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Black Duck Breeding Pair Surveys in
New Brunswick and Nova Scotia - 1999

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1. Introduction

Waterfowl management depends on surveys which monitor the status of populations, indicate where and when management is required and document the results of management action. Historically, the mid-winter inventory has been a primary source of information but banding programs and harvest surveys have added additional information for close to 50 years. Breeding ground surveys in the primary Black Duck breeding habitat were developed 1980 -1990. Breeding surveys now in place in eastern North America include helicopter surveys in Ontario, Quebec, New Brunswick, Nova Scotia, and Newfoundland-Labrador; ground surveys in Ontario, Prince Edward Island and eastern states; fixed-wing surveys in Maine, Ontario, Quebec, New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland-Labrador.

Development of the helicopter surveys in eastern Canada began in 1985 and continued through 1989 (Erskine et al., 1990). The early surveys were modified in 1990 to allow comparable Black Duck breeding pair surveys throughout the main breeding range of the Black Duck. The surveys done 1990 to 1994 are considered experimental surveys prior to designing an operational Black Duck breeding ground survey. In 1995 the survey was adjusted to accommodate reduced funding and in 1996 the survey was re-designed using information gathered during the previous ten years. This report presents results from the 1999 survey in New Brunswick and Nova Scotia. Information from previous surveys are included in Appendix I.

1.1 History

Statistical analyses of 1986-1989 aerial survey data from New Brunswick, Nova Scotia, Newfoundland, Ontario and Quebec (B.Collins, CWS/NWRC) indicated that a sample size of 200 plots across the Black Duck breeding range was adequate to detect a change of 10 percent in five years with 90 percent power and 95 percent confidence. The major breeding range of the Black Duck approximates and is defined here as strata 28 and 29 of the Breeding Bird Survey. The 200 required plots were allocated to provinces and states

on the basis of their area within Breeding Bird Strata 28 and 29. New Brunswick was allocated 9 plots and Nova Scotia, 8. To provide data useful for management on a smaller scale, additional plots were assigned to New Brunswick, Nova Scotia, Newfoundland and Maine to a total of 25 plots each. That sample size permitted a population change of 10 percent to be detected over a ten year period with 90 percent power. With the additional plots in the Atlantic provinces and Maine and minor modification to the number of plots in Quebec and Ontario in 1991, the total number of plots in the 1992 survey was 229. Modifications in 1991 included reduction in the number of helicopter plots in Ontario and the use of fixed-wing surveys in Wisconsin and Michigan instead of helicopter surveys. Further modification after statistical analyses of the 1990 to 1992 data resulted in a reduced number of helicopter plots in Ontario (25) and Quebec (50) in 1993 and 1994. In 1995 further reductions in sample size were necessary due to budget restrictions. In 1995, 10 plots were surveyed in Ontario; 36 in Quebec; 10, in Nova Scotia; 9, in New Brunswick; 13, in Newfoundland-Labrador and 6, in Maine. In 1996 the survey design was modified by changing plot size to 5 km x 5 km and implementing a rotational plot design. All plots are surveyed over a three year period and all plots are surveyed twice over a four year period.

2. Methods

2.1 Survey design

The current survey design was implemented in 1996 and allocated 30 plots to Nova Scotia and 40 to New Brunswick. All plots are 5 km x 5 km and were selected from plots flown in previous surveys to allow continuity of data. For each province, the plots were grouped in four units (10 plots each in New Brunswick and 7,8,7,8 plots in Nova Scotia) and two units are surveyed each year. Each year, one of the units surveyed was surveyed the previous year. Total plots surveyed each year is 20 in New Brunswick and 15 in Nova Scotia. All plots are surveyed over a three year period and all plots are surveyed twice over a four years.

2.2 Timing of surveys

Timing of the Nova Scotia survey was based on results from the original helicopter survey described in Erskine et al. (1990). The survey was flown at about the same time each year. The New Brunswick survey was flown in 1990 at the same time as the original helicopter surveys in that province. However, results from 1990 suggested an excessive number of migrants and in 1991 and subsequent years the survey was flown approximately one week later.

2.3 Flying, recording and data handling

The New Brunswick and Nova Scotia surveys were flown in a Bell 206L (Long Ranger) with two observers. Constant radio communication between the observers and the pilot prevented duplication of records and ensured good coverage of the plots. Each water body, wetland and all coastline within the plots were flown. Areas covered were marked on 1:50,000 National Topographical Series maps as the survey was in progress to ensure complete coverage. Surveys were carried out in compliance with the standard operating procedures for the Black Duck Joint Venture helicopter surveys prepared in March 1990 and modified in 1994. Surveys were flown at 16-50 meters (50-150 ft) above ground level and at 60-100 km/hr.(30-50kts).

All waterfowl observed were recorded and locations mapped on 1:50,000 topographical maps. Data were later transcribed onto data sheets and entered into a computer data base. Copies of mapped locations of all waterfowl observations were filed. In 1999 all crew members were experienced in this type of survey (Appendix II).

2.4 Interpretation of waterfowl data

Two Black Ducks together or a single Black Duck was considered an indicated pair and assumed to be breeding locally. The number of males and females of sexually dimorphic species was recorded where possible.

3. Results and Discussion

Twenty plots 25 km² in area were flown in New Brunswick and 15 25 km² plots were flown in Nova Scotia in 1999 (Figure 1). The Nova Scotia plots were surveyed between 30 April and 2 May. New Brunswick plots were surveyed between 3 May and 7 May and four plots were flown in Gaspe on 6 May (Appendix III). The 1990 to 1998 survey dates were between 30 April and 19 May (Table 1). Ice-out in the Maritimes was early in 1999 with vegetation as much as two weeks early in some areas. No ice was encountered in the New Brunswick or Nova Scotia plots but high elevation plots in Gaspe still had ice in some lakes. Total flying time for the New Brunswick and Gaspe survey was 24.8 hours and for the Nova Scotia survey was 18.3 hours. Average time on plot in Nova Scotia was 38.3 minutes and in New Brunswick was 36.6 minutes.

Table 1. Dates of helicopter breeding pair surveys in New Brunswick and Nova Scotia, 1990- 1998

Dates of Survey									
	1990	1991	1992	1993	1994	1995	1996	1997	1998
Nova Scotia	30 Ap- 10 May	30 A- 10 May	1 May- 11 May	3 May- 11 May	2 May- 12 May	2 May- 5 May	2 May- 6 May	3 May- 6 May	27 Ap- 29 Ap
New Brunswick	30 Ap- 8 May	8 May- 11 May	13 May- 19 May	14 May- 19 May	15 May- 21 May	10 May- 12 May	9 May- 15 May	11 May- 15 May	30 Ap- 10 May

The total numbers of the most common species of duck (Black Duck, ring-neck, green-wing, and Common and Red-breasted Mergansers) were 679 in Nova Scotia and 880 in New Brunswick (Tables 2, 3). Black Ducks made up 56 percent of the common species in Nova Scotia and 34 percent in New Brunswick. Ring-necks were 18 percent of the Nova Scotia total and 33 percent of the New Brunswick total. Results from previous surveys in Nova Scotia, not all on the same plots as surveyed in 1999, showed Black Ducks making up 48-57 percent of the common species and ring-necks, 21-27 percent. In

New Brunswick the previous surveys reported 35-50 percent of the common species were Black Ducks and 23-33 percent were ring-necks.

In the 1999 Nova Scotia survey results, 21 percent of the ducks of common species were Green-winged Teal and 5 percent were mergansers. In the 1999 New Brunswick survey results, 15 percent were green-wings and 19 percent were mergansers. Species composition on previous surveys showed green-wings making up 6 - 16 percent of the common species in Nova Scotia and 7 - 20 percent in New Brunswick. Mergansers were 6 - 13 percent of common species in Nova Scotia and 12 - 32 percent in New Brunswick.

3.1 Black Ducks

A total of 383 Black Ducks was recorded on the Nova Scotia survey and 300 on the New Brunswick plots. Two bird groups and single Black Ducks were considered pairs even though determination of the sex of Black Ducks was not always possible. The ratio of pairs of blacks to single ducks is used to indicate the stage of breeding chronology and should approach 1:1 during the survey. In 1999 the ratio was 1.4:1 in Nova Scotia and 0.8:1 in New Brunswick (Table 4). The suggestion of an "early" survey in Nova Scotia and a "late" survey in New Brunswick is difficult to explain given the spring chronology and dates of survey. The difficulty in determining sex of Black Ducks may have resulted in some post-breeding males in groups of two being considered pairs. The number of Black Ducks observed in flocks greater than two birds was 166 (43 percent of total blacks) in Nova Scotia and 55 (18 percent of total blacks) in New Brunswick.

Black Ducks were observed on all plots surveyed in both Nova Scotia and New Brunswick. The number of birds per plot ranged from 1 to 121 in the Nova Scotia plots and 1 to 38 in New Brunswick. The mean density of Black Ducks recorded on the Nova Scotia plots surveyed in 1999 was 36.8 indicated pairs per 100 km² and on the New Brunswick plots was 34.4 indicated pairs per 100 km² (Table 4). The mean density 1990 - 1999 on Nova Scotia plots was 21.6 indicated pairs per 100 km² and mean density 1992 - 1999 on New Brunswick plots was 20.4 indicated pairs per 100 km². The mean density

of observed blacks in Nova Scotia was 102 ducks per 100 km² and in New Brunswick was 60 ducks per 100 km² in 1999 (Table 4). Mean densities of total birds in Nova Scotia, 1990 - 1999, was 54.4 per 100 km² and in New Brunswick, 1992 - 1999, was 44.4 per 100 km².

Most recent analysis of Black Duck trends by Brian Collins (memo to BDJV, October 1998) was done using an estimating equations technique and included data from 1990 to 1998 (Appendix IV). Results from stratum 1 (data from Nova Scotia, New Brunswick and Gaspe) showed a statistically significant increase in total numbers of Black Ducks and in indicated pairs.

Data from Nova Scotia and New Brunswick also suggest an increase in each province since 1990 (Figures 2, 3). All data from each province are included and different plots were surveyed in different years causing variation due to spatial and habitat differences as well as differences over time.

3.2 Other species

A total of 123 Ring-necked Ducks were observed on the fifteen plots in Nova Scotia and 287 on the 20 New Brunswick plots (Tables 2, 3). Ring-necks were recorded on nine (60 percent) of the Nova Scotia plots and 15 (75 percent) of the New Brunswick plots. Mean density in Nova Scotia was 32.8 birds per 100 km² and in New Brunswick was 57.4 per 100 km². Mean density of ring-necks on Nova Scotia plots in previous years ranged from 12.5 (1990) to 54.1 (1997) birds per 100 km². The density range in New Brunswick in previous years was 11.5 (1992) to 38.8 (1998) ducks per 100 km².

Total Green-winged Teal recorded on the Nova Scotia plots in 1999 was 141 and total on the New Brunswick plots was 129 (Tables 2, 3). The mean density of observed green-wings on the Nova Scotia plots was 37.6 birds per 100 km² and on the New Brunswick plots was 25.8 birds per 100 km². These densities are the highest since the 1990 survey re-design. The recorded low densities are 3.4 in Nova Scotia (1995) and 2.4 in New

Brunswick (1991). Previous high densities are 26.9 in Nova Scotia (1998) and 16.8 in New Brunswick (1996). The numbers of ring-necks and teal are affected by weather and other factors which affect migration timing. Also, between year variation in the current survey design may be due to different plots being surveyed.

The surveys are timed for breeding Black Ducks and are too early to monitor Blue-winged Teal. Four birds were observed in Nova Scotia and four in New Brunswick in 1999. Habitat for this species is not abundant and not uniformly distributed and the changing plot design is likely to result in large between-year differences in numbers recorded. Mergansers (Common and Red-breasted) are consistently more numerous in New Brunswick than in Nova Scotia. The mean density in Nova Scotia in 1999 was 8.5 birds per 100 km² and in New Brunswick was 32.8. Densities of mergansers on Nova Scotia surveys 1990 - 1998 ranged from 5.8 (1991) to 18.1 birds per 100 km² (1997). Densities on the New Brunswick plots ranged from 4.4 (1992) to 38.0 birds per 100 km² (1997). Thirteen Mallards were recorded on the Nova Scotia survey in 1999 and 33 were recorded in New Brunswick.

4. Summary

1. Twenty plots 25 km² in area were flown in New Brunswick and 15 25 km² plots were flown in Nova Scotia between 30 April and 2 May 1999. These plots were part of the eastern Canada breeding waterfowl helicopter survey carried out as part of the Black Duck Joint Venture. Black Ducks were recorded on all plots surveyed in 1999.
2. Black Ducks made up 56 percent of the common species (Black Ducks, Ring-necked Ducks, Green-winged Teal and Common and Red-breasted Mergansers) in Nova Scotia and 34 percent in New Brunswick. Ring-necks accounted for 18 percent of the common species in Nova Scotia and 33 percent in New Brunswick.
3. Mean density of Black Ducks on the Nova Scotia plots was 36.8 indicated pairs per 100 km² in 1999, compared to the 1990 to 1999 average 21.6. Mean density in New Brunswick in 1999 was 34.4 indicated pairs per 100 km² compared to the 1992 to 1999 average 20.4.
4. Analysis of data (1990-1998) by B. Collins using an estimating equations technique showed a statistically significant increase in Black Duck numbers and indicated pairs in Nova Scotia, New Brunswick and Gaspe. Nova Scotia and New Brunswick data separately (1990-1999) suggest increases in Black Duck numbers in each province.

5. References cited

Erskine, A.J.; M.C.Bateman; R.I.Goudie; G.R.Parker. 1990. Aerial surveys for breeding waterfowl, Atlantic Region, 1985-1989. CWS Technical Report Series No. 85. 11pp.

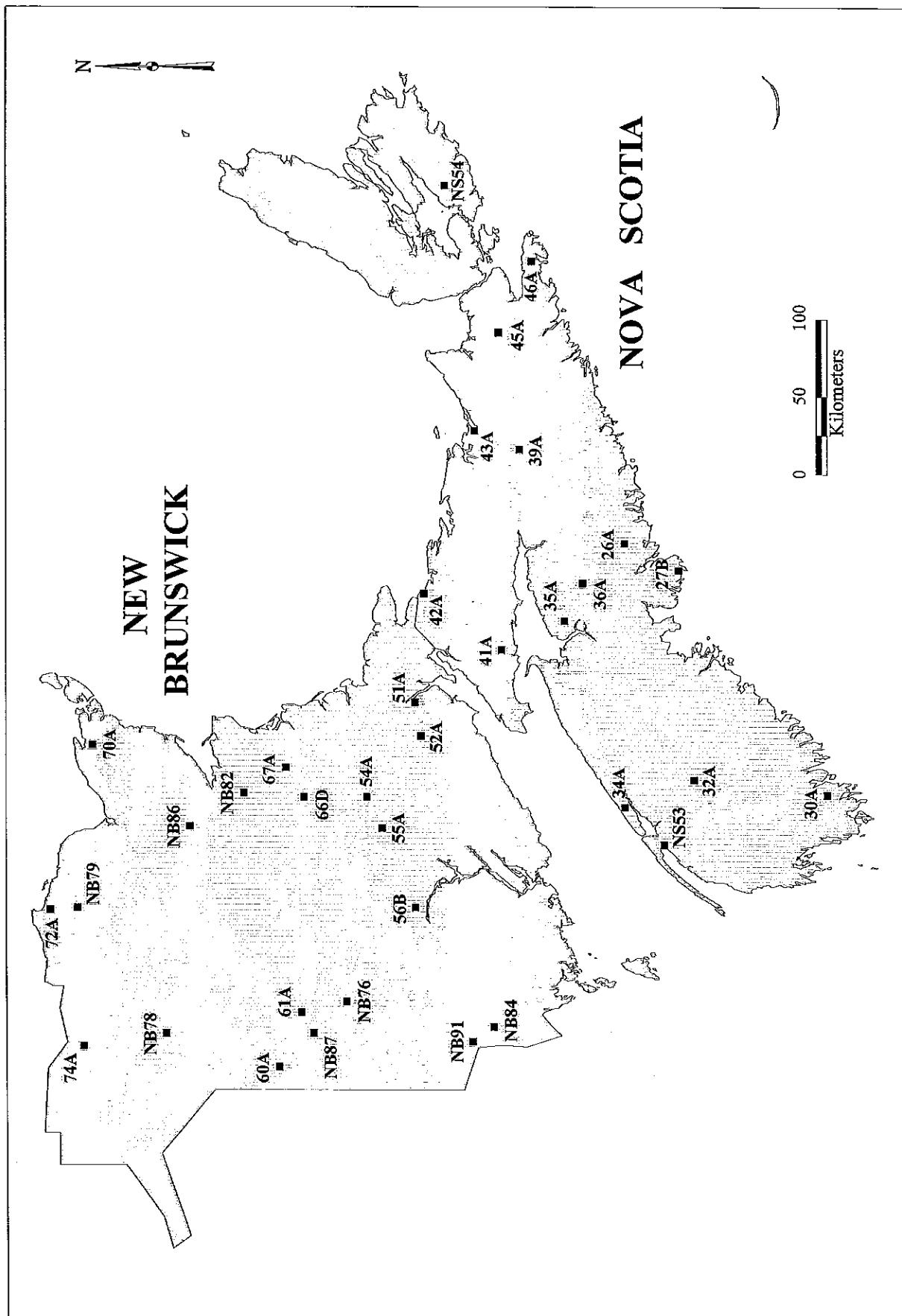
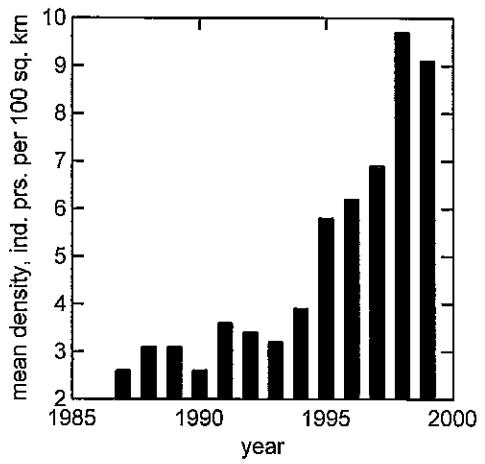


Figure 1. Approximate locations of the 5 km x 5 km blocks surveyed for breeding Black Ducks in Nova Scotia and New Brunswick in May, 1999.

Nova Scotia Black Ducks - ind. prs.



New Brunswick Black Ducks - ind. prs.

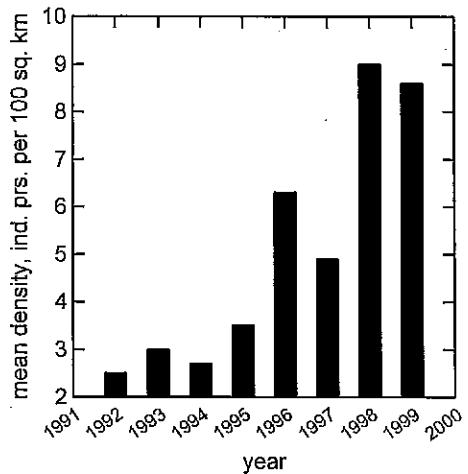
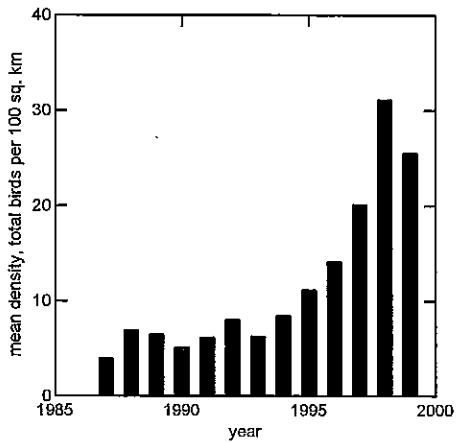


Figure 2. The mean number of indicated pairs of Black Ducks per 100 km² on helicopter breeding pair plots in New Brunswick and Nova Scotia, 1987-1999. (Data for 1987 to 1991 in New Brunswick are not included)

Nova Scotia Black Ducks - total birds



New Brunswick Black Ducks - total birds

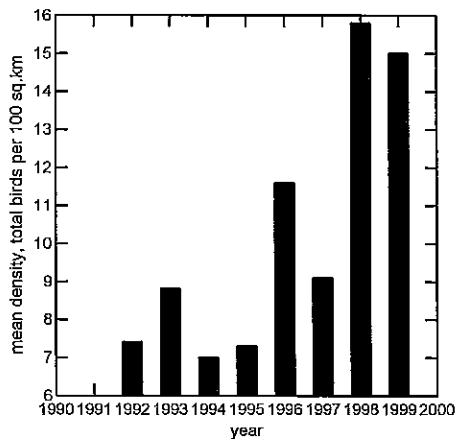


Figure 3. Mean densities of Black Ducks per 100 km² on helicopter breeding pair surveys in New Brunswick and Nova Scotia, 1987 - 1999. (Data in New Brunswick 1987 to 1991 are not included).

Table 2. The number of waterfowl recorded on 25 km² plots during the Nova Scotia breeding pair survey, May 1999

Plot #	Black Duck				Ring-necked Duck				Green-winged Teal				Wood Duck				Merganser (G&R-b)				Miscellaneous	
	P	P	S	F1	P	P	S	F1	Tot	P	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot
26A	5	9	14	33	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2 Mall; 10 Hood
27B	5	16	24	50	1	-	2	1	-	2	-	-	-	-	-	1	-	-	-	-	-	2
30A	3*	-	5	-	-	-	-	-	-	1	-	2	-	-	-	-	-	-	-	-	-	7 Mall
32A	6	2	7	21	-	-	-	-	-	1	-	1	-	-	-	-	-	-	1	1	2	2 Hood
34A	-	1	-	1	-	-	-	-	-	1	-	2	-	-	-	-	-	-	-	-	-	2 geese
35A	4	7	4	19	-	-	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	2 Mall
36A	-	1	9	10	-	-	5	5	-	-	-	-	-	2	-	-	-	-	-	-	6	6
39A	-	3	-	3	1	2	4	8	2	-	-	4	-	-	-	-	-	-	1	7	8	2 geese
41A	6	4	14	30	2	1	42	47	2	1	16	21	-	-	-	-	-	-	-	1	1	4 BWT; 2 wigeon
42A	24	2	71	121	2	-	5	9	8	2	85	103	-	-	-	-	-	-	-	-	-	1 Mall; 4 BWT; 4 shov
43A	9	3	17	38	-	-	-	-	-	1	-	1	-	-	2	1	-	-	-	-	-	1 Mall
45A	-	4	-	4	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	3	11
46A	3	-	-	6	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-
53	11	3	-	25	1	-	-	2	-	2	-	2	-	-	-	-	-	-	-	-	-	-
54	4	3	6	17	-	-	43	43	1	-	2	-	-	-	-	-	-	-	-	-	-	-
TOTAL	80	58	166	383	7	3	106	123	16	8	101	141	1	2	0	4	6	2	18	32		

*1 pair MBL

Table 3. The number of waterfowl recorded on 25 km² plots during the New Brunswick breeding pair survey, May 1999.

Plot #	Black Duck			Ring-necked Duck			Green-winged Teal			Wood Duck			Merganser (C&R-b)			Miscellaneous					
	P	S	F1	P	S	F1	P	S	F1	P	S	F1	P	S	F1	Tot	P	S	F1	Tot	
51A	6	7	10	29	-	-	3	1	-	7	-	-	-	-	-	8	8	2 hood			
52A	2	3	-	7	-	-	1	-	2	-	-	-	-	-	1	-	1				
54A	1	4	7	13	8	-	46	62	3	3	4	13	-	-	-	-	-	2 geese; 2 goldeneye			
55A	3	4	-	10	6	1	9	22	-	-	-	-	-	-	-	-	-	4 mall			
56B	3*	3	-	8	-	-	-	-	2	5	-	9	-	-	-	1	-	-	2	5 Mall; 2 goldeneye; 1 wigeon	
60A	5	8	-	18	4	-	19	27	-	1	-	1	1	4	4	10	-	-	-	4 mall; 5 hood; 2 geese; 2 bwt	
61A	5*	12	3	24	4	-	20	28	1	1	8	11	-	-	-	1	2	-	4	1 Mall; 16 geese; 2 wig; 3 geye	
66D	5	1	-	11	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-		
67A	5	2	-	12	-	-	14	14	2	-	4	8	1	1	-	3	2	-	4		
70A	5	7	-	17	5	1	3	14	2	5	13	22	-	1	-	1	-	-	-		
72A	1	1	-	3	3	1	13	20	2	-	8	12	-	1	-	1	3	2	-	8 goldeneye; 1 small	
74A	2	3	3	10	-	-	-	-	-	-	-	-	-	-	-	3	6	-	12	2 goldeneye	
76	2	2	-	6	1	-	3	5	-	-	-	-	-	-	-	-	2	-	2		
78	6	3	13	28	2	-	13	17	1	-	18	20	-	-	-	6	1	62	75	4 mall; 2 wigeon; 2 geese; 2 bwt	
79	-	1	-	1	-	-	-	-	-	1	-	1	-	-	-	1	-	1	3		
82	2	7	4	15	5	2	4	16	1	-	2	-	-	-	-	-	-	-	-		
84	8	4	-	20	2	1	8	13	-	1	-	1	-	-	-	1	3	8			
86	2	3	-	7	2	-	4	-	-	-	-	-	-	-	-	-	-	3 hood			
87	6	8**	3	23	2	1	-	5	4	2	8	18	-	-	-	1	23	24	14 mall; 4 geese		
91	6	14	12	38	8	1	20	37	1	-	2	-	1	2	3	4	1	4	13	10 hood; 2 geese	
TOTAL	75	97	55	300	52	8	175	287	23	20	63	129	2	8	6	18	2	129	101	164	

* 1 pair MBL

** 1 BD with 3 Mallards

Table 4. Results of Black Duck counts during the Nova Scotia and New Brunswick breeding pair survey 1999. Fifteen 25 km² plots were surveyed in Nova Scotia and twenty, in New Brunswick.

	Nova Scotia	New Brunswick
Number of pairs	80	75
Number of singles	58	97
Number in flocks	166	55
Total number	383	300
Number of indicated pairs	138	172
Mean number of indicated pairs per 100 km ²	36.8	34.4
Mean number of ducks per 100 km ²	102.1	60.0
Ratio of pairs:singles	1.4:1	0.8:1

Appendix I

Table i. The number of waterfowl recorded on 100 km² plots during the Nova Scotia breeding pair survey, May 1990.

Table ii. The number of waterfowl recorded on 100 km² plots during the New Brunswick breeding pair survey, May 1990.

Table iii. The number of waterfowl recorded on 100 km² plots during the Nova Scotia breeding pair survey, May 1991.

Table iv. The number of waterfowl recorded on 100 km² plots during the New Brunswick breeding pair survey, May 1991.

Table v. The number of waterfowl recorded on 100 km² plots during the Nova Scotia breeding pair survey, May 1992.

Table vi. The number of waterfowl recorded on 100 km² plots during the New Brunswick breeding pair survey, May 1992.

Table vii. The number of waterfowl recorded on 100 km² plots during the Nova Scotia breeding pair survey, May 1993.

Table viii. The number of waterfowl recorded on 100 km² plots during the New Brunswick breeding pair survey, May 1993.

Table ix. The number of waterfowl recorded on 100 km² plots during the Nova Scotia breeding pair survey, May 1994.

Table x. The number of waterfowl recorded on 100 km² plots during the New Brunswick breeding pair survey, May 1994.

Table xi. The number of waterfowl recorded on 100 km² plots during the Nova Scotia breeding pair survey, May 1995.

Table xii. The number of waterfowl recorded on 100 km² plots during the New Brunswick breeding pair survey, May 1995.

Table xiii. The number of waterfowl recorded on 25 km² plots during the Nova Scotia breeding pair survey, May 1996.

Table xiv. The number of waterfowl recorded on 25 km² plots during the New Brunswick breeding pair survey, May 1996.

Table xv. The number of waterfowl recorded on 25 km² plots during the Nova Scotia breeding pair survey, May 1997.

Table xvi. The number of waterfowl recorded on 25 km² plots during the New Brunswick breeding pair survey, May 1997

Table xvii. The number of waterfowl recorded on 25 km² plots during the Nova Scotia breeding pair survey, May 1998.

Table xviii. The number of waterfowl recorded on 25 km² plots during the New Brunswick breeding pair survey, May 1998.

Table i. The number of waterfowl recorded on 100 km² plots during the Nova Scotia breeding pair survey May 1990

Plot #	P	S	Black f1	Black Tot	Ring-necked Duck			Green-winged Teal			Blue-winged Teal			Merganser (C + R-B)			Miscellaneous			
					P	S	f1	Tot	P	S	f1	Tot	P	S	f1	Tot	P	S	f1	
26	7	17	24	55	8	2	12.4	34	-	-	-	-	-	-	-	1	-	-	2	
27	20	13	7	60	2	1	6	11	2	-	4	-	-	-	-	4	4	4	4	
28	25	5	3	18	1	-	2	-	-	8	-	-	-	-	3	-	5	11	1	
29	1	5	0	7	1	0	6.4.3	15	-	-	-	-	-	-	-	1	2	3	5	
30	10	7	20	47	1	-	2	4	1	2	4	5	-	-	-	1	-	-	2	
31	8	16	3	35	-	-	-	-	-	-	-	-	-	-	-	1	5	4	11	
32	3	2	5	13	-	2	2	4	-	-	-	-	-	-	-	5	2.3.4	21	5	
33	10	5	10	35	-	1	2.4.5	12	2	-	-	4	-	-	-	5	Wood D.	1 pr H	Merg. 7 geye	
34	7	9	11	34	1	1	-	3	4	-	15	23	-	-	-	1	1	4	7	
35	5	4	-	14	-	-	3	-	1	1	4	7	-	-	-	1	1	2	2	
36	4	2	3	13	2	-	3	-	1	1	4	7	-	-	-	1	1	2	2	
37	7	7	4	25	3	2	6.4.6.	38	-	-	-	-	-	-	-	1	1	2	2	
38	9	5	3	26	4	1	6.8	-	-	-	-	-	-	-	-	1	1	2	2	
39	3	1	-	7	4	-	4	9	-	-	-	-	-	-	-	1	2	2	2	
40	2	-	3	7	1	-	5	12	-	-	-	-	-	-	-	1	1	2	2	
41	12	7	10	41	3	2	3	11	7	4	8	26	1	2	-	1	1	5	8	
42	19	6	3	47	1	-	3	3	3	-	12.16	36	4	1	3	12	1	1	5	
43	6	4	6	22	-	2	2.4	8	1	1	4	7	2	1	4	8	1	2	2	
44	13	5	-	31	-	-	-	-	4	-	4.4	16	2	1	4	9	5	1	29	
Total	177	160	150	664	51	18	193	313	36	16	94	182	10	3	15	38	35	20	80	170

P = pairs
 S = singles
 F1 = flocks
 Tot = total

Total B.D.
 337

ave/plot
 13.5

ave/plot
 26.6

Total E.D.
 664

ave/plot
 21

Table ii. The number of waterfowl recorded on 100 km² plots during the New Brunswick breeding pair survey May 1990

P = pairs
 S = singles
 F1 = flocks
 Tot = total

Total ODEP 0.98 / 100% 9.6
24/1

Sept 26 1996

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Table iii. The number of waterfowl recorded on 100 km² plots during the Nova Scotia Breeding Pair Survey, May 1991.

Plot #	Black Duck			Ring-N Duck			Green-w Teal			Blue-w Teal			Merg. (CRB)			Miscellaneous			
				P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot
	P	S	F1	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot
26	6	14	24	50	4	1	35	44	-	-	-	-	-	-	2	-	6	10	
27	17	25	6	65	1	-	11	13	-	-	-	-	-	-	1	-	1	-	
28	6	9	-	21	1	-	2	-	-	-	-	-	-	-	1	-	1	-	
29	2	4	-	8	1	3	3	8	-	-	-	-	-	-	1	-	2	3	
30	7	6	7	27	-	-	4	4	-	2	1	3	-	-	1	-	2	4	
31	18	6	12	54	-	-	-	-	-	2	1	3	-	-	2	2	2	8	
32	5	4	-	14	1	-	1	2	-	-	-	-	-	-	1	1	1	3	
33	4	7	4	19	1	1	6	9	-	-	-	-	-	-	1	-	1	6	
34	7	5	11	30	1	-	-	2	1	3	22	27	2	2	7	1	-	2	
35	13	6	12	44	1	-	16	18	-	-	-	-	-	-	2	1	-	5	
36	5	6	3	19	1	-	-	2	-	-	-	-	-	-	2	-	-	4	
37	6	4	-	16	5	1	18	28	1	-	-	-	-	-	4	4	-	12	
38	12	9	4	37	2	-	3	7	-	-	-	-	-	-	2	2	6	12	
39	5	2	-	12	2	-	10	14	-	-	-	-	-	-	3	-	-	3	
40	1	-	-	2	-	2	-	2	-	-	-	-	-	-	1	1	-	3	
41	6	12	4	28	1	1	32	35	6	4	6	22	3	-	4	10	1	-	
42	16	5	24	61	3	-	5	11	9	2	16	36	12	3	-	27	2	1	
43	5	19	34	-	-	2	2	4	3	2	13	1	-	2	-	3	3	-	
44	13	9	38	73	2	-	2	6	7	-	41	55	-	-	7	-	1	14	
45	3	4	7	17	6	1	4	17	1	1	-	3	-	-	3	-	2	8	
46	11	13	4	39	3	-	19	25	1	2	3	7	1	-	2	-	3	7	
47	1	5	4	11	4	-	16	24	-	-	-	-	-	-	1	1	1	11	
48	14	19	18	65	6	3	26	41	2	6	6	16	-	-	1	-	1	14	
49	2	2	-	6	3	-	8	14	-	-	-	-	-	-	4	8	-	-	
50	8	10	13	39	-	-	-	-	4	1	4	13	2	-	4	-	-	-	
Total	193	191	214	791	49	12	220	330	38	23	103	202	23	4	10	60	38	17	51
																		144	

P = pairs
S = singles
F1 = flocks
Tot = total

Table iv. The number of waterfowl recorded on 100 km² plots during the New Brunswick Breeding Pair Survey, May 1991.

Plot #	Black Duck			Ring-N Duck			Green-w Teal			Blue-w Teal			Merg. (C&RB)			Miscellaneous				
				P	S	F1	P	S	F1	P	S	F1	P	S	F1	Tot	P	S	F1	Tot
	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot
51	1	4	-	6	2	-	2	1	-	5	1	-	1	-	-	2	-	-	-	
52	-	-	3	3	-	16	3	-	6	12	2	4	1	-	-	-	-	-	-	
53	7	2	-	16	5	1	14	25	2	5	2	9	-	1	-	2	-	-	-	
54	2	3	9	16	-	5	-	1	4	-	-	-	-	-	-	-	-	-	-	
55	1	3	-	5	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	
56	2	1	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
57	5	13	11	34	10	2	20	42	-	-	-	-	-	-	-	2	4	4	12	
58	10	7	4	31	-	7	20	27	-	-	-	-	-	-	-	4	1	4	13	
59	2	6	17	27	3	3	6	15	3	-	-	6	3	4	-	10	2	1	7	
60	13	8	3	37	4	1	38	47	2	-	5	2	-	4	8	4	2	12	22	
61	7	17	-	31	1	2	7	11	1	4	7	-	-	-	-	3	2	-	8	
62	2	1	-	5	-	8	-	8	-	-	-	-	-	-	-	1	-	-	2	
63	4	6	3	17	5	2	13	25	-	-	-	-	-	-	-	3	5	5	13	
64	1	2	-	4	1	-	-	2	-	-	-	-	-	-	-	1	1	-	3	
65	5	3	-	13	1	-	-	2	-	-	-	-	-	-	-	1	-	-	2	
66	2	3	-	7	1	-	-	2	-	-	-	-	-	-	-	1	-	-	2	
67	2	4	-	8	-	1	-	1	-	2	4	6	-	1	-	1	-	-	-	
68	3	1	7	14	2	-	11	15	1	-	2	-	-	1	-	3	2	1	71	
69	-	3	-	3	1	-	5	7	1	-	1	-	-	-	-	1	-	-	-	
70	1	5	-	7	4	2	8	18	2	1	-	3	-	-	-	-	-	-	-	
71	-	-	-	-	1	1	-	3	-	-	1	8	-	-	-	2	2	4	10	
72	4	3	3	14	4	1	22	31	1	-	2	-	-	-	-	1	-	3	5	
73	2	1	-	5	-	-	-	-	-	1	1	-	3	-	-	1	-	1	2	
74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	2	6	18	
75	5	1	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total	81	97	60	319	47	24	182	300	14	12	20	60	7	6	10	30	38	22	124	222

P = pairs
S = singles
F1 = flocks
Tot = total

Table V. The number of waterfowl recorded on 100 km² plots during the Nova Scotia breeding pair survey, May 1992.

Plot#	Black Duck			Ring-N Duck			Green-w Teal			Blue-w Teal			C. Merganser			MISCELLANEOUS				
	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot
26	25	11	20	81	24	3	32	83	-	-	-	-	-	-	-	-	2	-	-	4
27	24	19	30	97	5	3	10	23	-	-	-	-	-	-	-	-	6	2	-	14
28	3	6	6	18	2	2	-	6	1	-	2	-	-	-	-	-	1	-	1	1
29	8	7	-	23	2	1	-	5	1	1	1	-	-	-	-	-	2	1	-	5
30	11	8	23	53	2	1	9	13	1	2	3	7	-	-	-	-	1	1	-	3
31	9	12	4	34	-	-	3	3	4	1	-	8	-	-	-	-	2	1	-	5
32	3	4	-	10	5	1	8	19	-	-	-	-	-	-	-	-	3	3	-	9
33	3	8	16	30	1	1	3	5	-	-	-	-	-	-	-	-	2	4	1	11
34	11	5	7	34	4	-	8	6	-	14	26	-	-	-	-	-	-	-	-	-
35	7	6	80	100	5	1	5	16	3	-	7	13	-	-	-	-	-	-	-	10
36	4	4	13	25	3	-	7	13	-	-	-	-	-	-	-	-	2	2	-	6
37	10	8	9	37	9	4	15	37	1	-	2	-	-	-	-	-	2	-	8	12
38	8	11	-	27	3	5	6	17	-	-	-	-	-	-	-	-	1	6	2	8
39	4	1	-	9	7	-	6	20	-	-	-	-	-	-	-	-	1	-	1	5
40	1	-	-	2	1	1	-	3	-	-	-	-	-	-	-	-	2	-	-	2
41	9	5	86	109	7	9	30	44	4	2	23	33	4	-	5	13	-	-	3	3
42	28	18	75	149	7	1	3	18	18	2	120	158	8	-	19	35	2	-	22	26
43	9	7	13	38	1	-	29	31	3	2	13	21	2	1	8	13	2	-	-	3
44	10	2	38	60	-	-	-	-	6	1	16	29	-	-	-	4	3	-	11	13
45	1	4	-	6	9	2	8	28	1	4	3	5	-	-	-	4	5	-	4	5
46	13	12	4	42	6	1	24	37	9	2	3	23	-	-	-	-	2	-	-	4
47	1	3	6	11	2	2	15	21	1	-	2	-	-	-	-	-	2	4	1	6
48	10	10	6	36	5	1	94	105	1	2	-	4	-	-	-	-	1	3	12	17
49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50	12	7	3	34	3	-	36	42	3	3	12	-	-	-	5	5	1	-	-	2
Tot	224	178	439	1065	113	28	343	597	62	16	205	345	16	1	37	70	50	30	46	176

P = pairs
 S = singles
 F1 = flocks
 Tot = total

Table vi. The number of waterfowl recorded on 100 km² plots during the New Brunswick breeding pair survey, May 1992.

Plot #	Black Duck			Ring-N. Duck			Green-w Teal			Blue-w Teal			C. Merganser			MISCELLANEOUS				
	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot
51	4	6	-	14	-	-	-	-	3	2	-	8	-	-	-	1	-	-	2	
52	1	2	-	4	-	-	-	-	-	-	-	11	1	2	-	3	-	-	-	
53	12	4	-	28	4	1	-	9	4	3	-	12	-	-	-	-	-	-	-	
54	8	4	-	20	10	1	-	20	6	7	2	2	1	1	-	-	-	-	-	
55	3	-	-	6	1	-	-	-	2	2	-	6	-	-	-	-	-	-	-	
56	4	6	4	18	-	-	-	-	-	-	-	1	1	3	-	-	-	-	-	
57	11	8	6	36	18	-	17	53	1	-	1	3	-	-	-	-	-	-	-	
58	8	5	3	24	12	-	11	35	-	-	-	5	-	-	-	4	3	4	15	
59	19	12	-	50	13	5	8	39	4	1	3	12	-	-	-	3	-	-	6	
60	20	10	6	56	6	1	3	16	3	1	-	7	5	-	-	10	-	-	18	
61	7	7	6	27	5	2	5	17	2	2	-	6	-	-	-	1	-	-	1	
62	2	5	-	9	1	-	-	2	-	-	-	4	-	-	-	-	-	-	-	
63	8	6	6	28	13	1	10	37	2	-	-	4	-	-	-	-	-	-	-	
64	2	1	-	5	3	-	-	6	-	-	-	1	-	-	-	-	-	-	-	
65	6	2	-	14	-	-	-	-	-	-	-	2	-	-	-	1	-	-	2	
66	-	2	-	2	-	2	-	-	-	-	-	4	-	-	-	-	-	-	-	
67	7	4	3	21	-	1	3	4	2	2	-	6	-	-	-	1	-	-	11	
68	2	2	3	9	1	2	-	3	1	2	-	3	2	1	-	5	4	1	2	
69	5	4	3	17	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	
70	2	4	-	8	3	-	-	9	15	-	-	1	-	-	-	3	3	-	6	
71	4	4	3	15	5	1	6	17	-	-	-	1	-	-	-	-	-	-	8	
72	4	2	-	10	6	1	-	13	-	-	-	2	-	-	-	1	1	-	1	
73	1	6	-	8	-	-	-	-	-	-	-	1	-	-	-	1	1	-	3	
74	1	1	-	3	-	-	-	-	-	-	-	1	-	-	-	1	1	-	1	
75	2	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Tot	143	107	43	436	101	14	72	288	34	18	9	95	8	2	3	21	34	10	32	110

P = pairs
S = singles
F1 = flocks
Tot = total

Table vii. The number of waterfowl recorded on 100 km² plots during the Nova Scotia breeding pair survey, May 1993.

Plot #	Black Duck			Ring-n. Duck			Green-w. Teal			Blue-w. Teal			C. Merganser			MISCELLANEOUS				
	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot
26	10	10	22	52	10	3	28	51	-	-	-	-	-	-	-	-	-	-	-	2
27	17	15	34	83	-	2	8	10	1	-	4	6	-	-	-	-	2	2	-	6
28	6	7	8	27	-	-	8	10	-	-	-	-	-	-	-	-	1	4	3	9
29	4	3	-	11	1	-	-	-	-	-	-	-	-	-	-	-	3	3	-	9
30	11	4	9	35	-	5	5	6	-	-	12	-	-	-	-	-	2	-	3	7
31	15	5	10	45	-	-	5	5	2	1	-	5	-	-	-	-	-	-	1	1
32	6	9	7	28	-	2	-	10	-	3	1	-	7	-	-	-	3	1	-	7
33	12	5	-	29	-	-	-	-	7	3	14	31	1	-	-	-	6	3	-	15
34	10	10	15	45	-	-	-	-	7	3	14	-	4	-	-	-	2	-	-	-
35	10	6	9	35	-	-	-	-	5	5	2	-	-	-	-	-	-	-	-	2
36	3	6	-	12	-	1	3	4	-	1	1	3	6	-	-	-	1	2	4	8
37	2	6	11	21	12	4	2	30	-	-	-	-	-	-	-	-	3	2	3	11
38	10	3	17	40	6	1	3	16	-	-	-	-	-	-	-	-	2	1	9	14
39	4	1	-	9	9	-	8	26	-	-	-	-	-	-	-	-	2	-	-	4
40	1	2	-	4	1	-	2	-	9	7	34	59	5	1	12	23	-	1	-	1
41	12	21	15	60	10	-	23	43	9	7	34	59	5	1	1	3	2	-	3	-
42	8	4	-	20	4	1	-	9	4	4	-	12	1	1	3	6	-	4	4	-
43	5	2	-	12	1	-	-	2	1	-	7	9	1	-	4	6	-	6	1	54
44	4	1	14	23	-	-	-	-	4	-	14	22	-	-	-	-	-	-	-	67
45	4	5	3	16	10	-	-	20	1	-	2	-	-	-	-	-	-	-	-	10 Wig.
46	8	11	6	33	-	-	20	20	4	1	-	12	-	-	-	-	-	-	-	47 Elder
47	4	2	7	17	4	1	7	16	-	-	-	-	-	-	-	-	-	-	-	1 pr. Mall., 1 Mall.
48	7	8	7	29	1	-	32	34	1	-	-	2	-	-	-	-	-	-	-	3 Bl. x 1 M, 22 Geye
49	1	1	-	3	4	1	2	11	1	-	2	-	1	-	1	-	-	-	-	-
50	9	4	3	25	1	-	52	54	2	1	5	10	-	1	-	1	-	-	-	-
Tot	183	151	197	714	78	16	206	378	49	19	84	201	8	3	19	38	38	25	84	185

P = pairs
 Fl = flocks
 S = singles
 Tot = total

Table viii. The number of waterfowl recorded on 100 km² plots during the New Brunswick breeding pair survey, May 1993.

Plot #	Black Duck			Ring-n. Duck			Green-w. Teal			Blue-w. Teal			C. Merganser			Mall., 1 pr. Wig., 1 Geye 3 Bl., 1 M., 4 Bl. x 1 M. 1 pr. Bl. x M., 4 Bl. x 1 M. 1 pr. Mall., 1 pr. Wig. 1 Mall., 3 Geye	
	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	
51	7	4	8	26	-	-	-	5	3	-	13	3	1	-	7	-	2
52	4	2	5	15	-	-	-	-	-	-	-	-	-	-	-	-	7
53	4	7	-	15	5	1	9	20	5	2	-	12	1	-	-	-	1 pr. Mall.
54	12	6	6	36	5	1	9	20	-	-	-	-	-	-	-	-	1 Geye
55	1	5	-	7	3	1	13	20	-	-	-	-	-	-	-	-	1
56	2	4	-	8	-	1	-	1	-	-	3	-	-	-	-	-	5
57	9	11	6	35	19	8	21	67	-	1	-	1	-	-	2	1	26
58	9	12	15	45	11	-	12	34	1	1	-	3	-	-	7	1	15 Geye
59	9	11	-	29	16	-	8	40	-	1	-	1	-	-	-	-	1 pr. Bl. x M., 4 Bl. x 1 M.
60	16	11	14	57	27	3	34	91	1	4	9	15	4	3	7	18	1 pr. Mall., 1 pr. Wig.
61	12	16	4	44	2	-	5	9	3	2	3	11	-	-	-	-	1 pr. Mall., 3 Geye
62	2	2	-	6	3	-	7	15	-	1	-	3	-	-	-	-	5
63	5	9	7	26	4	-	1	1	-	1	-	3	-	-	-	-	1 pr. Wig., 1 pr. Wig.
64	2	1	-	5	1	-	7	9	-	1	-	1	-	-	-	-	2
65	5	5	3	18	-	-	-	-	-	1	-	3	-	-	-	-	1
66	1	2	3	7	-	-	-	-	-	1	-	1	-	-	-	-	1
67	6	9	-	21	2	-	1	5	-	4	-	13	-	-	-	-	2
68	5	7	4	21	-	-	4	4	-	5	-	8	16	1	-	-	1 pr. Wig., 1 pr. Wig.
69	2	6	-	10	-	-	-	6	-	3	2	8	1	-	-	-	1 Geye
70	4	5	5	18	3	-	6	15	3	2	-	8	1	-	-	-	14 Geye
71	6	3	3	18	3	6	3	17	-	11	17	-	-	-	-	-	5 Wig., 4 Geye
72	4	6	3	17	3	-	-	-	-	-	3	-	-	-	-	-	1
73	3	2	4	12	-	-	-	-	-	-	-	-	-	-	-	-	1
74	4	5	-	13	-	-	-	3	3	-	-	-	-	-	-	-	6
75	3	8	-	14	-	-	-	3	3	-	-	-	-	-	-	-	26
Tot	137	159	90	523	107	21	137	372	27	33	23	110	12	5	7	36	53
																	55
																	196

P = pairs

F1 = flocks

S = singles

Tot = total

Table ix. The number of waterfowl recorded on 100 km² plots during the Nova Scotia breeding pair survey, May 1994.

Plot #	Black Duck			Ring-n. Duck			Green-w. Teal			Wood Duck			C. Merganser			MISCELLANEOUS				
	P	S	Fl	Tot	P	S	Fl	Tot	P	S	Fl	Tot	P	S	Fl	Tot	P	S	Fl	Tot
26	22	21	46	111	10	1	23	44	1	1	-	3	-	-	1	2	1	6	11	1 Mal x 3 Bl., 3 Hood
27	24	17	20	85	3	-	6	1	1	-	3	-	-	-	-	1	-	1	-	2 Mal, 1 Mal x 1 Bl.
28	9	11	7	36	-	3	3	-	-	-	-	-	-	-	-	2	-	-	-	1 Mal
29	4	9	13	30	3	-	11	17	-	-	-	-	-	-	-	6	3	-	-	1 pr. Mallard
30	8	5	12	33	1	-	9	11	1	1	3	6	-	-	-	3	-	2	8	3 Mal
31	14	8	3	39	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	2
32	4	9	4	21	-	3	-	3	-	1	-	1	2	2	-	6	2	-	-	1 Hood
33	8	7	9	32	-	-	-	-	-	5	5	-	4	8	12	3	2	-	-	7 Hood
34	4	12	13	33	-	-	-	-	2	4	-	8	-	3	3	-	-	-	-	29 Surf., 5 Buff., 1 pr BW, 1 pr Wig, 19 Eider, 1 Goose
35	7	6	12	32	-	3	3	1	1	6	9	-	1	4	5	-	-	5	5	1 pr. Geese
36	6	3	-	15	3	-	6	12	-	-	-	2	-	2	-	-	1	2	3	1 Hood, 4 pr. Geese
37	6	5	8	25	6	4	2	18	1	-	-	1	1	6	9	3	2	-	2	3
38	6	9	11	32	3	2	3	11	-	-	-	1	2	-	4	-	1	-	-	8
39	3	4	6	16	6	-	11	23	-	-	-	-	-	-	-	1	1	-	-	3
40	2	1	4	9	1	-	2	-	-	-	-	-	-	-	-	1	2	-	-	4
41	4	10	3	21	11	2	6	30	5	1	13	24	-	-	-	1	-	-	-	2
42	8	9	5	30	1	-	5	7	12	1	33	58	6	6	24	42	-	3	-	3
43	6	1	-	13	5	-	9	19	4	2	3	13	1	1	4	7	1	-	-	2
44	2	13	30	47	-	3	3	8	-	7	23	-	-	-	-	6	3	39	54	
45	5	6	3	19	7	-	6	20	3	-	6	-	-	-	-	3	2	-	8	
46	8	9	6	31	4	3	4	15	6	5	2	19	-	-	-	-	-	-	54 Eider	
47	2	4	-	8	1	-	12	14	-	3	3	-	-	-	-	2	-	-	-	1 pr. Mal
48	8	11	3	30	9	3	23	44	-	1	4	5	-	-	-	6	4	5	21	
49	-	1	3	4	-	-	9	9	-	-	-	-	-	-	-	1	1	-	3	
50	11	2	14	38	1	-	6	8	9	1	17	36	-	-	-	-	1	-	1	1 Mal x 1 Bl., 1 pr. BW
Tot	182	193	235	792	75	19	154	323	54	20	96	224	11	20	49	91	43	31	64	181

P = pairs

S = singles

Fl = flocks

Tot = total

Table x. The number of waterfowl recorded on 100 km² plots during the New Brunswick breeding pair survey, May 1994.

Plot #	Black Duck			Ring-n. Duck			Green-w. Teal			Wood Duck			Merganser (C+R-b)			Miscellaneous		
	P	S	F1	P	S	F1	P	S	F1	P	S	F1	P	S	F1	P	S	F1
51	5	10	32	52	-	-	1	5	21	28	-	-	3	3	-	-	-	1 pr Wig, 10 BW
52	2	2	6	25	2	1	4	9	1	-	2	-	-	-	1	-	-	1 pr BW
53	4	6	11	25	6	-	13	25	1	2	-	4	1	-	-	-	-	1 pr Mal
54	3	3	4	13	1	1	1	1	-	-	-	-	-	-	-	-	-	-
55	1	3	-	5	1	-	3	-	-	-	-	-	-	-	-	-	-	1 Mal x 1 Bl.
56	3	2	-	8	1	-	2	1	-	-	2	-	4	4	-	-	-	1 pr Pin
57	10	7	7	34	19	3	45	86	-	-	1	-	5	2	-	-	-	4 7 11 1 Mal x 1 Bl, 4 Hood
58	10	10	7	37	5	1	11	22	-	1	-	1	-	4	4	-	-	1 Mal x 1 Bl, 1 Geye, 5 Hood
59	13	10	6	42	15	2	11	43	-	3	-	3	2	6	14	24	2	3 2 9 1 Mal x 1 Bl, 1 Hood, 1 pr Geye, 14 BW
60	17	16	13	63	15	4	19	53	2	3	-	7	2	5	9	18	1	1 0 3 3 Mal, 1 Hood, 1 pr Geye, 10 7 Geye
61	6	19	-	31	4	2	5	15	4	4	-	12	-	-	5	5	1	4 4 10
62	3	9	-	15	2	-	3	7	2	-	4	-	-	2	2	1	2 17 21	
63	8	9	-	25	7	5	-	19	3	5	-	11	-	2	-	2	9	8 8 34 1 Mall, 29 Geye
64	-	1	-	1	1	-	2	-	-	1	2	-	-	4	4	1	2 2 6 1 pr. Hood	
65	4	5	-	13	-	-	-	-	-	1	-	2	-	2	-	2	-	1 - 1
66	4	2	3	13	-	-	-	-	-	1	-	5	-	1	-	1	-	2 - 2
67	2	9	5	18	-	-	-	-	2	1	-	5	-	1	6	7	3 4 31 41 36 Wig, 2 pr BW	
68	3	2	3	11	1	-	2	-	2	1	-	3	-	-	3	-	-	1 BW
69	5	6	3	19	-	2	2	-	3	-	4	-	-	3	3	-	-	13 Geye, 1 pr Hood
70	4	2	4	14	3	4	14	2	-	3	-	3	-	-	-	-	1 - 1	
71	12	5	3	32	-	2	2	4	1	1	-	8	-	1	-	1	1 - 3 1 pr Geye, 5 Wig, 2 pr BW	
72	4	4	3	15	8	2	18	36	4	-	-	-	-	4	4	1	-	2
73	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	5	7 8 25 1 Mall, 1 pr. Geye	
74	3	2	-	8	-	-	-	-	2	-	4	-	-	-	-	6	7 6 25 1 pr. Geye	
75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Tot	126	145	104	501	92	27	137	348	27	30	23	107	6	18	71	101	38	53 94 223

P = pairs

S = singles

F1 = flocks

Tot = total

Table xi. The number of waterfowl recorded on 100 km² plots during the Nova Scotia breeding pair survey, May 1995.

Plot #	Black Duck						Ring-necked Duck						Green-winged Teal						Wood Duck						C. Merganser						Miscellaneous					
	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot				
27	22	40	26*	110*	2	2	5	11	2	-	-	4	-	-	-	-	-	-	-	4	1	-	9	1 Mall x 2 Blk; 1 Mall x 2 Blk 8-16 Blk; 5-16 Blk												
29	4	20	4	32	5	1	7	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	5										
32	7	4	-	18	-	2	-	2	-	-	-	-	-	-	-	-	2	4	6	2	-	-	-	4	6 Hood											
33	7	12	9	35	-	-	-	-	-	-	-	-	-	-	-	-	2	2	5	11	2	5	-	9												
36	5	5	11	26	1	2	17	21	1	-	-	2	-	-	-	-	-	-	-	-	2	4	-	8	1 pr Geese											
39	5	2	-	12	4	-	11	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	7	13										
40	3	-	-	6	-	-	8	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	6										
45	8	10	-	26	1	-	19	21	3	2	4	12	-	1	3	4	2	2	2	-	6															
47	5	6	4*	20*	3	-	12	18	1	-	-	2	-	-	-	-	-	-	-	-	-	1	-	1	1	1	2	5	1 pr Mall; 3 Bwt; 30 Unk							
50	13	5	13	44	-	-	40	40	2	-	10	14	-	-	-	-	-	-	-	-	1	1	2	5												
Total	79	104	67*	329*	16	7	119	158	9	2	14	34	2	5	12	21	17	21	11	66																

* Includes blacks in flocks with mallards.

P = Pairs

S = Singles

F1 = Flocks

Tot = Total

Table xii. The number of waterfowl recorded on 100 km² plots during the New Brunswick breeding pair survey, May 1995.

Plot #	Black Duck				Ring-necked Duck				Green-winged Teal				Wood Duck				Merganser (C.& R-b)				Miscellaneous
	P	S	F	Tot	P	S	F	Tot	P	S	F	Tot	P	S	F	Tot	P	S	F	Tot	
52	1	5	6	13	-	-	-	-	-	-	-	-	-	-	-	2	1	2	7	1 Mall	
53	9	4	3	25	1	-	2	2	3	-	7	-	1	2	3	-	-	-	-	1 Hood	
56	9	7	4*	29*	-	-	-	-	3	1	-	7	-	2	-	2	1	2	-	4	1 pr Wig; 1 Hood; 1 Mall; 2 Mall x 1 Blk
58	7	12	12	39*	7	-	20	34	1	-	2	1	1	-	3	6	9	3	24	7 Hood; 1 Mall x 1 Blk	
60	14	24	23	76*	6	-	58	70	3	4	6	16	-	1	-	1	1	4	15	21	2 pr Wig; 1 pr Geese; 9 Hood; 5 Bwt; 1 Mall x 1 Blk
62	3	5	4	15	-	4	4	1	4	-	6	-	-	-	-	2	1	3	8	1 Goose; 1 pr Mall	
65	5	1	6	17	-	-	2	2	-	-	3	3	-	-	-	3	4	-	10	1 Hood; 5 Geese	
71	6	4	4	20	2	-	6	10	-	-	-	-	-	-	-	1	2	10	14	4 Geye; 2 Hood	
73	6	4	4	20	-	-	-	-	2	1	-	5	-	1	-	1	-	-	-	2 Hood	
Total	60	66	66*	254*	16	-	90	122	12	13	9	46	1	6	2	10	16	23	33	88	

* include blacks in mixed pairs and flocks

P = Pairs

S = Singles

F = Flocks

Tot = Total

Table xiii. The number of waterfowl recorded on 25 km² plots during the Nova Scotia breeding pair survey, May 1996.

Plot #	Black Duck				Ring-necked Duck				Green-winged Teal				Wood Duck				Merganser(C.&R-b)				Miscellaneous				
	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	
27B	5	7	15	32	-	2	-	2	-	-	-	-	-	-	-	-	1	3	2	7	2	7	2	Eider	
29A	1	4	12	18	2	-	17	21	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	4	
32A	6	4	3	19	-	-	2	2	-	-	4	4	-	1	-	1	-	1	-	1	-	-	-	1	
33A	2	8	-	12	-	-	-	-	-	2	-	2	-	-	-	-	-	1	2	-	4	-	-	-	
36A	-	3	4	7	-	-	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2 Geese	
39A	1	2	-	4	1	-	10	12	-	-	-	-	-	-	-	-	-	4	1	2	11	-	-	-	
40A	-	-	-	-	-	-	14	14	-	-	-	-	-	-	-	-	-	1	-	-	2	-	-	-	
45A	2	3	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	6	-	-	-	
47A	-	2	-	2	-	-	12	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
50D	3	3	-	9	1	-	10	12	2	-	28	32	-	-	-	-	-	-	-	-	-	-	-	2 Bwt	
51	5	3	28	41	-	-	-	-	1	-	8	10	-	-	-	-	-	1	-	-	-	-	-	2	
52	4	3	-	11	2	-	17	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3 Geese	
53	4	3	7	18	-	-	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	
54	3	1	-	7	2	1	37	42	1	-	-	2	-	-	-	-	3	-	-	6	-	-	-	6 Geese; 11 Bwt	
55	4	7	10	25	3	-	41	47	6	-	2	14	-	1	-	1	3	-	6	12	-	-	-	-	
Total	40	53	79	212	11	3	164	189	11	2	42	66	-	2	-	2	19	7	10	55	-	-	-	-	
P = Pairs				S = Singles				F1 = Flocks				Tot = Total													

Table XIV. The number of waterfowl recorded on 25 km² plots during the New Brunswick breeding pair survey, May 1996

Plot #	Black Duck			Ring-necked Duck			Green-winged Teal			Wood Duck			Merganser (C. & R-b)			Miscellaneous				
	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot
52A	-	4	3	7	-	-	-	-	-	-	-	3	-	1	-	1	-	1	1	1 Mall
53A	4	5	8	21	1	-	7	9	3	1	-	7	-	-	-	-	-	-	-	5 Mall
56B	2	4	4	12	2	-	-	4	-	4	2	6	-	1	-	1	-	-	-	4 Wig
58A	5	4	-	14	8	-	6	22	-	-	6	6	-	-	-	1	-	-	-	2
60A	4	2	-	10	3	-	-	6	6	1	3	16	2	-	-	4	-	-	-	16 Bwt; 2 Geese; 2 Hood
62B	2	5	6	15	1	-	-	2	-	2	3	5	-	1	-	1	-	3	-	3
65A	-	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3 Geese
71A	3	2	3	11	-	-	-	1	-	-	2	-	-	-	-	-	-	-	-	3 Hood
76	2	4	3	11	-	1	3	4	-	-	-	-	-	-	-	-	3	3	-	9
77	5	3	-	13	-	-	-	-	-	-	7	7	-	-	-	-	2	-	11	15
78	5	2	-	12	-	-	6	6	-	-	15	15	-	-	-	-	-	4	6	10
79	2	6	4	14	1	-	-	2	2	-	-	4	-	-	-	-	-	-	-	6 Hood
80	3	1	-	7	1	-	7	9	1	-	4	6	-	-	-	-	-	-	-	13 Hood; 15 Geye; 1 Bwt
81	1	2	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2 Geye
82	1	2	9	13	3	1	4	11	-	1	-	1	-	-	-	-	-	-	-	2 Hood
83	-	-	4	4	-	-	6	6	-	-	2	-	-	3	3	2	-	-	4	2 Hood
84	5	8	-	18	-	-	4	4	1	-	-	2	-	-	1	1	1	1	-	3
85	5	4	3	17	-	-	-	-	1	-	-	2	-	-	1	1	1	-	-	-
86	2	5	-	9	-	-	4	4	-	3	-	3	-	-	-	-	-	-	-	-
87	4	5	-	13	-	-	-	-	-	-	2	-	2	-	-	2	-	25	29	1 Mall x 1 Blk; 2 Bwt
Total	55	71	47	228	20	2	47	89	15	14	40	84	2	3	6	13	12	16	50	90

P = Pairs S = Singles F1 = Flocks Tot = Total

Table xv. The number of waterfowl recorded on 25 km² plots during the Nova Scotia breeding pair survey, May 1997.

Plot #	Black Duck			Ring-necked Duck			Green-winged Teal			Wood Duck			Merganser(C.&R.-b)			Miscellaneous				
	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot
28A	5	3	-	13	-	-	37	37	-	1	-	1	-	-	-	-	-	-	-	-
29A	1	5	-	7	2	1	11	16	-	-	-	-	-	-	-	2	2	-	6	
31C	7	5	14	33	-	-	-	1	-	-	2	-	-	-	-	-	-	-	130 Eider; 10 Scaup	
33A	1	-	3	5	1	-	2	-	-	-	-	-	-	-	-	-	-	-	4 Hood; 6 Eider; 2 Geese	
37A	1	3	-	5	6	-	7	19	-	-	-	-	-	-	-	-	-	-	1 Hood; 2 Geese	
38A	3	5	6	17	3	-	4	10	-	-	-	-	-	-	-	1	1	-	3	
40A	-	1	-	1	-	1	-	1	-	-	-	-	-	-	-	1	-	-	1	
44A	8	6	46	68	-	-	28	28	2	1	53	58	-	-	-	-	43	43	5 Mall; 15 Wig; 16 Bwt; 8 Geese	
47A	1	-	-	2	1	-	5	7	-	-	-	-	-	-	-	-	-	-	-	
48A	7	8	-	22	-	-	29	29	-	-	-	-	-	-	-	-	-	-	-	
49A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6 Geese	
50D	6	3	7	22	1	-	12	14	2	-	4	8	-	-	-	-	-	4	4	
51	9	5	65	88	-	-	-	-	-	1	10	11	-	-	-	-	-	3	3 Mall; 465 Eider; 2 Bwt	
52	-	2	-	2	3	1	-	7	-	-	-	-	-	-	-	2	1	-	5	
55	6	2	3	17	4	-	25	33	8	1	-	17	-	-	-	3	-	-	6 Geye; 4 Bwt; 6 Geese; 6 Wig	
Total	55	48	144	302	21	3	158	203	13	4	67	97	-	-	-	8	5	47	68	

P = Pairs S = Singles
F1 = Flocks Tot = Total

Table xvi. The number of waterfowl recorded on 25 km² plots during the New Brunswick breeding pair survey, May 1997.

Plot #	Black Duck			Ring-necked Duck			Green-winged Teal			Wood Duck			Merganser (C. & R-b)			Miscellaneous				
	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot				
53A	1	2	19	23	4	1	-	9	2	3	2	9	-	-	-	-	2 Mall			
57B	8	2	-	18	2	-	28	32	-	-	-	1	-	2	-	-	2 Wig			
58A	4	6	-	14	3	-	6	-	2	-	2	1	-	2	1	1	1 Wig; 2 Hood			
59A	8	3	-	19	2	1	23	28	1	2	-	4	-	1	4	5	3 Hood; 1 Geye; 2 Bwt			
62B	4	4	3	15	-	1	-	1	2	1	-	5	-	1	2	3	3 Geye			
63A	1	2	-	4	3	-	3	9	-	-	3	3	-	-	-	-	11 Geye			
64A	-	1	-	1	1	-	-	2	-	-	-	-	-	-	-	-	-			
65A	1	3	-	5	-	1	-	1	1	-	3	-	-	-	-	-	3			
68A	8	6	-	22	-	-	-	2	-	5	9	-	1	-	1	3	58			
69A	1	3	-	5	1	-	5	7	-	-	-	-	-	-	-	-	18 Wig			
71A	3	3	3	12	1	-	-	2	-	1	-	1	-	-	-	-	2 Hood			
75A	-	-	-	-	-	-	-	1	-	-	2	-	-	-	-	-	2			
77	4	1	-	9	-	1	-	1	1	-	2	-	-	-	3	-	8 Mall; 8 Geye; 1 Unk			
80	1	3	3	8	2	-	23	27	2	-	4	-	-	-	2	1	28			
81	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	33 Geye			
83	-	1	-	1	-	-	42	42	1	-	2	-	-	-	1	4	5 Geye			
85	4	2	-	10	-	2	-	2	1	1	-	3	-	-	1	-	1 BDMH; 1 Unk			
88	2	3	4	11	-	-	2	2	1	-	-	2	-	-	1	-	8 Mall			
89	1	-	-	2	-	-	-	-	1	-	-	2	-	-	-	-	4 Mall			
90	1	-	-	2	-	-	-	-	-	1	-	1	-	-	-	-	-			
Total	53	45	32	183	19	7	126	171	16	12	10	54	2	3	6	13	22	10	136	190

P = Pairs S = Singles F1 = Flocks Tot = Total

Table xvii. The number of waterfowl recorded on 25 km² plots during the Nova Scotia breeding pair survey, April 1998.

Plot #	Black Duck			Ring-necked Duck			Green-winged Teal			Wood Duck			Merganser(C.&R-b)			Miscellaneous		
	P	S	Fl	P	S	Fl	P	S	Fl	P	S	Fl	Tot	P	S	Fl	Tot	
26A	3	7	22	35	-	-	5	5	-	-	-	-	-	-	-	12	12	
28A	5	4	6	20	-	-	8	8	-	-	-	-	-	-	-	-	10 Geye; 4 Hood	
30A	2	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	1 Mall	
31C	14	6	10	44	-	-	8	8	-	14	14	-	-	-	-	-	1 Mall	
34A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2 Buff	
35A	5	6	25	41	1	-	2	4	-	10	10	2	-	5	9	-	-	
37A	6	5	-	17	-	1	15	16	-	-	-	-	1	-	-	-	4 Hood; 2 Geese; 2 Geye	
38A	4	5	3	16	-	1	-	1	1	4	7	-	-	-	-	4	4 Geese	
41A	6	3	4	19	3	1	25	32	3	-	6	-	-	2	2	1	1 Wig	
42A	18	4	92	132	2	1	18	23	5	2	39	51	-	1	6	7	-	2 Mall; 2 Wig; 4 Bwt; 2 Hood; 60 Brant
43A	4	2	6	16	-	-	-	-	-	-	-	-	-	-	-	4	1 9	
44A	7	8	47	69	-	-	-	-	2	-	7	11	1	1	-	3	5 7	
46A	5	4	8	22	1	-	4	6	1	-	2	-	-	-	-	-	*3 Mall	
48A	4	*10	14	32	1	1	11	14	-	-	-	-	-	-	-	-	2 Geye	
49D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total	83	64	237	467	8	5	96	117	12	3	74	101	3	3	13	22	10 4 17 41	

* 1 pr MLBL
P = Pairs S = Singles
Fl = Flocks Tot = Total

Table xviii. The number of waterfowl recorded on 25 km² plots during the New Brunswick breeding pair survey, May 1998.

Plot #	Black Duck			Ring-necked Duck			Green-winged Teal			Wood Duck			Merganser (C. & R-b)			Miscellaneous		
	P	S	F1	P	S	F1	P	S	F1	P	S	F1	P	S	F1	P	S	F1
51A	3	8	12	26	1	-	2	3	2	6	14	-	-	-	-	-	-	2 Bwt
54A	2	-	6	1	1	10	13	1	1	4	7	-	-	-	-	-	-	2 Hood; 8 Geye
55A	3	5	11	22	3	-	4	10	-	-	-	-	-	-	1	-	1	2 Geese
57B	9	3	-	21	1	-	37	39	-	-	-	-	-	-	-	-	-	2 Wig
59A	3	8	-	14	3	2	7	15	-	-	-	-	-	-	1	1	-	3 Hood
61A	10	*17	3	40	3	1	4	11	2	2	6	-	-	-	-	-	-	*3 Mall; 3 Geye; 5 Geese
63A	5	2	-	12	6	1	12	25	-	-	-	-	-	-	3	1	7	16 Geye
64A	1	-	-	2	-	-	4	4	-	-	-	-	-	-	-	1	-	1
66D	6	2	-	14	-	7	7	-	-	-	-	-	-	-	-	-	-	2 Wig
67A	4	4	-	12	-	-	6	6	1	1	-	3	-	1	-	1	-	2 Wig
68A	4	5	3	16	1	-	-	2	3	1	-	7	-	-	3	1	18	25
69A	3	.5	-	11	1	-	-	2	-	1	-	1	-	-	-	-	-	1 Mall; 2 Geese
70A	3	6	-	12	1	-	6	8	2	1	-	5	-	-	-	-	-	27
72A	3	9	5	20	1	1	21	24	5	-	-	10	-	-	-	-	-	4 Wig; 2 Geye; 6 unk
74A	2	1	-	5	-	-	-	-	-	-	-	-	-	-	4	1	6	15
75A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
88	4	4	3	15	1	-	6	8	-	1	-	1	-	-	1	-	4	6
89	-	-	3	3	-	-	-	-	-	1	-	1	-	-	1	-	-	2
90	6	2	-	14	-	-	-	-	1	-	-	2	-	-	-	-	-	1 Mall
91	16	10	7	49	2	14	18	-	2	-	-	2	-	-	2	2	-	2 Geese
Total	87	93	47	314	25	6	138	194	18	13	10	59	-	1	2	3	14	870 106

* 1 pr MLBL
P = Pairs
S = Singles
F1 = Flocks
Tot = Total

Appendix II

List of pilots and observers on the New Brunswick and Nova Scotia helicopter surveys
1990-1999.

	New Brunswick	Nova Scotia
1990		
primary observer/navigator	W.R.Barrow	M.C.Bateman
secondary observer	R.J.Hicks	J.W.Maxwell
pilot	D.Wilton	G.Fisher
1991		
primary observer/navigator	W.R.Barrow	M.C.Bateman
secondary observer	R.Daury	R.J.Hicks
pilot	R.Folk	G.Fisher
1992		
primary observer/navigator	W.R.Barrow	M.C.Bateman
secondary observer	R.Daury	G.Boyd
pilot	R.Folk	R.Folk
1993		
primary observer/navigator	M.C.Bateman	M.C.Bateman
secondary observer	R.W.Daury	G.Boyd
pilot	R.Folk	R.Folk
1994		
primary observer/navigator	M.C.Bateman	M.C.Bateman
secondary observer	L.Willett	G.Boyd
pilot	R.Folk	R.Folk
1995		
primary observer/navigator	M.C.Bateman	M.C.Bateman
secondary observer	R.J.Hicks	R.J.Hicks
pilot	R.Moores	R.Moores
1996		
primary observer/navigator	M.C.Bateman	M.C.Bateman
secondary observer	R.J.Hicks	R.J.Hicks
pilot	C.Swannell	C.Swannell
1997		
primary observer/navigator	M.C.Bateman	M.C.Bateman
secondary observer	R.J.Hicks	R.J.Hicks
pilot	C.Swannell	C.Swannell
1998		
primary observer/navigator	M.C.Bateman	M.C.Bateman
secondary observer	R.J.Hicks	R.J.Hicks
pilot	C.Swannell	C.Swannell

Appendix II con't

	New Brunswick	Nova Scotia
1999		
primary observer/navigator	M.C.Bateman	M.C.Bateman
secondary observer	R.J.Hicks	R.J.Hicks
pilot	C.Swannell	C.Swannell

Appendix III

Table III-i. The number of waterfowl recorded on 25 km² plots during the Gaspe breeding pair survey, May 1996.

Table III-ii. The number of waterfowl recorded on 25 km² plots during the Gaspe breeding pair survey, May 1997.

Table III-iii. The number of waterfowl recorded on 25 km² plots during the Gaspe breeding pair survey, May 1998.

Table III-iv. The number of waterfowl recorded on 25 km² plots during the Gaspe breeding pair survey, May 1999.

Table III-1. The number of waterfowl recorded on 25 km² plots during the Gaspe breeding pair survey, May 1996

Plot #	Black Duck			Ring-necked Duck			Green-winged Teal			Wood Duck			Merganser (C&R-b)			Miscellaneous				
	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	2Mall;14geye; 4Hood; 2 unk			
1A2	2	-	-	4	2	-	-	30	34	1	1	3	6	-	1	-	-	3	3	
1A3	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
1B6	2	2	-	6	1	-	-	2	-	3	4	7	-	1	-	2	-	-	4	
1B8	4	1	-	9	1	1	4	7	1	-	-	2	-	-	1	-	-	2	2 Mall; 9 Hood	
TOTAL	8	4	-	20	4	1	34	43	2	4	7	15	-	2	-	2	3	-	3	9

Table III-2. The number of waterfowl recorded on 25 km² plots during the Gaspé breeding pair survey, May 1997

Plot #	Black Duck			Ring-necked Duck			Green-winged Teal			Wood Duck			Merganser (C&R-h)			Miscellaneous				
	P	S	Fl	Tot	P	S	Fl	Tot	P	S	Fl	Tot	P	S	Fl	Tot	P	S	Fl	Tot
1B6	5	1	-	11	1	-	7	9	1	-	2	-	-	-	-	-	-	-	-	2 HarD
1B8	2	9	-	13	3	-	6	12	-	3	3	6	-	-	-	-	3	3	3	3 Mall; 4 Geye; 3 Hood
1C1	-	-	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
1C5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	7	10	-	24	5	-	13	23	1	3	8	-	-	-	-	-	3	3	3	3

Table III-3. The number of waterfowl recorded on 25 km² plots during the Gaspé breeding pair survey, May 1998

Plot #	Black Duck			Ring-necked Duck			Green-winged Teal			Wood Duck			Merganser (C&R-b)			Miscellaneous		
	P	S	Fl	Tot	P	S	Fl	Tot	P	S	Fl	Tot	P	S	Fl	Tot	-	4 Geye
IC1	-	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-
IC5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ID4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2
ID7	2	2	3	9	2	-	-	6	1	1	-	3	-	-	-	-	-	2 Hood
TOTAL	2	2	3	9	3	-	8	1	1	-	3	-	-	-	-	2	-	2

Table III-4. The number of waterfowl recorded on 25 km² plots during the Gaspe breeding pair survey, May 1999

Plot #	Black Duck			Ring-necked Duck			Green-winged Teal			Wood Duck			Merganser (C&R-b)			Miscellaneous		
	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot	P	S	F1	Tot		
1A2	1	2	-	4	8	2	11	29	5	1	-	11	-	-	-	1	-	2
1A3	1	-	-	2	-	-	-	-	-	1	-	1	-	-	-	-	-	1 Mall
1D4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1D7	-	3	-	3	3	1	4	11	2	-	4	-	1	-	1	-	-	1 Mall
TOTAL	2	5	-	9	11	3	15	40	7	2	-	16	-	1	-	1	-	2

Appendix IV

Analysis of waterfowl data from eastern Canada helicopter surveys 1990 - 1998 by Brian Collins, CWS National Wildlife Research Centre.

Memorandum - Note de Service

1998/Oct/26

To: Myrtle Bateman (CWS- Atlantic Region)
Daniel Bordage (CWS -Quebec Region)
Brigitte Collins (CWS - Ontario Region)
Kathy Dickson (CWS -HQ)
Scott Gilliland (CWS- Atl)
Ken Ross (CWS - Ontario Region)

From: Senior Biostatistician
Migratory Bird Populations Division
National Wildlife Research Centre

Subject: ANALYSIS OF 1998 BLACK DUCK BREEDING GROUND SURVEY

This report describes the analysis of the 1998 Black Duck Breeding Ground Survey. The survey is based on a rotating sample in which a portion of the plots are retained from one year to the next while other plots are discarded and replaced. The sample is divided into 4 rotation groups A, B, C, and D. In each year two of the rotation groups are visited. In the first year groups A and B are visited, in the second year groups B and C are surveyed, in the third year groups C and D are done and in the fourth year groups D and A are surveyed. The survey then repeats this 4 year cycle. The plots assigned to each rotation cycle are given in Table 1.

The survey was substantially redesigned for the 1996 field season. The redesign involved reducing the plot size from 10 km by 10 km to 5 km by 5 km and substantially increasing the number of plots surveyed. The smaller plot size has been used since 1996. Many of the 5 km by 5 km plots were selected as a portion of a previously run 10 km by 10 km plots. For the years 1990-1995 the observations taken on the 5 km by 5 km portion of the original plots which are currently being run have been identified. The analysis done this year is based on the plots run at least once between 1996 and 1998 along with the observations made on these 5 km by 5 km plots for the years 1990-1995.

DATA EDITING

The data files were created by appending the 1998 data to a previously created data file covering the years 1990-1997. Hence, any if any editing was done this year to previous years data, it isn't reflected here. In 1998, no waterfowl were recorded on Plot 5 in Quebec Stratum 1. Hence there were no entries for this plot in the database. An artificial entry was created to indicate to the analysis program that this plot had been run.

This year represents the first time that all plots in the new sampling scheme have been surveyed at least once. This has allowed Table 1 which summarises the rotation group assignments assembled from the data files. Examination of the data files revealed some departures from the rotation design. The design called for rotation groups C and D to be run this year. In Newfoundland however, groups A and D were run. The departure of Newfoundland from the strict rotation schedule doesn't have any serious consequences for the data analysis for this year. The resulting variance of the annual indices and trends will be comparable since there still are two rotation groups which have been run twice in the last 3 years. In order to recover from this discrepancy in subsequent years, the Newfoundland survey should run rotation groups C and D in the 1999 season and return to the standard rotation pattern in subsequent years.

The data set consists of counts of number on males, females and unknown sex birds on individual wetlands. These numbers were converted to indicated pairs and total individuals using the scheme described in Table 2. In previous years total individuals was calculated as the sum of males, females and unknown sex birds. This year the calculation of total individuals has been modified to incorporate the number of indicated pairs.

The data analysis is based on the number of indicated pairs and total individuals seen on a plot in a year.

TREND ESTIMATION

A test for trend was done using the estimating equations technique (Link and Sauer, 1994). This approach to estimating trend has been developed to address some difficulties in analysing data using the route-regression technique. Notably it eliminates the need to add an arbitrary constant to each observation to accommodate taking logarithms of zero counts and it bases the expected value on the observed bird counts rather than the logarithm on the counts.

The data for the trend estimates was selected using the same criteria used in route-regression analyses done previously. The data for Ontario 1990 was discarded due to changing survey methodology. The data for Nova Scotia and New Brunswick was partitioned into two subsets (1990-1992) and (1993-1998) due to a change in observer in 1993. The number of plots available for analysis in each year is shown in Table 3. Appendix A includes a description of the estimating equation technique, some extensions to the approach which enable annual indices to be calculated and a description of the algorithms used to implement the calculations.

Within each stratum the plots were given equal area weight. Across strata, however, the area weight was given by the area of the stratum divided by 25 and then divided by the number of plots in the stratum. The area of each stratum and the corresponding area weighting factors are shown in Table 4.

The resulting estimates of trend for indicated pairs and total individuals are given in Table 5. The annual indices for the trend are shown in Figures 1-12.

POPULATION ESTIMATION

A set of population estimates was also made using the same data set. The estimates were made separately for each year using the standard equations for analysis of a stratified random sample. The results for indicated pairs and total individuals are shown in Tables 6 and 7 respectively.

This analysis fails to take into account the pattern of visits to the same plots in different years. Taking this pattern into account, would provide a more precise population estimates which would be more stable over time. An alternate population estimate could be developed based on an analysis using the theory of rotating samples. This more complicated approach has not been undertaken but will be evaluated for inclusion in future reports. An alternate approach to calculating a population estimate would be to multiply the annual index estimated from the trend calculation by the area weight factor given in Table 2. The appropriateness of performing this extrapolation will be evaluated in subsequent analysis of the data.

Brian Collins

REFERENCE

Link, W.A. and Sauer, J.R. (1994) Estimating equations estimates of trends, Bird Populations, 2, 23-32.

Table 1: Plots assigned to each rotation group

Stratum	Province	Rotation Group	Plots
1	New Brunswick	A	52 56 60 76 78 79 82 84 86 87
		B	53 58 62 65 71 77 80 81 83 85
		C	57 59 63 64 68 69 75 88 89 90
		D	51 54 55 61 66 67 70 72 74 91
	Nova Scotia	A	27 32 36 39 45 53 54
		B	29 33 40 47 50 51 52 55
		C	28 31 37 38 44 48 49
		D	26 30 34 35 41 42 43 46
	Quebec	A	2 3
		B	6 8
		C	1 5
		D	4 7
2	Newfoundland	A	1 5 6 10 14 16 17 21 24 38
		B	7 19 28 31 33 34 36 37
		C	3 4 13 15 20 25 26 27 29 30 35
		D	2 8 9 11 12 18 22 23 32
	Quebec	A	9 13 14 20 28 30 31 35 39 40 41
		B	1 6 11 12 16 17 18 23 25 32 43
		C	2 3 5 7 8 10 15 22 24 38 44
		D	4 19 21 26 27 29 33 34 36 37 42
	Quebec	A	2 3 12 14 16 18 19 21 22 29 35 42 43 45 48 56 58 61 64 73
		B	6 8 9 11 17 23 24 32 36 38 40 49 50 55 62 63 65 69 75 78
		C	5 10 20 26 27 28 31 33 41 46 51 52 54 57 60 66 67 68 70 72
		D	1 4 7 13 15 25 30 34 37 39 44 47 53 59 71 74 76 77 79 80
4	Quebec	A	2 4 11 13 21 23
		B	1 6 7 10 12 18
		C	3 5 8 9 22 24
		D	14 15 16 17 19 20
	Ontario	A	7 11 12 13 14 18 23 25 32 35
		B	1 5 6 17 21 24 27 36 37 44
		C	3 4 8 15 19 20 28 29 40 42
		D	2 9 10 16 22 26 30 31 33 34

Table 2: Calculation of Indicated Pairs and total individuals

Species Group(a)	Males	Females	Unknown	Indicated Pairs	Total Individuals
1	1	0	0	1	2
	1	1	0	1	2
	2	1	0	1	3
	2	0	0	2	4
	3	0	0	3	6
	4	0	0	4	8
	otherwise			0	$m+f+u$
2	1	0	0	1	2
	0	1	0	1	2
	1	1	0	1	2
	2	1	0	1	3
	2	0	0	2	4
	3	0	0	3	6
	4	0	0	4	8
otherwise			0		$m+f+u$
3	1	0	0	1	2
	0	1	0	1	2
	0	0	1	1	2
	1	1	0	1	2
	0	1	1	1	2
	1	0	1	1	2
	otherwise			0	$m+f+u$

(a) Species Groups

- 1 AGWT AMWI BUFF BWTE COGO COME HOME MALL WODU
- 2 GRSC LESC REDH RNDH RUDU
- 3 ABDU CAGO

Table 3: Number of plots used in trend analysis. Plots selected were those surveyed at least once in 1996, 1997 or 1998 and which were surveyed at least twice during 1990-98

Stratum	Year										Overall
	90	91	92	93	94	95	96	97	98		
1	47	50	52	48	48	20	29	37	37	65	
2	46	46	44	36	37	22	34	34	28	64	
3	38	37	38	18	19	17	29	40	32	61	
4	9	49	49	29	29	14	28	32	29	57	
Range-wide	140	182	183	131	133	73	120	143	126	247	

Table 4: Stratum area and area weights used in the analysis

Stratum	Nfld	Area (1000 Sq km)					Area Weight
		NS	NB	Que.	Ont.	Overall	
1		52.8	72.1	48.0		172.9	106.4
2	60.3			105.3		165.6	103.5
3				233.5		233.5	153.1
4				117.0	230.0	347.0	243.5

Table 5 Estimated trends 1990-98. The analysis was based on the 5 km by 5 km sub-plots from the 1990-95 plots which correspond to the 5 km by 5 km plots were run in 1996-1998.

Indicated Pairs

Species	Range-wide	Stratum 1	Stratum 2	Stratum 3	Stratum 4
Common Merganser	155 -5.9n	30 8.7	35 9.2	46 -11.2n	44 -6.1
Hooded Merganser	80 0.2			23 6.2	46 -0.4
Mallard	71 0.1			15 16.1	48 -0.6
Black Duck	210 -1.4	47 12.7*	53 -4.6	58 -0.8	52 -6.1*
American Wigeon	13 9.1				
Green-winged Teal	120 2.3	27 30.7*	30 3.0	28 -11.6	35 -3.3
Blue-winged Teal	20 -2.3				12 -5.1
Wood Duck	37 4.4	12 33.6			21 2.9
Ring-necked Duck	169 1.0	36 1.0	37 4.9	48 -3.0	48 1.5
Common Goldeneye	132 0.0		46 0.3	43 -2.0	37 4.0
Bufflehead	19 -28.9*				14 -28.1*
Canada Goose	61 3.8		37 5.1	13 -5.5	10 0.8

Total Individuals

Species	Range-wide	Stratum 1	Stratum 2	Stratum 3	Stratum 4
Common Merganser	170 -7.1*	34 -7.4	39 6.6	51 -9.3n	46 -7.7*
Hooded Merganser	89 3.8*			27 1.1	47 4.4*
Mallard	105 1.2		14 16.6n	31 6.4	52 0.9
Black Duck	226 4.0n	53 16.0*	57 0.1	60 2.8	56 -2.1
American Wigeon	15 -2.1				
Green-winged Teal	136 -4.0	31 8.6	33 -4.3	35 -18.0*	37 -7.3
Blue-winged Teal	21 -12.2				13 -14.6
Wood Duck	43 3.9	16 8.8			21 3.4
Ring-necked Duck	179 -5.3*	41 4.3	39 -6.9	50 -10.7	49 -5.5n
Common Goldeneye	139 0.6		47 -5.0	44 -8.2	40 8.7
Bufflehead	28 -21.8*				22 -18.0*
Canada Goose	90 -10.5*		48 4.4	24 -25.6*	13 -6.8

Table entries show the number of plots and the observed trend as an annual percentage change.

Trends which were significant at $p<0.05$ level are marked with an *

Trends which were close to significant $0.05 < p < 0.10$ are marked with an n

Table 6: Estimated number of indicated pairs and standard error

Black Duck

Year	--Stratum 1--	--Stratum 2--	--Stratum 3--	--Stratum 4--	-----Total-----
1990	13096	2181	16128	2601	34411
1991	17567	2599	14400	2507	36098
1992	14231	1933	12796	2007	28266
1993	16137	2370	8832	1644	27501
1994	17002	2821	10205	2516	18188
1995	16253	5379	9936	2208	18680
1996	22876	2240	9239	1566	24284
1997	19253	2621	13745	2938	28020
1998	27664	3917	14143	1866	31756
					3758
					44676
					6401
					118239
					8598

Mallard

Year	--Stratum 1--	--Stratum 2--	--Stratum 3--	--Stratum 4--	-----Total-----
1990	883	399	0	3441	1020
1991	968	441	144	1767	873
1992	665	284	151	2212	959
1993	432	318	184	2594	1264
1994	432	243	0	1475	1073
1995	346	345	602	601	1648
1996	1419	725	349	348	4904
1997	1869	951	331	230	4437
1998	1241	429	179	179	4203
					1563
					38170
					9803
					43793
					9938

Ring-necked Duck

Year	--Stratum 1--	--Stratum 2--	--Stratum 3--	--Stratum 4--	-----Total-----
1990	11330	2647	8064	1614	18680
1991	9406	1844	8928	1779	21457
1992	7847	1682	8581	2009	12781
1993	7781	1899	10856	2647	26463
1994	9510	2089	7340	1946	17205
1995	10374	3897	6323	1766	21427
1996	8689	2131	4532	1144	12376
1997	11776	1962	8942	2671	23817
1998	10640	2102	10742	2615	19614
					3037
					28628
					6001
					69623
					7516

Common Merganser

Year	--Stratum 1--	--Stratum 2--	--Stratum 3--	--Stratum 4--	-----Total-----
1990	5150	1079	3600	787	25316
1991	6363	1274	4752	998	34836
1992	4788	1128	4817	1276	23842
1993	5907	1947	1472	651	26982
1994	3746	983	3222	1074	16714
1995	5187	1493	4516	1402	17581
1996	9576	1989	4009	917	13777
1997	7103	1523	5134	1194	25218
1998	6916	1979	6803	1459	17513
					2894
					16483
					3859
					47714
					5414

Table 6 continued

Hooded Merganser

Year	--Stratum 1--	--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	2207	867	432	243	8111	2389	12338	5396	23088 5969
1991	277	193	1296	669	7321	2201	36258	8149	45151 8470
1992	266	186	301	210	3933	1476	35125	5331	39625 5539
1993	0	0	552	406	9340	3110	34939	10290	44831 10758
1994	1009	458	0	0	9340	3708	51691	15720	62040 16158
1995	2766	1267	301	301	9889	3345	32717	14220	45674 14666
1996	2305	890	1395	869	4904	1797	30363	6176	38966 6551
1997	1308	524	828	677	5838	1849	43809	7950	51783 8207
1998	1241	559	1611	697	7005	1520	31230	9420	41088 9584

Green-winged Teal

Year	--Stratum 1--	--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	5003	1433	3744	1242	5653	1632	24676	11277	39076 11551
1991	6224	1730	3888	1097	8078	1581	10481	2232	28671 3418
1992	4921	1408	5269	1167	6882	2871	11047	3076	28120 4588
1993	2882	959	5336	2261	3632	1337	11008	3601	22858 4559
1994	4178	1041	4476	1255	7374	3237	13401	4099	29429 5472
1995	6224	1934	4516	2192	4395	1624	14871	5336	30007 6298
1996	8867	1994	2615	769	8173	1675	24724	5593	44378 6218
1997	9907	2130	4802	1158	5371	1330	16049	4906	36128 5632
1998	8867	2010	7340	1912	5604	1695	11711	2792	33522 4285

Wood Duck

Year	--Stratum 1--	--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	736	377	0	0	1475	826	3084	3083	5295 3214
1991	830	468	0	0	505	351	30026	10476	31361 10493
1992	1729	652	0	0	492	342	30876	7879	33096 7913
1993	865	441	0	0	0	0	37332	12857	38197 12865
1994	1441	501	0	0	1475	1073	50255	21046	53171 21080
1995	3112	1275	0	0	4945	1979	32717	21988	40774 22114
1996	1951	564	174	174	701	699	24724	8575	27549 8623
1997	1308	646	331	230	1168	494	34266	16017	37073 16039
1998	2660	1355	0	0	934	651	19085	11166	22679 11267

Common Goldeneye

Year	--Stratum 1--	--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	3237	1701	15984	2118	14747	2622	20049	6980	54018 7936
1991	1107	796	13824	2774	19942	4009	23794	4060	58667 6394
1992	1596	859	10388	2007	15485	2684	31726	5540	59194 6531
1993	1441	1025	14352	4030	25944	6978	18666	5023	60403 9550
1994	288	201	8951	2307	22121	5936	22495	5650	53856 8516
1995	692	475	11743	3012	12636	3915	17846	6573	42916 8236
1996	1596	1253	10633	2122	14244	1827	35568	7971	62040 8541
1997	3551	1455	14242	2833	14711	2790	33399	7671	65902 8762
1998	2660	1178	16112	3515	12843	3247	21254	4445	52869 6636

Table 6 continued

Bufflehead

Year	--Stratum 1--	--Stratum 2--	--Stratum 3--	--Stratum 4--	-----Total-----
1990	0	0	2704	924	13880 8957 16584 9004
1991	0	0	3029	1808	8215 3153 11244 3635
1992	133	132	0	737	413 9064 2443 9935 2481
1993	144	144	0	519	518 1436 798 2099 962
1994	0	0	0	492	491 4308 1959 4799 2019
1995	0	0	0	549	549 1983 1346 2532 1454
1996	0	0	0	467	325 6073 1962 6540 1989
1997	0	0	0	934	651 2603 972 3537 1170
1998	177	177	0	0	0 0 177 177

Canada Goose

Year	--Stratum 1--	--Stratum 2--	--Stratum 3--	--Stratum 4--	-----Total-----
1990	294	205	6768	1472	3933 1146 6169 4079 17164 4490
1991	138	138	8208	1719	2019 895 4249 1860 14615 2690
1992	133	132	5721	1206	3687 1194 3399 1540 12940 2296
1993	288	201	10120	2677	7264 3814 3829 2565 21502 5323
1994	0	0	10026	2555	3933 2700 5743 3040 19702 4802
1995	0	0	6323	2063	3296 2255 2974 1579 12594 3440
1996	0	0	5578	1331	4670 1492 4338 2365 14586 3097
1997	0	0	10433	2291	2802 1066 9976 4233 23211 4930
1998	355	354	17187	4539	4437 1106 3904 1281 25882 4857

Blue-winged Teal

Year	--Stratum 1--	--Stratum 2--	--Stratum 3--	--Stratum 4--	-----Total-----
1990	1177	567	0	246	245 3084 3083 4507 3145
1991	1798	758	0	0	0 5665 1892 7463 2038
1992	2128	878	0	0	0 5099 2048 7227 2228
1993	1153	627	0	0	0 1914 904 3067 1100
1994	1297	568	0	0	0 957 664 2254 874
1995	0	0	0	0	0 1983 1346 1983 1346
1996	2483	1422	0	0	0 5205 3159 7688 3464
1997	748	446	0	0	0 3470 2411 4218 2452
1998	887	452	0	467	466 2169 1098 3522 1275

American Wigeon

Year	--Stratum 1--	--Stratum 2--	--Stratum 3--	--Stratum 4--	-----Total-----
1990	2060	1184	0	0	3084 2040 5145 2358
1991	968	521	0	0	567 396 1535 654
1992	931	569	0	246	245 283 283 1460 681
1993	1729	1188	0	0	0 1436 798 3165 1431
1994	2594	1749	0	0	0 2393 1549 4987 2336
1995	346	345	0	0	0 2974 2973 3320 2993
1996	532	530	0	0	0 1735 824 2267 980
1997	2617	1719	0	701	699 2603 1311 5920 2272
1998	2837	1493	0	0	0 868 866 3705 1726

Table 7: Estimated number of total individuals and standard error

Black Duck

Year	--Stratum 1--	--Stratum 2--	--Stratum 3--	--Stratum 4--	-----Total-----
1990	99326	25555	41472	8188	9530
1991	77183	12204	39312	9234	80274
1992	80997	10331	33421	6060	68575
1993	76796	9312	28888	8142	110523
1994	80975	11449	29002	9430	48175
1995	78842	17766	22883	4640	57688
1996	103208	10425	24753	3991	75187
1997	94394	12111	41234	7693	86862
1998	166516	28523	40639	6149	98304
					11380
					161355
					20691
					466814
					37537

Mallard

Year	--Stratum 1--	--Stratum 2--	--Stratum 3--	--Stratum 4--	-----Total-----
1990	2943	1181	1440	765	14010
1991	2766	1306	1584	773	11612
1992	1729	730	2860	895	12535
1993	865	637	5520	1833	29577
1994	865	487	3760	1526	18680
1995	1037	756	9936	3219	29668
1996	3724	1910	3312	1079	20081
1997	4486	2142	6458	1505	30822
1998	2660	935	358	357	9807
					3531
					92823
					23839
					105648
					24119

Ring-necked Duck

Year	--Stratum 1--	--Stratum 2--	--Stratum 3--	--Stratum 4--	-----Total-----
1990	48559	10938	41472	13951	71279
1991	47720	8836	44640	10868	48719
1992	38836	8030	30711	6244	53091
1993	52158	11727	40848	11068	89249
1994	42937	8897	24169	7840	58006
1995	54636	15659	17463	6476	60985
1996	59229	12893	19349	6397	48802
1997	76450	14059	22190	7170	68883
1998	59761	10937	25959	5450	44132
					6674
					72003
					14645
					201854
					20207

Common Merganser

Year	--Stratum 1--	--Stratum 2--	--Stratum 3--	--Stratum 4--	-----Total-----
1990	22955	6732	9216	1863	64888
1991	29600	10610	13248	2636	82293
1992	13433	3042	12345	2852	14497
1993	30978	10356	3680	1353	58989
1994	12823	5912	7519	2263	67974
1995	11757	3052	11140	3119	46700
1996	21457	4772	13945	4413	9385
1997	26356	10873	11261	2790	43404
1998	22876	5822	17724	3208	9533
					58609
					7960
					58990
					12682
					158198
					16382

Table 7: continued

Hooded Merganser

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	5297	1901	1152	690	24825	6579	33929	13703	65203	15335
1991	1107	746	2736	1370	25496	5353	99993	23090	129331	23754
1992	1330	569	903	508	11798	3862	112456	17468	126487	17906
1993	1873	957	1472	877	31133	9452	105297	27253	139775	28875
1994	2449	1222	358	357	23104	8750	158902	40934	184814	41878
1995	5879	2617	2710	1548	39008	11123	89229	34955	136825	36808
1996	8335	3186	3138	2020	14944	5306	111908	19566	138324	20621
1997	2991	1211	1987	1383	14711	4285	121884	21607	141572	22104
1998	3192	1288	5371	2244	22183	4308	126655	37813	157400	38146

Green-winged Teal

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	49736	25354	14400	6328	34902	8014	112582	31998	211621	42083
1991	21578	7217	20592	11558	23729	4328	37958	10456	103856	17713
1992	36176	15609	14302	3043	21138	7651	26060	6912	97676	18953
1993	25071	9195	11960	4765	7783	2848	25367	8706	70181	13826
1994	27088	8363	10026	3304	16222	6533	32546	11459	85881	15964
1995	16253	5379	9635	4599	9889	3531	30734	10900	66511	13467
1996	34048	7623	8367	2770	44132	11521	102365	33009	188912	35891
1997	33645	11465	12420	3165	15411	3140	38604	10578	100080	16224
1998	32275	10097	16470	4303	12376	3442	24724	5696	85844	12836

Wood Duck

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	1913	1042	0	0	3933	1881	6169	6167	12014	6531
1991	2213	993	0	0	1010	703	67700	24694	70923	24724
1992	5320	1761	0	0	983	684	65434	17137	71737	17241
1993	4178	1532	0	0	0	0	78494	26197	82672	26242
1994	6772	1771	0	0	4916	3996	108647	47362	120335	47563
1995	7953	3371	0	0	10439	4374	69400	44659	87792	44999
1996	4256	1231	349	348	2102	1685	52484	18104	59190	18227
1997	3365	1639	662	461	3036	1175	78509	35666	85571	35726
1998	6207	3027	0	0	2802	1424	44676	23207	53685	23447

Common Goldeneye

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	8093	3609	55872	12247	38097	6428	64773	23584	166836	27578
1991	15907	12499	40896	9084	50739	9615	74216	13894	181757	22896
1992	4788	2719	32518	6681	42522	6975	85546	16714	165374	19495
1993	3026	2051	39376	11878	71088	17581	49298	13193	162787	25069
1994	720	423	31509	8875	47192	12223	61263	19200	140684	24434
1995	1383	951	28001	7267	29668	8774	65434	20226	124487	23233
1996	6384	3961	27193	4771	32690	4300	159620	63603	225887	64049
1997	7103	2909	33451	6654	52538	12806	87184	20733	180275	25428
1998	8867	3600	42608	9368	36193	9309	69834	20491	157501	24643

Table 7: continued

Bufflehead

Year	--Stratum 1--	--Stratum 2--	--Stratum 3--	--Stratum 4--	-----Total-----
1990	0	0	0	10323	3650
1991	0	0	0	9592	4110
1992	3591	3318	0	2212	1080
1993	288	287	0	1038	1037
1994	0	0	0	3933	2292
1995	0	0	0	1099	1098
1996	0	0	0	934	651
1997	0	0	0	6071	4281
1998	355	354	0	0	0
				0	355
				0	354

Canada Goose

Year	--Stratum 1--	--Stratum 2--	--Stratum 3--	--Stratum 4--	-----Total-----
1990	589	410	22752	4837	72754
1991	830	827	32688	11117	41399
1992	6384	5831	17614	3668	20892
1993	865	637	25392	6476	120382
1994	576	574	25959	6740	12289
1995	1729	1726	18367	6152	11538
1996	2837	1334	21615	4022	49502
1997	5981	2538	33948	7437	82192
1998	3724	1496	41713	9810	29888
				9303	9303
				15181	5259
				90507	90507
					14583

Blue-winged Teal

Year	--Stratum 1--	--Stratum 2--	--Stratum 3--	--Stratum 4--	-----Total-----
1990	5886	2541	0	492	491
1991	5533	2521	0	0	17562
1992	5852	2665	0	0	13313
1993	5907	3630	0	519	518
1994	3746	1741	0	0	3829
1995	1383	1381	0	0	1914
1996	6384	3787	0	0	1807
1997	4486	3073	0	467	466
1998	1773	903	0	934	932
				4338	4338
				2195	2195
				7045	7045
					2550

American Wigeon

Year	--Stratum 1--	--Stratum 2--	--Stratum 3--	--Stratum 4--	-----Total-----
1990	11330	7380	0	0	0
1991	4703	3116	0	0	3399
1992	5453	3879	0	492	491
1993	9654	5358	0	0	0
1994	5331	3520	0	0	4786
1995	692	691	0	0	5949
1996	1064	1061	0	0	8241
1997	8224	4519	0	1401	1398
1998	5675	2986	0	0	0
				1735	1733
				1733	1733
				7410	7410
					3452

Figure 1: Annual population estimates indices by stratum
Black Duck: Indicated Pairs

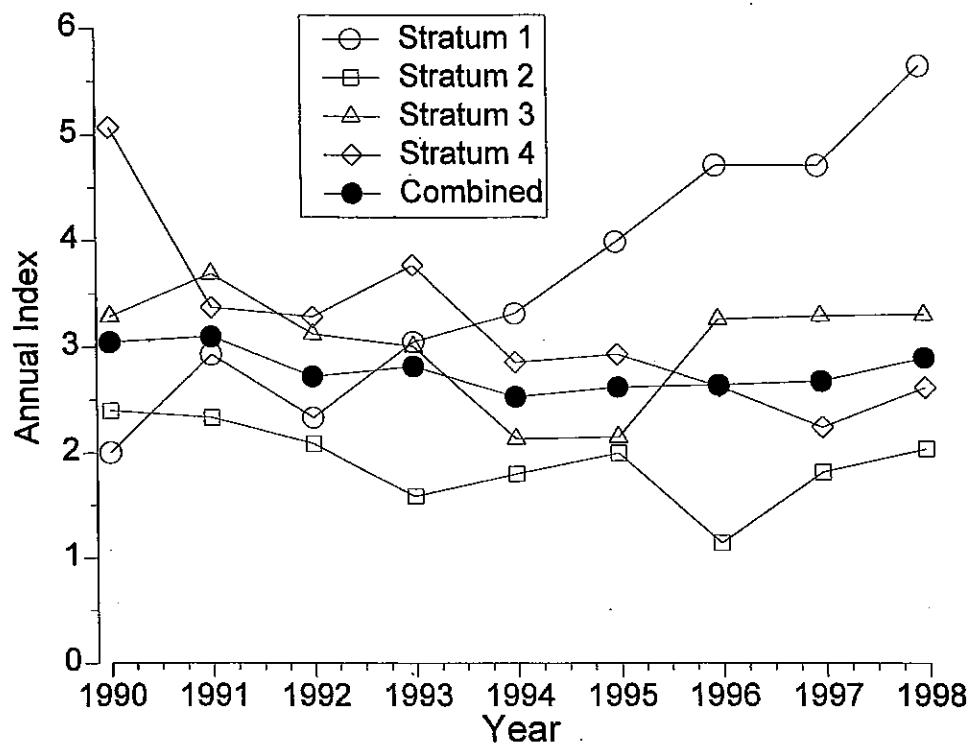


Figure 2: Annual population estimates indices by stratum
Mallard: Indicated Pairs

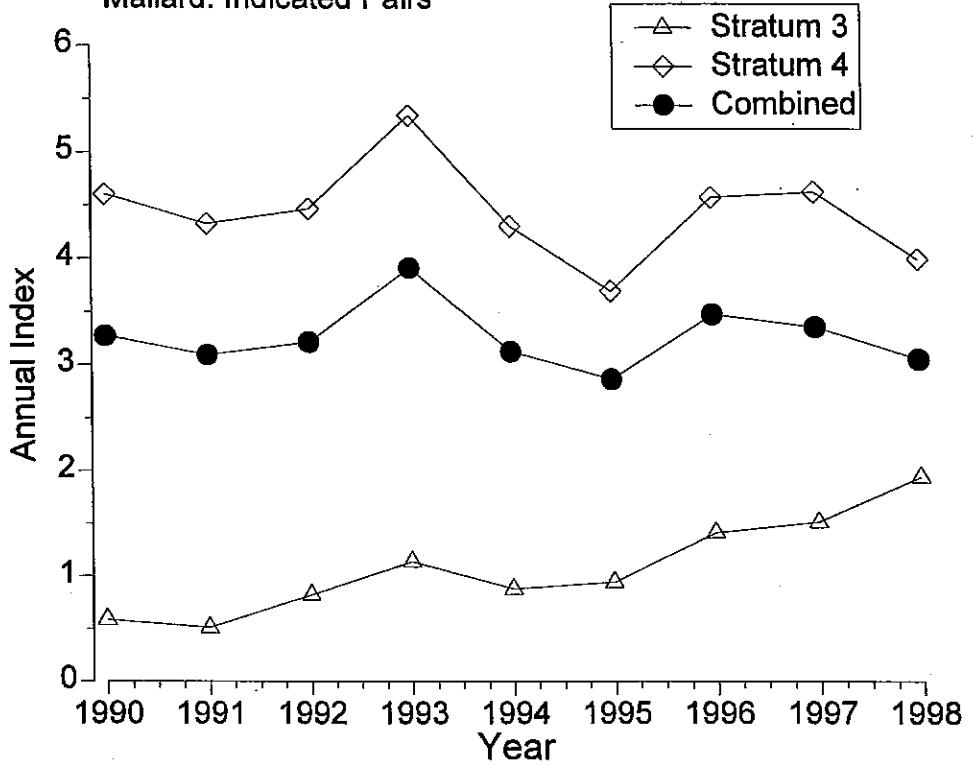


Figure 3: Annual population estimates indices by stratum
Ring-necked Duck: Indicated Pairs

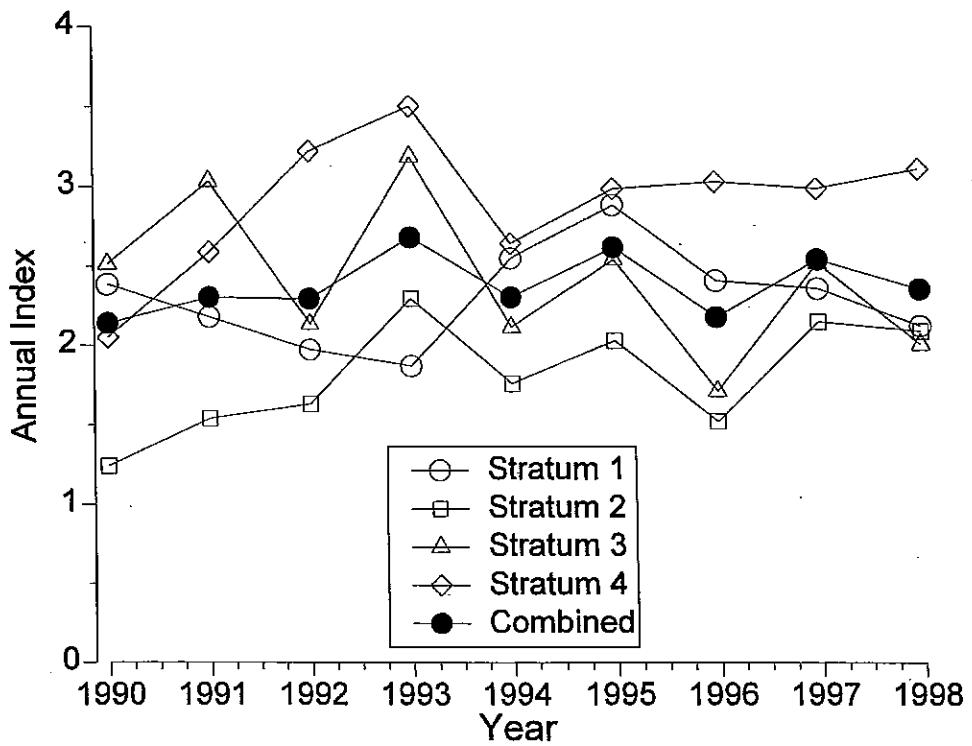


Figure 4: Annual population estimates indices by stratum
Common Merganser: Indicated Pairs

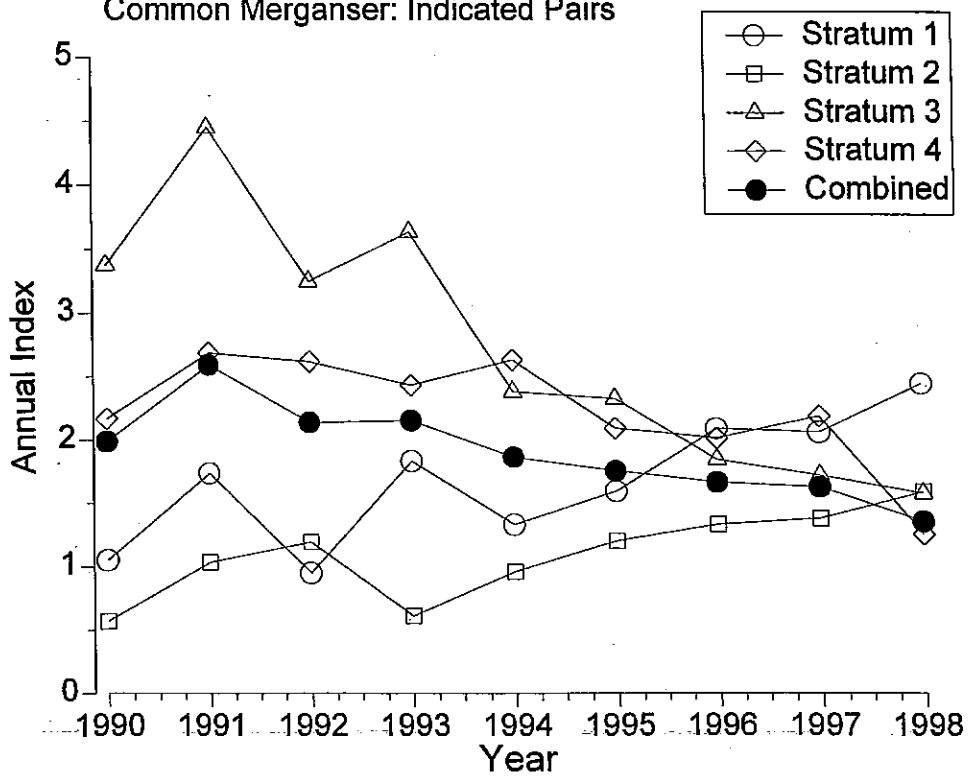


Figure 5: Annual population estimates indices by stratum
Hooded merganser: Indicated Pairs

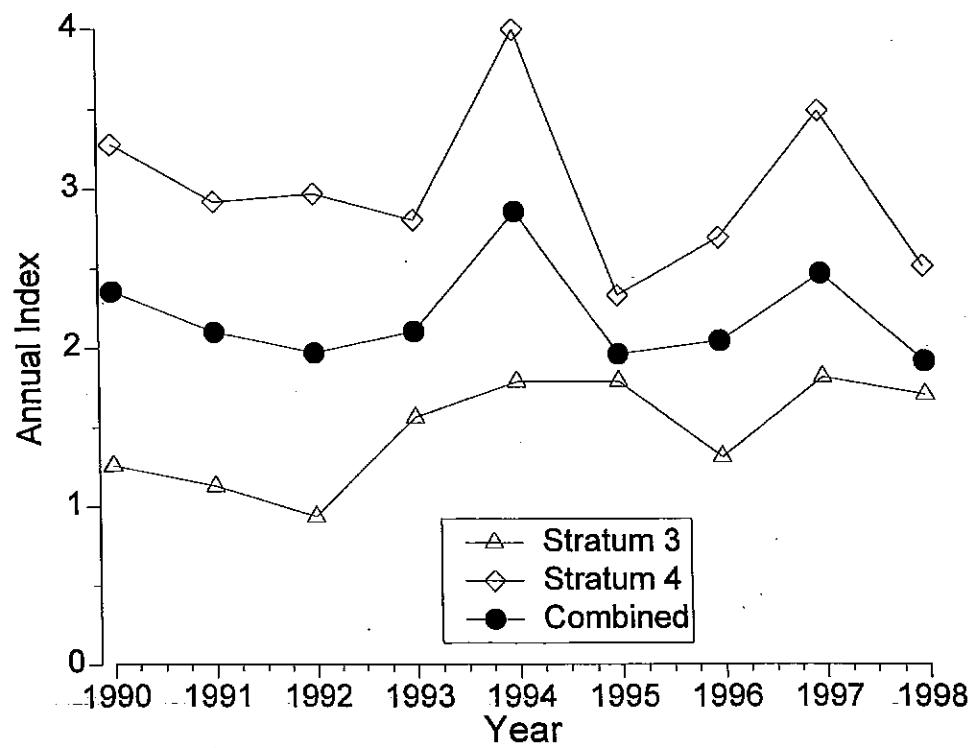


Figure 6: Annual population estimates indices by stratum
Green-winged Teal: Indicated Pairs

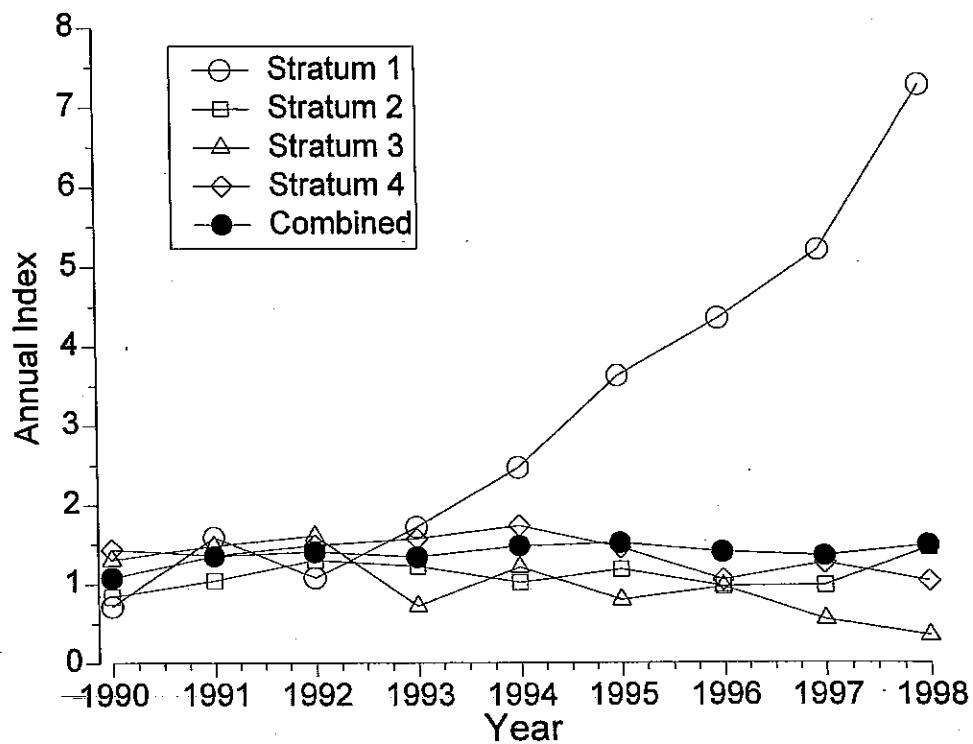


Figure 7: Annual population estimates indices by stratum
Wood Duck: Indicated Pairs

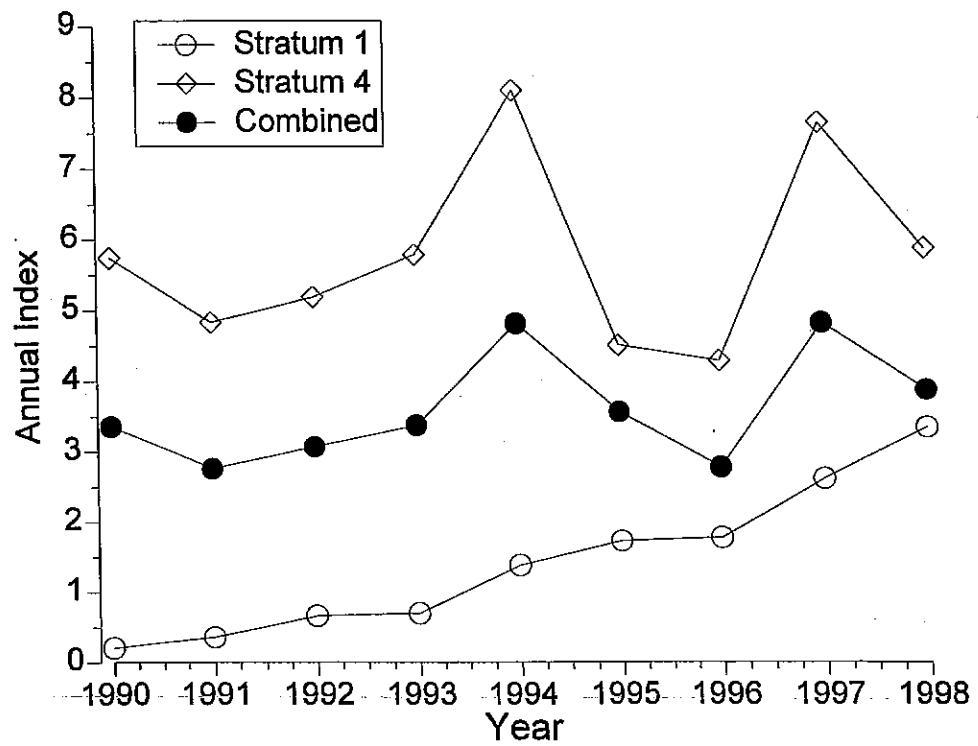


Figure 8: Annual population estimates indices by stratum
Common Goldeneye: Indicated Pairs

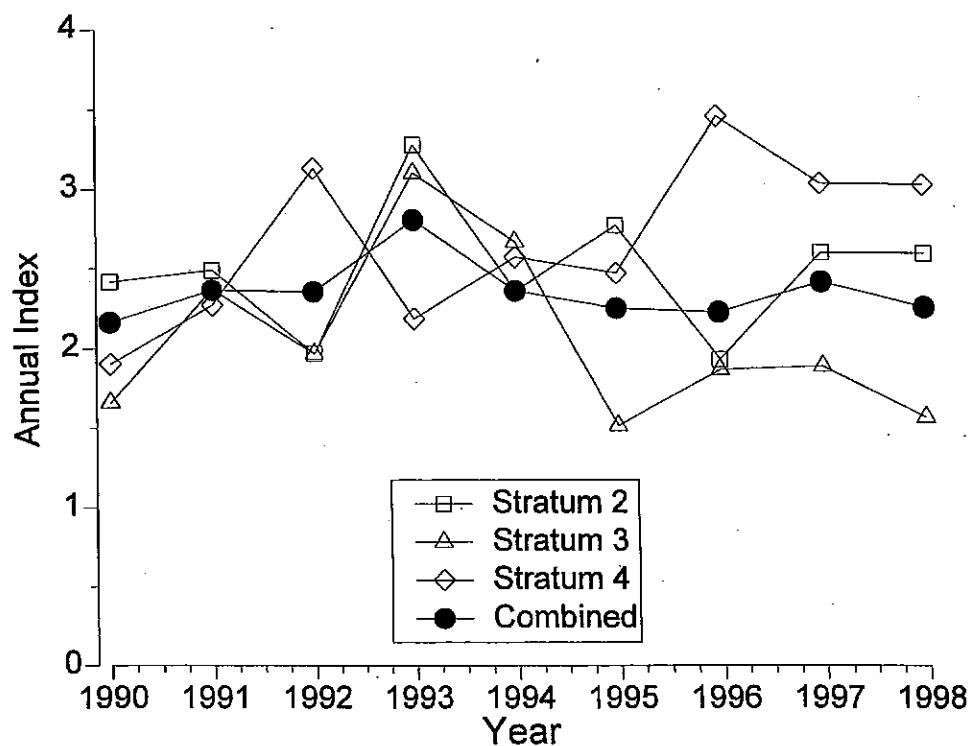


Figure 9: Annual population estimates indices by stratum
Bufflehead: Indicated Pairs

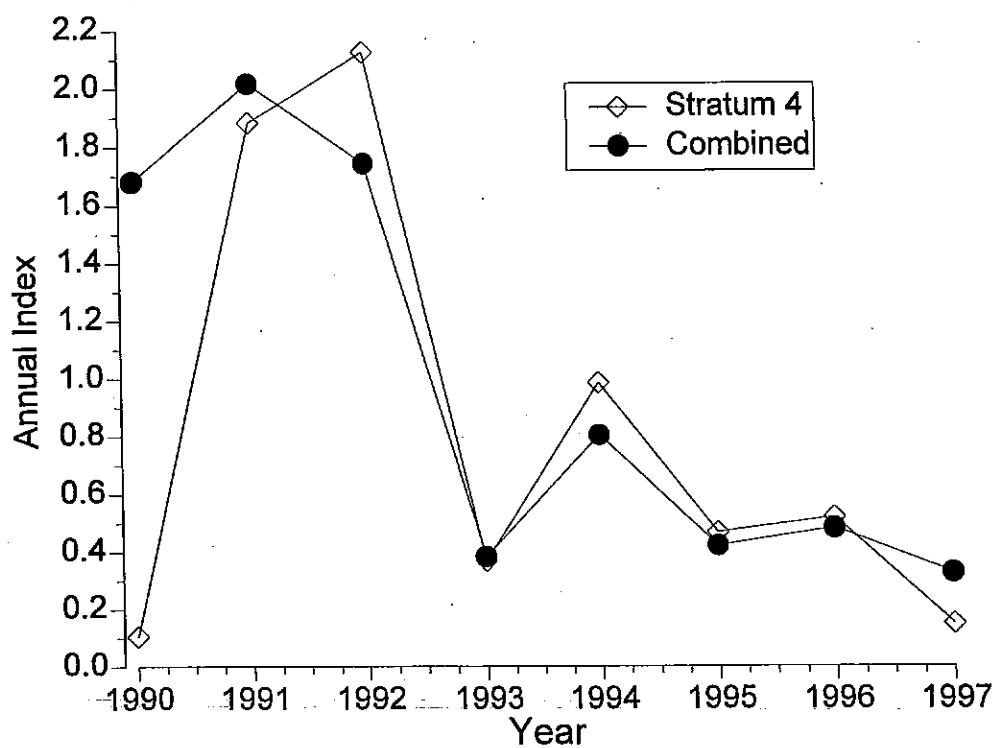


Figure 10: Annual population estimates indices by stratum
Canada Goose: Indicated Pairs

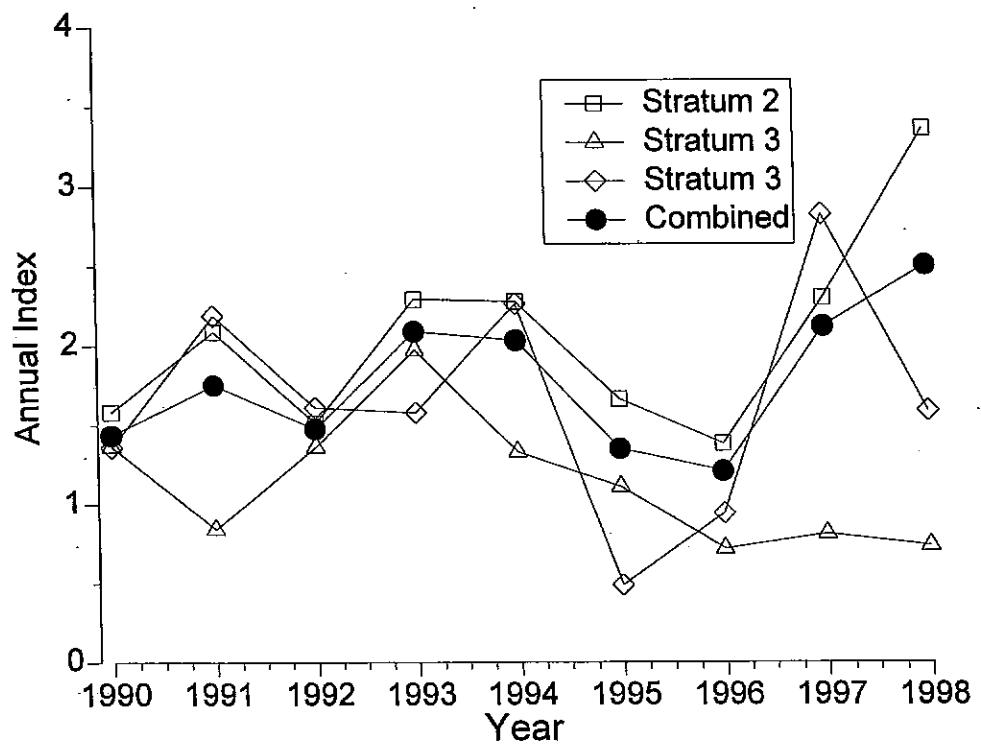


Figure 11: Annual population estimates indices by stratum
Blue-winged teal: Indicated Pairs

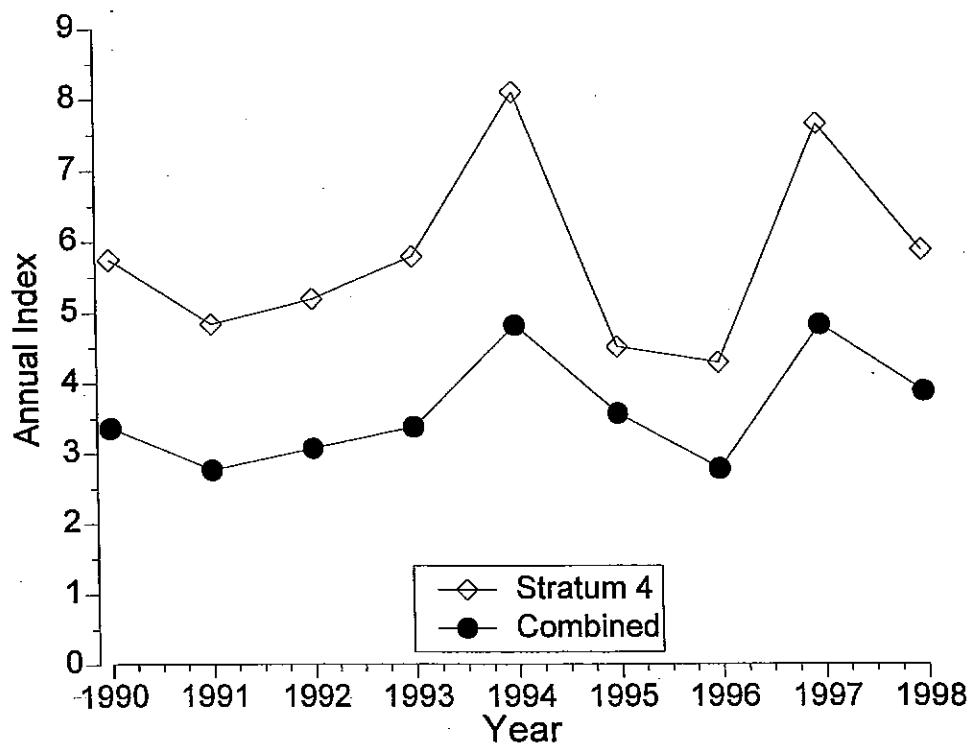
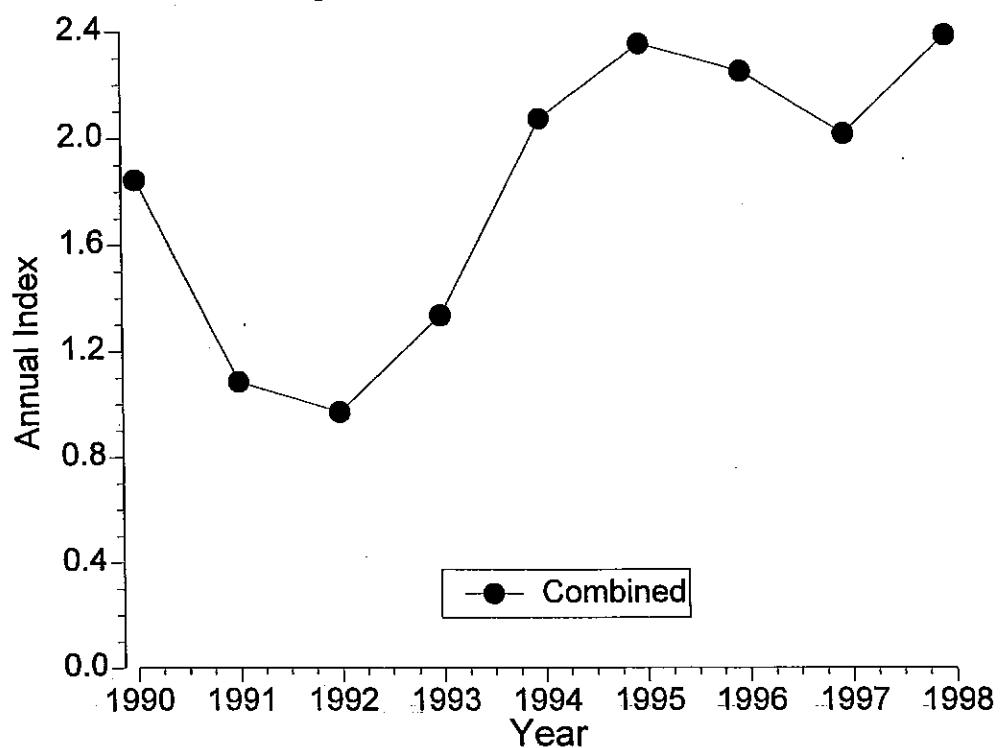


Figure 12: Annual population indices
American Wigeon: Indicated Pairs



Appendix A : Estimating Equations Measures of Trend

A.1) FITTING A LOCAL ESTIMATE OF TREND

The estimating equations analysis derives an estimate of an overall population trend as a weighted average of the trend seen on individual plots. This section describes how the local trends for each plot are estimated. The approach to estimating local trends was first presented by Link and Sauer (1994) and much of this section is simply a presentation of their technique with minor changes to the format of the equation. This presentation will establish a common notation which will be necessary for the further development in subsequent sections of this chapter.

Assume that the set of observations taken on route i are partitioned into blocks which were run under comparable conditions. A block of observations may be defined as comparable because they were run by the same observer or by being run under consistent weather conditions or similar values for dates and starting times. Partitioning the set of years for the route into sub-routes is equivalent to partitioning the route into years run by the same observer used by Link and Sauer but leaves the analysis open to use a more general definition of comparability. Assume that year y_i is run under the conditions for sub-route j ($j=1,2,\dots,J$) and let x_{ij} denote the observed count. It will be assumed that the observed count has a Poisson distribution with expected value

$$E(x_{ij}) = C_j \exp[B(y_i - M_j)] \quad (1.1)$$

where

B denotes the trend

C_j denotes a scaling factor for sub-route j and

M_j denotes the midyear for the observations taken under sub-route j .

This model can be made identical to that used by Link and Sauer by setting

$$\beta = \exp(B) \text{ and}$$

$$\gamma_j = C_j \exp(-BM_j)$$

The two formulations of the expected values will give rise to identical estimates for the individual route trend but expressing the expected value in terms of B , as was done in equation (1.1), will be more appropriate when combining trends from several routes. Subtracting the midyear of the time period from the observations was done to improve the numerical precision of the calculations which otherwise often involve extrapolating the observations on sub-routes to values outside the range of years in which they were observed.

The log-likelihood equation for the above model includes B , the trend parameter of interest, and a set of J nuisance parameters, C_j . By conditioning the on the total count for each sub-route the log-likelihood becomes an equation which depends only on the parameter B . Taking derivatives of the conditional log-likelihood with respect to B and equating the derivative to zero yields the equation

$$S - \sum_{j=1}^J \left[\frac{T_j \sum_i I_j(y_i) y_i \exp[b(y_i - M_j)]}{\sum_i I_j(y_i) \exp[b(y_i - M_j)]} \right] = 0 \quad (1.2)$$

where

b denotes the maximum likelihood estimate of B ,

$I_j(y_i) = 1$ if year y_i was observed under the conditions of sub-route j and 0 otherwise.

$T_j = \sum_i I_j(y_i)x_i$ is the total count for sub-route j , and

$$S = \sum_i x_i(y_i - M_j)$$

The maximum likelihood estimator in equation (1.2) can't be written in closed form but the estimate can be derived through computational procedures to find the zero of a function such as bisection.

An estimate of the variance of the maximum likelihood estimate can be derived from the Fisher information matrix. In this case there is only one parameter being estimated and the information matrix contains only 1 term. The estimated variance is

$$s^2 = \left[\sum_{j=1}^J T_j \frac{\left(\sum_i I_j(y_i)u_i(y_i - M_j - y^*)^2 \right)}{\left(\sum_i I_j(y_i)u_i \right)^2} \right]^{0.5} \quad (1.3)$$

where

$$u_i = \exp[b(y_i - M_j)] \text{ and}$$

$$y^* = \sum_i I_j(y_i)u_i(y_i - M_j) / \sum_i I_j(y_i)u_i$$

A.2) COMBINING LOCAL TREND ESTIMATES INTO A POPULATION TREND ESTIMATE

Once the trend estimates are calculated for individual routes the next step is to combine these trend estimates for all routes into an overall population estimate. Let B_h denote the local trend for route h and b_h denote an estimate of this trend which is estimated with a variance s_h^2 . The trends along individual routes have different importance to the overall population because i) the route may represent a larger portion of the population due to the sampling scheme or ii) the local population density may be higher and hence population changes along these routes will cause a larger change in the overall population. Let A_h be proportional to the number of individuals in the population which the route represents. The overall population trend can then be defined as

$$\tilde{B} = \frac{\sum_h A_h B_h}{\sum_h A_h}$$

where the summation extends over all routes in the population.

An unbiased estimate of \tilde{B} is provided by

$$\tilde{b} = \frac{\sum_h A_h B_h}{\sum_h A_h}$$

where the summation extends over the routes which have been visited.

The overall population trend will be estimated from the local trend as a weighted average of the local trend estimates viz.

$$\hat{b} = \frac{\sum_h w_h b_h}{\sum_h w_h} \quad (1.4)$$

The weights will be selected to minimise (in a restricted sense) the mean squared error conditional on the selected sample of routes i.e.

$$E_{2|1}(\hat{b} - \tilde{b})^2 = V_{2|1}(\hat{b}) + (\hat{b} - \tilde{b})^2 \quad (1.5)$$

where $E_{2|1}$ and $V_{2|1}$ denote the expected value and variance respectively taken over the within route randomisation component conditional on the routes selected.

Equation (1.5) shows the conditional mean squared error partitioned into two components: the conditional variance and the conditional bias. The bias term would be minimised by setting the weights $w_i = A_i$ while the variance would be minimised by setting $w_i = 1/s_i^2$. A weighting scheme which was intermediate between these two schemes will provide balance between minimising the variance and bias components of the mean squared error. The weighting scheme which will be used is a restricted minimisation of the mean squared error given by

$$w_h = dA_h + (1-d)/s_h^2 \quad (1.6)$$

The minimisation of the mean squared error is restricted because only those weighting schemes described by (1.6) were considered. The reasons for this choice are described below. The value for d was then selected to minimise the resulting mean squared error viz.

$$d = \frac{(\tilde{b} - \check{b})^2}{\sum_h (A_h - 1/s_h^2)^2 s_h^2 + (\tilde{b} - \check{b})^2} \quad (1.7)$$

where

$$\check{b} = \frac{\sum_h b_h / s_h^2}{\sum_h 1/s_h^2} \quad (1.8)$$

The above approach to weighting the routes is substantially different than that previously used in the analysis of BBS data. In previous analyses the routes were weighted as A_h / s_h^2 i.e. the product of the terms which would minimise the bias and variance components of the conditional mean squared error. The inappropriateness of such a scheme can be illustrated by considering an example in which $A_h = 1 / s_h^2$. In this situation setting $w_h = A_h$ would minimise both the variance and bias portions of the mean squared error and any other the weighting scheme wouldn't provide the minimum mean squared error.

Some other approaches to selecting the weighting scheme were examined. In one approach the weights w_i were selected to minimise the conditional mean squared error (1.5) over all weighting schemes. The resulting weighting scheme, however, resulted in routes being assigned negative weights. Another approach was to take the expected value of the mean squared error over all samples. In this approach the w_i are random variables and equation (1.4) must be interpreted as a ratio estimator. The unconditional mean squared error is an appreciably more complicated expression and the weights providing the minimum mean squared error can't be expressed in closed form. Various iterative schemes to calculate the weights were examined but in all trials some routes were assigned negative weights.

A.3) ASSESSING SIGNIFICANCE

The set of observations over time for any route are correlated. The significance of the estimated trend is assessed by examining the consistency of the trend seen at the different sampling locations. A jack-knife procedure is used to calculate the standard error. A t-test is then used to estimate the significance of the trend estimated based on the weighted average described in Section 1.2 and using the jack-knife estimate of the standard error.

A.4) RESIDUALS AND ANNUAL INDICES

Once the overall population trend has been calculated it is informative to graph the trend to provide a visual presentation of the magnitude of the trend and to show how the observations vary about the trend line. The first step involves estimating the predicted values for each observation. This requires estimates of the C_j in equation (1.1). From the likelihood equations for T_j , the maximum likelihood estimator for C_j can be shown to be

$$c_{hj} = \frac{T_{hj}}{\sum_i I_j(y_{hi}) \exp(b_h(y_{hi} - M_{hj}))} \quad (1.9)$$

where a subscript h has been introduced to identify the route since the subsequent discussion will involve combining the results for all routes. Hence, c_{hj} denotes the sub-route scaling factor for sub-route j on route h.

The predicted value for any observation can be computed by substituting the maximum likelihood estimates b and c_{hi} into (1.1). The residuals are then calculated as the difference between the observed count and the predicted count

$$r_{hi} = x_{hi} - c_{hj} \exp(b_h(y_{hi} - M_{hj})) \quad (1.10)$$

Since observers are assigned to routes at random the average of these trends should provide an estimate of the average scaling factor for the route. Further taking the average of these averages over all routes will provide an estimate of the average scaling factor over all routes. Hence one can define

$$c_{h.} = \sum_j c_{hj} / J_h$$

$$c_.. = \sum_h c_{h.} / H$$

where H is the number of routes.

The average scaling factor can then be used to predict the count for an average route and sub-route in year k.

$$x_k^{(p)} = c_.. \exp(b(y_k - M)) \quad (1.11)$$

where M is the midyear of the time period. A graph of the above predicted value against year would illustrate the magnitude of the population change predicted by the overall trend. The graph however wouldn't provide any diagnostic information on how well the model fits the observations. The annual index will be defined as the predict count in (1.11) plus the average residual for the year

$$x_k^{(I)} = x_k^{(p)} + r_k \quad (1.12)$$

where r_k denotes the average of all residuals from year k. A graph of these indices will provide some information on whether the observed counts are consistently above or below the overall trend line in some years and the magnitude of this departure.

A.5) PROGRAMMING CONSIDERATIONS

1.5.1) BOUNDS ON TREND ESTIMATE: The maximum likelihood estimate of trend is estimated using the IMSL subroutine ZBREN which finds the zero of a function. The subroutine ZBREN uses a combination of linear interpolation, inverse quadratic interpolation and bisection. It can be shown that the estimating equation (1.2) is monotone decreasing. Bounds on the maximum likelihood estimate b are set at -1 and 1. If the value of the left hand side of (1.2) is positive when $b=-1$ and negative when $b=1$ then these values bound the maximum likelihood estimate and the subroutine ZBREN is invoked to calculate the maximum likelihood estimate of trend. If the value of the left hand side of (1.2) is negative when $b=-1$ or positive when $b=1$ then the maximum likelihood estimate is outside the range (-1,1). This range of trend values covers a decline of 63% per year to an increase of 71% per year. Trend estimates outside this range are unlikely to occur in the real world and when the maximum likelihood estimate from estimating equations would be outside the range a route-regression estimate is substituted. The route regression estimate is the linear regression of $\log(x_i+0.23)$ against year with the sub-route structure retained in an ANCOVA model.

The route-regression analysis produces trend estimates which are smaller in absolute value than those calculated using estimating equation in all instances examined.

The program BBSANLYS will provide an estimate of trend for every route in which there is at least one sub-route with 2 or more observations and at least two non-zero counts. Previous analyses using the route-regression technique required at least one sub-route with 2 observations of which at least one observation was positive.

1.5.2) POPULATION WEIGHT: The population weight is the product of two terms: the population density and the area represented. The population density is estimated as the average count for all years in which the route was run while the area represented is a factor entered by the user.

1.5.3) WITHIN ROUTE VARIANCE: The within route variance given in equation (3.1) is a function of the observed counts and the trends. The within route variance, however, can provide an unsuitable measure of trend precision in some instances. Routes in which a species is seen intermittently can be given very large values for the trend slope. This occurs when the initial or final value for a sub-route includes a non-zero observation. The resulting large trend value then produces a very small variance estimate when substituted in equation (1.3) which gives an unreasonably large weighting to the route. To avoid this problem the variance term in equation (1.3) was calculated with $b=1$. This reduces the variance estimate to a term which is very similar to the variance inflation factor for an ANCOVA model.

REFERENCES

Link, W.A. and Sauer, J.R. (1994) Estimating equations estimates of trends, *Bird Populations*, 2, 23-32.