Progress Report

Black Duck Breeding Pair Surveys in New Brunswick and Nova Scotia - 2004

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Table of Contents

1. Introduction

Waterfowl management depends on surveys that 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 and Labrador; ground surveys in southern Ontario, Prince Edward Island and eastern states; fixed-wing surveys in Maine, Ontario, Quebec, New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland and Labrador. Additional surveys are being implemented in Quebec in 2004.

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 2004 survey in New Brunswick and Nova Scotia. Information from previous surveys is 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 Labrador 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. Maine is no longer included in the helicopter survey.

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 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.

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 coastlines 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 database. Copies of mapped locations of all waterfowl observations were filed. In 2004 all

crewmembers were experienced in this type of survey 29 April to 6 May. On 6 May a new pilot joined the crew (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. A pair or a single bird was considered a pair for sexually dimorphic species.

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 2004 (Figure 1). The Nova Scotia plots were surveyed between 29 April and 01 May. New Brunswick plots were surveyed between 5 May and 12 May and four plots were flown in Gaspe on 9, 10 May (Appendix III). The 1990 to 2003 survey dates were between 25 April and 21 May (Table 1). Spring conditions were of average or early timing in 2004. All ice and snow were gone from the plots when surveyed. This was particularly noticeable in northern New Brunswick and Gaspe plots where some ice cover in large lakes is common. Leaf-out was not well advanced at time of survey on any of the plots. Water level was lower than expected in many lakes and brooks, a situation attributed to the low snow accumulation in many areas of the Maritime Provinces in winter 2003-04. Total flying time for the New Brunswick and Gaspe survey was 32.8 hours and for the Nova Scotia survey was 18.6 hours. Average time on plot for 15 plots in Nova Scotia was 41.9 minutes and for 20 plots in New Brunswick was 42.4 minutes.

Table 1. Dates of helicopter breeding pair surveys in New Brunswick and Nova Scotia, 1990- 2004

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Nova Scotia	30 Ap-10 May	30 Ap-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	30 AP-2 May
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	3 May-7 May

	2000	2001	2002	2003	2004
Nova Scotia	25 Ap-29 Ap	30 Ap-2 May	1 May-5 May	28 April-30 April	29 April-1 May
New Brunswick	1 May-5 May	3 May-8 May	6 May-11 May	1 May-8 May	5 May-12 May

The total numbers of the most common species of duck (Black Duck, ring-neck, green-wing, and Common and Red-breasted Mergansers) were 705 in Nova Scotia and 533 in New

Brunswick (Tables 2, 3). Black Ducks made up 27 percent of the common species in Nova Scotia and 36 percent in New Brunswick. Ring-necks were 50 percent of the Nova Scotia total and 36 percent of the New Brunswick total. Results from previous surveys in Nova Scotia, not all on the same plots as surveyed in 2004, showed Black Ducks making up 43-68 percent of the common species and ring-necks, 18-29 percent. Black Ducks made up a much smaller proportion of ducks in Nova Scotia in 2004 than in previous years and ring-necks a much higher proportion. In New Brunswick the previous surveys reported 30-50 percent of the common species were Black Ducks and 23-33 percent were ring-necks. In New Brunswick the proportion of Black Ducks was not outside the range from previous years but ring-necks made up a higher proportion than in previous years.

In the 2004 Nova Scotia survey results, 15 percent of the ducks of common species were Green-winged Teal and 8 percent were mergansers. In the 2004 New Brunswick survey results, 12 percent were green-wings and 15 percent were mergansers. Species composition on previous surveys showed green-wings making up 6 - 29 percent of the common species in Nova Scotia and 7 - 27 percent in New Brunswick. Mergansers were 5 - 13 percent of common species in Nova Scotia and 12 - 32 percent in New Brunswick.

3.1 Black Ducks

A total of 188 Black Ducks was recorded on the Nova Scotia survey and 195 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 2004 the ratio was 0.9:1 in Nova Scotia and 0.8:1 in New Brunswick (Table 4). The survey in both provinces was timed well with breeding chronology. The number of Black Ducks observed in flocks greater than two birds was 56 (64 percent of total blacks) in Nova Scotia and 31 (16 percent of total blacks) in New Brunswick. Flocked birds are thought to be migrants and are encountered each year.

Table 2. The number of waterfowl recorded on 25 km² plots during the Nova Scotia breeding pair survey, April-May 2004.

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	P	S	Fl	Tot	
27B	2	7	17	28	-	-	7	7	-	-	-	-	-	-	-	-	-	-	-	-	1CAGO;35COEI;1COLO
29A	2	2	-	6	3	-	8	14	-	-	-	-	1	-	-	2	1	-	2	4	3MALL;2COLO
32A	2	6	6	16	-	-	-	-	1	1	-	3	-	1	-	1	2	1	-	5	
33A	6	4	13	29	-	-	4	4	-	-	4	4	1	-	-	2	-	-	-	-	18COGO;1MALL;2CAGO;3COLO
36A	1	-	3	5	-	-	-	-	-	-	3	3	1	-	-	2	-	-	-	-	2MALL;2COLO
39A	1	4	-	6	1	1	4	7	1	-	-	2	-	-	-	-	2	1	-	5	1CAGO;2SUSC
40A	-	-	-	-	-	-	3	3	-	-	4	4	-	-	-	-	-	-	4	4	
45A	-	2	-	2	1	1	-	3	1	-	6	8	1	-	-	2	-	-	-	-	1CAGO
47A	-	1	3	4	1	-	27	29	-	-	-	-	-	-	-	-	-	-	-	-	1COGO;1MALL
50D	8	3	7	26	1	1	95	98	6	-	20	32	-	-	-	-	-	-	-	-	2COGO;2AMWI
ns-51	8	4	7	27	-	-	-	-	1	-	21	23	-	-	-	-	-	-	6	6	7MALL;65COEI
ns-52	5	2	-	12	-	-	-	-	-	-	-	-	1	-	-	2	2	1	-	5	3COLO
ns-53	3	6	-	12	-	-	-	-	3	1	16	23	-	-	-	-	-	-	-	-	1CAGO;7COEI
ns-54	1	3	-	5	6	-	85	97	-	-	-	-	-	-	-	-	-	1	8	9	
ns-55	4	2	-	10	1	-	88	90	2	-	-	4	-	2	-	2	3	1	14	21	9COGO;1MALL;9CAGO;2AMWI
Total	43	46	56	188	14	3	321	352	15	2	74	106	5	3	0	13	10	5	34	59	

P = pair; S = single; Fl = flock

Table 3. The number of waterfowl recorded on 25 km² plots during the New Brunswick breeding pair survey, May 2004.

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	P	S	Fl	Tot	
52A	2	-	3	7	1	-	-	2	-	1	-	1	-	-	-	-	-	2	3	5	2CAGO
53A	2	9	-	13	1	1	9	12	-	-	-	-	-	-	-	-	-	-	-	-	3MALL
56B	3	5	-	11	-	-	-	-	1	1	-	3	-	-	-	-	-	-	-	-	8MALL;2HOME
58A	-	3	3	6	1	1	13	16	-	-	-	-	-	-	-	-	-	1	-	1	3HOME;2COLO
60A	7	7	-	21	6	-	34	46	1	1	-	3	-	-	-	-	1	-	2	2	3MALL;3HOME;4CAGO
62B	2	7	-	11	-	-	-	-	1	-	-	2	-	-	-	-	2	-	2	6	6MALL;2HOME;2CAGO
65A	2	1	-	5	-	-	15	17	2	-	-	4	-	-	-	-	-	1	-	1	4HOME;2CAGO
nb-76	2	-	6	10	1	-	-	-	2	2	2	8	-	-	-	-	1	1	3	6	3HOME
nb-77	2	2	3	9	-	-	-	-	1	-	-	2	-	-	-	-	2	-	5	9	1MALL;2HOME
nb-78	1	1	9	12	-	-	6	6	-	2	-	2	-	-	-	-	1	-	4	6	3MALL;1COLO
nb-79	1	-	-	2	-	-	-	-	-	-	2	2	-	-	-	-	-	1	-	1	2COGO
nb-80	2	1	-	5	2	-	34	38	-	-	-	-	-	-	-	-	-	-	-	-	8COGO;1HOME
nb-81	1	4	4	10	2	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	3HOME
nb-82	2	2	-	6	1	1	3	6	6	1	-	13	-	-	-	-	-	-	-	-	1CAGO;2NOPI
nb-83	3	2	-	8	3	1	10	17	-	-	-	-	-	-	-	-	3	-	10	16	1MALL;1HOME
nb-84	11	7	-	29	-	-	-	-	2	-	4	8	-	1	-	1	-	-	-	1	4HOME
nb-85	4	6	3	17	2	-	-	4	-	-	-	-	2	-	-	4	-	-	-	-	3HOME;6CAGO
nb-86	3	2	-	8	1	1	3	6	2	-	3	7	-	-	-	-	-	-	-	-	3HOME;2CAGO
nb-87	-	2	-	2	3	-	11	17	3	-	6	12	-	-	-	-	3	-	20	26	2COGO;9MALL;11CAGO
71A	1	1	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2HOME
Total	51	62	31	195	24	5	138	191	21	8	17	67	2	1	0	5	13	7	47	80	

P = pair; S = single; Fl = flock

8

Black Ducks were observed on 14 of 15 plots surveyed in Nova Scotia and on all plots in New Brunswick. The number of birds per plot ranged from 0 to 29 in the Nova Scotia plots and 2 to 29 in New Brunswick. The mean density of Black Ducks recorded on the Nova Scotia plots surveyed in 2004 was 23.7 indicated pairs per 100 km^2 and on the New

Table 4. Results of Black Duck counts during the Nova Scotia and New Brunswick breeding pair survey 2004. Fifteen 25 km^2 plots were surveyed in Nova Scotia and twenty, in New Brunswick.

	Nova Scotia	New Brunswick
Number of pairs	43	51
Number of singles	46	62
Number in flocks	56	31
Total number	188	195
Number of indicated pairs	89	113
Mean number of indicated pairs per 100 km^2	23.7	22.6
Mean number of ducks per 100 km^2	50.1	39.0
Ratio of pairs:singles	0.93:1	0.82:1

Brunswick plots was 22.6 indicated pairs per 100 km^2 (Table 4). The mean density 1990 - 2003 on Nova Scotia plots was 25.6 indicated pairs per 100 km^2 and mean density 1992 - 2003 on New Brunswick plots was 24.1 indicated pairs per 100 km^2. The mean density of observed blacks in Nova Scotia was 50.1 ducks per 100 km^2 and in New Brunswick was 39.0 ducks per 100 km^2 in 2004 (Table 4). Mean densities of total birds in Nova Scotia, 1990 - 2003, was 69.5 per 100 km^2 and in New Brunswick, 1992 - 2003, was 44.8 per 100 km^2. The low numbers of Black Ducks in 2003 were consistent across the range. Results from Quebec, Ontario and Newfoundland and Labrador for 2004 are not yet available.

Most recent analysis of Black Duck trends by Brian Collins (memo to BDJV, September 2003) was done using a new statistical technique and included data from 1990 to 2003 (Appendix IV). Results from stratum 1 (data from Nova Scotia, New Brunswick and Gaspe) showed a statistically significant (p<0.05) increase in total numbers of Black

Ducks and in indicated pairs. We note that numbers of Black Ducks in 2003 were consistently low across the range.

Data from Nova Scotia and New Brunswick also suggest an increase in each province since 1990 (Figures 2, 3). 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 352 Ring-necked Ducks was observed on the fifteen plots in Nova Scotia and 191 on the 20 New Brunswick plots (Tables 2, 3). Ring-necks were recorded on 10 (67 percent) of the Nova Scotia plots and 12 (60 percent) of the New Brunswick plots.   Mean density in Nova Scotia was 93.9 birds per 100 km^2 and in New Brunswick, was 38.2 per 100 km^2. The density in Nova Scotia was much higher than any previously recorded. Mean density of ring-necks on Nova Scotia plots in previous years ranged from 12.5 (1990) to 72.8 (2001) birds per 100 km^2. The density range in New Brunswick in previous years was 11.5 (1992) to 74.2 (2000) ducks per 100 km^2 (Figure 4).

Total Green-winged Teal recorded on the Nova Scotia plots in 2004 was 106 and total on the New Brunswick plots was 67 (Tables 2, 3).   The mean density of observed green-wings on the Nova Scotia plots was 28.3 birds per 100 km^2 and on the New Brunswick plots was 13.4 birds per 100 km^2. The recorded low densities of green-wings are 3.4 in Nova Scotia (1995) and 3.8 in New Brunswick (1992). High densities are 37.6 in Nova Scotia (1999) and 65.4 in New Brunswick (2000). The numbers of ring-necks and teal are affected by weather and other factors that affect migration timing. Also, between year variation may be due to the rotational survey design where different plots are surveyed in consecutive years.

The surveys are timed for breeding Black Ducks and are too early to monitor Blue-winged Teal. However, a few blue-wings are observed in both provinces in most years.

In 2004 no blue-wings were observed. 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.

The mean density of Common and Red-breasted Mergansers in Nova Scotia in 2004 was 14.1 birds per 100 km^2 and in New Brunswick, was 16.0. Densities of mergansers on Nova Scotia surveys 1990 - 2003 ranged from 4.3 (1990) to 25.9 birds per 100 km^2 (2001) (Figure 6). Densities on the New Brunswick plots ranged from 4.4 (1992) to 38.0 birds per 100 km^2 (1997). Fifteen Mallards were recorded on the Nova Scotia survey in 2004 and 34 were recorded in New Brunswick. Those Mallard numbers are the highest recorded.

4. Summary

1. Twenty plots 25 km^2 in area were flown in New Brunswick and 15 25 km^2 plots were flown in Nova Scotia between 29 April and 12 May 2004. 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 34 of the 35 plots surveyed in 2004.

2. Black Ducks made up 27 percent of the common species (Black Ducks, Ring-necked Ducks, Green-winged Teal and Common and Red-breasted Mergansers) in Nova Scotia and 36 percent in New Brunswick. Ring-necks accounted for 50 percent of the common species in Nova Scotia and 36 percent in New Brunswick.

3. Mean density of Black Ducks on the Nova Scotia plots was 23.7 indicated pairs per 100 km^2 in 2004, compared to the 1990 to 2003 average 25.6. Mean density in New Brunswick in 2004 was 22.6 indicated pairs per 100 km^2 compared to the 1992 to 2003 average 24.1.

4. Analysis of data (1990-2003) by B. Collins using a new statistical 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 (1990-2004) suggest increases in Black Duck numbers in each province since 1990 and stable numbers since 1998. Low numbers of Black Ducks were recorded in Nova Scotia and New Brunswick in 2003 and 2004.

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.
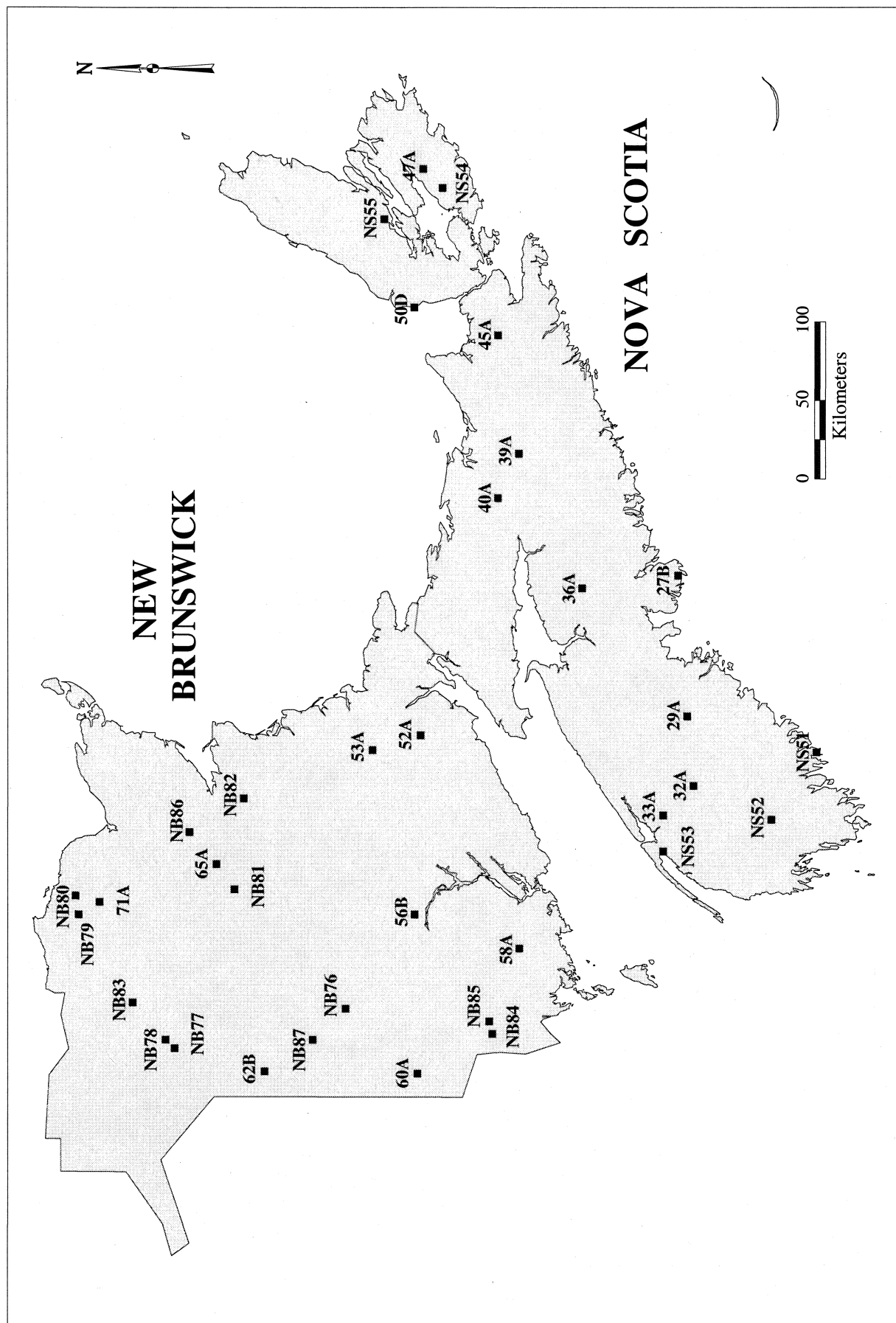
Figure 1. Approximate locations of the 5 km x 5 km blocks surveyed for breeding Black Ducks in Nova Scotia and New Brunswick in April - May, 2004.

Black Ducks in Nova Scotia

indicated pairs* from helicopter surveys

indicated prs per 100sq.km
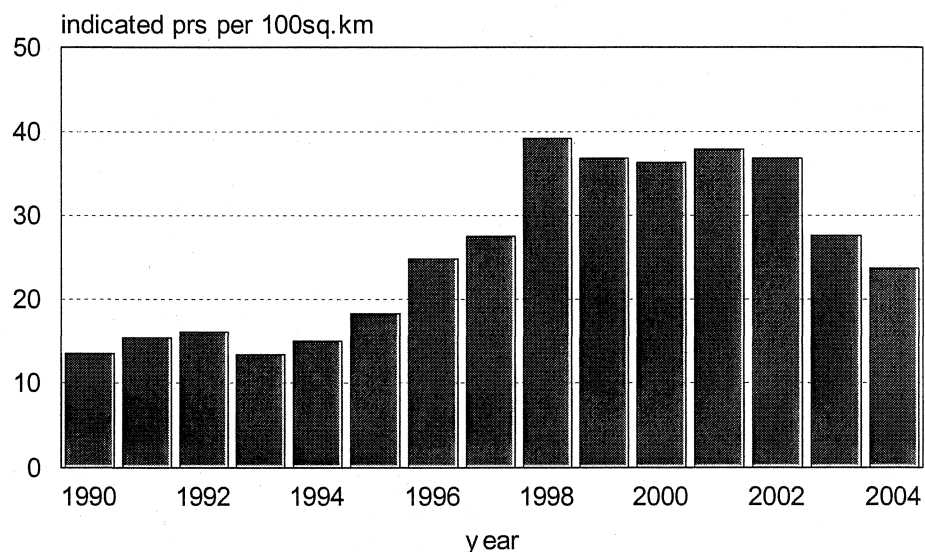
*indicated pairs = groups of 2 birds + single birds

Black Ducks in New Brunswick

indicated pairs* from helicopter surveys

indicated prs per 100sq.km
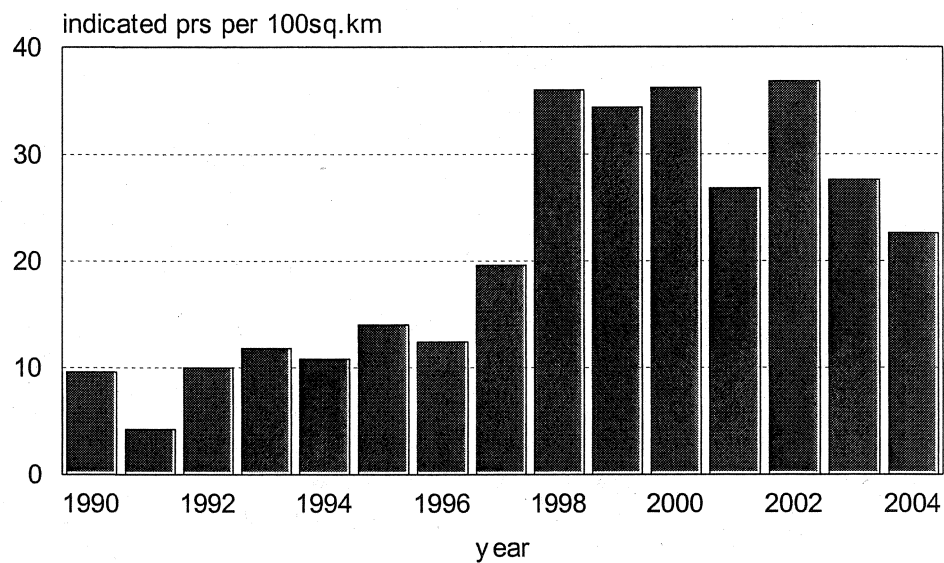
*indicated pairs = groups of 2 birds + single birds

Figure 2. Mean numbers of indicated pairs of Black Ducks per 100 km^2 on helicopter breeding pair surveys in New Brunswick and Nova Scotia, 1990-2003

Black Ducks in Nova Scotia

total birds from helicopter surveys

year

Black Ducks in New Brunswick

total birds from helicopter surveys

year
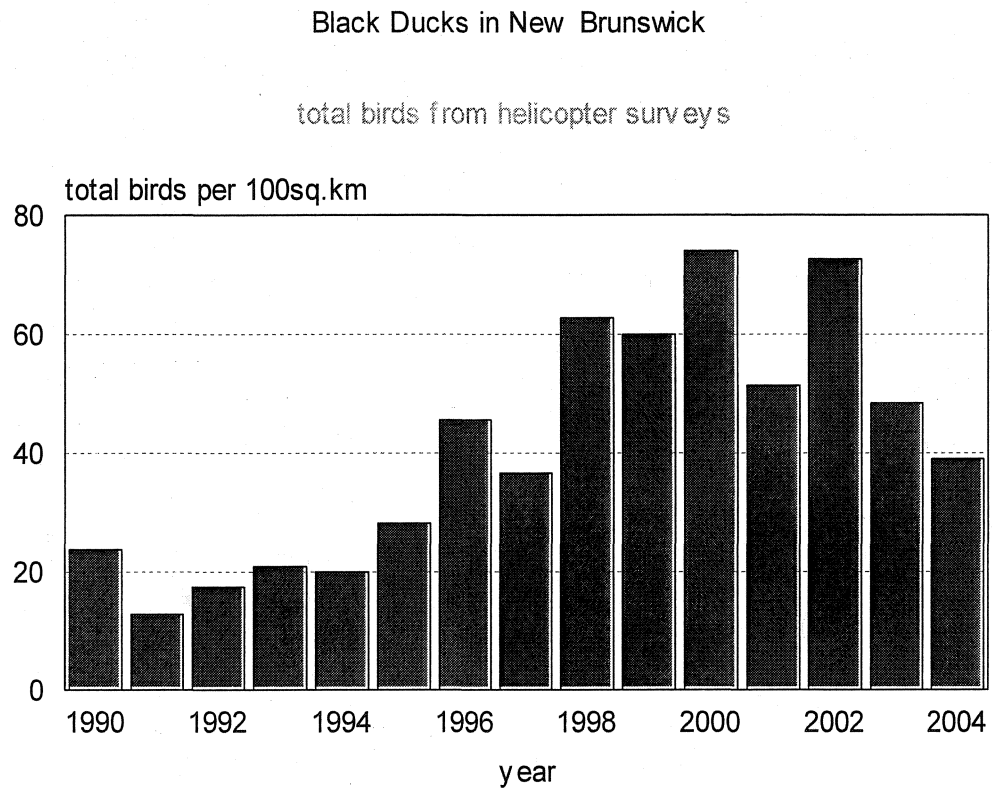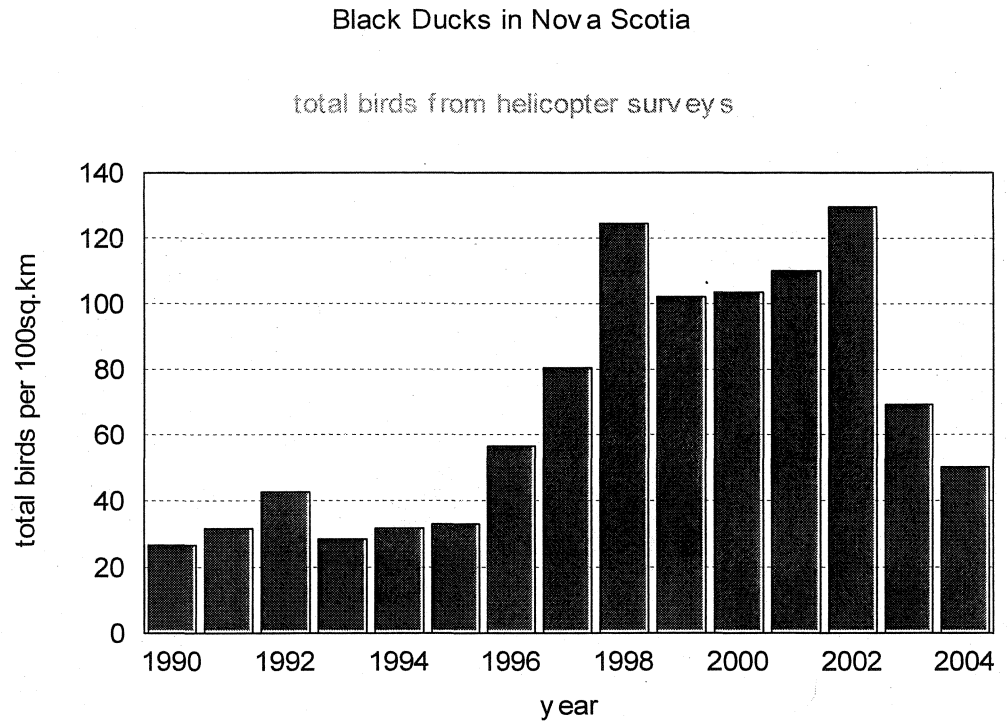
Figure 3. Mean densities of Black Ducks per 100 km^2 on helicopter breeding pair surveys in New Brunswick and Nova Scotia, 1990-2004.

Ring-necked Ducks in Nova Scotia

total birds from helicopter surveys
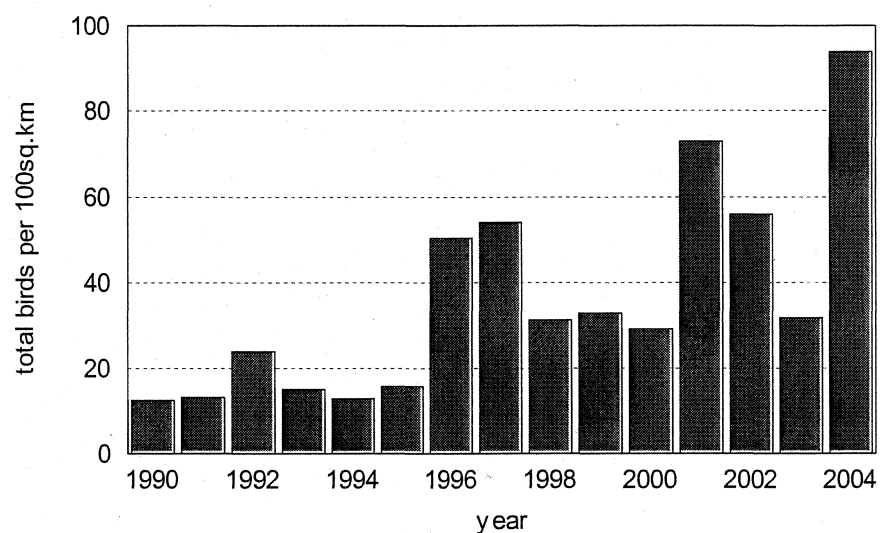
Ring-necked Ducks in New Brunswick

total birds from helicopter surveys
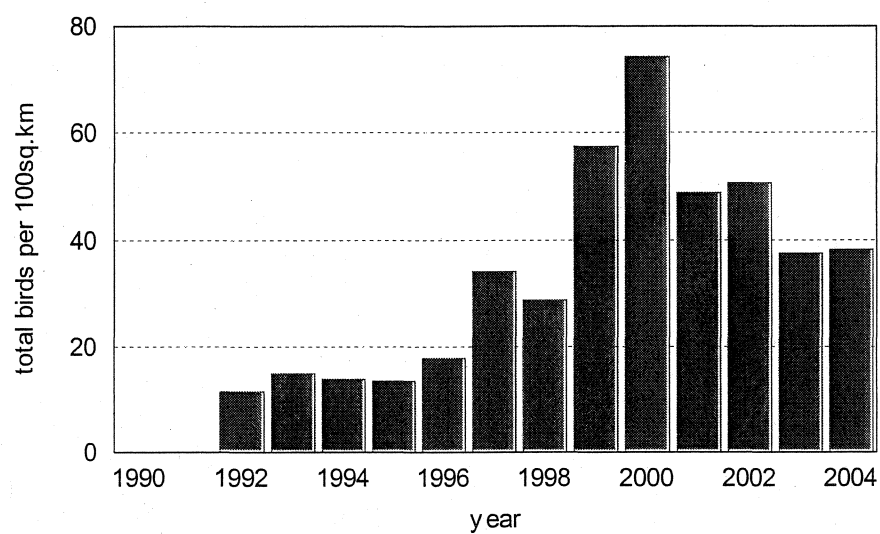
Figure 4. Mean densities of Ring-necked Ducks per 100 km^2 on helicopter breeding pair surveys in New Brunswick and Nova Scotia, 1990-2004. (1990 and 1991 New Brunswick data are not shown)

Green-winged Teal in Nova Scotia

total birds from helicopter surveys
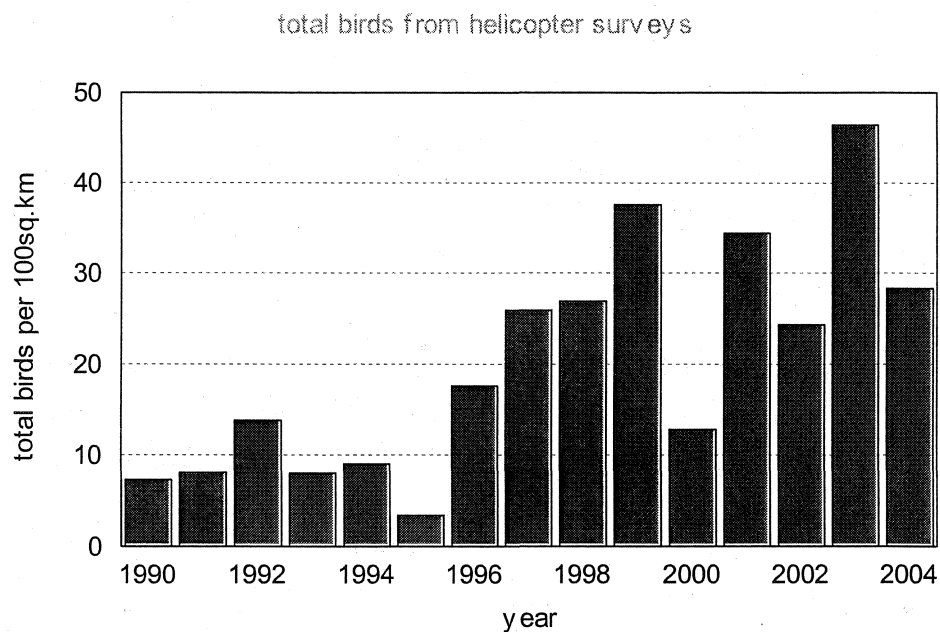
Green-winged Teal in New Brunswick

total birds from helicopter surveys
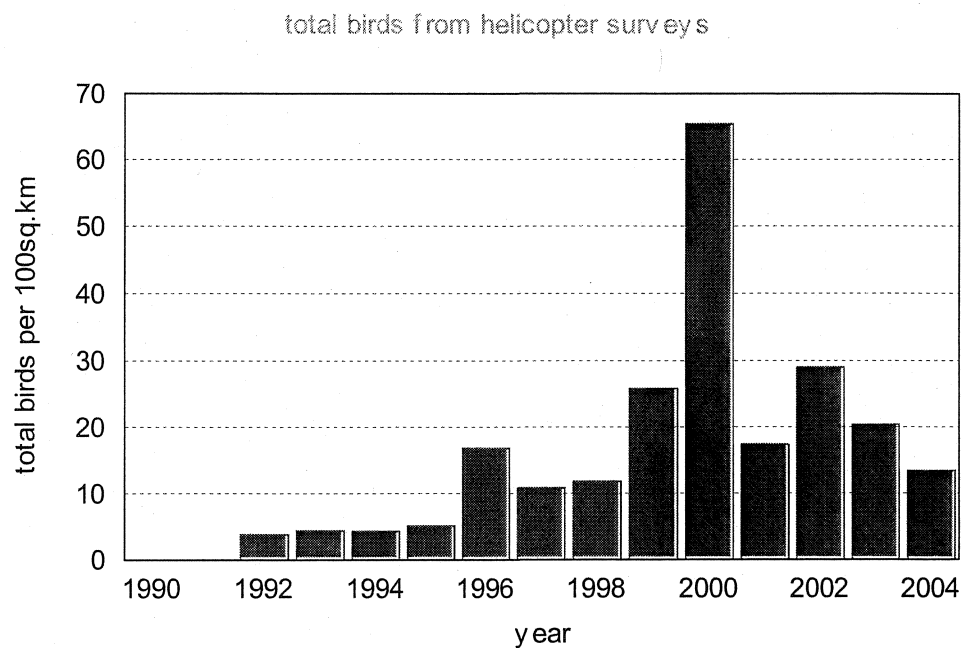
Figure 5. Mean densities of Green-winged Teal per 100 km^2 on helicopter
breeding pair surveys in New Brunswick and Nova Scotia, 1990-2004.
(1990 and 1991 New Brunswick data not shown)

18

C. & R-b Mergansers in Nova Scotia

total birds from helicopter surveys
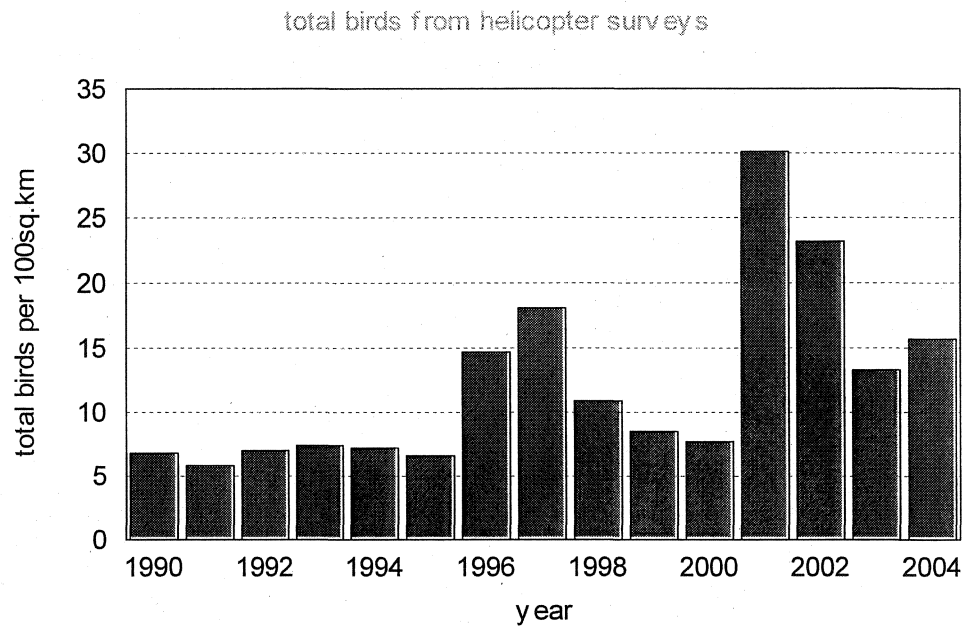
C. & R-b Mergansers in New Brunswick

total birds from helicopter surveys
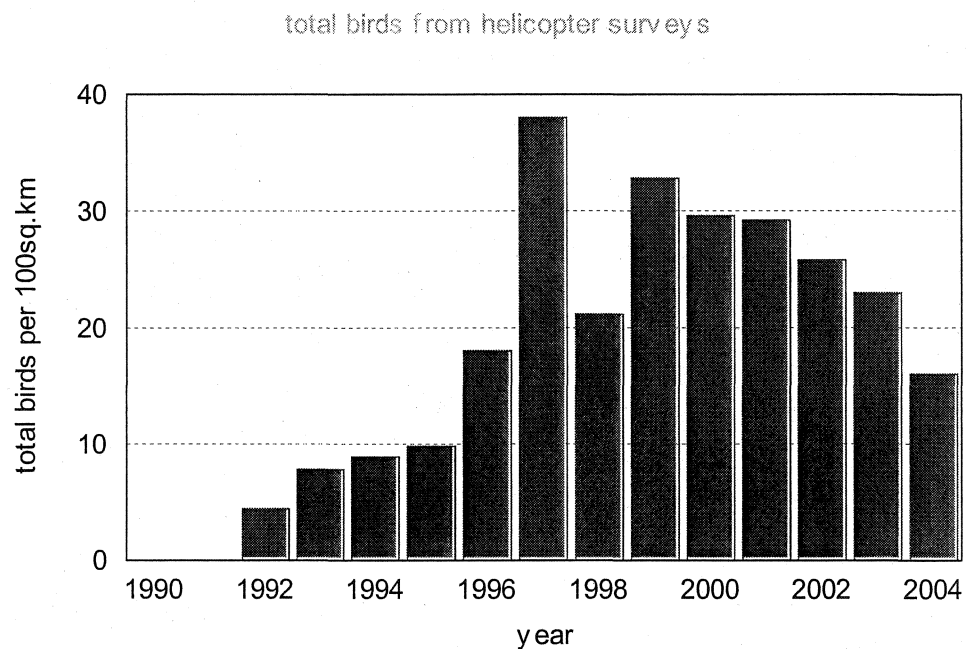
Figure 6. Mean densities of Common and Red-breasted Mergansers per 100 km^2 on helicopter breeding pair surveys in New Brunswick and Nova Scotia, 1990-2004. (1990 and 1991 New Brunswick data not shown)

Appendix I

Table i. Mean densities (birds per 100 km^2) of waterfowl recorded on helicopter surveys in Nova Scotia, 1990 – 2004. Plot size was 100 km^2 1990 – 1995 and 25 km^2 1990 -2004.

Table ii. Mean densities (birds per 100 km^2) of waterfowl recorded on helicopter surveys in New Brunswick, 1992 – 2004. Plot size was 100 km^2 1992 – 1995 and 25 km^2 1996 – 2004.

Table iii. Mean densities (indicated pairs per 100 km^2) of indicated pairs of waterfowl recorded on helicopter surveys in Nova Scotia, 1990 - 2004. Plot size was 100 km^2 1990 – 1995 and 25 km^2 1990 -2004.

Table iv. Mean densities (indicated pairs per 100 km^2) of indicated pairs of waterfowl recorded on helicopter surveys in New Brunswick, 1992 - 2004. Plot size was 100 km^2 1992– 1995 and 25 km^2 1990 -2004.

Table i. Mean densities (birds per 100 km²) of waterfowl recorded on helicopter surveys in Nova Scotia, 1990 – 2004. Plot size was 100 km² 1990 – 1995 and 25 km² 1996 – 2004.

Species

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Canada Geese	0.3	0.4	2	0.3	0.4	0.2	2.9	8.5	2.1	1.1	4	6.9	3.7	8.8	4.0
Black Duck	26.6	31.6	42.6	28.6	31.7	32.9	56.5	80.5	124.5	102.1	103.5	113.3	129.6	69.3	50.1
Green-w Teal	7.3	8.1	13.8	8	9	3.4	17.6	25.9	26.9	37.6	12.8	34.4	24.3	46.4	28.3
Blue-w Teal	1.5	2.4	2.8	1.5	1	0.3	3.5	5.9	1.6	2.1	0	1.1	2.4	8.3	0
Wood Duck	0.8	0.8	0	0	3.6	2.1	0.5	0	5.9	1.1	2.9	0.3	1.9	1.1	3.5
Mallard	0.6	0.6	0.8	0.4	0.8	0.5	0	2.1	2.1	3.5	1.6	1.1	3.2	2.7	4.0
Pintail															
Wigeon	0.5	1.5	1.7	1.4	0.8	0	0	5.6	2.1	0.5	0.5	0	5.3	1.3	1.1
Ring-n Duck	12.5	13.2	23.9	15.1	12.9	15.8	50.4	54.1	31.2	32.8	29.1	72.8	56	31.7	93.9
G.Scaup															
L.Scaup															
scaup															
Black Scoter															
Surf Scoter															0.5
C.Goldeneye	3.4	1.5	2.4	1.2	0	0	0	1.6	3.7	0	3.2	1.9	0	14.1	8.0
B.Goldeneye															
Bufflehead															
Hooded Merg	0.5	0.1	0	0	0.6	0.6	0	1.3	2.7	3.2	2.4	3.2	1.9	1.1	0
C.Merganser	4.3	5.9	7	7.4	7.2	4.5	9.9	4.8	10.7	5.6	5.6	24.8	22.9	8.3	14.1
R-b Merg.	0	0	0	0	0	0	1.1	7.5	0	0.5	2.1	1.1	0.3	1.1	0

Table ii. Mean densities (birds per 100 km^2) of waterfowl recorded on helicopter surveys in New Brunswick, 1992 – 2003. Plot size was 100 km^2 1992 – 1995 and 25 km^2 1990 – 2004.

Birds per 100 sq. km in New Brunswick

Species / Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Canada Geese			0	0	0	0.9	1	0	2.2	5.6	4.4	2	6	6.6	6.0
Black Duck			17.4	20.9	20	28.2	45.6	36.6	62.8	60	74	51.4	72.6	48.4	39.0
Green-w Teal			3.8	4.4	4.3	5.1	16.8	10.8	11.8	25.8	65.4	17.4	29	20.4	13.4
Blue-w Teal			0.8	1.4	1.4	0.6	3.8	0.4	0.8	0.8	0	0.8	0.6	0.2	0
Wood Duck			0	0	4	1.1	2.6	2.6	0.6	3.6	0.8	2.4	1.2	4.4	1.0
Mallard			0.6	0.4	0.4	0.9	1.4	2	1	6.6	10	3.6	2.2	4.8	6.8
Pintail															0.4
Wigeon			0.2	2.4	1.7	0.7	0.8	3.8	4.6	0.6	0	7.4	6.6	0.4	0
Ring-n Duck			11.5	14.9	13.9	13.6	17.8	34.2	38.8	57.4	74.2	48.8	50.6	37.6	38.2
G.Scaup															
L.Scaup															
scaup															
Black Scoter															
Surf Scoter															
C.Goldeneye			1.8	1.7	2.3	0.4	3.6	5	6.2	3.4	5.2	6.8	4.4	1.8	2.4
B.Goldeneye															
Bufflehead															
Hooded Merg			0	0	0.6	2.6	5.6	1.2	0.6	4	6.8	7.6	2.4	4.4	7.2
C.Merganser			4.4	7.8	8.9	9.8	18	38	15.6	23.2	29.2	27.2	25.8	22.8	16.0
R-b Merg.			0	0	0.1	0	0	0	5.6	9.6	0.8	2	0	0	0

22

Table iii. Mean densities (indicated pairs per 100 km^2) of indicated pairs of waterfowl recorded on helicopter surveys in Nova Scotia, 1990 - 2004. Plot size was 100 km^2 1990 – 1995 and 25 km^2 1990 – 2004.

Species

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Canada Geese	0.2	0.2	0.1	0.2	0.2	0.1	1.1	1.9	1.3	0.5	2.4	2.1	1.3	1.3	2.7
Black Duck	13.5	15.4	16.1	13.4	15	18.3	24.8	27.5	39.2	36.8	36.3	37.9	36.8	27.5	23.7
Green-w Teal	2.1	2.4	3.1	2.7	3	1.1	3.5	4.5	4	6.4	2.7	5.6	6.1	4	4.5
Blue-w Teal	0.5	1.1	0.6	0.4	0.3	0	1.3	0.8	0.8	1.1	0	0.5	1.3	1.1	0
Wood Duck	0.5	0.4	0.4	0.8	1.3	0.8	0.5	0	1.6	0.8	1.6	0.3	0.8	0.5	2.1
Mallard	0.5	0.2	0.4	0.2	0.3	0.1	0	0.3	1.1	1.3	1.1	0.5	1.9	1.1	2.9
Pintail															
Wigeon	0	0.3	0.3	0.2	0.2	0	0	0.8	1.1	0.3	0.3	0.3	1.1	0.3	0.5
Ring-n Duck	2.8	2.4	5.6	3.8	3.8	2.3	3.7	6.4	3.5	2.7	2.9	4.3	6.1	2.7	4.5
G.Scaup															
L.Scaup															
scaup															
Black Scoter															
Surf Scoter															0.3
C.Goldeneye	0	0	0.1	0.1	0	0	0	0.8	0.8	0	1.6	0.8	0	1.3	0.8
B.Goldeneye															
Bufflehead															
Hooded Merg	0.1	0.1	0.1	0	0.3	0.5	0	0.8	0.8	0.5	0.5	0.5	1.3	0.8	0
C.Merganser	1.7	1.9	2.2	0.8	2.4	2.5	5.3	2.7	3.5	5.6	2.7	4.5	2.1	1.6	4.0
R-b Merg.	0	0	0	0	0	0	0.5	0	0	0.3	1.3	0.5	0.3	0	0

Table iv. Mean densities (indicated pairs per 100 km²) of indicated pairs of waterfowl recorded on helicopter surveys in New Brunswick, 1992 – 2004. Plot size was 100 km² 1992 – 1995 and 25 km² 1990 – 2004.

Species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Year															
Canada Geese			0	0	0	0.2	0.2	0	0.6	2.2	1.8	1.4	3.6	2.8	3.0
Black Duck			10	11.8	10.8	14	25.2	19.6	36	34.4	36.2	26.8	36.8	27.8	22.6
Green-w Teal			2.1	2.4	2.3	2.8	5.8	5.6	6.2	8.6	8	7	5.8	5.8	5.8
Blue-w Teal			0.4	0.7	0.7	0.1	1.8	0.2	0.4	0.4	0	0.4	0.4	0.2	0
Wood Duck			0.4	1.1	1	0.8	1	1.8	0.2	2	0.6	0.6	0.2	1.8	0.6
Mallard			0.2	0.2	0.2	0.3	0.8	1.2	0.8	1.4	4.4	1.8	1.2	1.6	5.0
Pintail															0.2
Wigeon			0.1	1	0.8	0.3	0.2	2.2	2.4	0.6	0	2.2	3	0.2	0
Ring-n Duck			4.6	5.1	4.8	1.8	4.4	5.2	6.2	12	10.6	4.6	6.8	5.8	5.8
G.Scaup															
L.Scaup															
scaup															
Black Scoter															
Surf Scoter															
C.Goldeneye			0.4	1	1	0.3	0.4	2.8	2	1.8	2.2	2.2	2.4	1.2	1.4
B.Goldeneye															
Bufflehead															
Hooded Merg			0.3	0.2	0.3	1.3	1.4	0.6	0.4	1.2	4.2	4.2	1.4	2.8	4.0
C.Merganser			1.8	3.5	1.6	2.7	4.8	5.2	4	5.8	7.4	6.4	6.2	4.4	4.0
R-b Merg.			0	0	0.1	0	0	0	0	1.8	0.2	1	0	0	0

Appendix II

List of pilots and observers on the New Brunswick and Nova Scotia helicopter surveys 1990-2004.

	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
2000		
primary observer/navigator	M.C.Bateman	M.C.Bateman
secondary observer	R.J.Hicks	R.J.Hicks
pilot	J.Myra	J.Myra
2001		
primary observer/navigator	M.C.Bateman	M.C.Bateman
secondary observer	R.J.Hicks	R.J.Hicks
pilot	J.Myra	J.Myra
2002		
primary observer/navigator	M.C.Bateman	M.C.Bateman
secondary observer	R.J.Hicks	R.J.Hicks
pilot	C.Swannell	J.Myra/C.Swannell
2003		
primary observer/navigator	M.C.Bateman	M.C.Bateman
secondary observer	R.J.Hicks	R.J.Hicks
pilot	C.Swannell	C.Swannell
2004		
primary observer/navigator	M.C.Bateman	M.C.Bateman
secondary observer	R.J.Hicks	R.J.Hicks
pilot	J.Myra	J.Myra/M.Paddon

Appendix III

Table III-i. The number of waterfowl recorded on 25 km^2 plots during the Gaspe breeding pair survey, May 1996.

Table III-ii. The number of waterfowl recorded on 25 km^2 plots during the Gaspe breeding pair survey, May 1997.

Table III-iii. The number of waterfowl recorded on 25 km^2 plots during the Gaspe breeding pair survey, May 1998.

Table III-iv. The number of waterfowl recorded on 25 km^2 plots during the Gaspe breeding pair survey, May 1999.

Table III-v. The number of waterfowl recorded on 25 km^2 plots during the Gaspe breeding pair survey, May 2000.

Table III-vi. The number of waterfowl recorded on 25 km^2 plots during the Gaspe breeding pair survey, May 2001.

Table III-vii. The number of waterfowl recorded on 25 km^2 plots during the Gaspe breeding pair survey, May 2002.

Table III-viii. The number of waterfowl recorded on 25 km^2 plots during the Gaspe breeding pair survey, May 2003.

Table III-ix. The number of waterfowl recorded on 25 km^2 plots during the Gaspe breeding pair survey, May 2004.

Table III-i. The number of waterfowl recorded on 25 km^2 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	Fl	Tot	P	S	Fl	Tot	P	S	Fl	Tot	P	S	Fl	Tot	P	S	Fl	Tot	
1A2	2	-	-	4	2	-	30	34	1	1	3	6	-	1	-	1	-	-	3	3	2Mall;14geye; 4Hood; 2 unk
1A3	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1B6	2	2	-	6	1	-	-	2	-	3	4	7	-	1	-	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	

28

Table III-ii. The number of waterfowl recorded on 25 km^2 plots during the Gaspe breeding pair survey, May 1997

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	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 Mall;4 Geye; 3 Hood
1C1	-	-	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	
1C5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
TOTAL	7	10	-	24	5	-	13	23	1	3	3	8	-	-	-	-	-	-	3	3	

29

Table III-iii. The number of waterfowl recorded on 25 km^2 plots during the Gaspe 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	P	S	Fl	Tot	
1C1	-	-	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	4 Geye
1C5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1D4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	-
1D7	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-iv. 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	Fl	Tot	P	S	Fl	Tot	P	S	Fl	Tot	P	S	Fl	Tot	P	S	Fl	Tot	
1A2	1	2	-	4	8	2	11	29	5	1	-	11	-	-	-	-	1	-	-	2	5 Mall; 4 goldeneye; 9 Hood
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	1	-	-	2	

Table III-v. The number of waterfowl recorded on 25 km² plots during the Gaspe breeding pair survey, May 2000

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	P	S	Fl	Tot	
1A2	3	-	-	6	2	1	12	17	1	-	3	5	-	-	-	-	-	-	-	-	2 Mall; 2 COGO; 2 HOME
1A3	-	1	3	4	-	-	-	-	1	-	-	2	-	-	-	-	1	-	-	2	
1B6	6	1	-	13	2	-	-	4	1	-	4	6	-	-	-	-	2	-	-	4	
1B8	4	4	4	16	3	1	-	7	3	-	34	40	1	2	-	4	1	-	8	10	3 COGO; 1 HOME; 2 COLO
Total	13	6	7	39	7	2	12	28	6	-	41	53	1	2	-	4	4	-	8	16	

Table III-vi. The number of waterfowl recorded on 25 km² plots during the Gaspe breeding pair survey, May 2001

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	P	S	Fl	Tot	
1B6	6	1	-	13	-	-	9	9	-	-	-	-	-	-	-	-	-	1	-	1	2 HarD; 2 goldeneye
1B8	3	8	-	14	-	-	8	8	2	-	-	4	-	1	-	1	-	-	3	3	3 Mall;9 goldeneye; 6 Hood
1C1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1C5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
TOTAL	9	9	0	27	0	0	17	17	2	0	0	4	0	1	0	1	0	1	3	4	

Table III-vii. The number of waterfowl recorded on 25 km^2 plots during the Gaspe breeding pair survey, May 2002

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	P	S	Fl	Tot	
1C1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	
1C5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	
1D4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1D7	1	2	-	4	2	1	-	5	-	-	-	-	3	-	-	6	-	-	-	-	1 COLO; 2 HOME
TOTAL	1	2	-	4	2	1	-	5	-	-	-	-	3	-	-	6	0	1	3	4	

Table III-viii. The number of waterfowl recorded on 25 km^2 plots during the Gaspe breeding pair survey, May 2003

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	P	S	Fl	Tot	
1A2	2	-	-	4	3	-	39	45	1	-	-	2	-	-	-	-	1	-	-	2	4 MALL;3 pr COGO;2 pr HOME;1 COLO
1A3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2 MALL
1D4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1D7	2	-	-	5*	6	-	11	23	-	-	-	-	-	-	-	-	-	1	-	1	1 MALL*; 1 HOME
TOTAL	4	-	-	9*	9	-	50	68	1	-	-	2	-	-	-	-	1	1	-	3	

* MLBL included in totals for ABDU and MALL

Table III-ix. The number of waterfowl recorded on 25 km^2 plots during the Gaspe breeding pair survey, May 2004

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	P	S	Fl	Tot	
1A2	1	3	-	5	10	-	56	76	-	1	-	1	-	-	-	-	-	1	3	4	7 MALL;11 HOME;5 COLO; 2 NOPI
1A3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1B6	3	2	-	8	4	-	33	41	-	-	-	-	-	-	-	-	1	-	1	3	1 MALL;2 COGO
1B8	2	4	-	8	-	-	3	3	-	1	-	1	-	-	-	-	2	-	-	4	4 COGO; 1 COLO
TOTAL	6	9	-	21	14	-	92	120	-	2	-	2	-	-	-	-	3	1	4	11	

Appendix IV

Analysis of waterfowl data from eastern Canada helicopter surveys 1990 - 2003 by Brian Collins, CWS National Wildlife Research Centre.

Memorandum - Note de Service

2003/Sep/04

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

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

Subject: ANALYSIS OF 2003 BLACK DUCK BREEDING GROUND SURVEY

This report describes the analysis of the 2003 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, substantially increasing the number of plots surveyed and introducing the rotating sampling scheme. 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 be identified. The analysis done this year is based on the plots run at least once between 1996 and 2003 along with the observations made on these 5 km by 5 km plots for the years 1990-1995.

An expansion of the survey was undertaken in 2001. Six new plots were designated in Labrador. In addition a set of 4 plots which had been run in Labrador under a different program were included in the survey analysis. These 10 new plots expand the survey coverage to a larger portion of Labrador but have not been included in the analysis because the area covered by the new surveys isn't defined.

DATA EDITING

The data files were created by appending the 2003 data to a previously created data file covering the years 1990-2002. Except in Newfoundland where a new versionof the entire data file was sent, in order that the historic data on the new Labrdador routes oculd be included.

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 using the rules described in Table 2. Total individuals was simply calculated as the total observed count.

TREND ESTIMATION

The data have been analysis using a new technique this year as described in Appendix A. This analysis is based on fitting a two way model to the data to estimate year and plot effects. The year effects are used to calculate an annual index and the trend is estimated by fitting a curve through these annual indices. The statndard error of the trend is estimated thorugh a jackknife procedure by discarding one route at a time and rerunning the estimation procedure.

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 New Brunswick was partitioned into two subsets (1990-1992) and (1993-2003) due to a change in observer in 1993. The number of plots available for analysis in each year is shown in Table 3

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. Trends are reported for each species whenever there were at least 15 plots which could be analyzed. The annual indices for the trend are shown in Figures 1-15.

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 includes several species for which there wasn't sufficient data to report on the trend analysis and for some species an analysis by strata in which there wasn't sufficent data to provide a trend analysis.

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. Such estimates could be created by scaling the population indices from the trend estimates upward to estiamte the total population.

Table 1: Plots assigned to each rotation group

```
                           Rotation
Stratum    Province        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 43 46
                           B      7 19 28 31 33 34 36 37 40 41 48
                           C      3  4 13 15 20 25 26 27 29 30 35 42 47
                           D      2  8  9 11 12 18 22 23 32 39 44 45
           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
   3       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

M	F	U	Tot	Dabbler Group A	Black Duck	Diver Group B	Ring-necked Duck	Canada Goose	Common Loon
1	0	0	1	1	1	1	1	1	1
0	x	x	1	0	1	0	0	1	1
2	0	0	2	2	1.5	2	2	1	1
1	x	x	2	1	1.5	1	1	1	1
0	x	x	2	0	1.5	0	0	1	1
3	0	0	3	3	3	3	3	1	0
2	x	x	3	2	3	2	2	1	0
1	x	x	3	1	3	1	1	1	0
0	x	x	3	0	3	0	0	1	0
4	0	0	4	4	4	4	4	0	0
3	1	0	4	0	4	3	3	0	0
3	0	1	4	3	4	3	3	0	0
2	x	x	4	2	4	2	2	0	0
1	x	x	4	1	4	1	1	0	0
0	x	x	4	0	4	0	0	0	0
1	x	x	>4	0	0	0	1	0	0
2	x	x	>4	0	0	0	2	0	0
3	x	x	>4	0	0	0	3	0	0
4	x	x	>4	0	0	0	4	0	0
>4	x	x	>4	0	0	0	0	0	0

Dabbler Group A: AGWT AMWI BWTE GADW MALL NOPI NOSH WODU
Diver Group B   : BAGO BLSC BUFF COGO COME GRSC HARD HOME
                   LESC OLDS RBME SUSC WWSC

Table 3: Number of plots used in trend analysis. Plots selected were those surveyed at least once in 1996-2001 and which were surveyed at least twice during 1990-2003

```
            ---------------Stratum--------------
Year     1       2       3       4     Range-wide
1990     47      48      38       9       142
1991     50      48      38      49       185
1992     52      47      38      49       186
1993     48      36      19      29       132
1994     48      37      19      29       133
1995     20      22      17      14        73
1996     39      40      40      32       151
1997     39      41      40      32       152
1998     39      41      40      32       152
1999     39      42      40      32       153
2000     39      40      40      32       151
2001     37      41      40      32       150
2002     38      42      40      32       152
2003     39      41      40      32       152
Overall  78      82      80      64       304
```

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

```
            -------------Area (1000 Sq Km)-------------------
Stratum  Nfld      NS      NB     Que.    Ont.    Overall    Weight

  1              54.8    72.5    43.5              170.8      87.4
  2      186.1                  141.9              328.0     160.0
  3                             241.9              241.9     120.9
  4                             112.9   217.0      329.9     206.2
```

Table 5 Estimated trends 1990-2003. The analysis was based on the 5 km by 5 km sub-plots from the 1990-1995 plots which correspond to the 5 km by 5 km plots were run in 1996-2003

Indicated Pairs

Species	Range-wide		Stratum 1		Stratum 2		Stratum 3		Stratum 4	
Common Loon	226	4.6*	36	-4.8*	71	8.7*	70	4.9*	52	3.5*
Common Merganser	268	1.2	65	3.2	70	2.5	77	-0.9	57	0.8
Red-breasted Merganser	49	-2.6	19	14.9	21	-4.6				
Hooded Merganser	180	4.7*	41	25.0*	22	3.3	62	6.3*	59	2.8*
Mallard	160	5.2*	38	18.6*			50	8.4*	63	5.1*
Black Duck	299	4.3*	75	5.6*	80	4.3*	80	4.4*	64	2.2n
American Wigeon	36	6.5	19	-6.8					15	14.0
Green-winged Teal	259	5.2*	68	7.5*	64	1.9	69	4.9*	60	5.1n
Blue-winged Teal	56	-9.2*	23	-4.8					30	-8.3*
Northern Pintail	16	-2.9								
Wood Duck	118	5.2*	40	12.7*			26	8.7n	42	5.0*
Total Scaup	43	-7.5					21	-16.0		
Ring-necked Duck	282	3.0*	69	5.0*	74	4.1*	79	0.7	61	1.5
Common Goldeneye	235	4.1*	32	8.8	75	2.1n	79	2.3n	52	3.9*
Barrow's Goldeneye	26	-11.6			25	-10.6				
Bufflehead	66	-7.5*					27	-0.1	38	-5.8*
Surf Scoter	47	10.3*			28	10.2*	15	-4.3		
Canada Goose	203	9.1*	33	23.8*	75	6.4*	62	7.9*	36	11.3*

Total Individuals

Species	Range-wide		Stratum 1		Stratum 2		Stratum 3		Stratum 4	
Common Loon	226	4.3*	36	-3.8*	71	8.2*	70	4.8*	52	3.3*
Common Merganser	271	1.0	66	4.7*	70	2.8	78	-0.0	58	0.1
Red-breasted Merganser	58	-1.9	23	17.7	25	-5.1				
Hooded Merganser	188	4.1*	42	15.6*	25	8.1	64	4.0*	59	3.0*
Mallard	164	6.0*	38	18.7*			53	5.6	63	6.3*
Black Duck	300	4.9*	75	7.5*	81	4.2*	80	3.9*	64	2.7*
American Wigeon	37	2.0	19	-6.4					16	9.5
Green-winged Teal	270	3.4*	70	7.5*	67	-1.3	75	1.7	60	3.2
Blue-winged Teal	58	-11.3*	23	-3.9					30	-9.2*
Northern Pintail	18	3.9								
Wood Duck	122	5.8*	43	3.5			27	8.3n	42	6.1*
Total Scaup	51	-14.6*					23	-12.7		
Ring-necked Duck	282	3.0*	69	5.9*	74	2.2	79	-0.3	61	2.1
Common Goldeneye	240	3.4*	33	13.0	76	0.2	79	1.9	54	3.0*
Barrow's Goldeneye	26	-8.0			25	-8.2				
Bufflehead	74	-8.4*					27	-2.8	46	-5.1
Black Scoter	19	-5.8								
Surf Scoter	51	3.6			30	1.9	16	-8.6		
Canada Goose	216	10.7*	34	22.3*	75	6.7*	69	3.5	39	14.4

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

Common Loon

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	4788	1149	4647	1263	4583	1013				
1991	3410	916	8475	2045	5601	1529	18045	3698	35530	4586
1992	3147	802	4467	998	5601	1807	22354	3921	35569	4503
1993	3694	948	10935	2584	7638	2035	24573	5463	46840	6447
1994	2841	753	9930	2294	11202	2887	26849	5294	50822	6496
1995	3410	1523	12525	3394	7967	2070	23566	6657	47468	7901
1996	1749	647	4921	1383	6046	1647	28456	5922	41171	6333
1997	3147	1084	10882	1989	14511	2994	37116	8747	65656	9519
1998	2623	775	10562	2387	8465	1474	26806	5310	48455	6055
1999	1399	445	14059	2766	10158	1923	26806	5375	52422	6359
2000	2273	721	11810	2997	11609	3172	23507	4725	49199	6472
2001	4976	1595	15042	3348	8707	1887	35466	6359	64192	7599
2002	1795	492	16871	3070	7256	1536	38353	7037	64274	7845
2003	1749	482	14722	2005	12577	2498	32580	6064	61627	6875

Common Merganser

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	6094	1405	7928	1688	29532	6071				
1991	7501	1482	12302	2628	36406	6952	34473	5734	90682	9503
1992	4721	1112	10888	2769	28514	4634	35281	5029	79404	7461
1993	7387	2261	2916	1180	19349	4556	28214	6334	57866	8208
1994	3978	1067	6384	2131	19349	4310	34130	7973	63840	9371
1995	5796	1504	9543	2885	19918	3464	13197	3911	48454	6155
1996	10316	2315	9185	2056	16204	3001	30518	5990	66224	7381
1997	7868	1811	10562	2515	28539	4289	36703	7665	83673	9314
1998	7519	2072	12802	2726	19349	3111	16908	3800	56577	5987
1999	9092	2706	11560	3132	22977	3813	21857	5726	65486	8029
2000	10841	3404	10826	2731	25879	3323	35466	6359	83011	8398
2001	15113	3737	13762	3483	26604	3687	35879	8206	91358	10345
2002	11306	2530	11872	2132	43776	5162	40003	7065	106957	9354
2003	9092	2065	11842	2699	26846	3794	39590	7829	87371	9340

Red-breasted Merganser

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	145	145	1367	702	0	0				
1991	0	0	3007	1419	764	562	0	0	3771	1526
1992	0	0	1117	876	509	354	0	0	1626	945
1993	0	0	2551	1636	1018	699	1365	1364	4935	2242
1994	142	142	3546	2521	3055	2566	455	455	7199	3628
1995	0	0	596	596	569	569	0	0	1166	824
1996	350	243	328	328	0	.0	1650	1146	2327	1217
1997	0	0	2880	1168	0	0	825	824	3705	1429
1998	350	349	4801	2367	0	0	0	0	5150	2392
1999	2098	906	625	436	0	0	0	0	2723	1005
2000	1574	682	1640	694	0	0	825	824	4039	1275
2001	1290	580	320	320	0	0	0	0	1610	662
2002	179	179	2812	1141	242	241	412	412	3646	1250
2003	0	0	2240	1202	0	0	0	0	2240	1202

Table 6 continued

Hooded Merganser

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	2176	855	820	462	9165	2548				
1991	273	190	2734	1349	7638	2220	38782	9117	49426	9482
1992	262	183	558	390	4837	1698	39321	6128	44979	6373
1993	284	283	1093	805	8147	2887	33674	9761	43199	10214
1994	994	452	0	0	10183	3874	54152	16710	65330	17159
1995	3069	1351	1193	822	15365	4311	34877	14931	54504	15621
1996	2273	877	2624	1639	6046	2178	34229	6692	45173	7279
1997	1224	492	1600	1310	6046	1915	47838	9145	56709	9447
1998	1574	635	3200	1431	7739	1629	36291	11198	48805	11424
1999	3497	1517	3124	1076	17414	3774	37528	12430	61563	13123
2000	5770	1403	4265	2364	12577	2937	32167	4985	54778	6405
2001	6082	1662	960	707	10642	2605	34229	7389	51913	8040
2002	2692	978	937	691	18865	4572	63922	16370	86416	17039
2003	3497	1114	1280	615	14028	3473	56911	16331	75716	16745

Mallard

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	871	393	0	0	3564	1057				
1991	955	434	273	273	1782	881	55750	10750	58760	10798
1992	656	280	279	279	2546	1073	55750	10521	59230	10583
1993	426	314	729	728	1528	831	50512	9254	53194	9325
1994	426	240	0	0	1528	1112	44141	10035	46095	10099
1995	341	340	1193	1192	1707	1239	41476	19498	44717	19576
1996	1399	714	656	655	5563	1580	64747	13796	72364	13920
1997	1749	891	640	446	4595	1924	55261	13746	62245	13916
1998	1224	423	320	320	4837	1796	36291	9320	42672	9507
1999	5071	1534	312	312	7014	2131	60623	12497	73020	12773
2000	6120	2087	328	328	3144	1167	112585	23688	122177	23811
2001	2765	967	320	320	4595	1861	62272	14608	69952	14761
2002	2871	1136	0	0	5805	1756	51550	10806	60226	11006
2003	4896	1518	640	446	8707	3202	80830	17424	95073	17786

Black Duck

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	51869	9461	51804	9760	56518	6670				
1991	45211	6554	41963	7503	49390	6199	77026	7545	213590	13950
1992	48587	6109	39366	7327	45953	4858	76353	9666	210258	14423
1993	47663	5455	30618	6166	40225	7437	64846	10849	183352	15518
1994	45674	5534	36529	11189	28768	5323	56655	6850	167626	15201
1995	51485	11778	31910	5662	33860	5371	54201	9951	171456	17281
1996	60848	5167	42810	6130	52846	8141	88666	13838	245170	17946
1997	57963	7803	46887	7887	47041	4876	68458	9769	220350	15566
1998	91797	12005	43046	6531	63609	7399	74438	9789	272890	18366
1999	89874	13347	79981	12786	74976	7139	100419	16618	345250	25860
2000	90573	8432	86441	12081	77395	8647	94439	14365	348847	22320
2001	85332	13516	51848	8632	68204	9312	71757	7444	277141	19983
2002	86676	12162	57955	14560	78604	9235	129493	21416	352728	30064
2003	64520	9636	54728	6754	63730	8149	81036	11771	264014	18532

Table 6 continued

American Wigeon

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	2612	1470	0	0	0	0				
1991	1500	783	0	0	0	0	539	376	2039	869
1992	1180	665	0	0	255	254	269	269	1704	761
1993	1989	1444	0	0	0	0	1365	759	3354	1631
1994	2557	1724	0	0	0	0	2275	1473	4833	2268
1995	341	340	0	0	0	0	2828	2826	3169	2847
1996	525	523	0	0	0	0	2474	1097	2999	1216
1997	2798	1670	0	0	726	724	3299	1450	6822	2327
1998	2798	1472	0	0	0	0	825	824	3622	1687
1999	699	335	312	312	0	0	1650	1290	2661	1369
2000	175	174	0	0	0	0	9485	6013	9660	6016
2001	2580	1907	0	0	0	0	1237	909	3817	2112
2002	3769	2723	0	0	0	0	825	573	4593	2782
2003	699	418	0	0	0	0	4949	4536	5648	4555

Green-winged Teal

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	6674	2231	7654	2582	8401	2190				
1991	6410	1730	9841	2879	8147	1609	10773	2389	35171	4425
1992	6032	1686	9772	2199	7128	2974	11850	3265	34783	5213
1993	3978	1244	11299	4615	2546	1246	8646	2097	26469	5367
1994	5399	1401	8512	2791	8147	3408	13197	4033	35254	6135
1995	6137	1907	8947	4260	4553	1682	14139	5074	33776	7096
1996	9092	2034	8529	2324	9432	2059	24744	6028	51798	7080
1997	9792	2117	9601	2334	5805	1374	16496	4916	41694	5999
1998	9442	2084	13442	3529	5805	1756	11547	2696	40236	5210
1999	14338	3167	12809	5216	5563	1542	21445	6228	54155	8855
2000	11540	1769	12794	3199	20800	5040	28456	5492	73589	8302
2001	12164	2864	11202	3379	10400	2277	13197	3881	46962	6314
2002	13279	4087	13747	4441	11609	2568	16496	3451	55131	7412
2003	9967	2570	7041	2051	10158	2609	18558	5825	45724	7179

Blue-winged Teal

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	1451	799	0	0	255	254				
1991	2046	916	0	0	0	0	6733	2403	8779	2571
1992	2229	889	0	0	0	0	5656	2272	7885	2440
1993	1137	618	0	0	0	0	1820	859	2957	1058
1994	1279	560	0	0	0	0	910	631	2189	844
1995	682	681	0	0	0	0	1885	1280	2567	1450
1996	3147	1867	0	0	0	0	4949	3003	8096	3536
1997	699	418	0	0	0	0	3299	2292	3999	2330
1998	874	445	0	0	484	483	2062	1044	3420	1233
1999	1049	532	0	0	242	241	2887	1144	4178	1284
2000	0	0	0	0	242	241	4949	2422	5191	2434
2001	737	352	0	0	242	241	2062	1338	3041	1404
2002	1256	672	0	0	0	0	825	824	2081	1063
2003	874	714	0	0	0	0	2062	860	2936	1118

Table 6 continued

Northern Pintail

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	290	289	547	546	0	0				
1991	0	0	273	273	0	0	269	269	543	383
1992	0	0	0	0	509	354	539	376	1048	517
1993	284	283	0	0	0	0	0	0	284	283
1994	142	142	0	0	0	0	0	0	142	142
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	328	328	726	724	2062	1685	3116	1863
1997	0	0	960	707	242	241	825	824	2027	1112
1998	0	0	0	0	0	0	0	0	0	0
1999	0	0	937	691	0	0	0	0	937	691
2000	0	0	656	655	242	241	0	0	898	698
2001	0	0	640	639	0	0	0	0	640	639
2002	0	0	0	0	0	0	825	824	825	824
2003	0	0	0	0	0	0	0	0	0	0

Wood Duck

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	725	372	0	0	2037	974				
1991	818	461	0	0	509	354	29087	10001	30414	10018
1992	1967	777	0	0	509	354	30164	7644	32640	7691
1993	852	435	0	0	0	0	35495	12466	36347	12474
1994	1563	544	0	0	2546	2070	49147	20646	53255	20757
1995	3751	1673	0	0	5122	2050	32992	21230	41864	21394
1996	2273	676	328	328	726	724	23919	8379	27246	8444
1997	1574	768	640	446	1451	552	32580	15227	36244	15263
1998	2623	1336	0	0	967	674	19795	10961	23385	11063
1999	3497	1692	1250	601	1935	1303	52375	21392	59056	21507
2000	2448	917	656	655	2419	1328	45364	17305	50886	17392
2001	2027	1016	0	0	2902	1048	29693	11476	34622	11569
2002	2153	1091	625	624	2177	946	43302	23422	48257	23475
2003	3147	1025	640	639	2660	1146	55674	23003	62122	23064

Greater Scaup

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	2460	1543	0	0				
1991	0	0	1640	1004	0	0	269	269	1910	1039
1992	0	0	0	0	1528	1124	1347	960	2874	1478
1993	0	0	0	0	2546	1246	0	0	2546	1246
1994	0	0	0	0	2037	1582	455	455	2492	1646
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	1640	1342	0	0	0	0	1640	1342
1997	0	0	960	707	242	241	0	0	1202	747
1998	0	0	1280	1278	0	0	0	0	1280	1278
1999	0	0	312	312	0	0	0	0	312	312
2000	0	0	1968	1105	4353	1828	412	412	6734	2175
2001	0	0	640	639	0	0	0	0	640	639
2002	0	0	2499	1685	0	0	0	0	2499	1685
2003	0	0	1920	1622	0	0	1650	1146	3570	1986

Table 6 continued

Lesser Scaup

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	1367	1119	1782	1021				
1991	0	0	2734	2239	3819	3308	1077	752	7630	4065
1992	0	0	0	0	2800	2795	1077	845	3878	2920
1993	0	0	0	0	509	509	0	0	509	509
1994	0	0	0	0	1018	1017	1820	1818	2839	2084
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	825	824	825	824
1997	0	0	0	0	484	483	0	0	484	483
1998	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	412	412	412	412
2000	0	0	0	0	242	241	0	0	242	241
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	412	412	412	412
2003	0	0	0	0	242	241	0	0	242	241

Ring-necked Duck

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	16685	3120	28978	5718	32587	5587				
1991	15684	3255	33352	7105	22404	4007	57096	8712	128536	12371
1992	12983	2369	23452	5661	20112	3756	65176	8242	121723	10941
1993	15485	3372	26608	7129	23422	6019	48236	9235	113752	13554
1994	14775	3156	24471	6565	25968	5016	47781	7585	112995	11651
1995	16366	5375	14315	3651	27885	5912	35820	11929	94385	14814
1996	15562	2869	20339	4806	20800	4025	54024	8845	110725	11214
1997	18884	3865	20483	6053	33376	5080	47426	8155	120169	11995
1998	21157	3548	22403	5221	21042	3296	33404	7102	98006	10057
1999	30249	6102	23744	4194	35069	6190	45364	9281	134427	13390
2000	24479	3867	41334	10176	43534	5691	54437	8932	163784	15188
2001	26908	4930	50247	10951	30232	5290	42477	8510	149865	15640
2002	23329	4003	50613	12305	16446	3774	61860	10872	152248	17317
2003	21332	4037	32965	6123	38939	6554	67633	14324	160869	17376

Common Goldeneye

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	3482	1715	32805	4631	16803	2906				
1991	1364	951	29798	6051	20876	4192	26932	4544	78970	8703
1992	1705	967	22614	4413	18330	3085	32857	6063	75507	8166
1993	1421	1011	26973	7795	19858	4873	17292	5072	65544	10548
1994	284	198	19151	4964	23422	6457	21843	5484	64700	9821
1995	682	469	25647	6006	14227	4154	16967	6249	57524	9623
1996	1574	1235	29852	5139	16204	2142	35054	7820	82684	9679
1997	3322	1365	29444	5961	18623	3824	37116	8503	88505	11151
1998	2972	1473	30404	6347	14511	3941	21032	4579	68921	8886
1999	2098	834	34679	6436	19107	3517	23094	5193	78979	9026
2000	3847	1849	51175	7503	19349	3033	32580	6537	106950	10566
2001	4792	1823	28164	4854	20074	3582	45776	10251	98806	12033
2002	2871	1509	25931	6194	34586	5443	39178	7521	102566	11262
2003	2448	917	46407	7602	25637	4054	38353	8705	112845	12282

Table 6 continued

Barrow's Goldeneye

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	1367	702	0	0				
1991	0	0	2460	1079	0	0	0	0	2460	1079
1992	0	0	3909	1316	0	0	0	0	3909	1316
1993	0	0	364	364	0	0	0	0	364	364
1994	0	0	0	0	0	0	0	0	0	0
1995	0	0	1193	1192	0	0	0	0	1193	1192
1996	0	0	1312	785	0	0	0	0	1312	785
1997	0	0	960	707	484	337	0	0	1444	783
1998	0	0	3521	1587	0	0	0	0	3521	1587
1999	0	0	625	624	0	0	0	0	625	624
2000	0	0	328	328	0	0	0	0	328	328
2001	0	0	3521	1374	0	0	0	0	3521	1374
2002	0	0	312	312	0	0	0	0	312	312
2003	0	0	0	0	0	0	0	0	0	0

Bufflehead

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	0	0	3055	1099				
1991	0	0	0	0	3310	1831	8618	3062	11928	3568
1992	131	131	0	0	1018	608	11850	2829	13000	2897
1993	142	142	0	0	509	509	1365	759	2016	924
1994	0	0	0	0	1528	1112	5916	2583	7443	2812
1995	0	0	0	0	569	569	1885	1280	2454	1401
1996	0	0	0	0	484	337	8248	2696	8732	2717
1997	0	0	0	0	1451	1068	3712	1478	5163	1823
1998	175	174	0	0	0	0	0	0	175	174
1999	0	0	0	0	0	0	825	824	825	824
2000	0	0	0	0	967	464	4124	1912	5091	1967
2001	0	0	0	0	0	0	2062	860	2062	860
2002	0	0	0	0	4112	1890	9898	3551	14009	4023
2003	0	0	0	0	1451	737	2062	1044	3513	1278

Long-tailed Duck

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	0	0	0	0				
1991	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0
1993	0	0	364	364	0	0	0	0	364	364
1994	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0
1997	0	0	320	320	0	0	0	0	320	320
1998	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	312	312	0	0	0	0	312	312
2003	0	0	0	0	0	0	0	0	0	0

Table 6 continued

Harlequin Duck

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	0	0	0	0				
1991	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0
1997	175	174	0	0	0	0	0	0	175	174
1998	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0
2001	184	184	0	0	0	0	0	0	184	184
2002	0	0	625	624	0	0	0	0	625	624
2003	0	0	0	0	0	0	0	0	0	0

Black Scoter

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	0	0	255	254				
1991	0	0	273	273	1273	1270	0	0	1546	1299
1992	0	0	0	0	1018	709	0	0	1018	709
1993	0	0	0	0	1018	1017	0	0	1018	1017
1994	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	484	337	0	0	484	337
1997	0	0	0	0	0	0	412	412	412	412
1998	0	0	0	0	242	241	0	0	242	241
1999	0	0	625	624	242	241	0	0	867	669
2000	0	0	328	328	484	483	0	0	812	583
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0

White-winged Scoter

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	0	0	0	0				
1991	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	255	254	0	0	255	254
1993	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	1018	1017	0	0	1018	1017
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	825	824	825	824
1999	0	0	312	312	0	0	0	0	312	312
2000	0	0	0	0	0	0	0	0	0	0
2001	0	0	320	320	0	0	0	0	320	320
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0

Table 6 continued

Surf Scoter

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	4101	3099	1018	608				
1991	273	272	3827	2170	1528	1063	0	0	5628	2432
1992	0	0	1954	1194	1018	608	0	0	2973	1340
1993	0	0	5467	3016	0	0	0	0	5467	3016
1994	0	0	4965	2291	509	509	0	0	5474	2346
1995	0	0	1789	1788	1138	1137	0	0	2928	2119
1996	0	0	4265	2410	967	674	0	0	5232	2502
1997	0	0	5441	1829	242	241	0	0	5683	1845
1998	0	0	12162	6346	726	534	412	412	13300	6382
1999	0	0	3437	1344	3144	1672	0	0	6581	2145
2000	525	523	8529	4236	1693	1241	0	0	10747	4445
2001	0	0	15682	8339	726	534	0	0	16408	8356
2002	0	0	9060	4271	0	0	0	0	9060	4271
2003	0	0	15362	8373	3628	2122	412	412	19403	8647

Canada Goose

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	290	202	16676	2989	8147	2045				
1991	409	408	20503	4323	5601	1770	7272	3625	33785	5927
1992	262	183	12843	2535	8911	2285	9965	5132	31980	6166
1993	426	314	22599	5391	7128	2434	4551	2872	34704	6582
1994	284	283	21988	5302	5092	3573	5916	2895	33280	7024
1995	0	0	16701	5734	5691	2995	5656	2665	28047	6996
1996	1224	605	23619	4719	9432	2598	10310	4536	44586	7068
1997	1224	655	24324	4473	6046	1610	11135	4588	42729	6639
1998	1399	621	34245	7488	9674	2103	5774	1866	51092	8023
1999	2448	1131	34679	5048	18139	3645	10722	4245	65989	7620
2000	3147	1342	40022	8900	14270	3279	19795	7896	77234	12414
2001	3133	1105	29124	4401	9916	2253	21857	7311	64031	8895
2002	4127	1321	29681	4684	13060	2712	12372	3345	59240	6498
2003	3322	896	29444	5837	19590	3634	14434	4560	66791	8299

Table 7: Estimated number of total individuals and standard error

Common Loon

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	7835	1729	7108	2099	6619	1673				
1991	5319	1417	12575	3167	7128	1984	28548	5868	53571	7100
1992	4590	1234	7538	1815	7638	2871	37436	6339	57201	7297
1993	5256	1299	16767	3787	11202	3071	37315	7961	70540	9425
1994	4830	1230	16314	3421	16294	4559	44596	8286	82034	10132
1995	5796	2892	19086	5505	11382	3235	36762	10815	73027	12888
1996	3322	1085	7545	2092	8949	2354	42477	8892	62293	9496
1997	4371	1424	16322	3062	22735	4501	60623	14759	104051	15795
1998	4196	1264	15362	3770	12335	2186	39178	7659	71071	8902
1999	2448	809	20933	4142	14753	2993	42065	8081	80199	9595
2000	3147	929	17387	4630	17172	4967	38765	7692	76471	10303
2001	8109	2525	22403	4581	14995	3558	52787	10403	98295	12176
2002	3230	1110	24682	4579	9674	2131	57323	11652	94910	12748
2003	3147	895	22403	3077	16930	3703	51962	9813	94443	10967

Common Merganser

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	21473	6490	14489	3174	54736	10512				
1991	26458	10341	23237	4113	64665	11979	78103	16435	192464	23183
1992	12065	2783	17868	3992	49645	7535	102881	30354	182458	31652
1993	26566	9589	4738	1744	35642	8265	60068	11913	127015	17471
1994	11507	5777	9221	2998	39716	8193	63253	13221	123697	16861
1995	10229	2683	16104	4875	35852	8762	24508	6753	86693	12383
1996	18185	4061	24604	8222	29507	4851	63509	13410	135804	16955
1997	23605	10180	20163	4866	51032	7317	63922	12317	158722	18236
1998	19933	5307	23363	4304	43776	6765	43714	9272	130787	13358
1999	23430	9501	20933	4953	41116	6620	49075	13679	134554	18594
2000	31298	10307	17715	4339	55869	8659	77119	13767	182001	19738
2001	41468	12434	21123	4641	50548	7029	60210	13816	173350	20406
2002	39659	13115	18746	3033	82474	11313	80830	17212	221708	24605
2003	25878	10642	24644	5200	50065	6530	89903	18149	190489	22635

Red-breasted Merganser

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	3192	2900	1914	954	0	0				
1991	0	0	6561	3263	1273	1041	0	0	7834	3425
1992	131	131	2234	1751	1018	709	0	0	3383	1894
1993	0	0	5103	3272	2037	1398	2275	2273	9415	4222
1994	142	142	8157	4718	3564	2686	2730	2302	14594	5899
1995	0	0	1193	1192	569	569	0	0	1762	1321
1996	699	487	656	655	0	0	1650	1146	3005	1407
1997	4896	4882	7681	3453	0	0	1237	1236	13814	6106
1998	4896	4376	8321	4111	0	0	0	0	13217	6005
1999	8743	4964	1250	871	0	0	0	0	9992	5040
2000	2448	1074	3280	1388	0	0	825	824	6553	1939
2001	2580	1159	640	639	0	0	0	0	3220	1324
2002	179	179	4999	2139	484	483	825	824	6487	2349
2003	699	697	5441	2627	0	0	0	0	6140	2718

Table 7 continued

Hooded Merganser

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	3917	1515	1093	656	19858	4912				
1991	1091	736	3280	1677	21895	5081	71101	16282	97367	17154
1992	787	357	838	472	10438	3423	85106	13323	97168	13768
1993	1705	916	2187	1224	23422	7403	72810	17415	100124	18985
1994	2131	1129	355	354	17312	6716	114675	30322	134473	31079
1995	4092	1808	4175	2498	34145	9705	61271	23813	103682	25899
1996	7344	2949	4593	2950	12818	4668	84954	14676	109709	15956
1997	2448	1014	3200	2323	12335	3926	89078	16656	107061	17299
1998	2623	1106	8321	3566	15479	2929	94439	29127	120862	29511
1999	7519	3138	8436	2782	39665	8536	91553	31893	147171	33281
2000	8043	2027	6233	3350	24911	5886	79181	13352	118368	15108
2001	10321	2834	2560	2006	20316	4886	61035	13699	94232	14953
2002	3769	1350	3124	1884	34344	8425	133205	34303	174441	35398
2003	5595	1949	3521	1374	30474	8235	103512	28186	143102	29461

Mallard

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	1306	533	0	0	6110	1872			71783	13395
1991	1091	490	547	546	2546	1073	67600	13332	71783	13395
1992	918	418	558	390	3564	1430	72986	14475	78027	14557
1993	426	314	1093	1092	7638	6593	67349	11413	76506	13230
1994	568	341	0	0	1528	1112	61888	14877	63984	14922
1995	682	681	1193	1192	18210	15876	53730	27216	73815	31538
1996	1749	990	656	655	8223	2333	99388	21478	110016	21637
1997	2273	1040	640	446	5321	2014	73819	17111	82053	17266
1998	1574	584	320	320	6288	2281	59798	16999	67980	17164
1999	7519	2470	312	312	8465	2473	85779	17406	102075	17757
2000	10316	3415	328	328	3870	1538	162898	33686	177412	33895
2001	3502	1308	320	320	5563	2210	83717	18963	93101	19139
2002	3948	1465	0	0	10400	3632	77531	15362	91879	15853
2003	6295	1842	640	446	11851	3666	115472	24801	134257	25142

Black Duck

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	85748	24072	66976	13877	71030	8030			286246	30820
1991	59736	10413	75724	26396	61101	8111	89684	8884	286246	30820
1992	66356	8884	49137	9746	57791	6217	90761	11216	264046	18395
1993	60236	7407	43375	14457	56518	14298	72355	11714	232485	24608
1994	63504	9294	46459	16822	38697	8427	65074	8011	213733	22462
1995	63078	13291	36980	6434	46664	9567	62213	11354	208935	20940
1996	79208	8869	54128	7118	64576	10169	111348	16475	309259	22454
1997	70290	9911	64329	12164	71832	11823	94852	14514	301303	24426
1998	136909	26058	54408	9304	78362	9585	121658	16965	391336	33842
1999	120298	22693	119035	29567	88278	8497	123307	20904	450918	43570
2000	137258	20085	107928	14637	94325	11437	115059	17308	454570	32373
2001	128090	25188	71050	11682	82474	10722	89078	11088	370692	31762
2002	152894	28170	79981	21854	98920	11410	152175	24694	483970	44845
2003	87775	17600	69450	8635	81506	11147	95677	13664	334408	26368

Table 7 continued

American Wigeon

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	10446	7145	0	0	0	0				
1991	4637	3072	0	0	0	0	3232	2257	7869	3812
1992	5246	3789	0	0	509	508	539	538	6293	3861
1993	9092	5108	0	0	0	0	3185	1556	12278	5339
1994	4688	2926	0	0	0	0	4551	2946	9239	4152
1995	682	681	0	0	0	0	3771	3769	4452	3830
1996	699	697	0	0	0	0	7836	3494	8535	3563
1997	7344	4123	0	0	726	724	6598	2712	14668	4988
1998	5420	2784	0	0	0	0	1650	1648	7070	3235
1999	1224	605	625	624	0	0	3299	2580	5148	2722
2000	350	349	0	0	0	0	18558	12025	18908	12030
2001	7188	5773	0	0	0	0	2062	1463	9250	5956
2002	9511	5755	0	0	0	0	1650	1146	11161	5868
2003	1224	701	0	0	0	0	9485	8663	10709	8691

Green-winged Teal

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	48315	25007	27337	12101	34369	8221				
1991	19639	6718	38819	22552	22658	4204	31241	9662	112358	25782
1992	35407	15263	22056	4832	20367	7523	21007	5376	98837	18488
1993	23725	8763	14944	5864	5092	2380	11832	3093	55593	11243
1994	25288	8206	14541	5917	13239	5237	24573	8964	77640	14495
1995	12616	4615	13122	5591	8536	2857	18853	7146	53126	10573
1996	30424	7384	20339	5450	44986	11962	90315	31189	186064	34642
1997	27801	10460	18883	5257	12577	2726	27631	7209	86891	14016
1998	28501	9528	19203	4993	9191	2515	16084	3636	72978	11630
1999	48958	18471	41553	24560	10884	2704	34229	9012	135624	32139
2000	74836	26730	23619	6262	62641	17398	76294	19366	237391	37834
2001	40547	11779	14402	4571	15721	3554	20620	5797	91289	14348
2002	42351	12079	24369	8019	29507	6174	28043	6256	124270	16955
2003	48609	24785	10882	2962	18865	4650	39178	16973	117533	30542

Blue-winged Teal

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	5513	2362	0	0	509	508				
1991	4910	2118	0	0	0	0	13735	4495	18645	4969
1992	5639	2610	0	0	0	0	10773	3892	16412	4686
1993	5541	3408	0	0	509	509	2730	1369	8780	3707
1994	3694	1716	0	0	0	0	1365	1002	5059	1987
1995	1364	1362	0	0	0	0	2828	2041	4192	2453
1996	5595	3350	0	0	0	0	8660	5476	14256	6419
1997	4196	2877	0	0	484	483	4949	3636	9629	4662
1998	1749	891	0	0	967	965	3299	1872	6015	2287
1999	2098	1064	0	0	484	483	5361	2203	7943	2494
2000	0	0	0	0	242	241	7836	3736	8077	3744
2001	1474	704	0	0	484	483	3299	2214	5257	2373
2002	2153	1178	0	0	0	0	1237	1236	3391	1707
2003	3147	2964	0	0	0	0	3299	1450	6447	3300

Table 7 continued

Northern Pintail

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	580	578	1093	1091	1018	797				
1991	0	0	547	546	0	0	539	538	1085	766
1992	0	0	0	0	764	562	808	596	1572	819
1993	284	283	0	0	0	0	0	0	284	283
1994	284	283	0	0	0	0	910	909	1194	952
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	328	328	1693	1690	4124	3371	6145	3785
1997	0	0	960	707	484	483	1237	1236	2681	1503
1998	0	0	0	0	0	0	0	0	0	0
1999	0	0	6561	6239	0	0	0	0	6561	6239
2000	0	0	656	655	484	483	2887	2883	4027	2996
2001	0	0	1280	1278	0	0	0	0	1280	1278
2002	0	0	0	0	0	0	1650	1648	1650	1648
2003	0	0	0	0	0	0	0	0	0	0

Wood Duck

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	1886	1027	0	0	3564	1724				
1991	1364	644	0	0	764	562	39860	15051	41987	15076
1992	4459	1526	0	0	1018	709	37436	9915	42913	10057
1993	3410	1295	0	0	0	0	45051	15336	48461	15391
1994	5825	1606	0	0	3564	3066	63253	27667	72642	27882
1995	5114	2257	0	0	7967	3539	43361	28283	56442	28593
1996	2972	1024	656	655	2177	1745	32992	10913	38797	11118
1997	2273	1098	640	446	2660	1092	48251	21621	53824	21681
1998	4022	2025	0	0	2177	1065	29280	14542	35479	14721
1999	4022	1898	1562	799	2660	1985	77531	29071	85775	29211
2000	3322	1220	656	655	4595	2516	65984	25946	74557	26105
2001	2580	1246	0	0	4837	1925	41240	15588	48657	15756
2002	2333	1237	937	936	3386	1642	65984	32264	72640	32343
2003	4546	1330	640	639	4112	1580	72170	28854	81468	28935

Greater Scaup

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	3554	2091	0	0				
1991	0	0	2734	1457	0	0	539	538	3272	1553
1992	0	0	2234	2230	3564	2877	2155	1505	7952	3939
1993	0	0	0	0	4583	2380	0	0	4583	2380
1994	0	0	0	0	12220	9489	455	455	12675	9500
1995	0	0	0	0	0	0	20738	20727	20738	20727
1996	0	0	8529	6180	1451	1448	0	0	9980	6348
1997	0	0	1920	1415	16204	14111	10310	10297	28435	17526
1998	0	0	2560	2556	0	0	0	0	2560	2556
1999	0	0	2499	1958	0	0	0	0	2499	1958
2000	0	0	14434	9130	10158	4851	1650	1648	26242	10470
2001	0	0	960	959	0	0	0	0	960	959
2002	0	0	4062	2697	0	0	0	0	4062	2697
2003	0	0	4481	3872	0	0	6186	5056	10667	6368

Table 7 continued

Lesser Scaup

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	4101	3578	5092	3691				
1991	0	0	10115	9296	7128	6112	9157	6220	26400	12746
1992	0	0	0	0	10693	10672	12927	12632	23620	16536
1993	0	0	0	0	1018	1017	0	0	1018	1017
1994	0	0	0	0	2037	2035	16837	12428	18874	12594
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	14022	14005	14022	14005
1997	0	0	0	0	484	483	2474	2471	2958	2518
1998	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	412	412	412	412
2000	0	0	0	0	242	241	0	0	242	241
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	825	824	825	824
2003	0	0	0	0	484	483	0	0	484	483

Ring-necked Duck

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	45703	10557	72991	25540	70266	12422				
1991	44870	8374	79552	20674	44044	7317	110961	17568	279426	29321
1992	37506	7839	50533	11090	51936	9365	132237	21005	272212	26709
1993	49865	11442	65245	20284	49899	11575	82821	14700	247831	29873
1994	38358	8267	43976	15561	52954	12419	106939	18450	242228	28375
1995	50462	15003	29226	11951	54062	11753	65984	18499	199734	29125
1996	56827	12610	38054	11508	45711	12049	111760	20209	252351	29070
1997	69416	13514	36485	12383	61916	11120	85779	15331	253596	26356
1998	55778	10515	38406	7716	38455	5611	61860	12616	194498	18993
1999	79382	16780	48426	8980	61916	10787	88666	17816	278390	28213
2000	88650	26567	76107	19074	82232	11116	112585	18432	359573	39153
2001	98418	23980	94414	22166	55385	9704	84129	17494	332346	38296
2002	84881	19743	103413	27349	39181	9243	138978	24352	366454	42617
2003	67143	13100	59209	12063	68446	11871	146402	32837	341199	39196

Common Goldeneye

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	6384	2919	94314	22845	33351	5913				
1991	15275	12292	68890	17144	42262	8403	59520	11765	185947	25574
1992	4196	2412	53046	11984	35642	5996	67869	13488	160754	19165
1993	2131	1569	61236	20414	37679	8866	35950	10342	136995	24592
1994	710	417	51424	15370	38697	9407	43231	14227	134062	22963
1995	1023	745	43541	10649	21625	6501	45246	14013	111435	18777
1996	5595	3531	56096	11840	28056	4116	130730	59706	220477	61110
1997	6120	2593	47047	9398	46437	12402	69283	16603	168886	22903
1998	8568	3530	56648	12357	27572	7198	51550	16941	144338	22449
1999	3672	1673	79044	13383	34586	6484	53612	13286	170913	20012
2000	7519	3548	105960	14838	40632	7286	75057	16277	229167	23469
2001	9584	3922	56968	9248	35795	7302	87841	21063	190188	24452
2002	3948	2260	52175	13059	55627	9261	74644	15632	186395	22489
2003	11890	8749	90893	15672	47162	8746	65571	15518	215517	25288

Table 7 continued

Barrow's Goldeneye

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	2460	1331	0	0				
1991	0	0	4101	2142	0	0	0	0	4101	2142
1992	0	0	8097	3250	0	0	0	0	8097	3250
1993	0	0	364	364	0	0	0	0	364	364
1994	0	0	0	0	0	0	0	0	0	0
1995	0	0	1789	1788	0	0	0	0	1789	1788
1996	0	0	2296	1475	0	0	0	0	2296	1475
1997	0	0	1600	1139	484	337	0	0	2084	1188
1998	0	0	5441	2420	0	0	0	0	5441	2420
1999	0	0	1250	1248	0	0	0	0	1250	1248
2000	0	0	656	655	0	0	0	0	656	655
2001	0	0	5761	2290	0	0	0	0	5761	2290
2002	0	0	625	624	0	0	0	0	625	624
2003	0	0	0	0	0	0	0	0	0	0

Bufflehead

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	0	0	10183	3695				
1991	0	0	0	0	7892	3108	17237	6112	25129	6857
1992	3410	3266	0	0	1782	953	54672	17573	59864	17899
1993	284	283	0	0	1018	1017	1820	1080	3123	1510
1994	0	0	0	0	3055	2097	25028	11636	28083	11824
1995	0	0	0	0	1138	1137	10369	3954	11507	4114
1996	0	0	0	0	967	674	29280	8343	30248	8370
1997	0	0	0	0	6046	4243	23507	7711	29553	8801
1998	350	349	0	0	0	0	0	0	350	349
1999	0	0	0	0	0	0	4124	2926	4124	2926
2000	0	0	0	0	1451	737	17321	6989	18772	7027
2001	0	0	0	0	0	0	3712	1592	3712	1592
2002	0	0	0	0	8707	4058	31342	9334	40049	10178
2003	0	0	0	0	2177	1065	6598	2959	8775	3145

Long-tailed Duck

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	0	0	0	0				
1991	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0
1993	0	0	729	728	3055	3052	0	0	3784	3138
1994	0	0	0	0	0	0	27759	18531	27759	18531
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0
1997	0	0	640	639	0	0	0	0	640	639
1998	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	3712	3707	3712	3707
2000	0	0	0	0	0	0	825	824	825	824
2001	0	0	0	0	0	0	0	0	0	0
2002	0	0	312	312	0	0	0	0	312	312
2003	0	0	0	0	0	0	0	0	0	0

Table 7 continued

Harlequin Duck

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	0	0	0	0				
1991	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0
1997	350	349	0	0	0	0	0	0	350	349
1998	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0
2001	369	368	0	0	0	0	0	0	369	368
2002	0	0	1562	1560	0	0	0	0	1562	1560
2003	0	0	0	0	0	0	0	0	0	0

Black Scoter

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	0	0	509	508				
1991	0	0	1914	1654	7383	5295	269	269	9566	5554
1992	0	0	0	0	5092	3312	0	0	5092	3312
1993	0	0	3280	3276	5601	5595	0	0	8881	6484
1994	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	726	534	0	0	726	534
1997	0	0	0	0	8707	6220	825	824	9532	6275
1998	0	0	0	0	4112	2991	0	0	4112	2991
1999	0	0	937	936	7014	4961	0	0	7951	5049
2000	0	0	2296	1984	967	965	0	0	3264	2207
2001	0	0	0	0	7256	7241	0	0	7256	7241
2002	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	0

White-winged Scoter

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	0	0	0	0				
1991	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	255	254	0	0	255	254
1993	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	15275	10590	53697	50886	68972	51977
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	4353	4344	0	0	4353	4344
1998	0	0	0	0	0	0	1650	1648	1650	1648
1999	0	0	625	624	0	0	6598	6590	7223	6620
2000	0	0	0	0	0	0	0	0	0	0
2001	0	0	640	639	0	0	0	0	640	639
2002	0	0	1875	1872	0	0	0	0	1875	1872
2003	0	0	0	0	0	0	0	0	0	0

Table 7 continued

Surf Scoter

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	0	0	15582	11124	3310	1794			16897	8483
1991	409	408	13942	8286	2546	1772	0	0	16251	10330
1992	0	0	13959	10230	2291	1431	0	0	16251	10330
1993	0	0	19683	10882	0	0	0	0	19683	10882
1994	0	0	17732	8871	8656	7641	0	0	26388	11708
1995	0	0	10140	7316	2276	2274	0	0	12416	7662
1996	0	0	10498	6120	1693	1192	0	0	12191	6235
1997	0	0	12802	5326	3144	2686	0	0	15946	5965
1998	0	0	25604	15139	1209	989	1237	1236	28050	15222
1999	0	0	7186	2866	5563	3109	0	0	12749	4228
2000	699	697	24604	10323	3870	2464	0	0	29173	10636
2001	0	0	30404	16524	1451	1011	2887	2883	34742	16804
2002	0	0	31868	13521	0	0	0	0	31868	13521
2003	874	872	31365	17505	8707	5496	825	824	41771	18387

Canada Goose

Year	--Stratum 1--		--Stratum 2--		--Stratum 3--		--Stratum 4--		-----Total-----	
1990	435	320	34992	8449	71284	28213			97322	29567
1991	682	679	42920	10678	39716	26772	14005	6557	97322	29567
1992	6164	5748	28198	6235	17821	4811	37166	23761	89349	25684
1993	568	445	47020	12403	104381	68363	6371	3561	158340	69571
1994	568	566	44685	11804	8656	5954	8646	3886	62556	13791
1995	1705	1702	34594	10154	8536	4050	13197	8062	58032	13689
1996	2798	1315	44615	9345	46437	25543	199601	120124	293450	123172
1997	5595	2381	57288	13860	82232	71470	31755	14735	176870	74316
1998	3322	1271	57288	12995	26363	9391	12372	4620	99345	16734
1999	5420	2893	100289	30608	36762	11303	120008	102624	262480	107725
2000	6469	3059	76435	19193	45227	11128	85779	48789	213911	53684
2001	6635	2757	46727	8185	22735	7749	70933	39643	147029	41306
2002	7896	2386	88104	27625	83199	37303	20208	5614	199407	46817
2003	11540	5151	48967	11057	178975	83603	830983	802382	1070466	806818

APPENDIX A Estimation Of Annual Indices and Trend

A1 Model for Annual Index

Let y_{ij} denote the observed count on plot i in year j and z_{ij} be an indicator variable which shows whether the observations was taken.

$z_{ij} = 1$ if and observation was made on plot i in year j

$z_{ij} = 0$ otherwise

The y_{ij} will be assumed to have a Poisson distribution with expected value λ_{ij} i.e.

$$P(y) = \frac{\lambda_{ij}^{y} \exp(-\lambda_{ij})}{y!}$$

The expected value will be assumed to have the structure

$$\lambda_{ij} = \exp(\mu + \alpha_i + \beta_j + \gamma_{i(k)})$$

where
μ denotes the overall average
α_i denotes the effect of route i
β_j denotes the effect of year j and
$\gamma_{i(k)}$ denotes the effect of the observer.

Multiplying the probability terms together and taking logarithms gives the log-likelihood equation

$$L = \sum_{i}^{n} \sum_{j}^{m} z_{ij} \{ y_{ij} (\mu + \alpha_i + \beta_j + \gamma_{i(k)}) - \exp(\mu + \alpha_i + \beta_j + \gamma_{i(k)}) - \ln(y_{ij}) \} \qquad (1)$$

The maximum likelihood estimates of the parameters are the solution to the following set of equations

$$\sum_{i}^{n} \sum_{j}^{m} z_{ij} \{ y_{ij} - \exp(\hat{\mu} + \hat{\alpha}_i + \hat{\beta}_j + \hat{\gamma}_{i(k)}) \} = 0 \qquad (2)$$

$$\sum_{i}^{n} z_{ij} \{ y_{ij} - \exp(\hat{\mu} + \hat{\alpha}_i + \hat{\beta}_j + \hat{\gamma}_{i(k)}) \} = 0 \qquad (3)$$

$$\sum_{j}^{m} z_{ij} \{ y_{ij} - \exp(\hat{\mu} + \hat{\alpha}_i + \hat{\beta}_j + \hat{\gamma}_{i(k)}) \} = 0 \qquad (4)$$

$$\sum_{i \in k}^{n} z_{ij} \{ y_{ij} - \exp(\hat{\mu} + \hat{\alpha}_i + \hat{\beta}_j + \hat{\gamma}_{i(k)}) \} = 0 \qquad (5)$$

where the summation in equation (5) extends over the years with observations in conditions block k.

A2 Estimating the Model Parameters

The maximum likelihood estimators can't be written in closed form and the estimates are created through an iterative scheme.

Initial estimates were set to $\hat{\alpha}_i^{(0)} = 0$, $\hat{\beta}_j^{(0)} = 0$, $\hat{\gamma}_{i(k)}^{(0)} = 0$ and

$$\hat{\mu}^{(0)} = \frac{\sum\limits_i^n \sum\limits_j^m z_{ij} y_{ij}}{\sum\limits_i^n \sum\limits_j^m z_{ij}} \quad \text{(i.e. the average of all observations)}$$

Given the estimates at step g ($\alpha_i^{(g)}, \beta_j^{(g)}, \gamma_{i(k)}^{(g)}$) the estimates for the next step are calculated as

$$\sum\limits_i^n z_{ij} \left\{ y_{ij} - \exp(\hat{\mu}^{(0)} + \hat{\alpha}_i^{(g+1)} + \hat{\beta}_j^{(g)} + \hat{\gamma}_{i(k)}^{(g)}) \right\} = 0 \tag{6}$$

$$\sum\limits_j^m z_{ij} \left\{ y_{ij} - \exp(\hat{\mu}^{(0)} + \hat{\alpha}_i^{(g+1)} + \hat{\beta}_j^{(g+1)} + \hat{\gamma}_{i(k)}^{(g)}) \right\} = 0 \tag{7}$$

$$\sum\limits_{i \in k}^n z_{ij} \left\{ y_{ij} - \exp(\hat{\mu}^{(0)} + \hat{\alpha}_i^{(g+1)} + \hat{\beta}_j^{(g+1)} + \hat{\gamma}_{i(k)}^{(g+1)}) \right\} = 0 \tag{8}$$

The left hand sides of equations (6)-(8) each have only one unknown variable and are monotone decreasing functions. The solution is derived by initially calculating the equation at the current level of the parameter and then stepping up or down by one unit until the solution is bounded. The bounded solution is then refined using a binary search.

When the iteration is completed the change in the parameter estimates is calculated

$$C^{(g)} = \sum\limits_i^n (\alpha_i^{(g)} - \alpha_i^{(g+1)})^2 + \sum\limits_j^m (\beta_j^{(g)} - \beta_j^{(g+1)})^2 + \sum\limits_i^n \sum\limits_k (\gamma_{i(k)}^{(g)} - \gamma_{i(k)}^{(g+1)})^2 \quad \text{The iterations}$$

continue until $C^{(g)} < 0.001$

In the above algorithm the estimate, $\hat{\mu}^{(0)}$, is never updated by the iteration steps. This is because this is a redundant parameter that can be set arbitrarily. When the iterations have converged the estimates are adjusted to fit the constraints

$$\sum\limits_k \hat{\gamma}_{i(k)} = 0 \text{ for all i, } \sum\limits_i^n \hat{\alpha}_i = 0 \text{ and } \sum\limits_j^m \beta_j = 0 \text{ as follows. If G denotes the last iteration then the}$$

conditions block effects are adjusted to sum to zero within each route as follows.

$$\bar{\gamma}_i^{(G)} = \sum\limits_k \hat{\gamma}_{i(k)}^{(G)} / K_i$$

$$\hat{\gamma}_{i(k)} = \hat{\gamma}_{i(k)}^{G} - \overline{\gamma}_{i}^{(G)}$$

$$\hat{\alpha}_{i}^{(G+1)} = \hat{\alpha}_{i}^{(G)} + \overline{\gamma}_{i}^{(G)}$$

The route effects and block effect are then adjusted to that they each sum to zero through the following calculations.

$$\overline{\alpha}^{(G+1)} = \sum_{i}^{n} \hat{\alpha}_{i}^{(G+!)} / n \qquad\qquad \overline{\beta}_{j}^{(G)} = \sum_{j}^{m} \hat{\beta}_{j}^{(G)} / m$$

$$\hat{\alpha}_{i} = \hat{\alpha}_{i}^{(G+1} - \overline{\alpha}_{I}^{(G+1)} \qquad\qquad \hat{\beta}_{j} = \hat{\beta}_{j}^{(G)} - \overline{\beta}_{j}^{(G)} \qquad\qquad \hat{\mu} = \hat{\mu}^{(0)} + \overline{\alpha}^{(G+1)} + \overline{\beta}^{(G)}$$

The adjustments retain the same predicted count for every observation.

1.3 Annual Indices and Trend

The annual population index is calculated as

$$I_{j} = \left(\frac{\sum_{i} w_{i} v_{ij}}{\sum_{i} w_{i} u_{ij}} \right) \exp(\hat{\mu} + \hat{\beta}_{j}) \qquad\qquad (10)$$

The term in brackets in equation (9) scales the index downward to reflect the fact that the model can only be applied to a portion of the data set. This is an estimate of the count that would have been observed in year j if all routes had been run under average conditions.

The adjustment for number of routes observed in a given region can affect the interpretation of the data. An example is shown in Table 11. In this example 3 out of 4 routes could be used in the model fit. For route 3, however, only the data for the first block can be used in the analysis. If the adjustment for number of routes wasn't included then the fact that the species has disappeared from the route would be ignored in the analysis. Another affect of adjusting for the number of routes, is to take into account the proportion of routes on which the species is seen. As routes are discarded and introduced over time as volunteers retire or are recruited into the survey. In the example in Table 11, route 4 in introduced in the 7-th year. The fact that the proportion of routes where the species isn't seen changes from 100% in the beginning to only 50% in the latter years is accounted for by the term in brackets in equation (9).

For year in which the species is never sighted the annual index is set to zero. This is the maximum likelihood estimate in this situation but inclusion of this year in the model fitting process would have caused difficulties for the computer algorithm.

An estimate of trend in the ln scale can be placed through the annual indices as follows

$$\tau = \frac{\sum_{j} (x_{i} - \overline{x}) \ln(I_{j})}{\sum_{j} (x_{i} - \overline{x})^{2}} \qquad\qquad (11)$$

where x_{j} denotes the actual j-th year of observation, $\overline{x}$ denotes the average of all years of observations. The summation extends over all years in which the annual index isn't equal to zero.

1.4 Estimation of Standard Error

The standard error of the annual index is estimated through a jack-knife procedure. In this algorithm, pseudo-replicates are created through discarding one route at a time and recalculating the annual index and trend. The variability among the pseudo-replicates is used to estimate the variance of the annual index and trend. In the calculation implemented in the program all routes (including those in which the species was never seen) were used in the calculation of the variance. Because the number of routes visited varies among years the number of pseudo-replicates varies among the annual indices.

The complete variance-covariance matrix of the annual indices could be estimated using the jack-knife procedure but because the number of observations varies among years the number of observations used to create each entry in the table will be different. Such complexities may limit the usefulness of the estimated matrix. The estimation of the complete variance-covariance matrix hasn't been implemented.

1.5 Accuracy of Model Fitting

Since the maximum likelihood estimates can't be written in closed form, the estimates are computed through algorithms to find the solution of various equations. The algorithms involve an iterative search routine as described in section A2 above. The criterion for convergence is given by equation (9). Using a smaller value for the tolerance provides a more accurate estimate however the algorithm will take longer to run.

To select a suitable tolerance, the algorithm was run with the tolerance set to 10^{-10} (i.e. log(tol)=-10). This was assumed to provide an accurate estimate of the best model fit. The program was then run with the log(tol) =-4, -5,...,-9 and the resulting annual indices and their standard errors were compared with those when log(tol)=-10.

$$rel_j(\log(tol)) = \frac{\left| I_j(\log(tol)) - I_j(-10) \right|}{I_j(-10)}$$

where $I_j(\log(tol))$ denotes the annual index in year j estimated with convergence criteria tol. A similar calculation was done for the estimated standard error.

The model was fitted for 10 species for a 32-year time frame and the maximum value of the relative absolute error is shown in Table 1.2. It can be seen that the accuracy increases as the tolerance is reduced but that there is little change for log(tol) <-8. Setting log(tol)=-8 provides estimates which are accurate to at least 4 decimal places for the annual index and 3 decimal places for the standard error.

REFERENCES

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

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Table 1.1 Adjustment for number of routes included in the analysis.

Route	Year 1	2	3	4	5	6	7	8
1	X	X	X	-	X	-	X	X
2	X	- X	X X	X	X	X	X	X
3	X	X	-	X	0	0	0	0
4							0	0

x denotes an observed non-zero species count
0 denotes an observed count of zero
-    denote a missing observation
A set of observations enclosed in a box denotes observations taken under the same conditions. i.e. by the same observer.

Table 1.2: Maximum relative absolute difference between annual indices and their standard errors fitted with difference tolerance levels

	----------Maximum Relative Error----------	
log(tol)	Annual Index	SE of Annual Index
-4	0.0250	0.0556
-5	0.0213	0.0233
-6	0.0213	0.0127
-7	0.0068	0.0053
-8	0.0001	0.0017
-9	0.0001	0.0015

Figure 1 Indicated Pairs for Common Loon
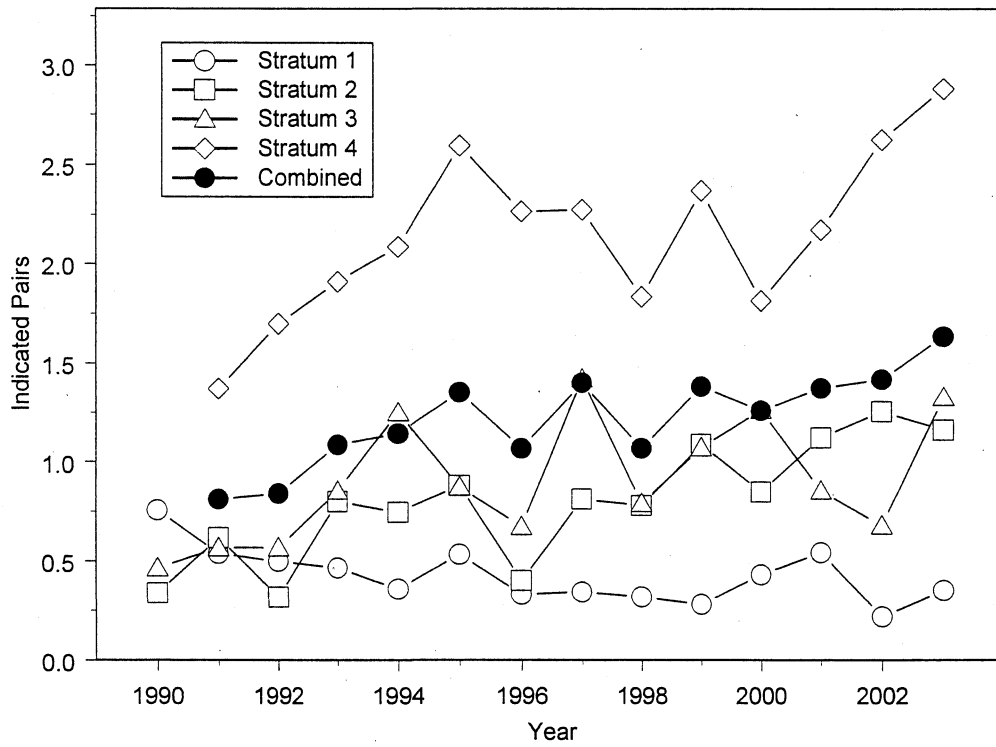
Figure 2 Indicated Pairs for Common Merganser
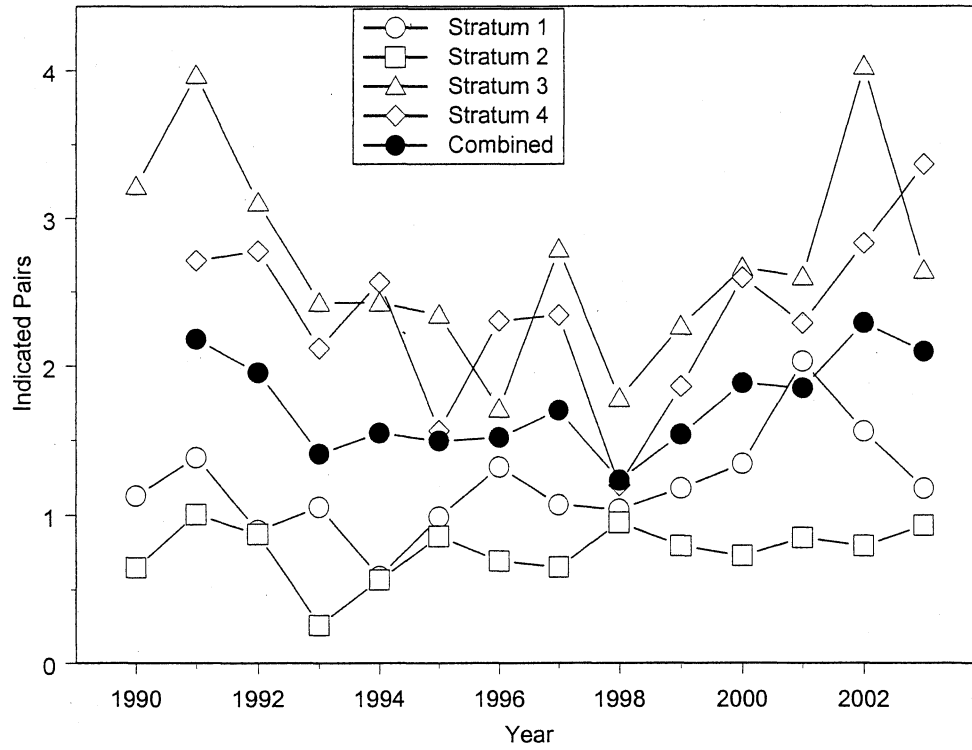
Figure 3 Indicated Pairs for Red-breasted Merganser
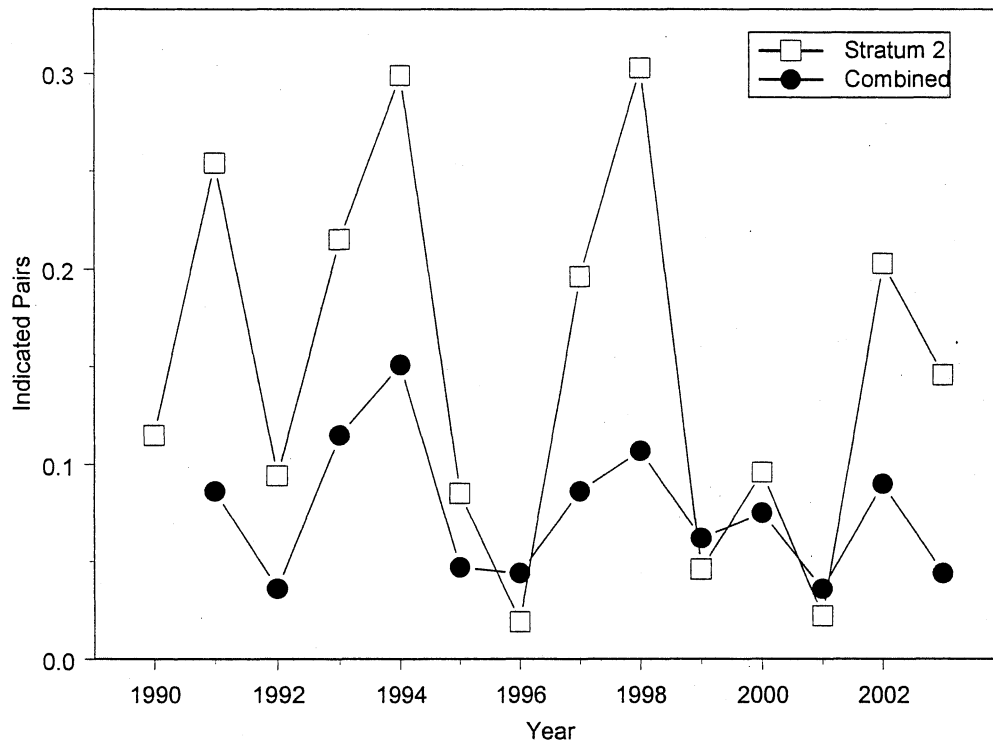
Figure 4 Indicated Pairs for Hooded Merganser
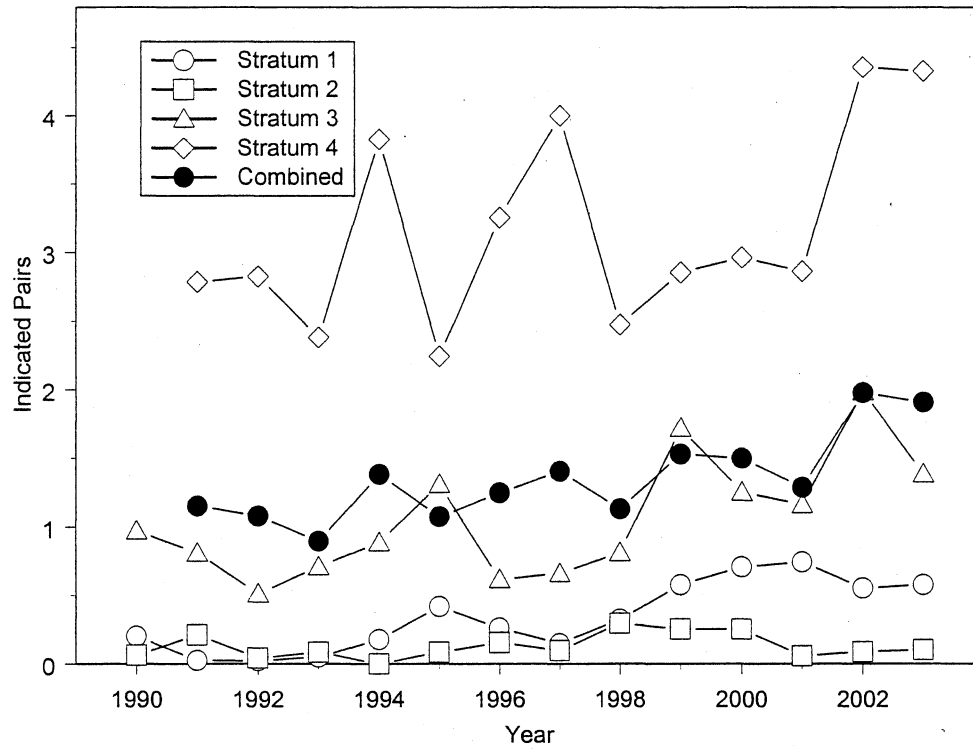
Figure 5 Indicated Pairs for Mallard
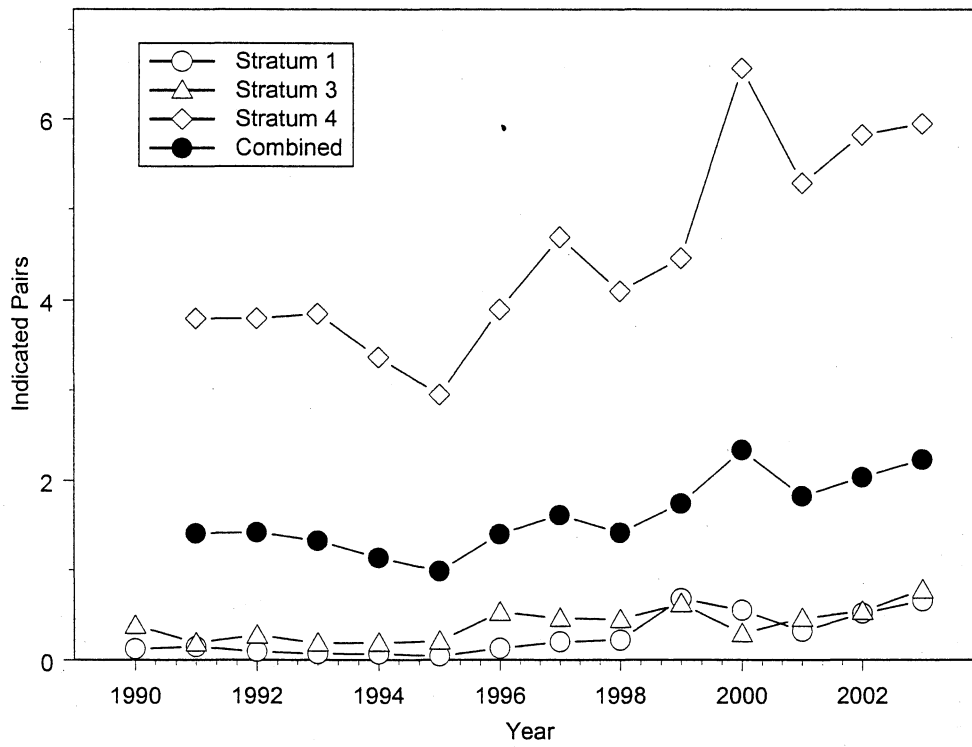
Figure 6 Indicated Pairs for Black Duck
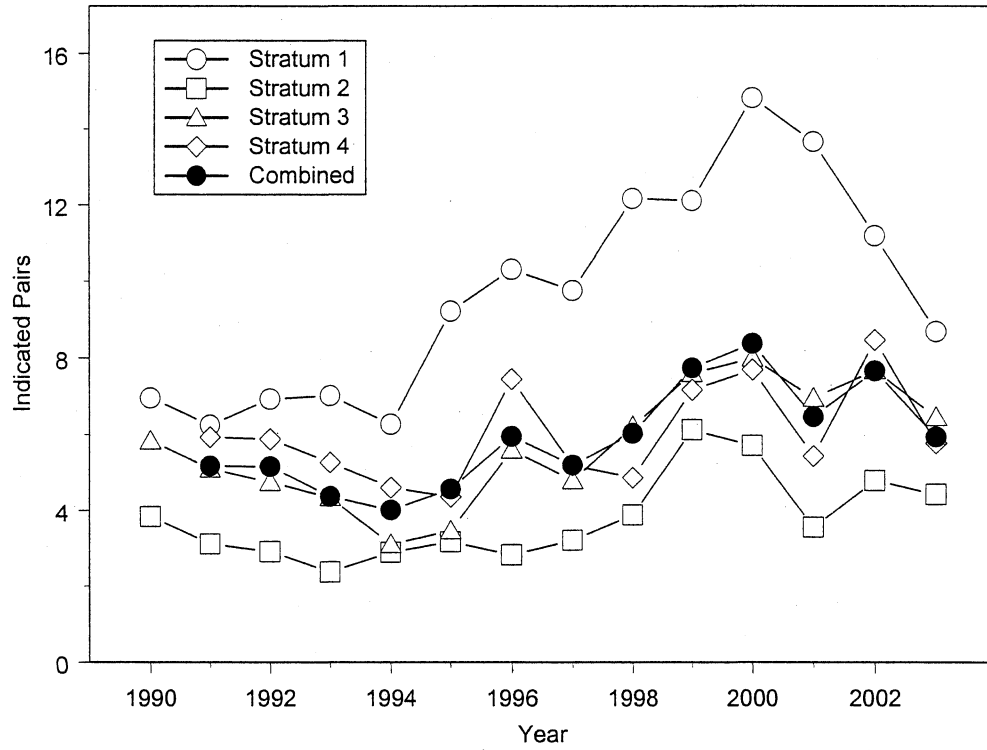
Figure 7 Indicated Pairs for American Wigeon
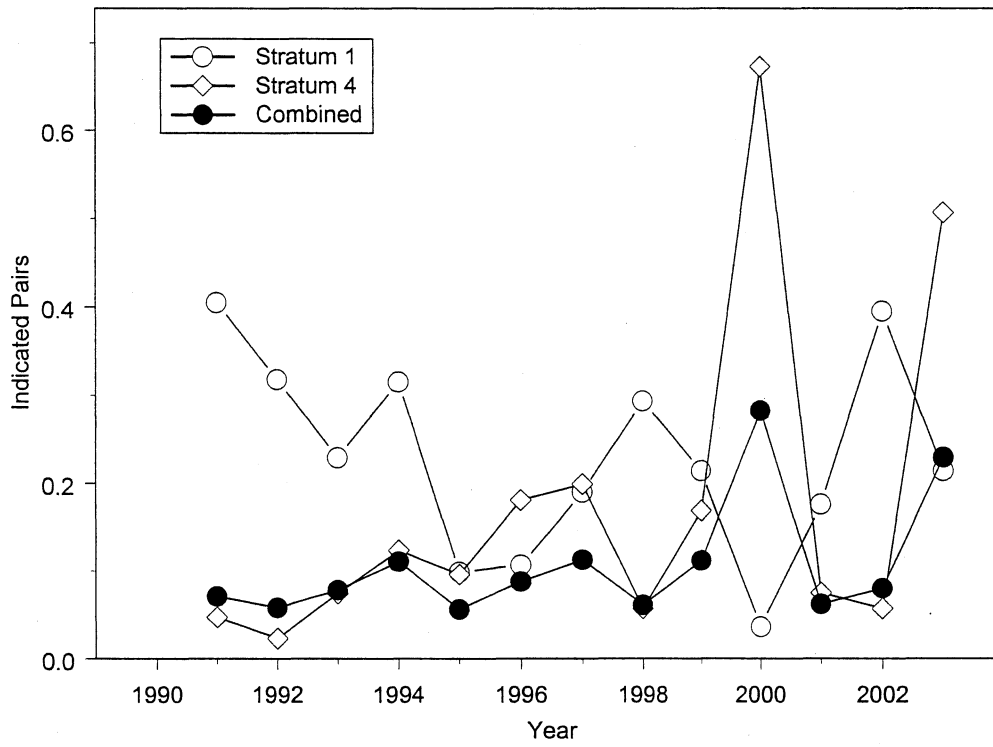
Figure 8 Indicated Pairs for Green-winged Teal
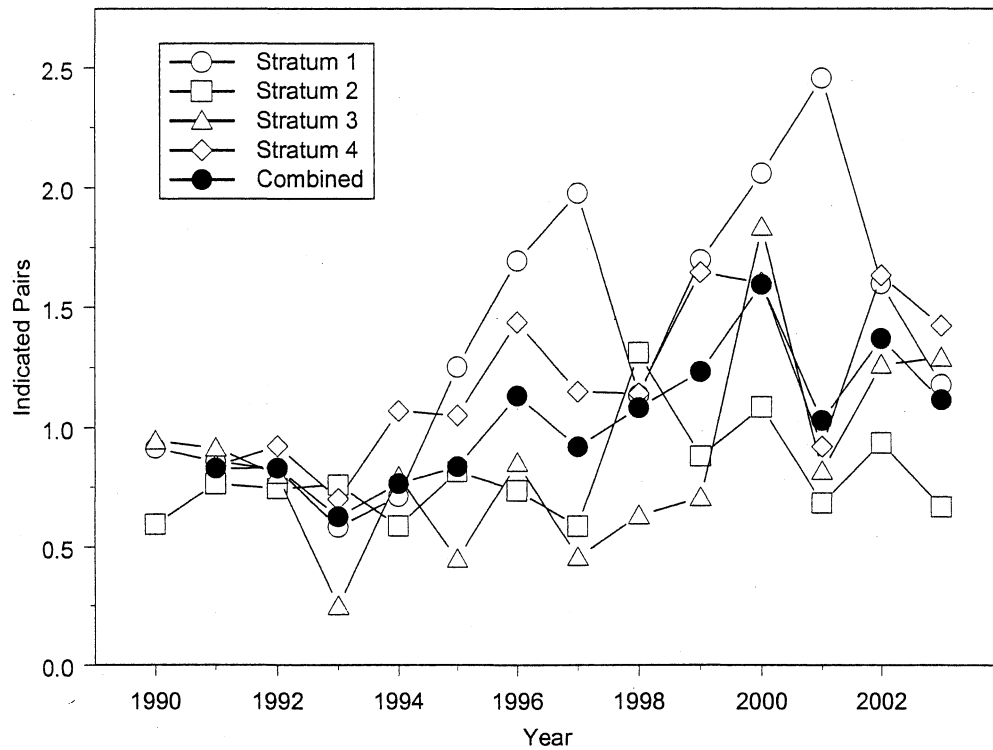
Figure 9 Indicated Pairs for Blue-winged Teal
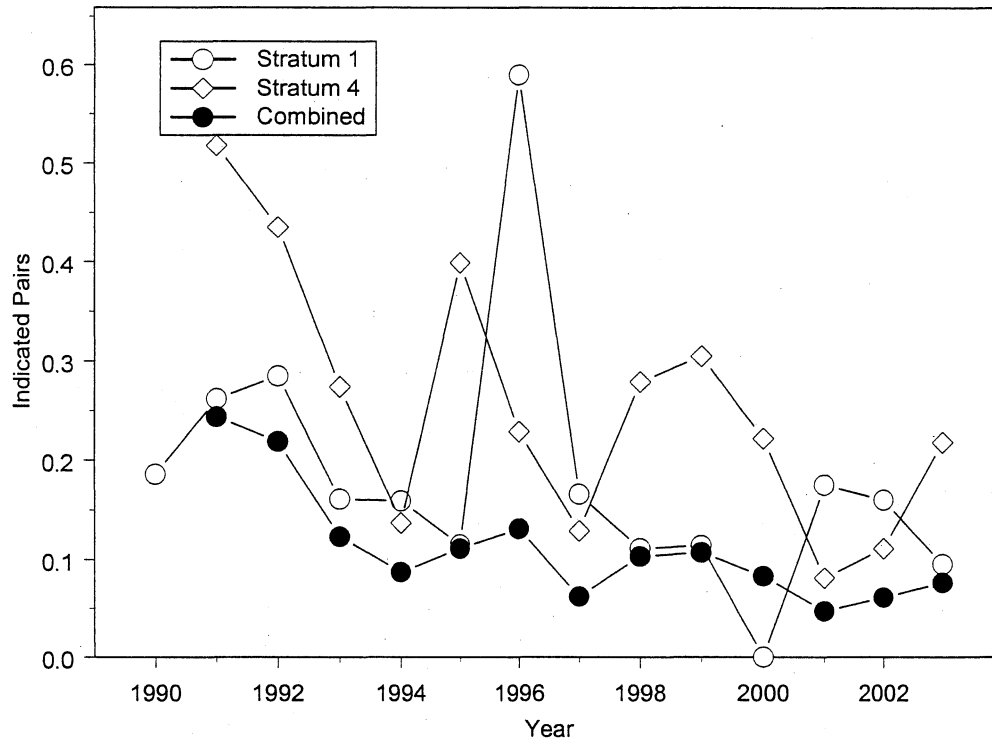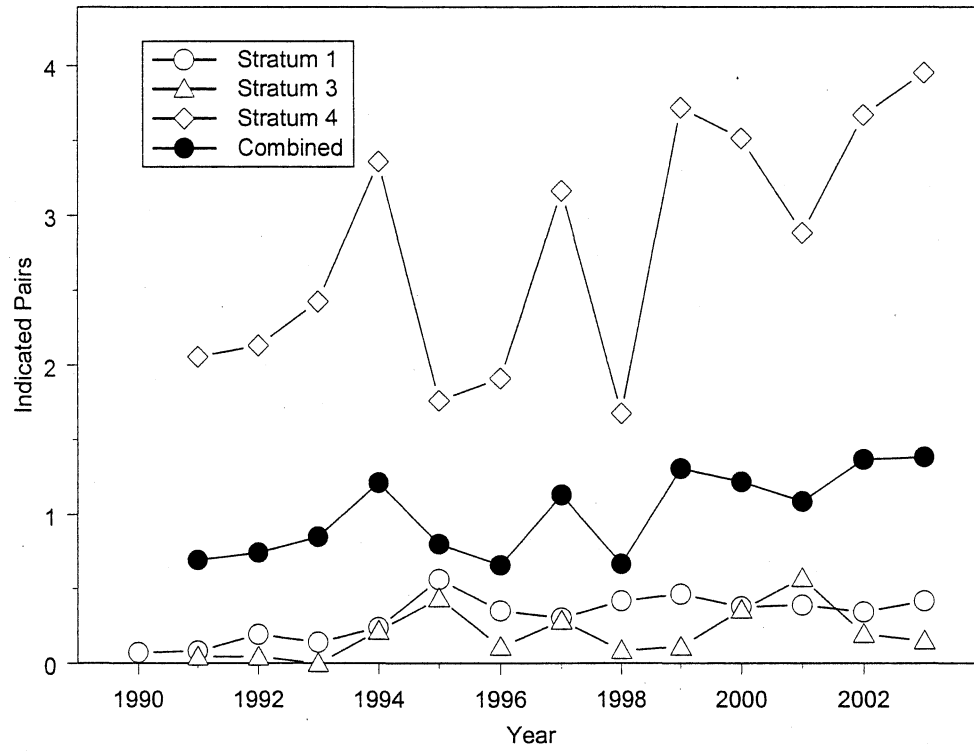
Figure 10 Indicated Pairs for Wood Duck

Figure 11 Indicated Pairs for Ring-necked Duck
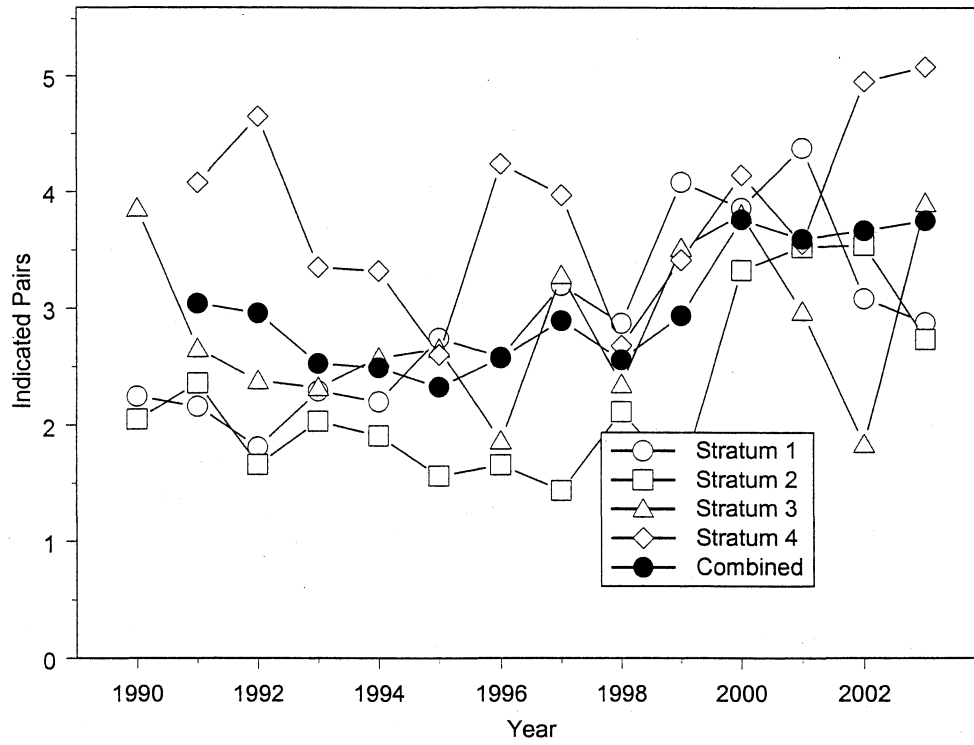
Figure 12 Indicated Pairs for Common Goldeneye
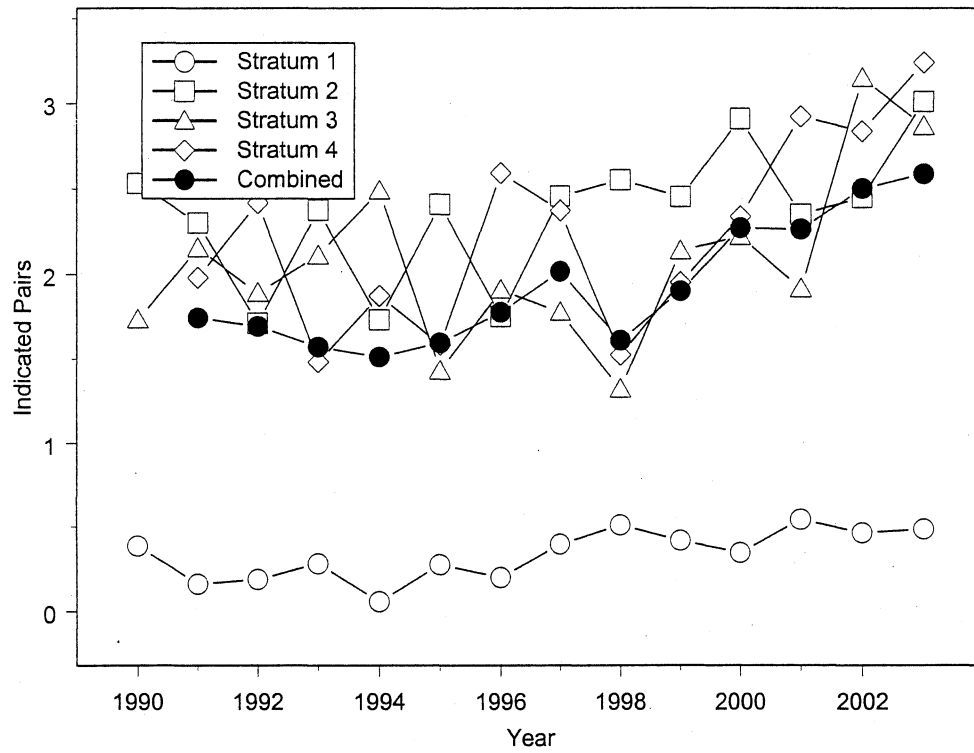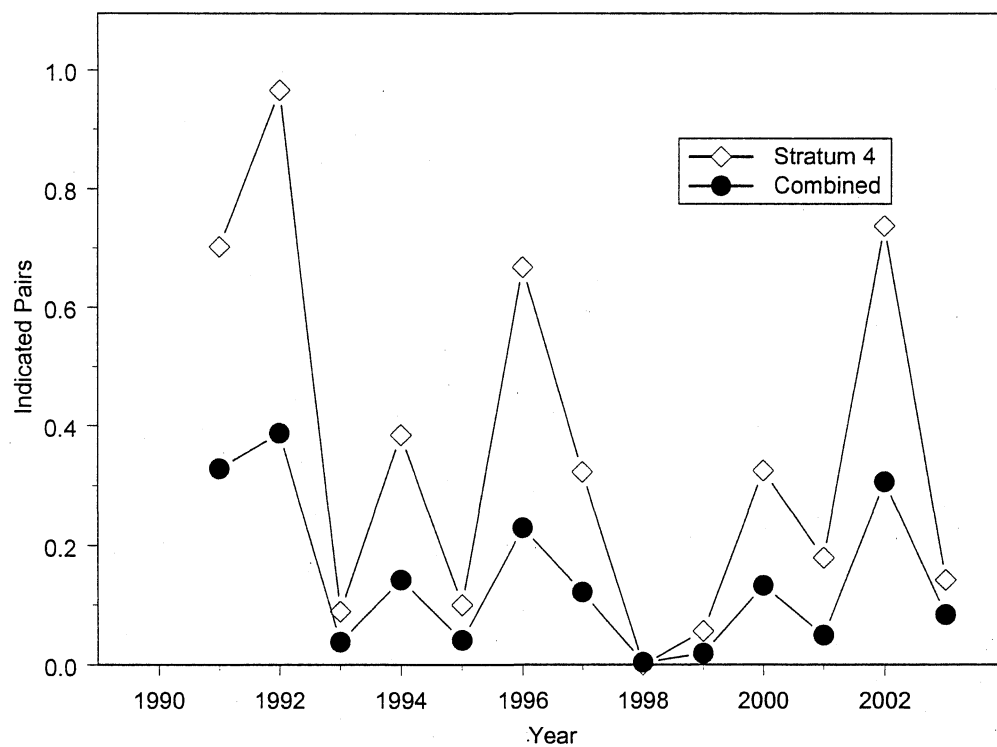
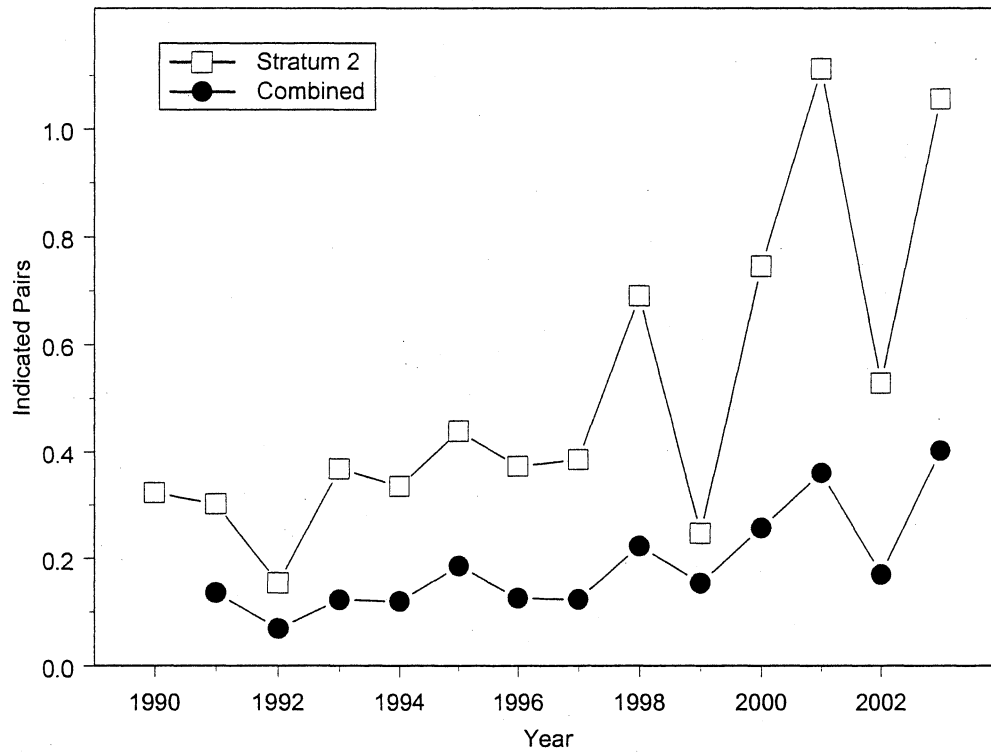Figure 13 Indicated Pairs for Bufflehead

Figure 14 Indicated Pairs for Surf Scoter

Figure 15 Indicated Pairs for Canada Goose