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Environment Canada	Environnement Canada
0022722F	SCF
CANADA. WILDLIFE SERVICE. PROGRESS NOTE	

Disponible également en français

No. 128, April 1982

Kill of Greater Snow Geese in Quebec, 1978-80

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Introduction

The population of Greater Snow Geese grew dramatically in the 1970s. When the population was smaller, almost all of it staged in the vicinity of Cap Tourmente National Wildlife Area (NWA). The importance of this area to the geese justified its establishment by CWS. In 1972 the population was large enough for the introduction of a controlled hunt at the NWA, and by 1978 substantial levels of hunting had developed in other areas away from the NWA.

Although the National Harvest Survey (NHS) run by CWS gave estimates of an increasing kill, we wanted to locate this kill on specific islands in the vicinity of the NWA. We also had an opportunity to study bias in questionnaire surveys by comparing the response with bag-check data from the NWA.

We conducted mail surveys in Quebec for the 1978-80 hunting seasons to determine the size and location of the annual kill of Greater Snow Geese, and compared the data from these surveys with kill estimates from the NHS and data from the controlled hunt at Cap Tourmente NWA.

Methods

Survey design

Each mail survey covered a stratified random sample of permit holders from the current year's Canada migratory game bird hunting (MGBH) permit sales. Since the sampling frame included only Quebec residents, we had to investigate out-of-province hunters through the national surveys.

The basis for stratification was the place of purchase of the permit, which defined three geographic categories and two hunting frequency categories: renewal and non-renewal (Fig. 1). (Hunters who purchased MGBH permits the previous year are termed "renewals"). Both of these factors have been found to affect kill in the NHS, and the data were readily available at sample selection time.

We defined the geographic strata and determined the optimal allocation of the sample among them by using the standard deviations of snow goose kill from the NHS in previous years.

Questionnaire design

The questionnaire asked respondents to assign their kill to one of seven zones (Fig. 2). These zones were designed primarily to locate kill along the St. Lawrence

estuary north of Quebec City, where the majority of Greater Snow Geese congregate during the fall migration.

Zone 2 included only the controlled hunt at Cap Tourmente NWA, but hunters not registered in this hunt often assigned their kill to this zone.

In the third year's survey (1980-81), we changed the questionnaire map slightly to try to reduce this source of error. Zone 2 was delineated by a small rectangle with the words "National Wildlife Area only" added to its caption.

Results

Sample allocation

To determine the gain in efficiency from using a stratified sample rather than a simple random sample, we compared harvest estimate variances with estimates of the variance that would have resulted from simple random sampling (Cochran 1977). Table 1 shows this comparison by zone of kill.

Because stratification usually increases the precision, we expected the estimated variances from simple random sampling to be larger than those from our surveys. For the most part this was true; however, there were some reversals of this tendency, as shown in Table 1.

It seemed that our allocation based on previous experience from the NHS was less than optimal for hunting zones 4 and 7. This indicates a shift in hunting practices in recent years that has changed the contributions of our survey strata to the variances. The allocations that would have been best in the years before our surveys were no longer optimal. To find out which strata were involved, we calculated a new allocation of our sample based on the variances obtained in these surveys for total kill throughout the province.

Table 2 shows the number of questionnaires mailed to each stratum on the basis of the original allocations, the number of responses received, total kill and days hunted reported, and the revised allocation. Stratum A and stratum C (1978-80) were the most conspicuously under-allocated.

The proportion of the harvest attributable to active respondents from each stratum sampled is shown in Table 3.

Response characteristics

Table 4 shows the number of hunters receiving questionnaires, the response rate, the number of MGBH permits sold, and the extrapolation factors used to calculate estimates for each year.

The response rate to the questionnaire averaged over 80% for all 3 years (Table 4). It fell below this only in stratum C. For the 1980 season, five times as many responses from this stratum would have been optimal, while in 1978 twice as many would have been

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Figure 1
Quebec Greater Snow Goose survey strata

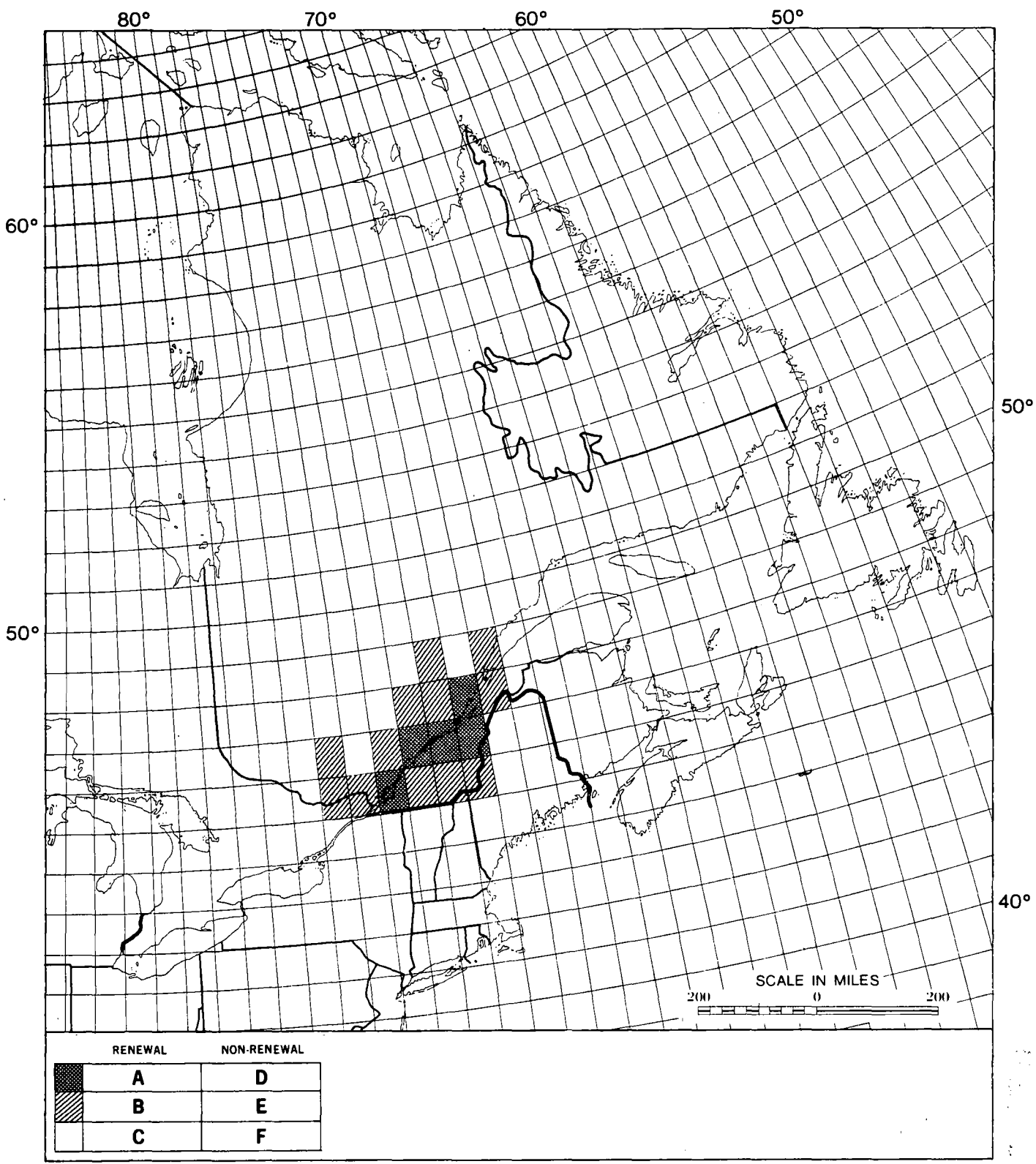


Figure 2
Zones of snow goose hunt (from 1980-81 survey form)

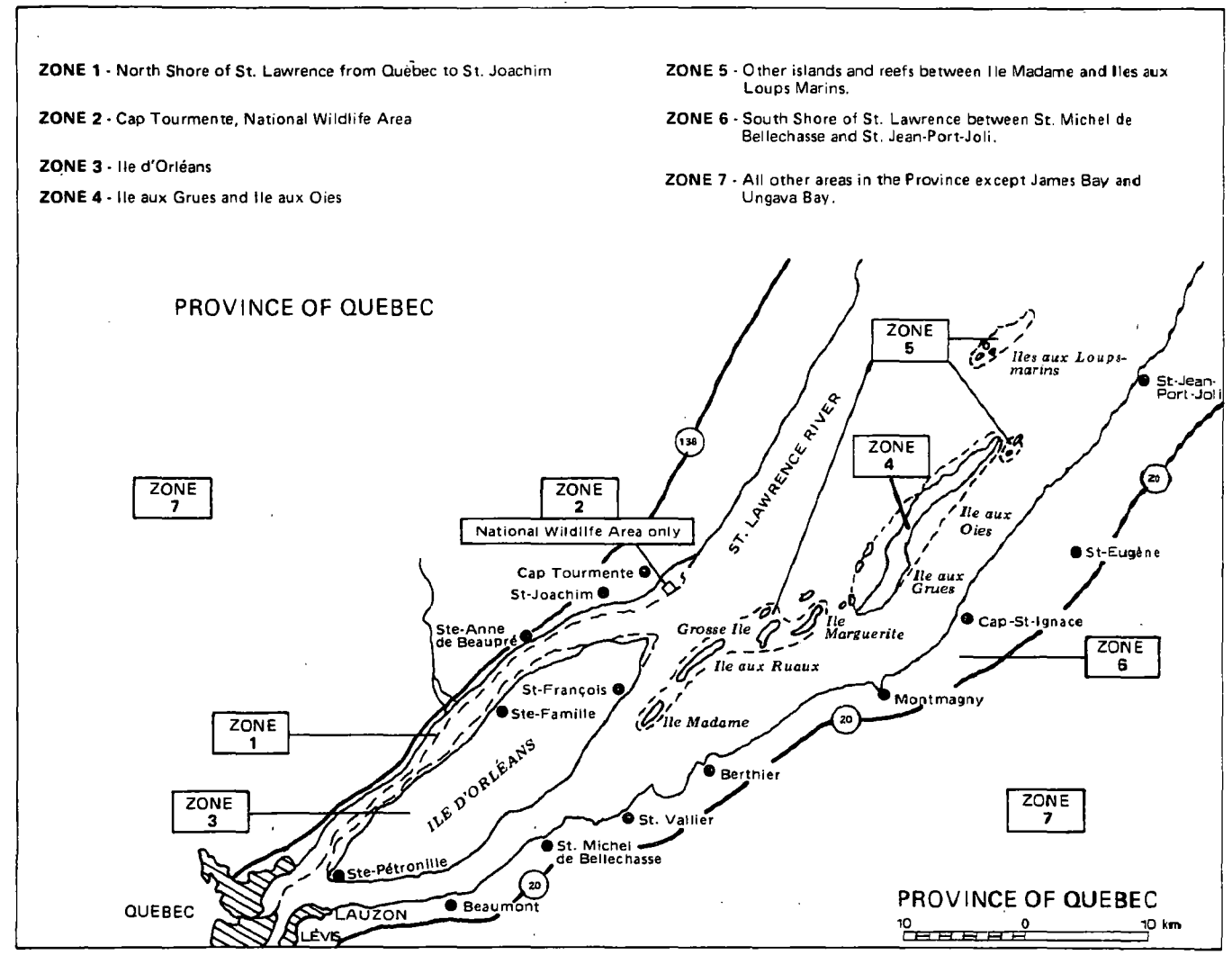


Table 1
Relative precision of stratified survey design to simple random sampling in calculation of kill and days hunted

Zone	Est. geese	Variances			Est. days	Variances		
		Strat.	Simple	%*		Strat.	Simple	%*
1980-81								
1	12 884	5.6E6†	7.3E6	132	10 139	2.6E6	3.2E6	127
2	2 426	3.6E5	4.1E5	114	813	3.2E4	3.7E4	118
3	4 159	1.3E6	1.8E6	134	3 679	7.5E5	1.0E6	135
4	19 363	1.4E7	7.5E6	54‡	5 513	8.0E5	6.2E5	78‡
5	2 477	6.1E5	7.2E5	119	750	5.3E4	6.7E4	125
6	14 410	4.4E6	5.8E6	130	12 331	2.8E6	3.6E6	126
7	15 312	6.7E6	6.8E6	102	25 645	1.3E7	9.5E5	71‡
Total	71 899	3.3E7	3.1E7	95‡	61 438	2.4E7	2.2E7	91‡
1979-80								
1	5 191	8.9E6	1.1E6	127	6 111	8.9E5	1.2E6	137
2	1 658	2.7E5	3.1E5	114	907	3.3E4	3.9E4	117
3	1 236	1.3E5	1.5E5	113	3 111	6.1E5	8.1E5	133
4	8 813	2.1E6	2.7E6	124	4 165	4.4E5	5.4E5	125
5	2 837	6.5E5	8.8E5	135	2 009	2.9E5	3.8E5	133
6	8 317	2.8E6	3.7E6	132	10 256	1.6E6	2.2E6	133
7	2 798	3.2E5	3.6E5	113	10 890	7.4E6	2.7E6	36‡
Total	31 830	7.5E6	9.5E6	128	39 109	1.2E7	8.2E6	71‡
1978-79								
1	8 794	2.7E6	3.5E6	132	7 098	1.7E6	2.0E6	120
2	4 316	6.7E5	8.2E5	122	1 491	6.5E4	8.1E4	125
3	1 988	3.5E5	4.7E5	134	1 948	2.3E5	3.1E5	134
4	9 166	2.3E6	2.9E6	127	3 793	5.5E5	7.2E5	131
5	2 199	3.3E5	4.5E5	138	1 032	8.9E4	1.2E5	134
6	9 949	5.0E6	5.9E6	118	10 160	2.0E6	2.5E6	122
7	6 010	1.7E6	7.9E5	46‡	16 121	3.5E7	6.0E6	17‡
Total	43 360	1.6E7	1.8E7	115	43 104	4.2E7	1.4E7	34‡

*Variances for simple/stratified sampling as %.

†E stands for exponentiation to the base 10: eg., 5.6E6 = 5.6 x 10⁶.

‡Reversal of tendency for estimated variances from simple random sampling to be larger than those in stratified surveys.

(no kill was reported from hunters in stratum C in 1979) (Table 2). Sampling in this stratum should have been greater both because of the changing pattern of snow-goose hunting (see results), and to accommodate the lower response rate from this group.

Response rates to the NHS in Quebec were 64% in 1980, 61% in 1979, and 70% in 1978 (Wendt and Hyslop 1981, 1980; Wendt *et al.* 1979). The higher response to this special survey may be due to the fact that the Greater Snow Goose is a species hunted almost exclusively in Quebec and is highly regarded in that province.

The number of active hunters responding to the questionnaires over the 3 years increased, as did the total number of respondents (Tables 3 and 4). This trend establishes that hunter activity is growing in response to the Greater Snow Goose populations.

Active hunters from stratum A, local to the birds' staging areas, contributed the highest proportion of the kill per hunter, and generally renewal hunters were more successful and spent more days hunting than non-renewal hunters in each geographic stratum (Table 3).

Harvest estimates

The estimated numbers of geese killed and days hunted, based on reported numbers and the extrapolation factors, are given by zone of hunt for each year in Table 5.

The harvest for the 3 years was centred in zones 4 and 6 (Fig. 2, Table 5). These two zones contributed 47% of the kill in 1980, 54% in 1979, and 44% in 1978.

The number of days devoted to the hunt was greatest in zone 7, followed by zone 6, with 62% of the days

hunted spent in zones 7 and 6 in 1980, 54% in 1979, and 61% in 1978. The controlled hunt at Cap Tourmente contributed 3%, 5%, and 10% of the kill in the 1980, 1979, and 1978 seasons respectively.

Table 6 compares the estimated numbers of geese killed with NHS estimates for the kill of Greater Snow Geese in Quebec. To ensure a standard definition for the NHS estimates, we included all non-Canada geese killed in Quebec away from known areas of Lesser Snow Goose migration. NHS estimates were within the confidence intervals for estimates from this survey each season: the values were 5-15% different.

The proportion of the NHS kill by hunters not resident in Quebec is also given (Table 6). Since they contributed only 1-3% of the total kill, we were justified in not including this group in our sampling frame.

Zone 2 correction

Hunters who stated on their questionnaires that they hunted in zone 2 (Cap Tourmente NWA), but whose names did not appear in the list of Cap Tourmente

registered guests, were reassigned to another zone. We placed them in either zone 1 (the zone immediately surrounding the NWA), or zone 7 (the remainder of the province not included in zones 1 to 6) if they had also hunted in zone 1.

The number of hunters that this correction was made for and their estimated harvest are reported in Table 7. Changing the questionnaire to improve the identification of zone 2 seems to have had the desired effect of reducing the number of errors. The percentage of the harvest wrongly assigned to this zone decreased to only 5% in 1980-81 from 10-13% in 1978-79.

Zone 2 bag-check comparison

We determined the number of geese harvested at the Cap Tourmente controlled hunt by a bag-check and compared them with the corrected estimates of the zone 2 harvest (Table 8). Although the estimates differed from 9-48%, all bag-check totals were within the confidence limits for the survey estimates except in one case (days hunted in 1978-79).

Table 2
Hypothetical sample allocation revised on the basis of variances from this survey

Stratum (residence of hunter)	Original allocation	No. of responses	Reported		Optimal no. responses	%*
			Kill	Days		
1980-81						
A	1925	1663	2659	1858	2019	121
B	700	595	279	437	410	69
C	60	47	24	19	237	504
D	555	481	346	292	229	48
E	200	183	74	139	123	67
F	60	49	0	2	0	0
Total	3500	3018	3382	2747	3018	—
1979-80						
A	1925	1613	1273	1311	2076	129
B	700	582	129	172	467	80
C	60	46	0	12	0	0
D	555	473	179	313	246	52
E	200	170	17	37	104	61
F	60	51	5	7	42	82
Total	3500	2935	1603	1852	2935	—
1978-79						
A	1925	1595	1504	1165	1774	111
B	700	566	226	253	640	113
C	60	43	5	28	91	212
D	555	462	305	289	312	68
E	200	164	7	21	30	18
F	60	48	6	24	31	65
Total	3500	2878	2053	1780	2878	—

*Optimal response as percent of actual response.

Table 3
Proportional harvest by stratum

Stratum	No. active respondents	Reported kill	% total	% kill/active respondent	Reported hunting days	% total	% days/active respondent
1980-81							
A	347	2659	78.62	0.23	1858	67.64	0.19
B	64	279	8.25	0.13	437	15.91	0.25
C	6	24	0.71	0.12	19	0.69	0.12
D	83	346	10.23	0.12	292	10.63	0.13
E	24	74	2.19	0.09	139	5.06	0.21
F	1	0	0.00	0.00	2	0.07	0.07
Total	525	3382	100	0.19	2747	100	0.19
1979-80							
A	291	1273	79.41	0.27	1311	70.79	0.24
B	44	129	8.05	0.18	172	9.29	0.21
C	1	0	0.00	0.00	12	0.65	0.65
D	84	179	11.17	0.13	313	16.90	0.20
E	11	17	1.06	0.10	37	2.00	0.18
F	3	5	0.31	0.10	7	0.38	0.13
Total	434	1603	100	0.23	1852	100	0.23
1978-79							
A	251	1504	73.26	0.29	1165	64.45	0.26
B	47	226	11.01	0.23	253	14.21	0.30
C	1	5	0.24	0.24	28	1.57	1.57
D	73	305	14.86	0.20	289	16.24	0.22
E	6	7	0.34	0.06	21	1.18	0.20
F	3	6	0.29	0.10	24	1.35	0.45
Total	381	2053	100	0.26	1780	100	0.26

Discussion

The total kill for the three seasons (Table 5) shows an increase in keeping with the trend for both Canadian and American harvests over several years (Reed *et al.* 1981). Canadian kill accounted for 23.9% of the estimated fall flight in 1980, 14.5% in 1979, and 18% in 1978 (fall flight estimates from Reed, pers. comm.). The combined Canadian and US sport harvest took 32.8% of the population in 1980, 22% in 1979, and 25% in 1978. These are significant proportions of the total population. Reed *et al.* (1981) estimated an average recruitment rate of about 24%.

The close correspondence of total kill estimates in our surveys to comparable NHS estimates indicates that the NHS performs well in provincial estimates for this species (Table 6). But when we tried to use NHS results for small areas, we found that we could not separate fine geographic divisions as well as in this survey. For example, we could not reliably separate zone 3 (L'Île d'Orleans) from zone 1 in the national survey data. When intricate results such as this are required, special surveys must be used.

Acknowledgements

Among the many people who helped or gave advice for these surveys, we especially thank A. Reed, G.E.J. Smith, F.G. Cooch, H. Boyd, F. Fillion, and L. Teevens.

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Table 4
Sampling response to Quebec Greater Snow Goose survey by stratum

Stratum	Quest. mailed	Quest. ret.	% resp.	Permit sales	Extrap. factor
1980-81					
A	1 925	1 663	86	31 774	19.118
B	700	595	85	17 511	29.430
C	60	47	78	9 397	199.936
D	555	481	87	8 098	16.836
E	200	183	92	5 514	30.131
F	60	49	82	3 739	76.306
Total	3 500	3 018	86	76 033*	—
1979-80					
A	1 925	1 613	84	30 871	19.139
B	700	582	83	17 194	29.543
C	60	46	77	9 175	199.457
D	555	473	85	7 446	15.742
E	200	170	85	4 896	28.800
F	60	51	85	3 547	69.549
Total	3 500	2 935	84	73 129*	—
1978-79					
A	1 925	1 595	83	31 267	19.603
B	700	566	81	16 718	29.537
C	60	43	72	8 741	203.279
D	555	462	83	7 939	17.184
E	200	164	82	5 149	31.396
F	60	48	80	3 749	78.104
Total	3 500	2 878	82	73 563*	—

*Totals do not include a limited number of permit sales not assigned to any stratum.

Table 5
Estimated harvest by zone, 1978-80

Zone	Kill est.	Rank order*	95% conf. interval	Est. no. days hunt.	Rank order*	95% conf. interval
1980-81						
1	12 884	4	8 256-17 511	10 139	3	6 962-13 316
2	2 426	7	1 257- 3 594	813	6	464- 1 162
3	4 159	5	1 918- 6 401	3 679	5	1 980- 5 379
4	19 363	1	12 071-26 656	5 513	4	3 759- 7 267
5	2 477	6	951- 4 005	750	7	296- 1 203
6	14 410	3	10 283-18 538	12 331	2	9 024-15 637
7	15 312	2	10 232-20 393	25 645	1	18 506-32 781
Total	71 899†		60 637-83 161	61 438†		51 848-71 027
1979-80						
1	5 191	3	3 324- 7 026	6 111	3	4 250- 7 940
2	1 658	6	634- 2 684	907	7	511- 1 227
3	1 236	7	530- 1 942	3 111	5	1 580- 4 642
4	8 813	1	5 946-11 680	4 165	4	3 343- 5 931
5	2 837	4	1 255- 4 418	2009	6	962- 3 057
6	8 317	2	5 039-11 594	10 256	2	7 758-12 754
7	2 798	5	1 694- 3 902	10 890	1	5 580-16 231
Total	31 830†		26 476-37 184	39 109†		32 378-45 714
1978-79						
1	8 794	3	6 169-12 596	7 098	3	4 792- 9 911
2	4 316	5	2 908- 6 117	1 491	6	1 162- 2 159
3	1 988	7	830- 3 146	1 948	5	1 011- 2 886
4	9 166	2	6 187-12 145	3 793	4	2 337- 5 248
5	2 199	6	1 076- 3 322	1 032	7	448- 1 616
6	9 949	1	5 574-14 324	10 160	2	7 361-12 959
7	6 010	4	2 596- 7 736	16 121	1	3 802-27 144
Total	43 360†		35 282-50 927	43 104†		30 761-56 244

*Order of magnitude from largest to smallest for comparative purposes.

†Totals are greater than the sum of the zone totals because zone of hunt was not specified on some questionnaires.

Table 6
Comparison of kill estimates with National Harvest Survey estimates

	1980-81		1979-80		1978-79	
	Kill	Confidence interval	Kill	Confidence interval	Kill	Confidence interval
Total kill estimate for all zones	71 899	60 637-83 161	31 830	26 476-37 184	43 360	35 282-50 927
NHS estimated Greater Snow Goose kill in Quebec	61 862	—	34 095	—	40 339	—
Kill in Quebec by non-resident hunters (NHS estimates)	788	—	267	—	1 432	—
%*	116	—	93	—	107	—

*Estimates from this survey as % of NHS estimates.

Table 7
Zone 2 hunt reassigned to zones 1 and 7

Season	No. hunters	Geese killed	% total*	Est. no. geese	% total†	Days hunted	% total*	Est. no. days	% total†
1980-81	37	181	5*	3473	5	150	5	2867	5
1979-80	51	128	8	2645	8	142	13	2850	7
1978-79	49	257	13	5227	12	162	10	3207	7

*% of reported harvest for all respondents.

†% of estimated harvest for all respondents.

Table 8
Comparison of Cap Tourmente bag-check data with zone 2 estimates

Season	Goose harvest				Days hunted			
	Active hunters	Bag-check	Zone 2	Confidence interval %*	Bag-check	Zone 2	Confidence interval %*	
1980-81	469	2170	2426	1257-3594 112	938	813	464-1162 87	
1979-80	425	1193	1658	634-2684 139	832	907	511-1227 109	
1978-79	505	3231	4316	2908-6117 134	1010	1491	1162-2159 148	

*Estimate from this survey as a percent of bag-check data.

