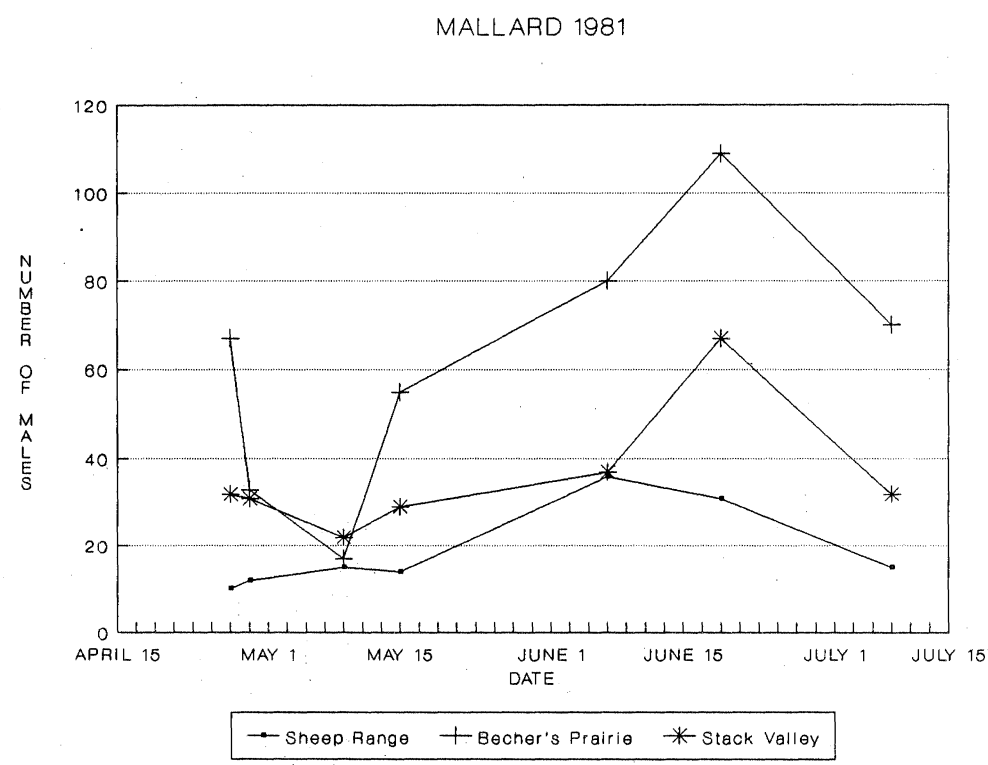


Figure 7.141 Seasonal fluctuations in the number of Mallard males in the three sub areas in 1980 and 1981.

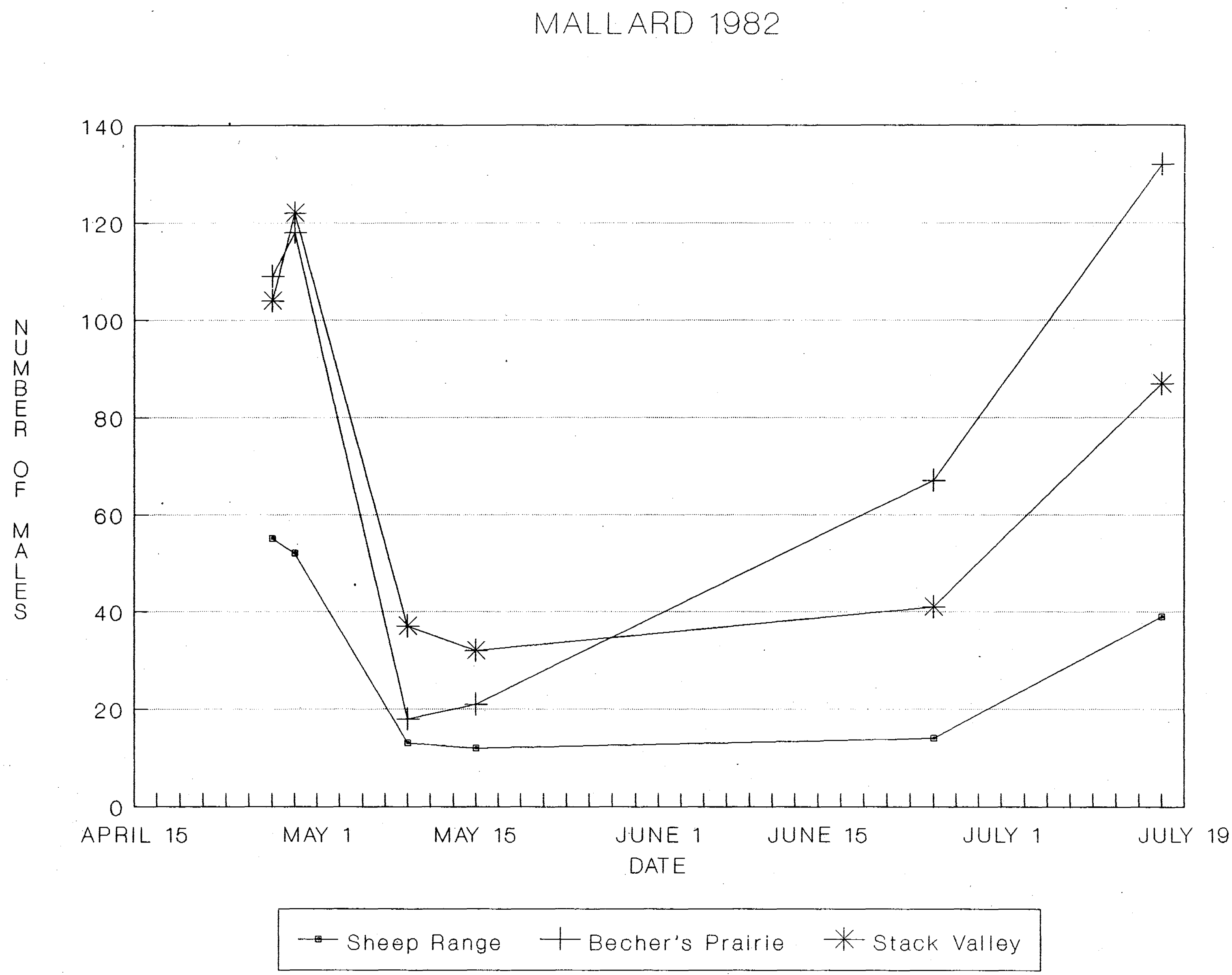


Figure 7.142 Seasonal fluctuations in the number of Mallard males in the three sub areas in 1982.

7.15 American Wigeon

Migrants were numerous in late April, 1980 in Becher's Prairie but not in the other two sub-areas and they left Becher's Prairie by May 7 (Fig. 7.151). Numbers of males remained more or less stable until early June and increased in Becher's Prairie and Sheep Range between June 5 and June 18, 1980.

Similar patterns were observed in 1981 with only Becher's Prairie showing any significant fluctuation in wigeon numbers (Fig. 7.151). In 1982, there was an obvious decrease in number of American Wigeon males between April 29 and May 15 (Fig. 7.152). As in 1981, numbers of males increased again between May 25 and June 25 in Becher's Prairie.

7.16 Blue-winged Teal

The arrival pattern of Blue-winged Teal drakes in 1980 was similar in all three sub-areas, with numbers building up until the end of May (Fig. 7.161). The number of Blue-winged Teal males stabilized in Sheep Range and Stack Valley in the first week of June but continued to increase in Becher's Prairie until June 18.

In 1982, the arrival patterns of Blue-winged Teal males was similar in all three sub-areas and numbers had stabilized by June 7 (Fig. 7.162). In 1982 again patterns were similar between sub-area until May 25. Between May 25 and June 24 numbers of Blue-winged Teal increased in Becher's Prairie while decreasing in the two other areas.

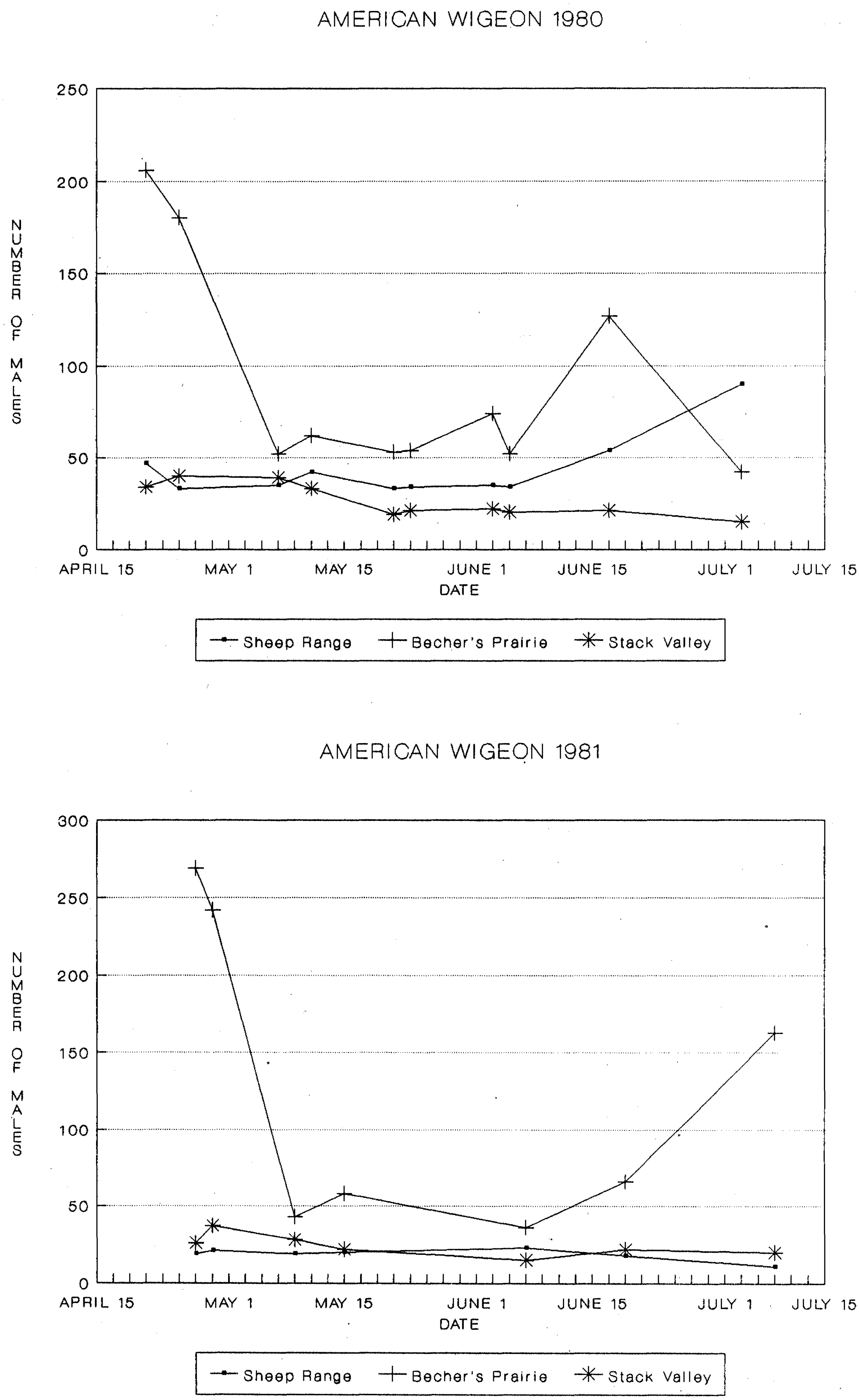


Figure 7.151 Seasonal fluctuations in the number of American Wigeon males in the three sub areas in 1980 and 1981.

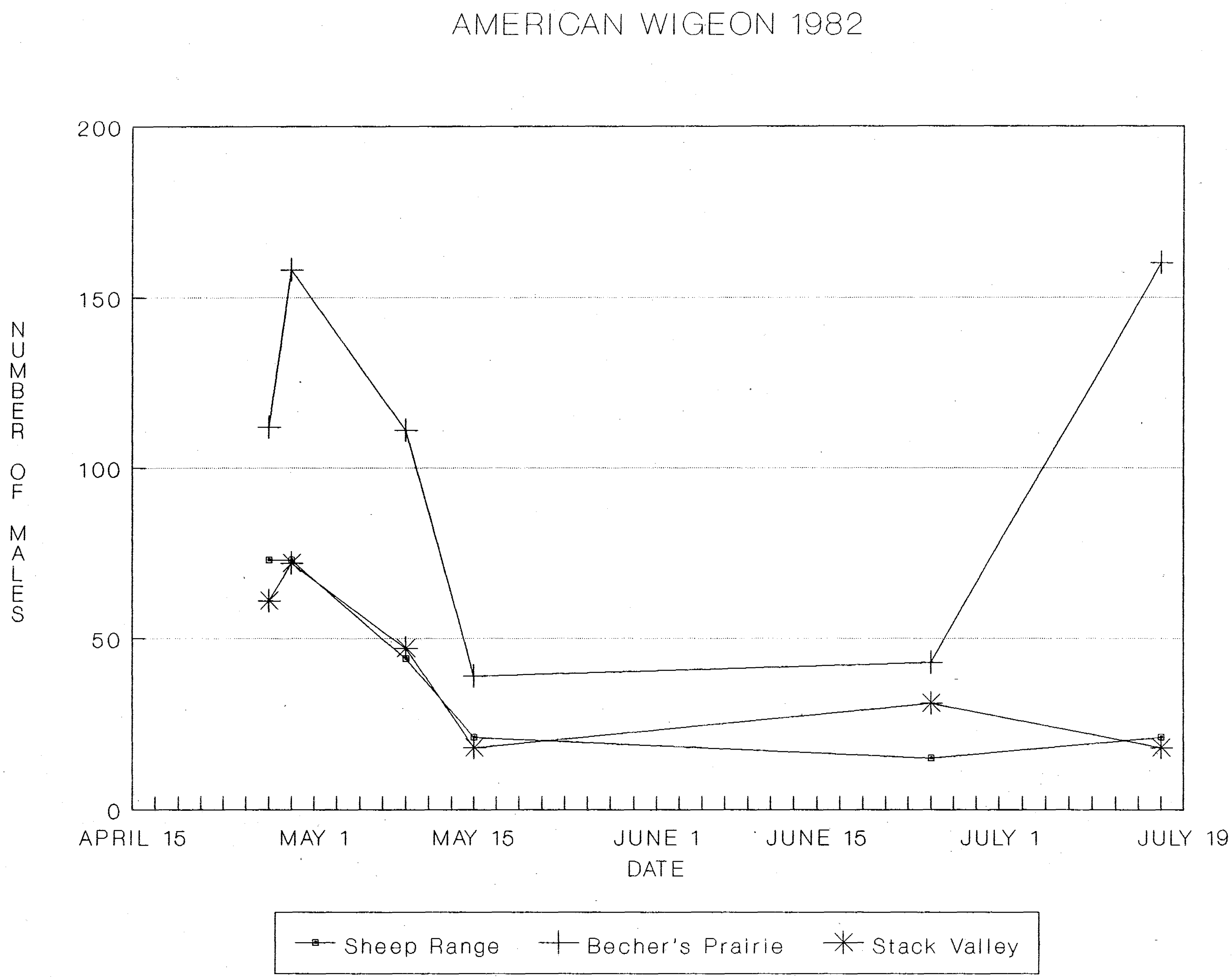
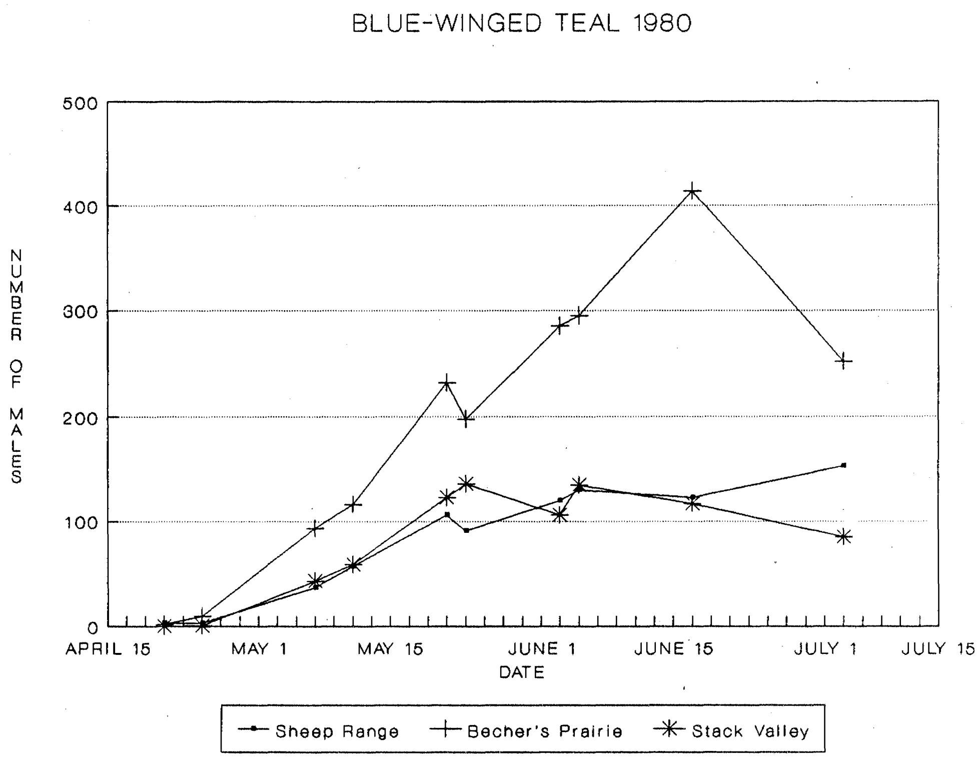


Figure 7.152 Seasonal fluctuations in the number of American Wigeon males in the three sub areas in 1982.



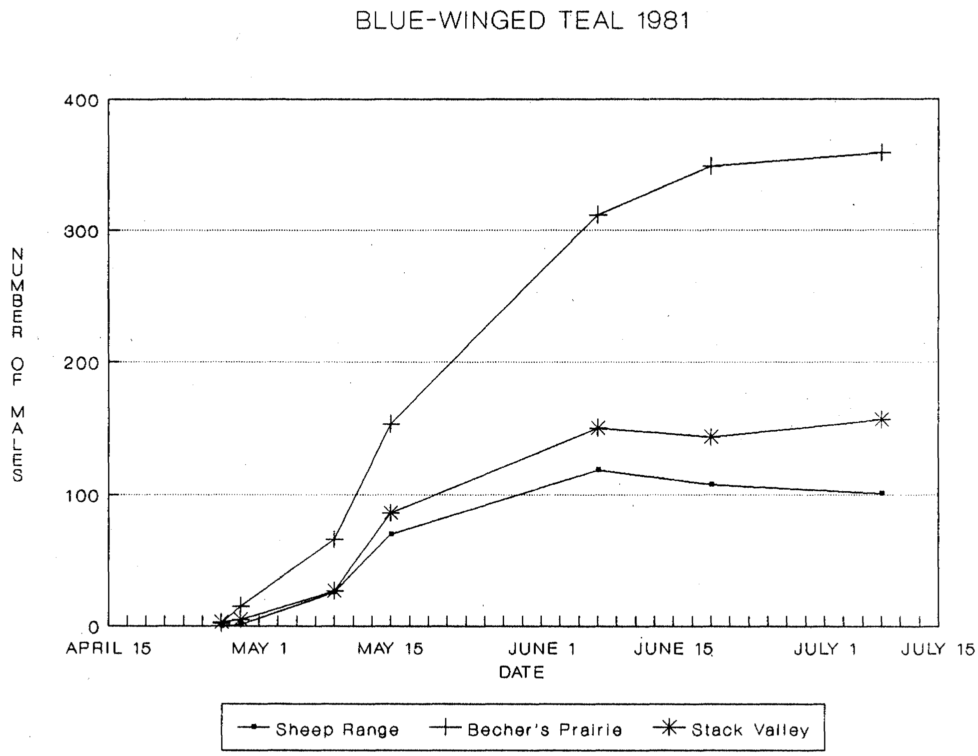


Figure 7.161 Seasonal fluctuations in the number of Blue-winged Teal males in the three sub areas in 1980 and 1981.

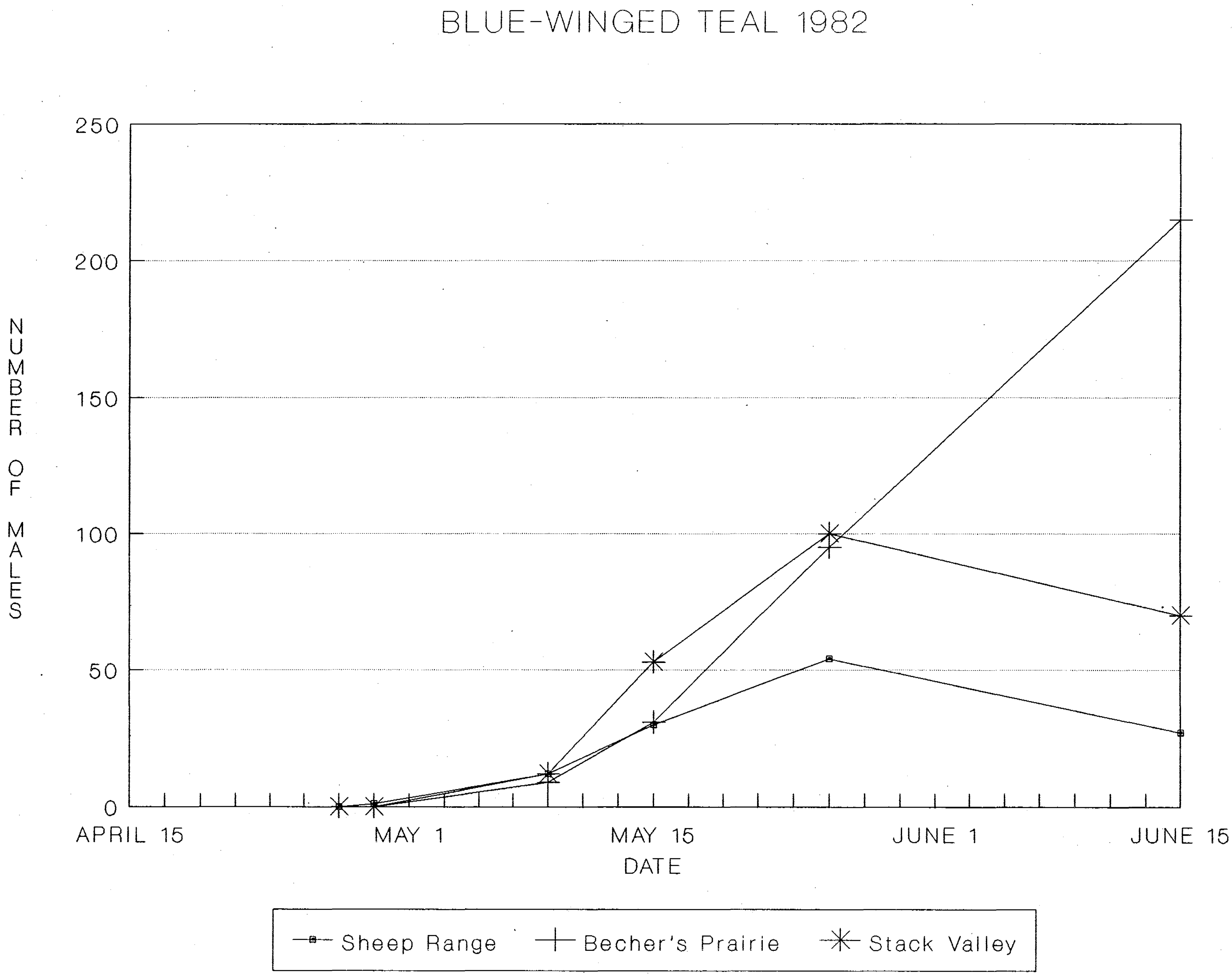


Figure 7.162 Seasonal fluctuations in the number of Blue-winged Teal males in the three sub areas in 1982.

7.2 Comparison of annual fluctuations in waterfowl abundance between three adjacent areas.

A) Mallard

Yearly fluctuations in numbers of Mallard drakes differed between each area (Fig. 7.21). All areas showed a decrease in Mallard abundance from 1980 to 1981. The decrease continued in 1982 in Bechers Prairie but not in the other two areas. From 1982 to 1984, Bechers Prairie and Stack valley had similar fluctuations in Mallard numbers but the number of Mallard drakes in Sheep Range was low and did not show any increase during this period.

B) American Wigeon

Numbers of wigeon drakes were lowest in the Sheep Range area, showing little yearly variation (Fig. 7.21). Numbers were greatest in Bechers Prairie where they fluctuated significantly between years. Numbers of wigeons were intermediate in Stack valley, with a different pattern of yearly fluctuations.

C) Barrow's Goldeneye

Highest numbers of Barrow's Goldeneye occurred in the Stack valley area and the lowest were in the Sheep Range area (Fig. 7.22). As with Mallard and wigeon, yearly fluctuations were most obvious in high density areas. Yearly fluctuations were significant in Stack valley and Bechers Prairie but not in Sheep Range.

D) Bufflehead

Tracking of yearly fluctuations in the number of Bufflehead drakes differed among areas, being similar in some years and different in others (Fig. 7.22). All three areas show a slight increase from 1981 to 1982, but after 1982 the three areas had slight pattern fluctuations.

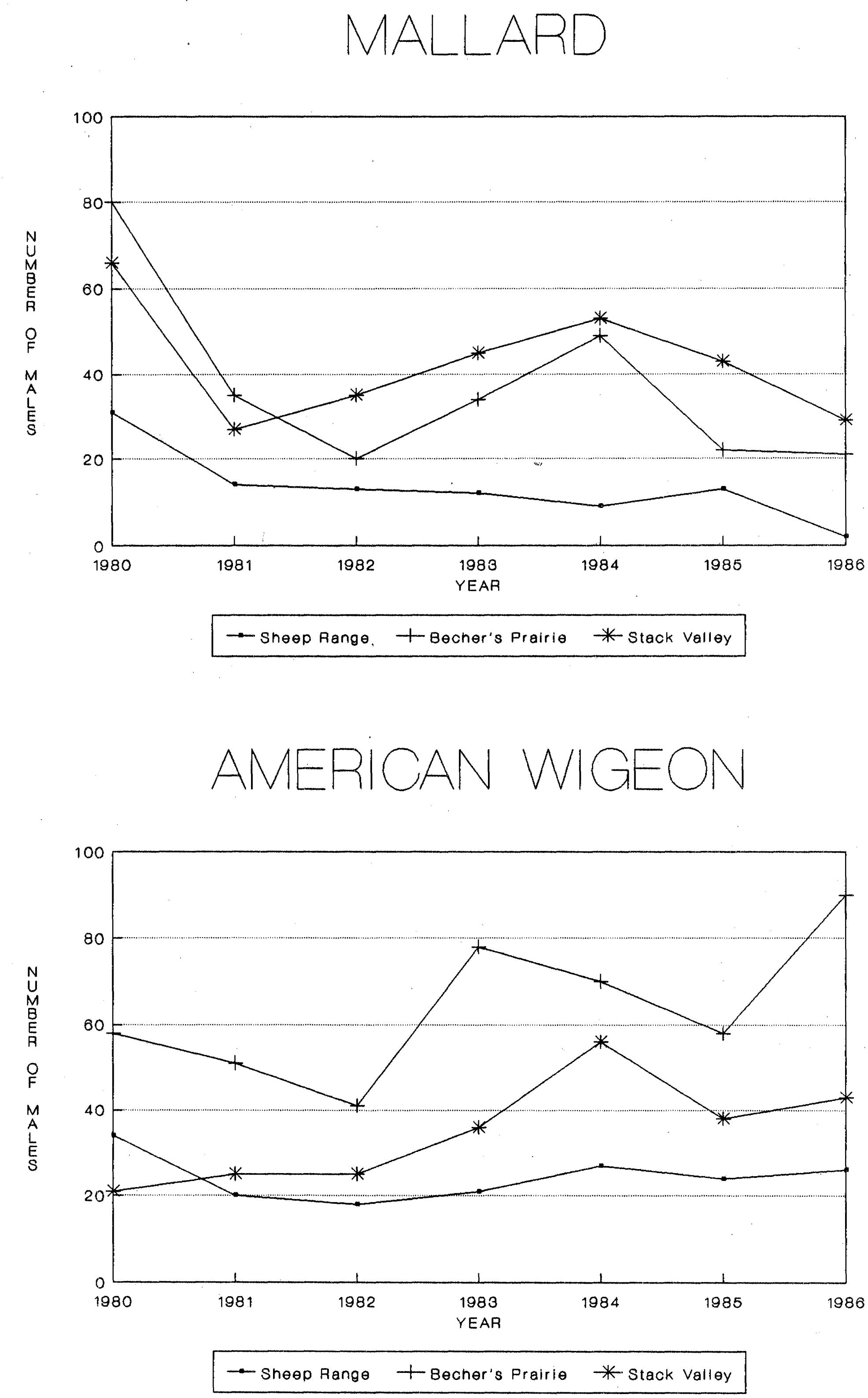
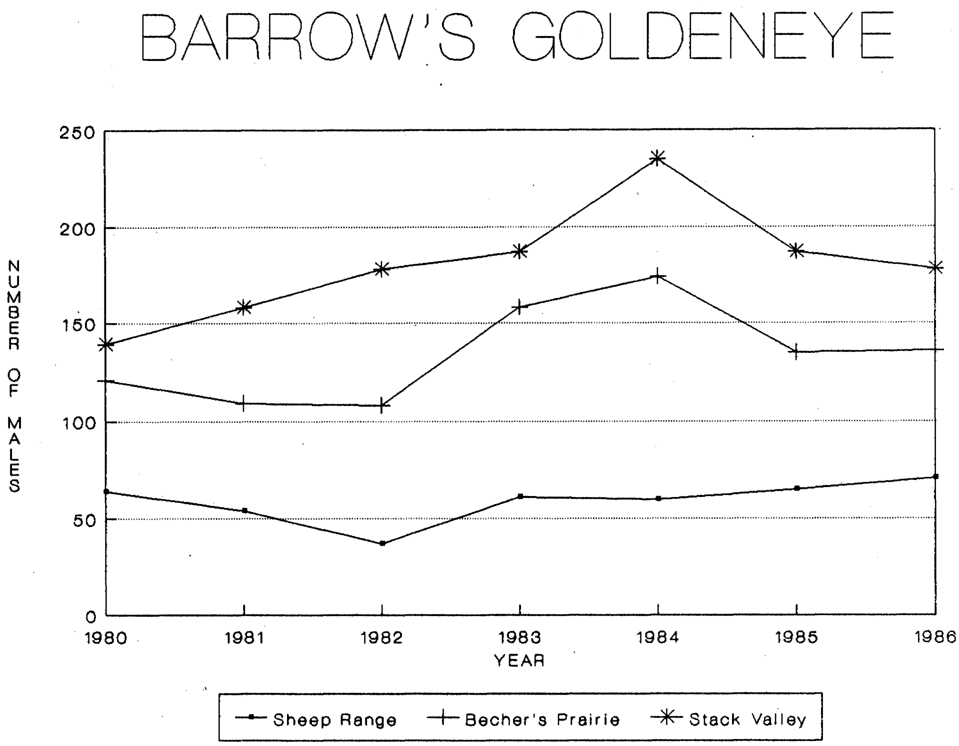


Figure 7.21 Annual fluctuations in the number of Mallard and American Wigeon males in the three sub areas.



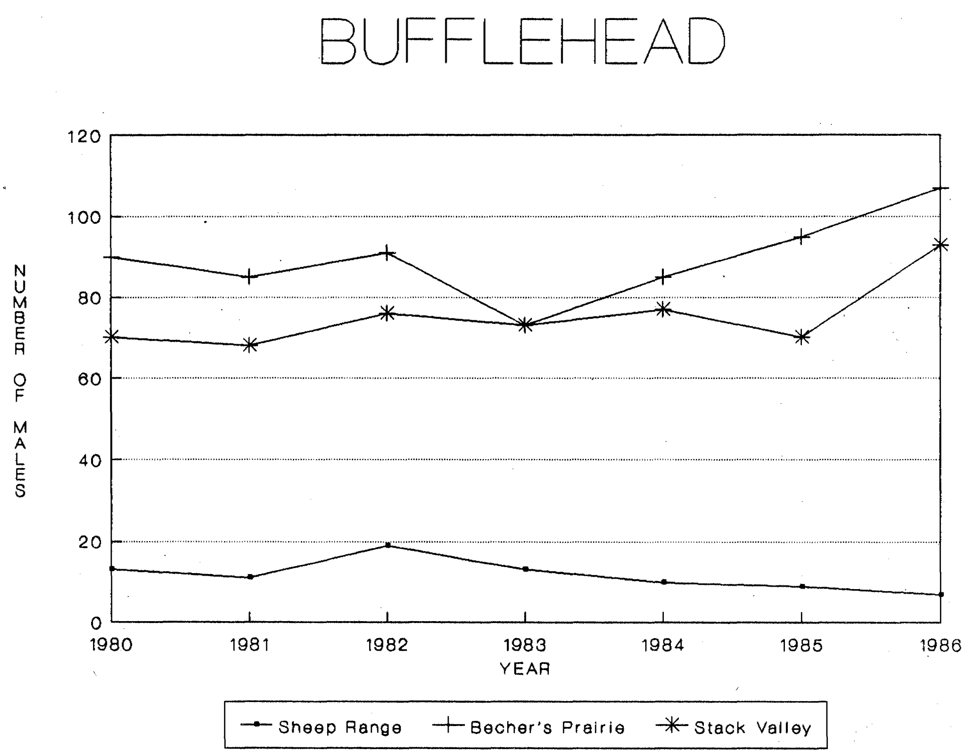


Figure 7.22 Annual fluctuations in the number of Barrow's Goldeneye and Bufflehead males in the three sub areas.

Appendix 8. Comparison of seasonal and annual fluctuations in waterfowl counts on small (<6 ha) lakes and large (>6 ha) lakes.

8.1 Seasonal fluctuations in numbers

Counts on lakes smaller than 6 ha were usually easier than those on larger lakes. I thus compare here whether counts on both types of lakes show similar seasonal patterns for a few selected species.

A) Mallard

In 1980, seasonal fluctuations in the number of Mallard males were similar on lakes smaller than 6 ha and on larger lakes (Fig. 8.11). However, between June 18 and July 2, the number of males decreased from over 230 to less than 60 on large lakes, but only from 200 to 140 on small lakes.

In 1981 patterns were similar on both type of lakes with the exception that between May 16 and June 7 there was no increase on large lakes compared to more than a doubling in numbers on small lakes (Fig. 8.11).

B) Green-winged Teal

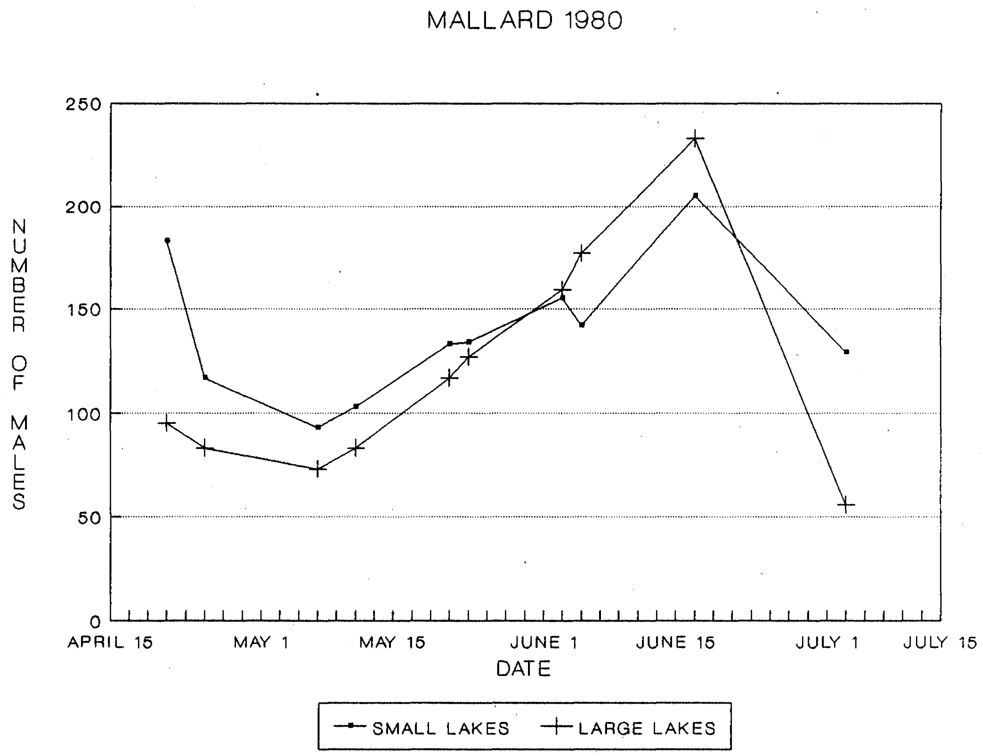
Seasonal fluctuations in the number of Green-winged Teal males were very similar on both lake sizes in both 1980 and 1981 (Fig. 8.12).

C) Blue-winged Teal

Again no differences in patterns of fluctuation between small (<6 ha) and large lakes (>6 ha) in 1980 (Fig. 8.13) However, in 1981 numbers of Blue- winged Teal males increased between June 19 and July 7 on small lakes but not on large lakes (Fig. 8.13). Also, in both years there were more teals on small than large lakes.

D) American Wigeon

In both 1980 and 1981, numbers of American Wigeon males fluctuated more widely on large lakes (Fig. 8.14). In late April 1981, there was a large number of migrants on the large lakes of the study area and their numbers decreased rapidly in early May. Although on a smaller scale, counts on smaller lakes



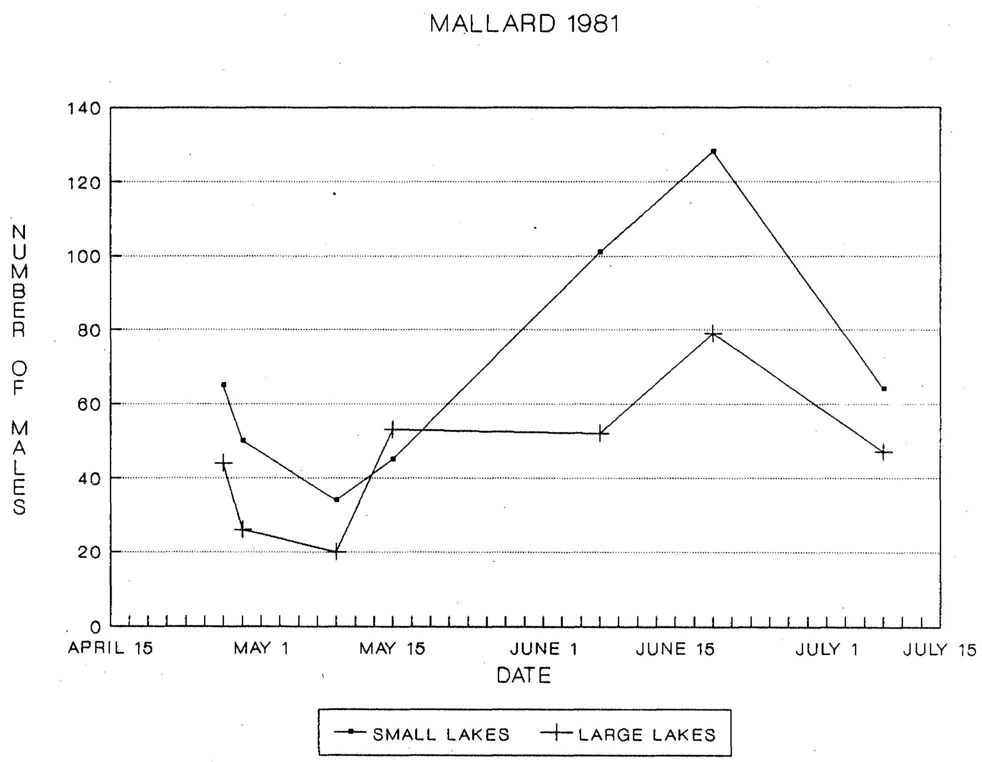


Figure 8.11 Seasonal fluctuations in the number of Mallard males on small and large lakes in 1980 and 1981.

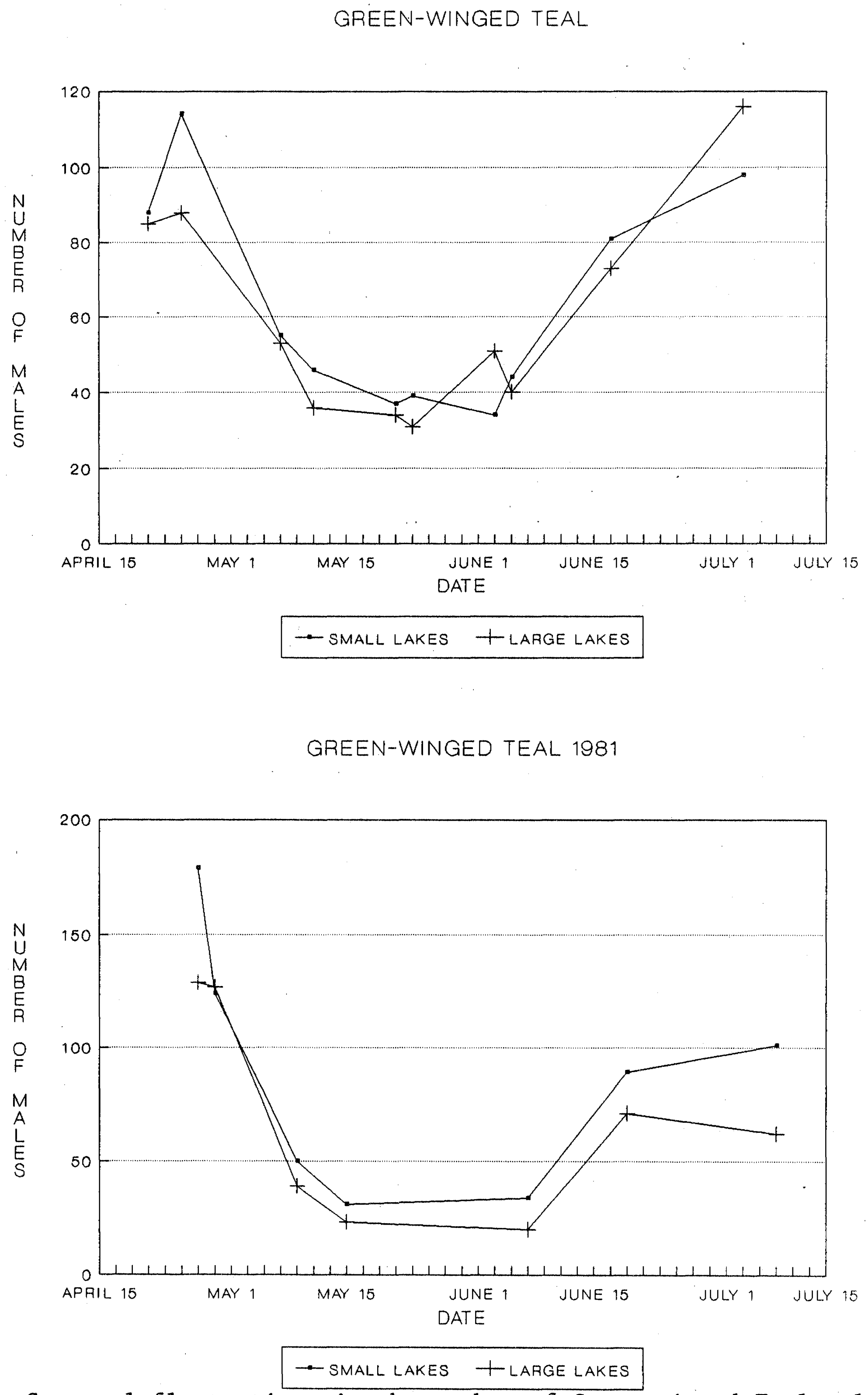


Figure 8.12 Seasonal fluctuations in the number of Green-winged Teal males on small and large lakes in 1980 and 1981.

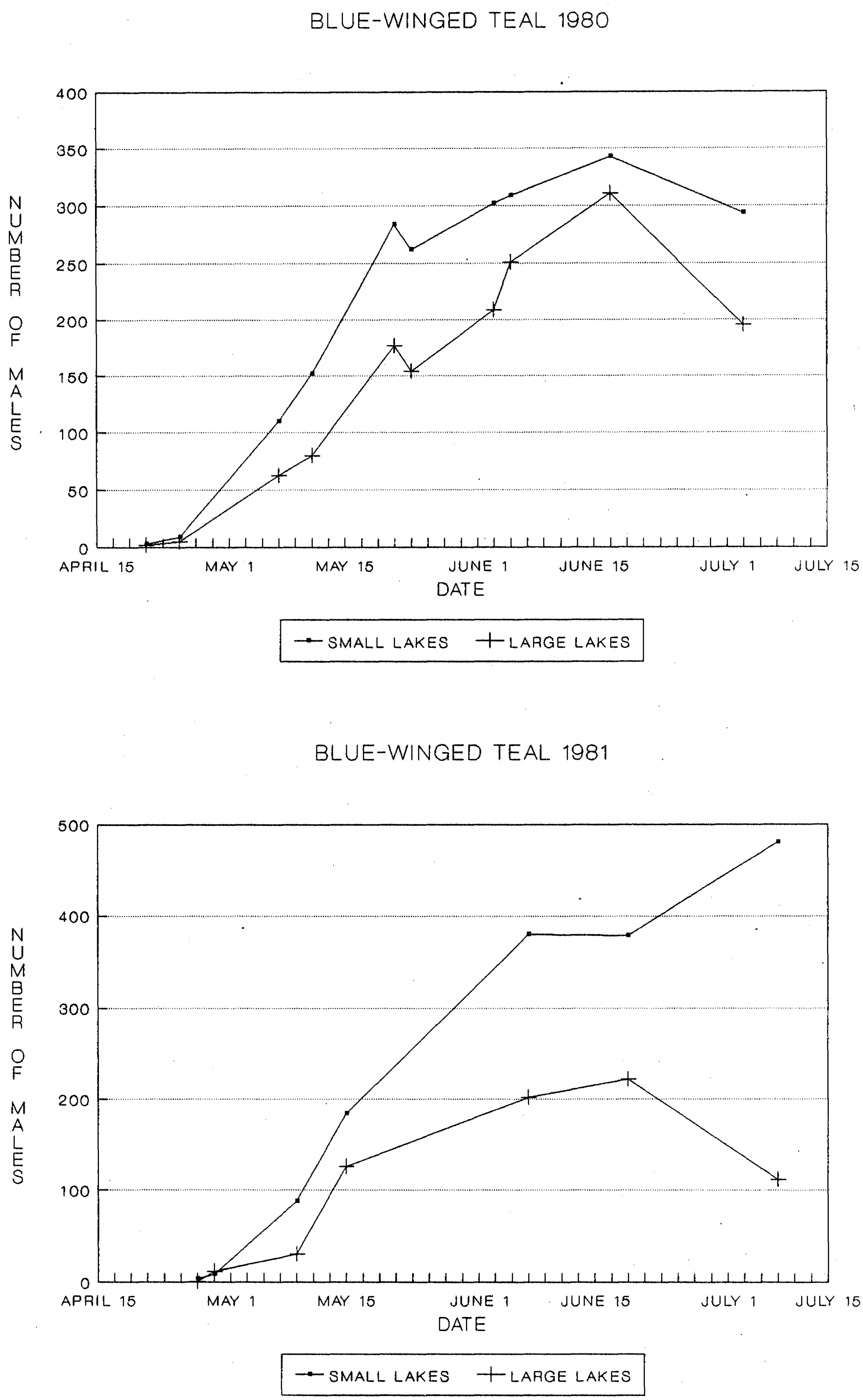


Figure 8.13 Seasonal fluctuations in the number of Blue-winged Teal males on small and large lakes in 1980 and 1981.

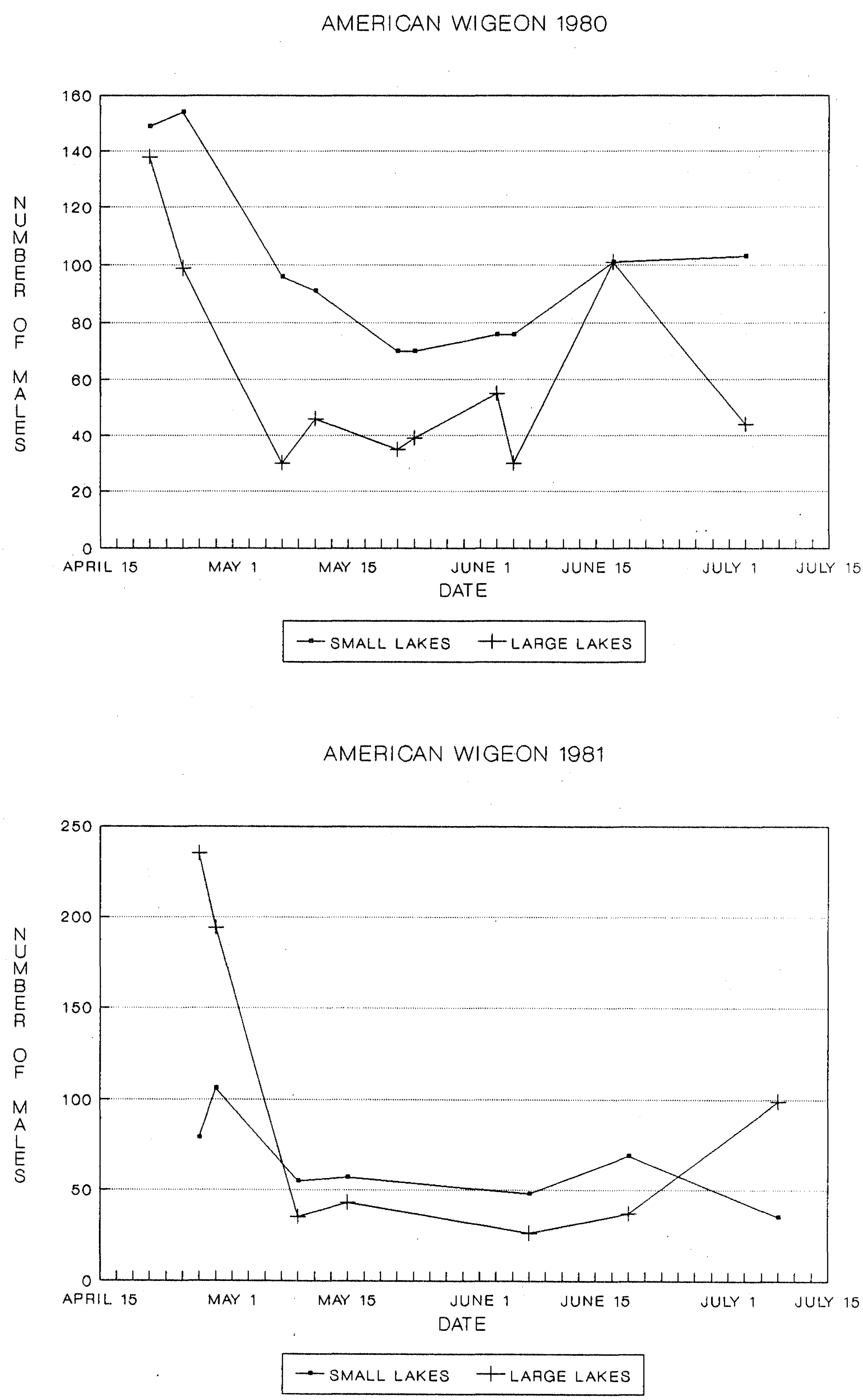


Figure 8.14 Seasonal fluctuations in the number of American Wigeon males on small and large lakes in 1980 and 1981.

reflected this pattern. Migrating American Wigeons appear to favour large lakes over smaller ones in the study area.

E) Ring-necked Duck

In 1980, fluctuations in numbers of Ring-necked Duck males were similar on small and large lakes in late April and early May (Fig. 8.15), the number of males decreasing between April 25 and May 7. In early June, however, the number of male Ring-necked Ducks increased on large lakes, while decreasing on small lakes. This may reflect males concentrating on some large molting lakes.

In 1981, patterns differed with an increase in the number of males on large lakes between April 27 and 29 but a significant decrease during the same period on small lakes (Fig. 8.15). The departure of migrants between April 29 and May 10 was obvious on both lake sizes. Patterns in June 1981 differed from those of 1980 with an increase in the number of males on both types of lake. However, the decrease observed between June 19 and July 8 on small lakes but not on large lakes strengthened the hypothesis that large lakes are preferred by Ring-necked Duck males for their molt.

F) Scaup

Fluctuations in the number of Scaup males was similar on small and large lakes both in 1980 and 1981 (Fig. 8.16). The departure of spring migrants was obvious on both types of lakes and the increase in the number of males in early July 1981 occurred on both small and large lakes.

G) Bufflehead

The departure of spring migrants and the departure of Bufflehead males from the study area was clear on both small and large lakes in both years (Fig. 8.17). Of interest, is an increase in the number of males in late May, early June on large lakes, coupled with a decrease of similar magnitude on small lakes. It suggests a movement of birds from small to large lakes.

H) Barrow's Goldeneye

In 1980, fluctuation patterns in the number of males was similar in late April and early May on small and large lakes (Fig. 18). Numbers of males were equally abundant on these lakes. As with Bufflehead, there was an increase on large lakes coupled with a similar decrease on small lakes in the number of males in

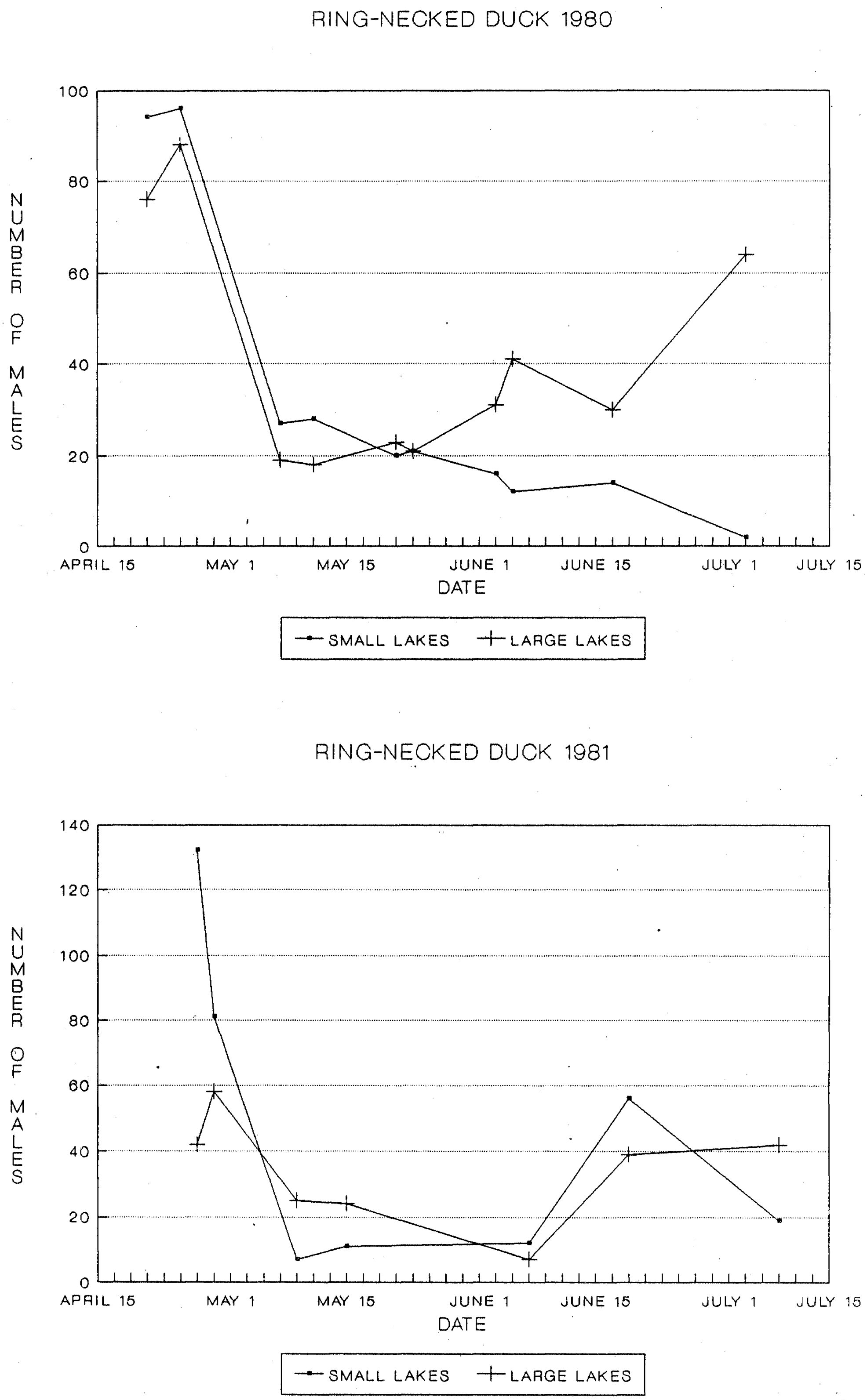


Figure 8.15 Seasonal fluctuations in the number of Ring-necked Duck males on small and large lakes in 1980 and 1981.

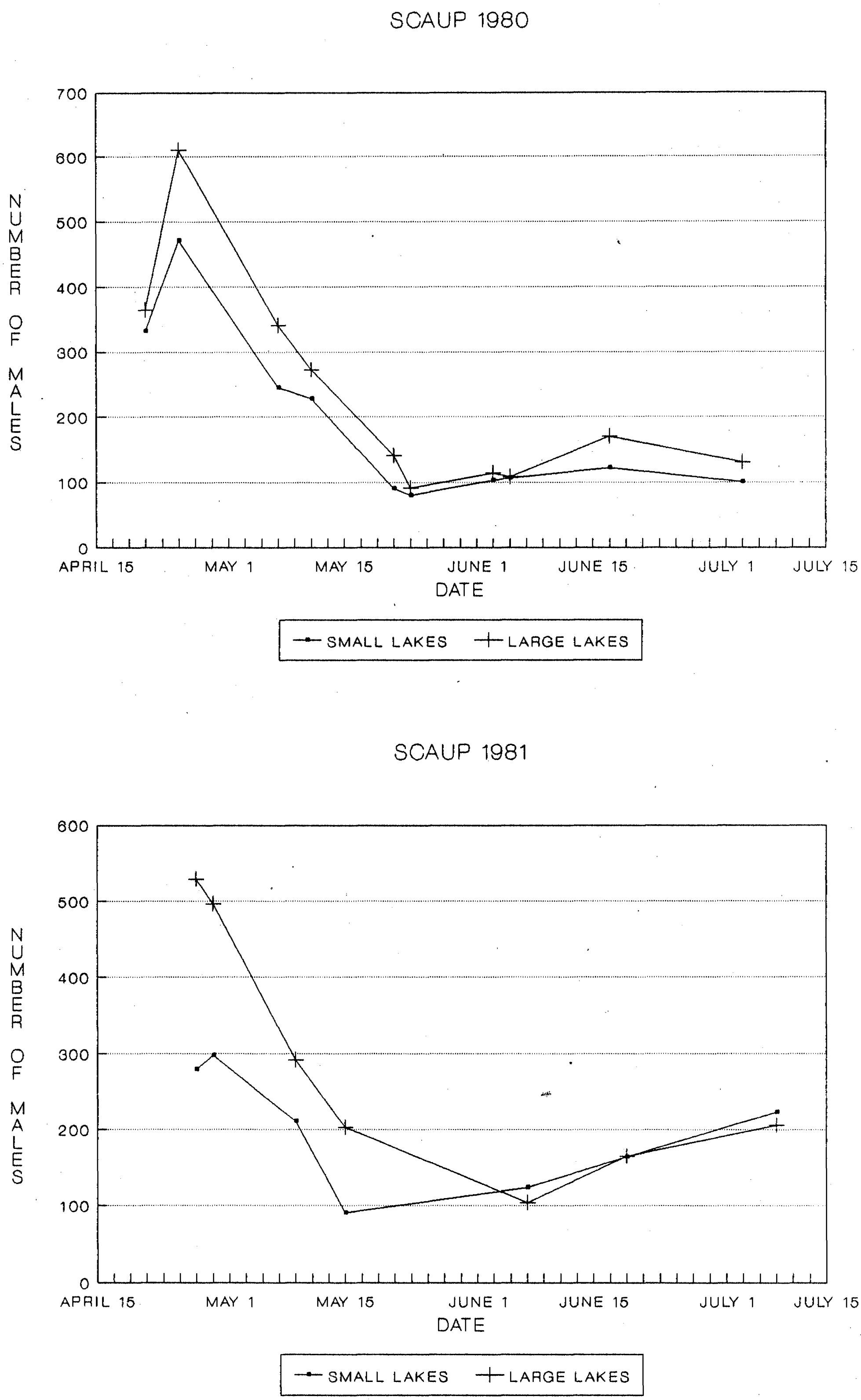
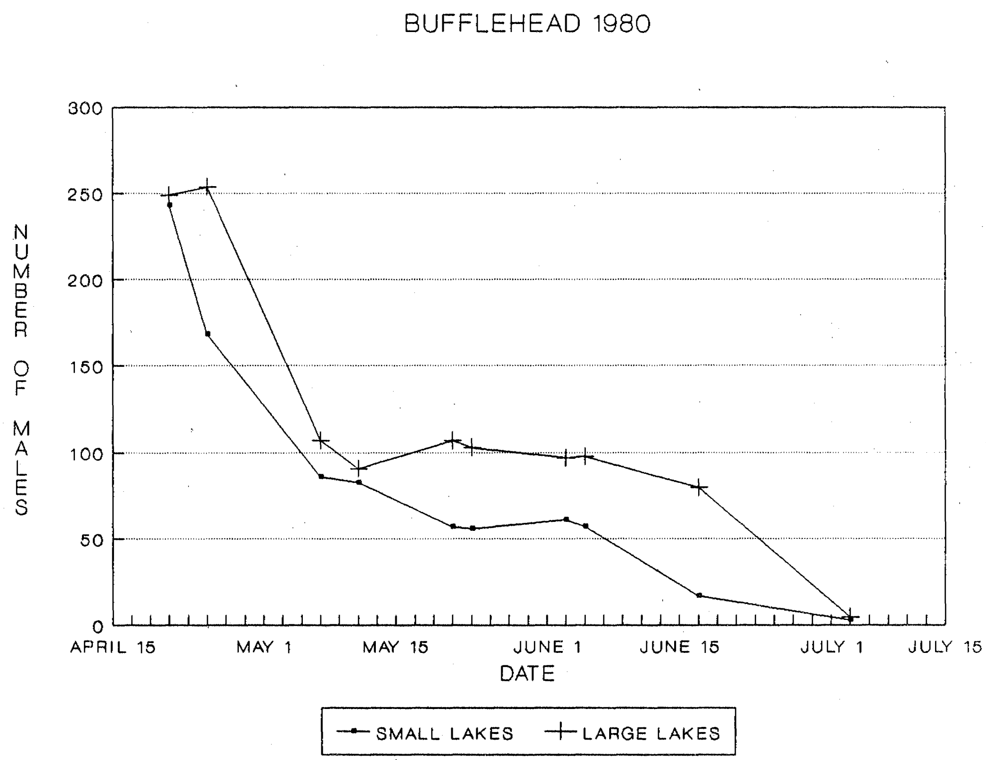


Figure 8.16 Seasonal fluctuations in the number of Scaup males on small and large lakes in 1980 and 1981.



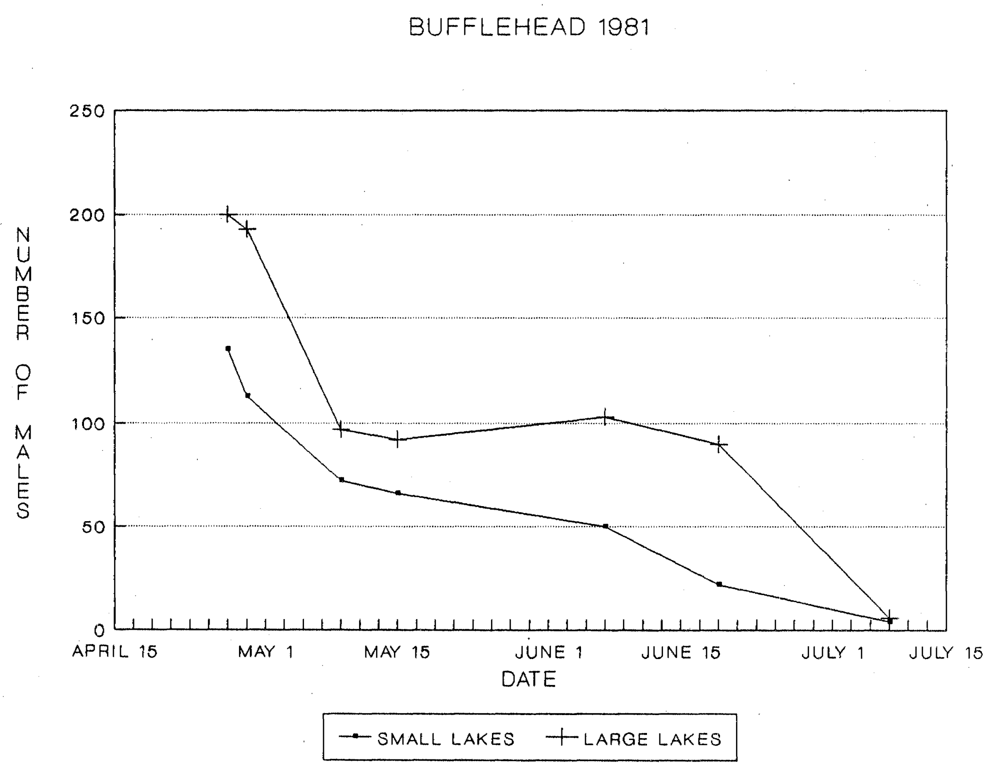
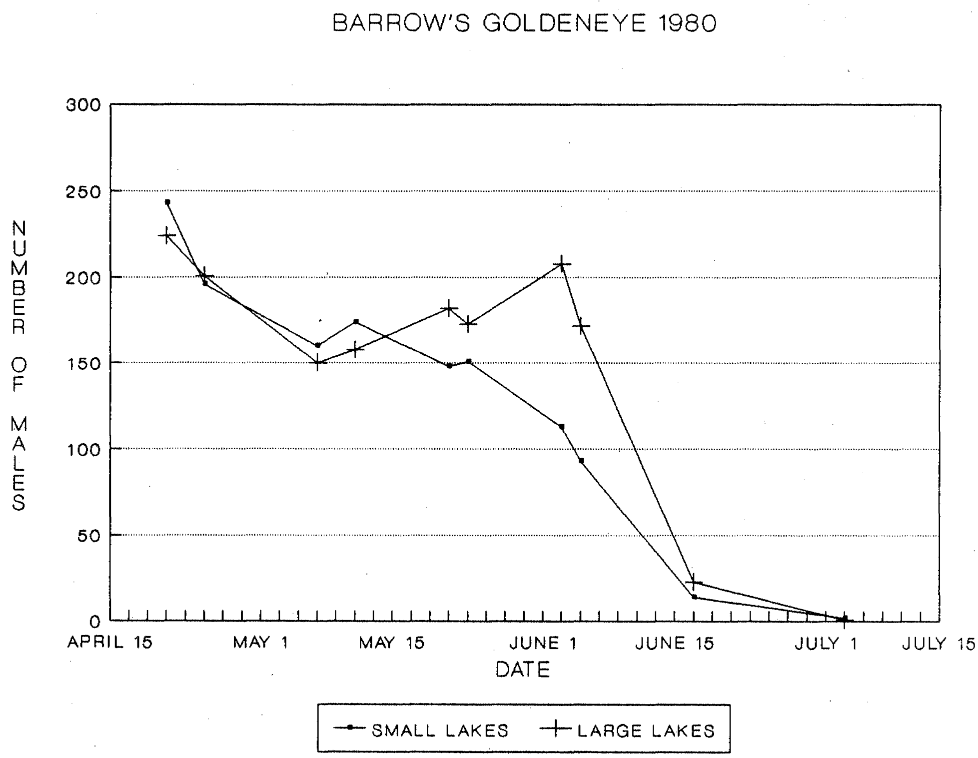


Figure 8.17 Seasonal in the number of Bufflehead males on small and large lakes in 1980 and 1981.



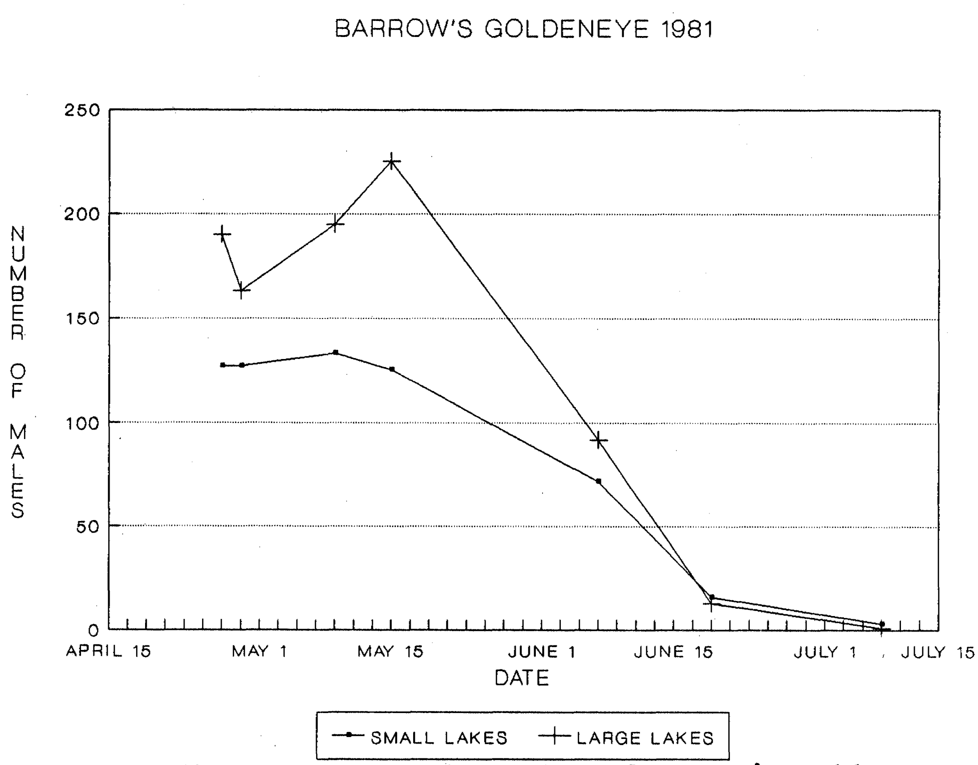


Figure 8.18 Seasonal fluctuations in the number of Barrow's Goldeneye males on small and large lakes in 1980 and 1981.

mid May and early June, indicating that large lakes are used for staging before the departure toward molting areas.

In 1981, there were fewer males on small lakes than on large ones (Fig. 18). Numbers of males remained stable from late April to mid May on small lakes but increased on large lakes. The departure of males for their molting areas was detected on both small and large lakes.

8.2 Annual fluctuations in numbers

A) Mallard

In all years more Mallards were seen on lakes <6 ha than on the larger lakes of the study area (Fig. 8.21). Yearly fluctuations in the number of males were similarly monitored on large and small lakes.

B) American Wigeon

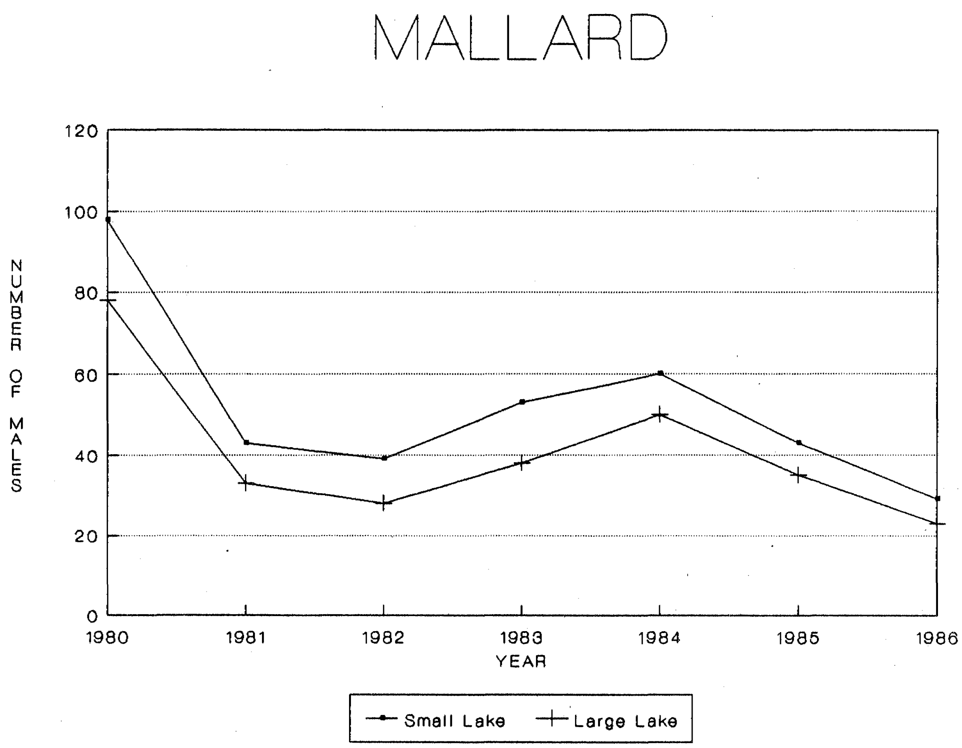
Unlike Mallards, American Wigeon males were more numerous on the larger lakes of the study area (Fig. 8.21). However, as with Mallards, counts of males on small and large lakes reflected similar yearly fluctuations.

C) Barrow's Goldeneye

There were slightly more male Barrow's Goldeneye on large lakes than on small ones, but the differences varied between years (Fig. 8.22). Yearly fluctuations differed between small and large lake counts: counts on small lakes indicated a decrease in the number of Barrow's Goldeneye from 1980 to 1982, whereas counts on large lakes indicated the reverse. The increase in the number of males from 1983 to 1984 on large lakes was not detected on small lakes.

D) Bufflehead

Like Barrow's Goldeneye, Bufflehead drakes were more numerous on large lakes than on small ones (Fig. 8.22). Yearly fluctuations differed between the two sizes of lake, being more variable on large lakes.



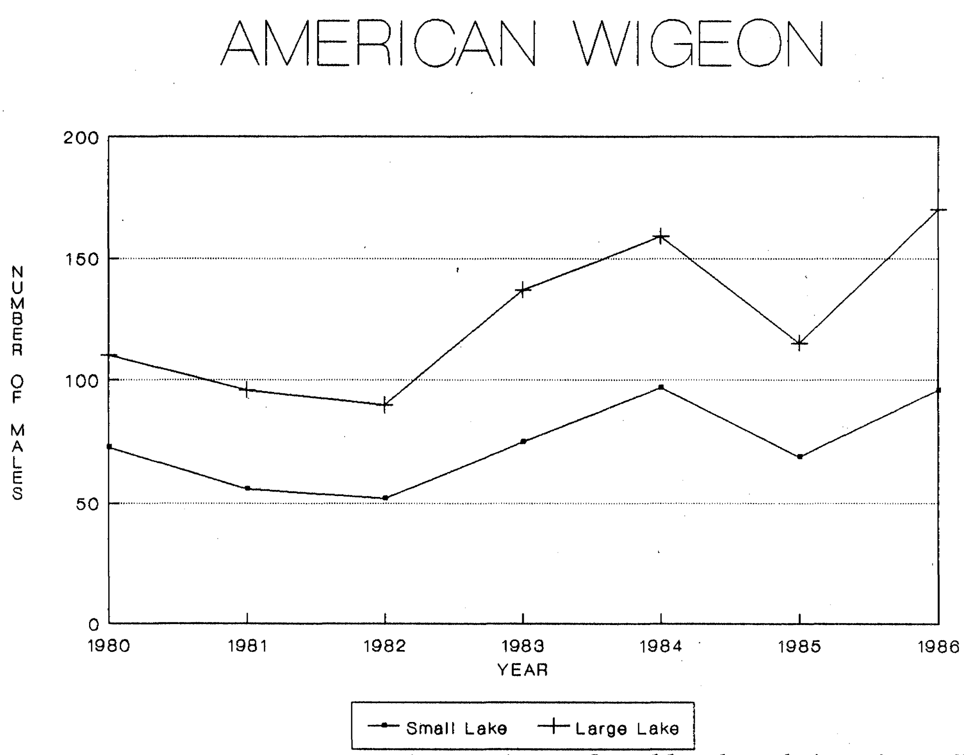


Figure 8.21 Annual fluctuations in the number of Mallard and American Wigeon males on small and large lakes.

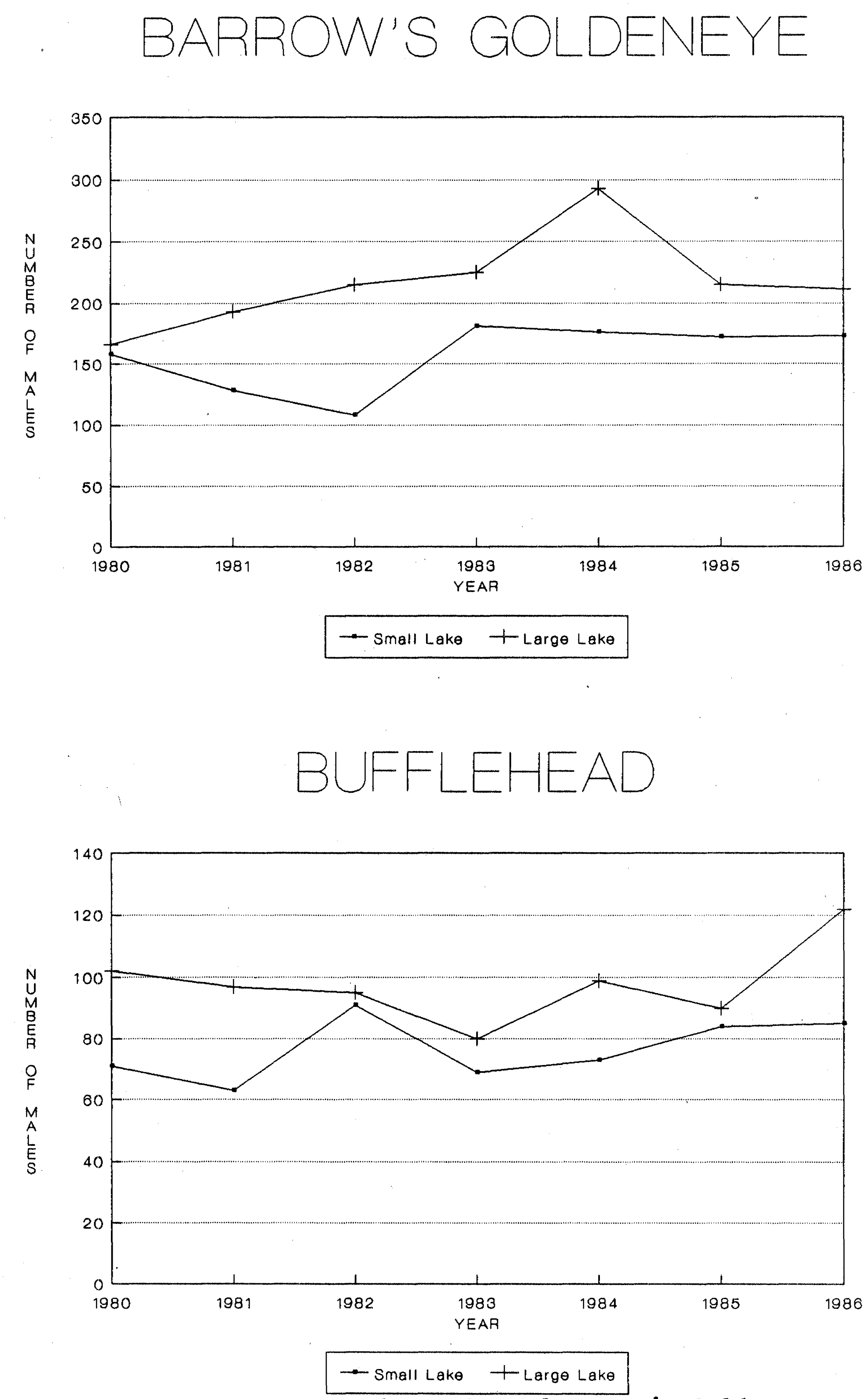


Figure 8.22 Yearly fluctuations in the number of Barrow's Goldeneye and Bufflehead males on small and large lakes.